PROJECT MANUAL

for:

NOVANT ASC LELAND
9151 OCEAN HIGHWAY E
LELAND, NC 28451
CONSTRUCTION DOCUMENTS
VOLUME 2

1721843900

SEPTEMBER 15, 2023

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SECTION 00 01 07 - SEALS PAGE

This section includes the Professional Seals by Design Professionals and others responsible for preparing the Construction Documents.

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NOVANT ASC LELAND
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A. Refer to Section 22 0700 for requirements.

END OF SECTION 210700

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SECTION 211313 - WET-PIPE SPRINKLER SYSTEM

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Sprinklers.
4. Alarm devices.
5. Pressure gages.

1.02 DEFINITIONS

A. Standard-Pressure Sprinkler Piping: Wet-pipe sprinkler system piping designed to operate at working pressure of 175 psig maximum.

1.03 SYSTEM DESCRIPTIONS

A. Wet-Pipe Sprinkler System: Automatic sprinklers are attached to piping containing water and that is connected to water supply through alarm valve. Water discharges immediately from sprinklers when they are opened. Sprinklers open when heat melts fusible link or destroys frangible device. Hose connections are included if indicated.

1.04 PERFORMANCE REQUIREMENTS

A. Standard-Pressure Piping System Component: Listed for 175-psig minimum working pressure.

B. Delegated Design: Design sprinkler system(s), including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

C. Sprinkler system design shall be approved by authorities having jurisdiction.

1. Margin of Safety for Available Water Flow and Pressure: 10 percent, including losses through water-service piping, valves, and backflow preventers.
2. Sprinkler Occupancy Hazard Classifications:
    a. Building Service Areas: Ordinary Hazard, Group 1.
    b. Electrical Equipment Rooms: Ordinary Hazard, Group 1.
    c. General Storage Areas: Ordinary Hazard, Group 1.
    d. Mechanical Equipment Rooms: Ordinary Hazard, Group 1.

e. Office and Public Areas: Light Hazard.

f. Residential Living Areas: Light Hazard.

g. Restaurant Service Areas: Ordinary Hazard, Group 1.

3. Minimum Density for Automatic-Sprinkler Piping Design:

a. Light-Hazard Occupancy: 0.10 gpm over 1500-sq. ft. area.

b. Ordinary-Hazard, Group 1 Occupancy: 0.15 gpm over 1500-sq. ft. area.

4. Maximum Protection Area per Sprinkler: Per UL listing.

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

a. Light-Hazard Occupancies: 100 gpm for 30 minutes.

b. Ordinary-Hazard Occupancies: 250 gpm for 60 to 90 minutes.

D. Seismic Performance: Sprinkler piping shall withstand the effects of earthquake motions determined according to NFPA 13 and ASCE/SEI 7.

1.05 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

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

C. Delegated-Design Submittal: For sprinkler systems indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.06 INFORMATIONAL SUBMITTALS

A. Shop Drawings: For wet-pipe sprinkler systems. Include plans, elevations, sections, details, and attachments to other work.

1. Wiring Diagrams: For power, signal, and control wiring.

B. Qualification Data: For qualified Installer and NICET Level III/IV Designer..

C. Fire-hydrant flow test report.

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

E. Field quality-control reports.

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

1.07 QUALITY ASSURANCE

A. Installer Qualifications:

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

a. Engineering Responsibility: Preparation of working plans, calculations, and field test reports by a NICET Level III/IV Designer.

B. Welding Qualifications: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. NFPA Standards: Sprinkler system equipment, specialties, accessories, installation, and testing shall comply with the following:

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

E. Owner’s Insurance Company: Comply with the design and installation requirements of the Owner’s current insurance company.

1.08 COORDINATION

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

1.09 EXTRA MATERIALS

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

1. Sprinkler Cabinets: Finished, wall-mounted, steel cabinet with hinged cover, and 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 used on Project.

PART 2 -PRODUCTS

2.01 PIPING MATERIALS

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

2.02 STEEL PIPE AND FITTINGS

A. Standard Weight, Galvanized- and Black-Steel Pipe: ASTM A 53/A 53M, Type E, Grade B. Pipe ends may be factory or field formed to match joining method.

B. Schedule 10, Black-Steel Pipe: ASTM A 135 or ASTM A 795/A 795M, Schedule 10 in NPS 5 and smaller; and NFPA 13-specified wall thickness in NPS 6 to NPS 10, plain end.

C. Black-Steel Pipe Nipples: ASTM A 733, made of ASTM A 53/A 53M, standard-weight, seamless steel pipe with threaded ends.

D. Galvanized and Uncoated, Steel Couplings: ASTM A 865, threaded.

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

F. Malleable- or Ductile-Iron Unions: UL 860.

G. Cast-Iron Flanges: ASME 16.1, Class 125.

H. Steel Flanges and Flanged Fittings: ASME B16.5, Class 150.

I. Steel Welding Fittings: ASTM A 234/A 234M and ASME B16.9.

J. Grooved-Joint, Steel-Pipe Appurtenances:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.

b. Tyco Fire & Building Products LP.

c. Victaulic Company.

2. Pressure Rating: 175 psig minimum.

3. Galvanized and Uncoated, Grooved-End Fittings for Steel Piping: ASTM A 47/A 47M, malleable-iron casting or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.

4. Grooved-End-Pipe Couplings for Steel Piping: AWWA C606 and UL 213, rigid pattern, unless otherwise indicated, for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gasket, and bolts and nuts.

2.03 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

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

C. Wrought-Copper, Solder-Joint Fittings: ASME B16.22, pressure fittings.

D. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

E. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

2.04 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free.

1. Class 125, Cast-Iron Flanges and Class 150, Bronze Flat-Face Flanges: Full-face gaskets.

2. Class 250, Cast-Iron Flanges and Class 300, Steel Raised-Face Flanges: Ring-type gaskets.

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

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

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

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

2.05 LISTED FIRE-PROTECTION VALVES

A. General Requirements:

1. Valves shall be UL listed or FM approved.

2. Minimum Pressure Rating for Standard-Pressure Piping: 175 psig.

3. Minimum Pressure Rating for High-Pressure Piping: 250 psig.

B. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.

b. Victaulic Company.

2. Standard: UL 1091 except with ball instead of disc.

3. Valves NPS 1-1/2 and Smaller: Bronze body with threaded ends.

4. Valves NPS 2 and NPS 2-1/2: Bronze body with threaded ends or ductile-iron body with grooved ends.

5. Valves NPS 3: Ductile-iron body with grooved ends.

C. Bronze Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Fivalco Inc.

b. Global Safety Products, Inc.

c. Milwaukee Valve Company.

2. Standard: UL 1091.

3. Pressure Rating: 175 psig.

4. Body Material: Bronze.

5. End Connections: Threaded.

D. Iron Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.

b. Fivalco Inc.

c. Global Safety Products, Inc.

d. Kennedy Valve; a division of McWane, Inc.

e. Milwaukee Valve Company.

f. NIBCO INC.

g. Shurjoint Piping Products.

h. Tyco Fire & Building Products LP.

i. Victaulic Company.

2. Standard: UL 1091.

3. Pressure Rating: 175 psig.

4. Body Material: Cast or ductile iron.

5. Style: Lug or wafer.

6. End Connections: Grooved.

E. Check Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.

b. Crane Co.; Crane Valve Group; Crane Valves.

c. Crane Co.; Crane Valve Group; Stockham Division.

d. Fivalco Inc.

e. Kennedy Valve; a division of McWane, Inc.

f. Milwaukee Valve Company.

g. NIBCO INC.

h. Potter Roemer.

i. Reliable Automatic Sprinkler Co., Inc.

j. Shurjoint Piping Products.

k. Tyco Fire & Building Products LP.

l. Victaulic Company.

m. Viking Corporation.

n. Watts Water Technologies, Inc.

2. Standard: UL 312.

3. Pressure Rating: 250 psig minimum.

4. Type: Swing check.

5. Body Material: Cast iron.

6. End Connections: Flanged or grooved.

F. Bronze OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.

b. Crane Co.; Crane Valve Group; Stockham Division.

c. Milwaukee Valve Company.

d. NIBCO INC.

e. United Brass Works, Inc.

2. Standard: UL 262.

3. Pressure Rating: 175 psig.

4. Body Material: Bronze.

5. End Connections: Threaded.

G. Iron OS&Y Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Crane Valves.

b. Crane Co.; Crane Valve Group; Stockham Division.

c. Milwaukee Valve Company.

d. NIBCO INC.

e. Shurjoint Piping Products.

f. Tyco Fire & Building Products LP.

g. United Brass Works, Inc.

h. Watts Water Technologies, Inc.

2. Standard: UL 262.

3. Pressure Rating: 250 psig minimum.

4. Body Material: Cast or ductile iron.

5. End Connections: Flanged or grooved.

H. Indicating-Type Butterfly Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.

b. Fivalco Inc.

c. Kennedy Valve; a division of McWane, Inc.

d. Milwaukee Valve Company.

e. NIBCO INC.

f. Shurjoint Piping Products.

g. Tyco Fire & Building Products LP.

h. Victaulic Company.

2. Standard: UL 1091.

3. Pressure Rating: 175 psig minimum.

4. Valves NPS 2 and Smaller:

a. Valve Type: Ball or butterfly.

b. Body Material: Bronze.

c. End Connections: Threaded.

5. Valves NPS 2-1/2 and Larger:

a. Valve Type: Butterfly.

b. Body Material: Cast or ductile iron.

c. End Connections: Flanged, grooved, or wafer.

6. Valve Operation: Integral electrical, 115-V ac, prewired, single-circuit, supervisory switch indicating device.

I. NRS Gate Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Stockham Division.

b. NIBCO INC.

c. Tyco Fire & Building Products LP.

2. Standard: UL 262.

3. Pressure Rating: 250 psig minimum.

4. Body Material: Cast iron with indicator post flange.

5. Stem: Nonrising.

6. End Connections: Flanged or grooved.

J. Indicator Posts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Crane Co.; Crane Valve Group; Stockham Division.

b. Kennedy Valve; a division of McWane, Inc.

c. NIBCO INC.

d. Tyco Fire & Building Products LP.

2. Standard: UL 789.

3. Type: Horizontal for wall mounting.

4. Body Material: Cast iron with extension rod and locking device.

5. Operation: Wrench.

2.06 AIR COMPRESSORS:

A. Manufacturers:

1. General Air Products

2. Reliable Sprinkler

3. United Fire Systems

B. Compressor: Single unit, riser mount, electric motor driven, motor, motor starter, safety valves, check valves, air maintenance device incorporating electric pressure switch and unloader valve.

C. Electrical characteristics: 120 volt, single phase, 60 hz.

2.07 TRIM AND DRAIN VALVES

A. General Requirements:

1. Standard: UL`s "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

2. Pressure Rating: 175 psig minimum.

B. Angle Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Fire Protection Products, Inc.

b. United Brass Works, Inc.

C. Ball Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.

b. Conbraco Industries, Inc.; Apollo Valves.

c. Kennedy Valve; a division of McWane, Inc.

d. Milwaukee Valve Company.

e. NIBCO INC.

f. Potter Roemer.

g. Tyco Fire & Building Products LP.

h. Victaulic Company.

i. Watts Water Technologies, Inc.

2.08 SPECIALTY VALVES

A. General Requirements:

1. Standard: UL`s "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

2. Pressure Rating:

a. Standard-Pressure Piping Specialty Valves: 175 psig minimum.

3. Body Material: Cast or ductile iron.

4. Size: Same as connected piping.

5. End Connections: Flanged or grooved.

B. Preaction Valves

1. Operated by detection system listed for releasing service and independent of building fare alarm system with provisions for local, and manual releases.

2. Incorporate mechanical latching mechanicsm incorporating valve clappers independent of system water pressure fluctuations.

3. Provide test detection device for each actuation circuit adjacent to each controlled valve in accordance with NFPA 13

4. Manufacturers:

a. Viking Corporation

b. Potter Roemer

C. Alarm Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Reliable Automatic Sprinkler Co., Inc.

b. Tyco Fire & Building Products LP.

c. Venus Fire Protection Ltd.

d. Victaulic Company.

e. Viking Corporation.

2. Standard: UL 193.

3. Design: For horizontal or vertical installation.

4. Include trim sets for bypass, drain, electrical sprinkler alarm switch, pressure gages, retarding chamber, and fill-line attachment with strainer.

5. Drip Cup Assembly: Pipe drain with check valve to main drain piping.

D. Automatic (Ball Drip) Drain Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AFAC Inc.

b. Reliable Automatic Sprinkler Co., Inc.

c. Tyco Fire & Building Products LP.

2. Standard: UL 1726.

3. Pressure Rating: 175 psig minimum.

4. Type: Automatic draining, ball check.

5. Size: NPS 3/4.

6. End Connections: Threaded.

2.09 FIRE-DEPARTMENT CONNECTIONS

A. Exposed-Type, Fire-Department Connection:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elkhart Brass Mfg. Company, Inc.

b. Fire Protection Products, Inc.

c. GMR International Equipment Corporation.

d. Guardian Fire Equipment, Inc.

e. Potter Roemer.

f. Tyco Fire & Building Products LP.

2. Standard: UL 405.

3. Type: Exposed, projecting, for wall mounting.

4. Pressure Rating: 175 psig minimum.

5. Body Material: Corrosion-resistant metal.

6. Inlets: Brass with threads according to NFPA 1963 and matching local fire-department sizes and threads. Include extension pipe nipples, brass lugged swivel connections, and check devices or clappers.

7. Caps: Brass, lugged type, with gasket and chain.

8. Escutcheon Plate: Round, brass, wall type.

9. Outlet: Back, with pipe threads.

10. Number of Inlets: Two.

11. Escutcheon Plate Marking: Similar to "AUTO SPKR & STANDPIPE."

12. Finish: Polished chrome plated.

13. Outlet Size: NPS 4.

2.10 SPRINKLER SPECIALTY PIPE FITTINGS

A. Branch Outlet Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Anvil International, Inc.

b. National Fittings, Inc.

c. Shurjoint Piping Products.

d. Tyco Fire & Building Products LP.

e. Victaulic Company.

2. Standard: UL 213.

3. Pressure Rating: 175 psig minimum.

4. Body Material: Ductile-iron housing with EPDM seals and bolts and nuts.

5. Type: Mechanical-T and -cross fittings.

6. Configurations: Snap-on and strapless, ductile-iron housing with branch outlets.

7. Size: Of dimension to fit onto sprinkler main and with outlet connections as required to match connected branch piping.

8. Branch Outlets: Grooved, plain-end pipe, or threaded.

B. Flow Detection and Test Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AGF Manufacturing Inc.

b. Reliable Automatic Sprinkler Co., Inc.

c. Tyco Fire & Building Products LP.

d. Victaulic Company.

2. Standard: UL`s "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

3. Pressure Rating: 175 psig minimum.

4. Body Material: Cast- or ductile-iron housing with orifice, sight glass, and integral test valve.

5. Size: Same as connected piping.

6. Inlet and Outlet: Threaded.

C. Branch Line Testers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Elkhart Brass Mfg. Company, Inc.

b. Fire-End & Croker Corporation.

c. Potter Roemer.

2. Standard: UL 199.

3. Pressure Rating: 175 psig.

4. Body Material: Brass.

5. Size: Same as connected piping.

6. Inlet: Threaded.

7. Drain Outlet: Threaded and capped.

8. Branch Outlet: Threaded, for sprinkler.

D. Sprinkler Inspector`s Test Fittings:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AGF Manufacturing Inc.

b. Triple R Specialty.

c. Tyco Fire & Building Products LP.

d. Victaulic Company.

e. Viking Corporation.

2. Standard: UL`s "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.

3. Pressure Rating: 175 psig minimum.

4. Body Material: Cast- or ductile-iron housing with sight glass.

5. Size: Same as connected piping.

6. Inlet and Outlet: Threaded.

2.11 SPRINKLERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AFAC Inc.
2. Globe Fire Sprinkler Corporation.
3. Reliable Automatic Sprinkler Co., Inc.
4. Tyco Fire & Building Products LP.
5. Venus Fire Protection Ltd.
6. Victaulic Company.
7. Viking Corporation.

B. General Requirements:

1. Standard: UL`s "Fire Protection Equipment Directory" listing or "Approval Guide," published by FM Global, listing.
2. Pressure Rating for Automatic Sprinklers: 175 psig minimum.

C. Automatic Sprinklers with Heat-Responsive Element:

1. Early-Suppression, Fast-Response Applications: UL 1767.
2. Nonresidential Applications: UL 199.
3. Characteristics: Nominal 1/2-inch orifice with Discharge Coefficient K of 5.6, and for "Ordinary" temperature classification rating unless otherwise indicated or required by application.

D. Sprinkler Escutcheons: Materials, types, and finishes for the following sprinkler mounting applications. Escutcheons for concealed, flush, and recessed-type sprinklers are specified with sprinklers.

1. Ceiling Mounting: Chrome-plated steel, one piece, flat.
2. Sidewall Mounting: Chrome-plated steel, one piece, flat.

E. Sprinkler Guards:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Reliable Automatic Sprinkler Co., Inc.
   b. Tyco Fire & Building Products LP.
   c. Victaulic Company.
   d. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.12 ALARM DEVICES

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

B. Coordinate with Electrical. This is often provided by Fire Alarm Contractor.

C. Electrically Operated Alarm Bell:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Fire-Lite Alarms, Inc.; a Honeywell company.

b. Notifier; a Honeywell company.

c. Potter Electric Signal Company.

2. Standard: UL 464.

3. Type: Vibrating, metal alarm bell.

4. Size: 6-inch minimum diameter.

5. Finish: Red-enamel factory finish, suitable for outdoor use.

D. Water-Flow Indicators:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ADT Security Services, Inc.

b. McDonnell & Miller; ITT Industries.

c. Potter Electric Signal Company.

d. System Sensor; a Honeywell company.

e. Viking Corporation.

f. Watts Industries (Canada) Inc.

2. Standard: UL 346.

3. Water-Flow Detector: Electrically supervised.

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

5. Type: Paddle operated.

6. Pressure Rating: 250 psig.

7. Design Installation: Horizontal or vertical.

E. Pressure Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. AFAC Inc.
    b. Barksdale, Inc.
    c. Detroit Switch, Inc.
    d. Potter Electric Signal Company.
    e. System Sensor; a Honeywell company.
    f. Tyco Fire & Building Products LP.
    g. United Electric Controls Co.
    h. Viking Corporation.
2. Standard: UL 346.
3. Type: Electrically supervised water-flow switch with retard feature.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design Operation: Rising pressure signals water flow.

F. Valve Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Fire-Lite Alarms, Inc.; a Honeywell company.
    b. Kennedy Valve; a division of McWane, Inc.
    c. Potter Electric Signal Company.
    d. System Sensor; a Honeywell company.
2. Standard: UL 346.
3. Type: Electrically supervised.
4. Components: Single-pole, double-throw switch with normally closed contacts.
5. Design: Signals that controlled valve is in other than fully open position.

G. Indicator-Post Supervisory Switches:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Potter Electric Signal Company.
    b. System Sensor; a Honeywell company.

2. Standard: UL 346.

3. Type: Electrically supervised.

4. Components: Single-pole, double-throw switch with normally closed contacts.

5. Design: Signals that controlled indicator-post valve is in other than fully open position.

2.13 PREACTION CONTROL PANELS

A. Provide a modular type control panel for electrically operated detection and extinguishing systems for each preaction valve.

1. Factory mount in surface mounted, steel cabinet with hinged doors, and cylinder lock.

2. Provide factory wired assembly containing components and equipment as required to perform specified system operating and supervisory functions.

3. Include isolation switch to allow system testing without activation of the preaction valve.

4. House batteries in separate and lockable, steel cabinet.

5. Finish interior and exterior of cabinet with enamel paint and provide identification plate in accordance with section 220553.

6. Include trouble lights and trouble alarm to be integrated to alarm at a monitored location.

7. Provide 120 volt, single phase service transformed through a two-winding, isolation type transformer and rectified to low voltage DC for operation of all system actualting, signal sounding, trouble signal, and fire alarm tripping circuits.

B. Secondary Power Supply

1. Provide nickel cadmium, lead calcium, or sealed lead acid rechargeable storage batteries and battery charger.

2. Storage Batteries:

a. Provide with sufficient ampere-hour rating to operate under supervisory and trouble conditions, including audible trouble signal devices under alarm conditions for an additional 10 minutes and as required in accordance with the equipment listing.

b. Prevent contact between terminals of adjacent cells, battery terminals, and other metal parts with separate cell construction.

3. Battery Charger

a. Provide solid-state automatic two rate type, capable of recharging completely discharged batteries to fully charged condition in 24 hours or less.

b. Locate charger within control panel or battery cabinet.

2.14 MANUAL CONTROL STATIONS

A. Description: UL listed or FM approved, hydraulic operation, with union, NPS 1/2 pipe nipple, and bronze ball valve. Include metal enclosure labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.15 CONTROL PANELS

A. Description: Single-area, two-area, or single-area cross-zoned control panel as indicated, including NEMA ICS 6, Type 1 enclosure, detector, alarm, and solenoid-valve circuitry for operation of deluge valves. Panels contain power supply; battery charger; standby batteries; field-wiring terminal strip; electrically supervised solenoid valves and polarized fire-alarm bell; lamp test facility; single-pole, double-throw auxiliary alarm contacts; and rectifier.

1. Panels: UL listed and FM approved when used with thermal detectors and Class A detector circuit wiring. Electrical characteristics are 120-V ac, 60 Hz, with 24-V dc rechargeable batteries.

2. Manual Control Stations: Electric operation, metal enclosure, labeled "MANUAL CONTROL STATION" with operating instructions and cover held closed by breakable strut to prevent accidental opening.

2.16 PRESSURE GAGES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. AMETEK; U.S. Gauge Division.

2. Ashcroft, Inc.

3. Brecco Corporation.

4. WIKA Instrument Corporation.

B. Standard: UL 393.

C. Dial Size: 3-1/2- to 4-1/2-inch diameter.

D. Pressure Gage Range: 0 to 250 psig minimum.

E. Water System Piping Gage: Include "WATER" or "AIR/WATER" label on dial face.

F. Air System Piping Gage: Include retard feature and "AIR" or "AIR/WATER" label on dial face.

PART 3 -EXECUTION

3.01 PREPARATION

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

B. Report test results promptly and in writing.

3.02 WATER-SUPPLY CONNECTIONS

A. Connect sprinkler piping to building`s interior water-distribution piping. Comply with requirements for interior piping in Division 22 Section "Domestic Water Piping."

B. Piping between the backflow preventer and the connection to the water service shall be considered water service pipe. Materials shall match those required for fire service piping as designated by the Authority Having Jurisdiction.

C. Fire Protection Service shall enter the building within 10 feet of the outside of the building and in accordance with NFPA 24.

D. Install shutoff valve, backflow preventer, pressure gage, drain, and other accessories indicated at connection to water-distribution piping. Comply with requirements for backflow preventers in Division 22 Section "Domestic Water Piping Specialties."

1. Backflow preventer will be located in a hot box near the service connection. See civil plans.

E. Install shutoff valve, check valve, pressure gage, and drain at connection to water supply.

3.03 PIPING INSTALLATION

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

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

B. Piping Standard: Comply with requirements for installation of sprinkler piping in NFPA 13.

C. Install seismic restraints on piping. Comply with requirements for seismic-restraint device materials and installation in NFPA 13.

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

E. Install unions adjacent to each valve in pipes NPS 2 and smaller.

F. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

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

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

I. Install sprinkler control valves, test assemblies, and drain risers adjacent to standpipes when sprinkler piping is connected to standpipes.

J. Install automatic (ball drip) drain valve at each check valve for fire-department connection, to drain piping between fire-department connection and check valve. Install drain piping to and spill over floor drain or to outside building.

K. Install alarm devices in piping systems.

L. Install hangers and supports for sprinkler system piping according to NFPA 13. Comply with requirements for hanger materials in NFPA 13.

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

N. Pressurize and check preaction sprinkler system piping and air compressors.

O. Fill wet portion of sprinkler system piping with water.

3.04 JOINT CONSTRUCTION

A. Install couplings, flanges, flanged fittings, unions, nipples, and transition and special fittings that have finish and pressure ratings same as or higher than system`s pressure rating for aboveground applications unless otherwise indicated.

B. Install unions adjacent to each valve in pipes NPS 2 and smaller.

C. Install flanges, flange adapters, or couplings for grooved-end piping on valves, apparatus, and equipment having NPS 2-1/2 and larger end connections.

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

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

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

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

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

H. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.

1. Shop weld pipe joints where welded piping is indicated. Do not use welded joints for galvanized-steel pipe.

I. Steel-Piping, Cut-Grooved Joints: Cut square-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe joints.

J. Steel-Piping, Roll-Grooved Joints: Roll rounded-edge groove in end of pipe according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

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

L. Copper-Tubing Grooved Joints: Roll rounded-edge groove in end of tube according to AWWA C606. Assemble coupling with housing, gasket, lubricant, and bolts. Join copper tube and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

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

3.05 INSTALLATION OF COVER SYSTEM FOR SPRINKLER PIPING

A. Install cover system, brackets, and cover components for sprinkler piping according to manufacturer`s "Installation Manual" and with NFPA 13 or NFPA 13R for supports.

3.06 VALVE AND SPECIALTIES INSTALLATION

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

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

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

D. Specialty Valves:

1. General Requirements: Install in vertical position for proper direction of flow, in main supply to system.

2. Alarm Valves: Include bypass check valve and retarding chamber drain-line connection.

3.07 SPRINKLER INSTALLATION

A. Install sprinklers in suspended ceilings in center of narrow dimension of acoustical ceiling panels.

B. Install preaction sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing.

3.08 FIRE-DEPARTMENT CONNECTION INSTALLATION

A. Install wall-type, fire-department connections.

B. Install automatic (ball drip) drain valve at each check valve for fire-department connection.

3.09 IDENTIFICATION

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

B. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Leak Test: After installation, charge systems and test for leaks. Repair leaks and retest until no leaks exist.

2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3. Flush, test, and inspect sprinkler systems according to NFPA 13, "Systems Acceptance" Chapter.

4. Energize circuits to electrical equipment and devices.

5. Coordinate with fire-alarm tests. Operate as required.

6. Coordinate with fire-pump tests. Operate as required.

7. Verify that equipment hose threads are same as local fire-department equipment.

C. Sprinkler piping system will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 CLEANING

A. Clean dirt and debris from sprinklers.

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

3.12 DEMONSTRATION

A. Train Owner`s maintenance personnel to adjust, and maintain specialty valves.

3.13 PIPING SCHEDULE

A. Piping between Fire-Department Connections and Check Valves: Galvanized, standard-weight steel pipe with threaded ends; cast-iron threaded fittings; and threaded or grooved ends; grooved-end fittings; grooved-end-pipe couplings; and grooved joints.

B. Sprinkler specialty fittings may be used, downstream of control valves, instead of specified fittings.

C. Copper-tube, extruded-tee connections may not be used for tee branches in copper tubing instead of specified copper fittings. Branch-connection joints must be brazed.

D. Standard-pressure, wet-pipe sprinkler system, NPS 2 and smaller, shall be one of the following:

1. Standard-weight black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. Type L, hard copper tube with plain ends; cast- or wrought-copper solder-joint fittings; and brazed joints.

E. Standard-pressure, wet-pipe sprinkler system, NPS 2-1/2 and larger, shall be one of the following:

1. Standard-weight, black-steel pipe with threaded ends; uncoated, gray-iron threaded fittings; and threaded joints.

2. Standard-weight, black-steel pipe with cut- or roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3. Schedule 10, black-steel pipe with roll-grooved ends; uncoated, grooved-end fittings for steel piping; grooved-end-pipe couplings for steel piping; and grooved joints.

3.14 SPRINKLER SCHEDULE

A. Use sprinkler types in subparagraphs below for the following applications:

1. Rooms without Ceilings: Upright sprinklers.

2. Rooms with Suspended Ceilings: Recessed sprinklers.

3. Wall Mounting: Sidewall sprinklers.

4. Spaces Subject to Freezing: Pendent, preaction sprinklers.

B. Provide sprinkler types in subparagraphs below with finishes indicated.

1. Concealed Sprinklers: Rough brass, with factory-painted white cover plate.

2. Recessed Sprinklers: Bright chrome, with white escutcheon.

3. Upright Sprinklers: Chrome plated in finished spaces exposed to view; rough bronze in unfinished spaces not exposed to view.

END OF SECTION 211313

SECTION 220000 - GENERAL MECHANICAL REQUIREMENTS

PART 1 -GENERAL

1.01 SUMMARY

A. Related Documents:

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

2. The requirements listed in this document are applicable to Divisions 21, 22, and 23 specifications.

1.02 WARRANTIES

A. Warrant all materials, workmanship, and equipment against defects for a period of one year after the date of substantial completion. Certain equipment shall be warranted beginning at the time of substantial completion or for longer periods of time as specified in those divisions of the Project Manual. Repair or replace, at no additional cost to the Owner, any item which may become defective within the warrant period. Any manufacturers' warranties concerning any item installed will run to the benefit of the Owner. The Contractor agrees not to void or impair, or to allow Sub-Contractors to void or impair, any warranties regarding products or items installed as part of this project. The repair of faulty workmanship shall be considered to be included in the contract.

B. Provide as base bid extended warranty as needed to accommodate any temporary use of any and all equipment prior to substantial competition. During this period, units shall be run at 100 percent outside air. Coordinate operation of unit with Engineer and appropriate subcontractors to verify capacity and run conditions.

1.03 QUALITY ASSURANCE

A. Source Limitations: To fullest extent possible, provide products of same kind, from a single source.

1. When specified product are available only from sources that do not, or cannot, produce a quality adequate to complete Project requirements in a timely manner, consult with Architect and Owner to determine most important product qualities before proceeding. Qualities may include attributes, such as visual appearance, strength, durability, or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to fullest extent possible.

B. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.

a. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect shall determine which products shall be used.

C. Comply with all State, and local codes and ordinances.

D. Make application, obtain, and pay for all required permits and certificates of inspection of the work.

E. Required access for servicing and maintenance shall be provided for all equipment (valves, specialties, filters, etc.) Provide architectural access panels as required.

F. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment of types, materials, and sizes required for the project, whose products have been in satisfactory use in similar service for not less than five (5) years.

G. Installers Qualifications: Firm with at least three (3) years of successful installation experience on projects with equipment installation work similar to that required for project.

1.04 INTERPRETATION OF DOCUMENTS

A. All questions from contractors or subcontractors as it pertains to contract documents during the bidding phase or construction shall be submitted to the Engineer for clarification. Clarification will be issued through official written correspondence. Verbal interpretation or explanation not issued in the form of an addendum or supplemental instruction shall not be considered part of the bidding documents or contract. The Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

B. If any ambiguities should appear in the contract documents, request clarification from the Engineer before proceeding with the work. Failure to obtain clarification may result in work not being accepted by the Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work.

1.05 PERMITS, FEES, AND NOTICES

A. Secure and pay for permits and governmental fees, licenses, and inspections necessary for proper execution and completion of the Work, and for Owner to occupy and operate systems.

B. Comply with and file notices required by laws, ordinances, rules, regulations, and lawful orders of public authorities applicable.

1.06 CODES

A. The work shall be performed by persons skilled in the trade involved and shall be done in a manner consistent with normal industry standards. All work shall conform to all applicable sections of currently adopted editions of all applicable codes. The contractor is responsible for verifying the local codes in the jurisdiction with which the work is performed and installing the work as listed by said codes.

1.07 PROJECT COORDINATION AND LAYOUT

A. The contractor is responsible for laying out and coordinating all work prior to installation. Produce coordination documents incorporating all mechanical, fire protection, electrical and other trades in conjunction with the building structure and architectural features. Coordinate all routing of systems prior to installation. Payment for changes due to pre-fabricating or moving of piping, ductwork, conduit, cable trays, equipment, or any other mechanical, electrical, plumbing, or technology system due to lack of coordination will not be approved.

B. Documents produced by Specialized Engineering Solutions are diagrammatical in nature. Not all system offsets are shown to accommodate final elevations and avoid interference with all other building structural, architectural, mechanical, electrical, fire protection, and technology systems. Include in base scope of work, offsets necessary to negotiate the building appropriately.

C. Specifications list specialties, valve, damper, and systems installation requirements in addition to what is shown on drawings. Not all valves, dampers, and accessories are shown on drawings.

1.08 EQUIPMENT ELECTRICAL CONNECTIONS

A. Electrical connections identified are for the specific equipment manufacturer and model scheduled, and includes equipment furnished by this trade or furnished by other trades under these contract documents. If the Contractor chooses to provide equipment found acceptable from a different manufacturer and model than that scheduled but listed as equivalent in the specifications, or otherwise accepted by the Architect/Engineer, include electrical connection revisions associated with that manufacturer's electrical connection requirements in bid. Upon approval of a manufacturer and model other than that specifically scheduled, request clarification of the required electrical connection revision from the Engineer for incorporation into the electrical design and construction documents. If the necessary revision is found to require extensive design modification by the Engineer, provide the Engineer reasonable compensation for incorporation of the selected manufacturer's equipment into the project design.

B. Coordinate short circuit current ratings of equipment electrical components to meet or exceed fault levels calculated at the equipment location by the Fault and Coordination study performed under the electrical sub-contract. Where this study is not required by the contract, short circuit current ratings of equipment shall meet or exceed the short circuit current rating of the branch source electrical panel serving the equipment.

1.09 OPERATION AND MAINTENANCE MANUALS

A. Manuals to be bound in 3 ring binders and include:

1. Title page with project name and location and date of submittal.

2. Title, Name, address, and telephone number all contractors and suppliers.

3. Table of contents with corresponding tabs to mark sections.

B. Manual to contain the following:

1. Equipment record document submittal.

2. Warranty details, expiration dates, and contacts.

3. Licensing requirements including inspection and renewal dates.

4. Equipment location.

5. Operating manuals including wiring and control diagrams.

6. Operating procedures.

7. Precautions against improper use.

8. Startup shutdown and switchover procedures.

9. Emergency procedures.

10. Schedule for routine cleaning and maintenance.

C. Provide the Operation and Maintenance manuals as hardcopy, electronically and on a thumb drive. Provide a thumb drive of the scanned as-built redlines, in addition to the hardcopy.

1.10 OPERATOR TRAINING

A. Schedule and conduct complete owner training for every system and associated piece of equipment. Operating and maintenance manuals shall be complete and accepted by owner and engineer prior to training. Coordinate a training session which will include the Owner/Owner's Representatives and all Sub-Contractors or equipment representatives needed to explain and train on the system. A training agenda shall be submitted prior to training. The agenda shall be reviewed and amended as necessary by the Engineer and Owner. Cover all information submitted in the operation and maintenance.

1.11 ALLOWANCES

A. Include in bid, appropriate allowances for material and labor for pulley changes on equipment, impeller changes on pumps, and air baffles necessary in air handling equipment.

1.12 PROJECT CONDITIONS

A. Participate in the development of infection control risk assessments and perform work in strict compliance with the work plan developed in conjunction with the Owner and all other Contractors. Take great care in performance of work to limit dust and debris. Aid in the erection of dust-free partitions and work within confines. Environments to include but shall not be limited to negative pressure partitions, HEPA filtered air, pressure and particle monitored environments.

1.13 COORDINATION OF WORK

Item	**Supplier**	**Installer**	**Power**	**Control (4)**
Motors	MC	MC (3)	EC	CC
Motor Control Center	EC	EC	EC	CC
Equipment Mounted Electrical Components	MC	MC	EC	CC
Loose Mounted Electrical Components	EC	EC	EC	CC
Control Relays, Transformers, Power	MC	EC	EC (4)	CC
120V Thermostats	MC	MC	MC	CC (1)
Temperature Control Sensors	MC	MC	CC	CC
Temperature Control Panels	MC	CC	EC (4)	CC
Variable Speed Drives	MC	MC	EC	CC
Terminal Box Controls	MC	MC	EC (4)	CC
PE/EP Switches, Solenoid Valves, Actuators	CC	CC	EC (4)	CC

Pushbutton Stations	EC	EC	EC (4)	EC
Electric Heaters	MC	MC	EC	EC
Time Clocks	EC	EC	EC	EC
Fan Coil Units	MC	MC	EC	CC (1)
DX Condensing Units and Condensers	MC	MC	EC	CC (1)
Smoke Dampers	MC	MC	EC	EC
Medical Gas Alarm Wiring	MC	MC	EC	MC (2)

(1) If no CC in Contract, MC to wire controls and EC to pipe conduit.
(2) All low voltage wiring of panels to be covered in MC bid, Wiring Contractor to be Subcontractor to MC.
(3) Installing Contractor is responsible for field alignment services when required by Common Motor Requirements specification or by individual equipment specifications.
(4) All hardware, software, equipment, accessories, wiring (power and sensor), piping, relays, sensors, power supplies, transformers, and instrumentation required for a complete and operational DDC system, but not shown on the electrical drawings, are the responsibility of the CC.

END OF SECTION 220000

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SECTION 220500 - COMMON WORK RESULTS FOR MECHANICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

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. Concrete bases and housekeeping pads.
8. Equipment installation requirements common to equipment sections.
9. Supports and anchorages.

B. Related Sections include the following:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
2. The requirements listed in this document are applicable to Divisions 21, 22, and 23 specifications

1.02 SUBMITTALS

A. Not required.

1.03 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.

3. Electrical Characteristics for Mechanical 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 without additional cost. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.04 DEFINITIONS

A. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct 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 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.

PART 2 -PRODUCTS

2.01 PIPE, TUBE, AND FITTINGS

A. Refer to individual 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.

2.02 JOINING MATERIALS

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

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

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

F. Solvent Cements for Joining Plastic Piping:

1. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.

2.03 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: Not permitted.

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

E. 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.

2.04 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: Reinforced nylon polymer. Include two for each sealing element.

D. Connecting Bolts and Nuts: Type 316 Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.05 SLEEVES

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

B. Steel Pipe:

1. Pipe sizes through 10 inch: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

2. Pipe sized 12 inch and greater: ASTM A 53, Type E, Grade B, wall thickness no less than 0.375 inches, galvanized, plan 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.

2. Sleeve length: as required to extend through structure.

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

2.06 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.

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

1. Finish: Polished chrome-plated.

2.07 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.

2.08 CONCRETE BASES AND HOUSEKEEPING PADS

A. Form Materials:

1. Comply with Building Code and ACI 347. Design, erect, support and maintain forms to safely carry all superimposed loads until such time as such loads can be safely supported by the concrete work. Construct formwork to shape, sizes and dimensions as required to ensure accurate alignment and elevation, and level and plumb finished concrete work.

2. Nails, spikes, lag bolts, through bolts, anchorages: Sized as required of strength and character to maintain formwork in place while placing concrete.

B. Concrete:

1. Cement:

a. ASTM C150, Type I/II or ASTM C595 Type IS.

b. 3000-psi, 28-day compressive-strength concrete

2. Aggregate:

a. Coarse aggregate for stone concrete: ASTM C33, with maximum size 3/4 in.

b. Fine aggregate: Clean, durable sand, uncoated, grains free from silt, loam, and clay. Graded from fine to coarse with 95-100 percent by weight passing a No. 4 sieve and 3-8 percent passing a No. 100 sieve. ASTM C33 with following maximum permissible limits for deleterious substances, measured in percentage by weight: clay lumps 1.00; coal and lignite 0.25; materials finer than No. 200 sieve 3.00.

3. Controlled concrete proportioned as outlined in Section 5.3 ACI 318, unless specified otherwise. Allowable design stresses are based on minimum 28-day compressive strength indicated.

4. Proportions of aggregate to cement shall produce non-segregating plastic mixture of consistency required to be worked readily into corners and angles of forms and around reinforcement with method of placement employed. Accomplish variations in consistency by changes in proportioning of mix with changing W/C (water/cement) ratios established.

C. Concrete reinforcement materials:

1. New, free from rust, and complying with the following:

a. Bars for reinforcement: A615, grade 60; stirrups and ties grade 60. 2.

b. Wire fabric: 6” x 6”, W1.4-W1.4 welded wire fabric complying with ASTM A185. 3.

c. Bar supports: "Bar Support Specifications," CRSI Manual of Standard Practice, Type: plastic tipped accessories.

d. Tie Wire: Cold drawn steel; ASTM A-82.
1) Supports for reinforcement: Provide supports including bolsters, chairs, spacers and other devices for supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI recommendations.

PART 3 -EXECUTION

3.01 BUILDING ELEMENTS

A. Where required for the removal or installation of elements within Contractor’s scope, Contractor shall include all necessary building element removal, modification, and reinstallation required to facilitate work. Such building elements include but are not limited to ceilings, floors, walls, roofs, doors, beams, piping, ductwork, conduits, and lights. Elements shall only be removed to the extent required to facilitate work and shall minimize the impact to the facility.

B. Where building elements are not required to be removed but are subject to potential damage during the execution of Contractor’s work, Contractor shall protect building elements from damage.

C. Where building elements are removed and reinstalled or subject to potential damage, Contractor shall walk construction area prior to work with Owner and document condition of building elements and finishes prior to work. Contractor shall restore all building elements and finishes to their original condition noted during the walkthrough. Items not documented shall be considered in “as new” condition.

D. Where building elements must be modified prior to reinstallation to accommodate new work and such modification is not specifically indicated on the plans, Contractor shall obtain Owner approval prior to making modifications. Failure to obtain approval shall not be grounds for additional compensation.

E. Contractor shall coordinate all building element removal and reinstallation with Owner. Where removal constitutes a significant impact to the Owner's operations, such work shall be performed during off hours as defined by the Owner. Significant impacts include but are not limited to utility shutdowns, facility access, occupant safety, occupant comfort, and noise.

3.02 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 and 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. Drainage piping shall not be routed over the following spaces. Where this is unavoidable, the drainage piping shall be accompanied by 18 gauge galvanized, sealed, 2" deep secondary containment drain pans with drain routed to floor drain in observable location.

1. Electrical rooms.
2. Communication/IT rooms.
3. Central Services/sterile processing department
4. Trauma rooms.
5. Operating rooms.
6. Delivery rooms.
7. Imaging rooms and associated equipment rooms.
8. Other locations identified on the plans.

D. Pressurized piping containing liquid shall not be routed over the following spaces or within one foot laterally from the edge of electrical and electronic/IT equipment in other spaces. Where this is unavoidable, the piping shall be accompanied by 18 gauge galvanized, sealed, 2" deep secondary containment drain pans with drain routed to floor drain in observable location . Pressurized piping dedicated to fixtures, equipment, and sprinkler heads in the below spaces shall not require drain pans provided that it is not within one foot laterally of the edge of electrical and electronic/IT equipment.

1. Electrical rooms.
2. Communication/IT rooms.
3. Operating rooms.
4. Delivery rooms.
5. Imaging rooms and associated equipment rooms.

6. Other locations identified on the plans.

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

F. 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.

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

H. Install piping to permit valve servicing.

I. Install piping at indicated slopes.

J. Install piping free of sags and bends.

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

L. Install piping to allow application of insulation.

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

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

O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions.

P. Installation of Install manufactured stack sleeve fittings and field installed water dams for pipes passing through concrete floor and roof slabs.

1. Install manufactured stack sleeve fittings per manufacturers recommendations.

2. Seal annular space around piping and insulation.

3. Maintain fire and smoke ratings at pipe penetrations of fire/smoke rated building elements.

4. Provide stack sleeve fittings or water dams around pipes penetrating the floor above rooms requiring drain/drip pans and in wet areas including but not limited to the following:

a. Mechanical rooms.

b. Boiler rooms.

c. Sterile Processing Areas.

d. Locations indicated on plans.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with UL listed through penetration firestop systems. Refer to Division 07 Section "Through-Penetration Firestop Systems" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Specifications Sections for roughing-in requirements.

3.03 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and other Specification 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. PVC Nonpressure Piping: Join according to ASTM D 2855.

J. PE Piping Heat-Fusion Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join according to ASTM D 2657.

1. Plain-End Pipe and Fittings: Use butt fusion.

2. Plain-End Pipe and Socket Fittings: Use socket fusion.

3.04 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. Install dielectric flange or nipple fittings to connect piping materials of dissimilar metals.

a. Use of brass or bronze ball valves in place of a dielectric nipple is acceptable.

3.05 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 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.

3.06 CONCRETE BASES AND HOUSEKEEPING PADS

A. Furnish and install concrete bases and housekeeping pads (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for all floor mounted equipment provided.

B. All concrete bases and housekeeping pads shall be reinforced in accordance with ACI 315.

C. Existing concrete bases and housekeeping pads may be used for new equipment. Where concrete base or housekeeping pad is too small to accommodate new equipment, do not extend concrete base or housekeeping pad; demolish concrete base or housekeeping pad and provide new.

D. Forms:

1. Construct forms to the exact sizes, shapes, lines and dimensions as required to obtain accurate alignment, locations, grades, level and plumb work in the finished structures.

2. Chamfer exposed external corners and edges.

3. Inserts, embedded parts and openings:

a. Provide formed openings where required for work embedded in or passing through concrete.

b. Coordinate work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

c. Install accessories in accordance with manufacturer`s instructions, level and plumb. Ensure items are not disturbed during concrete placement.

4. Form removal:

a. Do not remove forms and bracing until concrete has sufficient strength to support its own weight, and construction and design loads which may be imposed upon it.

b. Do not damage concrete surfaces during form removal.

5. Cleaning:

a. Clean forms to remove foreign matter as erection proceeds.

b. Ensure that water and debris drain to exterior through clean out ports.

c. During cold weather, remove ice and snow from forms. Do not use deicing salts. Do not use water to clean out completed forms, unless formwork and construction proceed within heated enclosure.

E. Reinforcement:

1. Before start of concrete placement, accurately size and place concrete reinforcement in accordance with ACI 315, positively securing and supporting by concrete blocks, metal chairs or spacers, or metal hangers.

2. Clearance: Clear space between bars and cover for bars shall conform to the Requirements of ACI 318.

3. Splicing:

a. Horizontal bars:
1) Place bars in horizontal members with laps at splices in accordance with the Contract Documents and the Requirements of ACI-318 (Latest Edition).
2) Bars may be wired together at laps.
3) Wherever possible, stagger the splices of adjacent bars.

b. Wire fabric:
1) Make splices in wire fabric at least 1-1/2 meshes wide.

c. Other splices:

1) Place required steel dowels and securely anchor into position before concrete is placed.

4. Coordinate placement with conduits, piping, inserts, sleeves or other items.

F. Concrete Bases and Housekeeping Pads: Anchor equipment to concrete bases and housekeeping pads according to equipment manufacturer`s written instructions.

1. Construct concrete bases and housekeeping pads not less than 4 inches larger in both directions than supported unit. Concrete bases and housekeeping pads shall be nominal 4 inches thick unless indicated otherwise on plans and details. Where a base is less than 12 inches from a wall, extend the base to the wall.

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. Place, install, and secure anchorage devices. Use manufacturer`s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to supported equipment.

5. Curing:

a. Keep forms in place for a seven-day curing period. Keep top exposed concrete surface wet and forms moist. Loosen forms to allow curing water to run down between concrete and forms.

3.07 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 mechanical materials and equipment.

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

3.08 GROUTING

A. Mix and install grout for mechanical 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.

END OF SECTION 220500

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SECTION 220513 - COMMON MOTOR REQUIREMENTS FOR MECHANICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Related Documents:

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

2. The requirements listed in this document are applicable to Divisions 21, 22, and 23 specifications.

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. None.

1.04 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.

3. Ratings and characteristics of electrical supply circuit and required control sequence.

4. Ambient and environmental conditions of installation location.

PART 2 -PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: NEMA premium efficiency, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.

2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

2. Motors Smaller than 15 HP: Manufacturer`s standard starting characteristic.

J. Enclosure Material: Rolled steel or cast iron construction. 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.

K. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

L. Provide factory installed bearing protection ring, AEGIS or equal on all motors powered by VFD.

2.04 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

2. Split phase.

3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

5. Electronic commutation.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type or electronic commutation type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type or electronic commutation type.

E. Electronic commutation motors shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 -EXECUTION

3.01 ROTATING EQUIPMENT FIELD ALIGNMENT

A. All coupled rotating equipment over 1 horsepower shall be laser-aligned, using a dual receiver coupling laser aligner or other approved laser alignment equipment after installation. Thermal growth calculations shall be made where appropriate to reflect operating conditions. If applicable, equipment, structure, and attached piping thermal growths shall be considered in addition to operational effects such as oil wedge, pressure/vacuum pull-down, etc. to insure in service alignment tolerances are achieved. The acceptable in service alignment tolerances shall be determined by the equipment manufacturer. Where no value is given, tolerance shall be 0.0005”. The installing contractor must check for and correct any soft foot conditions before attempting the laser alignment of any coupled rotating equipment. The soft foot tolerance is the differential at any foot on the equipment. Fluid film bearing machine shafts shall be level while in service.

B. A record of the final alignment settings, alignment setup, alignment tolerances, machine ID/Name, date of alignment, and alignment technician ID shall be printed and signed by the technician responsible for the alignment. Calculations for thermal effects and other operational considerations shall be attached to this printout. A copy shall be forwarded to the Owner and Engineer for review and acceptance. The accepted copy shall be included in the final Operation and Maintenance Manuals.

C. A minimum of two jacking bolts shall be installed at each hold-down bolt position to facilitate controlled movement in the axial (in line with the shaft, perpendicular to the bolt body) direction and “horizontal” (perpendicular to hold-down bolt body and axial direction). The jacking bolts must be positioned so that they do not interfere with the installation and removal of shim packs.

D. Hold-down bolts shall be tightened using a calibrated torque wrench in at least three stages (50%, 80%, and 100% of final torque value), each stage following a “cross” pattern. After alignment and tightening of hold-down bolts, all jacking bolts shall be backed-off ~0.100” and locked with jam nuts.

END OF SECTION 220513

SECTION 220517 - SLEEVES AND SLEEVE SEALS FOR PLUMBING PIPING

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. Pipe sleeves.

B. Manufactured sleeve-seal systems.

1.02 RELATED REQUIREMENTS

A. Section 078400 - Firestopping.

B. Section 099123 - Interior Painting: Preparation and painting of interior piping systems.

C. Section 220523 - General-Duty Valves for Plumbing Piping.

D. Section 220553 - Identification for Plumbing Piping and Equipment: Piping identification.

E. Section 220716 - Plumbing Equipment Insulation.

F. Section 220719 - Plumbing Piping Insulation.

1.03 REFERENCE STANDARDS

A. ASTM C592 - Standard Specification for Mineral Fiber Blanket Insulation and Blanket-Type Pipe Insulation (Metal-Mesh Covered) (Industrial Type) 2022a.

B. ASTM E814 - Standard Test Method for Fire Tests of Penetration Firestop Systems 2023a.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Shop Drawings: Indicate pipe materials used, jointing methods, supports, floor and wall penetration seals. Indicate installation, layout, weights, mounting and support details, and piping connections.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the Products specified in this section with minimum three years documented experience.

B. Installer Qualifications: Company specializing in performing work of the type specified this section.

1. Minimum three years experience.

2. Approved by manufacturer.

C. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver and store sleeve and sleeve seals in shipping containers, with labeling in place.

B. Provide temporary protective coating on cast iron and steel sleeves if shipped loose.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Correct defective Work within a five year period after Date of Substantial Completion.

PART 2 -PRODUCTS

2.01 PIPE SLEEVES

A. Manufacturers:

1. Flexicraft Industries; Pipe Wall Sleeve: www.flexicraft.com/#sle.

B. Vertical Piping:

1. Sleeve Length: 1 inch (25 mm) above finished floor.

2. Provide sealant for watertight joint.

3. Drilled Penetrations: Provide 1-1/2 inch (40 mm) angle ring or square set in silicone adhesive around penetration.

C. Pipe Passing Through Mechanical, Laundry, and Animal Room Floors above Basement:

1. Galvanized steel pipe or black iron pipe with asphalt coating.

2. Connect sleeve with floor plate except in mechanical rooms.

D. Clearances:

1. Provide allowance for insulated piping.

2. Wall, Floor, Floor, Partitions, and Beam Flanges: 1 inch (25 mm) greater than external; pipe diameter.

3. All Rated Openings: Caulked tight with fire stopping material complying with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.

2.02 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:

1. Advance Products & Systems, LLC; Innerlynx: www.apsonline.com/#sle.

2. Flexicraft Industries; PipeSeal: www.flexicraft.com/#sle.

3. Substitutions: See Section 016000 - Product Requirements.

B. Modular/Mechanical Seal:

1. Synthetic rubber interlocking links continuously fill annular space between pipe and wall/casing opening.

2. Provide watertight seal between pipe and wall/casing opening.

3. Elastomer element size and material in accordance with manufacturer's recommendations.

4. Glass reinforced plastic pressure end plates.

PART 3 -EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and foreign material, from inside and outside, before assembly.

3.02 INSTALLATION

A. Route piping in orderly manner, plumb and parallel to building structure. Maintain gradient.

B. Install piping to conserve building space, to not interfere with use of space and other work.

C. Install piping and pipe sleeves to allow for expansion and contraction without stressing pipe, joints, or connected equipment.

D. Inserts:

1. Provide inserts for placement in concrete formwork.

2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 m).

4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

E. Structural Considerations:

1. Do not penetrate building structural members unless indicated.

F. Provide sleeves when penetrating footings, floors, walls, and partitions. Seal pipe including sleeve penetrations to achieve fire resistance equivalent to fire separation required.

1. Underground Piping: Caulk pipe sleeve watertight with lead and oakum or mechanically expandable chloroprene inserts with bitumen sealed metal components.

2. Aboveground Piping:

   a. Pack solid using mineral fiber complying with ASTM C592.

   b. Fill space with an elastomer caulk to a depth of 0.50 inch (15 mm) where penetrations occur between conditioned and unconditioned spaces.

3. All Rated Openings: Caulk tight with fire stopping material complying with ASTM E814 in accordance with Section 078400 to prevent the spread of fire, smoke, and gases.

G. Manufactured Sleeve-Seal Systems:

1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.

2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.

3. Locate piping in center of sleeve or penetration.

4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.

5. Tighten bolting for a water-tight seal.

6. Install in accordance with manufacturer's recommendations.

H. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 CLEANING

A. Upon completion of work, clean all parts of the installation.

B. Clean equipment, pipes, valves, and fittings of grease, metal cuttings, and sludge that may have accumulated from the installation and testing of the system.

END OF SECTION 220517

SECTION 220519 - METERS AND GAUGES FOR MECHANICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Thermometers.
2. Pressure gauges.
3. Test plugs.

B. 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. The requirements listed in this document are applicable to Divisions 21, 22, and 23 specifications.

1.02 SUBMITTALS

A. Action Submittals:

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

B. Informational Submittals:

1. Operation and maintenance data.

1.03 CLOSE-OUTS

A. None.

PART 2 -PRODUCTS

2.01 LIQUID-IN-GLASS THERMOMETERS

A. Metal-Case, Industrial-Style, Liquid-in-Glass Thermometers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Miljoco Corporation.
   b. Weiss Instruments, Inc.
   c. Winters Instruments - U.S.

2. Standard: ASME B40.200.

3. Case: Cast aluminum; 9-inch nominal size unless otherwise indicated.

4. Case Form: Adjustable angle unless otherwise indicated.

5. Tube: Glass with magnifying lens and blue or red organic liquid.

6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F.

7. Window: Glass.

8. Stem: Aluminum and of length to suit installation.

   a. Design for Air-Duct Installation: With ventilated shroud.

   b. Design for Thermowell Installation: Bare stem.

9. Connector: 1-1/4 inches, with ASME B1.1 screw threads.

10. Accuracy: Plus or minus 1 percent of scale range or one scale division, to a maximum of 1.5 percent of scale range.

2.02 THERMOWELLS

A. Thermowells:

1. Standard: ASME B40.200.

2. Description: Pressure-tight, socket-type fitting made for insertion into piping tee fitting.

3. Material for Use with Copper Tubing: Brass.

4. Material for Use with Steel Piping: Type 304 Stainless Steel.

5. Type: Stepped shank unless straight or tapered shank is indicated.

6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, ASME B1.20.1 pipe threads.

7. Internal Threads: 1/2, 3/4, and 1 inch, with ASME B1.1 screw threads.

8. Bore: Diameter required to match thermometer bulb or stem.

9. Insertion Length: Length required to match thermometer bulb or stem.

10. Lagging Extension: Include on thermowells for insulated piping and tubing.

11. Bushings: For converting size of thermowell`s internal screw thread to size of thermometer connection.

2.03 PRESSURE GAUGES

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Miljoco Corporation.
    b. Weiss Instruments, Inc.
    c. Winters Instruments - U.S.
2. Standard: ASME B40.100.
3. Case: Liquid-filled 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.
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Metal.
11. Accuracy: Grade 1A, plus or minus 1% of full scale or span.

2.04 GAUGE 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. Siphons: Loop-shaped section of stainless-steel pipe with NPS 1/4 or NPS 1/2 pipe threads.

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

PART 3 -EXECUTION

3.01 INSTALLATION

A. Install thermowells with socket extending to center of pipe and in vertical position in piping tees.

B. Install thermowells of sizes required to match thermometer connectors. Include bushings if required to match sizes.

C. Install thermowells with extension on insulated piping.

D. Fill thermowells with heat-transfer medium.

E. Install direct-mounted thermometers in thermowells and adjust vertical and tilted positions.

F. Install remote-mounted thermometer bulbs in thermowells and install cases on panels; connect cases with tubing and support tubing to prevent kinks. Use minimum tubing length.

G. Install duct-thermometer mounting brackets in walls of ducts. Attach to duct with screws.

H. Install direct-mounted pressure gauges in piping tees with pressure gauge located on pipe at the most readable position.

I. Install valve and snubber in piping for each pressure gauge for fluids (except steam).

J. Install valve and syphon fitting in piping for each pressure gauge for steam.

K. Install thermometers in the following locations:

1. Inlet and outlet of each domestic water heater, heat exchanger, and storage tank.

2. Other locations indicated on plans

L. Install pressure gauges in the following locations:

1. Building water service entrance into building.

2. Inlet and discharge of each hydronic or domestic pressure-reducing valve.

3. Suction and discharge of each domestic water pump.

4. Other locations indicated on plans.

3.02 CONNECTIONS

A. Install thermometers and gauges adjacent to machines and equipment to allow service and maintenance of gauges, machines, and equipment.

3.03 ADJUSTING

A. Adjust faces of thermometers and gauges to proper angle for best visibility.

3.04 APPLICATION

A. Suitable for temperature and pressure application.

END OF SECTION 220519

SECTION 220523 - GENERAL-DUTY VALVES FOR MECHANICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.

B. Valves for specialty applications are specified in sections applicable to those services. This includes but is not limited to:

1. Plumbing.
2. Medical gas.
3. High purity water.

C. Related Sections:

1. Divisions 22 and 23 mechanical piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Mechanical Identification" for valve tags and schedules.

1.02 SUBMITTALS

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

1.03 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

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

C. NSF Compliance:

1. NSF 61 for valve materials for potable-water service.
2. NSF 372: Drinking water system components – lead content for valve materials for potable-water service.

PART 2 -PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to Part 3 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. Handwheel: For valves other than quarter-turn types.

2. Handlever: For quarter-turn valves NPS 6 and smaller.

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

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows full operation of valve without breaking the vapor seal or disturbing insulation.

2. Butterfly Valves: With extended stem.

F. Valve-End Connections:

1. Valve end connection shall match the joints specified for the associated piping systems used.

a. Flanged: With flanges according to ASME B16.1 for iron valves.

b. Grooved: With grooves according to AWWA C606.

c. Solder Joint: With sockets according to ASME B16.18.

d. Threaded: With threads according to ASME B1.20.1.

G. Valves intended for domestic water service shall be certified lead-free per NSF standards.

2.02 BRASS/BRONZE BALL VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Conbraco/Apollo.

2. Hammond Valve.

3. Jamesbury; a subsidiary of Metso Automation.

4. Milwaukee Valve Company.

5. Watts.

B. Two-Piece, Brass/Bronze Ball Valves:

1. 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. Seats: PTFE or TFE.

    g. Stem:
        1) Blowout proof.
        2) Stainless steel.

    h. Ball: Stainless steel.

    i. Port: Full.

2.03 IRON, LUGGED BUTTERFLY VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bray Controls; a division of Bray International.

2. Conbraco Industries, Inc.; Apollo Valves.

3. Crane Co.; Crane Valve Group; Stockham Division.

4. Crane/Centerline.

5. DeZurik Water Controls.

6. Hammond Valve.

7. Milwaukee Valve Company.

8. NIBCO INC.

2.04 BRONZE SWING CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane Co.; Crane Valve Group; Crane Valves.

2. Crane Co.; Crane Valve Group; Jenkins Valves.

3. Crane Co.; Crane Valve Group; Stockham Division.

4. Hammond Valve.

5. Kitz Corporation.
6. Milwaukee Valve Company.
7. NIBCO INC.
8. Powell Valves.
9. Red-White Valve Corporation.
10. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, Bronze Swing Check Valves:

1. Description:
   a. Standard: MSS SP-80, Type 3.
   b. CWP Rating: 200 psig.
   c. SWP Rating: 125 psig saturated.
   d. Body Design: Horizontal flow.
   e. Body Material: Bronze.
   f. Disc: Bronze.

2.05 BRONZE SILENT CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Jenkins Valves.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. Hammond Valve.
5. Milwaukee Valve Company.
6. NIBCO INC.
7. Powell Valves.
8. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, Bronze Silent Check Valves:

1. Description:
   a. Standard: MSS SP-139.
   b. CWP Rating: 250 psig.

c. Body Design: In-line lift type, spring actuated.

d. Body Material: Bronze.

e. Disc: PTFE.

PART 3 -EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

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

F. Provide extended stems on insulated piping systems to extend handle above insulation.

3.03 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.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Unless indicated otherwise, use the following:

1. Shutoff Service, Domestic Water: Gate valves and ball valves or ball valves.

2. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze silent check valves.

b. NPS 2-1/2 and Larger, except for Sanitary Waste and Storm Drainage: Iron silent check valves.

c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves.

B. Select valves, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends. Valves with soldered ends may be used in water systems only where soldered joints are permitted in other sections.

2. For Copper Tubing, NPS 2-1/2 and above: Flanged ends. Valves with grooved ends may be used in water systems only where grooved mechanical joints are permitted in other sections.

3. For Steel Piping, NPS 2 and Smaller: Threaded ends.

4. For Steel Piping, NPS 2-1/2 and above: Flanged ends. Valves with grooved ends may be used in water systems only where grooved mechanical joints are permitted in other sections.

C. Select valves to meet or exceed maximum anticipated maximum system operating pressure for intended service. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

END OF SECTION 220523

SECTION 220529 - HANGERS AND SUPPORTS FOR MECHANICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

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

B. 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. The requirements listed in this document are applicable to Divisions 21, 22, and 23 specifications.

1.02 SUBMITTALS

A. Action Submittals

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

1.03 CLOSE-OUTS

A. None.

1.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis, using performance requirements and design criteria indicated.

B. 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, including pipe stands, 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.

3. Design hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

1.05 DEFINITIONS

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry.

B. Terminology: As defined in MSS SP-90, “Guidelines on Terminology for Pipe Hangers and Supports”.

C. ASME B31.9: Building Services Piping.

D. ASME B31.1: Power Piping.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. B-Line Systems, Inc.; a division of Cooper Industries.

2. ERICO/Michigan Hanger Co. (Caddy-Pentair).

3. Grinnell Corp.

4. PHD Manufacturing, Inc.

5. Thermal Pipe Shields.

6. Tolco, Inc.

2.02 PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.

3. Nonmetallic Coatings: Plastic coating, jacket, or liner.

4. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.

2. Hanger Rods and Hardware: Continuous-thread rod, nuts, and washer made of 304 stainless steel.

C. Copper Pipe/Tube Hangers and Supports

1. Split ring hangers and clamps.

D. Materials:

1. Provide appropriate materials and protective coatings to prevent failure from environmental and galvanic corrosion.

2. Material that comes in contact with pipe shall be compatible with piping material so that neither has a deteriorating effect on the other.

E. Hanger Rods: Continuous-thread rod, nuts and washer made of stainless steel.

2.03 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.

2.04 METAL FRAMING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. B-Line Systems, Inc.; a division of Cooper Industries.

2. ERICO/Michigan Hanger Co. (Caddy-Pentair).

3. Tolco, Inc.

4. Unistrut.

B. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

2. Standard: MFMA-4.

3. Channels: Continuous slotted steel channel with inturned lips.

4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

6. Coating: Suitable for piping system supported.

2.05 THERMA-HANGER SADDLE AND SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Carpenter & Paterson, Inc.

2. ERICO/Michigan Hanger Co. (Caddy-Pentair).

3. Pipe Shields, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield to cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield to cover the lower 180 degrees of pipe.

F. Insert Length: Extend a minimum of 2 inches, or greater as recommended by manufacturer, beyond sheet metal shield for piping operating below ambient air temperature.

G. Fire Rating: 25/50 rated flame/smoke plenum rated.

2.06 FASTENER AND ANCHORING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Hilti, Inc.

2. ITW Ramset/Red Head.

3. Powers Fasteners.

4. Simpson Strong - Tie

B. Post-pour concrete inserts shall be selected based on “cracked concrete” applications, shall be installed in accordance with manufacturers’ requirements and shall be designed for “cracked concrete” in accordance with Appendix D of American Concrete Institute (ACI) standard 318 and have a current ICC-ES report.

C. 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. Must be designed and approved for “cracked concrete” in accordance with Appendix D of American Concrete Institute (ACI) standard 318 and have a current ICC-ES report.

D. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Must be designed and approved for “cracked concrete” in accordance with Appendix D of American Concrete Institute (ACI) standard 318 and have a current ICC-ES report.

2.07 PIPE STANDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. B-Line.

2. ERICO.

3. MIFAB.

4. MIRO.

5. Unistrut.

B. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

C. Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made form structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.08 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.

2.09 EQUIPMENT SUPPORTS

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

2.10 MISCELLANEOUS MATERIALS

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

PART 3 -EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

A. Do not support piping, ductwork equipment, or systems from metal roof decking material.

B. Where powder actuated or mechanical expansion hangers are used, notify Owner one week in advance of installation.

C. 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.

D. 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.

E. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

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

G. 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.

H. Pipe Stand Installation:

1. Pipe Stand Types: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

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

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

K. Equipment Support Installation: Fabricate form welded-structural-steel shapes.

L. 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.

M. Anchor piping at appropriate location and utilize guides to allow proper pipe expansion where expansion loops or expansion joints are used.

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

O. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, 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.

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

Q. 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 and ASME B31.1 for power piping.

R. 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. Provide protection saddle shield insert, minimum 4 inch, 180 degrees.

c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping and ASME B31.1 for power piping.

d. Insert Material: Length of at least as long as protective shield.

e. Thermal Hanger Shields: Install with insulation same thickness as piping insulation.

S. All piping when supported by non-rigid hangers in excess of 18 inches in length shall be braced against movement in any direction.

T. PVC, polypropylene, and other plastic piping: Follow pipe manufacturer's recommendations for hanger type, support, and spacing. Hanger material must be chemically compatible with the plastic pipe material.

3.02 EQUIPMENT SUPPORTS

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

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

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

3.03 METAL FABRICATIONS

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

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

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

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

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

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

3.05 HANGER AND SUPPORT SCHEDULE

A. Comply with MSS SP-69 for all pipe-hanger selections and applications.

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

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

D. Use carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general service applications.

E. Use stainless-steel pipe hangers and corrosion-resistant attachments for hostile environment applications.

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

G. 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. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 4.

3. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 4.

4. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 4.

5. 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.

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

1. 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.

I. 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.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Steel Weldless Eye Nuts (MSS type 17): For 120 to 450 deg F piping installations.

J. 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. C-Clamps (MSS Type 23): For support of pipes to NPS 4, attached to structural shapes. Provide retaining strap.

6. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

7. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

8. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

9. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

10. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

11. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

K. 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.

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

1. Install spring hangers and supports in the following areas:

a. All piping and equipment above, below, in, and adjacent to medical equipment rooms.

b. All piping and equipment above, below, in, and adjacent to operating rooms.

2. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

3. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

4. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

5. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

6. 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.

7. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

8. Constant Supports: For critical piping stress and if necessary, to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

a. Horizontal (MSS Type 54): Mounted horizontally.

b. Vertical (MSS Type 55): Mounted vertically.

c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

N. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

O. Use powder-actuated fasteners or mechanical-expansion anchors rated for “cracked concrete” 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 220529

SECTION 220548 - VIBRATION AND SEISMIC CONTROLS FOR MECHANICAL

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

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

B. The requirements listed in this document are applicable to Divisions 21, 22 and 23 specifications.

1.02 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Freestanding and restrained spring isolators.
5. Housed spring mounts.
6. Elastomeric hangers.
7. Spring hangers.
8. Spring hangers with vertical-limit stops.
9. Pipe riser resilient supports.
10. Resilient pipe guides.
11. Restrained vibration isolation roof-curb rails.
12. Seismic snubbers.
13. Steel, vibration isolation equipment bases.

1.03 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed.
2. Building Classification Category: I.

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.

1.04 SUBMITTALS

A. Action Submittals:

1. Product Data: For the following:

a. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

b. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.
1) Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.
2) Annotate to indicate application of each product submitted and compliance with requirements.

c. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic and wind forces required to select vibration isolators, seismic and wind restraints, and for designing vibration isolation bases.

a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

C. Informational submittals:

1. Coordination Drawings: Show coordination of seismic bracing for piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

2. Welding certificates.

3. Qualification Data: For professional engineer and testing agency.

4. Field quality-control test reports.

1.05 QUALITY ASSURANCE

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

1. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

B. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage or preapproval by agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 -PRODUCTS

2.01 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation.

3. Isolation Technology, Inc.

4. Kinetics Noise Control.

5. Mason Industries.

6. Vibration Eliminator Co., Inc.

7. Vibration Isolation.

8. Vibration Mountings & Controls, Inc.

B. 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.

C. 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.

D. 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.

E. 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.

F. 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.

G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.

2. Base: Factory drilled for bolting to structure.

3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

H. 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.

I. 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.

J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

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.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 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.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.02 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation.

3. Isolation Technology, Inc.

4. Kinetics Noise Control.

5. Mason Industries.

6. Vibration Eliminator Co., Inc.

7. Vibration Isolation.

8. Vibration Mountings & Controls, Inc.

B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.03 FACTORY FINISHES

A. Finish: Manufacturer`s standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.

2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

3. Baked enamel or powder coat for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 -EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. 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.

3.03 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install seismic snubbers on equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

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

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.

3. Brace a change of direction longer than 12 feet.

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

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. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

G. 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.

H. 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. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer`s recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 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. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless post connection testing has been approved), and with at least seven days` advance notice.

3. Obtain Architect`s approval before transmitting test loads to structure. Provide temporary load-spreading members.

4. Test at least four of each type and size of installed anchors and fasteners selected by Architect.

5. Test to 90 percent of rated proof load of device.

6. Measure isolator restraint clearance.

7. Measure isolator deflection.

8. Verify snubber minimum clearances.

9. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

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

E. Prepare test and inspection reports.

3.05 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.

3.06 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Refer to drawings for schedules.

END OF SECTION 220548

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 220553 - MECHANICAL IDENTIFICATION

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

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

B. The requirements listed in this document are applicable to Divisions 21, 22, and 23 specifications.

1.02 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Pipe labels.
3. Valve tags.
4. Fire/smoke wall penetration labeling.
5. Wiring/Cable labels.

1.03 SUBMITTALS

A. Action Submittals:

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

B. Informational submittals.

1. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label. Equipment Label Schedule shall be approved by the Owner prior to labeling.
2. Valve numbering scheme: Approved by Owner prior to labeling.
3. Valve Schedules: For each piping system to include in maintenance manuals. Provide electronic Excel document to Owner in addition to hard copy in operation and maintenance manuals.

PART 2 -PRODUCTS

2.01 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Plastic minimum 2-inch by 3/4-inch, black with white letters, mechanically fastened. Size shall increase appropriately for larger equipment.

B. Label Content: Owner shall designate all labeling names. Label shall include description of areas served.

2.02 PIPE LABELS

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

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive, applied with adhesive directional tape.

C. Pipe Label Contents: Include identification of piping service using full name designations per Drawings and an arrow indicating flow direction. Steam per systems shall bear pressure designation. Domestic water system shall bear water temperature designation.

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: Per ASME/ANSI A13.1.

3. Pumped condensate systems:

a. Provide a label near the system condensate pump noting the termination location of the condensate pipe. Ex. "TERMINATES AT ROOM 143 MOP SINK", "TERMINATES AT ROOM 146 FLOOR DRAIN NEAR DI"

2.03 FIRE BARRIER PENETRATION

A. Provide sticker complying with penetration sealant product requirements listing product, date, company name, and initials of installer. Sticker to be minimum 3-inch by 5-inch and red in color. Stickers to be affixed both sides of wall.

2.04 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass wire-link or beaded chain; or S-hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2. Provide additional Excel format electronic version of schedule to Owner.

2.05 WIRING/CABLING IDENTIFICATION

A. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

PART 3 -EXECUTION

3.01 COORDINATION

A. Coordinate equipment designation labeling with Owner before procuring labels.

3.02 PREPARATION

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

3.03 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.04 PIPE LABEL INSTALLATION

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

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment and in equipment rooms.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

B. Pipe Label Color Schedule:

1. Meet ASME/ANSI A13.1.

2. Match existing facility standard.

3. For projects performed in Omaha, Contractor shall conform to labeling and identification section of the Omaha Plumbing Code. This includes tagging, spacing, lettering size, color coding, and locations.

3.05 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; faucets; convenience and lawn-watering hose connections. List tagged valves in a valve schedule.

B. Where valve location exceeds reasonable distance from floor, valve tag to be extended down to within 24 inches of finished ceiling height.

3.06 FIRE/SMOKE WALL PENETRATION LABELING

A. Affix label at every rated fire and/or smoke wall penetrated with mechanical piping and duct systems, both sides of wall.

3.07 WIRE/CABLE LABELING

A. Install identification devices in accordance with manufacturer’s written instruction and requirements of NEC.

B. Alarm Circuit Identification: Tag or label conductors as follows:

1. For control and communications/signal wiring, use colored marking tape and/or wire/cable designation tape markers at terminations in wiring boxes, troughs, and control cabinets. Use consistent colors and/or letter/number conductor designations throughout on wire/cable marking tape.

2. Match identification markings with designations used in equipment shop drawings, Contract Documents, and similar previously established identification schemes for the facility’s electrical installations.

3. Identify Junction, Pull and Connection Boxes: Identification of systems and circuits shall indicate system and identity of contained circuits on outside of box cover. Labeling shall be 3/8-inch Kroy tape or Brother self-adhesive label color-coded same as conduits or permanent magic marker (color coded), neatly hand printed. In rooms that are painted out, provide labeling on inside of cover.

C. Provide typed legend of wire/cable wiring indicating tag, color, system, signal, starting room name and ending room name.

END OF SECTION 220553

SECTION 220700 - MECHANICAL INSULATION

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes mechanical insulation for mechanical system components, including the following:

1. Insulation Materials:

a. Cellular glass

b. Flexible elastomeric.

c. Mineral fiber.

2. Fire-rated insulation systems.

3. Adhesives.

4. Mastics.

5. Lagging adhesives.

6. Sealants.

7. Factory-applied jackets.

8. Field-applied jackets.

9. Tapes.

10. Securements.

11. Valve and specialty fitting wraps.

B. 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. The requirements listed in this document are applicable to Divisions 22 and 23 specifications.

1.02 DEFINITIONS

A. ASJ: All-service jacket.

B. FSK: Foil, scrim, kraft paper.

C. PSK: Metalized polypropylene scrim kraft.

D. FSP: Foil, scrim, polyethylene.

E. PVDC: Polyvinylidene chloride.

F. SSL: Self-sealing lap.

G. MICA: Midwest Insulation Contractor's Association.

H. Indoor: Outside surfaces are inside building within conditioned space or insulated building envelope.

I. Outdoor: Outside surfaces are exposed to weather or outside ambient air temperatures. This includes concealed locations such as ventilated attics, uninsulated soffits, and other locations not protected by the insulated building envelope.

J. Concealed: Outside surfaces are isolated from room ambient air conditions by physical barrier.

1. Concealed items are typically accessed through suspended ceilings, through access doors, or by cutting and patching.

2. Listed below are examples of spaces that typically contain concealed items:

a. Walls.

b. Partitions.

c. Chases.

d. Shafts.

e. Ceiling spaces.

K. Exposed: Outside surfaces are not isolated from room ambient air conditions by physical barrier.

1. Exposed items are typically accessed directly from within a room or space.

2. Listed below are examples of rooms/spaces that typically contain exposed items:

a. Mechanical rooms.

b. Rooms without ceilings.

1.03 HOT AND COLD WATER SYSTEM REQUIREMENTS

A. Insulation specified for hot water equipment and piping includes all systems that operate at temperatures greater than 105 deg F, with and without glycol. This includes the following:

1. Domestic hot water

2. Domestic hot water recirculating.

B. Insulation specified for cold water equipment and piping includes all systems that operate at temperatures less than 60 deg F, with and without glycol. This includes the following:

1. Domestic cold water.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Application schedule.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. MICA Standards Manual, current edition.

1.06 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.

B. Material shall be sealed and protected from dirt, debris, and moisture throughout staging and construction.

1.07 COORDINATION

A. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

B. Coordinate installation and testing of heat tracing.

C. Verify and document compliance with all local, state, and applicable energy codes.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds. Products shall be certified no voc and low odor.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials in contact with austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

D. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:

a. Cell-U-Foam Corporation; Ultra-CUF.

b. Pittsburgh Corning Corporation; Foamglas Super K.

2. Block Insulation: ASTM C 552, Type I.

3. Special-Shaped Insulation: ASTM C 552, Type III.

4. Board Insulation: ASTM C 552, Type IV.

5. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.

6. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

E. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products:

a. Aeroflex USA Inc.; Aerocel.

b. Armacell LLC; AP Armaflex.

c. Rubatex

d. K Flex USA

e. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

F. Mineral-Fiber, Preformed Pipe Insulation:

1. Products:

a. Fibrex Insulations Inc.; Coreplus 1200.

b. Johns Manville; Micro-Lok.

c. Knauf Insulation; 1000(Pipe Insulation.

d. Manson Insulation Inc.; Alley-K.

e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

2.03 ADHESIVES

A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated, unless otherwise indicated.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

C. Cellular-Glass, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

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

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

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

G. PVC Jacket Adhesive: Compatible with PVC jacket.

2.04 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II. Color shall match insulation color. Service shall match insulation application vapor permeance and installation environment.

2.05 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

2.06 SEALANTS

A. Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates. Color shall match insulation or jacket color. Service shall match insulation application, vapor permeance, and installation environment.

2.07 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. PSK Jacket: Metalized white polypropylene, fiberglass-reinforced kraft paper backing; complying with ASTM C 1136, Type II.

2.08 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.

2. Color: White.

3. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

   a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

4. Factory-fabricated tank heads and tank side panels.

2.09 TAPES

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

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. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Width: 2 inches.

2. Thickness: 6 mils.

3. Adhesion: 64 ounces force/inch in width.

4. Elongation: 500 percent.

5. Tensile Strength: 18 lbf/inch in width.

2.10 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, 1/2 inch wide with wing or closed seal.

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, 1/2 inch wide with wing or closed seal.

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. Install pins, hangers, and securements according to manufacturer's installation recommendation.

2.11 VALVE AND SPECIALTY FITTING WRAPS

A. All valves, strainers, autoflow valves, circuit setters, ball valves, balancing valves, and combination valves, etc., in chilled water, heating hot water, and steam systems shall be insulated with a factory fabricated removable and reusable cover.

B. Type 1:

1. Insulation shall have a minimum k- factor .26, using fiberglass blanket. Flame and smoke spread shall be 25/50 per ASTM E-84.

2. Installation shall not require the use of any special hand tools.

3. Manufacturers: No Sweat Valve Wraps, Inc., or approved equal.

PART 3 -EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation 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.

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

3.02 INSTALLATION

A. Install insulation after completion of pressure testing.

3.03 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

3.04 COMMON INSTALLATION REQUIREMENTS

A. Where vapor barrier is breeched by fastener, seal to maintain vapor permeance.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

D. 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.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials protected and dry during application and finishing.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. For all cold systems operating below ambient temperature, provide continuous vapor barrier. 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. Insulate all system components the same as connecting piping and ductwork to eliminate condensation.

3. 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.

4. 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.

5. 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.

L. Apply adhesives, mastics, and sealants at manufacturer`s recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are required, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. 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.

Q. 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.

R. MICA plate numbers referenced are provided to clarify the scope of installation. Install Insulation and accessory components per applicable MICA and manufacturers recommendations.

3.05 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 Below-Grade 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. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations on ductwork. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches. Install insulation at dampers as recommended by the SMACNA Fire, Smoke, and Radiation Damper Installation Guide for HVAC.

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

3.06 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. Identify all specialties with labels on exterior of insulation.

2. Install preformed sections or cut, miter, and bond all elbows and tees to provide continuous quality fitting contour.

3. 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.

4. 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.

5. 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.

6. 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.

7. For services not specified to receive a field-applied jacket except for flexible elastomeric, 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.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

3.07 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are required, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer`s recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

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

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

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

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

E. For all system components without factory applied jackets, cover insulation with factory furnished jacketing material appropriate for service and application.

3.08 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

A. Seal longitudinal seams and end joints with manufacturer`s recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer`s recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.09 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer`s recommended adhesive, overlap seams at least 2inch, and seal joints with flashing sealant.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where fiberglass-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 PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer`s recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

3.11 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous UL-listed fire rating.

B. Penetrations through fire rated walls and floors shall be installed with UL listed through penetration fire stopping system specific for the fire-rated insulation system manufacturer.

C. Insulate duct access panels and doors to achieve same fire rating as duct in accordance with its UL listing.

3.12 FINISHES

A. Flexible Elastomeric Thermal Insulation, Outdoor: After adhesive has fully cured, apply two coats of insulation manufacturer`s recommended protective UV coating.

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.

3.13 PIPING INSULATION, 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. Fire-suppression piping.

2. Drainage piping located in crawl spaces.

3. Below-grade piping.

4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.14 ABOVEGROUND PIPING INSULATION SCHEDULE

PIPING SYSTEM FLUID	TEMP. RANGE DEG. F.	THICKNESS IN INCHES FOR PIPE SIZES THROUGH SIZE LISTED					INSULATION TYPE (Note 1)	NOTES
		<1	1 TO 1.25	1.5 TO 3	4 TO 6	=8		
HPS AND MPS	251 TO 350	3	4	4.5	4.5	4.5	MF	
(STEAM PRESSURES UP TO 120 PSIG INCLUDING CONDENSATE)								
LPS	TO 250	2.5	2.5	2.5	3	3	MF	
(STEAM PRESSURES UP TO 15 PSIG INCLUDING CONDENSATE AND BOILER FEEDWATER.)								
INDOOR STEAM VENT AND BOILER BLOWDOWN	140 TO 200	1.5	1.5	2	2	2	MF	
INDOOR HOT WATER	140 TO 200	1.5	1.5	2	2	2	MF	2
INDOOR HOT WATER	105 TO 140	1	1	1.5	1.5	1.5	MF	2
OUTDOOR HOT WATER	140 TO 200	2.5	2.5	3	3	3	MF	2
OUTDOOR HOT WATER	105 TO 140	2	2	2.5	2.5	2.5	MF	2
VACUUM PUMP EXHAUST	TO 350	2	2	2	2	2	MF	3
INDOOR COLD WATER	40 TO 60	0.5	0.5	1	1	1	MF, E	

PIPING SYSTEM FLUID	TEMP. RANGE DEG. F.	THICKNESS IN INCHES FOR PIPE SIZES THROUGH SIZE LISTED					INSULATION TYPE (Note 1)	NOTES
		<1	1 TO 1.25	1.5 TO 3	4 TO 6	=8		
INDOOR COLD WATER	<40	0.5	1	1	1	1.5	MF, E	
OUTDOOR COLD WATER	40 TO 60	1.5	1.5	2	2	2	E	
OUTDOOR COLD WATER	<40	1.5	2	2	2	2.5	E	
REFRIGERANT	ANY	0.5	1	1	1	NA	E	4
STORM, STORM OVERFLOW AND DRAIN BODIES	ANY	1	1	1	1	1	MF, E	
AIR COMPRESSOR INTAKE	ANY	1	1	1	1	1	MF, E	
PLASTIC IN RETURN AIR PLENUM	ANY	0.5	0.5	0.5	0.5	0.5	MF	
HEAT TRACED	ANY	2	2	2	2	2	MF	3
INDOOR CONDENSATE AND EQUIPMENT DRAINS	BELOW 60	0.5	0.5	0.5	0.5	0.5	MF, E	5
CRYOGEN VENT	BELOW -100	2	2	2	2	2	CG	

ABBREVIATIONS: MF = MINERAL FIBER/FIBERGLASS, E = ELASTOMERIC, CG = CELLULAR GLASS

SCHEDULE NOTES:

1. MICA REFERENCE PLATES FOR PIPING ARE 1-100 FOR FIBERGLASS AND CELLULAR GLASS PIPE INSULATION, 1-200 FOR ELASTOMERIC AND 1-900 FIBERGLASS WITH HEAT TRACE.
2. HOT WATER SYSTEM TEMPERATURES EXCEEDING 200 DEG F TO BE TREATED FOR APPROPRIATE TEMPERATURE RANGE AS LISTED UNDER LPS OR HPS.
3. HEAT TRACED PIPING SHALL BE INSULATED TO THICKNESS INDICATED OR TO THICKNESS SPECIFIED FOR SPECIFIC SYSTEM, WHICHEVER IS GREATER.
4. UNDERGROUND REFRIGERANT PIPING SHALL BE INSULATED AS SPECIFIED FOR ABOVEGROUND PIPING AND INSTALLED IN PVC CONDUIT.
5. INCLUDES AIR CONDITIONING CONDENSATE, P-TRAPS FOR FLOOR DRAINS/SINKS RECEIVING AIR CONDITIONING CONDENSATE OR ICE MAKER DRAIN PIPING, AND SANITARY DRAINAGE PIPING FROM ELECTRIC WATER COOLERS TO MAIN.

3.15 VALVES AND SPECIALTY FITTINGS FOR PIPING SYSTEMS

A. Insulated Systems Operating Below Ambient Temperature:

1. NPS 6 and Smaller: Type 1.

2. Above NPS 6: Type 2.

B. Insulated Systems Operating Above Ambient Temperature and Below 200 Deg F:

1. NPS 6 and Smaller: Type 1.

2. Above NPS 6: Type 2.

3.16 FIELD-APPLIED JACKET GENERAL APPLICATION

A. Install field-applied jacket on piping as follows:

1. On exterior piping.

2. On all changes in direction and fittings.

3. In areas subject to traffic and damage exposed in mechanical rooms and tunnels. This includes the following:

a. Piping within 7 feet of finished floor.

b. Other areas specifically indicated on plans.

4. On exposed piping insulated in finished spaces including but limited to storage rooms, closets, and work areas.

5. Piping within air handling units.

B. Field-applied jacketing shall be installed on entire piping system including fittings, valves, strainers, and other piping components, except where jacketing is specifically limited to only fittings.

C. MICA Reference Plates:

1. Field applied metal jacketing: 1-400.

2. Field applied non-metal jacketing: 1-500.

3.17 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. High temperature equipment and piping:

1. Stainless Steel, Type 304, Smooth 2B Finish: 0.010 inch thick.

D. Piping, Concealed:

1. PVC 30 mil fitting covers on all fittings.

E. Piping, Exposed:

1. PVC 30 mil fitting covers on all fittings.

2. PVC 30 mil for the exposed indoor piping systems listed above under “FIELD-APPLIED JACKET GENERAL APPLICATION.”

END OF SECTION 220700

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 221005 - PLUMBING PIPING

PART 1 -GENERAL

1.01 SECTION INCLUDES

A. Pipe, pipe fittings, specialties, and connections for piping systems.

1. Sanitary sewer.
2. Chemical resistant sewer.
3. Domestic water.
4. Storm water.
5. Flanges, unions, and couplings.
6. Pipe hangers and supports.
7. Manufactured sleeve-seal systems.
8. Ball valves.
9. Balancing valves.
10. Water pressure reducing valves.

1.02 RELATED REQUIREMENTS

A. Section: Roof penetrations.

B. Section 078400 - Firestopping.

C. Section 083100 - Access Doors and Panels.

D. Section 099123 - Interior Painting.

E. Section 220516 - Expansion Fittings and Loops for Plumbing Piping.

F.

G. Section 220553 - Identification for Plumbing Piping and Equipment.

H. Section 220719 - Plumbing Piping Insulation.

I. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

J. Section 312316 - Excavation.

K. Section 312316.13 - Trenching.

L. Section 312323 - Fill.

M. Section 330110.58 - Disinfection of Water Utility Piping Systems.

1.03 REFERENCE STANDARDS

A. ASME B16.18 - Cast Copper Alloy Solder Joint Pressure Fittings 2021.

B. ASME B16.22 - Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings 2021.

C. ASME B16.23 - Cast Copper Alloy Solder Joint Drainage Fittings: DWV 2021.

D. ASME B16.26 - Cast Copper Alloy Fittings for Flared Copper Tubes 2018.

E. ASME B31.9 - Building Services Piping 2020.

F. ASME BPVC-IX - Boiler and Pressure Vessel Code, Section IX - Qualification Standard for Welding, Brazing, and Fusing Procedures; Welders; Brazers; and Welding, Brazing, and Fusing Operators 2023.

G. ASSE 1003 - Water Pressure Reducing Valves for Potable Water Distribution Systems 2023.

H. ASTM A74 - Standard Specification for Cast Iron Soil Pipe and Fittings 2021.

I. ASTM B42 - Standard Specification for Seamless Copper Pipe, Standard Sizes 2020.

J. ASTM B68/B68M - Standard Specification for Seamless Copper Tube, Bright Annealed 2019.

K. ASTM B75/B75M - Standard Specification for Seamless Copper Tube 2020.

L. ASTM B88 - Standard Specification for Seamless Copper Water Tube 2022.

M. ASTM B813 - Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube 2016.

N. ASTM C564 - Standard Specification for Rubber Gaskets for Cast Iron Soil Pipe and Fittings 2020a.

O. ASTM D2241 - Standard Specification for Poly(Vinyl Chloride) (PVC) Pressure-Rated Pipe (SDR Series) 2020.

P. ASTM D2466 - Standard Specification for Poly(Vinyl Chloride) (PVC) Plastic Pipe Fittings, Schedule 40 2023.

Q. ASTM D2564 - Standard Specification for Solvent Cements for Poly(Vinyl Chloride) (PVC) Plastic Piping Systems 2020.

R. ASTM D2729 - Standard Specification for Poly(Vinyl Chloride) (PVC) Sewer Pipe and Fittings 2021.

S. ASTM D2846/D2846M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Hot- and Cold-Water Distribution Systems 2019a.

T. ASTM D2855 - Standard Practice for the Two-Step (Primer and Solvent Cement) Method of Joining Poly (Vinyl Chloride) (PVC) or Chlorinated Poly (Vinyl Chloride) (CPVC) Pipe and Piping Components with Tapered Sockets 2020.

U. ASTM F437 - Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80 2021.

V. ASTM F438 - Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40 2023.

W. ASTM F439 - Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80 2019.

X. ASTM F441/F441M - Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe, Schedules 40 and 80 2023.

Y. ASTM F493 - Standard Specification for Solvent Cements for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe and Fittings 2022.

Z. AWS A5.8M/A5.8 - Specification for Filler Metals for Brazing and Braze Welding 2019.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data on pipe materials, pipe fittings, valves, and accessories. Provide manufacturers catalog information. Indicate valve data and ratings.

C. Welders' Certificates: Submit certification of welders' compliance with ASME BPVC-IX.

D. Shop Drawings: For non-penetrating rooftop supports, submit detailed layout developed for this project, with design calculations for loadings and spacings.

E. Sustainable Design Documentation: For soldered copper joints, submit installer's certification that the specified installation method and materials were used.

F. Sustainable Design Documentation: For products meeting regulatory lead-content restrictions.

G. Project Record Documents: Record actual locations of valves.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with applicable codes.

B. Valves: Manufacturer's name and pressure rating marked on valve body.

C. Identify pipe with marking including size, ASTM material classification, ASTM specification, potable water certification, water pressure rating.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Accept valves on site in shipping containers with labeling in place. Inspect for damage.

B. Provide temporary protective coating on cast iron and steel valves.

C. Provide temporary end caps and closures on piping and fittings. Maintain in place until installation.

D. Protect piping systems from entry of foreign materials by temporary covers, completing sections of the work, and isolating parts of completed system.

1.07 FIELD CONDITIONS

A. Do not install underground piping when bedding is wet or frozen.

PART 2 PRODUCTS

2.01 SANITARY SEWER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Cast Iron Pipe: ASTM A74 service weight.

1. Fittings: Cast iron.

2. Joints: Hub-and-spigot, CISPI HSN compression type with ASTM C564 neoprene gaskets or lead and oakum.

B. PVC Pipe: ASTM D2665 or ASTM D3034.

1. Joints: Solvent welded, with ASTM D2564 solvent cement.

2.02 SANITARY SEWER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.

2.03 CHEMICAL RESISTANT SEWER PIPING

A. CPVC Pipe: ASTM D2846/D2846M, ASTM F441/F441M, or ASTM F442/F442M.

2.04 DOMESTIC WATER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Copper Pipe: ASTM B42, hard drawn.

1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22 wrought copper and bronze.

2. Joints: AWS A5.8M/A5.8, BCuP copper/silver braze.

2.05 DOMESTIC WATER PIPING, ABOVE GRADE

A. Copper Tube: ASTM B88 (ASTM B88M), Type L (B), Drawn (H).

1. Fittings: ASME B16.18, cast copper alloy or ASME B16.22, wrought copper and bronze.

2. Mechanical Press Sealed Fittings: Double-pressed type, NSF 61 and NSF 372 approved or certified, utilizing EPDM, nontoxic, synthetic rubber sealing elements.

2.06 STORM WATER PIPING, BURIED WITHIN 5 FEET (1500 MM) OF BUILDING

A. Cast Iron Pipe: ASTM A74 service weight.

B. PVC Pipe: ASTM D2665 or ASTM D3034.

2.07 STORM WATER PIPING, ABOVE GRADE

A. Cast Iron Pipe: CISPI 301, hubless, service weight.

2.08 FLANGES, UNIONS, AND COUPLINGS

A. Unions for Pipe Sizes 3 Inches (80 mm) and Under:

1. Ferrous Pipe: Class 150 malleable iron threaded unions.

2. Copper Tube and Pipe: Class 150 bronze unions with soldered joints.

B. Flanges for Pipe Size Over 1 Inch (25 mm):

1. Ferrous Pipe: Class 150 malleable iron threaded or forged steel slip-on flanges; preformed neoprene gaskets.

2. Copper Tube and Pipe: Class 150 slip-on bronze flanges; preformed neoprene gaskets.

C. Mechanical Couplings for Grooved and Shouldered Joints: Two or more curved housing segments with continuous key to engage pipe groove, circular C-profile gasket, and bolts to secure and compress gasket.

1. Gasket Material: EPDM suitable for operating temperature range from minus 30 degrees F (minus 34 degrees C) to 230 degrees F (110 degrees C).

D. No-Hub Couplings:

1. Gasket Material: Neoprene complying with ASTM C564.

2. Band Material: Stainless steel.

3. Eyelet Material: Stainless steel.

2.09 PIPE HANGERS AND SUPPORTS

A. Plumbing Piping - Drain, Waste, and Vent:

1. Hangers for Pipe Sizes 1-1/2 Inches (50 mm) and Over: Carbon steel, adjustable, clevis.

2. Wall Support for Pipe Sizes to 3 Inches (80 mm): Cast iron hook.

3. Wall Support for Pipe Sizes 4 Inches (100 mm) and Over: Welded steel bracket and wrought steel clamp.

4. Floor Support: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

B. Plumbing Piping - Water:

1. Hangers for Cold Pipe Sizes 1/2 Inch (50 mm) and Over: Carbon steel, adjustable, clevis.

2. Hangers for Hot Pipe Sizes 1/2 Inches (50 mm) to 4 Inches (100 mm): Carbon steel, adjustable, clevis.

3. Wall Support for Pipe Sizes to 3 Inches (80 mm): Cast iron hook.

4. Floor Support for Cold Pipe: Cast iron adjustable pipe saddle, lock nut, nipple, floor flange, and concrete pier or steel support.

5. Copper Pipe Support: Carbon steel ring, adjustable, copper plated.

C. Hanger Fasteners: Attach hangers to structure using appropriate fasteners, as follows:

1. Concrete Wedge Expansion Anchors: Complying with ICC-ES AC193.

2. Other Types: As required.

3. Manufacturers:

a. Powers Fasteners, Inc: www.powers.com/#sle.

b. Substitutions: See Section 016000 - Product Requirements.

2.10 MANUFACTURED SLEEVE-SEAL SYSTEMS

A. Manufacturers:

1. The Metraflex Company; MetraSeal: www.metraflex.com/#sle.

2. Substitutions: See Section 016000 - Product Requirements.

2.11 BALL VALVES

A. Manufacturers:

1. Apollo Valves: www.apollovalves.com/#sle.

2. Grinnell Products: www.grinnell.com/#sle.

3. Nibco, Inc: www.nibco.com/#sle.

2.12 BALANCING VALVES

A. Manufacturers:

1. Griswold Controls: www.griswoldcontrols.com/#sle.

B. Construction: Class 125, brass or bronze body with union on inlet and outlet, temperature and pressure test plug on inlet and outlet, blowdown/backflush drain.

C. Manual Operated Y-Pattern Globe, Size 1/2 Inches (15 mm) to 2 Inches (50 mm):

1. Class 125, brass or bronze body, multi-turn handwheel, memory stop, variable orifice, soldered connections, dual PT (hot and cold pressure-temperature) test ports for 300 psi (2,068 kPa), minus 4 to 250 deg F (minus 20 to 121.1 deg C) WOG service.

D. Automatic Flow Limiting Cartridge, Size 3/4 Inches (20 mm):

1. Class 125, brass or bronze body, stainless steel cartridge, threaded connections with built-in union, dual PT (hot and cold pressure-temperature) test ports for 400 psi (2,758 kPa), 0.5 gpm (1.9 lpm) WOG service.

E. Automatic Flow Limiting Cartridge with Ball Valve, Size 1/2 to 1 Inches (15 to 25 mm):

1. Class 125, brass or bronze body, stainless steel cartridge, leak-proof stem, threaded or soldered connections with built-in union, dual PT (hot and cold pressure-temperature) test ports for 400 psi (2,758 kPa), 0.25 to 1.5 gpm (0.9 to 5.6 lpm) WOG service.

F. Calibration: Control flow within five percent of selected rating, over operating pressure range of 10 times minimum pressure required for control, maximum minimum pressure 3.5 psi (24 kPa).

2.13 WATER PRESSURE REDUCING VALVES

A. Manufacturers:

1. Apollo Valves: www.apollovalves.com/#sle.

2. Watts Regulator Company: www.wattsregulator.com/#sle.

3. Substitutions: See Section 016000 - Product Requirements.

B. Up to 2 Inches (50 mm):

1. ASSE 1003, bronze body, stainless steel, and thermoplastic internal parts, fabric reinforced diaphragm, strainer, threaded single union ends.

PART 3 -EXECUTION

3.01 PREPARATION

A. Ream pipe and tube ends. Remove burrs. Bevel plain end ferrous pipe.

B. Remove scale and dirt, on inside and outside, before assembly.

C. Prepare piping connections to equipment with flanges or unions.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Provide non-conducting dielectric connections wherever jointing dissimilar metals.

C. Route piping in orderly manner and maintain gradient. Route parallel and perpendicular to walls.

D. Install piping to maintain headroom, conserve space, and not interfere with use of space.

E. Group piping whenever practical at common elevations.

F. Install piping to allow for expansion and contraction without stressing pipe, joints, or connected equipment. See Section 220516.

G. Provide access where valves and fittings are not exposed.

1. Coordinate size and location of access doors with Section 083100.

H. Install vent piping penetrating roofed areas to maintain integrity of roof assembly

I. Prepare exposed, unfinished pipe, fittings, supports, and accessories for finish painting.

1. See Section 099123 for painting of interior plumbing systems and components.

J. Excavate in accordance with Section 312316.

K. Backfill in accordance with Section 312323.

L. Install bell and spigot pipe with bell end upstream.

M. Install valves with stems upright or horizontal, not inverted. See Section 220523.

N. Install water piping to ASME B31.9.

O. Copper Pipe and Tube: Make soldered joints in accordance with ASTM B828, using specified solder, and flux meeting ASTM B813; in potable water systems use flux also complying with NSF 61 and NSF 372.

P. PVC Pipe: Make solvent-welded joints in accordance with ASTM D2855.

Q. Sleeve pipes passing through partitions, walls, and floors.

R. Inserts:

1. Provide inserts for placement in concrete formwork.

2. Provide inserts for suspending hangers from reinforced concrete slabs and sides of reinforced concrete beams.

3. Provide hooked rod to concrete reinforcement section for inserts carrying pipe over 4 inches (100 mm).

4. Where concrete slabs form finished ceiling, locate inserts flush with slab surface.

5. Where inserts are omitted, drill through concrete slab from below and provide through-bolt with recessed square steel plate and nut above slab.

S. Pipe Hangers and Supports:

1. Install in accordance with ASME B31.9.

2. Support horizontal piping as indicated.

3. Install hangers to provide minimum 1/2 inch (15 mm) space between finished covering and adjacent work.

4. Place hangers within 12 inches (300 mm) of each horizontal elbow.

5. Use hangers with 1-1/2 inch (40 mm) minimum vertical adjustment. Design hangers for pipe movement without disengagement of supported pipe.

6. Support vertical piping at every other floor. Support riser piping independently of connected horizontal piping.

7. Where several pipes can be installed in parallel and at same elevation, provide multiple or trapeze hangers.

8. Provide copper plated hangers and supports for copper piping.

9. Prime coat exposed steel hangers and supports. Hangers and supports located in crawl spaces, pipe shafts, and suspended ceiling spaces are not considered exposed.

a. Painting of interior plumbing systems and components is specified in Section 099123.

b. Painting of exterior plumbing systems and components is specified in Section 099113.

10. Provide hangers adjacent to motor-driven equipment with vibration isolation; see Section 220548.

11. Support cast iron drainage piping at every joint.

T. Manufactured Sleeve-Seal Systems:

1. Install manufactured sleeve-seal systems in sleeves located in grade slabs and exterior concrete walls at piping entrances into building.

2. Provide sealing elements of the size, quantity, and type required for the piping and sleeve inner diameter or penetration diameter.

3. Locate piping in center of sleeve or penetration.

4. Install field assembled sleeve-seal system components in annular space between sleeve and piping.

5. Tighten bolting for a watertight seal.

6. Install in accordance with manufacturer's recommendations.

U. When installing more than one piping system material, ensure system components are compatible and joined to ensure the integrity of the system. Provide necessary joining fittings. Ensure flanges, union, and couplings for servicing are consistently provided.

3.03 APPLICATION

A. Install unions downstream of valves and at equipment or apparatus connections.

B. Provide spring-loaded check valves on discharge of water pumps.

C. Provide flow controls in water recirculating systems where indicated.

3.04 TOLERANCES

A. Drainage Piping: Establish invert elevations within 1/2 inch (10 mm) vertically of location indicated and slope to drain at minimum of 1/8 inch per foot (1:100) slope.

B. Water Piping: Slope at minimum of 1/32 inch per foot (1:400) and arrange to drain at low points.

3.05 DISINFECTION OF DOMESTIC WATER PIPING SYSTEM

A. Disinfect water distribution system in accordance with Section 330110.58.

B. Prior to starting work, verify system is complete, flushed, and clean.

C. Ensure acidity (pH) of water to be treated is between 7.4 and 7.6 by adding alkali (caustic soda or soda ash) or acid (hydrochloric).

D. Inject disinfectant, free chlorine in liquid, powder, tablet, or gas form throughout system to obtain 50 to 80 mg/L residual.

E. Bleed water from outlets to ensure distribution and test for disinfectant residual at minimum 15 percent of outlets.

F. Maintain disinfectant in system for 24 hours.

G. If final disinfectant residual tests less than 25 mg/L, repeat treatment.

H. Flush disinfectant from system until residual equal to that of incoming water or 1.0 mg/L.

I. Take samples no sooner than 24 hours after flushing, from 10 percent of outlets and from water entry, and analyze in accordance with AWWA C651.

3.06 SERVICE CONNECTIONS

A. Provide new sanitary and storm sewer services. Before commencing work, check invert elevations required for sewer connections, confirm inverts and ensure that these can be properly connected with slope for drainage and cover to avoid freezing.

3.07 SCHEDULES

A. Pipe Hanger Spacing:

1. Metal Piping:

a. Pipe Size: 1/2 inches (15 mm) to 1-1/4 inches (32 mm):
   1) Maximum Hanger Spacing: 6.5 ft (2 m).
   2) Hanger Rod Diameter: 3/8 inches (9 mm).

b. Pipe Size: 1-1/2 inches (40 mm) to 2 inches (50 mm):
   1) Maximum Hanger Spacing: 10 ft (3 m).
   2) Hanger Rod Diameter: 3/8 inch (9 mm).

c. Pipe Size: 2-1/2 inches (65 mm) to 3 inches (75 mm):
   1) Maximum Hanger Spacing: 10 ft (3 m).
   2) Hanger Rod Diameter: 1/2 inch (13 mm).

d. Pipe Size: 4 inches (100 mm) to 6 inches (150 mm):
   1) Maximum Hanger Spacing: 10 ft (3 m).
   2) Hanger Rod Diameter: 5/8 inch (15 mm).

END OF SECTION 221005

SECTION 221116 - DOMESTIC WATER PIPING

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Under-building slab and aboveground domestic water pipes, tubes, fittings, and specialties inside the building.

2. Encasement for piping.

3. Specialty valves.

4. Flexible connectors.

B. Related Section:

1. Division 02 Section "Water Distribution" for water-service piping and water meters outside the building from source to the point where water-service piping enters the building.

1.02 SUBMITTALS

A. Informational Submittals:

1. Water Samples: Specified in "Cleaning" Article.

2. Field quality-control reports.

1.03 QUALITY ASSURANCE

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

B. Comply with NSF 14 for plastic, potable domestic water piping and components.

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

D. Comply with NSF 372: Drinking water system components – lead content for potable domestic water piping and components.

1.04 PROJECT CONDITIONS

A. Interruption of Existing Water Service: Do not interrupt water service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water service according to requirements indicated:

1. Notify Owner no fewer than 14 days in advance of proposed interruption of water service.

2. Do not proceed with interruption of water service without Owner's written permission.

PART 2 -PRODUCTS

2.01 PIPING MATERIALS

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

2.02 COPPER TUBE AND FITTINGS

A. Hard Copper Tube: ASTM B 88, Type L water tube, drawn temper.

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

2. Wrought-Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

3. Bronze Flanges: ASME B16.24, Class 150, with solder-joint ends.

4. Copper Unions: MSS SP-123, cast-copper-alloy, hexagonal-stock body, with ball-and-socket, metal-to-metal seating surfaces, and solder-joint or threaded ends.

B. Soft Copper Tube: ASTM B 88, Type K water tube, annealed temper.

1. Copper Solder-Joint Fittings: ASME B16.22, wrought-copper pressure fittings.

2.03 DUCTILE-IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: ASNI A21.51/AWWA C151, cement lined in compliance with AWWA C104, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.

1. Standard-Pattern, Mechanical-Joint Fittings: AWWA C110, ductile or gray iron.

2. Compact-Pattern, Mechanical-Joint Fittings: AWWA C153, ductile iron.

a. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

2.04 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch thick or ASME B16.21, nonmetallic and asbestos free, unless otherwise indicated; 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. Include water-flushable flux according to ASTM B 813.

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

2.05 ENCASEMENT FOR PIPING

A. Standard: ASTM A 674 or AWWA C105.

B. Form: Sheet or Tube.

C. Material: LLDPE film of 0.008-inch minimum thickness or high-density, cross-laminated PE film of 0.004-inch minimum thickness.

D. Color: Manufacturer’s Standard.

2.06 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flex-Hose Co., Inc.

2. Hyspan Precision Products, Inc.

3. Mercer Rubber Co.

4. Metraflex, Inc.

5. Unaflex, Inc.

6. Universal Metal Hose; a Hyspan company

B. 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.

PART 3 -EXECUTION

3.01 EARTHWORK

A. Comply with requirements in Division 02 Section "Earthwork" for excavating, trenching, and backfilling.

3.02 PIPING INSTALLATION

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

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

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

D. Install underground copper tube and ductile-iron pipe in PE encasement according to ASTM A 674 or AWWA C105.

E. 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 Mechanical" for pressure gages and Division 22 Section "Domestic Water Piping Specialties" for drain valves and strainers.

F. Install water-pressure-reducing valves downstream from shutoff valves. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for pressure-reducing valves.

G. Install domestic water piping level and plumb.

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

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

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

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

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

M. Install piping to permit valve servicing.

N. 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.

O. Install piping free of sags and bends.

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

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

R. 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 Mechanical" for pressure gages.

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

T. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22 Section "Meters and Gages for Mechanical" for thermometers.

3.03 JOINT CONSTRUCTION

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

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

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

1. Apply appropriate tape or thread compound to external pipe threads.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged.

D. Brazed Joints: 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. Steel-Piping Grooved Joints: Cut or roll groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join steel pipe and grooved-end fittings according to AWWA C606 for steel-pipe grooved joints.

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

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

3.04 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22 Section "General-Duty Valves for Mechanical" 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.

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 calibrated balancing valves in each hot-water circulation return branch. Set calibrated balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22 Section "Domestic Water Piping Specialties" for calibrated balancing valves.

3.05 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing in accordance with specification section 22 05 00.

3.06 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports and installation requirements are specified in Division 22 Section "Hangers and Supports for Mechanical".

3.07 CONNECTIONS

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

B. 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 Section “Plumbing Fixture” 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.

3.08 SLEEVE INSTALLATION

A. Refer to section 22 05 00 for project sleeve requirements.

3.09 IDENTIFICATION

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

3.10 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.

3.11 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. 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.

3.12 CLEANING

A. Clean and disinfect potable and non-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. Protect piping from dirt and debris by sealing ends of piping when work on piping is not occurring.

3.13 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, ASTM B 88, Type K; wrought-copper solder-joint fittings; and brazed joints.

D. Under-building-slab, domestic water, building-service piping, and fire-service main piping, NPS 4 to NPS 12 and larger, shall be the following:

1. Mechanical-joint, ductile-iron pipe; standard- or compact-pattern mechanical-joint fittings; and mechanical joints.

E. Under-building-slab, domestic water piping, NPS 2 and smaller, shall be the following:

1. Soft copper tube, ASTM B88, Type K; wrought-copper solder-joint fittings; and brazed joints.

F. Aboveground domestic water piping, NPS 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 soldered joints.

G. Aboveground domestic water piping, NPS 2-1/2 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 soldered joints.

2. Hard copper tube, ASTM B 88, Type L; copper pressure-seal-joint fittings; and pressure-sealed joints.

3.14 VALVE SCHEDULE

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

1. Shutoff Duty: Use ball valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.

2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.

3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.

4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 221119 - DOMESTIC WATER PIPING SPECIALTIES

PART 1 -GENERAL

1.01 SUMMARY

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

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Flood Control Valves.
5. Balancing valves.
6. Temperature-actuated water mixing valves.
7. Strainers.
8. Outlet boxes.
9. Hose bibbs.
10. Hydrants.
11. Drain valves.
12. Water hammer arresters.
13. Trap-seal primers.

1.02 PERFORMANCE REQUIREMENTS

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

1.03 SUBMITTALS

A. Action Submittals:

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

B. Informational Submittal:

1. Trap-seal primer systems: power, signal, and control wiring diagrams.

C. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, maintenance manuals, and field quality-control test reports.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. 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."

3. Comply with NSF 372, “Drinking Water System Components – Lead Content.

PART 2 -PRODUCTS

2.01 VACUUM BREAKERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ames Co.

b. Cash Acme.

c. Conbraco Industries, Inc.

d. FEBCO; SPX Valves & Controls.

e. Rain Bird Corporation.

f. Toro Company (The); Irrigation Div.

g. Watts Industries, Inc.; Water Products Div.

h. 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: Chrome plated.

B. Hose-Connection Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Arrowhead Brass Products, Inc.

b. Cash Acme.

c. Conbraco Industries, Inc.

d. Legend Valve.

e. MIFAB, Inc.

f. Prier Products, Inc.

g. Watts Industries, Inc.; Water Products Div.

h. Woodford Manufacturing Company.

i. Zurn Plumbing Products Group; Light Commercial Operation.

j. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1011.

3. Body: Bronze, nonremovable, with manual drain.

4. Outlet Connection: Garden-hose threaded complying with ASME B1.20.7.

5. Finish: Chrome or nickel plated.

C. Pressure Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ames Co.

b. Conbraco Industries, Inc.

c. FEBCO; SPX Valves & Controls.

d. Flomatic Corporation.

e. Toro Company (The); Irrigation Div.

f. Watts Industries, Inc.; Water Products Div.

g. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1020.

3. Operation: Continuous-pressure applications.

4. Pressure Loss: 5 psig maximum, through middle 1/3 of flow range.

5. Accessories:

a. Valves: Ball type, on inlet and outlet.

D. Spill-Resistant Vacuum Breakers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Conbraco Industries, Inc.

b. Watts Industries, Inc.; Water Products Div.

2. Standard: ASSE 1056.

3. Operation: Continuous-pressure applications.

4. Accessories:

a. Valves: Ball type, on inlet and outlet.

2.02 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ames Co.

b. Conbraco Industries, Inc.

c. FEBCO; SPX Valves & Controls.

d. Flomatic Corporation.

e. Watts Industries, Inc.; Water Products Div.

f. Zurn Plumbing Products Group; Wilkins Div.

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; stainless steel 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 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.

9. Flood Control Valves:

    a. Application: backflow preventers 2-1/2 inch and larger.

    b. Flood control valve by same manufacturer as backflow preventer.

    c. Solenoid Valve:
        1) Standard: ANSI/AWWA C530 and NSF/ANSI 61.
        2) Pressure Rating: ANSI Class 150: 250 psig maximum.
        3) Body: Ductile iron ASTM A536.
        4) Trim: Stainless Steel
        5) End Connections: Flanged.
        6) Normally open operation with manual operator on solenoid valve.

    d. Controller Features:
        1) Automatic closure of solenoid valve upon detection of relief valve discharge.
        2) Time delay function to prevent activation due to intermittent discharges of less than 50 gallons.
        3) Input from and output to building automation system for activation and monitoring. Activation shall occur based on auxiliary water detection device. Upon activation, the operator interface shall be notified.

B. Beverage-Dispensing-Equipment Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.

    b. Watts Industries, Inc.; Water Products Div.

    c. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1022.

3. Operation: Continuous-pressure applications.

4. Size: NPS 1/4 or NPS 3/8.

5. Body: Stainless steel.

6. End Connections: Threaded.

C. Hose-Connection Backflow Preventers:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Conbraco Industries, Inc.

    b. Watts Industries, Inc.; Water Products Div.

    c. Woodford Manufacturing Company.

2. Standard: ASSE 1052.

3. Operation: Up to 10-foot head of water back pressure.

4. Inlet Size: NPS 1/2 or NPS 3/4.

5. Outlet Size: Garden-hose thread complying with ASME B1.20.7.

6. Capacity: At least 3-gpm flow.

2.03 WATER PRESSURE-REDUCING VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Cash Acme.

2. Conbraco Industries, Inc.

3. Honeywell Water Controls.

4. Watts Industries, Inc.; Water Products Div.

5. Zurn Plumbing Products Group; Wilkins Div.

B. Standard: ASSE 1003.

C. Pressure Rating: Initial working pressure of 150 psig.

D. 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 NPS 3.

E. Valves for Booster Heater Water Supply: Include integral bypass.

F. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and NPS 3.

2.04 FLOOD CONTROL VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Watts Industries, Inc.; Water Products Div.

2. Zurn Plumbing Products Group; Wilkins Div.

B. Solenoid Valve:

1. Standard: ANSI/AWWA C530 and NSF/ANSI 61.

2. Pressure Rating: ANSI Class 150: 250 psig maximum.

3. Body: Ductile iron ASTM A536.

4. Trim: Stainless Steel

5. End Connections: Flanged.

6. Normally open operation with manual operator on solenoid valve.

C. Controller:

1. Features:

    a. Automatic closure of solenoid valve upon detection of relief valve discharge.

    b. Time delay function to prevent activation due to intermittent discharges of less than 50 gallons.

    c. Input from and output to building automation system for activation and monitoring. Activation shall occur based on auxiliary water detection device. Upon activation, the operator interface shall be notified.

2.05 BALANCING VALVES

A. Copper-Alloy Calibrated Balancing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong International, Inc.

    b. Flo Fab Inc.

    c. ITT Industries; Bell & Gossett Div.

    d. NIBCO INC.

    e. TAC Americas.

    f. Taco, Inc.

    g. Watts Industries, Inc.; Water Products Div.

2. Type: Ball or Y-pattern globe valve with two readout ports and memory setting indicator.

3. Body: Brass or bronze.

4. Size: Same as connected piping, but not larger than NPS 2.

2.06 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Water-Temperature Limiting Devices:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Armstrong International, Inc.

    b. Leonard Valve Company.

    c. Powers; a Watts Industries Co.

    d. Symmons Industries, Inc.

2. Standard: ASSE 1017.

3. Pressure Rating: 125 psig.

4. Type: Thermostatically controlled water mixing valve.

5. Material: Bronze body with corrosion-resistant interior components.

6. Connections: Threaded or union inlets and outlet.

7. Accessories: Check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

8. Valve Finish: Provide chrome plated finish in occupied areas. In non-occupied areas Rough bronze is acceptable.

B. Primary, Thermostatic, Water Mixing Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armstrong International, Inc.

b. Lawler Manufacturing Company, Inc.

c. Leonard Valve Company.

d. Powers; a Watts Industries Co.

e. Symmons Industries, Inc.

2. Standard: ASSE 1017.

3. Pressure Rating: 125 psig.

4. Type: Exposed-mounting, thermostatically controlled water mixing valve.

5. Material: Bronze body with corrosion-resistant interior components.

6. Connections: Threaded or union inlets and outlet.

7. Accessories: Manual temperature control, check stops on hot- and cold-water supplies, and adjustable, temperature-control handle.

8. Valve Pressure Rating: 125 psig minimum, unless otherwise indicated.

9. Valve Finish: Polished, chrome plated in occupied areas.

10. Piping Finish: Chrome plated in occupied areas.

C. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Cash Acme.

b. Conbraco Industries, Inc.

c. Honeywell Water Controls.

d. Lawler Manufacturing Company, Inc.

e. Leonard Valve Company.

f. Powers; a Watts Industries Co.

g. Watts Industries, Inc.; Water Products Div.

h. Zurn Plumbing Products Group; Wilkins Div.

2. Standard: ASSE 1016, thermostatically controlled water tempering valve.

3. Pressure Rating: 125 psig minimum, unless otherwise indicated.

4. Body: Bronze body with corrosion-resistant interior components.

5. Temperature Control: Adjustable.

6. Inlets and Outlet: Threaded.

7. Finish: Rough or chrome-plated bronze.

2.07 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig minimum, unless otherwise indicated.

2. Body: Bronze for NPS 2 and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 and larger.

3. End Connections: Threaded for NPS 2 and smaller; flanged for NPS 2-1/2 and larger.

4. Screen: Stainless steel with round perforations, unless otherwise indicated.

5. Perforation Size:

a. Strainers NPS 2 and Smaller: 0.062 inch.

b. Strainers NPS 2-1/2 to NPS 4: 0.125 inch.

c. Strainers NPS 5 and Larger: 0.25 inch.

6. Drain: Provide hose-end drain valve in mechanical rooms. Provide end plug for above ceiling or occupied area locations.

2.08 OUTLET BOXES

A. Clothes Washer Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acorn Engineering Company.

b. Guy Gray Manufacturing Co., Inc.

c. IPS Corporation.

d. LSP Products Group, Inc.

e. Oatey.

f. Plastic Oddities; a division of Diverse Corporate Technologies.

g. Symmons Industries, Inc.

h. Watts Industries, Inc.; Water Products Div.

i. Whitehall Manufacturing; a div. of Acorn Engineering Company.

j. Zurn Plumbing Products Group; Light Commercial Operation.

2. Mounting: Recessed.

3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.

4. Faucet: Combination, valved fitting or separate hot- and cold-water, valved fittings complying with ASME A112.18.1. Include garden-hose thread complying with ASME B1.20.7 on outlets.

5. Supply Shutoff Fittings: NPS 1/2 gate, globe, or ball valves and NPS 1/2 copper, water tubing.

6. Drain: NPS 2 inch, unless noted otherwise on plans, standpipe and P-trap for direct waste connection to drainage piping.

7. Inlet Hoses: Two 60-inch- long, rubber household clothes washer inlet hoses with female, garden-hose-thread couplings. Include rubber washers.

8. Drain Hose: One 48-inch- long, rubber household clothes washer drain hose with hooked end.

B. Icemaker Outlet Boxes:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Acorn Engineering Company.

b. IPS Corporation.

c. LSP Products Group, Inc.

d. Oatey.

e. Plastic Oddities; a division of Diverse Corporate Technologies.

2. Mounting: Recessed.

3. Material and Finish: Enameled-steel or epoxy-painted-steel box and faceplate.

4. Faucet: Valved fitting complying with ASME A112.18.1. Include NPS 1/2 or smaller copper tube outlet.

5. Supply Shutoff Fitting: NPS 1/2 gate, globe, or ball valve and NPS 1/2 copper, water tubing.

2.09 HOSE BIBBS

A. Hose Bibbs:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company.

   b. MIFAB, Inc.

   c. Prier Products, Inc.

   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

   e. Tyler Pipe; Wade Div.

   f. Watts Drainage Products Inc.

   g. Woodford Manufacturing Company.

   h. Zurn Plumbing Products Group; Light Commercial Operation.

   i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.18.1 for sediment faucets.

3. Body Material: Bronze.

4. Seat: Bronze, replaceable.

5. Supply Connections: NPS 1/2 or NPS 3/4 threaded or solder-joint inlet.

6. Outlet Connection: Garden-hose thread complying with ASME B1.20.7.

7. Pressure Rating: 125 psig.

8. Vacuum Breaker: Integral or field-installation, nonremovable, drainable, hose-connection vacuum breaker complying with ASSE 1011.

9. Finish for Equipment Rooms: Rough bronze, or chrome or nickel plated.

10. Finish for Finished Rooms: Chrome or nickel plated.

11. Operation for Equipment Rooms: Wheel handle.

12. Operation for Finished Rooms: Wheel handle.

13. Include operating key with each operating-key hose bibb.

14. Include wall flange with each chrome- or nickel-plated hose bibb.

2.10 WALL HYDRANTS

A. Nonfreeze Wall Hydrants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company.

   b. MIFAB, Inc.

   c. Prier Products, Inc.

   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

   e. Tyler Pipe; Wade Div.

   f. Watts Drainage Products Inc.

   g. Woodford Manufacturing Company.

   h. Zurn Plumbing Products Group; Light Commercial Operation.

   i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.

3. Pressure Rating: 125 psig.

4. Operation: Loose key.

5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.

6. Inlet: NPS 3/4 or NPS 1.

7. Outlet: Concealed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

8. Box: Deep, flush mounting with cover.

9. Box and Cover Finish: Polished nickel bronze.

10. Outlet: Exposed, with integral vacuum breaker and garden-hose thread complying with ASME B1.20.7.

11. Nozzle and Wall-Plate Finish: Polished nickel bronze.

12. Operating Keys(s): One with each wall hydrant.

2.11 DRAIN VALVES

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

1. Size: NPS 3/4.

2. Refer to valve specification for ball valve requirements as applicable to system type and pressure. Provide the following additional accessories:

3. Size: NPS 3/4.

4. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.12 WATER HAMMER ARRESTERS

A. Water Hammer Arresters:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. AMTROL, Inc.

b. Josam Company.

c. MIFAB, Inc.

d. PPP Inc.

e. Sioux Chief Manufacturing Company, Inc.

f. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

g. Tyler Pipe; Wade Div.

h. Watts Drainage Products Inc.

i. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard: ASSE 1010 or PDI-WH 201.

3. Type: Metal bellows.

4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.13 TRAP-SEAL PRIMER VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. MIFAB, Inc.

a. PPP Inc.

b. Sioux Chief Manufacturing Company, Inc.

c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

d. Watts Industries, Inc.; Water Products Div.

2. Standard: ASSE 1018.

3. Pressure Rating: 125 psig minimum.

4. Body: Bronze.

5. Inlet and Outlet Connections: NPS 1/2 threaded, union, or solder joint.

6. Gravity Drain Outlet Connection: NPS 1/2 threaded or solder joint.

7. Finish: Chrome plated, or rough bronze for units used with pipe or tube that is not chrome finished.

2.14 TRAP-SEAL PRIMER SYSTEMS

A. Trap-Seal Primer Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. PPP Inc.

2. Standard: ASSE 1044.

3. Piping: NPS 3/4, ASTM B 88, Type L; copper, water tubing.

4. Cabinet: Surface-mounting steel box with stainless-steel cover.

5. Electric Controls: 24-hour timer, solenoid valve, and manual switch for 120-V ac power.

6. Vacuum Breaker: ASSE 1001.

7. Number Outlets: Four.

8. Size Outlets: NPS 1/2.

PART 3 -EXECUTION

3.01 INSTALLATION

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

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

1. Install drain for backflow preventers with pressure relief fittings using air-gap fitting. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

2. Route drain for backflow preventer relief to nearest floor drain. Floor drain shall have a waste connection size at least that of the backflow preventor relief piping.

3. Install flood control valves on all reduced pressure type backflow preventors 2-1/2" and larger. Connect all accessories, sensors, wiring and controls necessary for proper operation. Connect flood control valve controller to building automation system.

4. Install water detector at each backflow preventer location. Connect water detector to building automation system.

5. Do not install bypass piping around backflow preventers.

C. Install balancing valves in locations where they can easily be adjusted.

D. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install cabinet-type units recessed in or surface mounted on wall as specified.

E. Install Y-pattern strainers for water on supply side of each water meter, control valve, water pressure-reducing valve, solenoid valve, and pump.

F. Install outlet boxes recessed in wall. Reinforce outlet boxes between studs using 2-by-4-inch fire-retardant-treated-wood blocking wall reinforcement or metal brackets.

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

H. Install supply-type, trap-seal primer valves with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust valve for proper flow.

I. Install trap-seal primer systems with outlet piping pitched down toward drain trap a minimum of 1 percent, and connect to floor-drain body, trap, or inlet fitting. Adjust system for proper flow.

3.02 CONNECTIONS

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

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

C. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

3.03 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each backflow preventer 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.

3.04 ADJUSTING

A. Set field-adjustable pressure set points of water pressure-reducing valves.

B. Set field-adjustable flow set points of balancing valves.

C. Set field-adjustable temperature set points of temperature-actuated water mixing valves.

END OF SECTION 221119

SECTION 221123 - DOMESTIC WATER PUMPS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Circulators.

1.02 RELATED REQUIREMENTS

A. Section 220513 - Common Motor Requirements for Plumbing Equipment.

B. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

C. Section 253500 - Integrated Automation Instrumentation and Terminal Devices for HVAC.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks 2020, with Errata (2023).

B. ASME A13.1 - Scheme for the Identification of Piping Systems 2020.

C. ICC (IPC) - International Plumbing Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

D. NFPA 70 - National Electrical Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. NSF 61 - Drinking Water System Components - Health Effects 2022, with Errata.

F. UL 778 - Standard for Motor-Operated Water Pumps Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data:

1. Provide certified pump curve with duty point marked over pump and system operating conditions and NPSH curve and power requirement by pump tag.

2. Manufacturer's catalog sheets for fixtures, fittings, accessories, and supplies.

C. Shop Drawings: Include dimensions and performance data.

D. Project Record Documents: Record actual locations of components.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing type of products specified in this section, with minimum three years of documented experience.

B. Certifications: Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc, as suitable for purpose specified and indicated.

C. Identification: Provide pumps with manufacturer's name, model number, and rated capacity identified by permanently attached label.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

1.07 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Manufacturer Warranty: Provide 1-year manufacturer warranty for pumps except circulator type. Complete forms in Owner's name and register with manufacturer.

C. Manufacturer Warranty: Provide 5-year manufacturer warranty for circulators. Complete forms in Owner's name and register with manufacturer.

PART 2 PRODUCTS

2.01 CIRCULATORS

A. Manufacturers:

1. Bell & Gossett, a Brand of Xylem, Inc: www.xylem.com/#sle.

2. Grundfos Pumps Corporatio: www.grundfos.com/#sle.

B. Casing: Cast iron with impeller, and stainless steel rotor assembly.

C. Shaft: Alloy steel with integral thrust collar and two oil-lubricated bronze sleeve bearings.

D. Mechanical Seal: Carbon rotating against a stationary ceramic seat.

E. Pipe-End Connection: Flange connection.

F. Maximum Discharge Pressure: 145 psi (1000 kPa).

G. Motor: 1,750 rpm, ECM duty with flexible coupling.

H. Service Temperature Range: Minus 30 to 250 degrees F (Minus 34.4 to 121.1 degrees C).

I. Controls: Provide aquastat set for high-temp cutoff, electric plug, and illuminated hand switch.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install products with related fittings, and accessories according to manufacturer instructions.

B. Potable and Drinking Water Service: Provide NSF 61 certified; comply with ICC (IPC).

C. Electrical-Driven Pump Work:

1. Provide electric-motor-driven equipment specified complete with local disconnect switch and control panel with starter, controls, safety devices, and related wiring.

2. Provide automatic control and protective devices field-wired to interface-related devices required for specified operation.

D. Ensure that small pressure gauges are installed on both upstream and downstream ends.

E. Factory-Provided Pump Controls: Factory provided, tested for use.

F. ECM, VSD, or VFD Controlled Motors: Configure unit to operate within manufacturer-listed pump curve points unless factory set to do so. Then adjust to operate in automatic to maintain downstream pressure setpoint.

G. Ensure pumps operate at specified system fluid temperatures without vapor binding and cavitation, are nonoverloading in parallel or individual operation, and operate within 25 percent of midpoint of published maximum efficiency curve.

H. Coordinate BAS, BMS, or Integrated Automation linking between unit controller and remote software app or terminal; see Section 253500.

3.02 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Operational Tests: Upon completion and sterilization of plumbing systems, conduct operating tests to demonstrate satisfactory, functional, and operating efficiency.

3.03 CLEANING

A. Thoroughly clean plumbing fixtures and equipment.

3.04 PROTECTION

A. Protect installed products from damage due from subsequent construction operations.

B. Repair or replace products damaged before Date of Substantial Completion.

END OF SECTION 221123

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 221316 - SANITARY WASTE AND VENT PIPING

PART 1 -GENERAL

1.01 SUMMARY

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

1. Pipe, tube, and fittings.
2. Special pipe fittings.
3. Encasement for underground piping.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data: For pipe, tube, fittings, and couplings.

B. Informational Submittals:

1. Field quality-control inspection and test reports.

1.03 QUALITY ASSURANCE

A. Piping and fittings marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) or receive prior approval of the Engineer.

B. Plastic piping to Comply with NSF-14, “Plastic Piping Systems Components and Related Materials” and be marked accordingly.

1.04 PERFORMANCE REQUIREMENTS

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

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

1.05 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. LLDPE: Linear, low-density polyethylene plastic.

C. NBR: Acrylonitrile-butadiene rubber.

D. PE: Polyethylene plastic.

E. PVC: Polyvinyl chloride plastic.

F. TPE: Thermoplastic elastomer.

G. CISPI: Cast Iron Soil Pipe Institute.

H. CPVC: Chlorinated polyvinyl chloride.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class(es).

B. Gaskets: ASTM C 564, rubber.

2.03 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Charlotte Pipe and Foundry Co.

C. Shielded Couplings: ASTM C 1277C or ASTM C 1540 Heavy Duty Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

1. Manufacturers:

a. ANACO-Husky.

b. Fernco, Inc.

c. Ideal Div.; Stant Corp.

d. Mission Rubber Co.

e. Tyler Pipe; Soil Pipe Div.

2.04 CPVC PIPE AND FITTINGS

A. CPVC Type IV, Grade 1 Chemical Waste Drain System: Pipe and fittings to conform to ASTM F2618. Pipe to be Schedule 40 dimensions. Buried pipe installed to conform to ASTM D2321 and ASTM F1668 and following manufacturer’s installation instructions including bedding and support. Approved for use in non-pressure waste applications with a maximum working temperature of 220 deg F. Pipe joining shall be solvent weld using only primer and cement approved by manufacturer.

B. Approved manufacturers:

1. Charlotte Pipe – Chem Drain.

2.05 DWV PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, Schedule 40.

B. PVC Socket Fittings: ASTM D 2665, made to ASTM D 3311 and matched to pipe material and pipe schedule.

C. PVC Solvent Cement and Adhesive Primer:

1. ASTM D2564 solvent cement with VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Primer with VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.06 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Dallas Specialty & Mfg. Co.

b. Fernco, Inc.

c. Logan Clay Products Company (The).

d. Mission Rubber Co.

e. NDS, Inc.

f. Plastic Oddities, Inc.

2. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.

b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

PART 3 -EXECUTION

3.01 PIPING APPLICATIONS

A. Do not locate cleanouts in and above:

1. Electrical and communications rooms.

2. Other locations indicated on drawings.

B. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

C. Aboveground, soil, waste, and vent piping:

1. Hubless cast-iron soil pipe and fittings; heavy duty shielded, stainless-steel couplings; and hubless-coupling joints.

D. Underground, soil, waste, and vent piping:

1. Service class, cast-iron soil piping; and gasketed joints.

2. Solid wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

3. Dissimilar Pipe-Material Couplings: Flexible, shielded, nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

3.02 PIPING INSTALLATION

A. Sanitary waste piping outside the building are specified in Division 02.

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Mechanical."

C. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

D. Install cleanout fitting with closure plug inside the building in sanitary force-main piping.

E. Install mechanical sleeve seal at every penetration through exterior foundation wall. Installation to be watertight.

F. 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. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

G. 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.

H. 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.

I. Install soil and waste drainage and vent piping at no less than the minimum slopes allowed by state or local plumbing code.

J. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

K. Install underground PVC soil and waste drainage piping according to ASTM D 2321.

L. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI`s "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hubless cast-iron soil piping according to CISPI 310 and CISPI`s "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. Soldered Joints: Use ASTM B 813, water-flushable, lead-free flux; ASTM B 32, lead-free-alloy solder; and ASTM B 828 procedure, unless otherwise indicated.

D. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.04 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section “Hangers and Supports for Mechanical”. Install the following:

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

2. Install 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.

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

C. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch minimum rods.

D. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters. Support at every hub or every coupling within 18 inches of the hub or coupling. Installations that require multiple joints within a four-foot developed length may be supported at every other or alternating hub or coupling when approved.

1. NPS 1-1/2 and NPS 2: 60 inches with 3/8-inch rod.

2. NPS 3: 60 inches with 1/2-inch rod.

3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

4. NPS 6: 60 inches with 3/4-inch rod.

5. NPS 8 to NPS 12: 60 inches with 7/8-inch rod.

E. Install supports for vertical cast-iron soil piping every 15 feet and at each floor

F. Restrain joints and install sway bracing as needed to stabilize side movement and at changes in direction.

3.05 CONNECTIONS

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

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.

2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.

3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.

4. 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.

3.06 FIELD QUALITY CONTROL

A. Prior to connecting a new structure sanitary sewer to a previous building's sewer, the original sewer must be flushed thoroughly with water and tested with an electronic video inspection performed in the presence of the Plumbing Inspector. The electronic inspection may be recorded and submitted for later review if approved by the Inspector.

B. 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.

C. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

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

E. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping, except outside leaders, on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg. Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.07 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.

3.08 PROTECTION

A. Exposed PVC Piping: Protect plumbing vents exposed to sunlight with two coats of water-based latex paint.

END OF SECTION 221316

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SECTION 221319 - SANITARY WASTE PIPING SPECIALTIES

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Miscellaneous sanitary drainage piping specialties.
4. Flashing materials.

1.02 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. FOG: Fats, oils, and greases.

C. FRP: Fiberglass-reinforced plastic.

D. HDPE: High-density polyethylene plastic.

E. PE: Polyethylene plastic.

F. PP: Polypropylene plastic.

G. PVC: Polyvinyl chloride plastic.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

a. Drains.

B. Informational Submittals:

1. Operation and Maintenance Data: For drainage piping specialties to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with NSF 14, "Plastics Piping Components and Related Materials," for plastic sanitary piping specialty components.

PART 2 -PRODUCTS

2.01 CLEANOUTS

A. Exposed Metal Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.

   b. MIFAB, Inc.

   c. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

   d. Tyler Pipe; Wade Div.

   e. Watts Drainage Products Inc.

   f. Zurn Plumbing Products Group; Specification Drainage Operation.

   g. Josam Company; Blucher-Josam Div.

2. Standard: ASME A112.36.2M for cast iron for cleanout test tee.

3. Size: Same as connected drainage piping

4. Body Material: As required to match connected piping.

5. Closure: Raised-head, plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

B. Metal Floor Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Josam Company; Josam Div.

   b. Oatey.

   c. Sioux Chief Manufacturing Company, Inc.

   d. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

   e. Tyler Pipe; Wade Div.

f. Watts Drainage Products Inc.

g. Zurn Plumbing Products Group; Light Commercial Operation.

h. Zurn Plumbing Products Group; Specification Drainage Operation.

2. Standard and type: ASME A112.36.2M for threaded, adjustable housing cleanout.

3. Size: Same as connected branch.

4. Body or Ferrule: Cast iron.

5. Clamping Device: Required on all floors above base slab.

6. Outlet Connection: compatible with piping system.

7. Closure: Brass plug with threads and gasket.

8. Adjustable Housing Material: Cast iron with threads.

9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.

10. Frame and Cover Shape: Round.

11. Top Loading Classification: Extra Heavy Duty.

12. Riser: ASTM A 74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company; Josam Div.

b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

c. Zurn Plumbing Products Group; Specification Drainage Operation.

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.

8. Wall Access: Round, wall-installation frame wall-installation frame and cover.

2.02 FLOOR DRAINS

A. Cast-Iron Floor Drains:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Josam Company; Josam Div.

b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

c. Zurn Plumbing Products Group; Specification Drainage Operation.

2.03 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.

B. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.

C. Air-Gap Fittings:

1. Standard: ASME A112.1.2, for fitting designed to ensure fixed, positive air gap between installed inlet and outlet piping.

2. Body: Bronze or cast iron.

3. Inlet: Opening in top of body.

4. Outlet: Larger than inlet.

D. Sleeve Flashing Device:

1. Description: Manufactured, cast-iron fitting, with clamping device, that forms sleeve for pipe floor penetrations of floor membrane. Include galvanized-steel pipe extension in top of fitting that will extend 2 inches above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.

E. 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.

F. Expansion Joints:

1. Standard: ASME A112.21.2M.

2. Body: Cast iron with bronze sleeve, packing, and gland.

3. End Connections: Matching connected piping.

2.04 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:

1. General Applications: 12 oz./sq. ft. thickness.

2. Vent Pipe Flashing: 8 oz./sq. ft. thickness.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch minimum thickness, unless otherwise indicated. Include G90 hot-dip galvanized, mill-phosphatized finish for painting if indicated.

C. Elastic Membrane Sheet: ASTM D 4068, flexible, chlorinated polyethylene, 40-mil minimum thickness.

D. Fasteners: Metal compatible with material and substrate being fastened.

E. Metal Accessories: Sheet metal strips, clamps, anchoring devices, and similar accessory units required for installation; matching or compatible with material being installed.

F. Solder: ASTM B 32, lead-free alloy.

G. Bituminous Coating: SSPC-Paint 12, solvent-type, bituminous mastic.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Coordinate all cleanout locations with Architect prior to installation. In hard floor finished areas, extend cleanout to adjacent service space. In tile carpeted areas, install cleanout under carpet tile with carpet marker.

B. Do not install cleanouts or sanitary specialties in electrical and communications rooms.

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

D. Install backwater valves in building drain piping. For interior installation, provide cleanout deck plate flush with floor and centered over backwater valve cover, and of adequate size to remove valve cover for servicing.

E. Install cleanouts in aboveground piping and building drain piping according to local code and to the following, and as indicated on plans:

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 40 feet.

4. Locate at base of each vertical soil and waste stack.

F. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

G. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

H. Install 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. Refer to architectural plans for locations requiring floor sloping to drains.

3. Install 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 drains connected to sanitary building drain, unless otherwise indicated.

I. Install roof flashing on sanitary stack vents and vent stacks that extend through roof.

J. Assemble open drain fittings and install with top of hub 2 inches above floor.

K. 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.

L. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

M. Install blocking reinforcement for wall-mounting-type specialties.

N. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

O. Install escutcheons at wall, floor, and ceiling penetrations in exposed finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding pipe fittings.

3.02 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.

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

D. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

3.03 FLASHING INSTALLATION

A. Fabricate flashing from single piece unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Copper Sheets: Solder joints of copper sheets.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum length of 10 inches, and skirt or flange extending at least 8 inches around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches around sleeve.

3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches around specialty.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

E. Install flashing for piping passing through roofs with counterflashing or commercially made flashing fittings, according to Division 07 Section "Sheet Metal Flashing and Trim."

F. Extend flashing up vent pipe passing through roofs and turn down into pipe, or secure flashing into cast-iron sleeve having calking recess.

G. Fabricate and install flashing and pans, sumps, and other drainage shapes.

3.04 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION 221319

SECTION 221413 - STORM DRAINAGE PIPING

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the following storm drainage piping inside the building:

1. Pipe, tube, and fittings.

2. Special pipe fittings.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data: For pipe, tube, fittings, and couplings.

B. Informational Submittals:

1. Field quality-control inspection and test reports.

1.03 QUALITY ASSURANCE

A. Piping and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute or receive prior approval of the Engineer.

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

1.04 PERFORMANCE REQUIREMENTS

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

1. Storm Drainage Piping: 10-foot head of water.

1.05 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

C. PVC: Polyvinyl chloride plastic.

D. CISPI: Cast Iron Soil Pipe Institute.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class(es).

B. Gaskets: ASTM C 564, rubber.

2.03 HUBLESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 or ASTM C1540 Heavy Duty Couplings: CISPI 310, with stainless-steel corrugated shield; stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

1. Manufacturers:

a. ANACO.

b. Fernco, Inc.

c. Husky.

d. Ideal Div.; Stant Corp.

e. Mission Rubber Co.

f. Tyler Pipe; Soil Pipe Div.

g. Charlotte Pipe and Foundry Co.

2.04 PVC PIPE AND FITTINGS

A. Solid-Wall PVC Pipe: ASTM D 2665, drain, waste, and vent.

B. Solvent Cement and Adhesive Primer:

1. Use PVC solvent cement that has a VOC content of 510 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2. Use adhesive primer that has a VOC content of 550 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.05 SPECIAL PIPE FITTINGS

A. Flexible, Nonpressure Pipe Couplings: Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition pattern. Include shear ring, ends of same sizes as piping to be joined, and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Available Manufacturers:

a. Dallas Specialty & Mfg. Co.

b. Fernco, Inc.

c. Logan Clay Products Company (The).

d. Mission Rubber Co.

e. NDS, Inc.

f. Plastic Oddities, Inc.

2. Sleeve Materials:

a. For Cast-Iron Soil Pipes: ASTM C 564, rubber.

b. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

c. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

PART 3 -EXECUTION

3.01 EXCAVATION

A. Refer to Division 02 Section "Earthwork" for excavating, trenching, and backfilling.

3.02 PIPING APPLICATIONS

A. Cleanouts shall not be located in and above electrical and communications rooms.

B. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

C. Aboveground storm drainage piping shall be any of the following:

1. Hubless cast-iron soil pipe and fittings; heavy-duty shielded, stainless-steel couplings; and coupled joints.

D. Underground storm drainage piping shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Solid-wall PVC pipe, PVC socket fittings, and solvent-cemented joints.

3. Dissimilar Pipe-Material Couplings: Flexible, shielded, rigid nonpressure pipe couplings nonpressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

3.03 PIPING INSTALLATION

A. Storm sewer and drainage piping outside the building are specified in Division 02 Section "Storm Drainage."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Mechanical."

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers.

D. Install cast-iron storm piping according to CISPI`s "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

E. Make changes in direction for storm drainage piping using appropriate branches, bends, and long-sweep bends. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

F. Lay buried building storm drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer`s written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

G. Install storm drainage piping at a minimum of 1 percent except where indicated differently on plans.

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 storm drainage piping according to ASTM D 2665 and ASTM D 2321.

J. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

3.04 JOINT CONSTRUCTION

A. Hub-and-Spigot, Cast-Iron Soil Piping Gasketed Joints: Join according to CISPI`s "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Hubless Cast-Iron Soil Piping Coupled Joints: Join according to CISPI 310 and CISPI`s "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

C. PVC Nonpressure Piping Joints: Join piping according to ASTM D 2665.

3.05 HANGER AND SUPPORT INSTALLATION

A. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Mechanical”.

B. Install and space supports according to Division 22 Section “Hangers and Supports for Mechanical”.

3.06 CONNECTIONS

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

B. Connect interior storm drainage piping to exterior storm drainage piping. Use transition fitting to join dissimilar piping materials.

C. Connect storm drainage piping to roof drains and storm drainage specialties.

3.07 FIELD QUALITY CONTROL

A. Prior to connecting a new structure storm sewer to a previous building's sewer, the original sewer must be flushed thoroughly with water and tested with an electronic video inspection performed in the presence of the Plumbing Inspector. The electronic inspection may be recorded and submitted for later review if approved by the Inspector.

B. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

C. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

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

E. Test storm drainage piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced storm drainage piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Test Procedure: Test storm drainage piping on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water. From 15 minutes before inspection starts to completion of inspection, water level must not drop. Isolate test source and allow to stand for four hours. Inspect joints for leaks.

4. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

5. Prepare reports for tests and required corrective action.

3.08 CLEANING

A. Clean interior of piping. Remove dirt and debris as work progresses.

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

END OF SECTION 221413

SECTION 221423 - STORM DRAINAGE PIPING SPECIALTIES

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Metal roof drains.
2. Miscellaneous storm drainage piping specialties.
3. Cleanouts.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.03 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 -PRODUCTS

2.01 METAL ROOF DRAINS

A. See plumbing fixture schedule on drawings.

2.02 MISCELLANEOUS STORM DRAINAGE PIPING SPECIALTIES

A. Downspout Nozzles:

1. See plumbing fixture schedule on drawings.

2.03 CLEANOUTS

A. Cast-Iron Exposed Cleanouts:

1. Standard: ASME A112.36.2M.
2. Size: Same as connected branch.
3. Body Material: No-hub, cast-iron soil pipe test tee as required to match connected piping.
4. Closure: Countersunk or raised-head, brass plug.
5. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

B. Cast-Iron Exposed Floor Cleanouts:

1. Standard: ASME A112.36.2M.
2. Size: Same as connected branch.
3. Type: Adjustable housing.
4. Body or Ferrule: Cast iron.
5. Clamping Device: Not Required.
6. Outlet Connection: Threaded.
7. Closure: Brass plug with tapered threads.
8. Adjustable Housing Material: Cast-iron with threads.
9. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
10. Frame and Cover Shape: Square.
11. Top Loading Classification: Medium Duty.
12. Riser: ASTM A74, Extra-Heavy class, cast-iron drainage pipe fitting and riser to cleanout.

C. Cast-Iron Wall Cleanouts:

1. Standard: ASME A112.36.2M. Include wall access.
2. Size: Same as connected drainage piping.
3. Body: No-hub, cast-iron soil pipe test tee as required to match connected piping.
4. Closure Plug:
    a. Brass
    b. Countersunk
    c. Drilled and threaded for cover attachment screw.
    d. Size: Same as, or not more than, one size smaller than cleanout size.
5. Wall Access, Cover Plate: Round, flat, chrome-plated brass or stainless steel cover plate with screw.

D. Test Tees:

1. Standard: ASME A112.36.2M and ASTM A74, ASTM A888, or CISPI 301.
2. Size: Same as connected drainage piping.
3. Body Material: Hub-and-spigot, cast-iron soil-pipe T-branch or no-hub, cast-iron soil-pipe test tee as required to match connected piping.
4. Closure Plug: Countersunk, brass.

5. Closure Plug Size: Same as, or not more than, one size smaller than cleanout size.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Install roof drains at low points of roof areas in accordance with roof membrane manufacturer's written installation instructions.

1. Install flashing collar or flange of roof drain to prevent leakage between drain and adjoining roofing. Maintain integrity of waterproof membranes where penetrated.

2. Install expansion joints, if indicated, in roof drain outlets.

3. Position roof drains for easy access and maintenance.

B. Install downspout nozzles at exposed bottom of conductors where they spill onto grade.

C. Install cleanouts in aboveground piping and building drain piping in accordance with the following instructions unless otherwise indicated:

1. Use cleanouts the same size as drainage piping up to NPS 4. Use NPS 4 for larger drainage piping unless larger cleanout is indicated.

2. Locate cleanouts at each change in direction of piping greater than 45 degrees.

3. Locate cleanouts at minimum intervals of 50 feet for piping NPS 4 and smaller and 100 feet for larger piping.

4. Locate cleanouts at base of each vertical storm piping conductor.

D. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

E. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

F. Install horizontal backwater valves in floor with cover flush with floor.

G. Install test tees in vertical conductors and near floor.

H. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

I. Install through-penetration firestop assemblies for penetrations of fire- and smoke-rated assemblies.

J. Comply with requirements for piping specified in Section 221413 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

3.02 INSTALLATION OF FLASHING

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required.

B. Install sheet flashing on pipes, sleeves, and specialties passing through or embedded in floors and roofs with waterproof membrane.

C. Set flashing on floors and roofs in solid coating of bituminous cement.

D. Secure flashing into sleeve and specialty clamping ring or device.

3.03 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 221423

SECTION 223000 - PLUMBING EQUIPMENT

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Commercial electric water heaters.

B. Water softeners.

1.02 RELATED REQUIREMENTS

A. Section 220548 - Vibration and Seismic Controls for Plumbing Piping and Equipment.

B. Section 221123 - Domestic Water Pumps.

C. Section 251500 - Integrated Automation Software.

D. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

B. ICC (IPC) - International Plumbing Code Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

C. UL 174 - Standard for Household Electric Storage Tank Water Heaters Current Edition, Including All Revisions.

D. UL 1453 - Standard for Electric Booster and Commercial Storage Tank Water Heaters Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittals procedures.

B. Product Data:

1. Provide dimension drawings of water heaters indicating components and connections to other equipment and piping.

2. Provide electrical characteristics and connection requirements.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Certifications:

1. Water Heaters: NSF approved.

2. Electric Water Heaters: UL listed and labeled to UL 174.

3. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc., as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide temporary inlet and outlet caps. Maintain caps in place until installation.

PART 2 PRODUCTS

2.01 WATER HEATERS

A. Manufacturers:

1. A.O. Smith Water Products Co: www.hotwater.com/#sle.

2. Rheem Manufacturing Company: www.rheem.com/#sle.

B. Commercial Electric Water Heaters:

1. Type: Factory-assembled and wired, electric, vertical storage.

2. Minimum Efficiency Required: ASHRAE Std 90.1 I-P.

3. Performance:

4. Electrical Characteristics:

5. Tank: Glass lined welded steel; 4 inch (100 mm) diameter inspection port, thermally insulated with minimum 2 inches (50 mm) glass fiber encased in corrosion-resistant steel jacket; baked-on enamel finish.

6. Controls: Automatic immersion water thermostat; externally adjustable temperature range from 60 to 180 degrees F (16 to 82 degrees C), flanged or screw-in nichrome elements, high temperature limit thermostat.

7. Accessories:

a. Water Connections: Brass.

b. Dip Tube: Brass.

c. Drain valve.

d. Anode: Magnesium.

e. Temperature and Pressure Relief Valve: ASME labeled.

8. Tank: Welded steel ASME labeled pressure vessel; glass lining, mounted on steel channel base with lifting lugs, insulated with 2 inch (50 mm) glass fiber; enclosed with 16 gauge, 0.0598 inch (1.52 mm) steel jacket; baked enamel finish.

9. Controls: Ventilated control cabinet, factory-wired with solid state progressive sequencing step controller, fuses, magnetic contactors, control transformer, pilot lights indicating main power and heating steps, control circuit toggle switch, electronic low-water (probe-type) cut-off, high temperature limit thermostat, flush-mounted temperature and pressure gauges.

10. Heating Elements: Flange-mounted immersion elements; individual elements sheathed with Incoloy corrosion-resistant metal alloy, rated less than 75 W/sq in (11.6 W/sq m).

2.02 WATER SOFTENERS

A. Salt-Free Water Conditioner Using Catalytic Media Water Conditioner:

1. Manufacturers:

a. Culligan International Company: www.culligan.com/#sle.

b. US Water Systems, Inc: www.uswatersystems.com//#sle.

2. Throughput: Hardness under 3 grains/gallon or ppm (51.3 mg/L).

3. Capacity: Continuous duty, mineral-based cartridge type.

4. Glassfiber reinforced plastic self-standing vertical tank with bypass valve fitting.

5. Connections: manual tank inlet and outlet screwed on bypass fitting.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install plumbing equipment in accordance with manufacturer's instructions, as required by code, and complying with conditions required for applicable certifications.

B. Electrical Work: Provide automatic control and protective devices with associated wiring to interconnect related interfaced devices required for specified operation.

C. Coordinate system, equipment, and piping work with applicable electrical, vent, drain, and waste support interconnections as included or provided by other trades.

D. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 251500.

3.02 FIELD QUALITY CONTROL

A. See Section 014000 - Quality Requirements for additional requirements.

B. Coordinate BAS, BMS, or Integrated Automation linking between unit controller(s) and remote front-end interface; see Section 25 1500.

END OF SECTION 223000

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SECTION 224000 - PLUMBING FIXTURES

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the plumbing fixtures and related components:

1.02 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. Accessible Fixture: Plumbing fixture that can be approached, entered, and used by people with disabilities.

C. Cast Polymer: Cast-filled-polymer-plastic material. This material includes cultured-marble and solid-surface materials.

D. Cultured Marble: Cast-filled-polymer-plastic material with surface coating.

E. Fitting: Device that controls the flow of water into or out of the plumbing fixture. Fittings specified in this Section include supplies and stops, faucets and spouts, shower heads and tub spouts, drains and tailpieces, and traps and waste pipes. Piping and general-duty valves are included where indicated.

F. FRP: Fiberglass-reinforced plastic.

G. Plumbed Emergency Plumbing Fixture: Fixture with fixed, potable-water supply.

H. PMMA: Polymethyl methacrylate (acrylic) plastic.

I. PVC: Polyvinyl chloride plastic.

J. Self-Contained Emergency Plumbing Fixture: Fixture with flushing-fluid-solution supply.

K. Solid Surface: Nonporous, homogeneous, cast-polymer-plastic material with heat-, impact-, scratch-, and stain-resistance qualities.

L. Tepid: Moderately warm.

1.03 SUBMITTALS

A. Product Data: For each type of plumbing fixture indicated. Include selected fixture and trim, fittings, accessories, appliances, appurtenances, equipment, and supports. Indicate materials and finishes, dimensions, construction details, roughing in drawings, wiring requirements, and flow-control rates.

B. Operation and Maintenance Data: For plumbing fixtures to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain plumbing fixtures, faucets, and other components of each category through one source from a single manufacturer.

1. Exception: If fixtures, faucets, or other components are not available from a single manufacturer, obtain similar products from other manufacturers specified for that category.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. ANSI Standard: Comply with ANSI Z358.1, "Emergency Eyewash and Shower Equipment."

D. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities" and Public Law 101-336, "Americans with Disabilities Act" for plumbing fixtures for people with disabilities.

E. Regulatory Requirements: Comply with requirements in Public Law 102-486 (Energy Policy Act), WaterSense, Energy Star, adopted plumbing code, and drawings regarding water flow and consumption rates for plumbing fixtures. Comply with most stringent requirement.

F. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," for fixture materials that will be in contact with potable water.

G. Select combinations of fixtures and trim, faucets, fittings, and other components that are compatible.

H. Comply with the following applicable standards and other requirements specified for plumbing fixtures:

1. Enameled, Cast-Iron Fixtures: ASME A112.19.1M.

2. Plastic Shower Enclosures: ANSI Z124.2.

3. Slip-Resistant Bathing Surfaces: ASTM F 462.

4. Stainless-Steel Commercial, Handwash Sinks: NSF 2 construction.

5. Stainless-Steel Residential Sinks: ASME A112.19.3.

6. Vitreous-China Fixtures: ASME A112.19.2M.

7. Water-Closet, Flush Valve, Tank Trim: ASME A112.19.5.

I. Comply with the following applicable standards and other requirements specified for lavatory and sink faucets:

1. Backflow Protection Devices for Faucets with Side Spray: ASME A112.18.3M.

2. Backflow Protection Devices for Faucets with Hose-Thread Outlet: ASME A112.18.3M.

3. Diverter Valves for Faucets with Hose Spray: ASSE 1025.

4. Faucets: ASME A112.18.1.

5. Hose-Connection Vacuum Breakers: ASSE 1011.

6. Hose-Coupling Threads: ASME B1.20.7.

7. Integral, Atmospheric Vacuum Breakers: ASSE 1001.

8. NSF Potable-Water Materials: NSF 61.

9. Pipe Threads: ASME B1.20.1.

10. Sensor-Actuated Faucets and Electrical Devices: UL 1951.

11. Supply Fittings: ASME A112.18.1.

12. Brass Waste Fittings: ASME A112.18.2.

J. Comply with the following applicable standards and other requirements specified for shower faucets:

1. Backflow Protection Devices for Hand-Held Showers: ASME A112.18.3M.

2. Combination, Pressure-Equalizing and Thermostatic-Control Antiscald Faucets: ASSE 1016.

3. Deck-Mounted Bath/Shower Transfer Valves: ASME 18.7.

4. Faucets: ASME A112.18.1.

5. Hand-Held Showers: ASSE 1014.

6. High-Temperature-Limit Controls for Thermal-Shock-Preventing Devices: ASTM F 445.

7. Hose-Coupling Threads: ASME B1.20.7.

8. Manual-Control Antiscald Faucets: ASTM F 444.

9. Pipe Threads: ASME B1.20.1.

10. Pressure-Equalizing-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

11. Sensor-Actuated Faucets and Electrical Devices: UL 1951.

12. Thermostatic-Control Antiscald Faucets: ASTM F 444 and ASSE 1016.

K. Comply with the following applicable standards and other requirements specified for miscellaneous fittings:

1. Atmospheric Vacuum Breakers: ASSE 1001.

2. Brass and Copper Supplies: ASME A112.18.1.

3. Dishwasher Air-Gap Fittings: ASSE 1021.

4. Manual-Operation Flushometers: ASSE 1037.

5. Plastic Tubular Fittings: ASTM F 409.

6. Brass Waste Fittings: ASME A112.18.2.

7. Sensor-Operation Flushometers: ASSE 1037 and UL 1951.

L. Comply with the following applicable standards and other requirements specified for miscellaneous components:

1. Dishwasher Air-Gap Fittings: ASSE 1021.
2. Flexible Water Connectors: ASME A112.18.6.
3. Floor Drains: ASME A112.6.3.
4. Grab Bars: ASTM F 446.
5. Hose-Coupling Threads: ASME B1.20.7.
6. Hot-Water Dispensers: ASSE 1023 and UL 499.
7. Off-Floor Fixture Supports: ASME A112.6.1M.
8. Pipe Threads: ASME B1.20.1.
9. Plastic Shower Receptors: ANSI Z124.2.
10. Plastic Toilet Seats: ANSI Z124.5.
11. Supply and Drain Protective Shielding Guards: ICC A117.1.
12. Whirlpool Bathtub Equipment: UL 1795.

PART 2 -PRODUCTS

2.01 FAUCETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Chicago Faucets.

2.02 SHOWER MIXING VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Powers; a Watts Industries Co.
2. Symmons Industries, Inc.

2.03 FLUSHOMETERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Sloan Valve Company.

2.04 TOILET SEATS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bemis Manufacturing Company.

2. Church Seats.

2.05 ADA PROTECTIVE SHIELDING PIPE COVERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. TRUEBRO, Inc.

B. Description: Manufactured plastic wraps for covering plumbing fixture hot-water supplies, cold-water supplies, trap, and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

2.06 FIXTURE SUPPORTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Josam Company.

2. Smith, Jay R. Mfg. Co.

3. Zurn Plumbing Products Group; Specification Drainage Operation.

2.07 WATER CLOSETS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Standard Companies, Inc.

2. Kohler Co.

2.08 URINALS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Standard Companies, Inc.

2. Kohler Co.

2.09 LAVATORIES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Standard Companies, Inc.

2. Kohler Co.

2.10 SINKS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Elkay Manufacturing Co.

2. Just Manufacturing Company.

2.11 INDIVIDUAL SHOWERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Comfort Designs.

2.12 MOP SINK BASINS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Fiat Products.

2. Florestone Products Co., Inc.

2.13 EMERGENCY FIXTURES FOR SHOWERS, EYE WASH, EYE/FACE WASH, OR COMBINATION UNITS.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bradley Corporation.

2. Guardian Equipment Co.

3. Haws Corporation.

4. Speakman Company.

2.14 WATER-TEMPERING EQUIPMENT FOR EMERGENCY FIXTURES.

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Bradley Corporation.

2. Haws Corporation.

3. Lawler Manufacturing Co., Inc.

4. Powers, a Watts Industries Co.

5. Speakman Company.

2.15 CLINICAL SINKS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Standard Companies, Inc.

2. Kohler Co.

2.16 SURGEONS` SCRUB SINKS

A. Stainless-Steel Surgeons` Scrub Sinks:

1. Refer to medical equipment plans and specifications.

2.17 PLUMBING FIXTURE SCHEDULE

A. See plumbing fixture schedule on drawings.

PART 3 -EXECUTION

3.01 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before plumbing fixture installation.

B. Examine cabinets, counters, floors, and walls for suitable conditions where fixtures will be installed. Maintain required rough in dimensions required to meet ADA.

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

3.02 INSTALLATION

A. Assemble plumbing fixtures, trim, fittings, and other components according to manufacturers` written instructions.

B. Install off-floor supports, affixed to building substrate, for wall-mounting fixtures.

1. Use carrier supports with waste fitting and seal for back-outlet fixtures.

2. Use carrier supports without waste fitting for fixtures with tubular waste piping.

3. Use concealed arm type carrier supports with rectangular steel uprights for wall hung lavatories and sinks.

4. Use wide-chase chair-type carrier supports with multiple carrier bodies for fixture installations where the extension of the support bolts is greater than three (3) inches.

C. Install back-outlet, wall-mounting fixtures onto waste fitting seals and attach to supports.

D. Install floor-mounting fixtures on closet flanges or other attachments to piping or building substrate.

E. Install wall-mounting fixtures with tubular waste piping attached to supports.

F. Install floor-mounting, back-outlet water closets attached to building floor substrate and wall bracket and onto waste fitting seals.

G. Install counter-mounting fixtures in and attached to casework.

H. Install fixtures level and plumb according to manufacturer furnished roughing-in drawings.

I. Install water-supply piping with stop on each supply to each fixture to be connected to water distribution piping. Attach supplies to supports or substrate within pipe spaces behind fixtures. Install stops in locations where they can be easily reached for operation.

1. Exception: Use ball valves if supply stops or integral stops are not specified with fixture. Valves are specified in Division 22 Section "General-Duty Valves for Mechanical." Valves shall be lockable on emergency fixtures.

2. Exception: Omit shutoff valve on supply to emergency fixtures if prohibited by authorities having jurisdiction.

J. Install chrome plated brass supplies and p-traps on all new and relocated fixtures.

K. Install dielectric fitting in supply piping to fixture if piping and fixture connections are made of different metals. Dielectric fittings are specified in Division 22 Section "Common Work Results for Mechanical."

L. Install thermometers in supply and outlet piping connections to water-tempering equipment. Thermometers are specified in Division 22 Section "Meters and Gages for Mechanical."

M. Install trap and waste to wall on drain outlet of fixture receptors that are indicated to be directly connected to drainage system.

N. Install indirect waste piping to wall on drain outlet of fixture receptors that are indicated to be indirectly connected to drainage system. Drainage piping is specified in Division 22 Section "Sanitary Waste and Vent Piping."

O. Install trap and tubular waste piping on drain outlet of each fixture directly connected to sanitary drainage system.

P. Install tubular waste piping on drain outlet of each fixture indirectly connected to drainage system.

Q. 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. The top of the valve and the water supply shall be a minimum of 1-1/2 inches below the bottom of the grab bar for ADA accessible water closets.

R. Install tanks for accessible, tank-type water closets with lever handle mounted on wide side of compartment.

S. Install toilet seats on water closets.

T. Install faucet flow-control fittings with specified flow rates and patterns in faucet spouts if faucets are not available with required rates and patterns. Include adapters if required.

U. Install shower flow-control fittings with specified maximum flow rates in shower arms.

V. Install traps on fixture outlets.

1. Exception: Omit trap on fixtures with integral traps.

2. Exception: Omit trap on indirect wastes, unless otherwise indicated.

W. Install escutcheons at piping wall ceiling penetrations in exposed, finished locations and within cabinets and millwork. Use deep-pattern escutcheons if required to conceal protruding fittings. Escutcheons are specified in Division 22 Section "Common Work Results for Mechanical."

X. Set bathtubs, shower receptors, and individual showers in leveling bed of cement grout. Grout is specified in Division 22 Section "Common Work Results for Mechanical." Set fixtures on chlorinated polyethylene waterproof membrane sealed to drain and extended vertically no less than 12 inches along walls.

Y. Seal joints between fixtures and walls, floors, and countertops using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color.

1. Sealants are specified in Division 07 Section "Joint Sealants."

3.03 CONNECTIONS

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

B. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

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

D. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

E. Connect hot- and cold-water-supply piping to hot- and cold-water-tempering equipment. Connect output from water-tempering equipment to emergency plumbing fixtures.

F. Directly connect emergency plumbing fixture receptors with trapped drain outlet to sanitary drainage and vent piping.

G. Indirectly connect emergency plumbing fixture receptors without trapped drain outlet to sanitary or storm drainage piping.

H. Provide direct or indirect drain piping from medical and kitchen equipment to sanitary waste and vent piping or nearest drain per equipment manufacturer and adopted plumbing code requirements.

3.04 FIELD QUALITY CONTROL

A. Verify that installed plumbing fixtures are categories and types specified for locations where installed.

B. Check that plumbing fixtures are complete with trim, faucets, fittings, and other specified components.

C. Inspect installed plumbing fixtures for damage. Replace damaged fixtures and components.

D. Test installed fixtures after water systems are pressurized for proper operation. Replace malfunctioning fixtures and components, then retest. Repeat procedure until units operate properly.

E. Install fresh batteries in sensor-operated mechanisms.

F. Mechanical-Component Testing: After plumbing connections have been made, test for compliance with requirements. Verify ability to achieve indicated capacities and temperatures.

G. Electrical-Component Testing: After electrical circuitry has been energized, test for compliance with requirements. Test and adjust controls and safeties.

H. Repair or replace malfunctioning units. Retest as specified above after repairs or replacements are made.

I. Document and maintain test results in writing.

3.05 ADJUSTING

A. Operate and adjust fixtures and controls. Replace damaged and malfunctioning fixtures, fittings, and controls.

B. Adjust water pressure at fixtures to produce proper flow and stream.

C. Replace washers and seals of leaking and dripping faucets and stops.

D. Install fresh batteries in sensor-operated mechanisms.

E. Adjust or replace fixture flow regulators for proper flow.

F. Adjust equipment temperature settings.

3.06 CLEANING

A. Clean fixtures, faucets, and other fittings with manufacturers` recommended cleaning methods and materials. Do the following:

1. Remove faucet spouts and strainers, remove sediment and debris, and reinstall strainers and spouts.

2. Remove sediment and debris from drains.

B. After completing installation of exposed, factory-finished fixtures, faucets, and fittings, inspect exposed finishes and repair damaged finishes.

3.07 PROTECTION

A. Provide protective covering for installed fixtures and fittings.

B. Do not allow use of plumbing fixtures for temporary facilities unless approved in writing by Owner.

C. Do not allow disposal of any products used during construction into plumbing fixtures and other drains.

END OF SECTION 224000

SECTION 226113 - COMPRESSED-AIR, GAS, AND VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Medical air piping and specialties, designated "medical air".
2. Oxygen piping and specialties designated "medical oxygen" operating at 50 to 55 psig.
3. Medical surgical vacuum piping and specialties, designated "medical vacuum" operating at 20 inches mercury.
4. Waste anesthetic gas disposal piping and specialties, designated "WAGD evacuation" operating at 20 inches mercury.

1.02 DEFINITIONS

A. D.I.S.S.: Diameter-index safety system.

B. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control, signaling power-limited circuits.

C. Medical Compressed-Air Piping Systems: Include medical air and instrument air piping systems.

D. WAGD: Waste anesthetic gas disposal.

E. Medical vacuum piping systems include medical vacuum and WAGD evacuation piping systems.

F. CR: Chlorosulfonated polyethylene synthetic rubber.

G. Medical gas piping systems include nonflammable gas for healthcare facility patient care or for healthcare laboratory applications.

1.03 SUBMITTALS:

A. Action Submittals: Submit product data for the following:

1. Compressed-air, vacuum, and gas valves and valve boxes.
2. Medical compressed-air, vacuum, and gas service connections.
3. Medical gas alarm system components.

1.04 INFORMATIONAL SUBMITTALS:

A. Certifications: Submit documentation that the installers and testing agency meet the qualifications specified in "Quality Assurance" Article.

B. Contract Documents Examination Report: The project's testing agency shall prepare and submit a report on the adequacy of design for systems certification in accordance with the requirements of NFPA 99. The report shall include recommended changes and additions to systems to facilitate certification and compliance. The report shall also include recommended changes and additions to medical gas systems and general construction to allow access for certification.

1. Failure to submit testing agency's review of contract documents will be taken as acknowledgment that the contract documents illustrate a system that will be certified as compliant. Payment for modifications or relocations of components required for certification and not identified due to lack of testing agency review shall be the responsibility of the installing contractor.

C. Diagram power, signal, and control wiring.

D. Brazing certificates.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For compressed-air, vacuum, and gas piping specialties to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Compressed-Air, Vacuum, and Gas Piping Systems for Healthcare Facilities: Qualify installers according to ASSE Standard #6010.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for inspectors and ASSE Standard #6030 for verifiers.

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications," or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

D. 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.

E. ASME Compliance:

1. Comply with ASME B31.1, "Power Piping," for piping operating at more than 150 psig.

2. Comply with ASME B31.9, "Building Services Piping," for piping operating at 150 psig or less.

F. NFPA Compliance:

1. Comply with NFPA 99, "Health Care Facilities," for medical compressed-air system materials and installation in healthcare facilities.

G. UL Compliance:

1. Comply with UL 544, "Medical and Dental Equipment," for medical gas specialties.

1.06 COORDINATION

A. Confirm service connection types with Owner. Obtain Owner approval in writing prior to ordering materials.

PART 2 -PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

A. Copper Medical Gas Tube: ASTM B 819, Types K and L, seamless, drawn temper, that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and in blue for Type L tube.

1. General Requirements for Copper Fittings: Manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

2. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type or MSS SP-73, with dimensions for brazed joints.

3. Copper Unions: ASME B16.22 or MSS SP-123, wrought copper or cast-copper alloy.

2.02 JOINING MATERIALS

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

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

C. Threaded-Joint Tape: PTFE.

D. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch maximum thickness, full-face type.

E. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.03 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Ball Valves: MSS SP-110, 3-piece body, brass or bronze.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amico Corporation.

b. BeaconMedaes.

2. Pressure Rating: 300 psig minimum.

3. Ball: Full-port, chrome-plated brass.

4. Seats: PTFE or TFE.

5. Handle: Lever type with locking device.

6. Stem: Blowout proof with PTFE or TFE seal.

7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

C. Check Valves: In-line pattern, bronze.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amico Corporation.

b. BeaconMedaes.

2. Pressure Rating: 300 psig minimum.

3. Operation: Spring loaded.

4. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

D. Zone Valves: MSS SP-110, 3-piece-body, brass or bronze ball valve with gage.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Amico Corporation.

b. BeaconMedaes.

2. Pressure Rating: 300 psig minimum.

3. Ball: Full-port, chrome-plated brass.

4. Seats: PTFE or TFE.

5. Handle: Lever.

6. Stem: Blowout proof with PTFE or TFE seal.

7. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

8. Pressure Gage: Manufacturer installed on one copper-tube extension.

E. Zone Valve Boxes: Steel or aluminum with anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Amico Corporation.

    b. BeaconMedaes.

2. Interior Finish: Factory-applied white enamel.

3. Cover Plate: Aluminum or extruded-anodized aluminum, Satin-chrome finish steel, or Stainless steel with NAAMM AMP 503, No. 4 finish with frangible or removable windows.

4. Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

F. Safety Valves: Bronze-body, ASME-construction, poppet, pressure-relief type with settings to match system requirements.

G. Pressure Regulators: Bronze or Stainless Steel body and trim; spring-loaded, diaphragm-operated relieving type; manual pressure-setting adjustment; rated for 250-psig minimum inlet pressure; and capable of controlling delivered pressure within 0.5 psig for each 10-psig inlet pressure.

H. Automatic Drain Valves: Stainless-steel body and internal parts, rated for 200-psig minimum working pressure, capable of automatic discharge of collected condensate.

2.04 MEDICAL SERVICE CONNECTIONS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amico Corporation.

2. BeaconMedaes.

B. General Requirements for Medical Service Connections: For specific pressure and suction service listed. Include roughing-in assemblies, finishing assemblies, and cover plates. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate. Furnish recessed-type units made for concealed piping unless otherwise indicated.

1. Roughing-in Assembly:

    a. Steel outlet box for recessed mounting and concealed piping.

    b. Brass-body outlet block with secondary check valve that will prevent gas flow when primary valve is removed. Suction inlets to be without secondary valve.

    c. Double seals that will prevent gas leakage.

    d. ASTM B 819, NPS 3/8 copper outlet tube brazed to valve with service marking and tube-end dust cap.

2. Finishing Assembly:

    a. Brass housing with primary check valve.

b. Double seals that will prevent gas leakage.

c. Cover plate with gas-service label.

3. Quick-Coupler Service Connections: Pressure outlet with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

4. Quick-Coupler Service Connections: Suction inlets for service outlets with noninterchangeable keyed indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment, and with positive-locking ring that retains equipment stem in valve during use.

5. D.I.S.S. Service Connections: Pressure outlets, complying with CGA V-5, with threaded indexing to prevent interchange between services, constructed to permit one-handed connection and removal of equipment.

6. Cover Plates: One piece, finished metal with permanent, color-coded, identifying label matching corresponding service. Plastic cover plates not allowed.

7. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.

2.05 CEILING COLUMNS

A. General Requirements for Ceiling Columns: Ceiling-mounting units with medical gas service connections as specified in "Medical Gas Service Connections" Article and electrical service connections as specified in "Electrical Service Connections" Article. Include labels indicating services, and the following:

1. Ceiling-Mounting Plate: Manufacturer`s standard plate or roughing-in assembly.

2. Exposed Surfaces: Minimum 0.0375-inch- thick stainless steel with NAAMM AMP 503, No. 4 directional polish.

3. Servicing: Include access panels or means of removing shroud.

4. Blank cover plates for cutouts not having service connections.

5. ASTM B 819, NPS 3/8 copper-tube extensions for connection to medical gas systems.

6. Service Connections: Type and number indicated.

7. Dust Covers: For medical gas service connection.

B. Rigid Ceiling Columns: rectangular fixed column section with intravenous medication hooks. Include 0.078-inch- thick, stainless-steel bottom plate with the following service connections:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. BeaconMedaes.

2.06 MEDICAL ALARM SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amico Corporation.

2. BeaconMedaes.

B. Panels may be combined in single panels with medical compressed air, medical vacuum, and medical gas piping systems.

C. Components: Designed for continuous service and to operate on power supplied from 120-V ac power source to alarm panels and with connections for low-voltage wiring to remote sensing devices. Include step-down transformers if required.

D. Dew Point Monitors: Continuous line monitoring, having panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, factory- or field-installed valved bypass, and visual and cancelable audio signal for dryer site and master alarm panels. Alarm signals when pressure dew point rises above 39 deg F at 55 psig.

1. Operation: Chilled-mirror method or hygrometer moisture analyzer with sensor probe.

E. Pressure Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

1. Low-Pressure Operating Range: 0- to 100-psig.

2. High-Pressure Operating Range: Up to 250-psig.

F. Vacuum Switches or Transducer Sensors: Continuous line monitoring with electrical connections for alarm system.

1. Vacuum Operating Range: 0- to 30-on Hg.

G. Carbon Monoxide Monitors: Panel with gage or digital display, pipeline sensing element, electrical connections for alarm system, and factory- or field-installed valved bypass. Alarm signals when carbon monoxide level rises above 10 ppm.

H. General Requirements for Medical Alarm Panels: Factory wired with audible and color-coded visible signals to indicate specified functions.

1. Mounting:

a. Mechanical rooms: Exposed, surface mounting.

b. Finished areas: Recessed installation.

2. Enclosures: Fabricated from minimum 0.047 thick steel or minimum 0.05-inch- thick aluminum, with knockouts for electrical and piping connections.

I. Master Alarm Panels: Separate trouble alarm signals, pressure gages, and indicators for medical compressed-air, vacuum, and gas piping systems.

1. Include alarm signals when the following conditions exist:

a. Medical Air: Pressure drops below 40 psig or rises above 60 psig, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, dew point rises above 39 deg F at 55 psig, carbon monoxide level rises above 10 ppm, high water level is reached in receiver, and high discharge air temperature.

b. Instrument Air, Compressed-Air Equipment: Pressure drops below 165 psig or rises above 185 psig, backup air compressor is in operation, pressure drop across filter assembly increases more than 2 psig, de point rises above 39 deg F at 55 psig, and high water level is in receiver.

c. Medical Oxygen: Pressure downstream from main shutoff valve drops below 40 psig or rises above 60 psig and changeover is made to alternate bank.

d. Medical Vacuum: Vacuum drops below 12-in. Hg, backup vacuum pump is in operation, and high water level in receiver.

J. Area Alarm Panels: Separate trouble alarm signals, pressure/vacuum gages, and indicators for medical piping systems.

1. Include alarm signals when the following condition exists:

a. Medical Air: Pressure drops below 40 psig or rises above 60 psig.

b. Medical Oxygen: Pressure drops below 40 psig or rises above 60 psig.

c. Medical Vacuum: Vacuum drops below 12-in Hg.

2.07 NITROGEN

A. Description: Comply with USP 28 - NF 23 for oil-free dry nitrogen.

2.08 WIRING/CABLING IDENTIFICATION

A. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

PART 3 -EXECUTION

3.01 PREPARATION

A. Cleaning of Medical Gas Tubing: If manufacturer-cleaned and -capped fittings or tubing are not available or if precleaned fittings or tubing must be recleaned because of exposure, have supplier or separate agency acceptable to authorities having jurisdiction perform the following procedures:

1. Clean medical gas tube and fittings, valves, gages, and other components of oil, grease, and other readily oxidizable materials as required for oxygen service according to CGA G-4.1, "Cleaning Equipment for Oxygen Service."

3.02 PIPING APPLICATIONS

A. Medical Air Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

B. Instrument Air Piping:

1. NPS 3 and Smaller: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

C. Medical Gas Piping: Use Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

D. Medical Vacuum Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

E. WAGD Evacuation Piping: Type L, copper medical gas tube; wrought-copper fittings; and brazed joints.

F. Drain Piping: Refer to Division 23 “Hydronic Piping” for condensate drain piping.

3.03 PIPING INSTALLATION

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

B. Comply with ASSE Standard #6010 for installation of piping.

C. Install piping concealed from view and protected from physical contact by building occupants 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 and coordinate with other services occupying that space.

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

G. Install air, vacuum, and drain piping with 1 percent slope downward in direction of flow.

H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating unless otherwise indicated.

I. Install eccentric reducers where compressed-air and vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Install branch connections to mains from top of main. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and pressure gage on discharge piping from each manifold, air compressor and on each receiver. Comply with requirements in Division 22 Section "Meters and Gages for Mechanical."

L. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator. Comply with requirements in Division 22 Section "Meters and Gages for Mechanical."

M. Install piping to permit valve servicing.

N. Install piping free of sags and bends.

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

P. Install medical piping to medical service connections specified in this Section, and to equipment specified in other Sections requiring medical service.

Q. Install interconnecting piping for field assembled equipment.

R. Install service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

S. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.

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

3.04 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from equipment and specialties.

B. Install check valves to maintain correct direction of flow from equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install safety valves on receivers where required by NFPA 99 and where recommended by specialty manufacturers.

F. Install pressure regulators on piping where reduced pressure is required.

G. Install automatic drain valves on equipment, specialties, and piping with drain connection. Run drain piping to floor drain so contents spill over or into it.

H. Install flexible pipe connectors in discharge piping and in inlet air piping from remote air-inlet filter of each air compressor and suction inlet piping to each vacuum producer.

3.05 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

C. Threaded Joints: Apply appropriate tape to external pipe threads.

D. Brazed Joints: Join copper tube and fittings according to CDA`s "Copper Tube Handbook," "Brazed Joints" Chapter. Continuously purge joint with oil-free dry nitrogen during brazing.

E. Flanged Joints:

1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

3.06 MEDICAL PIPING ALARM SYSTEM INSTALLATION

A. Alarm panels for medical piping systems may be combined in single panels.

B. Install alarm system components for medical gas piping according to and in locations required by NFPA 99.

C. Install area and master alarm panels for medical piping system where indicated.

3.07 HANGER AND SUPPORT INSTALLATION

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

B. Comply with requirements in Division 22 Section "Hangers and Supports for Mechanical" for pipe hanger and support devices.

3.08 LABELING AND IDENTIFICATION

A. Install identifying labels and devices for nonmedical laboratory piping, valves, wiring and specialties. Comply with requirements in Division 22 Section "Mechanical Identification."

B. Install identifying labels and devices for medical piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99.

C. Alarm Circuit Identification: Tag or label conductors as follows:

1. For control and communications/signal wiring, use colored marking tape and wire/cable designation tape markers at terminations in wiring boxes, troughs, and control cabinets. Use colors consistent with NFPA 99 and indicated above for system type and consistent letter/number conductor designations throughout on wire/cable marking tape.

2. Match identification markings with designations used in equipment shop drawings, Contract Documents, and similar previously established identification schemes for the facility’s electrical installations.

3. Identify Junction, Pull and Connection Boxes: Identification of systems and circuits shall indicate system and identity of contained circuits on outside of box cover. Labeling shall be 3/8-inch Kroy tape or Brother self-adhesive label color-coded same as conduits or permanent magic marker (color coded), neatly hand printed. In rooms that are painted out, provide labeling on inside of cover.

4. Provide typed legend of wire/cable wiring indicating tag, color, system, signal, starting room name and ending room name.

3.09 FIELD QUALITY CONTROL FOR MEDICAL PIPING IN HEALTHCARE FACILITIES

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections of medical compressed-air piping in healthcare facilities and prepare test reports.

B. Perform tests and inspections of medical compressed-air piping systems in healthcare facilities and prepare test reports.

C. Tests and Inspections:

1. Medical Testing Coordination: Perform tests, inspections, verifications, and certification concurrently for all medical systems.

2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

a. Initial blowdown.

b. Initial pressure test.

c. Cross-connection test.

d. Piping purge test.

e. Standing pressure test for positive-pressure and vacuum piping.

f. Repair leaks and retest until no leaks exist.

3. System Verification: Comply with requirements in NFPA 99, ASSE Standard #6020, and ASSE Standard #6030 for verification of medical piping systems and perform the following tests and inspections:

a. Standing pressure test.

b. Cross-connection test.

c. Valve test.

d. Master and area alarm tests.

e. Piping purge test.

f. Piping particulate test.

g. Piping purity test.

h. Final tie-in test.

i. Operational pressure test.

j. Operational vacuum test.

k. Medical air purity test.

l. Medical gas concentration test.

m. Verify correct labeling of equipment and components.

n. Verify medical source equipment.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

a. Inspections performed.

b. Procedures, materials, and gases used.

c. Test methods used.

d. Results of tests.

D. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.10 DEMONSTRATION

A. Train Owner`s maintenance personnel to adjust, operate, and maintain equipment and alarm systems. Refer to Division 01 Section "Demonstration and Training."

END OF SECTION 226113

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 226213 - VACUUM PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Medical-surgical vacuum piping, designated "medical vacuum."

1.03 DEFINITIONS

A. HVE: High-volume (oral) evacuation.

B. WAGD: Waste anesthetic gas disposal.

C. Medical vacuum piping systems include medical vacuum, WAGD, dental vacuum, HVE, and medical laboratory vacuum piping systems.

D. Nonmedical laboratory vacuum piping systems include laboratory low-vacuum and laboratory high-vacuum piping systems.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Material Certificates: Signed by Installer certifying that medical vacuum piping materials comply with requirements in NFPA 99.

C. Brazing certificates.

D. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For vacuum piping specialties to include in emergency, operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

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

1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical vacuum suction inlets.

a. Medical Vacuum: Equal to 5 percent of amount installed, but no fewer than 3 units.

2. I.S.S. Service Connections: Furnish complete medical vacuum suction inlets complying with CGA V-5.

a. Medical Vacuum D.I.S.S. No. 1220: Equal to 5 percent of amount installed, but no fewer than 3 units.

1.08 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Vacuum Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers.

2. Pressure-Seal Joining Procedure for Copper Tubing: An authorized representative who is trained and approved by manufacturer.

3. Extruded-Tee Outlet Procedure: An authorized representative who is trained and approved by manufacturer.

4. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the vacuum piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Medical vacuum operating at 20 in. Hg (510 mm Hg).

2.02 PIPES, TUBES, AND FITTINGS

A. Comply with NFPA 99 for medical vacuum piping materials.

B. Copper Medical Gas Tube: ASTM B 819, Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in blue.

C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and sealed for medical gas service or according to CGA G-4.1 for oxygen service.

D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

E. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.

1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, full-face type.

2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

F. Flexible Pipe Connectors:

1. Flex-Hose or equivalent

2. Description: Corrugated-bronze tubing with bronze wire-braid covering and ends brazed to inner tubing.

a. Working-Pressure Rating: 200 psig (1380 kPa) minimum.

b. End Connections: Plain-end copper tube.

2.03 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

2.04 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

1. Exception: Factory cleaning and bagging are not required for valves for WAGD service.

B. Zone-Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages.

1. Zone-Valve Boxes:

a. Steel Box with Aluminum Cover:
1) Beacon Medaes or equal.

b. Description: Formed steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves. Medical air and medical vacuum tubing, valves, and gages may be incorporated in zone valve boxes for medical gases.
1) Interior Finish: Factory-applied white enamel.
2) Cover Plate: Aluminum with frangible or removable windows.

3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

C. Copper-Alloy Ball Valves:

1. Beacon Medaes or equal.

2. Standard: MSS SP-110.

3. Description: Three-piece body, brass or bronze.

4. Pressure Rating: 300 psig (2070 kPa) minimum.

5. Ball: Full-port, chrome-plated brass.

6. Seats: PTFE or TFE.

7. Handle: Lever type with locking device.

8. Stem: Blowout proof with PTFE or TFE seal.

9. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions and manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

D. Check Valves:

1. Beacon Medaes or equal.

2. Description: In-line pattern, bronze.

3. Pressure Rating: 300 psig (2070 kPa) minimum.

4. Operation: Spring loaded.

5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

2.05 MEDICAL VACUUM SERVICE CONNECTIONS

A. General Requirements for Medical Vacuum Service Connections:

1. Suitable for specific medical vacuum service listed.

2. Include roughing-in assemblies, finishing assemblies, and cover plates.

3. Individual cover plates are not required if service connection is in multiple unit or assembly with cover plate.

4. Recessed-type units made for concealed piping unless otherwise indicated.

B. Roughing-in Assembly:

1. Steel outlet box for recessed mounting and concealed piping.

2. Brass-body inlet block.

3. Seals that will prevent vacuum leakage.

4. ASTM B 819, NPS 3/8 (DN 10) copper outlet tube brazed to valve with service marking and tube-end dust cap.

C. Finishing Assembly:

1. Brass housing with primary check valve.

2. Seals that will prevent vacuum leakage.

3. Cover plate with gas-service label.

D. Quick-Coupler Suction Service Connections:

1. Inlets for medical vacuum with noninterchangeable keyed indexing to prevent interchange between services.

2. Constructed to permit one-handed connection and removal of equipment.

3. With positive-locking ring that retains equipment stem in valve during use.

E. I.S.S. Suction Service Connections:

1. Inlets complying with CGA V-5.

2. Threaded indexing to prevent interchange between services.

3. Constructed to permit one-handed connection and removal of equipment.

4. Medical Vacuum: CGA V-5, D.I.S.S. No. 1220.

5. WAGD: CGA V-5, D.I.S.S. No. 2220.

F. Vacuum Bottle Brackets: One piece, with pattern and finish matching corresponding service cover plate.

G. Cover Plates:

1. One piece.

2. stainless steel.

3. Permanent, color-coded, identifying label matching corresponding service.

2.06 NITROGEN

A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

PART 3 EXECUTION

3.01 PREPARATION

A. All tubing and fittings shall be especially prepared and cleaned for the gas service intended and shall conform to NFPA 99.

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of vacuum piping. Indicated locations and arrangements were used to size pipe and calculate friction loss, expansion, vacuum producer sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.

B. Comply with NFPA 99 for installation of vacuum piping.

C. Install piping concealed from view and protected from physical contact by building occupants 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 and coordinate with other services occupying that space.

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

G. Install vacuum piping with 1 percent slope downward in direction of flow.

H. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than piping pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.

I. Install eccentric reducers, if available, where vacuum piping is reduced in direction of flow, with bottoms of both pipes and reducer fitting flush.

J. Provide drain leg and drain trap at end of each main and branch and at low points.

K. Install thermometer and vacuum gage on inlet piping to each vacuum producer and on each receiver and separator. Comply with requirements in Section 220519 "Meters and Gages for Plumbing Piping."

L. Install piping to permit valve servicing.

M. Install piping free of sags and bends.

N. Install fittings for changes in direction and for branch connections. Extruded-tee branch outlets in copper tubing may be made where specified.

O. Install medical vacuum piping from medical vacuum service connections specified in this Section, to equipment specified in Section 226219 "Vacuum Equipment for Laboratory and Healthcare Facilities," and to equipment specified in other Sections requiring medical vacuum service.

P. Piping Restraint Installation: Install seismic restraints on vacuum piping. Seismic-restraint devices are specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

Q. Install medical vacuum service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

R. Install medical vacuum bottle bracket adjacent to each wall-mounted medical vacuum service connection suction inlet.

S. Connect vacuum piping to vacuum producers and to equipment requiring vacuum service.

T. Install unions in copper vacuum tubing adjacent to each valve and at final connection to each machine, specialty, and piece of equipment.

U. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.03 VALVE INSTALLATION

A. Install shutoff valve at each connection to and from vacuum equipment and specialties.

B. Install check valves to maintain correct direction of vacuum flow to vacuum-producing equipment.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install flexible pipe connectors in suction inlet piping to each vacuum producer.

3.04 JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

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

D. Threaded Joints: Apply appropriate tape to external pipe threads.

E. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Do not use flux. Continuously purge joint with oil-free dry nitrogen during brazing.

F. Soldered Joints: Apply ASTM B 813, water-flushable flux to tube end. Join copper tube and fittings according to ASTM B 828.

G. Flanged Joints:

1. Copper Tubing: Install flange on copper tubes. Use pipe-flange gasket between flanges. Join flanges with gasket and bolts according to ASME B31.9 for bolting procedure.

3.05 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

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

D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.

2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

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

G. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch- (10-mm-) minimum rods.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.

2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.

3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.

4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.

5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.

6. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.

7. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.

8. NPS 2-1/2 (DN 65): 13 feet (4 m) with 1/2-inch (13-mm) rod.

J. Install supports for vertical copper tubing every 10 feet (3 m).

3.06 IDENTIFICATION

A. Install identifying labels and devices for laboratory vacuum piping, valves, and specialties. Comply with requirements in Section 200553 "Mechanical Identification”.

B. Install identifying labels and devices for medical vacuum piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Medical Vacuum: Black letters on white background.

2. WAGD: White letters on violet background.

3.07 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL VACUUM PIPING

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections of medical vacuum piping systems in healthcare facilities and to prepare test and inspection reports.

B. All new piping, valves and fittings installed under this section shall be tested as described under each individual gas section. These tests shall be made on the new work only. The contractor shall verify the presence of the desired gas in all outlets served by the new piping. This shall be done with an analyzer and a written certification of these tests (for each gas) shall be made to the Architect by the Plumbing Contractor and the company certifying the medical gas system.

C. A final test of the medical gas system (all gases and vacuum) shall be made prior to turning the building over to the Owner. This test shall be made by an independent testing company with three or more years experience in certification of medical gas systems. This independent company shall be certified by MGPHCO or NITC. A written certification from this testing company shall be turned over to the Owner and the Architect. The certification shall include only the medical gas system installed under this contract. These tests and certification shall comply with the requirements and recommendations of N.F.P.A. 99. The cost of this certification shall be included in the Plumbing Contract. The certification shall include a recertification of the existing system as required by N.F.P.A. and the health authorities having jurisdiction.

D. Tests and Inspections:

1. Medical Vacuum Testing Coordination: Perform tests, inspections, verifications, and certification of medical vacuum piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical gas piping systems.

2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

    a. Initial blowdown.

    b. Initial pressure test.

    c. Cross-connection test.

    d. Piping purge test.

    e. Standing pressure test for vacuum systems.

    f. Repair leaks and retest until no leaks exist.

3. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:

    a. Standing pressure test.

    b. Individual-pressurization or pressure-differential cross-connection test.

    c. Valve test.

    d. Master and area alarm tests.

    e. Piping purge test.

    f. Final tie-in test.

    g. Operational vacuum test.

    h. Verify correct labeling of equipment and components.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

    a. Inspections performed.

    b. Procedures, materials, and gases used.

    c. Test methods used.

    d. Results of tests.

E. Inspections shall be conducted by a person(s) competent and experienced in the field of medical gas and vacuum pipeline inspections and testing and meeting the requirements of ASSE 6020 or ASSE 6030.

F. The initial pressure test performed by the installing contractor shall be witnessed by an ASSE 6020 inspector an ASSE 6030 verifier, or the AHJ or its designee. A form indicating that this test has been performed and witnessed shall be provided to the verifier at the start of test as required by NFPA 99.

G. Remove and replace components that do not pass tests and inspections and retest as specified above.

3.08 PROTECTION

A. Protect tubing from damage.

B. Retain sealing plugs in tubing, fittings, and specialties until installation.

C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.09 PIPING SCHEDULE

A. Flanges may be used where connection to flanged equipment is required.

B. Medical Vacuum Piping: Use copper medical gas tube, wrought-copper fittings, and brazed joints.

3.10 VALVE SCHEDULE

A. Shutoff Valves:

1. Copper Tubing: Copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.

B. Zone Valves: Copper-alloy ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

END OF SECTION 226213

SECTION 226313 - GAS PIPING FOR LABORATORY AND HEALTHCARE FACILITIES

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Oxygen piping, designated "medical oxygen."

B. Contractor-Furnished Material:

1. Ceiling column.

C. Related Requirements:

1. Section 226400 "Medical Gas Alarms" for combined medical air, vacuum, and gas alarms.

1.03 DEFINITIONS

A. CR: Chlorosulfonated polyethylene synthetic rubber.

B. Medical gas piping systems include medical carbon dioxide, medical helium, medical nitrogen, , and medical oxygen for healthcare facility patient care.

1.04 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer and testing agency.

B. Material Certificates: Signed by Installer certifying that medical gas piping materials comply with requirements in NFPA 99 for positive-pressure medical gas systems.

C. Brazing certificates.

D. Certificates of Shop Inspection and Data Report for Bulk Gas Storage Tanks: As required by ASME Boiler and Pressure Vessel Code.

E. Field quality-control reports.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For medical and specialty gas piping specialties to include in emergency, operation, and maintenance manuals.

1.07 MAINTENANCE MATERIAL SUBMITTALS

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

1. Quick-Coupler Service Connections: Furnish complete noninterchangeable medical gas pressure outlets and suction inlets.

a. Medical Carbon Dioxide: Equal to 5 percent of quantity installed, but no fewer than 5 units.

b. Medical Oxygen: Equal to 5 percent of quantity installed, but no fewer than 5 units.

2. I.S.S. Service Connections: Furnish complete medical gas pressure outlets and suction inlets complying with CGA V-5.

a. Medical Oxygen D.I.S.S. No. 1240: Equal to 5 percent of quantity installed, but no fewer than 5 units.

b. Medical Air D.I.S.S. No. 1160: Equal to 5 percent of quantity installed, but no fewer than 5 units.

1.08 QUALITY ASSURANCE

A. Installer Qualifications:

1. Medical Gas Piping Systems for Healthcare Facilities: According to ASSE Standard #6010 for medical-gas-system installers.

2. Bulk Medical Gas Systems for Healthcare Facilities: According to ASSE Standard #6015 for bulk-medical-gas-system installers.

3. Shape-Memory-Metal Coupling Joints: An authorized representative who is trained and approved by manufacturer.

B. Testing Agency Qualifications: An independent testing agency, with the experience and capability to conduct the medical gas piping testing indicated, that is a member of the Medical Gas Professional Healthcare Organization or is an NRTL, and that is acceptable to authorities having jurisdiction.

1. Qualify testing personnel according to ASSE Standard #6020 for medical-gas-system inspectors and ASSE Standard #6030 for medical-gas-system verifiers.

C. Brazing: Qualify processes and operators according to ASME Boiler and Pressure Vessel Code, Section IX, "Welding and Brazing Qualifications"; or AWS B2.2, "Standard for Brazing Procedure and Performance Qualification."

PART 2 PRODUCTS

2.01 SYSTEM DESCRIPTION

A. Medical oxygen operating at 50 to 55 psig (345 to 380 kPa).

2.02 PIPES, TUBES, AND FITTINGS

A. Comply with NFPA 99 for medical gas piping materials.

B. Copper Medical Gas Tube: ASTM B 819, Type K and Type L, seamless, drawn temper that has been manufacturer cleaned, purged, and sealed for medical gas service; or according to CGA G-4.1 for oxygen service. Include standard color marking "OXY," "MED," "OXY/MED," "OXY/ACR," or "ACR/MED" in green for Type K tube and blue for Type L tube.

C. Wrought-Copper Fittings: ASME B16.22, solder-joint pressure type that has been manufacturer cleaned, purged, and bagged for oxygen service according to CGA G-4.1.

D. Copper Unions: ASME B16.22 or MSS SP-123, wrought-copper or cast-copper alloy.

E. Cast-Copper-Alloy Flanges: ASME B16.24, Class 150.

1. Pipe-Flange Gasket Materials: ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness, full-face type.

2. Flange Bolts and Nuts: ASME B18.2.1, carbon steel.

2.03 JOINING MATERIALS

A. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys.

B. Threaded-Joint Tape: PTFE.

2.04 VALVES

A. General Requirements for Valves: Manufacturer cleaned, purged, and bagged according to CGA G-4.1 for oxygen service.

B. Zone-Valve Box Assemblies: Box with medical gas valves, tube extensions, and gages.

1. Zone-Valve Boxes:

a. Steel Box with Aluminum Cover:
1) Beacon Medaes or equal.

b. Description: Formed steel box with cover, anchors for recessed mounting, holes with grommets in box sides for tubing extension protection, and of size for single or multiple valves with pressure gages and in sizes required to permit manual operation of valves. Medical air and medical vacuum tubing, valves, and gages may be incorporated in zone valve boxes for medical gases.
1) Interior Finish: Factory-applied white enamel.
2) Cover Plate: Aluminum with frangible or removable windows.
3) Valve-Box Windows: Clear or tinted transparent plastic with labeling that includes rooms served, according to NFPA 99.

C. Ball Valves:

1. Beacon Medaes or equal.

2. Standard: MSS SP-110.

3. Description: Three-piece body, brass or bronze.

4. Pressure Rating: 300 psig (2070 kPa) minimum.

5. Ball: Full-port, chrome-plated brass.

6. Seats: PTFE or TFE.

7. Handle: Lever[type with locking device].

8. Stem: Blowout proof with PTFE or TFE seal.

9. Ends: manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

D. Check Valves:

1. Beacon Medaes or equal.

2. Description: In-line pattern, bronze.

3. Pressure Rating: 300 psig (2070 kPa) minimum.

4. Operation: Spring loaded.

5. Ends: Manufacturer-installed ASTM B 819, copper-tube extensions.

E. Safety Valves:

1. Bronze body.

2. ASME-construction, poppet, pressure-relief type.

3. Settings to match system requirements.

F. Pressure Regulators:

1. Bronze body and trim.

2. Spring-loaded, diaphragm-operated, relieving type.

3. Manual pressure-setting adjustment.

4. Rated for 250-psig (1725-kPa) minimum inlet pressure.

5. Capable of controlling delivered gas pressure within 0.5 psig for each 10-psig (5.0 kPa for each 100-kPa) inlet pressure.

2.05 NITROGEN

A. Comply with USP 32 - NF 27 for oil-free dry nitrogen.

PART 3 EXECUTION

3.01 PREPARATION

A. All tubing and fittings shall be especially prepared and cleaned for the gas service intended and shall conform to NFPA 99.

3.02 PIPING INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of gas piping. Indicated locations and arrangements were 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. Comply with NFPA 99 for installation of medical gas piping.

C. Install piping concealed from view and protected from physical contact by building occupants 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 and coordinate with other services occupying that space.

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

G. Install nipples, unions, special fittings, and valves with pressure ratings same as or higher than system pressure rating used in applications specified in "Piping Schedule" Article unless otherwise indicated.

H. Install piping to permit valve servicing.

I. Install piping free of sags and bends.

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

K. Install medical gas piping to medical gas service connections specified in this Section, to medical gas service connections in equipment specified in this Section, and to equipment specified in other Sections requiring medical gas service.

L. Piping Restraint Installation: Install seismic restraints on piping. Comply with requirements for seismic-restraint devices specified in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment."

M. Install medical gas service connections recessed in walls. Attach roughing-in assembly to substrate; attach finishing assembly to roughing-in assembly.

N. Connect gas piping to gas sources and to gas outlets and equipment requiring gas service.

O. Install unions in copper tubing adjacent to each valve and at final connection to each specialty and piece of equipment.

P. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

Q. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 220517 "Sleeves and Sleeve Seals for Plumbing Piping."

R. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 220518 "Escutcheons for Plumbing Piping."

3.03 VALVE INSTALLATION

A. Install shutoff valve at each connection to gas laboratory and healthcare equipment and specialties.

B. Install check valves to maintain correct direction of gas flow from laboratory and healthcare gas supplies.

C. Install valve boxes recessed in wall and anchored to substrate. Single boxes may be used for multiple valves that serve same area or function.

D. Install zone valves and gages in valve boxes. Arrange valves so largest valve is lowest. Rotate valves to angle that prevents closure of cover when valve is in closed position.

E. Install pressure regulators on gas piping where reduced pressure is required.

3.04 JOINT CONSTRUCTION

A. Ream ends of pipe and remove burrs.

B. Remove scale, slag, dirt, and debris from outside of cleaned tubing and fittings before assembly.

C. Threaded Joints: Apply appropriate tape to external pipe threads.

D. Brazed Joints: Join copper tube and fittings according to CDA's "Copper Tube Handbook," "Brazed Joints" chapter. Continuously purge joint with oil-free, dry nitrogen during brazing.

E. Shape-Memory-Metal Coupling Joints: Join new copper tube to existing tube according to procedures developed by fitting manufacturer for installation of shape-memory-metal coupling joints.

3.05 GAS SERVICE COMPONENT INSTALLATION

A. Assemble patient-service console with service connections. Install with supplies concealed in walls. Attach console box or mounting bracket to substrate.

B. Install nitrogen pressure-control panels in walls. Attach to substrate.

C. Assemble ceiling columns and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

D. Assemble ceiling-hose assemblies and install anchored to substrate. Provide structural steel, hanger rods, anchors, and fasteners in addition to components furnished with specialties necessary to fabricate supports.

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements in Section 220548 "Vibration and Seismic Controls for Plumbing Piping and Equipment" for seismic-restraint devices.

B. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for pipe hanger and support devices.

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

D. Individual, Straight, Horizontal Piping Runs:

1. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel, clevis hangers.

2. Longer Than 100 Feet (30 m): MSS Type 43, adjustable, roller hangers.

E. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze. Comply with requirements in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment" for trapeze hangers.

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

G. Support horizontal piping within 12 inches (300 mm) of each fitting and coupling.

H. Rod diameter may be reduced one size for double-rod hangers, with 3/8-inch- (10-mm-) minimum rods.

I. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1/4 (DN 8): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.

2. NPS 3/8 and NPS 1/2 (DN 10 and DN 15): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.

3. NPS 3/4 (DN 20): 84 inches (2100 mm) with 3/8-inch (10-mm) rod.

4. NPS 1 (DN 25): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.

5. NPS 1-1/4 (DN 32): 108 inches (2700 mm) with 3/8-inch (10-mm) rod.

6. NPS 1-1/2 (DN 40): 10 feet (3 m) with 3/8-inch (10-mm) rod.

7. NPS 2 (DN 50): 11 feet (3.4 m) with 3/8-inch (10-mm) rod.

J. Install supports for vertical copper tubing every 10 feet (3 m).

3.07 IDENTIFICATION

A. Install identifying labels and devices for specialty gas piping, valves, and specialties. Comply with requirements in Section 200553 "Mechanical Identification”

B. Install identifying labels and devices for healthcare medical gas piping systems according to NFPA 99. Use the following or similar captions and color-coding for piping products where required by NFPA 99:

1. Oxygen: White letters on green background or green letters on white background.

3.08 FIELD QUALITY CONTROL FOR HEALTHCARE FACILITY MEDICAL GAS

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Medical Gas Piping Testing Coordination: Perform tests, inspections, verifications, and certification of medical gas piping systems concurrently with tests, inspections, and certification of medical compressed-air piping and medical vacuum piping systems.

2. Preparation: Perform the following Installer tests according to requirements in NFPA 99 and ASSE Standard #6010:

a. Initial blowdown.

b. Initial pressure test.

c. Cross-connection test.

d. Piping purge test.

e. Standing pressure test for positive-pressure medical gas piping.

f. Standing pressure test for vacuum systems.

g. Repair leaks and retest until no leaks exist.

3. System Verification: Perform the following tests and inspections according to NFPA 99, ASSE Standard #6020, and ASSE Standard #6030:

a. Standing pressure test.

b. Individual-pressurization or pressure-differential cross-connection test.

c. Valve test.

d. Master and area alarm tests.

e. Piping purge test.

f. Piping particulate test.

g. Piping purity test.

h. Final tie-in test.

i. Operational pressure test.

j. Medical gas concentration test.

k. Medical air purity test.

l. Verify correct labeling of equipment and components.

m. Verify medical gas supply sources.

4. Testing Certification: Certify that specified tests, inspections, and procedures have been performed and certify report results. Include the following:

    a. Inspections performed.

    b. Procedures, materials, and gases used.

    c. Test methods used.

    d. Results of tests.

C. Remove and replace components that do not pass tests and inspections and retest as specified above.

D. Prepare test and inspection reports.

3.09 FIELD QUALITY CONTROL FOR LABORATORY FACILITY SPECIALTY GAS

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections medical gas piping systems in healthcare facilities and to prepare test and inspection reports.

B. All new piping, valves and fittings installed under this section shall be tested as described under each individual gas section. These tests shall be made on the new work only. The contractor shall verify the presence of the desired gas in all outlets served by the new piping. This shall be done with an analyzer and a written certification of these tests (for each gas) shall be made to the Architect by the Plumbing Contractor and the company certifying the medical gas system.

C. A final test of the medical gas system (all gases) shall be made prior to turning the building over to the Owner. This test shall be made by an independent testing company with three or more years experience in certification of medical gas systems. This independent company shall be certified by MGPHCO or NITC. A written certification from this testing company shall be turned over to the Owner and the Architect. The certification shall include only the medical gas system installed under this contract. These tests and certification shall comply with the requirements and recommendations of N.F.P.A. 99. The cost of this certification shall be included in the Plumbing Contract. The certification shall include a recertification of the existing system as required by N.F.P.A. and the health authorities having jurisdiction.

D. Tests and Inspections:

1. Piping Leak Tests for Specialty Gas Piping: Test new and modified parts of existing piping. Cap and fill specialty gas piping with oil-free, dry nitrogen to pressure of 50 psig (345 kPa) above system operating pressure, but not less than 150 psig (1035 kPa). Isolate test source and let stand for four hours to equalize temperature. Refill system, if required, to test pressure; hold for two hours with no drop in pressure.

2. Repair leaks and retest until no leaks exist.

3. Inspect specialty gas regulators for proper operation.

4. System inspections shall be performed prior to concealing piping distribution systems in wall, ceilings, chases, trenches, underground, or otherwise hidden from view.

5. Inspections shall be conducted by a person(s) competent and experienced in the field of medical gas and vacuum pipeline inspections and testing and meeting the requirements of ASSE 6020 or ASSE 6030.

6. The initial pressure test performed by the installing contractor shall be witnessed by an ASSE 6020 inspector an ASSE 6030 verifier, or the AHJ or its designee. A form indicating that this test has been performed and witnessed shall be provided to the verifier at the start of test as required by NFPA 99.

E. Remove and replace components that do not pass tests and inspections and retest as specified above.

F. Prepare test and inspection reports.

3.10 PROTECTION

A. Protect tubing from damage.

B. Retain sealing plugs in tubing, fittings, and specialties until installation.

C. Clean tubing not properly sealed, and where sealing is damaged, according to "Preparation" Article.

3.11 DEMONSTRATION

A. Engage factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain bulk gas storage tanks.

3.12 PIPING SCHEDULE

A. Connect new tubing to existing tubing with memory-metal couplings.

B. Medical Gas Piping except Medical Nitrogen Piping Larger Than NPS 3 (DN 80) and Operating at More Than 185 psig (1275 kPa): Type L, copper tube; wrought-copper fittings; and brazed joints.

3.13 VALVE SCHEDULE

A. Shutoff Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions.

B. Zone Valves: Ball valve with manufacturer-installed ASTM B 819, copper-tube extensions with pressure gage on one copper-tube extension.

END OF SECTION 226313

SECTION 230000 - GENERAL HVAC REQUIREMENTS

PART 1 -GENERAL

1.01 SUMMARY

A. Related Documents:

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

2. The requirements listed in this document are applicable to Divisions 23 specifications.

B. Commissioning:

1. An independent third-party Commissioning Agent will document completion of the Mechanical/HVAC Systems for the project. The Division 23 Mechanical/HVAC Contractor is a member of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 01 91 13 “General Commissioning Requirements” for the project Commissioning requirements and roles and responsibilities for each member of the Commissioning Team.

1.02 WARRANTIES

A. Warrant all materials, workmanship and equipment against defects for a period of one year after the date of substantial completion. Certain equipment shall be warranted beginning at the time of substantial completion or for longer periods of time as specified in those divisions of the Project Manual. Repair or replace, at no additional cost to the Owner, any item which may become defective within the warrant period. Any manufacturers’ warranties concerning any item installed will run to the benefit of the Owner. The Contractor agrees not to void or impair, or to allow Sub-Contractors to void or impair, any warranties regarding products or items installed as part of this project. The repair of faulty workmanship shall be included in the contract.

B. Provide as base bid extended warranty as needed to accommodate any temporary use of any and all equipment prior to substantial competition. During this period, units shall be run at 100 percent outside air. Coordinate operation of unit with Engineer and appropriate subcontractors to verify capacity and run conditions.

1.03 QUALITY ASSURANCE

A. Source Limitations: To fullest extent possible, provide products of same kind, from a single source.

1. When specified product are available only from sources that do not, or cannot, produce a quality adequate to complete Project requirements in a timely manner, consult with Architect and Owner to determine most important product qualities before proceeding. Qualities may include attributes, such as visual appearance, strength, durability, or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to fullest extent possible.

B. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, select product compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.

a. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect shall determine which products shall be used.

C. Comply with all State and local codes and ordinances.

D. Make application, obtain and pay for all required permits and certificates of inspection of the work.

E. Required access for servicing and maintenance shall be provided for all equipment (valves, specialties, filters, etc.) Provide architectural access panels as required.

F. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment of types, materials, and sizes required for the project, whose products have been in satisfactory use in similar service for not less than five (5) years.

G. Installers Qualifications: Firm with at least three (3) years of successful installation experience on projects with equipment installation work similar to that required for project.

1.04 INTERPRETATION OF DOCUMENTS

A. All questions from contractors or subcontractors as it pertains to contract documents during the bidding phase or construction shall be submitted to the Engineer for clarification. Clarification will be issued through official written correspondence. Verbal interpretation or explanation not issued in the form of an addendum or supplemental instruction shall not be considered part of the bidding documents or contract. The Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

B. If any ambiguities should appear in the contract documents, request clarification from the Engineer before proceeding with the work. Failure to obtain clarification may result in work not being accepted by the Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work.

1.05 PERMITS, FEES, AND NOTICES

A. Secure and pay for permits and governmental fees, licenses, and inspections necessary for proper execution and completion of the Work, and for Owner to occupy and operate systems.

B. Comply with and file notices required by laws, ordinances, rules, regulations, and lawful orders of public authorities applicable.

1.06 CODES

A. The work shall be performed by persons skilled in the trade involved and shall be done in a manner consistent with normal industry standards. All work shall conform to all applicable sections of currently adopted editions of all applicable codes. The contractor is responsible for verifying the local codes in the jurisdiction with which the work is performed and installing the work as listed by said codes.

1.07 PROJECT COORDINATION AND LAYOUT

A. The contractor is responsible for laying out and coordinating all work prior to installation. Produce coordination documents incorporating all mechanical, fire protection, electrical and other trades in conjunction with the building structure and architectural features. Coordinate all routing of systems prior to installation. Payment for changes due to pre-fabricating or moving of piping, ductwork, conduit, cable trays, equipment, or any other mechanical, electrical, plumbing, or technology system due to lack of coordination will not be approved.

B. Documents produced by Specialized Engineering Solutions are diagrammatic in nature. Not all system offsets are shown to accommodate final elevations and avoid interference with all other building structural, architectural, mechanical, electrical, fire protection, and technology systems. Include in base scope of work, offsets necessary to negotiate the building appropriately.

C. Specifications list specialties, valve, damper, and systems installation requirements in addition to what is shown on drawings. Not all valves, dampers, and accessories are shown on drawings.

1.08 EQUIPMENT ELECTRICAL CONNECTIONS

A. Electrical connections identified are for the specific equipment manufacturer and model scheduled, and includes equipment furnished by this trade or furnished by other trades under these contract documents. If the Contractor chooses to provide equipment found acceptable from a different manufacturer and model than that scheduled but listed as equivalent in the specifications, or otherwise accepted by the Architect/Engineer, include electrical connection revisions associated with that manufacturer’s electrical connection requirements in bid. Upon approval of a manufacturer and model other than that specifically scheduled, request clarification of the required electrical connection revision from the Engineer for incorporation into the electrical design and construction documents. If the necessary revision is found to require extensive design modification by the Engineer, provide the Engineer reasonable compensation for incorporation of the selected manufacturer’s equipment into the project design.

B. Coordinate short circuit current ratings of equipment electrical components to meet or exceed fault levels calculated at the equipment location by the Fault and Coordination study performed under the electrical sub-contract. Where this study is not required by the contract, short circuit current ratings of equipment shall meet or exceed the short circuit current rating of the branch source electrical panel serving the equipment.

1.09 SALVAGE RIGHTS

A. The Owner shall have first salvage rights to all items removed. If Owner refuses salvage, Contractor is responsible for disposal.

1.10 OPERATION AND MAINTENANCE MANUALS

A. Manuals to be bound in 3 ring binders and include:

1. Title page with project name and location and date of submittal.

2. Title, Name, address, and telephone number all contractors and suppliers.

3. Table of contents with corresponding tabs to mark sections.

B. Manual to contain the following:

1. Equipment record document submittal.
2. Warranty details, expiration dates, and contacts.
3. Licensing requirements including inspection and renewal dates.
4. Equipment location.
5. Operating manuals including wiring and control diagrams.
6. Operating procedures.
7. Precautions against improper use.
8. Startup shutdown and switchover procedures.
9. Emergency procedures.
10. Schedule for routine cleaning and maintenance.

C. Provide the Operation and Maintenance manuals as hardcopy, electronically and on a thumb drive. Provide a thumb drive of the scanned record drawing redlines, in addition to the hardcopy.

1.11 OPERATOR TRAINING

A. Schedule and conduct complete owner training for every system and associated piece of equipment. Operating and maintenance manuals shall be complete and accepted by owner and engineer prior to training. Coordinate a training session which will include the Owner/Owner's Representatives and all Sub-Contractors or equipment representatives needed to explain and train on the system. A training agenda shall be submitted prior to training. The agenda shall be reviewed and amended as necessary by the Engineer and Owner. Cover all information submitted in the operation and maintenance manual.

1.12 ALLOWANCES

A. Include in bid, appropriate allowances for material and labor for pulley changes on equipment, impeller changes on pumps, and air baffles necessary in air handling equipment.

1.13 PROJECT CONDITIONS

A. Participate in the development of infection control risk assessments and perform work in strict compliance with the work plan developed in conjunction with the Owner and all other Contractors. Take great care in performance of work to limit dust and debris. Aid in the erection of dust-free partitions and work within confines. Environments to include but shall not be limited to negative pressure partitions, HEPA filtered air, pressure and particle monitored environments.

END OF SECTION 230000

SECTION 230500 - COMMON WORK RESULTS FOR MECHANICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

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. Concrete bases and housekeeping pads.
8. Demolition.
9. Equipment installation requirements common to equipment sections.
10. Supports and anchorages.

B. Related Sections include the following:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and other Division 01 Specification Sections, apply to this Section.
2. The requirements listed in this document are applicable to Division 23 specifications

C. Commissioning:

1. An independent third-party Commissioning Agent will document completion of the Mechanical/HVAC Systems for the project. The Division 23 Mechanical/HVAC Contractor is a member of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 01 91 13 “General Commissioning Requirements” for the project Commissioning requirements and roles and responsibilities for each member of the Commissioning Team.

1.02 SUBMITTALS

A. Not required.

1.03 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.

3. Electrical Characteristics for Mechanical 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 without additional cost. If minimum energy ratings or efficiencies are specified, equipment shall comply with requirements.

1.04 DEFINITIONS

1.05 FINISHED SPACES: SPACES OTHER THAN MECHANICAL AND ELECTRICAL EQUIPMENT ROOMS, FURRED SPACES, PIPE AND DUCT CHASES, UNHEATED SPACES IMMEDIATELY BELOW ROOF, SPACES ABOVE CEILINGS, UNEXCAVATED SPACES, CRAWLSPACES, AND TUNNELS.

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

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

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

D. 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.

PART 2 - PRODUCTS

2.01 PIPE, TUBE, AND FITTINGS

A. Refer to individual 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.

2.02 JOINING MATERIALS

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

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

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

F. 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.

2.03 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: Not permitted.

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

E. 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.

2.04 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: Reinforced nylon polymer. Include two for each sealing element.

D. Connecting Bolts and Nuts: Type 316 Stainless steel of length required to secure pressure plates to sealing elements. Include one for each sealing element.

2.05 SLEEVES

A. Steel Pipe:

1. Pipe sizes through 10 inch: ASTM A 53, Type E, Grade B, Schedule 40, galvanized, plain ends.

2. Pipe sized 12 inch and greater: ASTM A 53, Type E, Grade B, wall thickness no less than 0.375 inches, galvanized, plan ends.

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

C. 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.

2. Sleeve length: as required to extend through structure.

2.06 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.

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

1. Finish: Polished chrome-plated.

2.07 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, non-staining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

2.08 CONCRETE BASES AND HOUSEKEEPING PADS

A. Form Materials:

1. Comply with Building Code and ACI 347. Design, erect, support and maintain forms to safely carry all superimposed loads until such time as such loads can be safely supported by the concrete work. Construct formwork to shape, sizes and dimensions as required to ensure accurate alignment and elevation, and level and plumb finished concrete work.

2. Nails, spikes, lag bolts, through bolts, anchorages: Sized as required of strength and character to maintain formwork in place while placing concrete.

B. Concrete:

1. Cement:

a. ASTM C150, Type I/II or ASTM C595 Type IS.

b. 3000-psi, 28-day compressive-strength concrete

2. Aggregate:

a. Coarse aggregate for stone concrete: ASTM C33, with maximum size 3/4 in.

b. Fine aggregate: Clean, durable sand, uncoated, grains free from silt, loam, and clay. Graded from fine to coarse with 95-100 percent by weight passing a No. 4 sieve and 3-8 percent passing a No. 100 sieve. ASTM C33 with following maximum permissible limits for deleterious substances, measured in percentage by weight: clay lumps 1.00; coal and lignite 0.25; materials finer than No. 200 sieve 3.00.

3. Controlled concrete proportioned as outlined in Section 5.3 ACI 318, unless specified otherwise. Allowable design stresses are based on minimum 28-day compressive strength indicated.

4. Proportions of aggregate to cement shall produce non-segregating plastic mixture of consistency required to be worked readily into corners and angles of forms and around reinforcement with method of placement employed. Accomplish variations in consistency by changes in proportioning of mix with changing W/C (water/cement) ratios established.

C. Concrete reinforcement materials:

1. New, free from rust, and complying with the following:

a. Bars for reinforcement: A615, grade 60; stirrups and ties grade 60. 2.

b. Wire fabric: 6” x 6”, W1.4-W1.4 welded wire fabric complying with ASTM A185. 3.

c. Bar supports: "Bar Support Specifications," CRSI Manual of Standard Practice, Type: plastic tipped accessories.

d. Tie Wire: Cold drawn steel; ASTM A-82.
1) Supports for reinforcement: Provide supports including bolsters, chairs, spacers and other devices for supporting and fastening reinforcing bars and welded wire fabric in place. Use wire bar type supports complying with CRSI recommendations.

PART 3 - EXECUTION

3.01 BUILDING ELEMENTS

A. Where required for the removal or installation of elements within Contractor’s scope, Contractor shall include all necessary building element removal, modification, and reinstallation required to facilitate work. Such building elements include but are not limited to ceilings, floors, walls, roofs, doors, beams, piping, ductwork, conduits, and lights. Elements shall only be removed to the extent required to facilitate work and shall minimize the impact to the facility.

B. Where building elements are not required to be removed but are subject to potential damage during the execution of Contractor’s work, Contractor shall protect building elements from damage.

C. Where building elements are removed and reinstalled or subject to potential damage, Contractor shall walk construction area prior to work with Owner and document condition of building elements and finishes prior to work. Contractor shall restore all building elements and finishes to their original condition noted during the walkthrough. Items not documented shall be considered in “as new” condition.

D. Where building elements must be modified prior to reinstallation to accommodate new work and such modification is not specifically indicated on the plans, Contractor shall obtain Owner approval prior to making modifications. Failure to obtain approval shall not be grounds for additional compensation.

E. Contractor shall coordinate all building element removal and reinstallation with Owner. Where removal constitutes a significant impact to the Owner's operations, such work shall be performed during off hours as defined by the Owner. Significant impacts include but are not limited to utility shutdowns, facility access, occupant safety, occupant comfort, and noise.

3.02 MECHANICAL DEMOLITION

A. Refer to Division 01 Sections "Cutting and Patching" and "Selective Demolition" for general demolition requirements and procedures.

B. Disconnect, demolish, and remove mechanical systems, equipment, and components indicated to be removed.

1. Piping to Be Removed: Remove portion of piping indicated to be removed and cap or plug remaining piping with same or compatible piping material.

2. Piping to Be Abandoned in Place: Drain piping and cap or plug piping with same or compatible piping material.

3. Ducts to Be Removed: Remove portion of ducts indicated to be removed and plug remaining ducts with same or compatible ductwork material.

4. Ducts to Be Abandoned in Place: Cap or plug ducts with same or compatible ductwork material.

5. Equipment to Be Removed: Disconnect and cap services and remove equipment. Remove all associated elements (e.g., housekeeping pad, roof curb, support rack, hangers, etc.) and patch structure and architectural elements (walls, roofs, floors, grade, landscaping) to match adjacent elements and finishes). Where equipment is controlled by or component of a DDC system, disconnect and remove controls devices, sensors, valves, dampers, and associated wiring; and revise existing DDC software and graphics to reflect the removed equipment.

6. Equipment to Be Removed and Reinstalled: Disconnect and cap services and remove, clean, and store equipment; when appropriate, reinstall, reconnect, and make equipment operational. Where equipment is controlled by or component of a DDC system, disconnect and remove, clean, and store controls devices, sensors, valves, dampers, and associated wiring; revise existing DDC software and graphics to reflect the removed equipment; and when appropriate, reinstall, reconnect, and reprogram controls devices, sensors, valves, dampers, wiring, and graphics.

7. Equipment to Be Removed and Salvaged: Disconnect and cap services and remove equipment and deliver to Owner. Remove all associated elements (e.g., housekeeping pad, roof curb, support rack, hangers, etc.) and patch structure and architectural elements (walls, roofs, floors, grade, landscaping) to match adjacent elements and finishes). Where equipment is controlled by or component of a DDC system, disconnect, remove, and deliver to the Owner controls devices, sensors, valves, dampers, and associated wiring; and revise existing DDC software and graphics to reflect the removed equipment.

C. If pipe, insulation, or equipment to remain is damaged in appearance or is unserviceable, remove damaged or unserviceable portions and replace with new products of equal capacity and quality.

D. If pipe, ductwork, or equipment to remain is supported by building elements to be removed, Contractor shall support from structure following the requirements specified in Division 23 Section “Hangers and Supports for Mechanical”.

3.03 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 23 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. Drainage piping shall not be routed over the following spaces. Where this is unavoidable, the drainage piping shall be accompanied by 18 gauge galvanized, sealed, 2” deep secondary containment drain-pans with moisture sensor alarms.

1. Electrical rooms.
2. Communication/IT rooms.
3. Food preparation rooms.
4. Food serving areas.
5. Food storage areas.
6. Nurseries.
7. Central Services/sterile processing department
8. Trauma rooms.
9. Operating rooms.
10. Delivery rooms.
11. Imaging rooms and associated equipment rooms.
12. Pharmacy clean rooms and medication storage areas.
13. Other locations identified on the plans.

D. Pressurized piping containing liquid shall not be routed over the following spaces or within one foot laterally from the edge of electrical and electronic/IT equipment in other spaces. Where this is unavoidable, the piping shall be accompanied by 18 gauge galvanized, sealed, 2” deep secondary containment drain-pans with moisture sensor alarms. Pressurized piping dedicated to equipment in the spaces listed below shall not require drain pans provided that it is not within one foot laterally of the edge of electrical and electronic/IT equipment.

1. Electrical rooms.

2. Communication/IT rooms.

3. Operating rooms.

4. Delivery rooms.

5. Imaging rooms and associated equipment rooms.

6. Other locations identified on the plans.

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

F. 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.

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

H. Install piping to permit valve servicing.

I. Install piping at indicated slopes.

J. Install piping free of sags and bends.

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

L. Install piping to allow application of insulation.

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

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

O. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions.

P. Installation of Install manufactured stack sleeve fittings and field installed water dams for pipes passing through concrete floor and roof slabs.

1. Install manufactured stack sleeve fittings per manufacturers recommendations.

2. As an alternate to manufactured stack sleeve fittings field installed water dams may be used. Construct field installed water dams to meet either of the following criteria:

a. Steel pipe with flange water dam: construct water dam by welding together Schedule 40 steel pipe and steel flange to be watertight. Cut flange from flat steel of same thickness as pipe wall. Flange ring width shall be a minimum of 1 inch and inside diameter of dam shall be 1 inch larger than outside diameter of piping or its insulation, whichever is larger. Top of water damn to be 4 inches above the finished floor. Permanently anchor dam flange to the floor and seal the flange-to-floor joint watertight.

b. Steel water dam: Construct dam by inserting end of Schedule 40 steel pipe or sheet steel fully into a groove approximately 13 mm 1/2 IN deep. Permanently anchor dam flange to floor and seal the flange to floor joint watertight.

3. Seal annular space around piping and insulation.

4. Maintain fire and smoke ratings at pipe penetrations of fire/smoke rated building elements.

5. Provide stack sleeve fittings or water dams around pipes penetrating the floor above rooms requiring drain/drip pans and in wet areas, including but not limited to the following:

    a. Mechanical rooms.

    b. Boiler rooms.

    c. Kitchens, Dishwashing and Food Service areas.

    d. Laundry Rooms.

    e. Pools and Hydrotherapy Rooms.

    f. Sterile Processing Areas.

    g. Dialysis Areas.

    h. Rooms where emergency showers are present.

    i. Locations indicated on plans.

Q. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using 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.

1. Install steel pipe for sleeves smaller than 6 inches in diameter.

2. Install cast-iron "wall pipes" for sleeves 6 inches and larger in diameter.

3. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

R. Underground, Exterior-Wall Pipe Penetrations: Install cast-iron "wall pipes" for sleeves. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

1. Mechanical Sleeve Seal Installation: Select type and number of sealing elements required for pipe material and size. Position pipe in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pipe and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

S. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with UL listed through penetration firestop systems. Refer to Division 07 Section "Through-Penetration Firestop Systems" for materials.

T. Verify final equipment locations for roughing-in.

U. Refer to equipment specifications in other Specifications Sections for roughing-in requirements.

3.04 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and other Specification 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.

3.05 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. Install dielectric flange or nipple fittings to connect piping materials of dissimilar metals.

3.06 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 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.

3.07 CONCRETE BASES AND HOUSEKEEPING PADS

A. Furnish and install concrete bases and housekeeping pads (not specifically indicated on the Drawings or in the Specifications of either the General Construction or Mechanical work as provided by another Contractor) for all floor mounted equipment provided.

B. All concrete bases and housekeeping pads shall be reinforced in accordance with ACI 315.

C. Existing concrete bases and housekeeping pads may be used for new equipment. Where concrete base or housekeeping pad is too small to accommodate new equipment, do not extend concrete base or housekeeping pad; demolish concrete base or housekeeping pad and provide new housekeeping pad.

D. Forms:

1. Construct forms to the exact sizes, shapes, lines and dimensions as required to obtain accurate alignment, locations, grades, level and plumb work in the finished structures.

2. Chamfer exposed external corners and edges.

3. Inserts, embedded parts and openings:

   a. Provide formed openings where required for work embedded in or passing through concrete.

   b. Coordinate work of other sections in forming and setting openings, slots, recesses, chases, sleeves, bolts, anchors, and other inserts.

   c. Install accessories in accordance with manufacturer's instructions, level and plumb. Ensure items are not disturbed during concrete placement.

4. Form removal:

   a. Do not remove forms and bracing until concrete has sufficient strength to support its own weight, and construction and design loads which may be imposed upon it.

   b. Do not damage concrete surfaces during form removal.

5. Cleaning:

   a. Clean forms to remove foreign matter as erection proceeds.

   b. Ensure that water and debris drain to exterior through clean out ports.

   c. During cold weather, remove ice and snow from forms. Do not use deicing salts. Do not use water to clean out completed forms, unless formwork and construction proceed within heated enclosure.

E. Reinforcement:

1. Before start of concrete placement, accurately size and place concrete reinforcement in accordance with ACI 315, positively securing and supporting by concrete blocks, metal chairs or spacers, or metal hangers.

2. Clearance: Clear space between bars and cover for bars shall conform to the Requirements of ACI 318.

3. Splicing:

   a. Horizontal bars:
      1) Place bars in horizontal members with laps at splices in accordance with the Contract Documents and the Requirements of ACI-318 (Latest Edition).
      2) Bars may be wired together at laps.
      3) Wherever possible, stagger the splices of adjacent bars.

   b. Wire fabric:
      1) Make splices in wire fabric at least 1-1/2 meshes wide.

   c. Other splices:
      1) Place required steel dowels and securely anchor into position before concrete is placed.

4. Coordinate placement with conduits, piping, inserts, sleeves or other items.

F. Concrete Bases and Housekeeping Pads: Anchor equipment to concrete bases and housekeeping pads according to equipment manufacturer's written instructions.

1. Construct concrete bases and housekeeping pads not less than 4 inches larger in both directions than supported unit. Concrete bases and housekeeping pads shall be nominal 4 inches thick unless indicated otherwise on plans and details. Where a base is less than 12 inches from a wall, extend the base to the wall.

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.

G.

1. Place, install and secure anchorage devices. Use manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Curing:

   a. Keep forms in place for a seven-day curing period. Keep top exposed concrete surface wet and forms moist. Loosen forms to allow curing water to run down between concrete and forms.

3.08 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 mechanical materials and equipment.

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

3.09 GROUTING

A. Mix and install grout for mechanical 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.

END OF SECTION 230500

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 230513 - COMMON MOTOR REQUIREMENTS FOR MECHANICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Related Documents:

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

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. None.

1.04 COORDINATION

A. Coordinate features of motors, installed units, and accessory devices to be compatible with the following:

1. Motor controllers.

2. Torque, speed, and horsepower requirements of the load.

3. Ratings and characteristics of electrical supply circuit and required control sequence.

4. Ambient and environmental conditions of installation location.

PART 2 - PRODUCTS

2.01 GENERAL MOTOR REQUIREMENTS

A. Comply with requirements in this Section except when stricter requirements are specified in equipment schedules or Sections.

B. Comply with NEMA MG 1 unless otherwise indicated.

2.02 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 50 feet above sea level.

B. Capacity and Torque Characteristics: Sufficient to start, accelerate, and operate connected loads at designated speeds, at installed altitude and environment, with indicated operating sequence, and without exceeding nameplate ratings or considering service factor.

2.03 POLYPHASE MOTORS

A. Description: NEMA MG 1, Design B, medium induction motor.

B. Efficiency: NEMA premium efficiency, as defined in NEMA MG 1.

C. Service Factor: 1.15.

D. Multispeed Motors: Variable torque.

1. For motors with 2:1 speed ratio, consequent pole, single winding.

2. For motors with other than 2:1 speed ratio, separate winding for each speed.

E. Rotor: Random-wound, squirrel cage.

F. Bearings: Regreasable, shielded, antifriction ball bearings suitable for radial and thrust loading.

G. Temperature Rise: Match insulation rating.

H. Insulation: Class F.

I. Code Letter Designation:

1. Motors 15 HP and Larger: NEMA starting Code F or Code G.

2. Motors Smaller than 15 HP: Manufacturer's standard starting characteristic.

J. Enclosure Material: Rolled steel or cast-iron construction. 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.

K. Motors Used with Variable Frequency Controllers: Ratings, characteristics, and features coordinated with and approved by controller manufacturer.

1. Windings: Copper magnet wire with moisture-resistant insulation varnish, designed and tested to resist transient spikes, high frequencies, and short time rise pulses produced by pulse-width modulated inverters.

2. Premium-Efficient Motors: Class B temperature rise; Class F insulation.

3. Inverter-Duty Motors: Class F temperature rise; Class H insulation.

4. Thermal Protection: Comply with NEMA MG 1 requirements for thermally protected motors.

L. Provide factory installed bearing protection ring, AEGIS or equal on all motors powered by VFD.

2.04 SINGLE-PHASE MOTORS

A. Motors larger than 1/20 hp shall be one of the following, to suit starting torque and requirements of specific motor application:

1. Permanent-split capacitor.

2. Split phase.

3. Capacitor start, inductor run.

4. Capacitor start, capacitor run.

5. Electronic commutation.

B. Multispeed Motors: Variable-torque, permanent-split-capacitor type or electronic commutation type.

C. Bearings: Prelubricated, antifriction ball bearings or sleeve bearings suitable for radial and thrust loading.

D. Motors 1/20 HP and Smaller: Shaded-pole type or electronic commutation type.

E. Electronic commutation motors shall be speed controllable down to 20% of full speed (80% turndown). Speed shall be controlled by either a potentiometer dial mounted on the motor or by a 0-10 VDC signal.

F. Thermal Protection: Internal protection to automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature rating of motor insulation. Thermal-protection device shall automatically reset when motor temperature returns to normal range.

PART 3 - EXECUTION

3.01 ROTATING EQUIPMENT FIELD ALIGNMENT

A. All coupled rotating equipment over 1 horsepower shall be laser-aligned, using a dual receiver coupling laser aligner or other approved laser alignment equipment after installation. Thermal growth calculations shall be made where appropriate to reflect operating conditions. If applicable, equipment, structure, and attached piping thermal growths shall be considered in addition to operational effects such as oil wedge, pressure/vacuum pull-down, etc. to insure in service alignment tolerances are achieved. The acceptable in-service alignment tolerances shall be determined by the equipment manufacturer. Where no value is given, tolerance shall be 0.0005”. The installing contractor must check for and correct any soft foot conditions before attempting the laser alignment of any coupled rotating equipment. The soft foot tolerance is the differential at any foot on the equipment. Fluid film bearing machine shafts shall be level while in service.

B. A record of the final alignment settings, alignment setup, alignment tolerances, machine ID/Name, date of alignment, and alignment technician ID shall be printed and signed by the technician responsible for the alignment. Calculations for thermal effects and other operational considerations shall be attached to this printout. A copy shall be forwarded to the Owner and Engineer for review and acceptance. The accepted copy shall be included in the final Operation and Maintenance Manuals.

C. A minimum of two jacking bolts shall be installed at each hold-down bolt position to facilitate controlled movement in the axial (in line with the shaft, perpendicular to the bolt body) direction and “horizontal” (perpendicular to hold-down bolt body and axial direction). The jacking bolts must be positioned so that they do not interfere with the installation and removal of shim packs.

D. Hold-down bolts shall be tightened using a calibrated torque wrench in at least three stages (50%, 80%, and 100% of final torque value), each stage following a “cross” pattern. After alignment and tightening of hold-down bolts, all jacking bolts shall be backed-off ~0.100” and locked with jam nuts.

END OF SECTION 230513

SECTION 230516 - EXPANSION FITTINGS AND LOOPS FOR MECHANICAL PIPING

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

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

1.02 SUMMARY

A. Section Includes:

1. Metal-bellows expansion joints.
2. Expansion compensators.
3. Flexible-hose expansion joints.
4. Packed slip expansion joints.
5. Pipe bends and loops.
6. Alignment guides and anchors.

1.03 DEFINITIONS

A. BR: Butyl rubber.

B. Buna-N: Nitrile rubber.

C. CR: Chlorosulfonated polyethylene synthetic rubber.

D. CSM: Chlorosulfonyl-polyethylene rubber.

E. EPDM: Ethylene-propylene-diene terpolymer rubber.

F. NR: Natural rubber.

G. PTFE: Polytetrafluoroethylene plastic.

1.04 PERFORMANCE REQUIREMENTS

A. Compatibility: Products shall be suitable for piping system fluids, materials, working pressures, and temperatures.

B. Capability: Products shall absorb 200 percent of maximum axial movement between anchors.

1.05 SUBMITTALS

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

B. Delegated-Design Submittal: For each anchor and alignment guide indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate requirements for thermal expansion of piping systems and for selecting and designing expansion joints, loops, and bends.

2. Anchor Details: Detail fabrication of each anchor indicated. Show dimensions and methods of assembly and attachment to building structure.

3. Alignment Guide Details: Detail field assembly and attachment to building structure.

4. Schedule: Indicate type, manufacturer's number, size, material, pressure rating, end connections, and location for each expansion joint.

C. Welding certificates.

D. Product Certificates: For each type of pipe expansion joint, signed by product manufacturer.

E. Maintenance Data: For pipe expansion joints to include in maintenance manuals.

1.06 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. Steel Shapes and Plates: AWS D1.1, "Structural Welding Code - Steel."

2. Welding to Piping: ASME Boiler and Pressure Vessel Code: Section IX.

PART 2 - PRODUCTS

2.01 EXPANSION JOINTS

A. Metal-Bellows Expansion Joints: ASTM F 1120, circular-corrugated-bellows type with external tie rods.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Adsco Manufacturing, LLC.

b. Flexicraft Industries.

c. Flex-Pression, Ltd.

d. Flex-Weld, Inc.

e. Hyspan Precision Products, Inc.

f. Metraflex, Inc.

g. Senior Flexonics, Inc.; Pathway Division.

h. Unaflex Inc.

2. Metal-Bellows Expansion Joints for Copper Piping: Single- or multiple-ply phosphor-bronze bellows, copper pipe end connections, and brass shrouds.

3. Metal-Bellows Expansion Joints for Steel Piping: Single- or multiple-ply stainless-steel bellows, steel pipe end connections, and carbon-steel shroud.

4. Minimum Pressure Rating: 150 psig, unless otherwise indicated.

5. End Connections: Flanged or welded.

B. Expansion Compensators: Double-ply corrugated steel, stainless-steel, or copper-alloy bellows in a housing with internal guides, antitorque device, and removable end clip for positioning.

END OF SECTION 230516

SECTION 230523 - GENERAL-DUTY VALVES FOR MECHANICAL

PART 1 GENERAL

1.01 SUMMARY

A. Section includes:

1. Ball valves.
2. Butterfly valves.
3. Check valves.
4. Gate valves.
5. Globe valves.

B. Valves for specialty applications are specified in sections applicable to those services. This includes but is not limited to:

1. Fire protection.
2. Natural gas, liquefied petroleum gas, or fuel oil.
3. Medical gas.
4. High purity water.

C. Related Sections:

1. Division 02 water distribution piping Sections for general-duty and specialty valves for site construction piping.
2. Divisions 23 mechanical piping Sections for specialty valves applicable to those Sections only.
3. Division 23 Section "Mechanical Identification" for valve tags and schedules.

1.02 SUBMITTALS

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

1.03 QUALITY ASSURANCE

A. Source Limitations for Valves: Obtain each type of valve from single source from single manufacturer.

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

C. NSF Compliance:

1. NSF 61 for valve materials for potable-water service.

2. NSF 372: Drinking water system components – lead content for valve materials for potable-water service.

PART 2 PRODUCTS

2.01 GENERAL REQUIREMENTS FOR VALVES

A. Refer to Part 3 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 with Handwheel: 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, as indicated in the "Valve Installation" Article. Where chainwheel is required, gear actuator with handwheel shall be used for quarter turn valves in lieu of handlever.

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

1. Ball Valves: With extended operating handle of non-thermal-conductive material, and protective sleeve that allows full operation of valve without breaking the vapor seal or disturbing insulation.

2. Butterfly Valves: With extended stem.

F. Valve-End Connections:

1. Valve end connection shall match the joints specified for the associated piping systems used.

a. Flanged: With flanges according to ASME B16.1 for iron valves.

b. Grooved: With grooves according to AWWA C606.

c. Solder Joint: With sockets according to ASME B16.18.

d. Threaded: With threads according to ASME B1.20.1.

G. Valves intended for domestic water service shall be certified lead-free per NSF standards.

2.02 BRASS/BRONZE BALL VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Anvil.

2. Conbraco/Apollo.

3. Hammond Valve.

4. Jamesbury; a subsidiary of Metso Automation.

5. Kitz Corporation.

6. Milwaukee Valve Company.

7. Sharpe Valve.

8. Watts.

B. Two-Piece, Brass/Bronze Ball Valves:

1. 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. Seats: PTFE or TFE.

g. Stem:
1) Blowout proof.
2) Stainless steel.
3) Brass.

h. Ball:
1) Stainless steel.
2) Chrome plated brass

i. Port:
1) Full.
2) Regular

2.03 IRON, LUGGED BUTTERFLY VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.

2. Bray Controls; a division of Bray International.

3. Conbraco Industries, Inc.; Apollo Valves.

4. Conbraco.

5. Crane Co.; Crane Valve Group; Stockham Division.

6. Crane/Centerline.

7. DeZurik Water Controls.

8. Hammond Valve.

9. Milwaukee Valve Company.

10. NIBCO INC.

11. Sharpe Valve.

12. Sure Seal.

B. 200 CWP, Iron, Lugged Butterfly Valves:

1. 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, bubble tight shut-off.

d. Body Material: ASTM A 126, cast iron or ASTM A 536, ductile iron.

e. Seat for water systems: EPDM.

f. Seat for systems containing glycol and petroleum products such as fuel oil: NBR.

g. Stem: One- or two-piece Type 416 stainless steel.

h. Disc: Aluminum bronze.

i. Disc: Type 316 Stainless steel.

j. Disc: Nickel plated ductile iron.

2.04 HIGH-PERFORMANCE BUTTERFLY VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABZ Valve and Controls; a division of ABZ Manufacturing, Inc.

2. Bray Controls; a division of Bray International.

3. Cooper Cameron Valves; a division of Cooper Cameron Corp.
4. Crane Co.; Crane Valve Group; Flowseal.
5. Crane Co.; Crane Valve Group; Stockham Division.
6. DeZurik Water Controls.
7. Hammond Valve.
8. Jamesbury; a subsidiary of Metso Automation.
9. Milwaukee Valve Company.
10. NIBCO INC.
11. Sharpe Valve.
12. Sure Seal.
13. Xomox Corporation.
14. Spence.

B. Lugged, High-Performance Butterfly Valves:

1. Description:
   a. Standard: MSS SP-68.
   b. Temperature Rating: 500 deg F.
   c. Body Design: Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange, bubble tight shut-off.
   d. Body Material: Carbon steel, cast iron, ductile iron, or stainless steel.
   e. Seat: Reinforced PTFE with titanium and type 316 stainless steel.
   f. Stem: Stainless steel; offset from seat plane.
   g. Disc: Carbon steel.
   h. Service: Bidirectional.
2. Class 150:
   a. Pressure Rating: 160 psig at 500 deg F.
3. Class 300:
   a. Pressure Rating: 480 psig at 500 deg F.

2.05 BRONZE SWING CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Jenkins Valves.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. Hammond Valve.
5. Kitz Corporation.
6. Milwaukee Valve Company.
7. NIBCO INC.
8. Powell Valves.
9. Red-White Valve Corporation.
10. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, Bronze Swing Check Valves:

1. Description:
    a. Standard: MSS SP-80, Type 3.
    b. CWP Rating: 200 psig.
    c. SWP Rating: 125 psig saturated.
    d. Body Design: Horizontal flow.
    e. Body Material: Bronze.
    f. Disc: Bronze.

C. Class 150, Bronze Swing Check Valves:

1. Description:
    a. Standard: MSS SP-80, Type 3.
    b. CWP Rating: 300 psig.
    c. SWP Rating: 150 psig saturated.
    d. Body Design: Horizontal flow.
    e. Body Material: Bronze.
    f. Ends: Threaded.

g. Disc: Bronze.

2.06 BRONZE SILENT CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Jenkins Valves.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. Hammond Valve.
5. Kitz Corporation.
6. Milwaukee Valve Company.
7. NIBCO INC.
8. Powell Valves.
9. Red-White Valve Corporation.
10. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, Bronze Silent Check Valves:

1. Description:

a. Standard: MSS SP-139.

b. CWP Rating: 250 psig.

c. Body Design: In-line lift type, spring actuated.

d. Body Material: Bronze.

e. Disc: PTFE.

2.07 IRON SWING CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane Co.; Crane Valve Group; Crane Valves.
2. Crane Co.; Crane Valve Group; Jenkins Valves.
3. Crane Co.; Crane Valve Group; Stockham Division.
4. Hammond Valve.
5. Kitz Corporation.

6. Legend Valve.
7. Milwaukee Valve Company.
8. NIBCO INC.
9. Powell Valves.
10. Red-White Valve Corporation.
11. Sure Flow Equipment Inc.
12. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
13. Zy-Tech Global Industries, Inc.

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

1. Description:
   a. Standard: MSS SP-71, Type I.
   b. NPS 2-1/2 to NPS 24, CWP Rating: 200 psig.
   c. SWP Rating: 125 psig saturated.
   d. Body Design: Clear or full waterway.
   e. Body Material: ASTM A 126, gray iron with bolted bonnet.
   f. Trim: Bronze.
   g. Gasket: suitable for temperature and service.

C. Class 150, Iron Swing Check Valves with Metal Seats:

1. Description:
   a. Standard: MSS SP-136.
   b. NPS 2-1/2 to NPS 12, CWP Rating: 250 psig.
   c. SWP Rating: 150 psig saturated.
   d. Body Design: Clear or full waterway.
   e. Body Material: ASTM A 395, ductile iron with bolted bonnet.
   f. Ends: Flanged.
   g. Trim: Bronze.
   h. Gasket: suitable for temperature and service.

D. Class 125, Iron Swing Check Valves with Nonmetallic-to-Metal Seats:

1. Description:

a. Standard: MSS SP-71, Type I.

b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

c. NPS 14 to NPS 24, CWP Rating: 150 psig.

d. Body Design: Clear or full waterway.

e. Body Material: ASTM A 126, gray iron with bolted bonnet.

f. Ends: Flanged.

g. Trim: Composition.

h. Seat Ring: Bronze.

i. Disc Holder: Bronze.

j. Disc: PTFE or TFE.

k. Gasket: suitable for temperature and service.

E. Class 250, Iron Swing Check Valves with Metal Seats:

1. Description:

a. Standard: MSS SP-71, Type I.

b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.

c. NPS 14 to NPS 24, CWP Rating: 300 psig.

d. SWP Rating: 250 psig.

e. Body Design: Clear or full waterway.

f. Body Material: ASTM A 126, gray iron with bolted bonnet.

g. Ends: Flanged.

h. Trim: Bronze.

i. Gasket: suitable for temperature and service.

2.08 IRON SILENT CHECK VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane Co.; Crane Valve Group; Crane Valves.

2. Crane Co.; Crane Valve Group; Jenkins Valves.

3. Crane Co.; Crane Valve Group; Stockham Division.

4. Hammond Valve.

5. Kitz Corporation.
6. Legend Valve.
7. Milwaukee Valve Company.
8. NIBCO INC.
9. Powell Valves.
10. Red-White Valve Corporation.
11. Sure Flow Equipment Inc.
12. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
13. Zy-Tech Global Industries, Inc.

B. Class 125, Iron Silent Check Valves with Metal Seats:

1. Description:
   a. Standard: MSS SP-125.
   b. CWP Rating: 200 psig.
   c. Body Design: In-line lift type, spring actuated.
   d. Body Material: ASTM 126, gray iron.
   e. Trim: Stainless steel.
   f. Gasket: suitable for temperature and service.

C. Class 250, Iron Silent Check Valves with Metal Seats:

1. Description:
   a. Standard: MSS SP-125.
   b. CWP Rating: 400 psig.
   c. Body Design: In-line lift type, spring actuated.
   d. Body Material: ASTM 126, gray iron.
   e. Trim: Stainless steel.
   f. Gasket: suitable for temperature and service.

2.09 BRONZE GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane Co.; Crane Valve Group; Crane Valves.

2. Crane Co.; Crane Valve Group; Stockham Division.
3. Hammond Valve.
4. Kitz Corporation.
5. Milwaukee Valve Company.
6. NIBCO INC.
7. Powell Valves.
8. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 125, NRS Bronze Gate Valves:

1. Description:
   a. Standard: MSS SP-80, Type 1.
   b. CWP Rating: 200 psig.
   c. SWP Rating: 125 psig saturated.
   d. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: suitable for temperature and service.
   h. Handwheel: Malleable iron.

C. Class 125, RS Bronze Gate Valves:

1. Description:
   a. Standard: MSS SP-80, Type 2.
   b. CWP Rating: 200 psig.
   c. SWP Rating: 125 psig saturated.
   d. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.
   e. Stem: Bronze.
   f. Disc: Solid wedge; bronze.
   g. Packing: suitable for temperature and service.
   h. Handwheel: Malleable iron.

D. Class 150, NRS Bronze Gate Valves:

1. Description:

a. Standard: MSS SP-80, Type 1.

b. CWP Rating: 300 psig.

c. SWP Rating: 150 psig saturated.

d. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.

e. Stem: Bronze.

f. Disc: Solid wedge; bronze.

g. Packing: suitable for temperature and service.

h. Handwheel: Malleable iron.

E. Class 150, RS Bronze Gate Valves:

1. Description:

a. Standard: MSS SP-80, Type 2.

b. CWP Rating: 300 psig.

c. SWP Rating: 150 psig saturated.

d. Body Material: ASTM B 62, bronze with integral seat and union-ring bonnet.

e. Stem: Bronze.

f. Disc: Solid wedge; bronze.

g. Packing: suitable for temperature and service.

h. Handwheel: Malleable iron.

2.10 IRON GATE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane Co.; Crane Valve Group; Crane Valves.

2. Crane Co.; Crane Valve Group; Jenkins Valves.

3. Crane Co.; Crane Valve Group; Stockham Division.

4. Flo Fab Inc.

5. Hammond Valve.

6. Kitz Corporation.

7. Legend Valve.

8. Milwaukee Valve Company.

9. NIBCO INC.

10. Powell Valves.

11. Red-White Valve Corporation.

12. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

13. Zy-Tech Global Industries, Inc.

B. Class 125, Iron Gate Valves:

1. Description:

a. Standard: MSS SP-70, Type I.

b. NPS 2-1/2 to NPS 12, CWP Rating: 200 psig.

c. NPS 14 to NPS 24, CWP Rating: 150 psig.

d. SWP Rating: 125 psig saturated.

e. Body Material: ASTM A 126, gray iron with bolted bonnet.

f. Trim: Bronze.

g. Disc: Solid wedge.

h. Packing and Gasket: suitable for temperature and service.

C. Class 150, Iron Gate Valves:

1. Description:

a. Standard: MSS SP-128.

b. NPS 2-1/2 to NPS 24, CWP Rating: 250 psig.

c. SWP Rating: 150 psig saturated.

d. Body Material: ASTM A 395, ductile iron with bolted bonnet.

e. Ends: Flanged.

f. Trim: Bronze.

g. Disc: Solid wedge.

h. Packing and Gasket: suitable for temperature and service.

D. Class 250, Iron Gate Valves:

1. Description:

a. Standard: MSS SP-70, Type I.

b. NPS 2-1/2 to NPS 12, CWP Rating: 500 psig.

c. NPS 14 to NPS 24, CWP Rating: 300 psig.

d. SWP rating: 250 psig saturated.

e. Body Material: ASTM A 126, gray iron with bolted bonnet.

f. Ends: Flanged.

g. Trim: Bronze.

h. Disc: Solid wedge.

i. Packing and Gasket: suitable for temperature and service.

2.11 BRONZE GLOBE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane Co.; Crane Valve Group; Crane Valves.

2. Crane Co.; Crane Valve Group; Stockham Division.

3. Hammond Valve.

4. Kitz Corporation.

5. Milwaukee Valve Company.

6. NIBCO INC.

7. Powell Valves.

8. Red-White Valve Corporation.

9. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

B. Class 150, Bronze Globe Valves:

1. Description:

a. Standard: MSS SP-80, Type 1.

b. CWP Rating: 300 psig.

c. SWP Rating: 150 psig saturated.

d. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.

e. Stem: Bronze.

f. Disc: Bronze.

g. Disc: PTFE or TFE.

h. Packing: suitable for temperature and service.

i. Handwheel: Malleable iron.

C. Class 125, Bronze Globe Valves:

1. Description:

a. Standard: MSS SP-80, Type 2.

b. CWP Rating: 200 psig.

c. SWP Rating: 125 psig saturated.

d. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.

e. Stem: Bronze.

f. Disc: Bronze.

g. Disc: PTFE or TFE.

h. Disc: PTFE or TFE.

i. Packing: suitable for temperature and service.

j. Handwheel: Malleable iron.

2.12 IRON GLOBE VALVES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Crane Co.; Crane Valve Group; Crane Valves.

2. Crane Co.; Crane Valve Group; Jenkins Valves.

3. Crane Co.; Crane Valve Group; Stockham Division.

4. Hammond Valve.

5. Kitz Corporation.

6. Milwaukee Valve Company.

7. NIBCO INC.

8. Powell Valves.

9. Red-White Valve Corporation.

10. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

11. Zy-Tech Global Industries, Inc.

B. Class 125, Iron Globe Valves:

1. Description:

a. Standard: MSS SP-85, Type I.

b. CWP Rating: 200 psig.

c. SWP rating: 125 psig saturated.

d. Body Material: ASTM A 126, gray iron with bolted bonnet.

e. Trim: Bronze.

f. Packing and Gasket: suitable for temperature and service.

C. Class 150, Iron Globe Valves:

1. Description:

a. Standard: MSS SP-85.

b. CWP Rating: 250 psig.

c. SWP rating: 150 psig saturated.

d. Body Material: ASTM A 395, ductile iron with bolted bonnet.

e. Trim: Bronze.

f. Packing and Gasket: suitable for temperature and service.

D. Class 250, Iron Globe Valves:

1. Description:

a. Standard: MSS SP-85, Type I.

b. CWP Rating: 500 psig.

c. Steam pressure rating: 250 psig saturated.

d. Body Material: ASTM A 126, gray iron with bolted bonnet.

e. Trim: Bronze.

f. Packing and Gasket: suitable for temperature and service.

2.13 CHAINWHEELS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Babbitt Steam Specialty Co.

2. Roto Hammer Industries.

3. Trumbull Industries.

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

1. Brackets: Type, number, size, and fasteners required to mount actuator on valve.

2. Attachment: For connection to butterfly valve stems.

3. Sprocket Rim with Chain Guides: Ductile iron, of type and size required for valve. [Include zinc coating.]

4. Chain: Hot-dip, galvanized steel, of size required to fit sprocket rim.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine valve interior for cleanliness, freedom from foreign matter, and corrosion. Remove special packing materials, such as blocks, used to prevent disc movement during shipping and handling.

B. Operate valves in positions from fully open to fully closed. Examine guides and seats made accessible by such operations.

C. Examine threads on valve and mating pipe for form and cleanliness.

D. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Verify that gasket is of proper size, that its material composition is suitable for service, and that it is free from defects and damage.

E. Do not attempt to repair defective valves; replace with new valves.

3.02 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. In mechanical spaces, install chainwheels on operators for all manually operated valves NPS 8 and larger and more than 96 inches above floor. Extend chains to 60 inches above finished floor.

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

G. Provide extended stems on insulated piping systems to extend handle above insulation.

3.03 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.

3.04 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

A. Unless indicated otherwise, use the following:

1. Shutoff Service, Except Steam and Steam Condensate: Ball and butterfly valves.

2. Shutoff Service, Steam and Steam Condensate: Gate valves, ball valves, [or high performance butterfly valves].

3. Throttling Service, Except Steam and Steam Condensate: Ball or butterfly valves.

4. Throttling Service, Steam and Steam Condensate: Globe valves.

5. Pump-Discharge Check Valves:

a. NPS 2 and Smaller: Bronze silent check valves.

b. NPS 2-1/2 and Larger, except for Sanitary Waste and Storm Drainage: Iron silent check valves.

c. NPS 2-1/2 and Larger for Sanitary Waste and Storm Drainage: Iron swing check valves.

B. Select valves, with the following end connections:

1. For Copper Tubing, NPS 2 and Smaller: Threaded ends. Valves with soldered ends may be used in water systems only where soldered joints are permitted in other sections.

2. For Copper Tubing, NPS 2-1/2 and above: Flanged ends. Valves with grooved ends may be used in water systems only where grooved mechanical joints are permitted in other sections.

3. For Steel Piping, NPS 2 and Smaller: Threaded ends.

4. For Steel Piping, NPS 2-1/2 and above: Flanged ends. Valves with grooved ends may be used in water systems only where grooved mechanical joints are permitted in other sections.

C. Select valves to meet or exceed maximum anticipated maximum system operating pressure for intended service. If valves with specified SWP classes or CWP ratings are not available, the same types of valves with higher SWP classes or CWP ratings may be substituted.

D. For steam and steam condensate systems, use valves with the following ANSI classes.

1. Low pressure systems 15 psi and under: Class 125 or 150.

2. High pressure systems Over 15 psi to under 100 psi: Class 125 or 150.

3. High pressure systems 100 psi to 125 psi: Class 150.

END OF SECTION 230523

SECTION 230529 - HANGERS AND SUPPORTS FOR MECHANICAL

PART 1 GENERAL

1.01 SUMMARY

A. Section Includes:

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

B. 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. The requirements listed in this document are applicable to Divisions 23 specifications.

1.02 SUBMITTALS

A. Action Submittals

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

B. Informational Submittals

1. Current ICC-ES reports for post-pour concrete inserts.
2. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:
    a. Trapeze pipe hangers.
    b. Metal framing systems.
    c. Pipe stands.
    d. Equipment supports.
    e. Thermal hanger saddles and shields.

f. Pipe positioning systems.

g. Steel and copper hangers and supports.

h. PVC, polypropylene and similar piping lacking rigidity hangers and supports.

1.03 CLOSE-OUTS

A. None.

1.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design trapeze pipe hangers and equipment supports, including comprehensive engineering analysis, using performance requirements and design criteria indicated.

B. 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, including pipe stands, 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.

3. Design hangers and supports so that piping live and dead loads and stresses from movement will not be transmitted to connected equipment.

1.05 DEFINITIONS

A. MSS: Manufacturers Standardization Society of the Valve and Fittings Industry.

B. Terminology: As defined in MSS SP-90, “Guidelines on Terminology for Pipe Hangers and Supports”.

C. ASME B31.9: Building Services Piping.

D. ASME B31.1: Power Piping.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. AAA Technology & Specialties Co., Inc.

2. Bergen-Power Pipe Supports.

3. B-Line Systems, Inc.; a division of Cooper Industries.

4. Carpenter & Paterson, Inc.
5. Empire Industries, Inc.
6. ERICO/Michigan Hanger Co. (Caddy-Pentair).
7. Globe Pipe Hanger Products, Inc.
8. Grinnell Corp.
9. GS Metals Corp.
10. National Pipe Hanger Corp.
11. PHD Manufacturing, Inc.
12. PHS Industries, Inc.
13. Piping Technology & Products, Inc.
14. RICO Manufacturing.
15. Thermal Pipe Shields.
16. Tolco, Inc.
17. Value Engineered Products.

2.02 PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pregalvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

B. Stainless-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Hanger Rods and Hardware: Continuous-thread rod, nuts, and washer made of [304] [316] stainless steel.

C. Copper Pipe/Tube Hangers and Supports

1. Split ring hangers and clamps.

D. Materials:

1. Provide appropriate materials and protective coatings to prevent failure from environmental and galvanic corrosion.

2. Material that comes in contact with pipe shall be compatible with piping material so that neither has a deteriorating effect on the other.

E. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.

F. Hanger Rods: Continuous-thread rod, nuts and washer made of stainless steel.

2.03 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.

2.04 METAL FRAMING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. B-Line Systems, Inc.; a division of Cooper Industries.

2. ERICO/Michigan Hanger Co. (Caddy-Pentair).

3. Tolco, Inc.

4. Unistrut.

B. MFMA Manufacturer Metal Framing Systems:

1. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.

2. Standard: MFMA-4.

3. Channels: Continuous slotted steel channel with inturned lips.

4. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.

5. Hanger Rods: Continuous-thread rod, nuts, and washer made of carbon steel.

6. Coating: Suitable for piping system supported.

2.05 THERMA-HANGER SADDLE AND SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Carpenter & Paterson, Inc.

2. ERICO/Michigan Hanger Co. (Caddy-Pentair).

3. Pipe Shields, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: ASTM C 591, Type VI, Grade 1 polyisocyanurate with 125-psig minimum compressive strength.

D. For Trapeze or Clamped Systems: Insert and shield to cover entire circumference of pipe.

E. For Clevis or Band Hangers: Insert and shield to cover the lower 180 degrees of pipe.

F. Insert Length: Extend a minimum of 2 inches, or greater as recommended by manufacturer, beyond sheet metal shield for piping operating below ambient air temperature.

G. Fire Rating: 25/50 rated flame/smoke plenum rated.

2.06 FASTENER AND ANCHORING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. B-Line Systems.

2. Empire Industries.

3. ERICO.

4. Hilti, Inc.

5. ITW Ramset/Red Head.

6. Masterset Fastening Systems, Inc.

7. MKT Fastening, LLC.

8. Powers Fasteners.

9. Simpson Strong - Tie

B. Post-pour concrete inserts shall be selected based on “cracked concrete” applications, shall be installed in accordance with manufacturers’ requirements and shall be designed for “cracked concrete” in accordance with Appendix D of American Concrete Institute (ACI) standard 318 and have a current ICC-ES report.

C. 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. Must be designed and approved for “cracked concrete” in accordance with Appendix D of American Concrete Institute (ACI) standard 318 and have a current ICC-ES report.

D. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated or stainless- steel anchors, for use in hardened portland cement concrete; with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used. Must be designed and approved for “cracked concrete” in accordance with Appendix D of American Concrete Institute (ACI) standard 318 and have a current ICC-ES report.

2.07 PIPE STANDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. B-Line.
2. Eberl RTS.
3. ERICO.
4. MIFAB.
5. MIRO.
6. OMG.
7. PHP.
8. Pipe Prop.
9. Unistrut.

B. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components to support roof-mounted piping.

C. Pipe Stand: One-piece stainless-steel base unit with plastic roller, for roof installation without membrane penetration.

D. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe support made form structural-steel shape, continuous-thread rods, and rollers for mounting on permanent stationary roof curb.

2.08 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.

2.09 EQUIPMENT SUPPORTS

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

B. Use premanufactured equipment supports on [new and] existing roof systems.

2.10 MISCELLANEOUS MATERIALS

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

PART 3 EXECUTION

3.01 HANGER AND SUPPORT INSTALLATION

A. Do not support piping, ductwork equipment, or systems from metal roof decking material.

B. Where powder actuated or mechanical expansion hangers are used, notify Owner one week in advance of installation.

C. 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.

D. 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.

E. Metal Framing System Installation: Arrange for grouping of parallel runs of piping, and support together on field-assembled metal framing systems.

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

G. 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.

H. Pipe Stand Installation:

1. Pipe Stand Types: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

I. Pipe Positioning-System Installation: Install support devices to make rigid supply and waste piping connections to each plumbing fixture. See Division 22 Section “Plumbing Fixtures” for requirements for pipe positioning systems for plumbing fixtures.

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

K. Equipment Support Installation: Fabricate form welded-structural-steel shapes.

L. 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.

M. Anchor piping at appropriate location and utilize guides to allow proper pipe expansion where expansion loops or expansion joints are used.

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

O. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, 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.

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

Q. 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 and ASME B31.1 for power piping.

R. 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. Provide protection saddle shield insert, minimum 4 inch, 180 degrees.

c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping and ASME B31.1 for power piping.

d. Insert Material: Length of at least as long as protective shield.

e. Thermal Hanger Shields: Install with insulation same thickness as piping insulation.

S. All piping when supported by non-rigid hangers in excess of 18 inches in length shall be braced against movement in any direction.

T. PVC, polypropylene, and other plastic piping: Follow pipe manufacturer’s recommendations for hanger type, support, and spacing. Hanger material must be chemically compatible with the plastic pipe material.

3.02 EQUIPMENT SUPPORTS

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

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

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

3.03 METAL FABRICATIONS

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

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

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

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.

2. Obtain fusion without undercut or overlap.

3. Remove welding flux immediately.

4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.04 ADJUSTING

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

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

3.05 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils.

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

3.06 HANGER AND SUPPORT SCHEDULE

A. Comply with MSS SP-69 for all pipe-hanger selections and applications.

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

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

D. Use carbon-steel [pipe hangers and supports] [metal trapeze pipe hangers] [and] [metal framing systems] and attachments for general service applications.

E. Use [stainless-steel pipe hangers] [and] [fiberglass pipe hangers] [and] [fiberglass strut systems] and [stainless-steel] [or] [corrosion-resistant] attachments for hostile environment 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. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 if little or no insulation is required.

5. 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.

6. Adjustable, Swivel Split- or Solid-Ring Hangers (MSS Type 6): For suspension of noninsulated, stationary pipes NPS 3/4 to NPS 4.

7. Adjustable, Steel Band Hangers (MSS Type 7): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 4.

8. Adjustable Band Hangers (MSS Type 9): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 8.

9. Adjustable, Swivel-Ring Band Hangers (MSS Type 10): For suspension of noninsulated, stationary pipes NPS 1/2 to NPS 4.

10. Split Pipe Ring with or without Turnbuckle Hangers (MSS Type 11): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 8.

11. Extension Hinged or Two-Bolt Split Pipe Clamps (MSS Type 12): For suspension of noninsulated, stationary pipes NPS 3/8 to NPS 3.

12. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30.

13. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.

14. 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.

15. 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.

16. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion type support for pipes NPS 2-1/2 to NPS 36 if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.

17. 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.

18. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24, from single rod if horizontal movement caused by expansion and contraction might occur.

19. 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.

20. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.

21. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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

1. 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.

3. Swivel Turnbuckles (MSS Type 15): For use with MSS Type 11, split pipe rings.

4. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

5. Steel Weldless Eye Nuts (MSS type 17): 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 support of pipes to NPS 4, attached to structural shapes. Provide retaining strap.

7. Top-Beam Clamps (MSS Type 25): For top of beams if hanger rod is required tangent to flange edge.

8. Side-Beam Clamps (MSS Type 27): For bottom of steel I-beams.

9. Steel-Beam Clamps with Eye Nuts (MSS Type 28): For attaching to bottom of steel I-beams for heavy loads.

10. Linked-Steel Clamps with Eye Nuts (MSS Type 29): For attaching to bottom of steel I-beams for heavy loads, with link extensions.

11. Malleable-Beam Clamps with Extension Pieces (MSS Type 30): For attaching to structural steel.

12. 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.

13. Side-Beam Brackets (MSS Type 34): For sides of steel or wooden beams.

14. Plate Lugs (MSS Type 57): For attaching to steel beams if flexibility at beam is required.

15. Horizontal Travelers (MSS Type 58): For supporting piping systems subject to linear horizontal movement where headroom is limited.

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. Install spring hangers and supports in the following areas:

    a. All piping and equipment above, below, in, and adjacent to medical equipment rooms.

    b. All piping and equipment above, below, in, and adjacent to operating rooms.

    c. All equipment located in mechanical rooms on upper levels.

2. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.

3. Spring Cushions (MSS Type 48): For light loads if vertical movement does not exceed 1-1/4 inches.

4. Spring-Cushion Roll Hangers (MSS Type 49): For equipping Type 41, roll hanger with springs.

5. Spring Sway Braces (MSS Type 50): To retard sway, shock vibration, or thermal expansion in piping systems.

6. Variable-Spring Hangers (MSS Type 51): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from hanger.

7. 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.

8. Variable-Spring Trapeze Hangers (MSS Type 53): Preset to indicated load and limit variability factor to 25 percent to allow expansion and contraction of piping system from trapeze support.

9. Constant Supports: For critical piping stress and if necessary to avoid transfer of stress from one support to another support, critical terminal, or connected equipment. Include auxiliary stops for erection, hydrostatic test, and load-adjustment capability. These supports include the following types:

    a. Horizontal (MSS Type 54): Mounted horizontally.

    b. Vertical (MSS Type 55): Mounted vertically.

    c. Trapeze (MSS Type 56): Two vertical-type supports and one trapeze member.

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

O. Comply with MFMA-103 for metal framing system selections and applications that are not specified in piping system Sections.

P. Use powder-actuated fasteners or mechanical-expansion anchors rated for “cracked concrete” instead of building attachments where required in concrete construction.

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

END OF SECTION 230529

SECTION 230548 - VIBRATION AND SEISMIC CONTROLS FOR MECHANICAL

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. The requirements listed in this document are applicable to Divisions 23 specifications.

1.02 SUMMARY

A. This Section includes the following:

1. Isolation pads.
2. Isolation mounts.
3. Restrained elastomeric isolation mounts.
4. Housed spring mounts.
5. Elastomeric hangers.
6. Spring hangers.
7. Spring hangers with vertical-limit stops.
8. Pipe riser resilient supports.
9. Resilient pipe guides.
10. Restrained vibration isolation roof-curb rails.
11. Seismic snubbers.
12. Restraining braces and cables.

1.03 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Basic Wind Speed: 120 MPH .
2. Building Classification Category: IV.
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. Seismic-Restraint Loading:

1. Site Class as Defined in the IBC: D.

2. Assigned Seismic Use Group or Building Category as Defined in the IBC: [I] [II] [III].

    a. Component Importance Factor: 1.5.

1.04 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.

2. Illustrate and indicate style, material, strength, fastening provision, and finish for each type and size of seismic-restraint component used.

    a. Tabulate types and sizes of seismic restraints, complete with report numbers and rated strength in tension and shear as evaluated by an agency acceptable to authorities having jurisdiction.

    b. Annotate to indicate application of each product submitted and compliance with requirements.

3. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Delegated-Design Submittal: For vibration isolation and seismic-restraint details indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Design Calculations: Calculate static and dynamic loading due to equipment weight and operation, seismic [and wind] forces required to select vibration isolators, seismic [and wind] restraints, and for designing vibration isolation bases.

    a. Coordinate design calculations with wind load calculations required for equipment mounted outdoors.

2. Riser Supports: Include riser diagrams and calculations showing anticipated expansion and contraction at each support point, initial and final loads on building structure, spring deflection changes, and seismic loads. Include certification that riser system has been examined for excessive stress and that none will exist.

3. Vibration Isolation Base Details: Detail overall dimensions, including anchorages and attachments to structure and to supported equipment. Include auxiliary motor slides and rails, base weights, equipment static loads, power transmission, component misalignment, and cantilever loads.

4. Seismic[- and Wind]-Restraint Details:

    a. Design Analysis: To support selection and arrangement of seismic [and wind] restraints. Include calculations of combined tensile and shear loads.

    b. Details: Indicate fabrication and arrangement. Detail attachments of restraints to the restrained items and to the structure. Show attachment locations, methods, and spacings. Identify components, list their strengths, and indicate directions and values of forces transmitted to the structure during seismic events. Indicate association with vibration isolation devices.

c. Coordinate seismic-restraint and vibration isolation details with wind-restraint details required for equipment mounted outdoors.

d. Preapproval and Evaluation Documentation: By an agency acceptable to authorities having jurisdiction, showing maximum ratings of restraint items and the basis for approval (tests or calculations).

C. Coordination Drawings: Show coordination of seismic bracing for piping and equipment with other systems and equipment in the vicinity, including other supports and seismic restraints.

D. Welding certificates.

E. Qualification Data: For [professional engineer] [and] [testing agency].

F. Air-Mounting System Performance Certification: Include natural frequency, load, and damping test data [performed by an independent agency].

G. Field quality-control test reports.

H. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: An independent agency, with the experience and capability to conduct the testing indicated, that is a nationally recognized testing laboratory (NRTL) as defined by OSHA in 29 CFR 1910.7, and that is acceptable to authorities having jurisdiction.

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

C. Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."

D. Seismic-restraint devices shall have horizontal and vertical load testing and analysis and shall bear anchorage or preapproval by agency acceptable to authorities having jurisdiction, showing maximum seismic-restraint ratings. Ratings based on independent testing are preferred to ratings based on calculations. If preapproved ratings are not available, submittals based on independent testing are preferred. Calculations (including combining shear and tensile loads) to support seismic-restraint designs must be signed and sealed by a qualified professional engineer.

PART 2 PRODUCTS

2.01 VIBRATION ISOLATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Ace Mountings Co., Inc.

2. Amber/Booth Company, Inc.

3. California Dynamics Corporation.

4. Isolation Technology, Inc.

5. Kinetics Noise Control.

6. Mason Industries.

7. Vibration Eliminator Co., Inc.

8. Vibration Isolation.

9. Vibration Mountings & Controls, Inc.

B. 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] [rubber] [hermetically sealed compressed fiberglass].

C. 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.

D. 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.

E. 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.

F. 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.

G. Housed Spring Mounts: Housed spring isolator with integral seismic snubbers.

1. Housing: Ductile-iron or steel housing to provide all-directional seismic restraint.

2. Base: Factory drilled for bolting to structure.

3. Snubbers: Vertically adjustable to allow a maximum of 1/4-inch travel up or down before contacting a resilient collar.

H. 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.

I. 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.

J. Spring Hangers with Vertical-Limit Stop: Combination coil-spring and elastomeric-insert hanger with spring and insert in compression and with a vertical-limit stop.

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.

7. Adjustable Vertical Stop: Steel washer with neoprene washer "up-stop" on lower threaded rod.

8. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

K. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 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.

L. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- thick neoprene. Where clearances are not readily visible, a factory-set guide height with a shear pin to allow vertical motion due to pipe expansion and contraction shall be fitted. Shear pin shall be removable and reinsertable to allow for selection of pipe movement. Guides shall be capable of motion to meet location requirements.

2.02 RESTRAINED VIBRATION ISOLATION ROOF-CURB RAILS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation.

3. Isolation Technology, Inc.

4. Kinetics Noise Control.

5. Mason Industries.

6. Thybar Corporation.

7. Vibration Eliminator Co., Inc.

8. Vibration Isolation.

9. Vibration Mountings & Controls, Inc.

B. General Requirements for Restrained Vibration Isolation Roof-Curb Rails: Factory-assembled, fully enclosed, insulated, air- and watertight curb rail designed to resiliently support equipment and to withstand seismic[and wind] forces.

C. Lower Support Assembly: Formed sheet-metal section containing adjustable and removable steel springs that support upper frame. Upper frame shall provide continuous support for equipment and shall be captive to resiliently resist seismic [and wind] forces. Lower support assembly shall have a means for attaching to building structure and a wood nailer for attaching roof materials, and shall be insulated with a minimum of 2 inches of rigid, glass-fiber insulation on inside of assembly.

D. Spring Isolators: Adjustable, restrained spring isolators shall be mounted on 1/4-inch- thick, elastomeric vibration isolation pads and shall have access ports, for level adjustment, with removable waterproof covers at all isolator locations. Isolators shall be located so they are accessible for adjustment at any time during the life of the installation without interfering with the integrity of the roof.

1. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic[or wind] restraint.

a. Housing: Steel with resilient vertical-limit stops and adjustable equipment mounting and leveling bolt.

b. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

c. Minimum Additional Travel: 50 percent of the required deflection at rated load.

d. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

e. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

2. 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.

a. Resilient Material: Oil- and water-resistant [standard neoprene] [natural rubber] [hermetically sealed compressed fiberglass].

E. Snubber Bushings: All-directional, elastomeric snubber bushings at least 1/4 inch thick.

F. Water Seal: Galvanized sheet metal with EPDM seals at corners, attached to upper support frame, extending down past wood nailer of lower support assembly, and counterflashed over roof materials.

2.03 VIBRATION ISOLATION EQUIPMENT BASES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation.

3. Isolation Technology, Inc.

4. Kinetics Noise Control.

5. Mason Industries.

6. Vibration Eliminator Co., Inc.

7. Vibration Isolation.

8. Vibration Mountings & Controls, Inc.

B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

C. Inertia Base: Factory-fabricated, welded, structural-steel bases and rails ready for placement of cast-in-place concrete.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch clearance above the floor. Include equipment anchor bolts and auxiliary motor slide bases or rails.

a. Include supports for suction and discharge elbows for pumps.

2. Structural Steel: Steel shapes, plates, and bars complying with ASTM A 36/A 36M. Bases shall have shape to accommodate supported equipment.

3. Support Brackets: Factory-welded steel brackets on frame for outrigger isolation mountings and to provide for anchor bolts and equipment support.

4. Fabrication: Fabricate steel templates to hold equipment anchor-bolt sleeves and anchors in place during placement of concrete. Obtain anchor-bolt templates from supported equipment manufacturer.

2.04 SEISMIC-RESTRAINT DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amber/Booth Company, Inc.

2. California Dynamics Corporation.

3. Cooper B-Line, Inc.; a division of Cooper Industries.

4. Hilti, Inc.

5. Kinetics Noise Control.

6. Loos & Co.; Cableware Division.

7. Mason Industries.

8. TOLCO Incorporated; a brand of NIBCO INC.

9. Unistrut; Tyco International, Ltd.

B. General Requirements for Restraint Components: Rated strengths, features, and applications shall be as defined in reports by [an evaluation service member of ICC-ES] [OSHPD] [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.

C. Snubbers: Factory fabricated using welded structural-steel shapes and plates, anchor bolts, and replaceable resilient isolation washers and bushings.

1. Anchor bolts for attaching to concrete shall be seismic-rated, drill-in, and stud-wedge or female-wedge type.

2. Resilient Isolation Washers and Bushings: Oil- and water-resistant neoprene.

3. Maximum 1/4-inch air gap, and minimum 1/4-inch- thick resilient cushion.

D. 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.

E. Restraint Cables: [ASTM A 603 galvanized] [ASTM A 492 stainless]-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.

F. Hanger Rod Stiffener: [Steel tube or steel slotted-support-system sleeve with internally bolted connections] [Reinforcing steel angle clamped] to hanger rod.

G. 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.

H. Bushing Assemblies for Wall-Mounted Equipment Anchorage: Assemblies of neoprene elements and steel sleeves designed for rigid equipment mountings, and matched to type and size of attachment devices used.

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

J. 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.

K. Adhesive Anchor Bolts: Drilled-in and capsule anchor system containing polyvinyl or urethane methacrylate-based resin and accelerator, or injected polymer or hybrid mortar adhesive. Provide anchor bolts and hardware with 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.

2.05 FACTORY FINISHES

A. Finish: Manufacturer's standard prime-coat finish ready for field painting.

B. Finish: Manufacturer's standard paint applied to factory-assembled and -tested equipment before shipping.

1. Powder coating on springs and housings.

2. All hardware shall be galvanized. Hot-dip galvanize metal components for exterior use.

3. Baked enamel or powder coat for metal components on isolators for interior use.

4. Color-code or otherwise mark vibration isolation and seismic- and wind-control devices to indicate capacity range.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic- and wind-control devices for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in of reinforcement and cast-in-place anchors to verify actual locations before installation.

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

3.02 APPLICATIONS

A. Multiple Pipe Supports: Secure pipes to trapeze member with clamps approved for application by an agency acceptable to authorities having jurisdiction.

B. Hanger Rod Stiffeners: Install hanger rod stiffeners where indicated or scheduled on Drawings to receive them and where required to prevent buckling of hanger rods due to seismic forces.

C. 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.

3.03 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

A. Comply with requirements in Division 07 Section "Roof Accessories" for installation of roof curbs, equipment supports, and roof penetrations.

B. Equipment Restraints:

1. Install seismic snubbers on equipment mounted on vibration isolators. Locate snubbers as close as possible to vibration isolators and bolt to equipment base and supporting structure.

2. Install resilient bolt isolation washers on equipment anchor bolts where clearance between anchor and adjacent surface exceeds 0.125 inch.

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

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of 40 feet o.c., and longitudinal supports a maximum of 80 feet o.c.

3. Brace a change of direction longer than 12 feet.

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

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

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

G. Install bushing assemblies for mounting bolts for wall-mounted equipment, arranged to provide resilient media where equipment or equipment-mounting channels are attached to wall.

H. 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.

I. 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. Adhesive Anchors: Clean holes to remove loose material and drilling dust prior to installation of adhesive. Place adhesive in holes proceeding from the bottom of the hole and progressing toward the surface in such a manner as to avoid introduction of air pockets in the adhesive.

5. Set anchors to manufacturer's recommended torque, using a torque wrench.

6. Install zinc-coated steel anchors for interior and stainless-steel anchors for exterior applications.

3.04 ACCOMMODATION OF DIFFERENTIAL SEISMIC MOTION

A. Install flexible connections in piping where they cross seismic joints, where adjacent sections or branches are supported by different structural elements, and where the connections terminate with connection to equipment that is anchored to a different structural element from the one supporting the connections as they approach equipment. Comply with requirements in Division 23 Section "Hydronic Piping" for piping flexible connections.

3.05 FIELD QUALITY CONTROL

A. Testing Agency: [Owner will engage] [Engage] a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Provide evidence of recent calibration of test equipment by a testing agency acceptable to authorities having jurisdiction.

2. Schedule test with Owner, through Architect, before connecting anchorage device to restrained component (unless postconnection testing has been approved), and with at least seven days' advance notice.

3. Obtain Architect's approval before transmitting test loads to structure. Provide temporary load-spreading members.

4. Test at least [four] of each type and size of installed anchors and fasteners selected by Architect.

5. Test to 90 percent of rated proof load of device.

6. Measure isolator restraint clearance.

7. Measure isolator deflection.

8. Verify snubber minimum clearances.

9. Air-Mounting System Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

10. Air-Mounting System Operational Test: Test the compressed-air leveling system.

11. Test and adjust air-mounting system controls and safeties.

12. If a device fails test, modify all installations of same type and retest until satisfactory results are achieved.

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

E. Prepare test and inspection reports.

3.06 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 air-spring leveling mechanism.

D. Adjust active height of spring isolators.

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

3.07 DEMONSTRATION

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

3.08 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE SCHEDULE

A. Refer to drawings for schedules.

END OF SECTION 230548

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 230553 - MECHANICAL IDENTIFICATION

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. The requirements listed in this document are applicable to Divisions 23 specifications.

1.02 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.
8. Fire/smoke wall penetration labeling.
9. Wiring/Cable labels.

1.03 SUBMITTALS

A. Action Submittals:

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

B. Informational submittals.

1. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label. Equipment Label Schedule shall be approved by the Owner prior to labeling.
2. Valve numbering scheme: Approved by Owner prior to labeling.
3. Valve Schedules: For each piping system to include in maintenance manuals. Provide electronic Excel document to Owner in addition to hard copy in operation and maintenance manuals.
4. Warning Tags: For each warning tag, submit proposed wording, size, and arrangement.

PART 2 PRODUCTS

2.01 EQUIPMENT LABELS

A. Metal Labels for Equipment:

1. Stainless-steel minimum 2-inch by 3/4-inch, mechanically fastened.

B. Plastic Labels for Equipment:

1. Plastic minimum 2-inch by 3/4-inch, black with white letters, mechanically fastened. Size shall increase appropriately for larger equipment.

C. Label Content: Owner shall designate all labeling names. Label shall include description of areas served.

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.

2.02 WARNING SIGNS AND LABELS

A. Red plastic with yellow letters mechanically fastened.

B. Label Content: Include caution and warning information, plus emergency notification instructions.

2.03 PIPE LABELS

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

B. Pretensioned Pipe Labels: Precoiled, semirigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive, applied with adhesive directional tape.

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

D. Pipe Label Contents: Include identification of piping service using full name designations per Drawings, [pipe size,] and an arrow indicating flow direction. Steam per systems shall bear pressure designation. Domestic water system shall bear water temperature designation.

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: Per ASME/ANSI A13.1.

2.04 DUCT LABELS

A. Stenciled and painted on ductwork [inside] [and] [outside] insulation. Black in color. Paint to comply with ASME/ANSI A13.1.

B. Duct Label Contents: Include identification of duct service using full name designations per Drawings, [duct size,] and an arrow indicating flow direction.

1. Flow-Direction Arrows: Integral with duct system service lettering to accommodate both directions, or as separate unit on each duct label to indicate flow direction.

2. Lettering Size: At least 6 inches high.

C. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch thick, and having predrilled holes for attachment hardware.

D. Letter Color: Comply with Novant Health Standards .

E. Background Color: Comply with Novant Health Standards.

F. Maximum Temperature: Able to withstand temperatures up to 160 deg F.

G. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch.

H. 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.

I. Fasteners: Stainless-steel [rivets] [rivets or self-tapping screws] [self-tapping screws].

J. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate.

2.05 FIRE BARRIER PENETRATION

A. Provide sticker complying with [facility standard][and] penetration sealant product requirements listing product, date, company name, and initials of installer. Sticker to be minimum 3-inch by 5-inch and red in color. Stickers to be affixed both sides of wall.

2.06 STENCILS

A. Stencils: Prepared with letter sizes according to ASME A13.1 for piping; minimum letter height of 1-1/4 inches for ducts; and minimum letter height of 3/4 inch for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: [Aluminum] [Brass] [Fiberboard] [Fiberboard or metal] .

2. Stencil Paint: Exterior, gloss, [alkyd enamel] [acrylic enamel] black unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, [alkyd enamel] [acrylic enamel] in colors according to ASME A13.1 unless otherwise indicated.

2.07 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch letters for piping system abbreviation and 1/2-inch numbers.

1. Tag Material: Brass, 0.032-inch minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass [wire-link or beaded chain; or S-hook] [wire-link chain] [beaded chain] [S-hook].

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch bond paper. Tabulate valve number, piping system, system abbreviation (as shown on valve tag), location of valve (room or space), normal-operating position (open, closed, or modulating), and variations for identification. Mark valves for emergency shutoff and similar special uses.

1. Valve-tag schedule shall be included in operation and maintenance data.

2. Provide additional Excel format electronic version of schedule to Owner.

2.08 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: [3 by 5-1/4 inches minimum] [Approximately 4 by 7 inches] .

2. Fasteners: [Brass grommet and wire] [Reinforced grommet and wire or string].

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

2.09 WIRING/CABLING IDENTIFICATION

A. Wire/Cable Designation Tape Markers: Vinyl or vinyl-cloth, self-adhesive, wraparound, cable/conductor markers with preprinted numbers and letter.

B. Colored Adhesive Marking Tape for banding Raceways, Wires, and Cables: Self-adhesive vinyl tape not less than 3 mils thick by 1 inch to 2 inches in width.

PART 3 EXECUTION

3.01 COORDINATION

A. Coordinate equipment designation labeling with Owner before procuring labels.

3.02 INSTALLATION

A. Where working in existing mechanical spaces, match existing identification scheme and labeling techniques [including full painting of systems and equipment].

B. Single family and Group R2 of Type IV construction are not required to identify piping.

3.03 PREPARATION

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

3.04 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.05 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Painting of piping is specified in Division 09 Section "[Interior Painting] [High-Performance Coatings]."

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels [with painted, color-coded bands or rectangles] [, complying with ASME A13.1,] on each piping system.

1. Identification Paint: Use for contrasting background.

2. Stencil Paint: Use for pipe marking.

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

1. Near each valve and control device.

2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.

3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.

4. At access doors, manholes, and similar access points that permit view of concealed piping.

5. Near major equipment items and other points of origination and termination.

6. Spaced at maximum intervals of 50 feet along each run. Reduce intervals to 25 feet in areas of congested piping and equipment and in equipment rooms.

7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.

D. Pipe Label Color Schedule:

1. Meet ASME/ANSI A13.1.

2. Match existing facility standard.

3. Chilled-Water Piping.

4. Heating Water Piping.

5. Refrigerant Piping.

3.06 DUCT LABEL INSTALLATION

A. Do not stencil exposed ductwork in finished spaces.

B. Install self-adhesive duct labels with permanent adhesive on air ducts in the following color codes:

1. Match existing facility standard.

C. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction. Lettering to be larger as needed for proper identification because of distance from normal location of required identification.

D. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 50 feet in each space where ducts are exposed or concealed by removable ceiling system. Reduce to 25 feet in equipment rooms.

3.07 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; faucets; convenience and lawn-watering hose connections. List tagged valves in a valve schedule.

B. Where valve location exceeds reasonable distance from floor, valve tag to be extended down to within 24 inches of finished ceiling height.

C. Valve-Tag Application Schedule: Tag valves according to size, shape, and color scheme and with captions similar to those indicated in the following subparagraphs:

1. Valve-Tag Size and Shape: Match existing facility standards

a. Chilled Water.

b. Refrigerant.

c. Hot Water.

2. Valve-Tag Color: Match existing facility standards

a. Chilled Water.

b. Refrigerant: [Natural] [Green] .

c. Hot Water.

3. Letter Color: Match existing facility standards

a. Chilled Water.

b. Refrigerant.

c. Hot Water.

3.08 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

1. Exhaust Fans:

a. Exhaust from areas containing hazardous materials.

2. Vents:

a. Medical gas manifold vents.

3.09 FIRE/SMOKE WALL PENETRATION LABELING

A. Affix label at every rated fire and/or smoke wall penetrated with mechanical piping and duct systems, both sides of wall.

3.10 WIRE/CABLE LABELING

A. Install identification devices in accordance with manufacturer's written instruction and requirements of NEC.

B. Alarm Circuit Identification: Tag or label conductors as follows:

1. For control and communications/signal wiring, use colored marking tape and/or wire/cable designation tape markers at terminations in wiring boxes, troughs, and control cabinets. Use consistent colors and/or letter/number conductor designations throughout on wire/cable marking tape.

2. Match identification markings with designations used in equipment shop drawings, Contract Documents, and similar previously established identification schemes for the facility's electrical installations.

3. Identify Junction, Pull and Connection Boxes: Identification of systems and circuits shall indicate system and identity of contained circuits on outside of box cover. Labeling shall be 3/8-inch Kroy tape or Brother self-adhesive label color-coded same as conduits or permanent magic marker (color coded), neatly hand printed. In rooms that are painted out, provide labeling on inside of cover.

C. Provide typed legend of wire/cable wiring indicating tag, color, system, signal, starting room name and ending room name.

END OF SECTION 230553

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 230593 - TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Testing, adjusting, and balancing of:

a. Air systems.

b. Heating systems.

c. Cooling systems.

d. Plumbing systems.

2. Measurement of initial operating condition of final systems.

3. Measurement of final operating condition of systems.

1.02 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. ADC: Air Diffusion Council.

C. AMCA: Air Movement and Control Association.

D. ASHRAE: American Society of Heating, Refrigeration, and Air-Conditioning Engineers.

E. NEBB: National Environmental Balancing Bureau.

F. SMACNA: Sheet Metal and Air Conditioning Contractors National Association.

G. TAB: Testing, adjusting, and balancing.

H. TABB: Testing, Adjusting, and Balancing Bureau.

I. TAB Specialist: An entity engaged to perform TAB Work.

1.03 REFERENCES

A. AAAB: National Standards for Total System Balance, 2002.

B. ADC: Test Code for Grilles, Registers, and Diffusers, ADC-1062, 1984.

C. AMCA: Publication 302-90; Field Performance Measurement of Fan Systems.

D. ASHRAE: 207 HVAC Applications Handbook; Chapter 37 – Testing, Adjusting, and Balancing.

E. ASHRAE/ANSI: Standard 111-2008; Testing, Adjusting, and Balancing of Building HVAC Systems.

F. NEBB: Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems, Seventh Edition, 2005.

G. SMACNA – HVAC Systems: Testing, Adjusting, and Balancing; Third Edition, 2002.

H. TABB: International Standards for Environmental Systems Balance.

1.04 SUBMITTALS

A. Within 15 days of Contractor's Notice to Proceed, submit the following documentation:

1. Qualification Data: Within 45 days of Contractor's Notice to Proceed, submit documentation that the TAB contractor and this Project's TAB team members meet the qualifications specified in "Quality Assurance" Article.

2. Contract Documents Examination Report: Within 45 days of Contractor`s Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

3. Sample report forms.

4. Instrument list.

B. Within 30 days of Owner's Acceptance of Substantial Completion, submit the following documentation:

1. Certified TAB reports.

2. Instrument calibration reports, to include the following:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

3. Schematic drawings for each system showing:

a. System components.

b. Balancing devices.

c. Testing locations.

1.05 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC, NEBB, or TABB. Entity shall have a minimum of 1 years experience. TAB Contractor shall not be or associated with the installing contractors. Work shall be performed in accordance with the requirements of the references listed at the start of this section.

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 compliant with certifying organization.

D. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.06 WARRANTY/GUARANTEE

A. The TAB Contractor shall include an extended warranty of 90 days after Owner receipt of completed balance report, during which time the Owner may request a recheck of terminals, or resetting of any outlet, coil, or device listed in the test report. This warranty shall provide a minimum of 16 man hours of onsite service time. If it is determined that the new test results are not within the design criteria, the TAB Contractor shall rebalance the system according to the design criteria.

B. Warranty/Guaranty must meet one of the following programs:

1. TABB International Quality Assurance Program.

2. AABC National Project Performance Guarantee.

3. NEBB Conformance Certification.

1.07 COORDINATION

A. Notice: Provide seven days` advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on distribution systems have been satisfactorily completed.

PART 2 -PRODUCTS (NOT APPLICABLE)

PART 3 -EXECUTION

3.01 GENERAL REQUIREMENTS

A. All procedures must conform to a published standard listed under “References”. All equipment shall be adjusted in accordance with the manufacturer’s recommendations. Any system not listed in this section but installed under the Contract Documents shall be tested, adjusted, and balanced using a procedure from a published standard listed under “References”.

3.02 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 Division 23 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 strainers. Verify that startup screens are replaced by permanent screens with indicated perforations.

L. Examine three-way valves for proper installation for their intended function of diverting or mixing fluid flows.

M. Examine heat-transfer coils for correct piping connections and for clean and straight fins.

N. Examine system pumps to ensure absence of entrained air in the suction piping.

O. Examine operating safety interlocks and controls on HVAC equipment.

P. 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.

Q. Examine motor driven equipment to verify rotation in proper direction.

R. Ensure all access doors are closed and caps are in place.

S. Report any deficiencies to the Architect/Engineer. Clearly identify any issues that prevent proper balancing. Beginning of work indicates acceptance of existing conditions.

3.03 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.

3.04 INSTALLATION TOLERANCES

A. Adjust supply, return, and exhaust air-handling systems to +10%/-5% of scheduled values.

B. Adjust outdoor air intakes to +5%/-0% of scheduled values.

C. Adjust air inlets and outlets to +/-5%/-0% of scheduled values.

D. Adjust fume exhaust systems to +3%/-0% of scheduled values.

E. Adjust supply and exhaust air-handling systems used for space pressurization to +/- 5% of scheduled values while maintaining proper pressurization.

F. Adjust piping systems to +/- 10% of scheduled values.

G. Adjust plumbing systems to +/- 10% of indicated values.

3.05 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. 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, install test ports and duct access doors that comply with requirements in Division 23 Section "Duct Accessories."

2. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

B. 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.

C. Take and report testing and balancing measurements in inch-pound (IP) units.

D. Leave systems in proper working order, replacing belt guards, closing access doors, closing doors to electrical switch boxes, plugging test hours, and restoring thermostats and other set point sensors to specified settings.

3.06 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.

C. Final Report:

1. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

    a. Include a certification sheet at the front of the report`s binder, signed and sealed by the certified testing and balancing engineer.

    b. Include a list of instruments used for procedures, along with proof of calibration.

    c. Pump curves.

    d. Fan curves.

    e. Manufacturers` test data.

    f. Field test reports prepared by system and equipment installers.

    g. Other information relative to equipment performance; do not include Shop Drawings and product data.

2. General Report Data: In addition to form titles and entries, include the following data:

    a. Title page.

    b. Name and address of the TAB contractor.

    c. Project name.

    d. Project location.

    e. Architect`s name and address.

f. Engineer`s name and address.

g. Contractor`s name and address.

h. Report date.

i. Signature of TAB supervisor who certifies the report.

j. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.

k. Summary of contents including the following:
   1) Indicated versus final performance.
   2) Notable characteristics of systems.
   3) Description of system operation sequence if it varies from the Contract Documents.

l. Nomenclature sheets for each item of equipment.

m. Data for terminal units, including manufacturer`s name, type, size, and fittings.

n. Notes to explain why certain final data in the body of reports vary from indicated values.

o. Test conditions for fans and pump performance forms including the following:
   1) Settings for outdoor-, return-, and exhaust-air dampers.
   2) Conditions of filters.
   3) Cooling coil, wet- and dry-bulb conditions.
   4) Face and bypass damper settings at coils.
   5) Fan drive settings including settings and percentage of maximum pitch diameter.
   6) Settings for supply-air, static-pressure controller.
   7) Other system operating conditions that affect performance.

3. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

   a. Quantities of outdoor, supply, return, and exhaust airflows.

   b. Water and steam flow rates.

   c. Duct, outlet, and inlet sizes.

   d. Pipe and valve sizes and locations.

   e. Terminal units.

   f. Balancing stations.

   g. Position of balancing devices.

4. Air Handling Equipment Test Reports: For all equipment that delivers air for the purpose of heating or cooling, include the following:

   a. Unit Data:
      1) Unit identification.
      2) Location.

3) Make and type.
4) Model number and unit size.
5) Manufacturer`s serial number.
6) Unit arrangement and class.

b. Fan Test Reports for each fan.

c. Test Reports for each heating and cooling component.

d. Other Test Data (Indicated and Actual Values):
1) Total air flow rate in cfm.
2) Static pressure profile indicating pressure drop across each individual section in inches wg.
3) Inlet static pressure in inches wg.
4) Discharge static pressure in inches wg.
5) Outdoor airflow in cfm.
6) Return airflow in cfm.
7) Outdoor-air damper position.
8) Return-air damper position.

5. Coil Test Reports: For each duct mounted coil and coil installed in air handling equipment, include the following:

a. Coil Data:
1) System identification.
2) Location.
3) Coil type.
4) Number of rows.
5) Fin spacing in fins per inch o.c.
6) Make and model number.
7) Face area in sq. ft.
8) Tube size in NPS.
9) Tube and fin materials.
10) Water balancing valve manufacturer and model.

b. Test Data (Indicated and Actual Values):
1) Air flow rate in cfm.
2) Average face velocity in fpm.
3) Air pressure drop in inches wg.
4) Outdoor-air, wet- and dry-bulb temperatures in deg F.
5) Return-air, wet- and dry-bulb temperatures in deg F.
6) Entering-air, wet- and dry-bulb temperatures in deg F.
7) Leaving-air, wet- and dry-bulb temperatures in deg F.
8) Water flow rate in gpm.
9) Water pressure differential in feet of head or psig.
10) Entering-water temperature in deg F.
11) Leaving-water temperature in deg F.

6. Fan Test Reports: For all supply, return, and exhaust fans, include the following:

a. Fan Data:
1) System identification.
2) Location.
3) Make and type.
4) Model number and size.
5) Manufacturer`s serial number.
6) Arrangement and class.
7) Sheave make, size in inches, and bore.

8) Center-to-center dimensions of sheave, and amount of adjustments in inches.

b. Motor Data:
1) Motor make, and frame type and size.
2) Horsepower and rpm.
3) Volts, phase, and hertz.
4) Full-load amperage and service factor.
5) Sheave make, size in inches, and bore.
6) Center-to-center dimensions of sheave, and amount of adjustments in inches.
7) Number, make, and size of belts.

c. Test Data (Indicated and Actual Values):
1) Total airflow rate in cfm.
2) Total system static pressure in inches wg.
3) Fan rpm.
4) Discharge static pressure in inches wg.
5) Suction static pressure in inches wg.
6) Motor voltage at each connection.
7) Motor amperage for each phase.

7. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

a. Report Data:
1) System and air-handling-unit number.
2) Location and zone.
3) Traverse air temperature in deg F.
4) Duct static pressure in inches wg.
5) Duct size in inches.
6) Duct area in sq. ft..
7) Indicated air flow rate in cfm.
8) Indicated velocity in fpm.
9) Actual air flow rate in cfm.
10) Actual average velocity in fpm.
11) Barometric pressure in psig.

8. Air-Terminal Reports: For each air inlet or outlet, include the following:

a. Unit Data:
1) System and air-handling unit identification.
2) Location and zone.
3) Apparatus used for test.
4) Area served.
5) Make.
6) Number from system diagram.
7) Type and model number.
8) Size.
9) Effective area in sq. ft.

b. Test Data (Indicated and Actual Values):
1) Preliminary air flow rate in cfm.
2) Final air flow rate in cfm.
3) Percent of design air flow rate.

9. Air-Terminal Unit Reports: For air terminal units connected to air handling equipment or exhaust fans, include the following:

a. Unit Data:
   1) System and air-handling-equipment identification.
   2) Location and zone.
   3) Room or riser served.
   4) Coil make and size.
   5) Coil balancing valve manufacturer and model.
   6) Motor horsepower, voltage, and full load amperage for fan powered units.

b. Test Data (Indicated and Actual Values):
   1) Cooling maximum flow rate in cfm.
   2) Heating maximum flow rate in cfm.
   3) Minimum flow rate in cfm.
   4) Coil Water flow rate in gpm.
   5) Coil Water pressure drop in feet of head or psig.
   6) Coil entering-water temperature in deg F.
   7) Coil Leaving-water temperature in deg F.
   8) Coil Entering-air temperature in deg F.
   9) Coil Leaving-air temperature in deg F.
   10) Motor voltage and amperage for fan powered units.

10. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

a. Unit Data:
   1) Unit identification.
   2) Location.
   3) Service.
   4) Make and size.
   5) Model number and serial number.
   6) Water flow rate in gpm.
   7) Water pressure differential in feet of head or psig.
   8) Required net positive suction head in feet of head or psig.
   9) Pump rpm.
   10) Impeller diameter in inches.
   11) Motor make and frame size.
   12) Motor horsepower and rpm.
   13) Voltage at each connection.
   14) Full-load amperage and service factor.
   15) Seal type.

b. Test Data (Indicated and Actual Values):
   1) Static head in feet of head or psig.
   2) Pump shutoff pressure in feet of head or psig.
   3) Actual impeller size in inches.
   4) Full-open flow rate in gpm.
   5) Full-open pressure in feet of head or psig.
   6) Final discharge pressure in feet of head or psig.
   7) Final suction pressure in feet of head or psig.
   8) Final total pressure in feet of head or psig.
   9) Final water flow rate in gpm.
   10) Voltage at each connection.
   11) Amperage for each phase.

11. Flow Measuring Station:

a. Unit Data:
   1) Unit identification.
   2) Service.

3) Location.
4) Manufacturer and model.
5) Serial number.
6) Size.

b. Test Data:
1) Flow rate.
2) Pressure drop.

12. Positive Airflow Test:

a. General Data:
1) Room identification.
2) Adjacent spaces.

b. Test Data:
1) Occupied supply, return, exhaust flows.
2) Unoccupied supply, return, exhaust flows.
3) Measured pressural differential.

13. Fire, Smoke, Fire/Smoke Dampers:

a. Unit Data:
1) Damper identification number.
2) System.
3) Type.
4) Size.
5) UL assembly number.
6) Location of damper and access room.
7) Fusible link temperature rating.
8) Manufacturer and model.

b. Test Data:
1) Operation pass/fail/reset.

14. Hot Water Boiler:

a. Unit Data:
1) Drawing symbol.
2) Service.
3) Location.
4) Manufacturer, model, and identification number.
5) Rating Btuh.

b. Test Data:
1) Entering water temperature; specified and actual.
2) Leaving water temperature; specified and actual.
3) Pressure drop; specified and actual.
4) Flow rate (gpm); specified and actual.
5) Control setting; specified and actual.
6) Measured output (Btuh).

15. Air Cooled Chiller:

a. Unit Data:
1) Drawings symbol.
2) Manufacturer and model.

3) Refrigerant type and capacity.
4) Starter type, size, and thermal protection.

b. Test Data:
1) Capacity; specified and actual.
2) Evaporator entering water temperature; specified and actual.
3) Evaporator leaving water temperature; specified and actual.
4) Evaporator pressure drop; specified and actual.
5) Evaporator water flow rate; specified and actual.
6) Condenser entering air temperature.
7) Condenser leaving air temperature.

16. Plumbing Systems:

a. Pump Data:
1) Unit Data:
(a) Drawing symbol.
(b) Service.
(c) Manufacturer, size, and model.
2) Test Data:
(a) Flow rate (gpm); specified and actual.
(b) Pump head; specified, operating, and shutoff.
(c) Suction pressure; operating and shutoff.
(d) Discharge pressure; operating and shutoff.
(e) Final frequency of motor at maximum flow rate (on pumps driven by VFD).

b. Electric Motors:
1) Unit Data:
(a) Drawing symbol of equipment served.
(b) Manufacturer, model, and frame.
(c) Nameplate: HP, phase, service factor, RPM, operating amps, efficiency.
2) Test Data:
(a) Measured: Amp for each phase.

c. Balancing Valve:
1) Unit Data:
(a) Drawing symbol.
(b) Service.
(c) Location.
(d) Size.
(e) Manufacturer and model.
2) Test Data:
(a) Flow rate (gpm); specified and actual.
(b) Pressure drop; specified and actual.

17. Instrument Calibration Reports:

a. Report Data:
1) Instrument type and make.
2) Serial number.
3) Application.
4) Dates of use.
5) Dates of calibration.

3.07 INSPECTIONS

A. Initial Inspection:

1. After testing and balancing are complete, operate each system and randomly check measurements to verify that the system is operating according to the final test and balance readings documented in the final report.

2. Check the following for each system:

a. Measure airflow of at least 10 percent of air outlets.

b. Measure water flow of at least 10 percent of terminals.

c. Measure room temperature at each thermostat/temperature sensor. Compare the reading to the set point.

d. Verify that balancing devices are marked with final balance position.

e. Note deviations from the Contract Documents in the final report.

B. Final Inspection:

1. After initial inspection is complete and documentation by random checks verifies that testing and balancing are complete and accurately documented in the final report, request that a final inspection be made by Owner’s representative.

2. The TAB contractor`s test and balance engineer shall conduct the inspection in the presence of Owner’s representative.

3. Owner’s representative shall randomly select measurements, documented in the final report, to be rechecked. Rechecking shall be limited to either 10 percent of the total measurements recorded or the extent of measurements that can be accomplished in a normal 8-hour business day.

4. If rechecks yield measurements that differ from the measurements documented in the final report by more than the tolerances allowed, the measurements shall be noted as "FAILED."

5. If the number of "FAILED" measurements is greater than 10 percent of the total measurements checked during the final inspection, the testing and balancing shall be considered incomplete and shall be rejected.

C. TAB Work will be considered defective if it does not pass final inspections. If TAB Work fails, proceed as follows:

1. Recheck all measurements and make adjustments. Revise the final report and balancing device settings to include all changes; resubmit the final report and request a second final inspection.

2. If the second final inspection also fails, Owner may contract the services of another TAB contractor to complete TAB Work according to the Contract Documents and deduct the cost of the services from the original TAB contractor`s final payment.

D. Prepare test and inspection reports.

3.08 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 230593

SECTION 230700 - MECHANICAL INSULATION

PART 1 GENERAL

1.01 SUMMARY

A. This Section includes mechanical insulation for mechanical system components, including the following:

1. Insulation Materials:

a. Cellular glass

b. Flexible elastomeric.

c. Mineral fiber.

d. Polyisocyanurate.

e. Polystyrene

2. Fire-rated insulation systems.

3. Adhesives.

4. Mastics.

5. Lagging adhesives.

6. Sealants.

7. Factory-applied jackets.

8. Field-applied jackets.

9. Tapes.

10. Securements.

11. Valve and specialty fitting wraps.

B. 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. The requirements listed in this document are applicable to Divisions [21][,] [and] [22][,] [and] [23] specifications.

1.02 DEFINITIONS

A. ASJ: All-service jacket.

B. FSK: Foil, scrim, kraft paper.

C. PSK: Metalized polypropylene scrim kraft.

D. FSP: Foil, scrim, polyethylene.

E. PVDC: Polyvinylidene chloride.

F. SSL: Self-sealing lap.

G. MICA: Midwest Insulation Contractor's Association.

H. Indoor: Outside surfaces are inside building within conditioned space or insulated building envelope.

I. Outdoor: Outside surfaces are exposed to weather or outside ambient air temperatures. This includes concealed locations such as ventilated attics, uninsulated soffits, and other locations not protected by the insulated building envelope.

J. Concealed: Outside surfaces are isolated from room ambient air conditions by physical barrier.

1. Concealed items are typically accessed through suspended ceilings, through access doors, or by cutting and patching.

2. Listed below are examples of spaces that typically contain concealed items:

a. Walls.

b. Partitions.

c. Chases.

d. Shafts.

e. Ceiling spaces.

f. Attics

g. Crawl Spaces

K. Exposed: Outside surfaces are not isolated from room ambient air conditions by physical barrier.

1. Exposed items are typically accessed directly from within a room or space.

2. Listed below are examples of rooms/spaces that typically contain exposed items:

a. Mechanical rooms.

b. Tunnels.

c. Rooms without ceilings.

1.03 HOT AND COLD WATER SYSTEM REQUIREMENTS

A. Insulation specified for hot water equipment and piping includes all systems that operate at temperatures greater than 105 deg F, with and without glycol. This includes the following:

1. Domestic hot water

2. Domestic hot water recirculating.

3. Heating water systems.

4. Snow melt and radiant flooring systems.

5. Condenser water systems for heat recovery chillers.

B. Insulation specified for cold water equipment and piping includes all systems that operate at temperatures less than 60 deg F, with and without glycol. This includes the following:

1. Domestic cold water.

2. Chilled water systems.

3. Condenser water or cooling tower water systems that have water side economizer to provide free cooling.

4. Geothermal heat pump water systems.

5. Exhaust air heat recovery run-around system.

1.04 SUBMITTALS

A. Product Data: For each type of product indicated, identify thermal conductivity, thickness, and jackets (both factory and field applied, if any).

B. Application schedule.

C. Field quality-control inspection reports.

1.05 QUALITY ASSURANCE

A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

B. Fire-Test-Response Characteristics: Insulation and related materials shall have fire-test-response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.

2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

C. MICA Standards Manual, current edition.

1.06 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.

B. Material shall be sealed and protected from dirt, debris, and moisture throughout staging and construction.

1.07 COORDINATION

A. Coordinate clearance requirements with piping Installer for piping insulation application, duct Installer for duct insulation application, and equipment Installer for equipment insulation application. Before preparing piping and ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

B. Coordinate installation and testing of heat tracing.

C. Verify and document compliance with all local, state, and applicable energy codes.

PART 2 PRODUCTS

2.01 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 INSULATION MATERIALS

A. Products shall not contain asbestos, lead, mercury, or mercury compounds. Products shall be certified no voc and low odor.

B. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

C. Insulation materials in contact with austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

E. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:

a. Cell-U-Foam Corporation; Ultra-CUF.

b. Pittsburgh Corning Corporation; Foamglas Super K.

2. Block Insulation: ASTM C 552, Type I.

3. Special-Shaped Insulation: ASTM C 552, Type III.

4. Board Insulation: ASTM C 552, Type IV.

5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.

6. Preformed Pipe Insulation with Factory-Applied [ASJ] [ASJ-SSL]: Comply with ASTM C 552, Type II, Class 2.

7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

F. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Products:

a. Aeroflex USA Inc.; Aerocel.

b. Armacell LLC; AP Armaflex.

c. Rubatex

d. K Flex USA

e. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.

G. 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 or PSK jacket. Thermal conductivity (k-value) at 100 deg F is 0.30 Btu x in./h x sq. ft. x deg F or less. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

1. Products:

a. CertainTeed Corp.; Duct Wrap.

b. Johns Manville; Microlite.

c. Knauf Insulation; Duct Wrap.

d. Manson Insulation Inc.; Alley Wrap.

e. Owens Corning; All-Service Duct Wrap.

H. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

1. Products:

a. Johns Manville; HTB 23 Spin-Glas.

b. Owens Corning; High Temperature Flexible Batt Insulations.

I. 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. For equipment applications, provide insulation with factory-applied FSK or ASJ jacket. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article. Coordinate subparagraph and list below with Part 2 "Manufacturers" Article. Retain "Available" for nonproprietary and delete for semiproprietary specifications.

1. Products:

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.

J. 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:

a. Fibrex Insulations Inc.; FBX.

b. Johns Manville; 1000 Series Spin-Glas.

c. Owens Corning; High Temperature Industrial Board Insulations.

d. Rock Wool Manufacturing Company; Delta Board.

e. Roxul Inc.; Roxul RW.

f. Thermafiber; Thermafiber Industrial Felt.

K. Mineral-Fiber, Preformed Pipe Insulation:

1. Products:

a. Fibrex Insulations Inc.; Coreplus 1200.

b. Johns Manville; Micro-Lok.

c. Knauf Insulation; 1000(Pipe Insulation.

d. Manson Insulation Inc.; Alley-K.

e. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

3. Type II, 1200 deg F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in Part 2 "Factory-Applied Jackets" Article.

L. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied [ASJ] [FSK jacket] 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 Part 2 "Factory-Applied Jackets" Article.

1. Products:

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.

M. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

1. Products:

a. Apache Products Company; ISO-25.

b. Dow Chemical Company (The); Trymer.

c. Duna USA Inc.; Corafoam.

d. Elliott Company; Elfoam.

2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.

3. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches as tested by ASTM E 84.

4. Fabricate shapes according to ASTM C 450 and ASTM C 585.

N. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

1. Products:

a. Dow Chemical Company (The); Styrofoam.

b. Knauf Insulation; Knauf Polystyrene.

2.03 FIRE-RATED INSULATION SYSTEMS

A. Fire-Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg F. Comply with ASTM C 656, Type II, Grade 6. UL tested and certified to provide a [1] [2]-hour fire rating.

B. Fire-Rated Blanket: High-temperature, flexible, blanket insulation with FSK jacket that is UL tested and certified to provide a two-hour fire rating.

1. Grease Duct: 2 layers.

2. Ventilation Duct: 1 layer.

2.04 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. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F.

C. Cellular-Glass, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg F.

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

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

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

G. PVC Jacket Adhesive: Compatible with PVC jacket.

2.05 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II. Color shall match insulation color. Service shall match insulation application vapor permeance and installation environment.

2.06 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

2.07 SEALANTS

A. Sealants:

1. Materials shall be compatible with insulation materials, jackets, and substrates. Color shall match insulation or jacket color. Service shall match insulation application, vapor permeance, and installation environment.

2.08 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. PSK Jacket: Metalized white polypropylene, fiberglass-reinforced kraft paper 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 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

6. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

2.09 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

B. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Adhesive: As recommended by jacket material manufacturer.

2. Color: White. [Paint exterior systems to match surroundings. Color selected by Architect.]

3. Color: Color shall match identification/painting system.

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.

5. Factory-fabricated tank heads and tank side panels.

C. Metal Jacket:

1. 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] [Factory cut and rolled to size].

b. Finish and thickness are indicated in field-applied jacket schedules.

c. 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.

2. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

a. [Sheet and roll stock ready for shop or field sizing] [Factory cut and rolled to size].

b. Material, finish, and thickness are indicated in field-applied jacket schedules.

c. 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.

D. Underground Direct-Buried Jacket: 125-mil-thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

E. Self-Adhesive Outdoor Jacket: Minimum 40-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:

a. AlumaGuard.

b. FlexClad 400.

F. PVDC Jacket for Indoor Applications: 4-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

G. PVDC Jacket for Outdoor Applications: 6-mil-thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

H. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

2.10 TAPES

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

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 and PSK Tape: Vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136 and UL listed.

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 or PSK Tape Disks and Squares: Precut disks or squares of FSK or PSK tape.

C. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.

1. Width: 2 inches.

2. Thickness: 6 mils.

3. Adhesion: 64 ounces force/inch in width.

4. Elongation: 500 percent.

5. Tensile Strength: 18 lbf/inch in width.

D. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches.

2. Film Thickness: 4 mils.

3. Adhesive Thickness: 1.5 mils.

4. Elongation at Break: 145 percent.

5. Tensile Strength: 55 lbf/inch in width.

E. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Width: 3 inches.

2. Film Thickness: 6 mils.

3. Adhesive Thickness: 1.5 mils.

4. Elongation at Break: 145 percent.

5. Tensile Strength: 55 lbf/inch in width.

2.11 SECUREMENTS

A. Bands:

1. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type [304] [316] [304 or Type 316];0.015 inch thick, [1/2 inch] [3/4 inch] wide with [wing seal] [closed seal] [wing or closed seal].

2. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, [1/2 inch] [3/4 inch] wide with [wing seal] [closed seal] [wing 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. Install pins, hangers, and securements according to manufacturer's installation recommendation.

2.12 VALVE AND SPECIALTY FITTING WRAPS

A. All valves, strainers, autoflow valves, circuit setters, ball valves, balancing valves, and combination valves, etc., in chilled water, heating hot water, and steam systems shall be insulated with a factory fabricated removable and reusable cover.

B. Type 1:

1. Insulation shall have a minimum k- factor .26, using fiberglass blanket. Flame and smoke spread shall be 25/50 per ASTM E-84.

2. Outer jacket shall be made of material equal to DuPont Tychem® QC, overlapping and completely covering the insulation with seams joined by tabs made from hook and loop fasteners (Velcro). Butt ends shall have sewn-in-place elastic.

3. Outer jacket shall overlap adjoining sections of pipe insulation.

4. Installation shall not require the use of any special hand tools.

5. Manufacturers: No Sweat Valve Wraps, Inc., or approved equal.

C. Type 2:

1. Flame Spread Index <25, smoke developed index <50 per ASTM E 84.

2. Thermal conductivity tested per ASTM C225. Minimum K-factor shall be 0.48 at 200 deg F.

3. Fiberglass insulation core meets ASTM C553, Type VI requirements.

4. Meets ASTM C1695-10 Standard Specification for fabrication of flexible removable and reusable blanket insulation for hot service.

5. Manufacturers: Auburn manufacturing, Inc., or approved equal.

D. Type 3:

1. Manufacturers: ThermaXX or approved equal.

2. Insulation:

a. Box Type Jackets:
1) High/low-temperature insulation blanket formed of silica Aerogel and reinforced with a non-woven, glass-fiber batting.
2) Insulation must be hydrophobic.
3) Estimation of maximum use temperature 1200 deg F.

b. Non-Box Type Jackets:
1) Glass mat, Type E needled fiber. 1/4 inch, 1/2 inch at 9 LB/CF and 1 inch at 11.3 LB/CF.
2) Estimation of maximum use temperature 1200 deg F.

c. All insulation materials shall be non-asbestos.

3. Jacket:

a. Pipe Side:
1) PTFE fiberglass composite jacketing, 16.5 oz/sq yd minimum.
2) Estimation of maximum use temperature 600 deg F.

b. Exterior Side:
1) PTFE fiberglass composite jacketing, 16.5 oz/sq yd minimum.
2) Estimation of maximum use temperature 600 deg F.

4. Thread:

a. Begins to decompose at about 800 deg.

b. Does not melt.

c. Diameter: 0114.

d. Break Point: 35 lbs.

5. Construction:

a. Double sewn lock stitch with a minimum 4 to 6 stitches per inch. Jackets shall be sewn with two (2) parallel rows of stitching using thread in Article 2.12, Subparagraph D.4. The thread must be able to withstand the skin temperatures without degradation.

b. Hog rings, staples, and wire are not acceptable methods of closure.

c. No raw cut jacket edges shall be exposed.

d. Jackets shall be fastened using hook and loop (Velcro) straps and 1 inch slide buckles.

e. All stitching will be done with thread in Article 2.12, Subparagraph D.4.

f. Provide a permanently attached aluminum or stainless steel nameplate on each jacket to identify its location, size, and tag number.

g. Provide a stainless steel or brass grommet at the low point of each jacket, in wet areas for moisture drain (on horizontal jackets as required).

h. The insulation shall be designed to prevent sweating in the space between the cold metal surface and the inner layer of insulation. To this end, during jacket fabrication, the layers of insulating mat shall be placed in an overlapping pattern.

i. All jacket pieces which match mating seams must include an extended 2 inch flap constructed from the exterior fabric and shall be secured using hook and loop closure (i.e., Velcro) parallel to the seam.

j. Insulation must be sewn as integral part of the jacket to prevent shifting of the insulation.

6. Jacket Performance and Insulation Thickness:

a. Insulation Thickness: Match adjacent piping insulation requirements.

E. Type 4:

1. Manufacturers: ThermaXX LLC or approved equal.

2. Insulation:

a. Box Type Jackets:
1) High-temperature insulation blanket formed of silica Aerogel and reinforced with a non-woven, glass-fiber batting.
2) Insulation must be hydrophobic.
3) Estimation of maximum use temperature 1200 deg F.

b. Non-Box Type Jackets:
1) Glass mat, Type E needled fiber. 1/4 inch or 1/2 inch at 9 lb/cf and 1 inch at 11.3 lb/cf.
2) Estimation of maximum use temperature 1200 deg F.

c. All insulation materials shall be non-asbestos.

3. Jacket:

a. Hot Side:
1) PTFE fiberglass composite jacketing, 16.5 oz/sq yd minimum.
2) Estimation of maximum use temperature 550 deg F.

b. Cold Side:
1) PTFE fiberglass composite jacketing, 165 oz/sq yd minimum.
2) Estimation of maximum use temperature 600 deg F.

4. Thread:

a. Begins to decompose at about 800 deg.

b. Does not melt.

c. Diameter: 0114.

d. Break Point: 35 lbs.

5. Construction:

a. Double sewn lock stitch with a minimum 4 to 6 stitches per inch. Jackets shall be sewn with two (2) parallel rows of stitching using thread in Article 2.12, Subparagraph E.4. The thread must be able to withstand the skin temperatures without degradation.

b. Hog rings, staples, and wire are not acceptable methods of closure.

c. No raw cut jacket edges shall be exposed.

d. Jackets shall be fastened using hook and loop (Velcro) straps and 1 inch slide buckles.

e. All stitching will be done with thread in Article 2.12, Subparagraph E.4.

f. Provide a permanently attached aluminum or stainless steel nameplate on each jacket to identify its location, size, and tag number.

g. Provide a stainless steel or brass grommet at the low point of each jacket, in wet areas for moisture drain (on horizontal jackets as required).

h. The insulation shall be designed to prevent sweating in the space between the cold metal surface and the inner layer of insulation. To this end, during jacket fabrication, the layers of insulating mat shall be placed in an overlapping pattern.

i. All jacket pieces which match mating seams must include an extended 2 inch flap constructed from the exterior fabric and shall be secured using hook and loop closure (i.e., Velcro) parallel to the seam.

j. Insulation must be sewn as integral part of the jacket to prevent shifting of the insulation.

6. Steam trap and steam trap station jackets must be constructed in a box shape for removal and replacement inspection ease. Jacket Performance and Insulation Thickness:

a. Insulation Thickness: As required to touch temperature.
1) Exterior of all jacket <120 deg F.

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation 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.

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

3.02 INSTALLATION

A. Install insulation after completion of pressure testing.

3.03 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.

3.04 COMMON INSTALLATION REQUIREMENTS

A. Where vapor barrier is breeched by fastener, seal to maintain vapor permeance.

B. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.

C. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.

D. 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.

E. Install insulation with longitudinal seams at top and bottom of horizontal runs.

F. Install multiple layers of insulation with longitudinal and end seams staggered.

G. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

H. Keep insulation materials protected and dry during application and finishing.

I. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

J. Install insulation with least number of joints practical.

K. For all cold systems operating below ambient temperature, provide continuous vapor barrier. 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. Insulate all system components the same as connecting piping and ductwork to eliminate condensation.

3. 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.

4. 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.

5. 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.

L. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

M. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 2 inches o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are required, apply vapor-barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.

N. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

O. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

P. 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.

Q. 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.

R. MICA plate numbers referenced are provided to clarify the scope of installation. Install Insulation and accessory components per applicable MICA and manufacturers recommendations.

3.05 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 Below-Grade 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. Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations on ductwork. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least 2 inches.

F. Insulation Installation at Floor Penetrations:

1. Duct: Install insulation continuously through floor penetrations that are not fire rated. 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.

2. Pipe: Install insulation continuously through floor penetrations.

3.06 DUCT AND PLENUM INSULATION INSTALLATION

A. Blanket Insulation Installation on Ducts and Plenums: Secure per manufacturer's installation recommendations.

3.07 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Secure insulation per manufacturer's installation recommendations.

B. 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] [aluminum] [stainless steel], at least [0.040 inch] [0.050 inch] [0.060 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.

3.08 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. Identify all specialties with labels on exterior of insulation.

2. Install preformed sections or cut, miter, and bond all elbows and tees to provide continuous quality fitting contour.

3. 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.

4. 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.

5. 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.

6. 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.

7. For services not specified to receive a field-applied jacket except for flexible elastomeric, 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.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.09 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Boiler Breechings and Ducts:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation material.

2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

B. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch intervals and tighten bands without deforming insulation materials.

2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless-steel bands at 12-inch intervals.

3. Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

3.10 CELLULAR-GLASS INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are required, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.

4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

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

2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

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

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

E. For all system components without factory applied jackets, cover insulation with factory furnished jacketing material appropriate for service and application.

3.11 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.12 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 2inch, and seal joints with flashing sealant.

C. Blanket and Board Insulation Installation on Ducts and Plenums: Secure per manufacturer’s installation recommendations.

1. 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.

2. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

3.13 POLYISOCYANURATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.

2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.

3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation.

C. Insulation Installation on Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of polyisocyanurate 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.

3.14 POLYSTYRENE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.

2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.

3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2-inch thickness.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed section of polystyrene insulation to valve body.

2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

3.15 FIELD-APPLIED JACKET INSTALLATION

A. Where fiberglass-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 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.

E. Where PVDC jackets are indicated, install as follows:

1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.

2. Wrap factory-presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.

3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.

4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2-inch-circumference limit allows for 2-inch-overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.

5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.16 FIRE-RATED INSULATION SYSTEM INSTALLATION

A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous UL-listed fire rating.

B. Penetrations through fire rated walls and floors shall be installed with UL listed through penetration fire stopping system specific for the fire-rated insulation system manufacturer.

C. Insulate duct access panels and doors to achieve same fire rating as duct in accordance with its UL listing.

3.17 FINISHES

A. Duct, Equipment, and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Division 09 painting Sections.

1. Flat Acrylic Finish: [Two] finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

a. Finish Coat Material: Interior, flat, latex-emulsion size.

B. Flexible Elastomeric Thermal Insulation, Outdoor: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective UV 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.

3.18 FIELD QUALITY CONTROL

A. Testing Agency: [Owner will engage] [Engage] a qualified independent inspecting agency to perform field inspections and prepare inspection reports.

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

1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to [one] location(s) for each duct system defined in the "Duct Insulation Schedule, General" Article.

2. 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.

3. Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to [three] locations of straight pipe, [three] locations of threaded fittings, [three] locations of welded fittings, [two] locations of threaded strainers, [two] locations of welded strainers, [three] locations of threaded valves, and [three] locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

C. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements. Remove defective Work.

D. Install new insulation and jackets to replace insulation and jackets removed for inspection. Repeat inspection procedures after new materials are installed.

3.19 BOILER BREECHING INSULATION SCHEDULE

A. Round, exposed breeching and connector insulation shall be[any of] the following:

1. Calcium Silicate: 4 inches thick.

2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.

3. High-Temperature Mineral-Fiber Board: 3 inches thick and [3-lb/cu. ft.] [6-lb/cu. ft.] nominal density.

B. Round, concealed breeching and connector insulation shall be[any of] the following:

1. Calcium Silicate: 4 inches thick.

2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.

3. High-Temperature Mineral-Fiber Board: 3 inches thick and [3-lb/cu. ft.] [6-lb/cu. ft.] nominal density.

C. Rectangular, exposed breeching and connector insulation shall be[any of] the following:

1. Calcium Silicate: 4 inches thick.

2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.

3. High-Temperature Mineral-Fiber Board: 3 inches thick and [3-lb/cu. ft.] [6-lb/cu. ft.] nominal density.

D. Rectangular, concealed breeching and connector insulation shall be[any of] the following:

1. Calcium Silicate: 4 inches thick.

2. High-Temperature Mineral-Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.

3. High-Temperature Mineral-Fiber Board: 3 inches thick and [3-lb/cu. ft.] [6-lb/cu. ft.] nominal density.

3.20 DUCT INSULATION, GENERAL

A. Plenums and Ducts Requiring Insulation:

1. Indoor and outdoor ductwork and plenums as scheduled.

2. All duct mounted components shall be externally insulated the same R value as connecting ductwork. This includes but is not limited to the following.

    a. Duct mounted coils, including coils mounted to VAV boxes. Insulation shall cover u-bends and piping header.

    b. Duct mounted sound attenuators.

    c. Duct mounted dampers.

B. Items Not Insulated:

1. Exposed supply air distribution systems with architectural significance where specifically noted on plans.

2. Fibrous-glass ducts.

3. Metal ducts with duct liner where thickness is increased to comply with energy code and ASHRAE/IESNA 90.1.

    a. Use of duct liner is limited to only those locations duct liner is specified or indicated.

4. Factory-insulated flexible ducts.

5. Factory-insulated plenums and casings.

6. Flexible connectors.

7. Vibration-control devices.

8. Factory-insulated access panels and doors.

9. Fire dampers where not permitted by UL listing.

10. Return air ductwork in ceiling spaces utilized as return air plenums.

C. Insulation thickness and associated thermal conductivity shall meet installed R value scheduled. For mineral fiber blanket insulation, installed R value shall be based on the insulation being compressed 25%.

D. Provide the following factory applied insulation jacketing:

1. Mineral fiber blanket:

    a. Exposed applications: PSK

    b. Concealed applications: FSK

2. Mineral fiber board:

    a. Exposed applications: ASJ

    b. Concealed applications: FSK

3.21 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

DUCT SYSTEM TYPE	INSULATION			PLATE MICA NUMBER	NOTES
	TYPE	INSTALLED R VALUE	MINIMUM DENSITY LB/SF		
SUPPLY AIR (CONCEALED)	MF BLANKET	6	0.75	3-100	
RETURN AIR (CONCEALED)	MF BLANKET	6	0.75	3-100	
SUPPLY AIR RECTANGULAR (EXPOSED)	MF BOARD	6	3.0	3-120	
SUPPLY AIR ROUND OR FLAT OVAL(EXPOSED)	MF BLANKET	6	0.75	3-100	
OUTSIDE AIR RECTANGULAR	MF BOARD	6	3.0	3-120	1
OUTSIDE AIR ROUND OR FLAT OVAL	MF BLANKET	6	3.0	3-100	1
RELIEF/EXHAUST AIR (NON HEAT RECOVERY APPLICATIONS)	MF BLANKET	6	0.75	3-100	2
HEAT RECOVERY EXHAUST AT OUTLET OF HEAT RECOVERY EQUIPMENT TO EXTERIOR LOUVER OR OPENING	MF BLANKET	6	0.75	3-100	
ABBREVIATIONS: MF=MINERAL FIBER(FIBERGLASS), E= ELASTOMERIC SCHEDULE NOTES:					
1. FOR OUTSIDE AIR DUCTWORK DOWNSTREAM OF AN AIR HANDLING UNIT THAT HEATS OR COOLS THE OUTSIDE AIR, INSULATE AS SPECIFIED FOR SUPPLY AIR.					
2. INSULATE FROM EXTERIOR LOUVER OR OPENING TO 20 FEET AWAY OR TO 5 FEET PAST CONTROL OR BACKDRAFT DAMPER, WHICHEVER IS LESS.					

3.22 FIRE RATED INSULATION SYSTEMS SCHEDULE

A. Commercial, kitchen hood exhaust duct and plenum Insulation for all Type I kitchen exhaust systems: Fire-rated [blanket] [board] [blanket or board]; thickness as required to achieve 2-hour fire rating.

B. Ventilation duct and plenum Insulation where specifically indicated on plans: Fire-rated [blanket] [board] [blanket or board]; thickness as required to achieve 2-hour fire rating.

3.23 ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.

B. Rectangular, round, and flat-oval, supply and return air duct insulation shall be the following:

1. All sizes: Two layers of 1-1/2” flexible elastomeric insulation with Self-Adhesive Outdoor Jacket, 3 inch total thickness.

3.24 EQUIPMENT INSULATION, GENERAL

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in schedule below that is not factory insulated. Type 3 or 4 specialty fitting wraps may be substituted for field insulating specified.

C. On hot equipment secure insulation to bottom of flat surfaces wider than 24 inches by impaling over adhesive pin mechanical fasteners.

1. Secure insulation on mechanical fasteners with speed clips.

2. Space mechanical fasteners to hold insulation securely in place using a maximum spacing of 12 inches on center. If manufacturers recommended spacing is less than 12 inches the manufacturers recommended spacing is to be used.

3. Seal joints and speed clips with 3 inch wide pressure sensitive joint sealing tape that matches facing.

D. On high temperature equipment and piping, attach as recommended by manufacturer.

E. On cold equipment secure insulation using adhesive as recommended by the manufacturer for the application and associated operating temperature.

F. Insulate flanges and fittings as indicated for the applicable piping system associated with the equipment, tank or vessel.

G. Where two layers of insulation are indicated in the schedule, each layer shall be installed with half the scheduled thickness and with staggered joints to achieve scheduled thickness.

3.25 EQUIPMENT INSULATION SCHEDULE

	INSULATION		MICA PLATE
	TYPE	THICKNESS	NUMBER
HOT EQUIPMENT			
HOT WATER AIR SEPARATORS	PT	2	4-100, 4-120
STEAM CONDENSATE RECEIVERS	MF BOARD, PT	2	
STEAM DEAERATOR/BOILER FEED WATER TANKS	PT	2	4-100
DOMESTIC INSTANTANEOUS WATER	PT	2	4-100

HEATERS			
DOMESTIC WATER HEATER STORAGE TANK	PT	2	4-100
STEAM FLASH TANK, BLOWDOWN SEPARATOR	PT	2	4-120
HOT WATER EXPANSION TANK	PT	2	4-100, 4-120
STEAM TO WATER HEAT EXCHANGER	PT	2	4-130
WATER TO WATER HEAT EXCHANGER	PT	2	4-130
HIGH TEMPERATURE EQUIPMENT AND PIPING			
INDOOR BOILER BREECHING AND FLUE SYSTEM (TWO LAYERS)	CS	3-1/2	1-100
INDOOR EMERGENCY GENERATOR MUFFLER (TWO LAYERS)	CS	3-1/2	1-800
INDOOR EMERGENCY GENERATOR EXHAUST PIPING (TWO LAYERS)	CS	3-1/2	1-100
COLD EQUIPMENT			
WATER CHILLER BOXES (TWO LAYERS)	E	1-1/2	4-200, 8-210
EVAPORATOR HEAT EXCHANGERS OF CHILLERS(TWO LAYERS)	E	1-1/2	4-200, 8-210
COLD WATER PUMP CASINGS	E	1	4-210 OR 8-400
WATER TO WATER HEAT EXCHANGERS	E	1	4-200, 8-210
DOMESTIC WATER METER	E	1	8-400
ROOF DRAIN BODIES	E	1	
COLD WATER EXPANSION TANKS	E	1	4-200
COLD WATER AIR SEPARATORS	E	1	4-200
WATER SOFTENERS	E	1	4-200
ABBREVIATIONS: PT= PIPE AND TANK INSULATION, MF= MINERAL FIBER(FIBERGLASS),			
CS= CALCIUM SILICATE, E= ELASTOMERIC.			

3.26 PIPING INSULATION, 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. Fire-suppression piping.

2. Drainage piping located in crawl spaces.

3. Below-grade piping.

4. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.27 ABOVEGROUND PIPING INSULATION SCHEDULE

PIPING SYSTEM FLUID	TEMP. RANGE DEG. F.	THICKNESS IN INCHES FOR PIPE SIZES THROUGH SIZE LISTED					INSULATION TYPE (Note 1)	NOTES
		<1	1 TO 1.25	1.5 TO 3	4 TO 6	≥8		
HPS AND MPS	251 TO 350	3	4	4.5	4.5	4.5	MF	
(STEAM PRESSURES UP TO 120 PSIG INCLUDING CONDENSATE)								
LPS	TO 250	2.5	2.5	2.5	3	3	MF	
(STEAM PRESSURES UP TO 15 PSIG INCLUDING CONDENSATE AND BOILER FEEDWATER.)								
INDOOR STEAM VENT AND BOILER BLOWDOWN	140 TO 200	1.5	1.5	2	2	2	MF	
INDOOR HOT WATER	140 TO 200	1.5	1.5	2	2	2	MF	2
INDOOR HOT WATER	105 TO 140	1	1	1.5	1.5	1.5	MF	2
OUTDOOR HOT WATER	140 TO 200	2.5	2.5	3	3	3	MF	2
OUTDOOR HOT WATER	105 TO 140	2	2	2.5	2.5	2.5	MF	2
VACUUM PUMP EXHAUST	TO 350	2	2	2	2	2	MF	3
INDOOR COLD WATER	40 TO 60	0.5	0.5	1	1	1	MF, E	
INDOOR COLD WATER	<40	0.5	1	1	1	1.5	MF, E	
OUTDOOR COLD WATER	40 TO 60	1.5	1.5	2	2	2	E	
OUTDOOR COLD WATER	<40	1.5	2	2	2	2.5	E	
REFRIGERANT	ANY	0.5	1	1	1	NA	E	4
STORM, STORM OVERFLOW AND DRAIN BODIES	ANY	1	1	1	1	1	MF, E	
AIR COMPRESSOR INTAKE	ANY	1	1	1	1	1	MF, E	
PLASTIC IN RETURN AIR	ANY	0.5	0.5	0.5	0.5	0.5	MF	

PLENUM								
HEAT TRACED	ANY	2	2	2	2	2	MF	3
INDOOR CONDENSATE AND EQUIPMENT DRAINS	BELOW 60	0.5	0.5	0.5	0.5	0.5	MF, E	5
CRYOGEN VENT	BELOW -100	2	2	2	2	2	CG	

ABBREVIATIONS: MF = MINERAL FIBER/FIBERGLASS, E = ELASTOMERIC, CG = CELLULAR GLASS
SCHEDULE NOTES:
1. MICA REFERENCE PLATES FOR PIPING ARE 1-100 FOR FIBERGLASS AND CELLULAR GLASS PIPE INSULATION, 1-200 FOR ELASTOMERIC AND 1-900 FIBERGLASS WITH HEAT TRACE.
2. HOT WATER SYSTEM TEMPERATURES EXCEEDING 200 DEG F TO BE TREATED FOR APPROPRIATE TEMPERATURE RANGE AS LISTED UNDER LPS OR HPS.
3. HEAT TRACED PIPING SHALL BE INSULATED TO THICKNESS INDICATED OR TO THICKNESS SPECIFIED FOR SPECIFIC SYSTEM, WHICHEVER IS GREATER.
4. UNDERGROUND REFRIGERANT PIPING SHALL BE INSULATED AS SPECIFIED FOR ABOVEGROUND PIPING AND INSTALLED IN PVC CONDUIT.
5. INCLUDES AIR CONDITIONING CONDENSATE, P-TRAPS FOR FLOOR DRAINS/SINKS RECEIVING AIR CONDITIONING CONDENSATE OR ICE MAKER DRAIN PIPING, AND SANITARY DRAINAGE PIPING FROM ELECTRIC WATER COOLERS TO MAIN.

3.28 VALVES AND SPECIALTY FITTINGS FOR PIPING SYSTEMS

A. Insulated Systems Operating Below Ambient Temperature:

1. NPS 6 and Smaller: Type 1.

2. Above NPS 6: Type 2 [or] [3].

B. Insulated Systems Operating Above Ambient Temperature and Below 200 Deg F:

1. NPS 6 and Smaller: Type 1.

2. Above NPS 6: Type 2 [or] [4].

C. Insulated Systems Operating Above 200 Deg F:

1. All Sizes: Type 2 [or] [4]

3.29 OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

A. Loose-fill insulation, for belowground piping, is specified in Division 02 piping distribution Sections.

B. Factory insulated double wall conduit piping is specified in Section.

3.30 FIELD-APPLIED JACKET GENERAL APPLICATION

A. Install field-applied jacket on piping as follows:

1. On exterior piping.

2. On all changes in direction and fittings.

3. In areas subject to traffic and damage exposed in mechanical rooms and tunnels. This includes the following:

a. Piping within 7 feet of finished floor.

b. Other areas specifically indicated on plans.

4. On exposed piping insulated in finished spaces including but limited to storage rooms, closets, and work areas.

5. Piping within air handling units.

B. Field-applied jacketing shall be installed on entire piping system including fittings, valves, strainers, and other piping components, except where jacketing is specifically limited to only fittings.

C. MICA Reference Plates:

1. Field applied metal jacketing: 1-400.

2. Field applied non-metal jacketing: 1-500.

3.31 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. Ducts and Plenums, Concealed:

1. None.

2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.

3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.

5. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

6.

D. Ducts and Plenums, Exposed:

1. None.

2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.

3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.

5. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

6.

E. Equipment, Concealed:

1. None.

2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.

3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.

5. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

6.

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

1. None.

2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.

3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.

5. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

6.

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

1. None.

2. [Painted]Aluminum, [Smooth] [Stucco Embossed] with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.032 inch] [0.040 inch] thick.

3. Stainless Steel, Type [304] [316] [304 or 316], [Smooth] [Stucco Embossed], with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.020 inch] [0.024 inch] thick.

4.

H. High temperature equipment and piping:

1. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

I. Piping, Concealed:

1. PVC 30 mil fitting covers on all fittings.

2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.

3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.

5. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

6.

J. Piping, Exposed:

1. PVC 30 mil fitting covers on all fittings.

2. PVC 30 mil for the exposed indoor piping systems listed above under “FIELD-APPLIED JACKET GENERAL APPLICATION.”

3. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.

4. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

5. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.

6. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

7.

3.32 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. Ducts and Plenums, Concealed:

1. None.

2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.

3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.

5. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

6.

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

1. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

2. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.

3. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

4.

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

1. [Painted]Aluminum, [Smooth] [Stucco Embossed] with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.032 inch] [0.040 inch] thick.

2. Stainless Steel, Type [304] [316] [304 or 316], [Smooth] [Stucco Embossed], with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.020 inch] [0.024 inch] thick.

3.

F. Equipment, Concealed:

1. None.

2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.

3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.

5. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

6.

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

1. [Painted]Aluminum, [Smooth] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

2. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

3.

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

1. [Painted]Aluminum, [Smooth] [Stucco Embossed] with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.032 inch] [0.040 inch] thick.

2. Stainless Steel, Type [304] [316] [304 or 316], [Smooth] [Stucco Embossed], with [1-1/4-Inch-Deep Corrugations] [2-1/2-Inch-Deep Corrugations] [4-by-1-Inch Box Ribs]: [0.020 inch] [0.024 inch] thick.

3.

I. Piping, Concealed:

1. None.

2. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] thick.

3. Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

4. Painted Aluminum, [Smooth] [Corrugated] [Stucco Embossed]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] thick.

5. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

6.

J. Piping, Exposed:

1. [PVC] [PVC, Color-Coded by System]: [20 mils] [30 mils] [40 mils] thick.

2. [Painted]Aluminum, [Smooth] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: [0.016 inch] [0.020 inch] [0.024 inch] [0.032 inch] [0.040 inch] thick.

3. Stainless Steel, Type [304] [316] [304 or 316], [Smooth 2B Finish] [Corrugated] [Stucco Embossed] [with Z-Shaped Locking Seam]: [0.010 inch] [0.016 inch] [0.020 inch] [0.024 inch] thick.

4.

END OF SECTION 230700

SECTION 230800 - COMMISSIONING OF HVAC

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

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

B. OPR, BoD, and documentation prepared by Owner and Architect contains requirements that apply to this Section.

1.02 SUMMARY

A. This Section includes requirements for commissioning the HVAC system and its subsystems and equipment. This Section supplements the general requirements specified in Division 01 Section "General Commissioning Requirements."

B. Related Sections include the following:

1. Section 019113 "General Commissioning Requirements" for general requirements for commissioning processes that apply to this Section.

2. Section 26 0800 “Commissioning of Electrical Systems” for electrical systems commissioning requirements.

1.03 DEFINITIONS

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

C. BoD: Basis of Design.

D. CxA: Commissioning Authority.

E. OPR: Owner`s Project Requirements.

F. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

G. TAB: Testing, Adjusting, and Balancing.

1.04 CONTRACTOR`S RESPONSIBILITIES

A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Contractor:

1. Perform commissioning tests at the direction of the CxA as defined in the Commissioning Plan.

2. Attend Construction phase controls coordination meeting.

3. Participate in HVAC&R systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

4. Provide information requested by the CxA for final commissioning documentation.

5. Provide training to Owner's personnel on system operations, preventive maintenance, sequence of operations, and function on systems.

6. Attend TAB review & coordination meeting for TAB Work.

7. Certify that TAB Work is complete.

C. Mechanical Contractor:

1. Attend TAB verification testing.

2. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.

D. HVAC Instrumentation and Control Contractor: With the CxA, review control designs for compliance with the OPR and BoD, controllability with respect to actual equipment to be installed, and recommend adjustments to control designs and sequence of operation descriptions.

E. TAB Contractor:

1. Contract Documents Review: With the CxA, review the Contract Documents before developing TAB procedures.

a. Verify the following:
1) Accessibility of equipment and components required for TAB Work.
2) Adequate number and placement of duct balancing dampers to allow proper balancing while minimizing sound levels in occupied spaces.
3) Adequate number and placement of balancing valves to allow proper balancing and recording of water flow.
4) Adequate number and placement of test ports and test instrumentation to allow reading and compilation of system and equipment performance data needed to conduct both TAB and commissioning testing.
5) Air and water flow rates have been specified and compared to central equipment output capacities.

b. Identify discontinuities and omissions in the Contract Documents.

c. This review of the Contract Documents by the TAB Subcontractor satisfies requirements for a design review report as specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

2. Additional Responsibilities: Participate in tests specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" and

F. Electrical Contractor:

1. With the Mechanical Contractor, coordinate installations and connections between and among electrical and HVAC systems, subsystems, and equipment.

1.05 COMMISSIONING DOCUMENTATION

A. The following are in addition to documentation specified in Division 01 Section "General Commissioning Requirements."

B. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.

2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

3. Process and schedule for completing construction checklists and manufacturer's prestart and startup checklists for HVAC&R systems, assemblies, equipment and components to be verified and tested.

4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.

5. Certificate of readiness certifying that HVAC&R systems, subsystems equipment and associated controls are ready for testing.

6. Test and inspection reports and certificates.

7. Corrective action documents.

8. Verification of testing, adjusting, and balancing reports.

C. Test Checklists: CxA shall develop test checklists for HVAC systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Contractors shall complete test checklists. In addition to the requirements specified in Division 01 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:

1. Calibration of sensors and sensor function.

2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.

3. Control sequences for HVAC systems.

4. Strength of control signal for each set point at specified conditions.

5. Responses to control signals at specified conditions.

6. Sequence of response(s) to control signals at specified conditions.

7. Electrical demand or power input at specified conditions.

8. Power quality and related measurements.

9. Expected performance of systems, subsystems, and equipment at each step of test.

10. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.

11. Interaction of auxiliary equipment.

12. Issues log.

1.06 SUBMITTALS

A. The following submittals are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.

C. Certificate of Readiness: CxA shall compile certificates of readiness from the appropriate Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.

D. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed.

E. Certified Pipe Cleaning and Flushing Report: Contractors shall certify that pipe cleaning, flushing, hydrostatic testing, and chemical treating have been completed. CxA shall Verify reports.

F. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates, and shall include them in systems manual and commissioning report.

G. Corrective Action Documents: CxA shall submit corrective action documents.

H. Certified TAB Reports: CxA shall submit verified, certified TAB reports.

PART 2 -PRODUCTS (NOT USED)

PART 3 -EXECUTION

3.01 TESTING PREPARATION

A. Prerequisites for Testing: (Completed by Contractor)

1. Certify that HVAC systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the OPR, BoD, and Contract Documents; and that Certificates of Readiness are signed and submitted.

2. Certify that HVAC instrumentation and control systems have been completed and calibrated; are operating according to the OPR, BoD, and Contract Documents; and that pretest set points have been recorded.

3. Certify that TAB procedures have been completed, and that TAB reports have been submitted, discrepancies corrected, and corrective work approved.

4. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.

5. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power, and alarm conditions).

6. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.

7. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable, or failed. Repeat this test for each operating cycle that applies to system being tested.

8. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

9. Annotate checklist or data sheet when a deficiency is observed.

10. Verify equipment interface with monitoring and control system and TAB criteria; include the following:

    a. Supply and return flow rates for VAV and constant volume systems in each operational mode.

    b. Operation of terminal units in both heating and cooling cycles.

    c. Minimum outdoor-air intake in each operational mode and at minimum and maximum airflows.

    d. Building pressurization.

    e. Total exhaust airflow and total outdoor-air intake.

    f. Operation of indoor-air-quality monitoring systems.

11. Verify proper responses of monitoring and control system controllers and sensors to include the following:

    a. For each controller or sensor, record the indicated monitoring and control system reading and the test instrument reading. If initial test indicates that the test reading is outside of the control range of the installed device, check calibration of the installed device and adjust as required. Retest malfunctioning devices and record results on checklist or data sheet.

    b. Report deficiencies and prepare an issues log entry.

12. Verify that HVAC equipment field quality-control testing has been completed and approved. CxA shall direct, witness, and document field quality-control tests, inspections, and startup specified in individual Division 23 Sections.

B. Testing Instrumentation: Install measuring instruments and logging devices to record test data for the required test period. Instrumentation shall monitor and record full range of operating conditions and shall allow for calculation of total capacity of system for each mode of operation. For individual room cooling tests, provide temporary heaters to impose a cooling load indicated in BoD. Operational modes include the following:

1. Occupied and unoccupied.

2. Warm up and cool down.

3. Economizer cycle.

4. Emergency power supply.

5. Life-safety and safety systems.

6. Smoke control.

7. Fire safety.

3.02 TAB VERIFICATION

A. Prior to performance of testing and balancing work, provide TAB plan at the pre TAB meeting with the Contractor, HVAC Contractor, and CxA.

B. Prior to performance of testing and balancing work, provide copies of sample reports, forms, checklists, and certificates to the CxA.

C. TAB Contractor shall coordinate with CxA for work required in Division 23 Section "Testing, Adjusting, and Balancing for HVAC" TAB Contractor shall copy CxA with required reports, sample forms, checklists, and certificates.

D. The Contractor, HVAC Contractor, and CxA shall witness TAB Work.

E. TAB Preparation:

1. TAB Contractor shall provide CxA with data required for "Pre-Field TAB Engineering Reports" specified in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

    a. CxA shall use this data to certify that prestart and startup activities have been completed for systems, subsystems, and equipment installation.

F. Ductwork Air Leakage Testing:

1. Architect will identify, for HVAC Contractor and CxA, portions of duct systems to have ductwork air leakage testing. Ductwork air leakage testing shall be performed according to Division 23 Section "Metal Ducts," and shall be witnessed by the CxA.

2. On approval of preliminary ductwork air leakage testing report, the CxA shall coordinate verification testing of ductwork air leakage testing. Verification testing shall include random retests of portions of duct section tests, reported in preliminary ductwork air leakage testing report. The HVAC Contractor shall perform tests using the same instrumentation (by model and serial number) as for original testing; the CxA shall witness verification testing.

G. Verification of Final TAB Report:

1. Provide technicians, instrumentation, and tools to verify testing & balancing of HVAC & Plumbing systems at the direction of CxA.

2. CxA shall select 20 percent of report for field verification.

3. CxA shall notify TAB Contractor 10 days in advance of the date of field verification; however, notice shall not include data points to be verified. The TAB Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.

4. Failure of an item is defined as follows:

   a. For all readings other than sound, a deviation of more than 10 percent.
      1) For sound pressure readings, a deviation of 3 dB. (Note: Variations in background noise must be considered.)

5. Failure of more than 10 percent of selected items shall result in rejection of final TAB report.

H. If deficiencies are identified during verification testing, CxA shall notify the HVAC Contractor, Construction Manager and Architect, and shall take action to remedy the deficiency. Architect shall review final tabulated checklists and data sheets to determine if verification is complete and that system is operating according to the Contract Documents.

I. CxA shall certify that TAB Work has been successfully completed.

3.03 TESTING

A. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

B. Perform tests using design conditions whenever possible.

1. Simulate conditions by imposing an artificial load when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

2. Alter set points when simulating conditions is not practical and when directed by CxA.

3. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.

C. Scope of HVAC Contractor Testing:

1. Testing scope shall include entire HVAC installation, from central equipment for heat generation and refrigeration through distribution systems to each conditioned space. It shall include measuring capacities and effectiveness of operational and control functions.

2. Test all operating modes, interlocks, control responses, responses to abnormal or emergency conditions, and verify proper response of building automation system controllers and sensors.

D. Detailed Testing Procedures: CxA, with HVAC Contractor, TAB Contractor, and HVAC Instrumentation and Control Contractor, shall prepare detailed testing plans, procedures, and checklists for HVAC systems, subsystems, and equipment.

E. Heating Water Testing and Acceptance Procedures: Testing requirements are specified in Division 23 boiler Sections. CxA shall review and comment on submittals, test data, and shall compile information for inclusion in systems manual.

F. HVAC Instrumentation and Control System Testing:

1. Field testing plans and testing requirements are specified in Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operation for HVAC Controls" The CxA, HVAC Contractor, and the HVAC Instrumentation and Control Contractor shall collaborate to prepare testing plans.

2. CxA shall convene a meeting of appropriate entities to review test report of HVAC instrumentation and control systems.

G. Pipe cleaning, flushing, hydrostatic tests, and chemical treatment requirements are specified in Division 23 piping Sections. HVAC Contractor shall prepare pipe system cleaning, flushing, and hydrostatic testing. CxA shall review and comment on plan and final reports. CxA shall certify that pipe cleaning, flushing, hydrostatic tests, and chemical treatment have been completed. Plan shall include the following:

1. Sequence of testing and testing procedures for each section of pipe to be tested, identified by pipe zone or sector identification marker. Markers shall be keyed Drawings for each pipe sector showing the physical location of each designated pipe test section. Drawings keyed to pipe zones or sectors shall be formatted to allow each section of piping to be physically located and identified when referred to in pipe system cleaning, flushing, hydrostatic testing, and chemical treatment plan.

2. Description of equipment for flushing operations.

3. Minimum flushing water velocity.

4. Tracking checklist for managing and ensuring that all pipe sections have been cleaned, flushed, hydrostatically tested, and chemically treated.

H. Heat-Generation System Testing: HVAC Contractor shall prepare a testing plan to verify performance of boilers, feedwater equipment, pumps and auxiliary equipment. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.

2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

I. Chilled Water-Generation System Testing: HVAC Contractor shall prepare a testing plan to verify performance of chillers, air cooled condensers, pumps, and auxiliary equipment. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings for each pipe sector showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.

2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

J. HVAC Distribution System Testing: HVAC Contractor shall prepare a testing plan to verify performance of air, and hydronic distribution systems; special exhaust; and other distribution systems. Include HVAC terminal equipment and unitary equipment. Plan shall include the following:

1. Sequence of testing and testing procedures for each item of equipment and section of pipe to be tested, identified by identification marker. Markers shall be keyed to Drawings showing the physical location of each item of equipment and pipe test section. Drawings shall be formatted to allow each item of equipment and section of piping to be physically located and identified when referred to in the system testing plan.

2. Tracking checklist for managing and ensuring that all pipe sections have been tested.

K. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the HVAC system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.

2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented and additional tests scheduled.

END OF SECTION 230800

SECTION 230900 - DIRECT DIGITAL CONTROL (DDC) SYSTEM FOR HVAC

PART 1 GENERAL

1.01 RELATED DOCUMENTS

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

B. Commissioning:

1. An independent third-party Commissioning Agent will document completion of the Mechanical/HVAC Systems for the project. The Division 23 Mechanical/HVAC Contractor is a member of the Commissioning Team and will facilitate completion of the Commissioning process. Refer to section 01 91 13 “General Commissioning Requirements” for the project Commissioning requirements and roles and responsibilities for each member of the Commissioning Team.

1.02 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. Related Sections include the following:

1. Section 23 05 19 “Meters and Gages for HVAC Piping”

2. Section 23 05 00 “Basic Mechanical Requirements”

3. Section 23 05 10 “Basic Mechanical Materials and Methods”

1.03 DESCRIPTION OF WORK

A. The Instrumentation and Control System shall be a digital, distributed microprocessor-based system with a pneumatic and electronic interface, where required. The Control System for this project will be referred to as a Building Automation System (BAS).

B. The Control System Contractor shall provide a complete system using new, existing and relocated control devices to operate as specified and indicated on drawings. The contractor shall inspect the existing conditions prior to submitting a proposal. The existing temperature control system control devices, dampers, operators, wiring, conduit, air piping, valves, etc. not being modified and which are no longer utilized, shall be removed, and not abandoned in place.

1. All temperature control devices to be removed shall be returned to the Owner in good condition.

C. The Control Contractor will be responsible for all; installation, programming, commissioning, testing and performance verification.

D. The Controls Contractor will be responsible for providing all devices required for a complete operating control system.

E. Total quantity and type of control points shall consist of specifications, drawings and as required to complete the sequence of operation as specified. Additional points shall be provided as required to meet all sequence of operation functions, safeties and data base. The drawings and Specifications are not intended to show all details necessary to make the system complete and operable so as to perform all functions and operate according to the specified sequences.

F. The Control Contractor shall be responsible for all phases of software design, all equipment, installation and warranty for the BAS.

G. The Contractor shall leave operable existing controls in operation until the BAS is tested and proven operative. At that point, and with concurrence from the Owner and the Engineer, the Contractor shall be responsible for removing existing controls that are no longer necessary. Start-up of the BAS system, and any installation work that requires the interruption of the normal operation of any piece of equipment, shall be scheduled with the Owner. If the interruption of the normal operation of any piece of equipment during normal working hours is unacceptable to the Owner, then it shall be scheduled during after hours (night or weekend).

H. This installation shall not be used as a test site for any new products unless explicitly approved by the Owner or Architect/Engineer in writing. Unless approved otherwise, all products (including firmware revisions) used in this installation shall have been used in at least twelve (12) projects prior to this installation. The previous sites may be located anywhere in the U.S.A. This requirement is not intended to restrict the Contractor to the use of any outdated equipment. Therefore, all products used in this installation shall also be currently under manufacture and have available, for at least ten years after completion of the contract, a complete line of spare parts. If the above requirements are mutually exclusive, the Contractor shall include a specific statement to this effect in the Bid.

I. Provide electrical work as required, complying with requirements of Division 26 sections including, but not limited to raceways, wires, cables, electrical identification, supporting devices and electrical connections for equipment. Work includes, but is not limited to, the following:

1. Interlock and control wiring between field-installed controls, indicating devices and unit control panels.

2. The Contractor shall be responsible for all additional electrical and other costs involved to accommodate the temperature control system panel, motors and electrical devices requiring power which differs from the power requirements shown on the electrical drawings.

3. Refer to Division 20 sections for mechanical/electrical coordination.

J. Coordinate with other contractors & identify location requirements for all necessary control devices which are provided under this section and may be installed by others. Including, but not limited to, the following:

1. Automatic control valves.

2. Flow switches.

3. Modulating dampers.

4. Required wells for insertion thermostats and/or temperature sensing wells.

5. Pressure Sensors.

1.04 DEFINITIONS

A. DDC: Direct digital control.

B. I/O: Input/output.

C. LonWorks: A control network technology platform for designing and implementing interoperable control devices and networks.

D. MS/TP: Master slave/token passing.

E. PC: Personal computer.

F. PID: Proportional plus integral plus derivative.

G. RTD: Resistance temperature detector.

1.05 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.

1.06 SEQUENCE OF OPERATION

A. Refer to sequences of control on drawings.

1.07 SUBMITTALS

A. Submit in accordance with Division 1, Division 20 and the following submittal requirements.

B. Product Data: Include manufacturer's technical literature for each control device. Indicate:

1. Dimensions.

2. Capacities.

3. Performance characteristics.

4. Electrical characteristics.

5. Finishes for materials.

6. Commissioning, installation and startup instructions.

7. DDC System Hardware: Bill of materials of equipment indicating quantity, manufacturer, and model number. Include technical data for interface equipment, control units, transducers/transmitters, sensors, actuators, valves, relays/switches, control panels, and operator interface equipment.

8. Control System Software: Include technical data for operating system software, operator interface, color graphics, and other third-party applications.

9. Controlled Systems: Instrumentation list with element name, type of device, manufacturer, model number, and product data. Include written description of sequence of operation including schematic diagram.

C. 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.

   a. Label each control device with setpoint or adjustable range of control. Provide a bill of materials with manufacturer's part number.

3. Wiring Diagrams: Power, signal, and control wiring.

   a. Indicate all required point to point electrical wiring. Clearly differentiate between portions of wiring that are existing and portions to be field-installed.

4. Details of control panel faces, including controls, instruments, and labeling.

5. Written description of sequence of operation.

6. Schedule of dampers including size, leakage, and flow characteristics.

7. Schedule of valves including flow characteristics.

8. Schedule of wells and taps.

9. 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 trunk data conductors and wiring between operator workstation and control unit locations.

10. Control System Software: List of color graphics indicating monitored systems, data (connected and calculated) point addresses, output schedule, and operator notations. Provide a detailed listing of all software program code written for each system

11. Controlled Systems:

    a. Schematic diagrams of each controlled system with, control points labeled, controlled equipment 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. Provide a point list with database input information to include a point name, address, base and span, action and other required information

12. Provide a detailed test plan and procedure for each HVAC system and for each type of terminal unit control including valves. The test plans shall fully define reporting methods, procedure, equipment utilized, milestones for the tests, identifying the simulation programs, and personnel. The test procedures shall be developed from the test plans and shall consist of instructions for test execution and evaluation. A test report form shall be developed for each point and sequence of operation. Commissioning procedures shall be provided for each HVAC system and for each type of terminal unit control system. If the control devices do not have auto-tuning, the procedure shall include setpoint, prop. band, integral, derivative, mode constraints input, output settings, tuning procedures., etc.

D. Submit manufacturer's installation instructions.

E. Submittal data and shop drawings shall be prepared and submitted in the following formats:

1. All drawings prepared for the project shall be developed using the AutoCAD CADD program (most current version) or Visio. Any other format must be approved by the Engineer.

2. All submittals data shall be the same size for any group of information and shall be bound - i.e. three screw and post binder or similar. All the information shall be indexed and tabbed with reference to the specific section of these specifications.

3. The format for different groups of submittal information are as follows:

a. Control drawings, building plans (including complete floor plans), schematics and system configurations shall be CADD prepared drawing, bound and indexed. Drawings that cannot represent the total information on an individual ANSI size B (11" x 17") drawing, i.e. a building plan, shall be noted with appropriate match lines, cross references and key plans.

b. Technical data, sequence of operations, material list, point lists, program listings, I/O schedules, operator's and programmer's manuals, etc. shall be type written, original product data sheets or CADD prepared drawings, ANSI size A or ANSI size B.

4. Upon completion of the project and acceptance of systems the contractor shall provide to the Owner one set of hard copy as-built shop drawings and diskettes.

F. Shop drawings shall include riser diagram depicting locations of all controllers and workstations, with associated network wiring. Also included shall be individual schematics of each mechanical system showing all connected points with reference to their associated controller. Typicals will be allowed where appropriate.

G. When the Architect/Engineer requires, the Contractor will resubmit with the corrected or additional submittal data. This procedure shall be repeated until all corrections are made to the satisfaction of the Engineer and the submittals are fully reviewed.

H. Contractor agrees that shop drawing submittals processed by the Architect/Engineer are not change orders, that the purpose of shop drawing submittals by the Contractor is to demonstrate to the Architect/Engineer that the Contractor understands the design concept, that he demonstrates his understanding by indicating which equipment and material he intends to furnish and install, and by detailing the fabrication and installation methods he intends to use.

I. Contractor further agrees that if deviations, discrepancies, or conflicts between shop drawing submittals and the contract documents in the form of design drawings and specifications are discovered either prior to or after shop drawing submittals are processed by the Architect/Engineer, the design drawings and specifications shall control and shall be followed. If alternates do not meet these requirements, it shall be this Contractor's responsibility to remove them and install material originally specified, at no cost to the Owner.

J. Samples for Verification: For each color required, of each type of thermostat or sensor cover.

1.08 INFORMATIONAL SUBMITTALS

A. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with ASHRAE 135.

B. Data Communications Protocol Certificates: Certify that each proposed DDC system component complies with LonWorks.

C. Qualification Data: For Installer and manufacturer.

D. Software Upgrade Kit: For Owner to use in modifying software to suit future systems revisions or monitoring and control revisions.

E. Field quality-control test reports.

1.09 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For HVAC instrumentation and control system to include in emergency, operation, and maintenance manuals. In addition to items specified in Section 017823 "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.

B. 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.

1.10 MAINTENANCE MATERIAL SUBMITTALS

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. Replacement Materials: One replacement diaphragm or relay mechanism for each unique valve motor, controller, thermostat and positioning relay.

2. Maintenance Materials: One thermostat adjusting key(s).

3. Maintenance Materials: One pneumatic thermostat test kit.

1.11 QUALITY ASSURANCE

A. Only those manufacturers specified are allowed to bid temperature controls. All bidders shall make available, upon the Owner's request, open book unit pricing of all materials and labor.

B. Bidders must have installed and completed at least two (2) direct digital temperature control jobs of similar design, size and scope using the same equipment as specified.

C. Bidders must have a local office in the area of the project site.

D. Bidders must have capabilities of doing component level repairs on all systems, including electronic systems.

E. Installer Qualifications: Automatic control system manufacturer's authorized representative, who is trained, approved and regularly employed by the Temperature Control Contractor for installation of system components required for this project. Firms regularly engaged in installation and commissioning and servicing of digital control equipment, of types and sizes required, whose firm has been in business in similar service for not less than 5 years.

F. No Field Devices shall be multiplexed to a single I/O point unless specified. Each control or sensing point shall be terminated at a unique location on the BAS panel, Slave or Dedicated Controller and be associated with a unique software point on the BAS.

G. 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.

H. Comply with ASHRAE 135 for DDC system components.

I. Codes and Standards:

1. All equipment and the installation shall comply with the requirements of all applicable local and national codes including but not limited to the currently enforced edition of the International Building Code, International Fire Code, and all applicable codes of the National Fire Protection Association including the National Electrical Code.

2. Electrical Standards: Provide electrical products, which have been tested, listed and labeled by UL and comply with NEMA standards.

3. NEMA Compliance: Comply with NEMA standards pertaining to components and devices for electric control systems.

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

J. All bidders must have a minimum of one person dedicated to software generation. This person shall be located in an office local to the project site.

K. The equipment and software proposed by the supplier shall be currently in manufacture. No custom products shall be allowed unless required by the Specification. All products shall be supported by the manufacturer for a minimum of 5 years including spare parts, board repairs and software revisions.

L. The Temperature Control Contractor shall cooperate with other contractors performing work on this project necessary to achieve a complete and neat installation. To that end, each contractor shall consult the drawings and specifications for all trades to determine the nature and extent of others work.

M. It will be the responsibility of this Contractor to work in cooperation with the Owner and with all other contractors and employees rendering such assistance and so arrange his work such that the entire project will be delivered complete in the best possible condition and in the shortest time.

1.12 PROPRIETARY INFORMATION:

A. Project Documentation: All custom software, programs, code, databases, graphic files and drawings (whether hard copy or CADD based files) prepared for this system shall be the exclusive property of the Owner and shall not be reproduced or distributed without prior written permission from the Owner.

B. The use or reference to Owner any of its subsidiaries or any of the facility automation projects shall not be used by the Manufacturer or Contractor in any promotional media, including advertisements, sale brochures, annual reports and client references or endorsements, without prior written permission from the Owner. The Owner reserves the right to restrict or refuse access to any or all of its facilities.

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

C. System Software: Update to latest version of software at Project completion.

1.14 COORDINATION

A. The controls contractor is responsible for costs/effort required to support the recalibration and rebalancing of existing air terminal boxes to new min/max airflows by the Test and Balance (TAB) contractor.

B. Coordinate location of thermostats, humidistats, and other exposed control sensors with plans and room details before installation.

C. Coordinate supply of conditioned electrical branch circuits for control units and operator workstation.

D. Coordinate equipment with Section 23 33 00 Air Duct Accessories to achieve monitoring capability of the fire/smoke dampers.

PART 2 PRODUCTS

2.01 CONTROL SYSTEM

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:

1. Johnson Controls, Inc.; Controls Group.

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, accessories, and software connected to distributed controllers operating in multiuser, multitasking environment on token-passing network and programmed to control mechanical systems. An operator workstation permits interface with the network via dynamic color graphics with each mechanical system, building floor plan, and control device depicted by point-and-click graphics.

2.02 GENERAL PRODUCTS DESCRIPTION:

A. The Building Automation System (BAS) shall be capable of integrating multiple building function including equipment supervision and control, alarm management, energy management, and historical data collection and archiving. All products and materials installed shall be suitable for the intended application requirements including but not limited to:

1. Accuracy
2. Rangeability
3. Temperature and pressure ranges
4. Shut-off pressures
5. Differential pressures
6. Repeatability
7. Materials of construction suitable with the environment and/or media in which they are in contact with
8. Code compliance
9. Velocities.

B. The BAS shall consist of the following:

1. Standalone DDC panels
2. Standalone application specific controllers (ASCs)
3. High Speed Communication Network (LAN) by Owner.

C. The system shall be modular in nature, and shall permit expansion of both capacity and functionality through the addition of sensors, actuators, standalone DDC panels, and operator devices.

D. System architectural design shall eliminate dependence upon any single device for alarm reporting and control execution. Each DDC panel shall operate independently by performing its own specified control, alarm management, operator I/O, and historical data collection. The failure of any single component or network connection shall not interrupt the execution of control strategies at other operational devices.

E. Standalone DDC panels shall be able to access any data from, or send control commands and alarm reports directly to, any other DDC panel or combination of panels on the network without dependence upon a central processing device. Standalone DDC panels shall also be able to send alarm reports to multiple operator workstations without dependence upon a central processing device.

F. Shared points will not be allowed except for outside air temperature, outside air pressure, outside air relative humidity and inside building pressure.

G. BAS shall allow third party software to operate on personal computer workstation without any degradation to the controls operating normally. Third party software will not be allowed on the ADX server/main building server.

2.03 NETWORKING/COMMUNICATIONS:

A. The expansion of the BAS shall utilize networking/communications compatible with BAS infrastructure.

B. Local Area Network

1. Workstation/DDC Panel Support: Operator workstations and DDC panels shall directly reside on a local area network such that communications may be executed between controllers, directly between workstations, and between controllers and workstations on a peer-to-peer basis.

2. Dynamic Data Access: All operator devices, either network resident or connected via dial-up modems, shall have the ability to access all point status and application report data, or execute control functions for any and all other devices via the local area network. Access to data shall be based upon logical identification of building equipment.

a. Access to system data shall not be restricted by the hardware configuration of the BAS. The hardware configuration of the BAS network shall be totally transparent to the user when accessing data or developing control programs.

3. General Network Design: Network design shall include the following provisions:

a. High speed data transfer rates for alarm reporting, quick report generation from multiple controllers and upload/download efficiency between network devices. The minimum baud rate shall be 1 Megabaud.

b. Support of any combination of controllers and operator workstations directly connected to the local area network. A minimum of 50 devices shall be supported on a single local area network.

c. Detection and accommodation of single or multiple failures of either workstations, DDC panels, or the network media. The network shall include provisions for automatically reconfiguring itself to allow all operational equipment to perform their designated functions as effectively as possible in the event of single or multiple failures.

d. Message and alarm buffering to prevent information from being lost.

e. Error detection, correction, and retransmission to guarantee data integrity.

f. Default device definition to prevent loss of alarms or data, and ensure alarms are reported as quickly as possible in the event an operator device does not respond.

g. Commonly available, multiple sourced, networking components and protocols shall be used to allow the BAS to coexist with other networking applications such as office automation. BACNET, MAP, ETHERNET, IBM Token Ring and ARCNET are acceptable technologies.

h. Use of industry standard IEEE 802.x protocol. Communications must be of a deterministic nature to assure calculable performance under worst-case network loading.

i. Synchronization of the realtime clocks in all DDC panels shall be provided.

2.04 STANDALONE DDC PANELS:

A. General: Standalone DDC panels shall be microprocessor based, multi-tasking, multi-user, real-time digital control processors. Each standalone DDC panel shall consist of modular hardware with plug-in enclosed processors, communication controllers, power supplies, and input/output modules. A sufficient number of controllers shall be supplied to fully meet the requirements of this specification and the attached point list.

B. Memory: Each DDC panel shall have sufficient memory to support its own operating system and databases including:

1. Control Processes

2. Energy Management Applications

3. Alarm Management

4. Historical/Trend Data for all points

5. Maintenance Support Applications

6. Custom Processes

7. Operator I/O

8. Dial-Up Communications

9. Manual Override Monitoring

C. Point Types: Each DDC panel shall support the following types of point inputs and outputs:

1. Digital Inputs for status/alarm contacts

2. Digital Outputs for on/off equipment control

3. Analog Inputs for temperature, pressure, humidity, flow and position measurements

4. Analog Outputs for valve and damper position control, and capacity control of primary equipment

5. Pulse inputs for pulsed contact monitoring

D. Expandability:

1. The system shall be modular in nature, and shall permit easy expansion through the addition of software applications, workstation hardware, field controllers, sensors and actuators.

2. The system architecture shall support a minimum capacity of 20% for all types of DDC panels, and all point types included in the initial installation.

E. Wireless Bluetooth Technology: Standalone DDC panels shall have wireless Bluetooth technology for simultaneous operation of multiple operator I/O devices such as industry standard printers, laptop workstations, etc.

F. Hardware Override Monitoring: DDC panels shall monitor the status or position of all overrides, and include this information in logs and summaries to inform the operator that automatic control has been inhibited. DDC panels shall also collect override activity information for daily and monthly reports.

G. Local Status Display Indicator Lamps: The DDC panel shall provide local status indication for each binary input and output for constant, up-to-date verification of all point conditions without the need for an operator I/O device.

H. Integrated On-Line Diagnostics: Each DDC panel shall continuously perform self-diagnostics, communication diagnosis, and diagnosis of all subsidiary equipment. The DDC panel shall provide both local and remote annunciation of any detected component failures, or repeated failure to establish communication. Indication of the diagnostic results shall be provided at each DDC panel, and shall not require the connection of an operator I/O device.

I. Surge and Transient Protection: Isolation shall be provided at all network terminations, as well as all field point terminations to suppress induced voltage transients consistent with the latest IEEE Standard 587.

1. Provide ISLATROL active tracking filters or equal, which provides both high and low voltage transients, non-linear characteristics, capable of instantaneously responding to spikes or transients without degradation to the filter or its performance. Power protection device shall be UL listed and have reliability in excess of 100,000 hours of mean time between failures.

2. Signal wiring shall not be installed in same conduit as high voltage wiring.

J. Power Fail Restart:

1. In the event of the loss of power, there shall be an orderly shutdown of all standalone DDC panels to prevent the loss of database or operating system software. Non-volatile memory shall be incorporated for all critical controller configuration data, and battery back-up shall be provided to support the real-time clock and all volatile memory for a minimum of 72 hours.

2. Upon restoration of power, the DDC panel shall automatically resume full operation without manual intervention.

3. Should DDC panel memory be lost for any reason, the user shall have the capability of reloading the DDC panel via the local area network or via the local RS-232C port.

2.05 SYSTEM SOFTWARE FEATURES:

A. General

1. All necessary software to form a complete operating system as described in this specification shall be provided.

2. The software programs specified in this section shall be provided as an integral part of the DDC panel and shall not be dependent upon any higher level computer for execution.

B. Control Software Description

1. Pre-Tested Control Algorithms: The DDC panels shall have the ability to perform the following pre-tested control algorithms.

a. Two Position Control

b. Proportional Control

c. Proportional plus Integral Control

d. Proportional, Integral, plus Derivative Control

e. Automatic Control Loop Tuning

2. Equipment Cycling Protection; Control software shall include a provision for limiting the number of times each piece of equipment may be cycled within any one-hour period.

3. Heavy Equipment Delays: The system shall provide protection against excessive demand situations during start-up periods by automatically introducing time delays between successive start commands to heavy electrical loads.

4. Power Fail Motor Restart: Upon the resumption of normal power, the DDC panel shall analyze the status of all controlled equipment, compare it with normal occupancy scheduling, and turn equipment on or off as necessary to resume normal operation.

C. Energy Management Applications: DDC panels shall have the ability to perform any or all of the following energy management routines.

1. Time of Day Scheduling

2. Calendar Based Scheduling

3. Holiday Scheduling

4. Temporary Schedule Overrides

5. Optimal Start

6. Optimal Stop

7. Night Setback Control

8. Enthalpy Switchover (Economizer)

9. Peak Demand Limiting

10. Temperature Compensated Load Rolling

11. Fan Speed/CFM Control

12. Heating/Cooling Interlock

13. Cold Deck Reset

14. Hot Deck Reset

15. Hot Water Reset

16. Chilled Water Reset

17. Condenser Water Reset

18. Chiller Sequencing

D. All programs shall be executed automatically without the need for operator intervention, and shall be flexible enough to allow user customization. Programs shall be applied to building equipment as described in the Execution portion of this specification.

E. Custom Process Programming Capability: DDC panels shall be able to execute custom, job-specific processes defined by the user, to automatically perform calculations and special control routines.

1. Process Inputs and Variables: It shall be possible to use any of the following in a custom process:

a. Any system-measured point data or status

b. Any calculated data

c. Any results from other processes

d. User-Defined Constants

e. Arithmetic functions (+, -, *, /, square root, exp, etc.)

f. Boolean logic operators (and, or, exclusive or, etc.)

g. On-delay/Off-delay/One-shot timers.

2. Process Triggers: Custom processes may be triggered based on any combination of the following:

a. Time interval

b. Time of day

c. Date other processes

d. Time programming

e. Events (e.g., point alarms)

3. Dynamic Data Access:

a. single process shall be able to incorporate measured or calculated data from any and all other DDC panels on the local area network.

b. In addition, a single process shall be able to issue commands to points in any and all other DDC panels on the local area network.

4. Advisory/Message Generation: Processes shall be able to generate operator messages and advisories to operator I/O devices. A process shall be able to directly send a message to a specified device, buffer the information in a follow-up file, or cause the execution of a dial-up connection to a remote device such as a printer or pager.

5. Custom Process Documentation: The custom control programming feature shall beself-documenting. All interrelationships defined by this feature shall be documented via graphical flowcharts and English language descriptors.

F. Alarm Management: Alarm management shall be provided to monitor, buffer, and direct alarm reports to operator devices and memory files. These alarms shall be added in a manner to match the existing alarm management system. Each DDC panel shall perform distributed, independent alarm analysis and filtering to minimize operator interruptions due to non-critical alarms, minimize network traffic, and prevent alarms from being lost. At no time shall the DDC panel's ability to report alarms be affected by either operator activity at a PC Workstation or local I/O device, or communications with other panels on the network.

1. Point Change Report Description: All alarm or point change reports shall include the point's English language description, and the time and date of occurrence.

2. Prioritization: The user shall be able to define the specific system reaction for each point. Alarms shall be prioritized to minimize nuisance reporting and to speed operator response to critical alarms. A minimum of three priority levels shall be provided. Each DDC panel shall automatically inhibit the reporting of selected alarms during system shutdown and start-up. Users shall have the ability to manually inhibit alarm reporting for each point.

3. The user shall also be able to define under which conditions point changes need to be acknowledged by an operator, and/or sent to follow-up files for retrieval and analysis at a later date.

4. Report Routing: Alarm reports, messages, and files will be directed to a user-defined list of operator devices, or PCs used for archiving alarm information. Alarms shall also be automatically directed to a default device in the event a primary device is found to be off-line.

5. Alarm Messages: In addition to the point's descriptor and the time and date, the user shall be able to print, display or store a 65-character alarm message to more fully describe the alarm condition or direct operator response.

6. Each standalone DDC panel shall be capable of storing a library of a least 250 Alarm

7. Messages. Each message may be assignable to any number of points in the panel.

8. Auto-Dial Alarm Management: In Dial-up applications, only critical alarms shall initiate a call to a remote operator device. In all other cases, call activity shall be minimized by time-stamping and saving reports until an operator scheduled time, a manual request, or until the buffer space is full. The alarm buffer must store a minimum of 50 alarms.

G. Historical Data and Trend Analysis: A variety of Historical Data collection utilities shall be provided to automatically sample, store, and display system data in all of the following ways.

1. Continuous Point Histories: Standalone DDC panels shall store Point History Files for all analog and binary inputs and outputs.

2. The Point History routine shall continuously and automatically sample the value of all analog inputs at half hour intervals. Samples for all points shall be store for the past 24 hours to allow the user to immediately analyze equipment performance and all problem related events for the past day. Point History files for binary input or output points and analog output points shall include a continuous record of the last ten status changes or commands for each point.

3. Control Loop Performance Trends: Standalone DDC panels shall also provide high resolution sampling capability with an operator-adjustable resolution of 10-300 seconds in one second increments for verification of control loop performance.

4. Extended Sample Period Trends: Measured and calculated analog and binary data shall also be assignable to user-definable trends for the purpose of collecting operator-specified performance data over extended periods of time. Sample intervals of one minute to two hours, in one-minute intervals, shall be provided. Each standalone DDC panel shall have a dedicated buffer for trend data, and shall be capable of storing a minimum of 500 data samples.

5. Data Storage and Archiving: Trend data shall be stored at the Standalone DDC panels, and uploaded to hard disk storage when archival is desired. Uploads shall occur based upon either user-defined interval, manual command, or when the trend buffers become full. All trend data shall be available in disk file form for use in 3rd Party person computer applications.

H. Runtime Totalization: Standalone DDC panels shall automatically accumulate and store runtime hours for binary input and output points as specified in the Execution portion of this specification.

1. The Totalization routine shall have a sampling resolution of one minute or less.

2. The user shall have the ability to define a warning limit for Runtime Totalization.

3. Unique, user-specified messages shall be generated when the limit is reached.

I. Analog/Pulse Totalization: Standalone DDC panels shall automatically sample, calculate, and store consumption totals on a daily, weekly, or monthly basis for user-selected analog and binary pulse input-type points.

1. Totalization shall provide calculation and storage of accumulations of up to 99,999.9 units (e.g. KWH, gallons, KBTU, tons, etc.).

2. The Totalization routine shall have a sampling resolution of one minute or less.

3. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

J. Event Totalization: Standalone DDC panels shall have the ability to count events such as the number of times a pump or fan system is cycled on and off. Event totalization shall be performed on a daily, weekly, or monthly basis.

1. The Event Totalization feature shall be able to store the records associated with a minimum of 9,999,999 events before reset.

2. The user shall have the ability to define a warning limit. Unique, user-specified messages shall be generated when the limit is reached.

2.06 INTEGRATION FOR BUILDING SYSTEMS:

A. The project will include a fully integrated direct digital building automation and control system (BAS). BAS system installation and all BAS integration will be performed by a single capable contractor. All control components and all integrated and interfaced building systems exchanging data with the BAS as detailed below in the interoperability section will be monitored via a common Graphical User Interface. The Graphical User Interface will be web- based, enabling building operators to securely retrieve and acknowledge alarms and perform full featured operation, programming and monitoring functions via a common web browser from any computer accessing the facility-wide Ethernet TCP/IP LAN/WAN. The BAS will support accessibility both locally via a direct physical connection to the facility-wide LAN/WAN and remotely via a secure Internet or Virtual Private Network (VPN) connection to the facility- wide LAN/WAN. The full operational capabilities of the user interface will be identical for each workstation or laptop accessing the BAS regardless of the computer's physical location ordata connection method. The interface will have full command and control capabilities over all DDC control equipment as well as the integrated/interfaced building systems comprising the complete BAS architecture.

B. Interoperability

1. A significant amount of interoperability between building systems will be provided. Throughout the BAS, data transmission and exchange will be accomplished via IT and BAS industry standard open communication protocols. To accommodate flexibility and future expandability, the BAS will intrinsically support, without the addition of any supplemental hardware or software, the BACnet and LonTalk® industry standard open communication protocols. The scope of building systems incorporated and their level of interoperability are as follows:

a. Integrated building systems shall connect to the BAS providing coordinated bi-directional control via real-time data exchange using a common communications protocol. Integration shall extend to the operator’s workstation software, which shall support user interaction with all building system components. The following building systems shall be fully integrated and all points available through each system’s microprocessor panel shall be monitored:
   1) Lenel Security Systems (Security & Parking Access)
   2) Elevator Systems
   3) Johnson Controls (Building Automation)
   4) Fireworks Systems (Fire Monitoring Systems)
   5) Translogic Pneumatic Tube System
   6) Leviton Lighting Control System
   7) Oracle Maintenance Management System
   8) Powerex (Medical Vacuum)

2.07 APPLICATION OF SPECIFIC CONTROLLERS - HVAC APPLICATIONS:

A. Each Standalone DDC Controller shall be able to extend its performance and capacity through the use of remote Application Specific Controllers (ASCs).

B. Each ASC shall operate as a Standalone controller capable of performing its specified control responsibilities independently of other controllers in the network. Each ASC shall be a microprocessor-based, multi-tasking, real-time digital control processor. Points shall not be shared between controllers.

C. Each ASC shall have sufficient memory to support its own operating system and data base including:

1. Control Processes

2. Energy Management Applications

3. Operator I/O (Portable Service Terminal)

D. The operator interface to any ASC point data or programs shall be through any network-resident PC workstation, or any PC or portable operator's terminal connected to any DDC panel in the network.

E. Application Specific Controllers shall directly support the temporary use of a portable service terminal. The capabilities of the portable service terminal shall include, but not be limited to, the following:

1. Display temperatures

2. Display status

3. Display setpoints

4. Display control parameters

5. Override binary output control

6. Override analog setpoints

7. Modification of gain and offset constants

F. Power Fail Protection: All system setpoints, proportional bands, control algorithms, and any other programmable parameters shall be stored such that a power failure of any duration does not necessitate reprogramming the controller.

2.08 AHU CONTROLLERS:

A. AHU Controllers shall support, but not be limited to, the following configurations of systems to address current requirements as described in the Execution portion of this specification, and for future expansion.

1. Large Air Handling Units

a. Mixed Air-Single Path

b. Mixed Air-Dual Path

c. 100% Single Path

d. 100% Dual Path

B. AHU Controllers shall support all the necessary point inputs and outputs to perform the specified control sequences in a totally standalone fashion.

C. AHU Controllers shall have a library of control routines and program logic to perform the sequence operation as specified in the Execution portion of this specification.

D. Occupancy-Based Standby/Comfort Mode Control: Each AHU Controller shall have a provision for occupancy sensing overrides. Based upon the contract status of either a manual wall switch or an occupancy sensing device, the AHU Controller shall automatically select either Standby or Comfort mode to minimize the heating and cooling requirements while satisfying comfort conditions.

E. Continuous Zone Temperature Histories: Each AHU Controller shall automatically and continuously maintain a history of the associated zone temperature to allow users to quickly analyze space comfort and equipment performance for the past 24 hours. A minimum of two samples per hour shall be stored.

F. Alarm Management: Each AHU Controller shall perform its own limit and status monitoring and analysis to maximize network performance by reducing unnecessary communications.

2.09 OPERATOR INTERFACE:

A. General: The intent is for any new operator interface to match existing.

B. Basic Interface Description:

1. Command Entry/Menu Selection Process: Operator Workstation interface softwareshall minimize operator training through the use of English language prompting, English language point identification, and industry standard PC application software.

2. The operator interface shall minimize the use of a typewriter style keyboard through the use of a mouse or similar pointing device, and "point and click" approach to menu selection. Users shall be able to start and stop equipment or change setpoints from graphical displays through the use of a mouse or similar pointing device.

3. Graphical and Text-Based Displays: At the option of the user, Operator Workstations shall provide consistent graphical or text-based displays of all system point and applications data described in this specification. Point identification, engineering units, status indication, and application naming conventions shall be the same at all workstations.

4. Multiple, Concurrent Displays: The Operator Interface shall provide the ability to simultaneously view several different types of system displays in overlapping windows to speed building analysis. For example, the interface shall provide the ability to simultaneously display a graphic depicting an air handling unit, while displaying the trend graph of several associated space temperatures to allow the user to analyze the system performance. If the interface is unable to display several different types of displays at the same time, the BAS Contractor shall provide at least two operator stations.

5. Password Protection: Multiple-level password access protection shall be provided to allow the user/manager to limit workstation control, display, and data base manipulation capabilities as deemed appropriate for each user, based upon an assigned password.

a. Passwords shall be exactly the same for all operator devices, including portable or panel-mounted network terminals. Any additions or changes made to password definition shall automatically cause passwords at all DDC panels on a network to be updated and downloaded to minimize the task of maintaining system security. Users shall not be required to update passwords for DDC panels individually.

b. A minimum of five levels of access shall be supported:
   1) Level 1 = Data Access and Display
   2) Level 2 = Level 1 + Operator Overrides
   3) Level 3 = level 2 + Database Modification
   4) Level 4 = Level 3 + Database Generation
   5) Level 5 = Level 4 + Password Add/Modification

c. A minimum of 50 passwords shall be supported at each DDC panel.

d. Operators will be able to perform only those commands available for their respective passwords. Menu selections displayed at any operator device, including portable or panel mounted devices, and shall be limited to only those items defined for the access level of the password used to log-on.

e. User-definable, automatic log-off timers from 1 to 60 minutes shall be provided to prevent operators from inadvertently leaving devices on-line.

6. Operator Commands: The operator interface shall allow the operator to perform commands including, but not limited to, the following:

   a. Start-up or shutdown selected equipment

   b. Adjust setpoints

   c. Add/Modify/Delete time programming

   d. Enable/Disable process execution

   e. Lock/Unlock alarm reporting for each point

   f. Enable/Disable Totalization for each point

   g. Enable/Disable Trending for each point

   h. Override PID loop setpoints

   i. Enter temporary override schedules

   j. Define Holiday Schedules

   k. Change time/date

   l. Enter/Modify analog alarm limits

   m. Enter/Modify analog warning limits

   n. View limits

   o. Enable/Disable demand limiting for each meter

   p. Enable/Disable duty cycle for each load.

7. Logs and Summaries:

   a. Summaries shall be provided for specific points, for a logical point group, for a user-selected group of groups, or for the entire facility without restriction due to the hardware configuration of the facility management system. Under no conditions shall the operator need to specify the address of hardware controller to obtain system information.

   b. Reports shall be generated automatically or manually, and directed to either CRT displays, printers, or disk files. As a minimum, the system shall allow the user to easily obtain the following types of reports:
      1) A general listing of all points in the network
      2) List of all points currently in alarm
      3) List of all off-line points
      4) List all points currently in override status
      5) List of all disabled points
      6) List all points currently locked out
      7) List of all items defined in "Follow-Up" file
      8) List all weekly Schedules
      9) List all Holiday Programming
      10) List of limits and deadbands

C. Dynamic Color Graphic Displays: Color graphic floor plan displays, and system schematics for each piece of mechanical equipment, including air handling units, chilled water systems, and hot water boiler systems, shall be provided as specified in the Execution portion of this specification to optimize system performance analysis and speed alarm recognition.

1. System Selection/Penetration: The operator interface shall allow users to access the various system schematics and floor plans via a graphical penetration scheme, menu selection, or text-based commands.

2. Dynamic Data Displays: Dynamic temperature values, humidity values, flow values, and status indication shall be shown in their actual respective locations, and shall automatically update to represent current conditions without operator intervention.

3. Windowing: The windowing environment of the PC Operator Workstation shall allow the user to simultaneously view several graphics at the same time to analyze total building operation, or to allow the display of a graphic associated with an alarm to be viewed without interrupting work in progress.

4. Graphics Definition Package: Graphic generation software shall be provided to allow the user to add, modify, or delete system graphic displays.

   a. The BAS Contractor shall provide libraries of pre-engineered screens and symbols depicting standard air handling unit components (i.e. fans, cooling coils, filters, dampers, etc.), complete mechanical systems (i.e. constant volume- terminal reheat, VAV, etc.) and electrical symbols.

   b. The graphic development package shall use a mouse or similar pointing devicein conjunction with a drawings program to allow the user to perform the following:
      1) Define symbols
      2) Position and size symbols
      3) Define background screens
      4) Define connecting lines and curves
      5) Locate, orient, and size descriptive text
      6) Define and display colors for all elements
      7) Establish correlation between symbols or text and associated system points or other displays.

c. Graphical displays can be created to represent any logical grouping of system points or calculated data based upon building function, mechanical system, building layout, or any other logical grouping of points which aid the operator in the analysis of the facility.
   1) To accomplish this, the user shall be able to build graphic displays that include point data from multiple DDC panels, including application specific controllers used for DDC unitary or VAV terminal unit control.

D. System Configuration and Definition: All temperature and equipment control strategies and energy management routines shall be definable by the Operator. System definition and modification procedures shall not interface with normal system operation and control.

1. The system shall be provided complete with all equipment and documentation necessary to allow an operator to independently perform the following functions:

   a. Add/Delete/Modify Standalone DDC Panels

   b. Add/Delete/Modify Operator Workstations

   c. Add/Delete/Modify Application Specific Controllers

   d. Add/Delete/Modify points of any type, and all associated point parameters, and tuning constants

   e. Add/Delete/Modify alarm reporting definition for each point.

   f. Add/Delete/Modify control loops

   g. Add/Delete/Modify energy management applications

   h. Add/Delete/Modify time and calendar-based programming

   i. Add/Delete/Modify Totalization for every point

   j. Add/Delete/Modify Historical Data Trending for every point

   k. Add/Delete/Modify custom control processes

   l. Add/Delete/Modify any and all graphic displays, symbols, and cross-references to point data

   m. Add/Delete/Modify dial-up telecommunication definition

   n. Add/Delete/Modify all operator passwords

   o. Add/Delete/Modify Alarm Messages

2. Programming Description: Definition of operator device characteristics, DDC panels, individual points, applications and control sequences shall be performed through fill-in-the-blank templates and graphical programming approach.

   a. Graphical programming shall allow the user to define the software configuration of DDC control logic for HVAC system control sequences, fan interlocks, pump interlocks, PID control loops, and other control relationships through the creation of graphical logic flow diagrams.

b. Graphical Programming: Control sequences are created by using a mouse input device to draw interconnecting (comparisons and mathematical calculations), and outputs of a control sequence. As a minimum, graphic symbols shall be used to represent:
   1) Process Inputs, such as temperature, humidity, or pressure values, status, time, date, or any other measured or calculated system data.
   2) Mathematical Process Operators, such as addition, subtraction, multiplication, or greater than, equal to, less than, etc.
   3) Logical Process Operators such as AND, OR, Exclusive OR, NOT, etc.
   4) Time Delays
   5) Process Control Outputs such as start/stop control points, analog adjust points, etc.
   6) Process Calculation Outputs
   7) Text file Outputs and Advisories

c. Network-Wide Strategy Development: Inputs and outputs for any process shall not be restricted to a single DDC panel, but shall be able to allow the development of all other DDC panels to allow the development of network-wide control strategies. Processes shall also allow the operator to use the results of one process as the input to any number of other processes (cascading).

d. Sequencing, Testing, and Simulation: A software tool shall be provided, which allows a user to simulate control sequence execution to test strategies before they are actually applied to mechanical systems. Users shall be able to enter hypothetical input data, and verify desired control response and calculation results via graphical displays and hardcopy printouts.

3. System Definition/Control Sequence Documentation: All portions of system definition shall be self-documenting to provide hardcopy printouts of all configuration and application data. Control process and DDC control loop documentation shall be provided in logical, graphical flow diagram format to allow control sequences to be easily interpreted and modified at any time in the future.

4. Database Save/Restore/Back-Up: Back-up copies of all standalone DDC panel databases shall be stored in at least one personal computer operator workstation.

5. Continuous supervision of the integrity of all DDC panel databases shall be provided. In the event that any DDC panel on the network experiences a loss of its data base for any reason, the system shall automatically download a new copy of the respective database to restore proper operation. Database back-up/Download shall occur over the local area network without operator intervention. Users shall also have the ability to manually execute downloads of any or all portions of a DDC panel's database.

2.10 MATERIALS AND EQUIPMENT:

A. General: The Contractor shall provide control products in the sizes and capacities indicated.

B. The existing control system shall remain and be reused as is. Additional controllers, sensors, and devices which are required to make a complete control system shall be the responsibility of the controls contractor.

C. Dampers:

1. Shall be constructed of a minimum of 13 gauge galvanized steel frame, 1/16" extruded aluminum air foil blades, zinc plated steel concealed in frame linkage, zinc plated steel blade pin, oil impregnated bronze bearings, self compensating stainless steel side seals, neoprene blade seals. Leakage rates shall not exceed 7 cfm/ft2 at 4" w.c. static pressure differential for a 24" x 24" damper. Provide extended shaft for proper and adequate actuator connection and operation. Damper blades shall not exceed 6" in height.

2. Damper blade operation shall be as follows:

APPLICATION	OPERATION
Modulating Air Volume Control	Opposed Blade
Mixing Plenum	Parallel Blade
Isolation/Shut-off Service	Parallel Blade

3. Select dampers to fail in normally open or closed positions as follows:

   a. Air Handlers:
      1) Return Air: N.O.
      2) Exhaust Air: N.C.
      3) Minimum Outside Air: N.O.
      4) Outside Air (Economizer): N.C.

   b. VAV's: Last position

   c. Relief Dampers: Last position

D. Automatic Control Valves:

1. Control valves shall have equal percentage plugs. Ball valves may use characterization disks.

2. Control Valve Construction:

   a. Small Valves 1/2" through 1": Valves shall be constructed with a cast brass body and screwed ends. Trim shall consist of a removable cage providing valve plug guiding throughout the entire travel range. An alloy stem with brass trim shall be provided. Bonnet, cage and the stem and plug assembly shall be removable for servicing. Body rating shall be 400 psi at 150 deg. F.

   b. Valves - 1/2" through 2": Valves shall be constructed with a cast brass body and screwed ends. For some applications where reviewed with the engineer, valves may be selected by the control manufacturer to have either bronze or cast iron bodies with screwed or flanged ends.

   c. Valves - 2 - 1/2" and above: Valves shall be constructed with a cast iron body and have flanged connections.

   d. For motorized plug, butterfly and ball valves, the operator shall be provided with the valve by the valve manufacturer. See Section 23 05 23.

   e. Steam control valves shall be suitable for superheat conditions where superheat may occur in operating system conditions.

3. Control Valve Operators/Actuators:

a. All automatic control valves shall be fully proportioning with modulating plugs for equal percentage of linear flow characteristics and shall be provided with actuators of sufficient power for the duty intended. Valve body and actuator election shall be sufficient to handle system pressure which will be encountered on the project.

b. Where required by the sequence of operation, valves shall be capable of being sequenced either with other valves or other pneumatically actuate devices. Where such sequencing is required the actual spring range, when adjusted for spring shift, shall be such that no overlapping occurs. In the event that spring shift can cause an overlap, a pilot positioning operator shall be furnished.

c. Actuator shall be spring return type.

4. Temperature control contractor and manufacturer shall size control valves for proper control characteristics for each application.

5. Water control valves shall be sized for a pressure drop between 4 to 6 psig at full flow condition.

6. Steam control valves shall be sized as follows:

a. For line pressures 15 psig and less: The pressure drop across the valve shall be 80% of the inlet gauge pressure at full flow condition.

b. For line pressures greater than 15 psig: The pressure drop across the valve shall be equal to the critical pressure drop which is 45% of the absolute inlet pressure.

7. Select valves to fail in normally open or closed position as follows:

a. Steam Convertors:
1) Hospitals, Patient Care: N.C.

b. Terminal Heating Devices:
1) Offices, Patient Care, Hospital, Public Areas.
2) Terminal boxes (VAV/CV): Fail in Last Position

c. Chilled Water Service:
1) Offices, Patient Care, Hospital: NC

d. All humidifier Valves: NC

e. Or as dictated by life safety, freeze protection, humidity, fire or temperature protection.

2.11 INPUTS/OUTPUTS:

A. General: The following section shall be used as a guide for identifying minimum performance requirements. The intent is for the contractor to install devices to match existing.

B. All input accuracies required by this section shall be end-to-end (from sensing point to BAS display). End-to-end accuracy includes all errors due to the sensor, transmitter, wiring and BAS signal measurement and A/D conversion.

C. Thermistors or solid state sensors shall be provided for temperature sensing applications except where accuracies or ranges required cannot be met by these devices, Nickel RTD's shall be used. The sensors shall be powered by the BAS panel or Dedicated Controller. The solid state sensors shall be accurate to within ±1.0deg F. over the following ranges and meet the following requirements:

1. Room Type Instruments: 50deg F to 100deg F. For room space applications: Sensor shall be surface recessed mounted in a plastic aluminum/stainless cover with an insulated baseplate & vandelproof screws.

2. Each thermostat shall have the following features:

   a. Exposed/Concealed setpoint adjustment dial with temperature graduation indication.

   b. LCD Display.

   c. All/Public area thermostats shall be provided with a plastic vented, lockable security cover.

3. Duct & Plenum Applications: -30deg F. to 240deg F. Supply, return, exhaust or mixed air averaging type, which shall have an extended element of sufficient length to cover the entire duct cross-section with a minimum of three passes. If a single averaging thermistor of sufficient length to meet the preceding are not available then two or more sensors and AIs shall be used and averaged in software.

4. Water Temperature Applications: 30deg F to 230deg F.

D. Where RTD's are required, they shall be 1000-ohm nickel type. They shall be accurate to within ±1.0deg F over the range of 32deg F to 600deg F.

E. Where thermocouples are required, they shall be type J and be supplied with a 4-20 mA DC transmitter. They shall be accurate to within ±2.0deg F over the range of 32deg F to 1300deg F.

F. Provide matched temperature sensors for applications which require both inlet and outlet temperatures of any device.

G. Thermowells shall be monel, brass or copper for use in copper water lines; and 300 series stainless steel for all other applications.

H. Outdoor Air Temperature & Humidity Transmitter:

1. Provide relative humidity and temperature probe with membrane filters and UVstabilized solar radiation shield. Probe shall have a temperature measuring range of -40deg F. to +120deg F. with an accuracy of ±.54deg F at 68deg F. and relative humidity measuring range of 0 to 100% RH with an accuracy of 2% 0 to 90% RH with a repeatability better than 1% RH per year. RH and temperature probe shall be capable of a continuous temperature operating range of -40deg F. to +120deg F. Provide necessary transmitter for output signals.

2. Provide 1 spare set of protective filters for each transmitter.

I. Humidity Transmitter:

1. Transmitters shall measure relative humidity from 0-100% RH with repeatable accuracy of ±2% RH. Long range RH stability shall be better than 1% RH/year. Duct mounting enclosure shall be cast aluminum, NEMA 4. Instruments shall be temperature compensated over entire range of operation. Sensor shall utilize the registered HUMICAP H-sensor. Sensor filter shall be membrane type, 18.5 mm. Provide 4-20 mA output signal to building automation control system.

2. Wall Mounted Humidity Transmitter: Transmitter shall measure relative humidity from 0 to 100% RH, ±2% accuracy, wall mounted ABS plastic box, with a long range RH stability better than 1% RH/year and temperature compensated over the entire range. Sensor shall utilize the registered HUMICAP H-sensor. Sensor filter shall be membrane type 18.5 mm and a 4-20 mA output signal.

    a. Provide 1 spare set of filters for each transmitter.

J. Humidity and temperature calibrator kit:

1. Provide Viasala HMK41 Kit for single point calibration of air temperature and humidity transmitters. Kit shall include:

    a. HMI41 Sensor.

    b. HMP46 Probe.

    c. I.S.T. Certificate.

    d. 1911622 Calibration Cable.

    e. Carrying Case.

K. Energy Meters (Chilled Water):

1. Furnish and install chilled water flow/totalization meters and compatible transmitter systems where shown, specified and as scheduled on the point list to measure the chilled water usage. Water temperature (CHS/CHR) shall be sensed by the noted DDC points. The DDC system shall convert the flow and temperature signal inputs into BTU and/or ton-hours.

2. Isolation valves shall be located inside the building after the isolation flanges. Downstream of the supply isolation valve inside the building, a transit time ultrasonic flow meter shall be installed in a length of straight pipe in order to achieve accurate readings as per manufacturer’s recommendations. Temperature sensors (thermowells) on both the supply and return lines are necessary to monitor the thermal energy absorbed by the system. Pressure transducers on the supply and return lines (between the building wall and the main building isolation valves) may be required by UC Denver facilities to monitor the chilled water system operation and provide more efficient operation of the central plant and the distribution system. Coordinate the meter installation with the HVAC Contractor to ensure a minimum of diameters of straight piping upstream and diameters downstream of the meter.

3. The water flow meter shall be factory calibrated and furnished with test data verifying the GPM flow of test water per inch w.g. differential.

4. A differential pressure transmitter, temperature transmitter and a pressure transmitter shall be provided and installed as required. The differential transmitter shall include (3) valve manifold. Temperature transmitter shall be furnished and installed when required with RTD type element and threaded thermowell for installation in the media flow piping downstream from the primary sensor unit. A pressure transmitter shall be furnished and installed when required and shall be installed upstream of the primary flow sensor unit.

L. Pressure Sensors, Transmitters and Differential Switches:

1. Pump/Liquid (wet) differential pressure switches shall be as manufactured by Dwyer with neoprene diaphragm, stainless steel internal parts, NEMA 4 housing.

2. Air Differential Pressure Transmitters shall be the Veris PX series (as required) with an accuracy of ±1% of range (including nonlinearity and hysteresis), solid state circuitry, no moving parts, capacitance principle capable of sensing positive, negative and differential pressures. Transmitter shall have 4-20 mA output signal and be powered by the control system or dedicated controller and capable of withstanding momentary overpressure of 8 times the pressure range.

3. Differential air pressure switches for filter or proof of airflow status shall be DwyerSeries 1910, with automatic reset, SPDT or Cleveland.

4. Hi-static pressure safety switches shall be Dwyer series 1900 MR, with manual reset, snap switch, SPDT, with repetitive accuracy within 3%.

5. Water/Liquid/Steam/Refrigerant Pressure Transmitter: Kele & Associates Model SA, stainless pressure transmitter with 4-20 mA output signal, watertight enclosure with stainless steel bulkhead fitting, accuracy of ±1% full scale, temperature compensated, 300 series stainless steel wetted parts.

a. Provide Model 47S pressure snubber for applications where the transmitter is subjected to fluid hammer, pressure surge or pulsation.

b. Provide Model PT steam syphon pigtail steam applications and where the fluid temperature is higher than the maximum operating temperature rating of the transmitter.

6. Air and Vacuum Pressure Transmitter: Kele & Associates Model P100GTE, solid state, 4-20 mA signal with a full scale accuracy of 1%.

M. Output Devices:

1. Control Relays: Control relay contacts shall be rated for the application, with a minimum of 2 sets of Form C contacts enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage. Provide with LED to indicate status.

2. Analog output transducers shall be of positioning type with position feedback and control internal to the transducer. As an option, position feedback may also be input to the BAS.

3. Analog output transducers shall meet the following requirements:

a. 4-20 mA DC output.

b. Two-pipe electromechanical design or microprocessor-based design.

c. 3-15 psi output range adjustable to a 0-20 psi range minimum.

d. Linearity, repeatability and hysteresis no greater than 2% of full scale.

e. Air capacity of 1000 SCIM minimum.

f. Air consumption of no more than 100 SCIM.

g. Pressure gauges shall be installed on the branch and supply lines.

h. Acceptable transducers are the Bellofram T1000, Fairchild T5700, Johnson

i. N6810, Mamac EP-310 or an equivalent.

4. Electronic analog output transducers shall output a signal to match the controlled device. The Contractor shall be responsible for verifying the required signals for all controlled devices. Transducers shall be completely solid-state with no mechanical parts.

5. Time Delay Relays: Time delay relay contacts shall be rated for the application with a minimum of 2 sets of Form C contacts enclosed is a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Relays shall be equipped with coil transient suppression, devices to limit transients to 150% of rated coil voltage. Delayed contact openings or closing shall be adjustable from 1 to 60 seconds with a minimum accuracy of ±2% of setting.

6. Latching Relays: Latching Relay contacts shall be rated for the application with a minimum of 2 sets of Form C contacts enclosed in a dustproof enclosure. Relays shall be rated for a minimum life of one million operations. Operating time shall be 20 milliseconds or less, with release time of 10 milliseconds or less. Relays shall be equipped with coil transient suppression devices to limit transients to 150% of rated coil voltage.

2.12 GAUGES:

A. General: Provide air pressure gauges for indication of supply and control air pressure at each branch for all control valve sizes 1" and larger, as well as all control dampers, all controllers, relays and EP and PE switches.

B. Air pressure gauges shall be a minimum of 1-1/2" diameter, resistant to effects of shock, pulsation and vibration, with a full scale accuracy of ±2.5%.

C. Round receiver gauges for continuous indication of analog values shall be 4" dial face instruments. Gauges shall be calibrated in appropriate units for the variable being measured and shall operate through their full range on a change in air pressure from 3 to 15 psi. Accuracy shall be plus or minus 1/2% of full scale.

2.13 POSITIONERS:

A. Positive positioning relays shall be provided on valve actuators and damper operators when required to provide sufficient power, sequencing and repeatability.

B. Provide for smooth gradual operation over operating span adjustment of 0 to 15 psi and start point adjustment of 3 to 10 psi.

2.14 CUMULATORS, SWITCHES AND MISCELLANEOUS ITEMS:

A. Provide all cumulators, switches and other miscellaneous items as may be required for the successful operation of the temperature regulation systems specified herein and/or shown on Drawings.

B. Provide suitable indicating plates with all switches.

C. Pressure/Electric switches shall be micro switch type. Range shall be 0 - 20 psi with electrical rating of 10 amperes minimum for 115V/1/60.

2.15 POWER MONITORING:

A. General: Provide current switches, current transducers, voltage transducers, current transformers as required to meet the specified sequence of operation and indicated below.

B. Current Operated Switches: AC current switch, Neilsen - Kuljian Model PD50AC, or PD75, solid state, 5 year warranty, three selectable ranges for optimum adjustability and resolution. Provide external current transformer where required.

C. Current Transducers: AC current to DC current output, ±.5% accuracy, 4-20 mA output signal, Kele and Associates Model 4CMA. Provide external current transformer where required.

D. application, ±1/2% accuracy, 4-20 mA DC output.

2.16 TEMPERATURE CONTROL CABINETS:

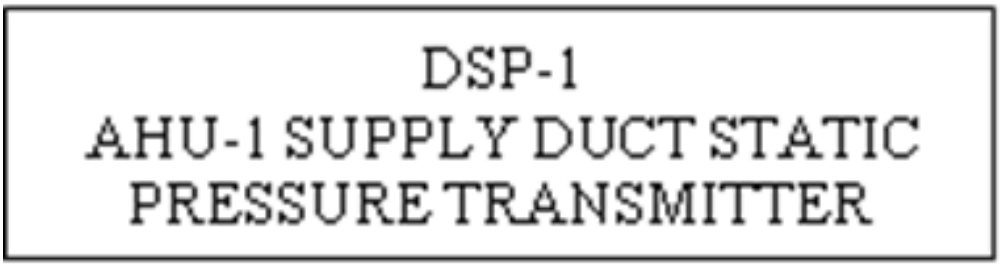
A. General: All controllers and field interface devices shall be installed in control panel cabinet/enclosure as described below.

B. Cabinets shall be UL listed, 14 gauge furniture grade steel, finished with baked enamel painted finish inside and out, cabinet doors shall have piano hinge and standard key cylinder locking latch.

C. Control panels located outdoors shall be NEMA 4X.

D. All devices installed on the control cabinet shall be labeled with a fixed mounted, color contrasted, engraved laminated plastic tags, including describing the function of the device, similar to the following example:

∆P Transmitter Device Label:



E. All electrical devices within the panel shall be prewired to terminal strips with all inter-device wiring within the panel completed prior to installation of the system.

F. Mount control panels adjacent to associated equipment on vibration free walls or free standing steel angle supports or "Unistrut" support stand.

2.17 VARIABLE FREQUENCY DRIVES:

A. Variable frequency drives shall be arranged so that it can be operated in an open circuit mode, disconnected from the motors, for start-up adjustments and trouble shooting.

B. Automatic operation shall be from a 4-20 milliamp signal follower, which shall follow a transducer signal. The signal follower shall contain the following design features.

1. Shall accept a transducer output signal and condition it to produce a speed reference signal for the invertor.

2. Minimum speed adjustment (Zero to Maximum RPM).

C. Wire all safeties to operate both in hand and auto positions as well as drive and by-pass sections.

D. Provide communication interface necessary to forward VFD computer communication information to and from the BAS/VFD through BACNET. Also see Section 23 05 05.

2.18 HIGH & LOW TEMPERATURE LIMIT CONTROL DEVICES:

A. Provide PENN A70 series or equal, DPST, manual reset, two isolated sets of contacts.

B. Control responds to temperature along any one foot of entire element.

C. Vapor charged sensing element shall be calibrated for altitude of project site.

D. Provide multiple limit control devices as required to provide complete and full coverage of the entire coil face area and/or duct cross section area.

2.19 ELECTRICAL MATERIALS:

A. All wiring installed in inaccessible areas shall be in conduit. Wiring in accessible areas may be in conduit or cable tray. See Division 26 for conduit installation requirements. Where wiring is exposed in plenum locations (i.e. open cable tray, wiring shall be plenum rated.) See Division 27 for cable tray installation requirements.

B. Conduit and Conductors: Types as indicated in Division 26 sized per Division 26 except for low-voltage twisted pair or single jacketed cable (3/4" minimum). All low voltage conductors shall be stranded 22 gauge copper minimum; twisted pair.

C. Fittings per Division 26: Bushings or nylon insulated throats are not required for jacketed cables.

D. All J-boxes shall be identified and labeled per Division 26.

E. All conductors and cables shall be labeled per Division 26.

F. Conduit and box supports shall be per Division 26.

G. Junction boxes shall be of types and sizes as indicated in Division 26.

H. Conduits shall not exceed 40% maximum fill for single conductor and jacketed cables.

I. Fiber Optic Cable:

1. Acceptable fiber optic cable shall include the following sizes; 50/125, 62.5/125 or100/140. Only glass fiber is acceptable, no plastic.

2. Fiber optic cable shall only be installed and terminated by an experienced contractor.

3. The BAS contractor shall submit to the Engineer the name of the intended contractor of the fiber optic cable with his submittal documents.

J. Coaxial Cable:

1. Coaxial cable shall conform to RG62 or RG59 rating.

2. Provide plenum rated coaxial cable when running in return air plenums.

K. All temperature control panels & controllers shall be provided with fuse protection on both incoming power load supply (primary side) and on low voltage side of control transformer (secondary side).

L. Provide lightning arresters Kele & Associates Model 392-SVSR2 or equal, at all points where communication cables exit or enter the building.

M. All communication cabling shall be shielded type.

2.20 END SWITCHES:

A. All end switches shall be NEMA rated contacts, NEMA 4X enclosure if required, either SPDT, DPDT DPST as required to meet the sequence of operation, complete the points list and necessary interlocks or safeties control wiring. End switches shall be as manufactured by Cutler-Hammer, Allen-Bradley, or Kele.

B. All end switches shall be designed and configured to provide positive indication of a control device (i.e. damper or valve) position for the service intended.

2.21 POINT SCHEDULE:

A. Refer to the following output/input charts:

1. Critical Room Control Valve

POINT DESCRIPTION (EACH BOX)	DO	DI	AO	AI	REMARKS
DAMPER CONTROL			1		BACNET CONTROLLER
CFM MEASUREMENT AND ADJUSTMENT				1	BACNET CONTROLLER
REHEAT VALVE CONTROL			1		BACNET CONTROLLER
DISCHARGE AIR TEMPERATURE				1	BACNET CONTROLLER
ROOM TEMPERATURE WITH OVERRIDE &				1	BACNET CONTROLLER

SETPOINT ADJUSTMENT					

VAV WITHOUT REHEAT

POINT DESCRIPTION (EACH BOX)	DO	DI	AO	AI
ROOM TEMPERATURE W/OVERRIDE & SETPOINT ADJUSTMENT				1
DAMPER CONTROL			1	
CFM MEASUREMENT AND ADJUSTMENT				1
RADIATION/RADIANT PANEL VALVE (IF REQUIRED)			1	
DISCHARGE AIR TEMPERATURE				1

CV/VAV WITH REHEAT

POINT DESCRIPTION (EACH BOX)	DO	DI	AO	AI
ROOM TEMPERATURE W/OVERRIDE & SETPOINT ADJUSTMENT				1
DAMPER CONTROL			1	
REHEAT VALVE CONTROL			1	
CFM MEASUREMENT AND ADJUSTMENT				1
DISCHARGE AIR TEMPERATURE				1

OUTSIDE AIR TEMPERATURE/HUMIDITY/CO2

POINT DESCRIPTION	DO	DI	AO	AI	REMARKS
OUTSIDE AIR TEMPERATURE SENSOR				1	EXISTING GLOBAL POINT
OUTSIDE AIR HUMIDITY SENSOR				1	EXISTING GLOBAL POINT
OUTSIDE AIR				1	1

CARBON DIOXIDE (CO2) SENSOR					

DEMAND CONTROL VENTILATION

POINT DESCRIPTION	DO	DI	AO	AI
CARBON DIOXIDE (CO2) SENSOR				1

AIR HANDLING UNIT HUMIDIFIERS

POINT DESCRIPTION	DO	DI	AO	AI	REMARKS
SPACE HUMIDITY				2	
SUPPLY HIGH LIMIT WITH DUCT HUMIDISTAT AND RESET				1	
HUMIDIFIER VALVE			1		
HUMIDIFIER SAFETY CIRCUIT (AQUASTAT)		1			INTERLOCK WITH ASSOCIATED FANS

AIR HANDLERS

POINT DESCRIPTION	DO	DI	AO	AI	REMARKS
SUPPLY FAN (START/STOP)	1				
RETURN FAN (START/STOP)	1				
FAN STATUS		X			PROVIDE ONE PER FAN.
CHILLED WATER VALVE CONTROL & COIL AIR TEMPS			1	1	AIR TEMP.
STEAM PREHEAT CONTROL (1/3-2/3) & COIL AIR TEMPS			4	1	AIR TEMP.
DISCHARGE TEMPERATURE				1	
MIXED AIR TEMPERATURE AND HUMIDITY				2	
RETURN AIR TEMPERATURE AND HUMIDITY				2	
CHILLED WATER				2	

SUPPLY & RETURN TEMPERATURE					
FREEZESTAT		1			HARDWIRE ALARM. WIRE IN SERIES ONE FREEZESTAT FOR EVERY 25 SQUARE FEET OF COIL FACE AREA.
2/3 STATIC PRESSURE SENSOR (SUPPLY)				2	RESET
SUPPLY AIR AFM STATION CFM				X	PROVIDE ONE PER FAN.
RETURN FAN AFM STATION CFM				X	PROVIDE ONE PER FAN.
SUPPLY STATIC HIGH LIMIT		1			HARDWIRE
RETURN AIR FAN HIGH LIMIT		1			HARDWIRE
PREFILTER ALARM		1			
INTERMEDIATE FILTER ALARM		1			
HEPA/FINAL FILTER ALARM		1			
VARIABLE SPEED DRIVE CONTROL (FOR EACH DRIVE PROVIDED. REFER TO SCHEDULE.)		1	1		NETWORK INTEGRATION INCLUDING ALARM AND CONTROL
SMOKE DETECTOR STATUS (SUPPLY AND RETURN)		X			SOFTWARE INTEGRATION
RETURN HUMIDITY SENSOR				1	
SUPPLY HUMIDITY SENSOR				1	
SUPPLY HUMIDITY HIGH LIMIT				1	
HUMIDIFIER CONTROL VALVE			1		
OUTDOOR AIR QUANTITY (CFM)				1	
MINIMUM O.A. DAMPER (OPEN/CLOSE)	1	1		1	DAMPER END SWITCH, POSITION

					FEEDBACK
MAXIMUM/ECONOMIZER O.A. DAMPER (MODULATING)			1	1	POSITION FEEDBACK
EXHAUST AIR DAMPER			1		
RETURN AIR DAMPER		1	1		END SWITCH ONLY FOR AHUS WITH SMOKE EVAC MODE
MOTOR KW DEMAND (VIA FAN STATUS SOFTWARE)				X	VFD INTEGRATION

EXHAUST FANS WITH DAMPERS

POINT DESCRIPTION	DO	DI	AO	AI	REMARKS
START/STOP	1				
STATUS (3 HP AND LARGER = AI) (UNDER 3 HP = DI)		1		1	
ISOLATION DAMPER	1	1			DAMPER END SWITCH
VARIABLE SPEED DRIVE CONTROL		1	1		NETWORK INTEGRATION INCLUDING ALARM AND CONTROL

RELIEF AIR DAMPER CONTROL

POINT DESCRIPTION	DO	DI	AO	AI	REMARKS
ROOM PRESSURE SENSOR				3	AVERGE
ROOM DIFFERENTIAL PRESSURE SENSOR				3	AVERAGE
FINAL FILTER ALARM		1			

CONDENSATE PUMPS (TYPICAL OF EACH DUPLEX SET)

POINT DESCRIPTION (EACH)	DO	DI	AO	AI
HIGH WATER ALARM		1		

ENERGY METERS

POINT	DO	DI	AO	AI	REMARKS

DESCRIPTION					
CHILLED WATER FLOW AND TEMPERATURES (CHS/CHR) & TONNAGE CONVERSION				1	
MAIN HIGH PRESSURE STEAM METERS				1	

CENTRAL CHILLED WATER SYSTEM (CAMPUS LOOP/PLATE-HEAT-EXCHANGER)

POINT DESCRIPTION	DO	DI	AO	AI	REMARKS
INCOMING CHILLED WATER SUPPLY TEMPERATURE				1	
CHILLED WATER RETURN TEMPERATURE				1	
SECONDARY CHILLED WATER PUMP START/STOP	4				
SECONDARY (BUILDING SIDE) CHILLED WATER PUMP STATUS		4			
SECONDARY CHILLED WATER PUMP VARIABLE SPEED DRIVE CONTROL	X	X	X		VFD INTEGRATION
PRIMARY CHILLED WATER CONTROL VALVE			1		
SECONDARY CHILLED WATER DIFFERENTIAL PRESSURE				1	
SECONDARY			1		

CHILLED WATER BYPASS VALVE					
SECONDARY CHILLED WATER SUPPLY TEMPERATURE				1	
SECONDARY CHILLED WATER RETURN TEMPERATURE				1	

ELECTRICAL

POINT DESCRIPTION	DO	DI	AO	AI	REMARKS
TRANSFER SWITCH STATUS		7			SOFTWARE INTEGRATION THROUGH THE ETHERNET
UNIT SUBSTATION MAIN BREAKER STATUS		X			SOFTWARE INTEGRATION THROUGH THE ETHERNET
UNIT SUBSTATION FEEDER BREAKER STATUS		X			SOFTWARE INTEGRATION THROUGH THE ETHERNET
UNIT SUBSTATION TIE BREAKER STATUS		X			SOFTWARE INTEGRATION THROUGH THE ETHERNET
SITE LIGHTING CONTROL	X				SOFTWARE INTEGRATION

PLUMBING AND FIRE PROTECTION

POINT DESCRIPTION	DO	DI	AO	AI	REMARKS
CITY WATER SERVICE PRESSURE				1	
FP WATER SERVICES PRESSURE				1	
WATER BOOSTER PUMP PRESSURE (EACH)				1	

WATER SOFTENER (LOW SALT)+		1			
CHLORINE DIOXIDE INJECTION SYSTEM		1			
DOMESTIC HOT WATER HEATERS TEMPERATURE WITH ALARM (EACH)				3	ALARM THROUGH SOFTWARE INTEGRATION
DOMESTIC HOT WATER HEATER – 1/3 – 2/3 STEAM CONTROL VALVE				1	
MEDICAL VACUUM PUMP PRESSURE (EACH)				1	
MEDICAL AIR COMPRESSOR PRESSURE (EACH)				1	
LAB SYSTEM AIR COMPRESSOR PRESSURE (EACH)				1	
MOISTURE CONTENT METER (AIR) MEDICAL AIR COMPRESSOR				1	
MEDICAL GAS SERVICES HIGH PRESSURE SYSTEM (EACH SYSTEM)				1	
MEDICAL GAS SERVICES LOW PRESSURE SYSTEM (EACH SYSTEM)				1	
MASTER MEDICAL GAS				1	

ALARM PANEL					
WATER METER FLOW				2	

THE ATC CONTRACTOR SHALL REFER TO THE PLUMBING AND FIRE PROTECTION SECTIONS FOR ADDITIONAL POINTS REQUIRED. THE PLUMBING AND FIRE PROTECTION CONTRACTORS SHALL PROVIDE SWITCHES AND SENSORS IN PIPING SYSTEM AND TERMINAL CONNECTIONS IN PLUMBING/FIRE PROTECTION EQUIPMENT PANELS FOR CONNECTION TO BY THE ATC CONTRACTOR. THE ATC CONTRACTOR SHALL PROVIDE ALL CONDUIT AND WIRING REQUIRED TO EXTEND THESE POINTS BACK TO THE DDC AUTOMATION SYSTEM. THE ATC CONTRACTOR SHALL REVIEW THE PLUMBING DRAWINGS TO DETERMINE THE QUANTITY OF PLUMBING EQUIPMENT PROVIDED. THE ATC CONTRACTOR SHALL PROVIDE ALL INTEGRATING SOFTWARE REQUIRED TO INCORPORATE THESE POINTS INTO THE AUTOMATION SYSTEM.

16.01 PROVIDE ANY AND ALL ADDITIONAL POINTS FOR THE SYSTEMS TO FUNCTION IN ACCORDANCE WITH THE SEQUENCES OR AS DESCRIBED OR IMPLIED ELSEWHERE WITHIN THE SPECIFICATIONS OR ON THE DRAWINGS

16.02 DDC EQUIPMENT

A. Operator Workstation: Existing front-end operator station shall be used.

B. Diagnostic Terminal Unit: Portable notebook-style, PC-based microcomputer terminal capable of accessing system data by connecting to system network with minimum configuration as follows:

1. System: With one integrated USB 2.0 port, integrated Intel Pro 10/100 (Ethernet), integrated audio, bios, and hardware monitoring.

2. Processor: Core i9, 4 GHz.

3. Random-Access Memory: 128 MB.

4. Graphics: Video adapter, minimum 1024 x 768 pixels, 64-MB video memory.

5. Monitor: 17 inches, LCD color.

6. Keyboard: QWERTY 105 keys in ergonomic shape.

7. Hard-Disk Drive: 800 MB.

8. CD-ROM Read/Write Drive: 48x24x48.

9. Pointing Device: Touch pad or other internal device.

C. Control Units: Modular, comprising processor board with programmable, nonvolatile, random-access memory; local operator access and display panel; integral interface equipment; and backup power source.

1. Units monitor or control each I/O point; process information; execute commands from other control units, devices, and operator stations; and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.

b. Discrete/digital, analog, and pulse I/O.

c. Monitoring, controlling, or addressing data points.

d. Software applications, scheduling, and alarm processing.

e. Testing and developing control algorithms without disrupting field hardware and controlled environment.

3. Standard Application Programs:

a. Electric Control Programs: Demand limiting, duty cycling, automatic time scheduling, start/stop time optimization, night setback/setup, on-off control with differential sequencing, staggered start, antishort cycling, PID control, DDC with fine tuning, and trend logging.

b. HVAC Control Programs: Optimal run time, supply-air reset, and enthalpy switchover.

c. Chiller Control Programs: Control function of condenser-water reset, chilled-water reset, and equipment sequencing.

d. Programming Application Features: Include trend point; alarm processing and messaging; weekly, monthly, and annual scheduling; energy calculations; run-time totalization; and security access.

e. Remote communications.

f. Maintenance management.

g. Units of Measure: Inch-pound and SI (metric).

4. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

5. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

6. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

D. Local Control Units: Modular, comprising processor board with electronically programmable, nonvolatile, read-only memory; and backup power source.

1. Units monitor or control each I/O point, process information, and download from or upload to operator workstation or diagnostic terminal unit.

2. Stand-alone mode control functions operate regardless of network status. Functions include the following:

a. Global communications.

b. Discrete/digital, analog, and pulse I/O.

c. Monitoring, controlling, or addressing data points.

3. Local operator interface provides for download from or upload to operator workstation or diagnostic terminal unit.

4. ASHRAE 135 Compliance: Control units shall use ASHRAE 135 protocol and communicate using ISO 8802-3 (Ethernet) datalink/physical layer protocol.

5. LonWorks Compliance: Control units shall use LonTalk protocol and communicate using EIA/CEA 709.1 datalink/physical layer protocol.

E. I/O Interface: Hardwired inputs and outputs may tie into system through controllers. Protect points so that shorting will cause no damage to controllers.

1. Binary Inputs: Allow monitoring of on-off signals without external power.

2. Pulse Accumulation Inputs: Accept up to 10 pulses per second.

3. Analog Inputs: Allow monitoring of low-voltage (0- to 10-V dc), current (4 to 20 mA), or resistance signals.

4. Binary Outputs: Provide on-off or pulsed low-voltage signal, selectable for normally open or normally closed operation with three-position (on-off-auto) override switches and status lights.

5. Analog Outputs: Provide modulating signal, either low voltage (0- to 10-V dc) or current (4 to 20 mA) with status lights, two-position (auto-manual) switch, and manually adjustable potentiometer.

6. Tri-State Outputs: Provide two coordinated binary outputs for control of three-point, floating-type electronic actuators.

7. Universal I/Os: Provide software selectable binary or analog outputs.

F. Power Supplies: Transformers with Class 2 current-limiting type or overcurrent protection; limit connected loads to 80 percent of rated capacity. DC power supply shall match output current and voltage requirements and be full-wave rectifier type with the following:

1. Output ripple of 5.0 mV maximum peak to peak.

2. Combined 1 percent line and load regulation with 100-mic.sec. response time for 50 percent load changes.

3. Built-in overvoltage and overcurrent protection and be able to withstand 150 percent overload for at least 3 seconds without failure.

G. 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.

16.03 UNITARY CONTROLLERS

A. Unitized, capable of stand-alone operation with sufficient memory to support its operating system, database, and programming requirements, and with sufficient I/O capacity for the application.

1. Configuration: Local keypad and display; diagnostic LEDs for power, communication, and processor; wiring termination to terminal strip or card connected with ribbon cable; memory with bios; and 72-hour battery backup.

2. Operating System: Manage I/O communication to allow distributed controllers to share real and virtual object information and allow central monitoring and alarms. Perform scheduling with real-time clock. Perform automatic system diagnostics; monitor system and report failures.

3. ASHRAE 135 Compliance: Communicate using read (execute and initiate) and write (execute and initiate) property services defined in ASHRAE 135. Reside on network using MS/TP datalink/physical layer protocol and have service communication port for connection to diagnostic terminal unit.

4. LonWorks Compliance: Communicate using EIA/CEA 709.1 datalink/physical layer protocol using LonTalk protocol.

5. Enclosure: Dustproof rated for operation at 32 to 120 deg F.

6. Enclosure: Waterproof rated for operation at 40 to 150 deg F.

16.04 ALARM PANELS

A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch- thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels.

B. Indicating light for each alarm point, single horn, acknowledge switch, and test switch, mounted on hinged cover.

1. Alarm Condition: Indicating light flashes and horn sounds.

2. Acknowledge Switch: Horn is silent and indicating light is steady.

3. Second Alarm: Horn sounds and indicating light is steady.

4. Alarm Condition Cleared: System is reset and indicating light is extinguished.

5. Contacts in alarm panel allow remote monitoring by independent alarm company.

C. Refrigerator, Freezer, Cooler Temperature Sensors

1. For use in refrigerators, freezers and coolers to monitor the temperature of the contents instead or the air temperature.

D. Acceptable Manufacturers:

1. Kele ACI A/ - Thermal Vial Temperature Sensor and Transmitter

E. Materials and Construction:

1. Glycol filled vial/bottle with mounting bracket.

2. 1000 OHM platinum RTD sensor. Accuracy +/- 1.5% of span.

3. Operating Range: -58 to 120 □F.

4. Transmitter supply voltage: 18.5 to 32 VDC.

5. Signal output: 4-20 mA

16.05 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Manufacturers:

a. BEC Controls Corporation.

b. Ebtron, Inc.

c. Heat-Timer Corporation.

d. T.M. Instruments Inc.

e. MAMAC Systems, Inc.

f. RDF Corporation.

2. Accuracy: Plus or minus 0.5 deg F at calibration point.

3. Wire: Twisted, shielded-pair cable.

4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.

5. Averaging Elements in Ducts: 36 inches long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft.

6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches.

7. Room Sensor Cover Construction: Manufacturer's standard locking covers.

a. Set-Point Adjustment: Concealed.

b. Set-Point Indication: Concealed.

c. Thermometer: Concealed.

d. Color: Coordinate with Architect.

e. Orientation: Vertical.

8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

C. RTDs and Transmitters:

1. Manufacturers:

a. BEC Controls Corporation.

b. MAMAC Systems, Inc.

c. RDF Corporation.

2. Accuracy: Plus or minus 0.2 percent at calibration point.

3. Wire: Twisted, shielded-pair cable.

4. Insertion Elements in Ducts: Single point, 8 inches long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft.

5. Averaging Elements in Ducts: 18 inches long, rigid; use where prone to temperature stratification or where ducts are larger than 9 sq. ft.; length as required.

6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches.

7. Room Sensor Cover Construction: Manufacturer's standard locking covers.

a. Set-Point Adjustment: Concealed.

b. Set-Point Indication: Concealed.

c. Thermometer: Concealed.

d. Color: Coordinate with Architect.

e. Orientation: Vertical.

8. Outside-Air Sensors: Watertight inlet fitting, shielded from direct sunlight.

9. Room Security Sensors: Stainless-steel cover plate with insulated back and security screws.

D. Humidity Sensors: Bulk polymer sensor element.

1. Manufacturers:

a. BEC Controls Corporation.

b. General Eastern Instruments.

c. MAMAC Systems, Inc.

d. ROTRONIC Instrument Corp.

e. TCS/Basys Controls.

f. Vaisala.

2. Accuracy: 2 percent full range with linear output.

3. Room Sensor Range: 20 to 80 percent relative humidity.

4. Room Sensor Cover Construction: Manufacturer's standard locking covers.

a. Set-Point Adjustment: Concealed.

b. Set-Point Indication: Concealed.

c. Thermometer: Concealed.

d. Color: Coordinate with Architect.

e. Orientation: Vertical.

5. Duct Sensor: 20 to 80 percent relative humidity range with element guard and mounting plate.

6. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, suitable for operation at outdoor temperatures of 32 to 120 deg F.

7. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Manufacturers:

a. BEC Controls Corporation.

b. General Eastern Instruments.

c. MAMAC Systems, Inc.

d. ROTRONIC Instrument Corp.

e. TCS/Basys Controls.

f. Vaisala.

2. Static-Pressure Transmitter: Nondirectional sensor with suitable range for expected input, and temperature compensated.

a. Accuracy: 2 percent of full scale with repeatability of 0.5 percent.

b. Output: 4 to 20 mA.

c. Building Static-Pressure Range: 0- to 0.25-inch wg.

d. Duct Static-Pressure Range: 0- to 5-inch wg.

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure; linear output 4 to 20 mA.

4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig operating pressure and tested to 300-psig; linear output 4 to 20 mA.

5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential.

6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

F. Room Sensor Cover Construction: Manufacturer's standard locking covers.

1. Set-Point Adjustment: Concealed.

2. Set-Point Indication: Concealed.

3. Thermometer: Concealed.

4. Color: Coordinate with Architect.

5. Orientation: Vertical.

G. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.

2. Guards: Locking; heavy-duty, transparent plastic; mounted on separate base.

3. Adjusting Key: As required for calibration and cover screws.

16.06 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg.

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig, piped across pump.

C. Status Inputs for Electric Motors: Comply with ISA 50.00.01, current-sensing fixed- or split-core transformers with self-powered transmitter, adjustable and suitable for 175 percent of rated motor current.

D. Voltage Transmitter (100- to 600-V ac): Comply with ISA 50.00.01, single-loop, self-powered transmitter, adjustable, with suitable range and 1 percent full-scale accuracy.

E. Power Monitor: 3-phase type with disconnect/shorting switch assembly, listed voltage and current transformers, with pulse kilowatt hour output and 4- to 20-mA kW output, with maximum 2 percent error at 1.0 power factor and 2.5 percent error at 0.5 power factor.

F. Current Switches: Self-powered, solid-state with adjustable trip current, selected to match current and system output requirements.

G. Electronic Valve/Damper Position Indicator: Visual scale indicating percent of travel and 2- to 10-V dc, feedback signal.

H. Water-Flow Switches: Bellows-actuated mercury or snap-acting type with pilot-duty rating, stainless-steel or bronze paddle, with appropriate range and differential adjustment, in NEMA 250, Type 1 enclosure.

1. Manufacturers:

a. BEC Controls Corporation.

b. T.M. Instruments Inc.

16.07 GAS DETECTION EQUIPMENT

A. Manufacturers:

1. W. Technologies.

2. CEA Instruments, Inc.

3. Ebtron, Inc.

4. Gems Sensors Inc.

5. Greystone Energy Systems Inc.

6. Honeywell International Inc.; Home & Building Control.

7. INTEC Controls, Inc.

8. T.M. Instruments Inc.

9. MSA Canada Inc.

10. QEL/Quatrosense Environmental Limited.

11. Sauter Controls Corporation.

12. Sensidyne, Inc.

13. TSI Incorporated.

14. Vaisala.

15. Vulcain Inc.

B. Carbon Monoxide Detectors: Single or multichannel, dual-level detectors using solid-state plug-in sensors with a 3-year minimum life; suitable over a temperature range of 32 to 104 deg F; with 2 factory-calibrated alarm levels at 50 and 100 ppm.

C. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

D. Oxygen Sensor and Transmitter: Single detectors using solid-state zircon cell sensing; suitable over a temperature range of minus 32 to plus 1100 deg F and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

E. Occupancy Sensor: Passive infrared, with time delay, daylight sensor lockout, sensitivity control, and 180-degree field of view with vertical sensing adjustment; for flush mounting.

16.08 FLOW MEASURING STATIONS

A. Duct Airflow Station: Combination of air straightener and multiport, self-averaging pitot tube station.

1. Manufacturers:

a. Air Monitor Corporation.

b. Wetmaster Co., Ltd.

2. Casing: Galvanized-steel frame.

3. Flow Straightener: Aluminum honeycomb, 3/4-inch parallel cell, 3 inches deep.

4. Sensing Manifold: Copper manifold with bullet-nosed static pressure sensors positioned on equal area basis.

16.09 THERMOSTATS

A. Manufacturers:

1. Erie Controls.

2. Danfoss Inc.; Air-Conditioning and Refrigeration Div.

3. Heat-Timer Corporation.

4. Sauter Controls Corporation.

5. tekmar Control Systems, Inc.

6. Theben AG - Lumilite Control Technology, Inc.

B. Electric, solid-state, microcomputer-based room thermostat with remote sensor.

1. Automatic switching from heating to cooling.

2. Preferential rate control to minimize overshoot and deviation from set point.

3. Set up for four separate temperatures per day.

4. Instant override of set point for continuous or timed period from 1 hour to 31 days.

5. Short-cycle protection.

6. Programming based on every day of week.

7. Selection features include degree F or degree C display, 12- or 24-hour clock, keyboard disable, remote sensor, and fan on-auto.

8. Battery replacement without program loss.

9. Thermostat display features include the following:

    a. Time of day.

    b. Actual room temperature.

    c. Programmed temperature.

    d. Programmed time.

    e. Duration of timed override.

    f. Day of week.

    g. System mode indications include "heating," "off," "fan auto," and "fan on."

C. Low-Voltage, On-Off Thermostats: NEMA DC 3, 24-V, bimetal-operated, mercury-switch type, with adjustable or fixed anticipation heater, concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

D. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch or equivalent solid-state type, with heat anticipator; listed for electrical rating; with concealed set-point adjustment, 55 to 85 deg F set-point range, and 2 deg F maximum differential.

1. Electric Heating Thermostats: Equip with off position on dial wired to break ungrounded conductors.

2. Selector Switch: Integral, manual on-off-auto.

E. Remote-Bulb Thermostats: On-off or modulating type, liquid filled to compensate for changes in ambient temperature; with copper capillary and bulb, unless otherwise indicated.

1. Bulbs in water lines with separate wells of same material as bulb.

2. Bulbs in air ducts with flanges and shields.

3. Averaging Elements: Copper tubing with either single- or multiple-unit elements, extended to cover full width of duct or unit; adequately supported.

4. Scale settings and differential settings are clearly visible and adjustable from front of instrument.

5. On-Off Thermostat: With precision snap switches and with electrical ratings required by application.

6. Modulating Thermostats: Construct so complete potentiometer coil and wiper assembly is removable for inspection or replacement without disturbing calibration of instrument.

F. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

G. Airstream Thermostats: Two-pipe, fully proportional, single-temperature type; with adjustable set point in middle of range, adjustable throttling range, plug-in test fitting or permanent pressure gage, remote bulb, bimetal rod and tube, or averaging element.

H. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet.

2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

I. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual- or automatic- reset switch that trips if temperature sensed across any 12 inches of bulb length is equal to or above set point.

1. Bulb Length: Minimum 20 feet.

2. Quantity: One thermostat for every 20 sq. ft. of coil surface.

J. Heating/Cooling Valve-Top Thermostats: Proportional acting for proportional flow, with molded-rubber diaphragm, remote-bulb liquid-filled element, direct and reverse acting at minimum shutoff pressure of 25 psig, and cast housing with position indicator and adjusting knob.

16.10 HUMIDISTATS

A. Manufacturers:

1. MAMAC Systems, Inc.

2. ROTRONIC Instrument Corp.

B. Duct-Mounting Humidistats: Electric insertion, 2-position type with adjustable, 2 percent throttling range, 20 to 80 percent operating range, and single- or double-pole contacts.

16.11 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 Section 230513 "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: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

4. Spring-Return Motors for Valves Larger Than NPS 2-1/2: Size for running and breakaway torque of 150 in. x lbf.

5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running torque of 150 in. x lbf and breakaway torque of 300 in. x lbf.

6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft.: Size for running and breakaway torque of 150 in. x lbf.

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. of damper.

b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. of damper.

c. Parallel-Blade Damper without Edge Seals: 4 inch-lb/sq. ft of damper.

d. Opposed-Blade Damper without Edge Seals: 3 inch-lb/sq. ft. of damper.

e. Dampers with 2- to 3-Inch wg of Pressure Drop or Face Velocities of 1000 to 2500 fpm: Increase running torque by 1.5.

f. Dampers with 3- to 4-Inch wg of Pressure Drop or Face Velocities of 2500 to 3000 fpm: Increase running torque by 2.0.

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-V ac.

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.

11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F.

12. Run Time: 12 seconds open, 5 seconds closed.

16.12 CONTROL VALVES

A. Manufacturers:

1. Danfoss Inc.; Air Conditioning & Refrigeration Div.

2. Erie Controls.

3. Hayward Industrial Products, Inc.

4. Magnatrol Valve Corporation.

5. Neles-Jamesbury.

6. Parker Hannifin Corporation; Skinner Valve Division.

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 and Smaller: Class 125 bronze body, bronze trim, rising stem, renewable composition disc, and screwed ends with backseating capacity repackable under pressure.

2. NPS 2-1/2 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: 3-psig maximum pressure drop at design flow rate or the following:

a. Two Position: Line size.

b. Two-Way Modulating: Either the value specified above or twice the load pressure drop, whichever is more.

c. Three-Way Modulating: Twice the load pressure drop, but not more than value specified above.

5. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

6. Close-Off (Differential) Pressure Rating: Combination of actuator and trim shall provide minimum close-off pressure rating of 150 percent of total system (pump) head for two-way valves and 100 percent of pressure differential across valve or 100 percent of total system (pump) head.

D. Butterfly Valves: 200-psig, 150-psig 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: Wafer, Lug or Grooved.

2. Disc Type: Nickel-plated ductile iron.

3. Sizing: 1-psig maximum pressure drop at design flow rate.

E. 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 and 250 deg F operating conditions.

2. Sizing: 3-psig 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.

F. 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 and 250 deg F operating conditions.

2. Thermostatic Operator: Liquid-filled integral sensor with integral adjustable dial.

16.13 DAMPERS

A. Manufacturers:

1. Air Balance Inc.

2. Don Park Inc.; Autodamp Div.

3. TAMCO (T. A. Morrison & Co. Inc.).

4. United Enertech Corp.

5. Vent Products Company, Inc.

B. Dampers: AMCA-rated, parallel-blade design; 0.108-inch- minimum thick, galvanized-steel or 0.125-inch- minimum thick, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- thick galvanized steel with maximum blade width of 8 inches and length of 48 inches.

1. Secure blades to 1/2-inch- diameter, zinc-plated axles using zinc-plated hardware, with oil-impregnated sintered bronze blade bearings, blade-linkage hardware of zinc-plated steel and brass, ends sealed against spring-stainless-steel blade bearings, and thrust bearings at each end of every blade.

2. Operating Temperature Range: From minus 40 to plus 200 deg F.

3. Edge Seals, Standard Pressure Applications: Closed-cell neoprene.

4. Edge Seals, Low-Leakage Applications: Use inflatable blade edging or replaceable rubber blade seals and spring-loaded stainless-steel side seals, rated for leakage at less than 10 cfm per sq. ft. of damper area, at differential pressure of 4-inch wg when damper is held by torque of 50 in. x lbf; when tested according to AMCA 500D.

16.14 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Section 27 15 00 "Communications Horizontal Cabling."

PART 3 EXECUTION

17.01 EXAMINATION

A. Verify that emergency power supply is available to control units and operator workstation.

B. Verify that duct-, pipe-, and equipment-mounted devices are installed before proceeding with installation.

17.02 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 48 inches above the floor.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

D. The Contractor shall install all equipment, control air piping/tubing, conduit and wiring parallel to building lines.

E. Install guards on thermostats in the following locations:

1. Entrances.

2. Public areas.

3. Where indicated.

F. Install automatic dampers according to Section 23 33 00 "Air Duct Accessories."

G. Install damper motors on outside of duct in warm areas, not in locations exposed to outdoor temperatures.

H. Install labels and nameplates to identify control components according to Section 23 05 53 "Mechanical Identification".

I. All automatic control valves, control dampers, wells, and similar control devices furnished by the Temperature Control Contractor shall be installed under his supervision by the Mechanical Contractor.

J. Install current sensors for fans controlled by VFDs on the load side of the VFD.

K. Install steam and condensate instrument wells, valves, and other accessories according to Section 23 22 16 Steam and Condensate Piping Specialties."

L. Install duct volume-control dampers according to Section 23 31 13 "Metal Ducts" and Section 23 31 16 "Nonmetal Ducts."

M. Install electronic and fiber-optic cables according to Section 27 15 00 "Communications Horizontal Cabling."

17.03 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Horizontal runs of conduit, trays, tubing or wiring shall be hung from structural members using new supports, or where feasible, utilizing existing temperature control conduit and piping. The Contractor shall verify adequacy of existing systems and warrant these systems as if they were new. Single runs of conduit, tubing or wire shall be by clevis ring and all thread rod. Multiple runs shall be by "Trapeze" or "Unistrut" supports. "Plumber's Strap" shall not be allowed. Maximum distance between supports shall be per the NEC. Existing supports shall only be used upon written concurrence by the Architect, Engineer or Owner.

B. All vertical runs of conduit or tubing shall be through new core drills. Existing core drills may be used if approved by the Owner. The installation shall be supported above each floor penetration using clamps to "Unistrut".

C. All communication wire that enters or leaves a building structure shall be installed with lightning protection per NEC.

D. All wire terminations shall be with compression type round hole spade lugs under a pan head screw landing; Stay-Kon or equivalent. All wire splices shall be with compression type insulated splice connectors or properly sized "wire-nut" connectors. Hand twisted, soldered and/or taped terminations or splices are not acceptable.

E. Where tubing, wiring or conduit penetrates floors or walls, sleeves with bushings shall be provided for tubing and wires. The conduit or sleeve opening shall be sealed with fire proof packing so the smoke and fire rating of the wall or floor is maintained.

F. Under no circumstances shall wire, tubing, tray, J-boxes or any BAS equipment be run in, mounted on, or suspended from any of the telephone system's equipment, cable trays or support structure (Grey Iron).

G. All the material installed under this contract must be mounted on, or supported from the building structure or supports furnished by this Contractor.

H. Control Wiring:

1. Run wiring in metallic conduit, tubing or raceways. Exceptions are as follows:

   a. NEC Class 2 low voltage wiring where not exposed to view such as above suspended ceilings, in shafts, etc., may be run in cable (when approved by code authority). Run cable in owner approved race-ways or cable supports

   b. Wiring enclosed in temperature control panels.

2. Where conduit is used, provide steel fittings.

3. Low Voltage Conductors: 18 gauge minimum, except 19 gauge may be used for home runs to central panels and 22 gauge minimum for resistance or thermistor sensing element connections.

4. Wire control interlocks and control panels, except one 120V power circuit to each temperature control panel shown on drawings and schedules shall be provided under Division 26. Coordinate with Electrical Contractor.

5. All wiring shall comply with the requirements of local and national electrical codes.

6. Do not interlock alarms with starter switching to bypass alarm when equipment is manually disconnected.

7. Variable frequency drives shall be arranged so that it can be operated in an open circuit mode, disconnected from the motors, for start-up adjustments and trouble shooting.

8. All costs of controls, wiring conduit and associated labor shall be included in the temperature control bid. The control wiring shall be installed under the supervision of this Contractor.

9. Install exposed cable in raceway.

10. Install concealed cable in conduit.

11. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

12. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

13. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

14. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

I. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

J. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

17.04 ENCLOSURES:

A. The tubing and wiring within all enclosures shall be run in plastic trays. Tubing and wiring within BAS panels may be run using adhesive-backed tie wraps.

B. All plastic tubing shall be connected to enclosures through conduit. All copper tubing shall be connected to enclosures through bulkhead fittings.

C. Mount all enclosures, including those which house BAS Panels, Slaves and Field Device Panels, so that the top of the enclosure does not exceed six feet, six inches (6'-6"); and the center of any keypad/LCD combination does not exceed five foot, six inches (5'-6") from the floor or is less than four feet zero inches (4'-0") from the floor.

D. Field Device Panels contain related Field Devices such as relays, control power (24V) transformers, output transducers, etc., that are outboard of the BAS Panels or Dedicated Controllers. Each Field Device Panel shall be mounted within an enclosure.

17.05 EXISTING CONTROLS:

A. Remove all existing controls, controllers, receiver/controllers, thermostats, sensors, Field Devices, gauges, etc.; and all associated wiring, piping and mounting hardware whose functions are being replaced by the BAS.

1. When existing equipment is removed, coordinate with a detailed Method of Procedure (MOP). Do not remove until Owner reviews.

2. Refer to General Conditions.

17.06 INSTALLATION PRACTICES:

A. The Contractor shall install and calibrate all Field Devices, sensors and transducers necessary for the complete operation of the I/O points described herein.

B. Sensors shall be removable without shutting down the system in which they are installed unless safety concerns are an issue requiring a lockout our tag-out.

C. All immersion sensors shall be installed in new, welded thermowells supplied by the Contractor. Existing thermowells may be reused with concurrence from the Owner. Coordinate any required shutdown with Owner.

D. Thermistor wire leads shall be permanently terminated at panels or controllers with wire clamps.

E. Where none exist, furnish and coordinate with mechanical contractor the installation of pressure/temperature gauges adjacent to each immersion type sensor.

F. Sensors shall be installed with the use of a wet or hot tap without draining the system if required.

17.07 IDENTIFICATION:

A. All control air piping/tubing, J-boxes, conduit and wiring shall be labeled.

B. Electrical devices, wiring, conduit and J-boxes shall be labeled and identified as required by Division 16.

1. As a minimum regardless of Division 26 requirements, all temperature control J-box covers shall be painted blue.

C. Main supply control air piping and tubing shall be labeled with Brady or equivalent markers or pre-printed identification sleeves at each end and junction point, and protected. Identification scheme shall be consistent with the drawings.

D. Identification shall be provided for all enclosures, panels, junction boxes, controllers or Field Devices. Except for enclosures, provide Brady labels. The lettering shall be white on a black background with minimum 1/4-inch high letters.

1. All new devices will be tagged. Color code to differentiate between new devices.

E. Thoroughly clean the surface to which the label shall be applied with a solvent before applying the identification.

F. The plan code designation shown on all shop drawing identification shall be consistent with the contract documents.

G. All I/O Field Devices that are not mounted within Field Device Panel enclosures shall be identified with engraved plastic laminated nameplates or Brady labels installed so that they are visible from ground level.

H. The identification shall show the designation used on the record documents and identify the function such as "mixed air temperature sensor" and "fan status DP switch".

I. Calibration settings shall be marked with paint or indelible ink.

17.08 LOCATIONS:

A. All sensing devices and locations shall be located by the Contractor as shown on the submittal shop drawings with final review by the Engineer.

B. Wall mount space sensors shall be mounted five (5) feet above finished floor. Pendant mount space sensors shall be mounted eight (8) feet above finished floor.

C. Enclosures housing Field Devices shall be located, as much as possible, immediately adjacent horizontally to the BAS panels or Slaves which are being interfaced to.

17.09 VALVES, WELLS, FLOW SWITCHES AND AUTOMATIC CONTROL DAMPERS:

A. The Controls Contractor shall have his control equipment on the project site when required and give the Owner 24 hours written notice when systems must be shut down for installation.

17.10 SENSORS:

A. Temperature controls trades shall verify all wall mounted sensor locations with the Architect/ Engineer/Owner in order to avoid interference with wall mounted and space furnishings.

1. Where interferences require moving the temperature sensor more than two feet, consult with the Architect/Engineer for relocation.

2. Do not install wall mounted sensors in decorative, tile or stone walls without specific direction from the Architect or Engineer.

B. Wall mounted temperature sensors shall be mounted in metal wall boxes as specified in, and installed per Division 26. Provide insulation around box where adjacent temperature fluctuations may affect sensor performance.

C. Provide ¾” minimum size conduit from wall box to above accessible ceiling.

D. Check and verify location of thermostats and other exposed control sensors with plans and room details before installation. Locate thermostats 60" above finished floor except for in corridors/hallways which should be 84” above finished floor.

17.11 REFRIGERATOR, FREEZER, COOLER TEMPERATURE SENSORS

A. Install vial type RTD sensors wherever monitoring of refrigerators, freezers or coolers is required.

B. Install per manufacturer’s recommendations.

C. Coordinate the installation with the refrigerator / freezer manufacturer. Including; penetrations through walls of the equipment, sealing of penetrations and mounting of vial bracket.

D. Verify alarm set points with owner / user.

E. All refrigerator, freezer, and cooler temperature sensors along with all associated controllers and equipment, needed to signal and/or send alarms, shall be powered from the emergency power system and backed-up with 20-minute (minimum) uninterruptible power supplies (UPS). Where the facility does not have an emergency power system, these items are to be backed-up with a 90-minute (minimum) UPS.

17.12 EQUIPMENT PROTECTION AND COORDINATION:

A. Where existing walls are penetrated with conduit or piping, provide a fire stop assembly which meets or exceeds the original rating of the assembly. Refer to Division 23.

B. Extreme care must be exercised while working in existing facilities and around operating equipment, particularly sensitive telephone switching and computer equipment. Close coordination with the Owner is required for the protection of this operating equipment from dust, dirt and construction material while maintaining the operational environment for the equipment. Under no circumstances shall the power or environmental requirements of the operating equipment be interrupted during the installation and check-out without submitting to the Architect, Owner and Engineer for approval.

C. A detailed Method of Procedure (MOP) stating the steps to be taken, time schedule and impacted systems for the service interruption shall be submitted to the Architect for approval prior to beginning work. Refer to Division 1 and Division 23 for requirements.

17.13 CLEANUP:

A. At the completion of the work, all equipment pertinent to this contract shall be checked and thoroughly cleaned and all other areas shall be cleaned around equipment provided under this contract. Clean the exposed surfaces of tubing, hangers, and other exposed metal of all grease, plaster, dust, or other foreign materials.

B. Upon final completion of work in an area, vacuum and/or damp wipe all finished room surfaces and furnishings. Use extreme care in cleaning around telephone switching and computer equipment and under no circumstances shall water or solvents be used around this equipment.

C. At the completion of the work and at the end of each work day, remove from the building, the premises, and surrounding streets, etc., all rubbish and debris resulting from the operations and leave all equipment spaces absolutely clean and ready for use.

17.14 SOFTWARE, DATABASE AND GRAPHICS:

A. Software Installation: The Contractor shall provide all labor necessary to install, initialize, start-up and debug all system software as described in this section. This includes any operating system software or other third party software necessary for successful operation of the system.

B. Database Configuration: The Contractor will provide all labor to configure those portions of the database that are required by the points list and sequence of operation.

C. Color Graphics: Unless otherwise directed by the Owner, the Contractor will provide color graphic displays for all systems which are specified with a sequence of operation, depicted in the mechanical drawings for each system and floor plan. For each system or floor plan, the display shall contain the associated points identified in the point list and allow for setpoint changes as required by the Owner.

17.15 TEMPERATURE CONTROL DRAWINGS:

A. Upon completion of project and after record drawings of the temperature controls have been prepared and reviewed, the Contractor shall provide one (1) complete set of temperature controls drawings.

17.16 START UP AND TESTING:

A. Prior to Beneficial Use of the BAS, the contractor shall perform virtual testing of the software and the Contractor shall supply to Architect/Engineer two (2) debugged printouts of all software entered into the BAS. Also supply all users programming and engineering manuals required to interpret the software. Included in the printouts, though not limited to, shall be the following:

1. Point data base.

2. All custom control programs written in the BAS control language.

3. All parameters required for proper operation of BAS control and utility firmware such as start-stop routines, etc.

4. Printouts or plotted detailed copies of the complete interactive system graphics.

B. The software printout shall be fully documented for ease of interpretation by the Architect/Engineer and Owner, without assistance from the Contractor. English language descriptions shall be either integrated with or attached to the BAS printout. Specifically, the following shall be documented:

1. All point (I/O and virtual) names.

2. All BAS Programming Language commands, functions, syntax, operators, and reserved variables.

3. Use of all BAS firmware.

4. The intended actions, decisions, and calculations of each line or logical group of lines in the custom control program(s). Sequences of operation are not acceptable for use in this documentation requirement.

5. Complete descriptions of and theories explaining all software and firmware algorithms. The algorithms to be described include, but are not limited to, PID, optimum start/stop, demand limiting, etc.

C. Documentation that was supplied as part of the submittals need not be submitted at this time.

D. Upon review of software, a point-to-point test of the BAS installation shall commence. The Contractor shall provide two men equipped with two-way communication and shall test actual field operation of each control and sensing point. This procedure shall occur during off hour periods. The purpose is to test the calibration, response, and action of every point. Any test equipment required to prove the proper operation of the BAS shall be provided by and operated by the Contractor. The Engineer and/Owner will be present to oversee, observe, and review the test. Demonstrate compliance that system functions per the Sequence of Operation.

1. Upon review of the point-to-point demonstration, the Contractor shall start up the BAS by putting all controlled equipment in automatic and enabling software. Contractor shall commence final software and overall BAS hardware/software debugging.

2. The point-to-point demonstration shall include any existing BAS equipment if it affects the operation of the equipment included under this contract.

3. As a minimum, existing conditions shall be maintained during system changeover.

E. Final acceptance of the BAS is contingent upon a hardware/software system test. All groups of points that yield a system of control shall be tested for compliance with the sequences of operation. Included in the test, but not limited to, shall be:

1. BAS loop response for devices that do not have the autotuning feature. The Contractor shall supply a trend data output in graphical form showing the step response of each BAS loop. The test shall show the loop's response to a change in set point which represents a change in the actuator position of at least 25% of its full range. The sampling rate of the trend shall be from one to three minutes depending on the speed of the loop. The trend data shall show for each sample the set point, actuator position, and controlled variable values. Any loop that does not yield temperature control of + 0.2deg F or humidity control of + 3% RH shall require further tuning by the Contractor.

2. Interlocks and other sequences.

3. BAS control under HVAC equipment failure.

4. HVAC operation under BAS equipment failure.

5. Battery backup.

6. BAS control under power failure/restart.

7. Reset schedules.

8. BAS alarm reporting capability.

F. A detailed test report as defined under Submittals shall be provided indicating its completion and proper system operation.

G. The BAS will not be accepted as meeting the requirements of Beneficial Use until all tests described in this section have been performed to the satisfaction of both the Architect/Engineer and Owner. Any tests that cannot be performed due to circumstances beyond the control of the Contractor shall be exempt from the Beneficial Use requirements if requested in writing by the Contractor and concurred by the Owner and Architect/Engineer. Such tests shall be performed as part of the BAS warranty.

1. A typed written document stating that the system has been fully checked out on a point by point basis shall be submitted to the Architect/Engineer. All documentation associated with the check out shall be included.

17.17 PROJECT RECORD DOCUMENTS:

A. The Contractor shall be responsible for updating all existing Project Record Documents associated with the Scope of Work outlined in the Drawings and Specifications.

B. Prior to final completion of the installation, prepare a complete set of record drawings on a clear and legible set of ANSI size 'B' (11" x 17") prints. The content, format and procedure of the submittal shall be as described by the General Conditions.

C. Provide one set of control drawings for the Facility Control Room, locate as directed by the Engineer.

D. Prior to final completion of the installation, prepare three (3) operation and maintenance manuals. The information is to be inserted in the existing operation and maintenance manuals or provided in a tabbed and indexed, 3 ring binder. The information shall include:

1. Operator's manual with step-by-step procedures for logging on/off, interrogating the system, producing reports, acknowledging alarms, overriding computer control, and changing firmware parameters.

2. Programmer's manual with complete description of the custom control language and associated editor, including sample written programs. Provide complete sets of all programming forms, applications memorandums, and addenda to the programmer's manual. All software or firmware algorithms shall be completely described and documented.

3. Maintenance, Installation, and Engineering manual(s) that clearly explains how to debug hardware problems, how to repair or replace hardware, preventive maintenance guidelines and schedules, calibration procedures, and how to engineer and install new points, panels, and Operator Interfaces.

4. Documentation of all software including software parameters that will need updating by the Owner such as, though not limited to, holiday, seasonal and start/stop schedules, comfort and duty cycling schedules.

5. All programs, code, databases, graphic files, CADD drawings and symbol libraries generated for operation of the system shall be included as a part of the system documentation. This information shall be submitted both in hard copy bound format and digital media format.

6. Input/output schedules, data sheets, and all other items required under Submittals.

7. Describe all regular maintenance that will need to be performed on the BAS hardware. List replacement parts with part numbers.

8. Complete original issue documentation and software diskettes for all third party software furnished and installed as a part of the system or required for the operation of the system including text editors, control language program and compiler, database managers, graphics and CADD packages, operating systems and communications software.

9. Complete original issue documentation, installation and operational manuals and supporting software for all third party hardware furnished and installed as a part of the system or required for the operation of the system including remote terminals, user's computer workstation, monitors, graphics and memory boards, printers and modems.

10. During the warranty period, all copies of the drawings and manuals shall be updated to include all hardware and software changes. A final update at 1 year shall be provided to the Owner.

E. All of the above documentation shall record both the equipment installed under this contract and the exact termination to all other existing control or BAS equipment.

F. The record drawings shall document the complete existing control system. This includes all mechanical equipment in work area which has automatic control.

17.18 WARRANTY:

A. The Warranty period shall begin on the date of beneficial use completion as authorized by the Architect/Engineer and Owner in writing. Beneficial use shall not occur before the Contractor has performed the tests required. With these requirements met, beneficial use shall not occur until, in the opinion of the Architect/Engineer, the BAS is sufficiently complete to be utilized for the purposes for which it is intended.

1. There shall be a warranty start date after each of the three main phases of the Project is complete – East Addition, West Addition, Remodel.

B. The BAS system shall be guaranteed to be free from defects in material and workmanship and in software design and operation for a period of the warranty after completion of the contract. The Contractor shall provide the necessary skills, labor, and parts to assure the proper operation of, and to provide all required current and preventive maintenance. This warranty shall become effective starting the date of Beneficial Use completion.

1. The hardware warranty shall include all equipment which has been purchased by the Contractor. The existing hardware is not subject to the warranty requirements.

2. All software work completed by the Contractor, associated with existing hardware, is subject to the warranty requirements outlined herein.

3. The Contractor shall respond to all calls during the warranty period for all problems or questions experienced in the operation of the installed equipment and shall take steps to correct any deficiencies that may exist.

4. The response time to any problems shall be four (4) hours maximum 24 hours per day, 7 days per week. Corrective action, temporary or permanent shall be made within one business day.

C. The Contractor shall perform an on-site or remote internet inspection of the operation of the system 3 months after each phase is completed. They shall report to the Owner in writing after each inspection, define any problems with the system and its operation, and define the procedure which will be taken to correct the problem. Contractor shall comment on the possible resolution of any problems that are out of the scope of their Contract.

1. Any problems shall be corrected as required by the warranty requirements.

D. The system shall be polled via the internet inspection for any alarm signals or "abnormal off" messages. Upon receiving such a message, the Contractor shall take indicated corrective action.

E. The Contractor shall maintain a backup of all BAS software installed in the system. The backup shall be updated monthly or whenever a change to the software is made. A reload of backup software into the system shall be performed by the Contractor immediately upon notification by the Owner. The reload shall be free of charge unless it is due to a power failure of a duration longer than the battery backup.

F. The Contractor shall optimize all control software to assure acceptable operating and space conditions, and peak energy efficiency.

G. At the end of the warranty period, the Contractor shall supply updated copies of the latest versions of all Project Record Documentation. This includes final updated drawings, software documentation and magnetic media backups that include all changes that have been made to the system during the warranty period.

17.19 TRAINING:

A. The Contractor shall provide 40 hours of training for the building operators with no limit to the number of attendees. The training sessions shall be broken into no more than (20) 2-hour sessions. The training session shall be made available to the Owner prior to the end of the warranty period but after final completion of the contract. The session shall be given at the Owner's facility. Scheduling shall be approved by the Owner. The training shall focus on general design, operation, and maintenance procedures of the products installed, though not necessarily the specific system designed, and shall cover:

1. Hardware configuration including PC boards, switches, communication and point wiring, and location and installation of all sensors and control devices.

2. Hardware maintenance, calibration, troubleshooting, diagnostics, and repair instructions.

3. Operation of man-machine interface including logging on/off, interrogating the system, producing reports, acknowledging alarms, overriding computer control, and changing firmware/software parameters.

4. Programming the BAS using the editor and the design of custom control software.

5. Recovery procedures from both BAS and HVAC failures.

17.20 THE INSTRUCTOR FOR THE ABOVE SESSION SHALL BE AN EMPLOYEE OF THE CONTRACTOR, WHO IS QUALIFIED TO PROVIDE CUSTOMER TRAINING AND APPLICATIONS SUPPORT.

17.21 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing. Report results in writing.

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

1. Operational Test: After electrical circuitry has been energized, start units to confirm proper unit operation. Remove and replace malfunctioning units and retest.

2. Test and adjust controls and safeties.

3. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

4. Pressure test control air piping at 30 psig or 1.5 times the operating pressure for 24 hours, with maximum 5-psig loss.

5. Pressure test high-pressure control air piping at 150 psig and low-pressure control air piping at 30 psig for 2 hours, with maximum 1-psig loss.

6. Test calibration of electronic controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

7. Test each point through its full operating range to verify that safety and operating control set points are as required.

8. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

9. Test each system for compliance with sequence of operation.

10. 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.

17.22 ADJUSTING

A. Calibrating and Adjusting:

1. Calibrate instruments.

2. Make three-point calibration test for both linearity and accuracy for each analog instrument.

3. 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.

4. 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.

5. 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.

6. 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.

7. 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.

8. 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.

9. 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.

10. Provide diagnostic and test instruments for calibration and adjustment of system.

11. 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.

17.23 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain HVAC instrumentation and controls. Refer to Section 01 79 00 "Demonstration and Training."

END OF SECTION 230900

SECTION 232113 - HYDRONIC PIPING

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes pipe and fitting materials, joining methods, special-duty valves, and specialties for the following:

1. Hot-water heating piping.
2. Chilled-water piping.
3. Condensate-drain piping.

1.02 DEFINITIONS

A. PTFE: Polytetrafluoroethylene.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: For each type of the following:
    a. Valves: Include flow and pressure drop curves based on manufacturer`s testing for calibrated-orifice balancing valves and automatic flow-control valves.
    b. Air control devices.
    c. Closed System Chemical treatment.
    d. Hydronic specialties.

B. Informational Submittals:

1. Operation and Maintenance Data: For air control devices, hydronic specialties, and special-duty valves to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

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

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

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. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label. Fabricate and stamp air separators and expansion tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

1.05 EXTRA MATERIALS

A. Closed System Water-Treatment Chemicals: Furnish enough chemicals for initial system startup and for preventive maintenance for one year from date of Substantial Completion.

B. Differential Pressure Meter: For each type of balancing valve and automatic flow control valve, include flowmeter, probes, hoses, flow charts, and carrying case.

PART 2 -PRODUCTS

2.01 COPPER TUBE AND FITTINGS

A. Drawn-Temper Copper Tubing: ASTM B 88, Type L.

B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.

C. Wrought-Copper Fittings: ASME B16.22.

1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.

D. Copper or Bronze Pressure-Seal Fittings:

1. Housing: Copper.

2. O-Rings and Pipe Stops: EPDM.

3. Tools: Manufacturer`s special tools.

4. Minimum 200-psig working-pressure rating at 250 deg F.

E. Wrought-Copper Unions: ASME B16.22.

2.02 STEEL PIPE AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; type, grade, and wall thickness as indicated in Part 3 "Piping Applications" Article.

B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in Part 3 "Piping Applications" Article.

C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in Part 3 "Piping Applications" Article.

D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in Part 3 "Piping Applications" Article.

E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in Part 3 "Piping Applications" Article.

F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.

G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

1. Material Group: 1.1.

2. End Connections: Butt welding.

3. Facings: Raised face.

H. Grooved Mechanical-Joint Fittings and Couplings:

1. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

2. Couplings: Ductile- or malleable-iron housing and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

I. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

2.03 JOINING MATERIALS

A. 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.

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

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

D. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.

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

2.04 VALVES

A. Gate, Globe, Check, Ball, and Butterfly Valves: Comply with requirements specified in Division 22 Section "General Duty Valves for Mechanical."

B. Automatic Temperature-Control Valves, Actuators, and Sensors: Comply with requirements specified in Division 23 Section "HVAC Instrumentation and Controls."

C. Bronze, Calibrated-Orifice, Balancing Valves:

1. Body: Bronze, ball or plug type with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Plug: Resin.
4. Seat: PTFE.
5. End Connections: Threaded or socket.
6. Pressure Gage Connections: Integral seals for portable differential pressure meter.
7. Handle Style: Lever, with memory stop to retain set position.
8. CWP Rating: Minimum 125 psig.
9. Maximum Operating Temperature: 250 deg F.

D. Cast-Iron or Steel, Calibrated-Orifice, Balancing Valves:

1. Body: Cast-iron or steel body, ball, plug, or globe pattern with calibrated orifice or venturi.
2. Ball: Brass or stainless steel.
3. Stem Seals: EPDM O-rings.
4. Disc: Glass and carbon-filled PTFE.
5. Seat: PTFE.
6. End Connections: Flanged or grooved.
7. Pressure Gage Connections: Integral seals for portable differential pressure meter.
8. Handle Style: Lever, with memory stop to retain set position.
9. CWP Rating: Minimum 125 psig.
10. Maximum Operating Temperature: 250 deg F.

E. Diaphragm-Operated, Pressure-Reducing Valves:

1. Body: Bronze or brass.
2. Disc: Glass and carbon-filled PTFE.
3. Seat: Brass.
4. Stem Seals: EPDM O-rings.
5. Diaphragm: EPT.
6. Low inlet-pressure check valve.
7. Inlet Strainer: [<>], removable without system shutdown.

8. Valve Seat and Stem: Noncorrosive.

9. Valve Size, Capacity, and Operating Pressure: Selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

F. Diaphragm-Operated Safety Valves:

1. Body: Bronze or brass.

2. Disc: Glass and carbon-filled PTFE.

3. Seat: Brass.

4. Stem Seals: EPDM O-rings.

5. Diaphragm: EPT.

6. Wetted, Internal Work Parts: Brass and rubber.

7. Inlet Strainer: removable without system shutdown.

8. Valve Seat and Stem: Noncorrosive.

9. Valve Size, Capacity, and Operating Pressure: Comply with ASME Boiler and Pressure Vessel Code: Section IV, and selected to suit system in which installed, with operating pressure and capacity factory set and field adjustable.

G. Automatic Flow-Control Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Autoflow.

b. Griswold Controls.

c. Hays.

d. Nexus.

e. FDI.

f. Pro Hydronic Specialties.

2. Body: Brass or ferrous metal.

3. Piston and Spring Assembly: Stainless steel, tamper proof, self cleaning, and removable.

4. Combination Assemblies: Include bonze or brass-alloy ball valve.

5. Identification Tag: Marked with zone identification, valve number, and flow rate.

6. Size: Same as pipe in which installed.

7. Performance: Maintain constant flow, plus or minus 5 percent over system pressure fluctuations.

8. Minimum CWP Rating: 175 psig.

2.05 AIR CONTROL DEVICES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Amtrol, Inc.

2. Armstrong Pumps, Inc.

3. Bell & Gossett Domestic Pump; a division of ITT Industries.

4. Taco.

5. Wessels.

B. Manual Air Vents:

1. Body: Bronze.

2. Internal Parts: Nonferrous.

3. Operator: Screwdriver or thumbscrew.

4. Inlet Connection: NPS 1/2.

5. Discharge Connection: NPS 1/8.

6. CWP Rating: 150 psig.

7. Maximum Operating Temperature: 225 deg F.

C. Automatic Air Vents:

1. Body: Bronze or cast iron.

2. Internal Parts: Nonferrous.

3. Operator: Noncorrosive metal float.

4. Inlet Connection: NPS 1/2.

5. Discharge Connection: NPS 1/4.

6. CWP Rating: 150 psig.

7. Maximum Operating Temperature: 240 deg F.

D. Bladder-Type Expansion Tanks:

1. Tank: Welded steel, rated for 125-psig working pressure and 375 deg F maximum operating temperature. Factory test with taps fabricated and supports installed and labeled according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 01.

2. Bladder: Securely sealed into tank to separate air charge from system water to maintain required expansion capacity.

3. Air-Charge Fittings: Schrader valve, stainless steel with EPDM seats.

4. Replaceable bladder.

E. Air Eliminator and Dirt Separator:

1. All units shall be fabricated steel, rated for 150 psig working pressure with entering velocities not to exceed 4 feet per second at specified GPM.

2. Units shall include an internal Spirotube® bundle filling the entire vessel to suppress turbulence and provide high efficiency.

3. The bundle must consist of a copper core tube with continuous wound copper medium permanently affixed to the core.

4. A separate copper medium is to be wound completely around and permanently affixed to the internal element.

5. Each eliminator shall have a separate venting chamber to prevent system contaminants from harming the float and venting valve operation.

6. At the top of the venting chamber shall be an integral full port float actuated brass venting mechanism.

7. Units shall include a valved side tap to flush floating dirt or liquids and for quick bleeding of large amounts of air during system fill or refill.

8. Separator shall have the vessel extended below pipe connections an equal distance for dirt separation.

9. Air eliminator shall be dirt model and be capable of removing 100 percent of the free air, 100 percent of the entrained air, and up to 99.6 percent of the dissolved air in the system fluid. Dirt separation shall be at least 80 percent of all particles 30 micron and larger within 100 passes.

10. Separator shall include a removeable lower head to facilitate removal of internal assembly for inspection or cleaning. Dirt separation shall be at last 80 percent of all particles 30 micron and larger within 100 passes.

2.06 CLOSED SYSTEM CHEMICAL TREATMENT

A. Bypass Chemical Feeder: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.

1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

B. Propylene Glycol: Industrial grade with corrosion inhibitors and environmental-stabilizer additives for mixing with water in systems indicated to contain antifreeze or glycol solutions.

2.07 HYDRONIC PIPING SPECIALTIES

A. Y-Pattern Strainers:

1. Body: ASTM A 126, Class B, cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 60-mesh startup strainer, and 20 mesh perforated stainless-steel basket with 8:1 area ratio.

4. CWP Rating: 125 psig.

B. Basket Strainers:

1. Body: ASTM A 126, Class B, high-tensile cast iron with bolted cover and bottom drain connection.

2. End Connections: Threaded ends for NPS 2 and smaller; flanged ends for NPS 2-1/2 and larger.

3. Strainer Screen: 60-mesh startup strainer, and perforated stainless-steel basket with 50 percent free area.

4. CWP Rating: 125 psig.

C. Stainless-Steel Bellow, Flexible Connectors:

1. Body: Stainless-steel bellows with woven, flexible, bronze, wire-reinforcing protective jacket.

2. End Connections: Threaded or flanged to match equipment connected.

3. Performance: Capable of 3/4-inch misalignment.

4. CWP Rating: 150 psig.

5. Maximum Operating Temperature: 250 deg F.

D. Spherical, Rubber, Flexible Connectors:

1. Body: Fiber-reinforced rubber body.

2. End Connections: Steel flanges drilled to align with Classes 150 and 300 steel flanges.

3. Performance: Capable of misalignment.

4. CWP Rating: 150 psig.

5. Maximum Operating Temperature: 250 deg F.

E. Expansion fittings are specified in Division 22 Section "Expansion Fittings and Loops for Mechanical."

PART 3 -EXECUTION

3.01 PIPING APPLICATIONS

A. All fittings, gaskets, couplings, equipment, and specialties shall be listed as appropriate for installation in glycol systems.

B. All imaging equipment and medical specialty piping shall be installed in material as shown on equipment vendor drawings.

C. Hot-water heating piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

D. Hot-water heating piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

E. Hot-water heating piping installed belowground and within slabs shall be any the following:

1. Type K, annealed-temper copper tubing, wrought-copper fittings with no joints.

F. Chilled-water piping, aboveground, NPS 2 and smaller, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

2. Schedule 40 steel pipe; Class 125, cast-iron fittings; cast-iron flanges and flange fittings; and threaded joints.

G. Chilled-water piping, aboveground, NPS 2-1/2 and larger, shall be any of the following:

1. Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered or brazed joints.

2. Schedule 40 steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

3. Schedule 40 steel pipe; grooved, mechanical joint coupling and fittings; and grooved, mechanical joints.

H. Chilled-water piping installed belowground and within slabs shall be any the following:

1. Type K, annealed-temper copper tubing, wrought-copper fittings with no joints.

I. Chemical Feed Piping:

1. PE tubing.

J. Condensate-Drain Piping: Type L, drawn-temper copper tubing, wrought-copper fittings, and soldered joints.

K. Piping for Blowdown-Drain, air vents, safety-valves and other ancillary hydronic piping: Same materials and joining methods as for piping specified for the service in which device is installed unless indicated otherwise.

3.02 VALVE APPLICATIONS

A. Install shutoff-duty valves at:

1. Base of each supply and return riser.

2. Supply and return mains connected to vertical risers.

3. Supply and return connection to each piece of equipment, coil and heat exchanger.

4. Additional locations as shown on plans.

B. Install calibrated-orifice, balancing valve in the return pipe of each piece of equipment, coil and heat exchanger. Calibrated orifice type balancing valves shall be used in lieu of automatic flow control valves where indicated on drawings.

C. Install check valves at each pump discharge and elsewhere as required to control flow direction.

D. Install safety valves at hot-water generators and elsewhere as required by ASME Boiler and Pressure Vessel Code. Install drip-pan elbow on safety-valve outlet and pipe without valves to the outdoors; and pipe drain to nearest floor drain or as indicated on Drawings. Comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 01, for installation requirements.

E. Install pressure-reducing valves at makeup-water connection to regulate system fill pressure.

3.03 PIPING INSTALLATIONS

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

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

C. Install piping at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

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

K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.

L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage including base of all risers.

M. Install piping at a uniform grade of 0.2 percent towards drain location.

N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.

O. Install branch connections to mains using tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.

P. Install valves according to Division 22 Section "General Duty Valves for Mechanical."

Q. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.

R. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.

S. Install strainers on inlet side of each control valve, pressure-reducing valve, solenoid valve, in-line pump, and elsewhere as indicated. Install NPS 3/4 nipple and ball valve in blowdown connection of strainers NPS 2 and larger. Match size of strainer blowoff connection for strainers smaller than NPS 2.

T. Install expansion loops, expansion joints, anchors, and pipe alignment guides as specified in Division 22 Section "Expansion Fittings and Loops for Mechanical." Where loops or in-line expansion joints are shown, provide associated anchors and guides.

U. Identify piping as specified in Division 22 Section "Mechanical Identification."

3.04 DIELECTRIC FITTING INSTALLATION

A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing in accordance with specification section 22 05 00.

3.05 HANGER AND SUPPORT INSTALLATION

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

B. Pipe hangers and supports and installation requirements are specified in Division 22 Section "Hangers and Supports for Mechanical".

3.06 PIPE 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/D10.12M, 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. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer`s written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

3.07 HYDRONIC SPECIALTIES INSTALLATION

A. Install manual air vents at high points in piping, at heat-transfer coils, and elsewhere as required for system air venting.

B. Install automatic air vents at high points of system piping in mechanical equipment rooms only. Manual vents at heat-transfer coils and elsewhere as required for air venting.

C. Install piping from boiler air outlet, air separator, or air purger to expansion tank with a 2 percent upward slope toward tank.

D. Install blowdown piping for air separators with full-port ball valve; extend full size to nearest floor drain.

E. Install bypass chemical feeders in each hydronic system, in upright position with top of funnel not more than 48 inches above the floor. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections. Install NPS 3/4 pipe from chemical feeder drain, to nearest equipment drain and include a full-size, full-port, ball valve.

F. Install expansion tanks on the floor unless indicated otherwise. Vent and purge air from hydronic system, and ensure tank is properly charged with air to suit system Project requirements. Change expansion tank to 5 psi above highest elevation of system with respect to tank location.

3.08 TERMINAL EQUIPMENT CONNECTIONS

A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.

B. Install control valves in accessible locations close to connected equipment.

C. Install ports for pressure gages and thermometers at coil inlet and outlet connections according to Division 22 Section "Meters and Gages for Mechanical."

D. Minimum runout/connection size to be 3/4 inch unless otherwise noted.

3.09 CHEMICAL TREATMENT

A. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.

B. Add initial chemical treatment and maintain water quality to prevent accumulation of scale and corrosion in piping and connected equipment the first year of operation.

C. Glycol Systems:

1. Fill systems indicated to have antifreeze or glycol solutions with the following concentrations:

a. Chilled-Water Piping: Minimum 25 percent propylene glycol.

2. Refer to Section 235000, HVAC Water Treatment for Glycol Systems, for additional requirements.

3.10 FIELD QUALITY CONTROL

A. Prepare hydronic piping according to ASME B31.9 and as follows:

1. Leave joints, including welds, uninsulated and exposed for examination during test.

2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

3. Flush hydronic piping systems according to chemical treatment procedure above; then remove and clean or replace strainer screens.

4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

B. Perform the following tests on hydronic piping:

1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

3. Isolate expansion tanks and determine that hydronic system is full of water.

4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system`s working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times "SE" value in Appendix A in ASME B31.9, "Building Services Piping."

5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

6. Prepare written report of testing.

C. Perform the following before operating the system:

1. Open manual valves fully.

2. Inspect pumps for proper rotation.

3. Set makeup pressure-reducing valves for required system pressure.

4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

5. Set temperature controls so all coils are calling for full flow.

6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

7. Verify lubrication of motors and bearings.

END OF SECTION 232113

SECTION 232123 - HYDRONIC PUMPS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Close-coupled, in-line centrifugal pumps.

1.02 DEFINITIONS

A. Buna-N: Nitrile rubber.

B. EPT: Ethylene propylene terpolymer.

1.03 SUBMITTALS

A. Action Submittals:

1. Product Data: Include certified performance curves and rated capacities, operating characteristics, furnished specialties, final impeller dimensions, and accessories for each type of product indicated. Indicate pump`s operating point on curves.

B. Informational submittals:

1. Operation and Maintenance Data: For pumps to include in emergency, operation, and maintenance manuals.

1.04 QUALITY ASSURANCE

A. Product Options: Drawings indicate size, profiles, and dimensional requirements of hydronic pumps and are based on the specific system indicated. Refer to Division 01 Section "Product Requirements."

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.05 DELIVERY, STORAGE, AND HANDLING

A. Manufacturer`s Preparation for Shipping: Clean flanges and exposed machined metal surfaces and treat with anticorrosion compound after assembly and testing. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

B. Store pumps in dry location.

C. Retain protective covers for flanges and protective coatings during storage.

D. Protect bearings and couplings against damage from sand, grit, and other foreign matter.

E. Comply with pump manufacturer`s written rigging instructions.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 PUMP REQUIREMENTS

A. Install piping, shutoff valve, and pressure gauges across all pump impellers. Isolation valves provided on each side of impeller.

B. Pump to be selected at best operating point on curve. Select pump to allow impeller changes in submitted casing.

2.03 CLOSE-COUPLED, IN-LINE CENTRIFUGAL PUMPS

A. Manufacturers:

1. Armstrong Pumps Inc.

2. Aurora Pump; Division of Pentair Pump Group.

3. Bell & Gossett; Div. of ITT Industries.

4. PACO Pumps/Sulzer.

5. Peerless Pump; a Member of the Sterling Fluid Systems Group.

6. Taco, Inc.

B. Description: Factory-assembled and -tested, centrifugal, overhung-impeller, close-coupled, in-line pump as defined in HI 1.1-1.2 and HI 1.3; designed for installation with pump and motor shafts mounted vertically. Rate pump for 175-psig minimum working pressure and a continuous water temperature of 225 deg F.

C. Pump Construction:

1. Casing: Radially split, cast iron, with replaceable bronze wear rings, threaded gage tappings at inlet and outlet, and companion-flange or union end connections.

2. Impeller: ASTM B 584, cast bronze; statically and dynamically balanced, keyed to shaft, and secured with a locking cap screw. Trim impeller to match specified performance.

3. Pump Shaft: Stainless steel.

4. Mechanical Seal: Carbon rotating ring against a ceramic seat held by a stainless-steel spring, and Buna-N bellows and gasket. Include water slinger on shaft between motor and seal.

D. Motor: Single speed, with permanently lubricated ball bearings, unless otherwise indicated; and rigidly mounted to pump casing. Comply with requirements in Division 22 Section "Common Motor Requirements for Mechanical."

PART 3 -EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for piping systems to verify actual locations of piping connections before pump installation.

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

3.02 PUMP INSTALLATION

A. Provide Venturi ports in developed length on discharge of pumps for balancing.

B. Impellers shall not bear the weight of the piping during installation.

C. Comply with HI 2.4.

D. Install pumps with access for periodic maintenance including removal of motors, impellers, couplings, and accessories.

E. Suspend vertically mounted, in-line centrifugal pumps independent of piping. Install pumps with motor and pump shafts vertical.

3.03 CONNECTIONS

A. Install hose end connections and drains at low point of base mounted pump piping system.

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

C. Install piping adjacent to machine to allow service and maintenance.

D. Connect piping to pumps. Install valves that are same size as piping connected to pumps.

E. Install suction and discharge pipe sizes equal to or greater than diameter of pump nozzles.

F. Install check and venturi valve on discharge side of pumps. Additional shut-off valve shall be provided downstream of triple duty valve for isolation.

G. Install Y-type strainer on inline pumps and suction diffuser and shutoff valve on suction side of pumps.

H. Install flexible connectors on suction and discharge sides of base-mounted pumps between pump casing and valves.

I. Install pressure gages on pump suction and discharge, at integral pressure-gage tapping, or install single gage with multiple input selector valve.

J. Install check valve and gate or ball valve on each condensate pump unit discharge.

K. Install electrical connections for power, controls, and devices.

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

M. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

3.04 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer`s written instructions.

2. Check piping connections for tightness.

3. Clean strainers on suction piping.

4. Perform the following startup checks for each pump before starting:

a. Verify bearing lubrication.

b. Verify that pump is free to rotate by hand and that pump for handling hot liquid is free to rotate with pump hot and cold. If pump is bound or drags, do not operate until cause of trouble is determined and corrected.

c. Verify that pump is rotating in the correct direction.

5. Prime pump by opening suction valves and closing drains, and prepare pump for operation.

6. Start motor.

7. Open discharge valve slowly.

3.05 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner`s maintenance personnel to adjust, operate, and maintain hydronic pumps.

END OF SECTION 232123

SECTION 232500 - HVAC WATER TREATMENT FOR GLYCOL SYSTEMS

PART 1 -GENERAL

1.01 WORK INCLUDED

A. This Section includes hydronic systems treatment for HVAC hydronic systems that contain glycol. The Contractor performing the hydronic systems treatment shall provide labor, materials, equipment, instruments and transportation associated with the glycol-based solutions. Hydronic systems work required by this section is indicated on drawings and schedules by requirements of this Section.

B. Types of hydronic piping and specialties specified in this section include the following:

1. Propylene Glycol Solution.

2. Automatic Chemical Feeders.

3. System Cleaning and Water Treatment.

C. Hydronic system shall include all piping both inside the building and outside the building.

D. Provide the following electrical work as work of this Section, in compliance with electrical specifications:

1. Automatic Chemical Feeders: Control and interlock wiring between operating controls and indicating devices.

1.02 SUBMITTALS

A. Action Submittals:

1. Product Data: From manufacturers, for solution feeder specified, include rated capacities of selected models, weights (shipping, installed, and operating), furnished specialties and accessories, and installation instructions.

B. Informational Submittals:

1. Maintenance Data: For solution feeder, system cleaning and water treatment, and glycol-based solution handling and storage, for inclusion in operation and maintenance manual.

1.03 QUALITY ASSURANCE

A. Comply with all applicable codes in the transportation, use, storage and disposal of glycol-based solutions.

B. Verify if local plumbing codes require industrially inhibited propylene glycol-based heat transfer fluid where contact with food or potable water is possible.

C. All system components in contact with the glycol-based solution in normal use, testing, repair or servicing, including but not limited to pumps, valves, gaskets, seals, O-rings, etc., shall be fully compatible with the solution of heat transfer fluid at the temperatures and pressures used in the system. “Fully compatible” in this paragraph means free from corrosion within the limits of the ASTM Standard D1384, free from erosion and scaling, free from fluid leaks, capable of performing the stated or implied function without binding, sticking or plugging, free from degradation of system materials, leaching of the system materials or degradation of the glycol solution and the inhibitors.

D. After installation and circulation of the glycol mixture, a representative sample shall be sent to the manufacturer for analysis. For a system containing more than 250 gallons of fluid, an annual analysis must be provided free of charge by the fluid manufacturer. The analysis shall report glycol concentration, freeze point temperature, inhibitor level, pH, reserve alkalinity, contaminants such as: chloride, sulfate, nitrite, nitrate, and total hardness. Recommendations on additions of glycol or inhibitors shall also be given as needed. The analysis results will be returned to the Contractor/Engineer as requested.

E. Annual analysis of the fluid will be provided by the manufacturer, free of charge to ensure fluid quality. Recommendations for adjustment, if necessary, will be made at that time.

1.04 MAINTENANCE

A. Maintenance Stock: Furnish a sufficient quantity of chemical for initial system start-up and for preventive maintenance for one (1) year from Substantial Completion.

B. Maintenance Service: Provide a service program to maintain water conditions required. Annually test and certify the concentration of glycol, corrosion, inhibitors, pH, reserve alkalinity and trace chemicals.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide hydronic system treatment products from one (1) of the following:

1. Propylene Glycol:

    a. DowFrost HD; The Dow Chemical Co.

    b. Intercool P-323; Interstate Chemical Co.

    c. Safe-T-Therm; Houghton Chemical Corp.

2. Automatic Chemical Feeders:

    a. General Treatment Products

    b. J.L. Wingert Co.

    c. Wessels.

    d. Winters.

2.02 GLYCOL-BASED SOLUTIONS

A. Propylene Glycol: Furnish industrially inhibited propylene glycol containing corrosion inhibitor for all metals including yellow metals. Propylene glycol shall be United States Pharmacopeia (USP) grade.

B. Glycol shall be suitable for a bulk operating range of -20 deg F to 300 deg F and a maximum film temperature of 320 deg F.

C. Refer to drawings and schedules for glycol concentration by volume.

D. The glycol must be dyed to facilitate leak detection.

E. The glycol must pass ASTM D1384 (less than 0.5 mil penetration per year for all system metals).

2.03 DILUTION WATER

A. The water used to dilute the concentrated glycol-based fluid must be either distilled, deionized or contain less than 25 PPM of each of chloride and sulfate, and less than 50 PPM each of hard water ions (calcium and magnesium as calcium carbonate) with a total hardness not to exceed 100 PPM. If good quality water is unavailable, the manufacturer of the product will provide the heat transfer fluid and water to meet the specifications of the system.

2.04 CHEMICAL FEEDERS

A. Manual Chemical Feeders: Bypass type chemical feeders of 5-gallon capacity, welded steel construction; 200 PSIG working pressure; complete with fill funnel and inlet, outlet and drain valves. Quarter-turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.

B. Automatic Chemical Feeders: 50-gallon chemical solution tank fabricated from polyethylene with polyethylene hinged cover, supported by a carbon steel bottom mount stand, complete with 1/3-HP gear pump, NEMA 4X control panel, low level switch with 10-amp relay, brass pressure relief valve, pressure switch and gauge, drain valve and strainer.

2.05 HYDRONIC SYSTEM CLEANING SOLUTION

A. As required by the cleaning methods described in Part 3 – Execution of this Section.

PART 3 -EXECUTION

3.01 SYSTEM PREPARATION

A. Install manual chemical feeders in each hydronic system; in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line of main using ball or butterfly valves on each side of feeder and in the main between bypass connections. Pipe drain, with ball valve, to nearest equipment drain.

B. Install automatic chemical feeders within 10 feet of injection point in each hydronic system where indicated; bolt to a level concrete pad. Install feeder in bypass line using isolation ball valve or gate valve on each side of feeder in main between bypass connections.

C. The system shall be cleaned, degreased and thoroughly flushed prior to the installation of the glycol-based solution to remove dirt, weld slag, filings, solder flux, oil, etc. A new or mildly corroded system shall be cleaned with a solution of trisodium phosphate in water, prepared in a portion of 1 lb/50 gallons of water in the system, or another approved cleaning solution. After system is filled with this solution, the circulation pump should be started, trapped air vented and the boiler set to supply approximately 100 deg F loop temperature. This cleaning solution shall be circulated for 8-12 hours. Remove, clean and replace strainer screens.

D. The system shall be drained completely, refilled with fresh water and circulated for a minimum of 72 hours, at which time a sample should be taken to verify that the system is free of particulates, mil scale, weld scale, solder flux, rust, metal filings, oil, grease, chlorides, sulfates, silicates and other foreign matter that could degrade the glycol-based solution.

E. After system has been completely cleaned as specified herein, it shall be tested by litmus paper or other dependable methods and left on slightly alkaline side (PH 7.5). If system is still on acid side, cleaning by use of trisodium phosphate shall be repeated.

F. If the water in the system is not acceptable, as defined in 2.3.A, the water shall be removed from the system and good quality water obtained to meet the requirements for use in diluting the glycol-based solution. If the manufacturer is supplying both fluid and water, they may be installed upon removal of the flush water.

G. Chemical Treatment: Provide a water analysis prepared by the chemical treatment supplier to determine the type and level of chemicals required for prevention of scale and corrosion. Perform initial treatment after completion of system testing.

3.02 FLUID INSTALLATION

A. The system piping shall be hydrostatically tested to ensure that there are no leaks. This may be done using the flush water in the system.

B. The Contractor shall furnish and install a water meter to measure the volume of flush water put into the system. The total volume of the system is needed to determine the amount of glycol required to meet the specified glycol concentration for the system. The Contractor is responsible for disposal of the glycol or water overages.

C. For systems with over 500 gallons of glycol required, the Contractor shall provide and install a 2-inch fill connection. The 2-inch fill connection shall be fitted with a Camlock fitting to accept the tanker truck hose. The Contractor shall also inform the Glycol Supplier of the distance in feet between the tanker truck and the location of the special fill connection, so that the truck has an adequate supply of hose. After system filling, this fitting will be removed and replaced with a pipe cap. The carrier shall be responsible for connecting the hose to the system and all required tanker truck operations.

D. A refractometer as manufactured by Misco Products shall be provided by the Contractor and left with the building Owner. This refractometer shall be used to measure the freezing point in degrees Fahrenheit of the glycol/water solution in the system.

3.03 IDENTIFICATION MATERIALS

A. The Contractor shall provide a system nameplate permanently encased in clear plastic with, but not limited to, the following information; date, description of heat transfer fluid, manufacturer's name, address and telephone numbers for normal and emergency contact, percent glycol by volume, freeze point, total system volume in gallons, a copy of or reference to the Material Safety Data Sheet (MSDS), instructions for sampling the fluid, and the address to which the sample is to be sent. Include a notation that the samples will be analyzed free of charge and that recommendations will be provided for adjusting glycol concentration, adding corrosion inhibitors, and for filtering particulates. Include a notation that proper inhibitor monitoring and maintenance must be performed (via annual analysis by the manufacturer) in order to prevent corrosion of the piping system components, degradation of piping system materials, degradation of the glycol, sludge formation in the system or freezing of the solution

3.04 START UP SERVICES

A. Fill system and perform initial chemical treatment.

B. The Contractor shall take a fluid sample with the manufacturer's supplied test kit after the system has been circulating for a minimum of 24 hours. The manufacturer shall provide a thermal fluid analysis report to the Engineer in writing. The Contractor shall be responsible to complete any changes in the heat transfer solution if it does not meet with these specifications.

END OF SECTION 232500

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 232923 - VARIABLE FREQUENCY CONTROLLERS FOR HVAC

PART 1 -GENERAL

1.01 SUMMARY

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

B. See Division 26 Section "Motor-Control Centers" for VFCs installed in motor-control centers.

1.02 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. IGBT: Insulated-gate bipolar transistor.

F. LAN: Local area network.

G. LED: Light-emitting diode.

H. MCP: Motor-circuit protector.

I. NC: Normally closed.

J. NO: Normally open.

K. OCPD: Overcurrent protective device.

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

M. PWM: Pulse-width modulated.

N. RFI: Radio-frequency interference.

O. VFC: Variable-frequency motor controller.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: VFCs shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.04 SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

B. LEED Submittals:

1. Product Data for Credit EA 5: For continuous metering equipment for energy consumption.

C. Shop Drawings: For each VFC indicated. Include dimensioned plans, elevations, and sections; and conduit entry locations and sizes, mounting arrangements, and details, including required clearances and service space around equipment.

1. Show tabulations of installed devices, equipment features, and ratings.

2. Schematic and Connection Wiring Diagrams: For power, signal, and control wiring.

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

E. Seismic Qualification Certificates: For VFCs, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.

2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.

3. Detailed description of equipment anchorage devices on which the certification is based, and their installation requirements.

F. Product certificates.

G. Source quality-control reports.

H. Field quality-control reports.

I. Operation and maintenance data.

1.05 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

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.

D. IEEE Compliance: Fabricate and test VFC according to IEEE 344 to withstand seismic forces defined in Division 26 Section "Vibration and Seismic Controls for Electrical."

1.06 WARRANTY

A. Special Warranty: Manufacturer`s standard form in which manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 -PRODUCTS

2.01 MANUFACTURED UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. ABB.

2. Baldor Electric Company.

3. Danfoss Inc.; Danfoss Drives Div.

4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

5. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

6. Rockwell Automation, Inc.; Allen-Bradley Brand.

7. Siemens Energy & Automation, Inc.

8. Square D; a brand of Schneider Electric.

9. Toshiba International Corporation.

10. Yaskawa Electric America, Inc; Drives Division.

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

C. Application: Constant torque and variable torque.

D. VFC Description: Variable-frequency power converter (rectifier, dc bus, and IGBT, PWM inverter) factory packaged in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1, Design A and Design B motors as defined by NEMA MG 1, Section IV, Part 30, "Application Considerations for Constant Speed Motors Used on a Sinusoidal Bus with Harmonic Content and General Purpose Motors Used with Adjustable-Voltage or Adjustable-Frequency Controls or Both."

2. Units suitable for operation of inverter-duty motors as defined by NEMA MG 1, Section IV, Part 31, "Definite-Purpose Inverter-Fed Polyphase Motors."

3. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

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

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

G. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.

2. Input AC Voltage Unbalance: Not exceeding 3 percent.

3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.

4. Minimum Efficiency: 96 percent at 60 Hz, full load.

5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.

6. Minimum Short-Circuit Current (Withstand) Rating: 10 kA.

7. Ambient Temperature Rating: Not less than 14 deg F and not exceeding 104 deg F.

8. Ambient Storage Temperature Rating: Not less than minus 4 deg F and not exceeding 140 deg F

9. Humidity Rating: Less than 95 percent (noncondensing).

10. Altitude Rating: Not exceeding 3300 feet.

11. Vibration Withstand: Comply with IEC 60068-2-6.

12. Overload Capability: 1.1 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.

13. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.

14. Speed Regulation: Plus or minus 5 percent.

15. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.

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

H. Inverter Logic: Microprocessor based, 16 bit, isolated from all power circuits.

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

J. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.

2. Maximum Speed: 80 to 100 percent of maximum rpm.

3. Acceleration: 0.1 to 999.9 seconds.

4. Deceleration: 0.1 to 999.9 seconds.

5. Current Limit: 30 to minimum of 150 percent of maximum rating.

K. Self-Protection and Reliability Features:

1. Input transient protection by means of surge suppressors to provide three-phase protection against damage from supply voltage surges 10 percent or more above nominal line voltage.

2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.

3. Under- and overvoltage trips.

4. Inverter overcurrent trips.

5. VFC and Motor Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor overload alarm and trip; settings selectable via the keypad; NRTL approved.

6. Critical frequency rejection, with three selectable, adjustable deadbands.

7. Instantaneous line-to-line and line-to-ground overcurrent trips.

8. Loss-of-phase protection.

9. Reverse-phase protection.

10. Short-circuit protection.

11. Motor overtemperature fault.

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

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

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

O. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

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

Q. Integral Input Disconnecting Means and OCPD: NEMA AB 1, instantaneous-trip circuit breaker with pad-lockable, door-mounted handle mechanism.

1. Disconnect Rating: Not less than 115 percent of VFC input current rating.

2. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.

2.02 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

1. Power on.

2. Run.

3. Overvoltage.

4. Line fault.

5. Overcurrent.

6. External fault.

B. Panel-Mounted Operator Station: Manufacturer`s standard front-accessible, sealed keypad and plain-English language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.

2. Security Access: Provide electronic security access to controls through identification and password with at least three levels of access: View only; view and operate; and view, operate, and service.

a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

1. Running log of total power versus time.

2. Total run time.

3. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).

2. Motor speed (rpm).

3. Motor status (running, stop, fault).

4. Motor current (amperes).

5. Motor torque (percent).

6. Fault or alarming status (code).

7. PID feedback signal (percent).

8. DC-link voltage (V dc).

9. Set point frequency (Hz).

10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:

a. A minimum of two programmable analog inputs: 0- to 10-V dc.

b. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

a. 0- to 10-V dc.

b. 4- to 20-mA dc.

c. Potentiometer using up/down digital inputs.

d. Fixed frequencies using digital inputs.

e. Insert signal input.

3. Output Signal Interface: A minimum of one programmable analog output signal(s) (0- to 10-V dc), which can be configured for any of the following:

a. Output frequency (Hz).

b. Output current (load).

c. DC-link voltage (V dc).

d. Motor torque (percent).

e. Motor speed (rpm).

f. Set point frequency (Hz).

g. Insert indication.

4. Remote Indication Interface: A minimum of two programmable dry-circuit relay outputs (120-V ac, 1 A) for remote indication of the following:

a. Motor running.

b. Set point speed reached.

c. Fault and warning indication (overtemperature or overcurrent).

d. PID high- or low-speed limits reached.

e. Insert indication.

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: One.

G. BAS Interface: Factory-installed hardware and software to enable the BAS to monitor, control, and display VFC status and alarms and energy usage. Allows VFC to be used with an external system within a multidrop LAN configuration; settings retained within VFC`s nonvolatile memory.

1. Network Communications Ports: Ethernet and RS-422/485.

2. Embedded BAS Protocols for Network Communications: ASHRAE 135 BACnet; protocols accessible via the communications ports.

2.03 LINE CONDITIONING AND FILTERING

A. Input Line Conditioning: Insert requirements.

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

2.04 BYPASS SYSTEMS

A. Bypass Operation: Safely transfers motor between power converter output and bypass circuit, manually, automatically, or both. Selector switches set modes and indicator lights indicate mode selected. Unit is capable of stable operation (starting, stopping, and running) with motor completely disconnected from power converter.

B. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor and retransfer shall only be allowed with the motor at zero speed.

C. Bypass Mode: Field-selectable automatic or manual, allows local and remote transfer between power converter and bypass contactor and retransfer, either via manual operator interface or automatic control system feedback.

D. Bypass Controller: Two-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter and permit safe troubleshooting and testing, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break, IEC-rated contactor.

2. Output Isolating Contactor: Non-load-break, IEC-rated contactor.

3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

E. Bypass Controller: Three-contactor-style bypass allows motor operation via the power converter or the bypass controller; with input isolating switch and barrier arranged to isolate the power converter input and output and permit safe testing and troubleshooting of the power converter, both energized and de-energized, while motor is operating in bypass mode.

1. Bypass Contactor: Load-break, IEC-rated contactor.

2. Input and Output Isolating Contactors: Non-load-break, IEC-rated contactors.

3. Isolating Switch: Non-load-break switch arranged to isolate power converter and permit safe troubleshooting and testing of the power converter, both energized and de-energized, while motor is operating in bypass mode; pad-lockable, door-mounted handle mechanism.

F. Bypass Contactor Configuration: Full-voltage (across-the-line) type.

1. NORMAL/BYPASS selector switch.

2. HAND/OFF/AUTO selector switch.

3. NORMAL/TEST Selector Switch: Allows testing and adjusting of VFC while the motor is running in the bypass mode.

4. Contactor Coils: Pressure-encapsulated type with coil transient suppressors.

a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer`s standard matching control power or line voltage.

b. Power Contacts: Totally enclosed, double break, and silver-cadmium oxide; assembled to allow inspection and replacement without disturbing line or load wiring.

5. Control Circuits: 120-V ac; obtained from integral CPT, with primary and secondary fuses, with CPT of sufficient capacity to operate all integral devices and remotely located pilot, indicating, and control devices.

a. CPT Spare Capacity: 50 VA.

6. Overload Relays: NEMA ICS 2.

2.05 OPTIONAL FEATURES

A. Damper control circuit with end of travel feedback capability.

B. Firefighter`s Override (Smoke Purge) Input: On a remote contact closure from the firefighter's control station, this password-protected input:

1. Overrides all other local and external inputs (analog/digital, serial communication, and all keypad commands).

2. Forces VFC to operate motor, without any other run or speed command, at a field-adjustable, preset speed.

3. Forces VFC to transfer to Bypass Mode and operate motor at full speed.

4. Causes display of Override Mode on the VFC display.

5. Reset VFC to normal operation on removal of override signal automatically.

C. Communication Port: RS-232 port, USB 2.0 port, or equivalent connection capable of connecting a printer and a notebook computer.

D. Insert optional feature.

2.06 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.

2. Outdoor Locations: Type 3R.

3. Kitchen Areas: Type 4X, stainless steel.

4. Other Wet or Damp Indoor Locations: Type 4.

5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

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

2.07 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oil-tight type.

B. Push Buttons: Covered types; maintained.

1. Pilot Lights: Incandescent types; Insert color(s); push to test.

a. Selector Switches: Rotary type.

C. NC bypass contactor auxiliary contact(s).

D. Control Relays: Auxiliary and adjustable pneumatic time-delay relays.

E. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

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

F. Supplemental Analog Meters:

1. Elapsed time meter.

2. Kilowatt meter.

3. Kilowatt-hour meter.

G. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 4 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

H. Space heaters, with NC auxiliary contacts, to mitigate condensation in NEMA 250, Type 3R enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

I. Cooling Fan and Exhaust System: For NEMA 250, Type 1; UL 508 component recognized: Supply fan, with composite intake and exhaust grilles and filters; 120-V ac; obtained from integral CPT.

2.08 SOURCE QUALITY CONTROL

A. Testing: Test and inspect VFCs according to requirements in NEMA ICS 61800-2 .

1. Test each VFC while connected to its specified motor.

2. Verification of Performance: Rate VFCs according to operation of functions and features specified.

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

C. Prepare test and inspection reports.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Wall-Mounting Controllers: Install VFCs on walls with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished floor unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical."

B. Roof-Mounting Controllers: Install VFC on roofs with tops at uniform height and with disconnect operating handles not higher than 79 inches above finished roof surface unless otherwise indicated, and by bolting units to curbs or mounting on freestanding, lightweight, structural-steel channels bolted to curbs. Seal roof penetrations after raceways are installed.

1. Curbs and roof penetrations are specified in Division 07 Section "Roof Accessories."

2. Structural-steel channels are specified in Division 26 Section "Hangers and Supports for Electrical."

C. Seismic Bracing: Comply with requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical."

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

E. Install fuses in each fusible-switch VFC.

F. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

G. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

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

I. Comply with NECA 1.

3.02 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each VFC with engraved nameplate.

3. Label each enclosure-mounted control and pilot device.

3.03 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Division 26 Section "Control-Voltage Electrical Power Cables."

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

C. Connect selector switches and other automatic control devices where applicable.

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

2. Connect selector switches with control circuit in both manual and automatic positions for safety-type control devices such as low- and high-pressure cutouts, high-temperature cutouts, and motor overload protectors.

3.04 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

D. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.

2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.

3. Test continuity of each circuit.

4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Architect before starting the motor(s).

5. Test each motor for proper phase rotation.

6. Perform each electrical test and visual and mechanical inspection stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

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

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

3.05 ADJUSTING

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

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

C. Adjust the trip settings of MCPs and thermal-magnetic circuit breakers with adjustable, instantaneous trip elements. Initially adjust to six times the motor nameplate full-load amperes and attempt to start motors several times, allowing for motor cool-down between starts. If tripping occurs on motor inrush, adjust settings in increments until motors start without tripping. Do not exceed eight times the motor full-load amperes (or 11 times for NEMA Premium Efficient motors if required). Where these maximum settings do not allow starting of a motor, notify Architect before increasing settings.

D. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.06 DEMONSTRATION

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

END OF SECTION 232923

SECTION 233113 - METAL DUCTS

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Sheet metal materials.
4. Sealants and gaskets.
5. Hangers and supports.

1.02 PERFORMANCE REQUIREMENTS

A. 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.

B. Structural Performance: Duct hangers and supports shall withstand the effects of gravity loads and stresses within limits and under conditions described in SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible".

1.03 SUBMITTALS

A. Informational Submittals

1. Shop Drawings:
   a. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
   b. Factory- and shop-fabricated ducts and fittings.
   c. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
   d. Elevation of top of ducts.
   e. Dimensions of main duct runs from building grid lines.
   f. Fittings.
   g. Reinforcement and spacing.
   h. Seam and joint construction.

i. Penetrations through fire-rated and other partitions.

j. Equipment installation based on equipment being used on Project.

k. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.

l. Hangers and supports, including methods for duct and building attachment[<>] and vibration isolation.

2. Coordination Drawings: Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

a. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.

b. Suspended ceiling components.

c. Structural members to which duct will be attached.

d. Size and location of initial access modules for acoustical tile.

e. Penetrations of smoke barriers and fire-rated construction.

f. Items penetrating finished ceiling including the following:
1) Lighting fixtures.
2) Air outlets and inlets.
3) Speakers.
4) Sprinklers.
5) Access panels.
6) Perimeter moldings.

B. Close Outs

1. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports.

2. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

PART 2 -PRODUCTS

2.01 SINGLE-WALL RECTANGULAR DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible" based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-1, "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 2-2, "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 4, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible."

2.02 SINGLE-WALL ROUND DUCTS AND FITTINGS

A. General Fabrication Requirements: Comply with SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on indicated static-pressure class unless otherwise indicated.

B. Transverse Joints: Select joint types and fabricate according to SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "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 3-2, "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.

2. Fabricate flat-oval ducts larger than 72 inches in width (major dimension) 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 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible."

2.03 SHEET METAL MATERIALS

A. General Material Requirements: Comply with SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G90.

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

C. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

D. Tie Rods: Galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.04 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. 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.

C. 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.

6. For indoor applications, use sealant that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

D. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

E. 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.

2.05 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Strap and Rod Sizes: Comply with SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct."

C. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

D. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

E. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

F. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

PART 3 -EXECUTION

3.01 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 "Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA`s "Duct Cleanliness for New Construction Guidelines."

3.02 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."

3.03 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible," Chapter 5, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.

2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.

3. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches thick.

C. Hanger Spacing: Comply with SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible," Table 5-1, "Rectangular Duct Hangers Minimum Size," and Table 5-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches of each elbow and within 48 inches of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports. Trim threaded rods to no more than 1” overrun.

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 interval 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.

G. Insulated Duct:

1. Attach spacers to duct.

a. Duct Operating Above Ambient Air Temperature: Hangers and supports may project through insulation.

b. Duct Operating Below Ambient Air Temperature: Use thermal-hanger shield insert. Provide protection saddle shield insert, minimum 4 inch, 180 degrees for round duct and a minimum of 4” turn up on rectangular duct.

c. Insert Material: Length of at least as long as protective shield.

d. Thermal Hanger Shields: Install with insulation same thickness as duct insulation.

3.04 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Duct Accessories."

B. Comply with SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.05 PAINTING

A. Paint interior of metal ducts that are visible through registers and grilles and that do not have duct liner. Apply one coat of flat, black, latex paint over a compatible galvanized-steel primer. Paint materials and application requirements are specified in Division 09 painting Sections.

3.06 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Leakage Tests:

1. Comply with SMACNA`s "HVAC Air Duct Leakage Test Manual." Submit a test report for each test.

2. Test representative duct sections totaling no less than 25 percent of total installed duct area for each system.

3. Disassemble, reassemble, and seal segments of systems to accommodate leakage testing and for compliance with test requirements.

4. Test for leaks before applying external insulation.

5. Conduct tests at static pressures equal to maximum design pressure of system or section being tested. If static-pressure classes are not indicated, test system at maximum system design pressure. Do not pressurize systems above maximum design operating pressure.

6. Give seven days` advance notice for testing.

C. Duct System Cleanliness Tests:

1. Visually inspect duct system to ensure that no visible contaminants are present.

2. Test sections of metal duct system, chosen randomly by Owner, for cleanliness according to "Vacuum Test" in NADCA ACR, "Assessment, Cleaning and Restoration of HVAC Systems."

a. Acceptable Cleanliness Level: Net weight of debris collected on the filter media shall not exceed 0.75 mg/100 sq. cm.

D. Duct system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.07 DUCT CLEANING

A. The following shall be used if new ductwork fails duct system cleanliness tests.

B. Use service openings for entry and inspection.

1. Create new openings and install access panels appropriate for duct static-pressure class if required for cleaning access. Provide insulated panels for insulated or lined duct. Patch insulation and liner as recommended by duct liner manufacturer. Comply with Division 23 Section " Duct Accessories" for access panels and doors.

2. Disconnect and reconnect flexible ducts as needed for cleaning and inspection.

3. Remove and reinstall ceiling to gain access during the cleaning process.

C. Particulate Collection and Odor Control:

1. When venting vacuuming system inside the building, use HEPA filtration with 99.97 percent collection efficiency for 0.3-micron-size (or larger) particles.

2. When venting vacuuming system to outdoors, use filter to collect debris removed from HVAC system, and locate exhaust downwind and away from air intakes and other points of entry into building.

D. Clean the following components by removing surface contaminants and deposits:

1. Air outlets and inlets (registers, grilles, and diffusers).

2. Supply, return, and exhaust fans including fan housings, plenums (except ceiling supply and return plenums), scrolls, blades or vanes, shafts, baffles, dampers, and drive assemblies.

3. Air-handling unit internal surfaces and components including mixing box, coil section, air wash systems, spray eliminators, condensate drain pans, humidifiers and dehumidifiers, filters and filter sections, and condensate collectors and drains.

4. Coils and related components.

5. Return-air ducts, dampers, actuators, and turning vanes except in ceiling plenums and mechanical equipment rooms.

6. Supply-air ducts, dampers, actuators, and turning vanes.

7. Dedicated exhaust and ventilation components and makeup air systems.

E. Mechanical Cleaning Methodology:

1. Clean metal duct systems using mechanical cleaning methods that extract contaminants from within duct systems and remove contaminants from building.

2. Use vacuum-collection devices that are operated continuously during cleaning. Connect vacuum device to downstream end of duct sections so areas being cleaned are under negative pressure.

3. Use mechanical agitation to dislodge debris adhered to interior duct surfaces without damaging integrity of metal ducts, duct liner, or duct accessories.

4. Clean fibrous-glass duct liner with HEPA vacuuming equipment; do not permit duct liner to get wet. Replace fibrous-glass duct liner that is damaged, deteriorated, or delaminated or that has friable material, mold, or fungus growth.

5. Clean coils and coil drain pans according to NADCA 1992. Keep drain pan operational. Rinse coils with clean water to remove latent residues and cleaning materials; comb and straighten fins.

6. Provide drainage and cleanup for wash-down procedures.

7. Antimicrobial Agents and Coatings: Apply EPA-registered antimicrobial agents if fungus is present. Apply antimicrobial agents according to manufacturer`s written instructions after removal of surface deposits and debris.

3.08 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.09 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

1. Supply Ducts:

   a. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
      1) Pressure Class: Positive 2-inch wg.
      2) Minimum SMACNA Seal Class: A.
      3) SMACNA Leakage Class for Rectangular: 12.
      4) SMACNA Leakage Class for Round and Flat Oval: 6.

   b. Ducts Connected to Variable-Air-Volume Air-Handling Units:
      1) Pressure Class: 125% of scheduled total static capability of fan or AHU.
      2) Minimum SMACNA Seal Class: A.
      3) SMACNA Leakage Class for Rectangular: 6.
      4) SMACNA Leakage Class for Round and Flat Oval: 3.

   c. Ducts Connected to Equipment Not Listed Above:
      1) Pressure Class: Positive 4-inch wg.
      2) Minimum SMACNA Seal Class: A.
      3) SMACNA Leakage Class for Rectangular: 6.
      4) SMACNA Leakage Class for Round and Flat Oval: 3.

2. Return Ducts:

   a. Ducts Connected to Fan Coil Units, Furnaces, Heat Pumps, and Terminal Units:
      1) Pressure Class: Positive or negative 2-inch wg.
      2) Minimum SMACNA Seal Class: A.
      3) SMACNA Leakage Class for Rectangular: 12.

4) SMACNA Leakage Class for Round and Flat Oval: 6.

b. Ducts Connected to Air-Handling Units:
1) Pressure Class: 125% of scheduled total static capability of fan or AHU.
2) Minimum SMACNA Seal Class: A.
3) SMACNA Leakage Class for Rectangular: 6.
4) SMACNA Leakage Class for Round and Flat Oval: 3.

c. Ducts Connected to Equipment Not Listed Above:
1) Pressure Class: Positive 4-inch wg.
2) Minimum SMACNA Seal Class: A.
3) SMACNA Leakage Class for Rectangular: 6.
4) SMACNA Leakage Class for Round and Flat Oval: 3.

3. Exhaust Ducts:

a. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
1) Pressure Class: 125% of scheduled total static capability of fan.
2) Minimum SMACNA Seal Class: A.
3) SMACNA Leakage Class for Rectangular: 12.
4) SMACNA Leakage Class for Round and Flat Oval: 6.

b. Ducts Connected to Equipment Not Listed Above:
1) Pressure Class: Scheduled total static capability of fan.
2) Minimum SMACNA Seal Class: A.
3) SMACNA Leakage Class for Rectangular: 12.
4) SMACNA Leakage Class for Round and Flat Oval: 6.

4. Intermediate Reinforcement:

a. Exposed to Airstream: Match duct material.

b. Not Exposed to Airstream: Match duct material.

B. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-2, "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 4-3, "Vanes and Vane Runners," and Figure 4-4, "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 4-3, "Vanes and Vane Runners," and Figure 4-4, "Vane Support in Elbows."

2. Round Duct: Comply with SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "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.

    b. Round Elbows, 12 Inches and Smaller in Diameter: Stamped or pleated.

    c. Round Elbows, 14 Inches and Larger in Diameter: Standing seam or welded.

C. Branch Configuration:

1. Rectangular Duct: Comply with SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible," Figure 4-6, "Branch Connections."

    a. Rectangular Main to Rectangular Branch: 45-degree entry.

    b. Rectangular Main to Round Branch: Conical spin in.

2. Round and Flat Oval: Comply with SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-5, "90 Degree Tees and Laterals," and Figure 3-6, "Conical Tees." Saddle taps are permitted in existing duct.

    a. Velocity 1500 fpm or Lower: Conical tap.

    b. Velocity 1500 fpm or Higher: 45-degree lateral.

END OF SECTION 233113

SECTION 233300 - DUCT ACCESSORIES

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Backdraft and pressure relief dampers.
2. Manual volume dampers.
3. Fire dampers.
4. Combination fire and smoke dampers.
5. Remote damper operators.
6. Duct-mounted access doors.
7. Flexible connectors.
8. Flexible ducts.
9. Duct accessory hardware.

1.02 SUBMITTALS

A. Action Submittals

1. Product Data: For each of the following:

a. Fire Dampers, Smoke Dampers, Combination Fir and Smoke Dampers

B. Informational Submittals

1. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

a. Detail duct accessories fabrication and installation in ducts and other construction. Include dimensions, weights, loads, and required clearances; and method of field assembly into duct systems and other construction. Include the following:
   1) Special fittings.
   2) Manual volume damper installations.
   3) Control damper installations.
   4) Fire-damper, smoke-damper, combination fire- and smoke-damper, and ceiling installations, including sleeves; and duct-mounted access doors and remote damper operators.
   5) Duct security bars.
   6) Wiring Diagrams: For power, signal, and control wiring.

2. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which ceiling-mounted access panels and access doors required for access to duct accessories are shown and coordinated with each other, using input from Installers of the items involved.

C. Close Outs

1. Source quality-control reports.

2. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.03 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.

PART 2 -PRODUCTS

2.01 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. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316 to match duct system material, and having a finish matching that of the associated ductwork.

D. Aluminum Sheets: Comply with ASTM B 209, Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, one-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221, Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: ASTM A36 galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: ASTM A36 galvanized steel, 1/4-inch minimum diameter for lengths 36 inches or less; 3/8-inch minimum diameter for lengths longer than 36 inches.

2.02 BACKDRAFT AND PRESSURE RELIEF DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by air moving equipment manufacturer or one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.

2. Greenheck Fan Corporation.

3. Nailor Industries Inc.

4. NCA Manufacturing, Inc.

5. Pottorff; a division of PCI Industries, Inc.

6. Ruskin Company.

B. Description: Gravity balanced parallel blade.

C. Ratings:

1. Leakage:

a. Dampers shall have a maximum leakage of 10 cfm @ 1 in. wg. Tested in accordance with AMCA standard 500-D.

2. Differential Pressure:

a. Dampers shall have a maximum differential pressure rating of 10 in. wg.

3. Velocity:

a. Dampers shall have a maximum velocity rating of 3500 fpm.

D. Construction:

1. Extruded aluminum frame with multiple single-piece blades, maximum 6-inch width, extruded aluminum with sealed edges, extruded vinyl or neoprene, mechanically locked blade seals, aluminum axels with synthetic sleeve bearings.

E. Accessories:

1. Adjustment device to permit setting for varying differential static pressure.

2. Adjustable tension spring return.

3. Counterweights and spring-assist kits for vertical airflow installations.

4. 90-degree stops.

2.03 MANUAL VOLUME DAMPERS

A. Standard, Manual Volume Dampers:

1. Standard leakage rating, with linkage outside airstream.

2. Suitable for horizontal or vertical applications.

3. Frames:

a. Material and construction shall match that of the duct system. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.

4. Blades and Blade Axles:

a. Material and construction shall match that of the duct system. Fabricate in accordance with SMACNA Duct Construction Standards, and as indicated.

b. Multiple or single blade. Single blades shall be limited to 12” in height/diameter.

c. Parallel- or opposed-blade design.

d. Stiffen damper blades for stability.

5. 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.

B. Damper Hardware:

1. Provide locking quadrant regulators on single and multi-blade dampers.

2. On insulated ducts, mount quadrant regulators on stand-off mounting brackets, bases, or adapters.

2.04 FIRE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.

2. Arrow United Industries; a division of Mestek, Inc.

3. Greenheck Fan Corporation.

4. McGill AirFlow LLC.

5. METALAIRE, Inc.

6. Nailor Industries Inc.

7. NCA Manufacturing, Inc.

8. Pottorff; a division of PCI Industries, Inc.

9. Prefco; Perfect Air Control, Inc.

10. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 4000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Curtain type with blades outside airstream; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

1. Where dampers are located in aluminum or stainless steel duct, provide stainless steel dampers.

F. 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.

a. Where dampers are located in aluminum or stainless steel duct, provide stainless steel dampers.

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.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. 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.

1. Where dampers are located in aluminum or stainless steel duct, provide stainless steel dampers.

I. Heat-Responsive Device: Replaceable, 165 deg F rated, fusible links.

2.05 COMBINATION FIRE AND SMOKE DAMPERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Air Balance Inc.; a division of Mestek, Inc.

2. Arrow United Industries; a division of Mestek, Inc.

3. Greenheck Fan Corporation.

4. McGill AirFlow LLC.

5. METALAIRE, Inc.

6. Nailor Industries Inc.

7. NCA Manufacturing, Inc.

8. Pottorff; a division of PCI Industries, Inc.

9. Prefco; Perfect Air Control, Inc.

10. Ruskin Company.

B. Type: Dynamic; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg static pressure class and minimum 2000-fpm velocity.

D. Fire Rating: 1-1/2 and 3 hours.

E. Frame: Multiple-blade type; fabricated with roll-formed, 0.034-inch- thick galvanized steel; with mitered and interlocking corners.

1. Where dampers are located in aluminum or stainless steel duct, provide stainless steel dampers.

F. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

G. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- thick, galvanized-steel blade connectors.

1. Where dampers are located in aluminum or stainless steel duct, provide stainless steel dampers.

H. Leakage: Class I.

I. Rated pressure and velocity to exceed design airflow conditions.

J. Mounting Sleeve: Factory-installed, 0.052-inch- thick, galvanized sheet steel; length to suit wall or floor application.

1. Where dampers are located in aluminum or stainless steel duct, provide stainless steel dampers.

K. Damper Motors: two-position action.

L. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Mechanical."

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 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 and breakaway torque rating of 150 in. x lbf.

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.

6. Nonspring-Return Motors: For dampers larger than 25 sq. ft., size motor for running torque rating of 150 in. x lbf and breakaway torque rating of 300 in. x lbf.

7. Electrical Connection: 115 V, single phase, 60 Hz.

M. Accessories:

1. Auxiliary switches for signaling.

2. Momentary test switch, damper mounted.

2.06 REMOTE DAMPER OPERATORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Pottorff; a division of PCI Industries, Inc.

2. Ventfabrics, Inc.

3. Young Regulator Company.

B. Description: Cable system designed for remote manual damper adjustment.

C. Tubing: Brass.

D. Cable: Stainless steel.

2.07 DUCT-MOUNTED ACCESS DOORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. American Warming and Ventilating; a division of Mestek, Inc.

2. Ductmate Industries, Inc.

3. Flexmaster U.S.A., Inc.

4. Greenheck Fan Corporation.

5. McGill AirFlow LLC.

6. Nailor Industries Inc.

7. Pottorff; a division of PCI Industries, Inc.

8. Ventfabrics, 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. Hinges and Latches: 1-by-1-inch butt or piano hinge and cam latches.

d. 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 with outside and inside handles.

d. Access Doors Larger Than 24 by 48 Inches: Four hinges and two compression latches with outside and inside handles.

C. Pressure Relief Access Door:

1. Door and Frame Material: Galvanized sheet steel.

2. Door: Double wall with insulation fill with metal thickness applicable for duct pressure class.

3. Operation: Open outward for positive-pressure ducts and inward for negative-pressure ducts.

4. Factory set at 10-inch wg.

5. Doors close when pressures are within set-point range.

6. Hinge: Continuous piano.

7. Latches: Cam.

8. Seal: Neoprene or foam rubber.

9. Insulation Fill: 1-inch- thick, fibrous-glass or polystyrene-foam board.

2.08 FLEXIBLE CONNECTORS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

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. Metal-Edged Connectors: Factory fabricated with a fabric strip 3 inches wide attached to 2 strips of 3-inch- wide, 0.028-inch- thick, galvanized sheet steel or 0.032-inch- thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 30 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.

F. Thrust Limits: Combination coil spring and elastomeric insert with spring and insert in compression, and with a load stop. Include rod and angle-iron brackets for attaching to fan discharge and duct.

1. Frame: Steel, fabricated for connection to threaded rods and to allow for a maximum of 30 degrees of angular rod misalignment without binding or reducing isolation efficiency.

2. Outdoor 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.

7. Coil Spring: Factory set and field adjustable for a maximum of 1/4-inch movement at start and stop.

2.09 FLEXIBLE DUCTS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Flexmaster U.S.A., Inc.

2. McGill AirFlow LLC.

3. Thermaflex.

4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Noninsulated, Flexible Duct: UL 181, Class 1, multiple layer of aluminum laminate supported by helically wound spring steel wire.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.

3. Temperature Range: Minus 20 to plus 210 deg F.

C. Insulated, Flexible Duct: UL 181, Class 1, multiple layer of aluminum laminate supported by helically wound spring steel wire, insulated; with vapor-barrier film.

1. Pressure Rating: 10-inch wg positive and 1.0-inch wg negative.

2. Maximum Air Velocity: 4000 fpm.

3. Temperature Range: Minus 20 to plus 210 deg F.

4. Insulation R-value: Comply with ASHRAE/IESNA 90.1

D. Flexible Duct Connectors:

1. Clamps: Stainless-steel band with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches, to suit duct size.

2.10 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA`s "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated. Gravity backdraft dampers are acceptable for fans operating below 300 cfm.

D. 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.

1. Install steel volume dampers in steel ducts.

2. Install aluminum volume dampers in aluminum ducts.

E. Set dampers to fully open position before testing, adjusting, and balancing.

F. Install test holes at fan inlets and outlets and elsewhere as indicated.

G. Install fire, smoke and combination fire and smoke dampers according to UL listing.

H. Connect ducts to duct silencers with flexible duct connectors.

I. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. On both sides of duct coils.

2. Upstream and downstream from duct filters.

3. At outdoor-air intakes and mixed-air plenums.

4. At drain pans and seals.

5. Downstream from control dampers, backdraft dampers, and equipment.

6. Adjacent to and close enough to fire or smoke dampers, to reset or reinstall fusible links. Access doors for access to fire or smoke 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.

J. Install access doors with swing against duct static pressure.

K. Access Door Minimum Sizes:

1. Hand Access: 24 by 24 inches. Where duct is less than 24 inches, use largest size allowable.

2. Head and Hand Access: 18 by 16 inches.

3. Head and Shoulders Access: 21 by 16 inches.

4. Body Access: 25 by 16 inches.

5. Body plus Ladder Access: 25 by 17 inches.

L. Label access doors according to Division 22 Section "Mechanical Identification" to indicate the purpose of access door.

M. Install flexible connectors to connect ducts to equipment.

N. For fans developing static pressures of 5-inch wg and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

O. Connect terminal units to supply ducts directly.

P. Connect diffusers to ducts directly or with maximum 48-inch lengths of flexible duct banded in place. Do not use flexible ducts to change directions.

Q. Connect flexible ducts to metal ducts with draw bands.

R. Install duct test holes where required for testing and balancing purposes.

S. Install thrust limits at centerline of thrust, symmetrical on both sides of equipment. Attach thrust limits at centerline of thrust and adjust to a maximum of 1/4-inch movement during start and stop of fans.

3.02 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Inspect turning vanes for proper and secure installation.

4. Inspect turning vanes for blockage and remove any debris prior to startup.

5. Operate remote damper operators to verify full range of movement of operator and damper.

6. Fire, Smoke and Combination Fire and Smoke Dampers

   a. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

   b. Full unobstructed access to the fire or combination fire/smoke damper shall be verified and corrected as required.

   c. If the damper is equipped with a fusible link, the link shall be removed for testing to ensure full closure and lock-in place if so equipped.

   d. The operational test of the damper shall verify that there is no damper interference due to rusted, bent, misaligned, or damaged frame or blades, or defective hinges or other moving parts.

   e. The damper frame shall not be penetrated by any foreign objects that would affect fire damper operations.

   f. The damper shall not be blocked from closure in any way.

   g. The fusible link shall be reinstalled after testing is complete.
      1) If the link is damaged or painted, it shall be replaced with a link of the same size, temperature, and load rating.

   h. All inspections and testing shall be documented indicating the location of the fire damper or combination fire/smoke damper, date of inspection, name of inspector, and deficiencies discovered.
      1) The documentation shall have a space to indicate when and how the deficiencies were corrected.

   i. All documentation shall be maintained and made available for review by the AHJ.

   j. Maintenance.
      1) Reports of changes in airflow or noise from the duct system shall be investigated to verify that they are not related to damper operation.
      2) All exposed moving parts of the damper shall be dry lubricated as required by the manufacturer.
      3) If the damper is not operable, repairs shall begin without delay.
      4) Following any repairs, the damper shall be tested for operation.
      5) All maintenance shall be documented.

   k. Provide an 11-month test.

B. All tests shall be completed in a safe manner by personnel wearing personal protective equipment.

END OF SECTION 233300

SECTION 233443 - FANS

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Plenum fans.

2. Domed roof, upblast roof, and sidewall exhaust fans.

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Submit the following product data for each unit:

a. Static pressure, airflow (CFM), speed (RPM), system curve, outlet velocity, and fan tag for each fan.

b. Certified fan curves showing fan performance with the system operating points identified on curves. Surge, or “Do not operate” line, indicated on fan curve.

c. Performance curves published by the fan manufacturer and based on tests in accordance with AMCA 210. Curves drawn with the fan flow rate plotted against fan total pressure and fan brake horsepower per AMCA 210.

d. Bearing sizing and life calculations for each similar size and type of fan.

e. Sound power levels for each size and type of fan. Sound levels provided for all 8 octave bands for discharge of fan, inlet to fan, and radiated noise through casing.

f. Dimensional data for each size and type of fan, including operating and maintenance clearances.

g. Details of vibration isolation bases including selections for vibration isolation springs.

h. Motor ratings, electrical characteristics, and motor accessories. Include wiring diagrams for power, signal, and control wiring.

i. Roof curbs.

j. Fan speed controller.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, or BIM model, drawn to scale and coordinated with all building trades.

B. Seismic Qualification Data: For fans, accessories, and components, from manufacturer.

C. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.05 SOURCE QUALITY CONTROL

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by an NRTL, and marked for intended location and application.

1. Motors and electrical accessories: Comply with NEMA 1.

B. Fan Sound Ratings: Comply with AMCA 311 and label fans with the AMCA-Certified Ratings Seal. Sound ratings to comply with AMCA 301. Factory test fans according to AMCA 300.

C. Fan Performance Ratings: Comply with AMCA 211 and label fans with AMCA-Certified Rating Seal. Test fans for air performance - flow rate, fan pressure, power, fan efficiency, air density, speed of rotation, and fan efficiency - according to AMCA 210/ASHRAE 51.

D. Operating Limits: Classify fans according to AMCA 99.

E. Test high-plume induction type fans and certify to provide specified primary and secondary air volumes. Provide certified reports.

F. Base fan performance ratings on actual project site elevation.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Provide protection to ensure that the interior and exterior of each fan is completely protected from dirt or weather during shipping. Cover all openings with sealed sheet metal or plastic.

B. Lift and support units with manufacturer’s designated lifting and support points.

1.07 WARRANTY

A. Provide a complete parts and labor warranty for a minimum of one year from the date of Substantial Completion.

1.08 COORDINATION

A. Coordinate size and location of structural-steel support members.

B. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

C. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section “Roof Accessories”.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Centrifugal:

a. Loren Cook Co.

b. Acme.

c. Twin City Fan.

d. Aerovent.

e. Greenheck.

f. Trane.

g. PennBarry.

2. Vane-Axial and Tube-Axial:

a. Howden Buffalo, Inc.

b. Woods.

c. Trane.

d. Greenheck.

e. Cook.

2.02 PERFORMANCE REQUIREMENTS

A. Capacities and Characteristics: As scheduled on the drawings.

2.03 GENERAL CONSTRUCTION - ALL FANS

A. Variable sheaves for motors 7.5 HP and under and fixed sheaves for motors 10 HP and over. Size variable sheaves at midpoint of specified operating conditions to allow field adjustment up or down during balancing procedures. Provide one (1) additional fixed sheave set for final balancing.

B. Selection and ratings based on tests made in accordance with AMCA 210.

C. AMCA licensed and bear the AMCA seal for both sound and performance levels.

D. Minimum Class I construction with proper UL label.

E. Specified fan RPM, outlet velocity, and tip speed are the maximum acceptable. Motor horsepower, CFM, and static pressure are the minimum acceptable.

F. Fasteners corrosion resistant type.

G. Fan housing of suitable thickness and bracing required for stable and rigid construction, with no deflection, and to prevent vibration and pulsation.

H. Fans having duct-connected inlets provided with a flanged inlet and/or outlet collar matching companion flange.

I. OSHA belt guards on all belt driven fans.

J. Spark-proof Type A, B, or C (AMCA 99-0401) as required by application.

K. Weatherproof housing for exterior fan with ventilation grilles to cover motor and drive assembly.

L. Special construction fans, such as spark-proof, explosion-proof, or specially coated fans as required by application.

M. Birdscreen on fans exposed to the exterior environment.

N. Fan shaft of solid high carbon steel, accurately turned, ground and polished, and ring gauged for accuracy.

1. Shafts dial indicator inspected for straightness after the keys are cut.

2. Fan shaft coated with rust inhibitive coating.

O. Fan wheel assembly or propeller assembly statically and dynamically balanced prior to fan assembly.

P. The entire rotating assembly designed so the first critical speed is minimum 25% over the maximum fan class speed.

Q. Fan Shaft Bearings:

1. Bolted on a rigid welded steel framework integral with the housing.

2. Designed and individually tested specifically for use in air handling applications.

3. Sized for a minimum L-10 life of 200,000 hours at the maximum fan class operating speed and horsepower. Selection to account for all operating conditions including belt pull. Bearings selected in accordance with standards set forth by the American Bearing Manufacturers Association (ABMA).

4. Grease lubricated self-aligning ball or roller type. Provide tapered roller bearings for vertical applications.

5. Housings to be solid cast iron, pillow block or flange mount type. Provide split pillow block bearings where required by the application speed.

6. Stamped bearing housings permitted on fans of 1/4 HP or less.

7. Bearings of type that can be re-lubricated, and equipped with grease fittings.

R. Where fan bearings are not easily accessible or are installed in a hazardous exhaust airstream, provide clear plastic grease leads, properly secured to avoid damage or fatigue, routed to an accessible location.

S. Fan Drive:

1. Multiple V-belt type sized for 1.65 times the fan motor horsepower. Sheaves fixed or adjustable based on fan motor horsepower. Fan sheave shall have a tapered lock, split and keyed hub. Spacing on equipment and motor pulleys to align. For fans 1/2 HP and larger, quantity of belts such that if any one belt fails, remaining belts to allow fan to continue functioning as designed. Multiple belts provided as a matched set.

2. OSHA approved type fan drive guards provided with provision for RPM measurement at both motor and fan without removing the guard.

3. Fan belts oil resistant 24,000-hour non-static belts.

T. Provide thrust arrestors to limit movement of the fan upon start-up.

U. For pulleys: Cast iron or cast steel with split, tapered bushing, dynamically balanced at factory.

2.04 PAINTING

A. Each fan component shall be thoroughly cleaned, degreased, and deburred.

B. Prior to assembly, prime coat all non-galvanized ferrous metal parts with zinc rich primer (minimum 70 percent zinc), total dry film thickness of not less than 1.3 mils.

C. For interior units, finish paint all non-galvanized ferrous metal parts with alkyd enamel paint.

1. Low-luster interior enamel; total dry film thickness of not less than 2.6 mils.

D. For exterior units, finish paint all non-galvanized ferrous metal parts with alkyd enamel paint.

1. Semi-gloss exterior enamel; total dry film thickness of not less than 2.6 mils.

E. Aluminum and stainless steel parts do not require painting.

F. Special coatings for corrosive exhaust systems specified in the specific exhaust fan specifications.

2.05 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, and efficiency requirements for motors specified in Division 23 Section “Common Motor Requirements for Mechanical”.

B. Where variable-frequency drives are indicated or scheduled, provide fan motor compatible with variable-frequency drive.

C. Motor Enclosure: Open drip-proof, totally enclosed, fan-cooled or explosion-proof as required per fan per application.

2.06 CENTRIFUGAL FANS

A. Domed Roof, Up Blast Roof, and Sidewall Exhaust Fans

1. General:

a. Housing constructed of heavy gauge spun aluminum with a rigid internal support structure.

b. Fan wheel backward inclined.

c. Drive frame assembly constructed of heavy gauge steel.

d. Fresh air for motor cooling shall be drawn into the motor through a tube free of contaminants or through a space between the fan shroud and the motor cover.

e. Fan drives sized for 1.5 times the motor horsepower. Pulleys cast type, keyed and securely attached to the wheel and motor shafts.

f. Motor pulleys adjustable for final balancing.

g. Provide factory-installed disconnect switch, wired from the fan motor to a junction box installed within the motor compartment. Provide a conduit chase through the base to the motor compartment.

h. Belt tensioner for quick belt service.

2. Roof-mounted up blast exhaust fans to have a leak proof housing constructed with a one-piece windband with an integral rolled bead, and shall be joined to the curb-cap with a continuously welded seam.

3. Sidewall mounted exhaust fans to have a leak proof housing constructed with a one-piece windband with an integral rolled bead. Provide a mounting plate that will be attached and sealed to the wall prior to installing fan.

4. Variable-Speed Controller: Solid-state control to reduce speed from 100 to less than 50 percent.

5. Bird Screens: Removable 1/2-inch mesh, aluminum or brass wire.

6. Motorized Dampers: Parallel-blade dampers mounted in curb base with electric actuator; wired to close when fan stops.

7. Roof Curbs: Galvanized steel; mitered and welded corners; 1-1/2-inch thick, rigid, fiberglass insulation adhered to inside walls; and 1-1/2-inch wood nailer. Size as required to suit roof opening and fan base.

a. Configuration: Built-in cant and mounting flange.

b. Overall Height: 12 inches.

c. Sound Curb: Curb with sound-absorbing insulation matrix.

d. Pitch Mounting: Manufacture curb for roof slope.

e. Metal Liner: Galvanized steel.

2.07 PLENUM FANS

A. Single width non-overloading centrifugal type, mounted on rigidly built and braced all welded fan pedestals made of structural steel, mounted to square, flat mounting plates, and equipped with lifting lugs.

B. Wheel matched to inlet cone to provide precise running tolerances and maximum operating performance and efficiency.

C. Fan wheel with a completely enclosing protective cage with a removable section large enough to service the fan or drive easily. Cages across the fan plenum access door are not acceptable.

D. Lubrication lines with Zerk fittings, extended to the exterior of the protective fan cage.

E. Removable fan inlet screen.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Lift and support units with manufacturer`s designated lifting or supporting points.

B. Install fans in accordance with details, approved submittals, and the fan manufacturer's installation requirements and recommendations. Ensure fans are installed to allow easy accessibility for service or removal of fan components.

C. Provide and install supplemental steel, supports, isolators and hangers necessary to hang or mount fans. Coordinate final location and placement of intermediate steel and ductwork connections in field.

1. Install suspended fans with supports attached to structural members.

D. Install any associated motors, drives, or other components that have been shipped loose.

E. Install flexible inlet and discharge couplings to prevent vibration transmission to ductwork.

F. Inlet and discharge ductwork shall have a minimum straight run of two (2) fan diameters upstream and downstream of the fan.

G. Prior to final acceptance, thoroughly clean fan of all grease, dirt, and dust, etc. Apply touch-up paint or touch-up coating after final cleaning to repair any damage to the finish.

H. Install units with clearances for service and maintenance.

I. Label fans according to requirements specified in Division 22 Section "Mechanical Identification".

3.02 DUCTWORK AND PIPING CONNECTIONS

A. Drawings indicate general arrangement of ducts and duct accessories. Make final duct connections with flexible connectors. Flexible connectors are specified in Division 23 Section "Duct Accessories".

B. Install ducts adjacent to fans to allow service and maintenance.

C. Install piping from scroll drain connection, with trap with seal equal to 1.5 times specified static pressure, to nearest floor drain with pipe sizes matching the drain connection.

3.03 ELECTRICAL CONNECTIONS

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

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

C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.

3.04 CONTROL CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring according to Division 26 Section “Control-Voltage Electrical Power Cables”.

3.05 FIELD QUALITY CONTROL

A. Engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections prior to fan operation:

1. Verify that shipping, blocking, and bracing are removed.

2. Verify that unit is secure on mountings and supporting devices, and that connections to ducts and electrical components are complete.

3. Verify that proper thermal-overload protection is installed in motors, starters, and disconnect switches.

4. Verify that cleaning and adjusting are complete.

5. Inspect fan scroll for debris or water.

6. Remove guards. Align and adjust belt tension, verify that fan wheel and motor rotate freely, and that bearing operation is smooth. Re-install belt guards.

7. Adjust damper linkages for proper damper operation.

8. Verify lubrication of bearings and other moving parts. Use proper bearing venting procedures, in particular at motor bearings. Use only grease type specifically recommended by fan manufacturer. Do not over-grease. Fill extended grease lines if not already filled, using manufacturer recommended grease and proper venting procedures.

9. Verify proper motor and fan rotation.

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

C. Test and adjust controls and safeties. Controls and equipment will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports.

3.06 ADJUSTING

A. Comply with requirements in Division 23 Section “Testing, Adjusting, and Balancing for HVAC” for testing, adjusting, and balancing procedures.

B. Replace fan and motor pulleys as required to achieve design airflow.

3.07 DEMONSTRATION

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

END OF SECTION 233443

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 233600 - AIR TERMINAL UNITS

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Shutoff, single-duct air terminal units.

1.02 ACTION SUBMITTALS

A. Product Data: For each type, including construction, rated capacities, furnished specialties, sound-power ratings, and accessories.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

B. Field quality-control reports.

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data:

1. Manufacturer standard operating and maintenance manual for each type.

2. Performance curves, including heating coils.

3. Instructions for resetting minimum and maximum air volumes.

4. Instructions for adjusting software set points.

PART 2 -PRODUCTS

2.01 VARIABLE VOLUME, SINGLE-DUCT AIR TERMINAL UNITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Enviro-Tec.

2. Krueger.

3. Price Industries.

4. Titus.

5. Trane; a business of American Standard Companies.

6. Tuttle & Bailey.

B. Configuration: Volume-damper assembly inside unit casing with control components inside a protective metal shroud.

C. Casing: Minimum 22 gauge, single wall.

1. Liner: 1 inch thick fiber-free foam, ASHRAE 62.1, UL-181 and ASTM E 84 25/50 compliant.

a. Cover liner with nonporous foil.

2. Air Inlet: Oval, round or rectangular collar connection.

3. Air Outlet: S-slip and drive connections.

4. Access: Removable panels for access to parts requiring service, adjustment, or maintenance; with airtight gasket.

D. Volume Damper: Low leakage galvanized steel with peripheral gasket and self-lubricating bearings.

E. Airflow Sensor: Multi-point flow sensor to maintain control accuracy independent of field conditions.

F. Hydronic Coils: Copper tube, with mechanically bonded aluminum fins. Minimum 2 row coil. Refer to schedule on drawings.

G. Direct Digital Controls: Unitary controller and actuator specified in Division 23 Section “HVAC Instrumentation and Controls”.

2.02 SOURCE QUALITY CONTROL

A. Label each air terminal unit with plan number, nominal airflow, maximum and minimum factory-set airflows, coil type, and ARI certification seal.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Install air terminal units according to NFPA 90A, “Standard for the Installation of Air Conditioning and Ventilating Systems”.

B. Install air terminal units level and plumb. Maintain sufficient clearance for normal service and maintenance.

C. Provide insulated access panels with quarter turn sash latches on bottom of all air terminals for access to coil and airflow sensor.

D. Unit shall be installed with rigid inlet connection with minimum five duct diameter inlet straight length.

E. Maintain minimum 36 inch clearance around controls and piping package without interference with other trades.

3.02 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA`s “HVAC Duct Construction Standards - Metal and Flexible, Chapter 4, “Hangers and Supports” and Division 23 Section “Metal Ducts”.

3.03 CONNECTIONS

A. Install piping adjacent to air terminal unit to allow service and maintenance.

B. Connect ducts to air terminal units according to Division 23 Section “Metal Ducts”.

3.04 IDENTIFICATION

A. Label each air terminal unit. Comply with requirements in Division 22 Section “Mechanical Identification” for equipment labels and warning signs and labels.

3.05 FIELD QUALITY CONTROL

A. Perform the following tests and inspections.

1. After installing air terminal units, test for compliance with requirements.

2. Leak Test: After installation, fill water coils and test for leaks. Repair leaks and retest until no leaks exist.

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

B. Air terminal unit will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.06 DEMONSTRATION

A. Train Owner`s maintenance personnel to adjust, operate, and maintain air terminal units.

END OF SECTION 233600

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 233713 - DIFFUSERS, REGISTERS, AND GRILLES

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes ceiling- and wall-mounted diffusers, registers, and grilles.

1.02 ACTION SUBMITTALS

A. Product Data: For each 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.

1.03 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1.04 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Except 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 following manufacturers:

a. Krueger.

b. METALAIRE; a division of Metal Industries Inc.

c. Nailor.

d. Price Industries.

e. Titus.

f. Tuttle & Bailey.

2.02 GENERAL REQUIREMENTS

A. The following requirements shall apply to all grilles, registers and diffusers. Where conflicting requirements are indicated for specific titles below, those requirements shall supersede the general requirements.

1. Devices shall be specifically designed for variable-air-volume flows.

2. Material: As scheduled.

3. Finish: As scheduled.

4. Face Style: As scheduled.

5. Face Size: As scheduled.

6. Mounting: Verify ceiling frame and panel style and dimension with reflected ceiling plan, room finish schedule and material type.

7. Pattern: Adjustable.

8. Accessories: As scheduled.

2.03 LAMINAR FLOW DIFFUSERS AND CEILING FRAMING SYSTEMS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified:

1. Precision Air Products.

2. Titus.

3. Flanders.

4. AAF.

5. Price.

6. Krueger.

7. Tuttle & Bailey.

B. Description:

1. Diffuser shall provide non-aspirating vertical air distribution.

2. Integrated ceiling framing system to include laminar flow diffusers, fill-in blank panels and ceiling grid with gasketing to support all components within the system.

3. Finish: Antimicrobial white.

C. HEPA-filtered Diffusers with Room-side Replaceable HEPA Filters:

1. ASHRAE Group E non-aspirating laminar flow type in accordance with ASHRAE 170 for operating rooms.

2. Upper (pressure) chamber constructed of 0.063 inch aluminum, all mating surfaces continuously welded and internally sealed. Upper chamber to form a knife edge seal with filter gel.

3. Top inlet collar with internal air balancing mechanism, room-side adjustable. Integral or external dampers (opposed blade or butterfly) are not allowed.

4. HEPA filters held firmly in place by clip assemblies with stainless steel filter clips, nuts, and bolts.

5. Diffuser frame assembly constructed of extruded aluminum with mitered, continuously welded and internally sealed corners. The frame assembly shall align with the upper chamber's knife edge to form a dual knife edge seal with the filter's gel to form an air-tight seal.

6. Perforated faceplate shall be 0.050 inch aluminum and perforations to be nominal 16% open area. Provide vinyl coated stainless steel cable safety retainers. The faceplate shall be installed in an extruded aluminum mounting frame with mitered back-welded corners.

7. Manufacturer to insulate the assembly with 1-1/2 inch duct wrap foil-faced insulation.

8. One diffuser per room shall include a red LED indicator light, factory mounted in corner of faceplate. Light shall be connected to factory preset pressure switch. Coordinate 24 volt power supply with project Electrical Contractor.

9. Provide factory installed ports in diffuser plenum of one diffuser per room to accept pressure monitoring tubing; one above and one below the filter. Ports shall be accessible in the field for connection by the Controls Contractor.

10. Dedicated aerosol port and dispersion manifold to allow field testing.

D. HEPA Filters:

1. Individually tested IEST-RP-CC001 Type J test meeting minimum efficiency of 99.99% on 0.3 micron size particles.

2. Media: Pleated to 53mm pack thickness.

3. Pressure drop shall not exceed 0-.45 inches w.g. at filter face velocity of 100 fpm. All material shall meet UL900 class.

4. Filter frame: Integral channel filled with cleanroom grade, non-flowing urethane gel.

2.04 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, Method of Testing for Rating the Performance of Air Outlets and Inlets.

PART 3 -EXECUTION

3.01 EXAMINATION

A. Examine areas where diffusers, registers, and grilles are to be installed for compliance with requirements for installation tolerances and other conditions affecting performance of equipment.

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

3.02 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb according to manufacturer's written instructions and coordination drawings.

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 practicable. 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/Engineer for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of manual dampers, fire and smoke dampers.

D. All return grilles in plenums shall be installed with 24x24x12 or 24x12x12 back pan matching return grille dimensions unless detailed otherwise in documents. Back pan shall be painted black.

3.03 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

3.04 CLEANING

A. Inspect exposed finish of diffusers, registers, and grilles after installation. Clean exposed surfaces and replace diffusers, registers, and grilles having damaged finishes.

END OF SECTION 233713

SECTION 233723 - HVAC LOUVERS AND GRAVITY VENTILATORS

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Louvered-penthouse ventilators.
2. Hooded ventilators.
3. Louvers

1.02 ACTION SUBMITTALS

A. Product Data: For each type of product including performance data.

B. Samples: For each exposed product and for each color and texture specified.

1.03 CLOSEOUT SUBMITTALS

A. Operation and maintenance requirements.

1.04 COORDINATION

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

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Louvers:
    a. American Warming and Ventilating, Inc.
    b. Arrow United Industries.
    c. Carnes Company, Inc.
    d. Construction Specialties, Inc.
    e. Greenheck.
    f. Industrial Louvers, Inc.

g. Louvers & Dampers, Inc.

h. Metal Form Manufacturing Company, Inc.

i. NCA Manufacturing, Inc.

j. Reliable Products; Hart & Cooley, Inc.

k. Ruskin Company; Tomkins PLC.

l. Vent Products Company, Inc.

2.02 PERFORMANCE REQUIREMENTS

A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes, without buckling, opening of joints, overstressing of components, failure of connections, or other detrimental effects.

1. Temperature Change (Range):

a. Ambient: 120 deg F.

b. Material Surfaces: 180 deg F.

B. Water Entrainment: Limit water penetration through unit to comply with ASHRAE 62.1.

2.03 FABRICATION

A. Factory or shop fabricate gravity ventilators to minimize field splicing and assembly. Disassemble units to the minimum extent as necessary for shipping and handling. Clearly mark units for reassembly and coordinated installation.

B. Fabricate frames, including integral bases, to fit in openings of sizes indicated, with allowances made for fabrication and installation tolerances, adjoining material tolerances, and perimeter sealant joints.

C. Fabricate units with closely fitted joints and exposed connections accurately located and secured.

D. Fabricate supports, anchorages, and accessories required for complete assembly.

E. Perform shop welding by AWS-certified procedures and personnel.

2.04 STATIONARY BLADE WALL LOUVERS

A. Description: Stationary drainable louver type with drain gutters in each blade and head with downspouts in jambs and mullions with all welded construction. Hidden vertical supports to allow continuous line appearance up to 120 inches. Steeply angled integral sill.

B. Performance Data:

1. Based on testing 48 inch x 48 inch size unit in accordance with AMCA 500.

2. Free Area: 54 percent, minimum.

3. Free Area Size: 8.58 square feet, minimum.

4. Water Penetration: Maximum of 0.01 ounces per square foot of free area at an air flow of 873 feet per minute free area velocity when tested for 15 minutes.

C. Construction:

1. Material: Provide one of the following:

a. Aluminum, of thickness required to comply with structural performance requirements, but not less than 4 inch deep frame with 0.081-inch wall thickness for frame and blades; suitably reinforced.

2. Finish

a. Aluminum Finish:
1) Finish: Prime Coat:
(a) Apply alkyd prime coat following chemical cleaning and pretreatment.
(b) Primer preparation for field painting.

D. Accessories:

1. Bird Screening: Aluminum, 1/2-inch square mesh wire or 5/8 inches by 0.040 inch, expanded and flattened.

2. Dampers:

a. Location: Back of louver.

b. Control: Motorized.

2.05 MATERIALS

A. Aluminum Extrusions: ASTM B221, Alloy 6063-T5 or T-52.

B. Aluminum Sheet: ASTM B209, Alloy 3003 or 5005, with temper as required for forming or as otherwise recommended by metal producer for required finish.

C. Galvanized-Steel Sheet: ASTM A653/A653M, G90 zinc coating, mill phosphatized.

D. Fasteners: Same basic metal and alloy as fastened metal or 300 Series stainless steel unless otherwise indicated. Do not use metals that are incompatible with joined materials. Use types and sizes to suit unit installation conditions.

E. Post-Installed Fasteners for Concrete and Masonry: Torque-controlled expansion anchors made from stainless-steel components, with capability to sustain without failure a load equal to 4 times the loads imposed for concrete, or 6 times the load imposed for masonry, as determined by testing according to ASTM E488, conducted by a qualified independent testing agency.

F. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D1187.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Louvers

1. Install louvers at locations indicated on the drawings and in accordance with manufacturer`s instructions.

2. Install louvers plumb, level, in plane of wall, and in alignment with adjacent work.

3. The supporting structure shall be designed to accommodate the point loads transferred by the louvers when subject to the design wind loads.

4. Install joint sealants as specified in Division 07 Section “Joint Sealants”.

5. Apply field topcoat within 6 months of application of shop prime coat. Apply field topcoat as specified in Division 09 Section “Painting”.

3.02 CONNECTIONS

A. Duct installation and connection requirements are specified in Division 23 Section "Metal Ducts". Drawings indicate general arrangement of ducts and duct accessories.

END OF SECTION 233723

SECTION 235213 - ELECTRIC BOILERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Boiler.

B. Boiler controls.

C. Water connections.

D. Electrical hook-up.

1.02 REFERENCE STANDARDS

A. ASME BPVC-IV - Boiler and Pressure Vessel Code, Section IV - Rules for Construction of Heating Boilers 2023.

B. ASME BPVC-VIII-1 - Boiler and Pressure Vessel Code, Section VIII, Division 1: Rules for Construction of Pressure Vessels 2023.

C. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

D. UL (DIR) - Online Certifications Directory Current Edition.

1.03 SUBMITTALS

A. See Section 013000 - Administrative Requirements for submittal procedures.

B. Product Data: Provide literature indicating general assembly components, controls, safety controls, wiring diagrams with electrical characteristics and connection requirements, and service connections.

C. Shop Drawings: Indicate assembly, weights, heater configuration, and electrical characteristics and connection requirements.

D. Manufacturer's Instructions: Indicate rigging, installation, and start-up procedures.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, cleaning procedures, replacement parts list, and maintenance and repair data.

F. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Protect units before, during, and after installation from damage to casing by leaving factory shipping packaging in place until immediately prior to final acceptance.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals for additional warranty requirements.

B. Provide five year warranty to include coverage for vessel.

C. Provide one year warranty to include coverage on parts, from date of startup.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Lochinvar_____.

B. Laars.

2.02 REGULATORY REQUIREMENTS

A. Comply with applicable codes for internal wiring of factory wired equipment.

B. Comply with ASME BPVC-IV and ASME BPVC-VIII-1 for boiler construction.

C. Products Requiring Electrical Connection: Listed and classified by UL (DIR) as suitable for the purpose specified and indicated.

2.03 MANUFACTURED UNITS

A. Description: Electric hot water boiler completely packaged, factory assembled, ready for operation except for connections of piping and electrical connections.

2.04 FABRICATION

A. Assembly: Welded steel shell; heater support nipples or flanges; inspection handhole; necessary fittings to accept gauges, safety and operating controls; threaded or flanged inlet and outlet connections; inlet diffuser; and lifting lugs, complying with ASME BPVC-IV and ASME BPVC-VIII-1 requirements, and tested for maximum working pressure of 160 psig (1103.16 kPa) .

B. Heating Elements: Threaded or flanged, incoloy sheathed, with maximum density of 75 W/sq in (116 kW/sq m), suitable for operation at 150 psig (). Attach each element to tube sheet by mechanical assembly permitting single elements to be replaced without replacing entire tube bundle.

C. Enclose in stainless steel jacket, excluding control panel, with factory applied baked enamel, insulated with 4 inch (10 mm) thick fiberglass insulation.

2.05 TRIM

A. ASME rated pressure relief valve set at 45 psi (310 kPa).

B. Assemble with pressure gauge, thermometer in brass separable well, automatic air vent, and drain valve.

C. Low water cut-off with manual reset and inlet flow switch to automatically prevent operation when water falls below safe level or on low flow through boiler.

D. Electronic operating temperature controller with full cover integral controller, ambient temperature range minus 30 to 150 degrees F (minus 34 to 66 degrees C), OA reset wtih BMS interface, adjustable reset ration of outside air temperature change to discharge control point change 1:2 to 100:1, integral setpoint adjustment 80 to 250 degrees F (27 to 121 degrees C), electronic primary and outdoor sensors, for on-off switching of pilot duty relays.

E. High limit temperature controller with automatic reset to prevent boiler water temperature from exceeding safe system temperature.

2.06 CONTROLS

A. Provide pre-wired, factory assembled electric controls enclosed in NEMA 250, Type 1 cabinet, factory mounted integral with unit.

B. Controls:

1. Unfused disconnect switch with door interlock.

2. Splitter arrangement and fused magnetic contactors for each element.

3. Fused control circuit transformer with control circuit on/off switch.

4. Proportioning step controller.

5. Remote bulb operating thermostat complete with brass separable well.

6. Remote bulb high limit thermostat complete with brass separable well.

7. Pilot lights for each step of control.

C. Peak load control system.

1. BMS interface for pump motor starter auxiliary contact.

2. Flow switch.

3. Remote mounted three wire temperature controller.

END OF SECTION 235213

SECTION 236423 - AIR-COOLED, SCROLL WATER CHILLERS

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes packaged, air-cooled, electric-motor-driven, scroll water chillers.

1.02 DEFINITIONS

A. BAS: Building automation system.

B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.

C. DDC: Direct digital control.

D. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.

E. GFI: Ground fault interrupt.

F. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.

G. I/O: Input/output.

H. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.

I. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.

J. SCCR: Short-circuit current rating.

K. TEAO: Totally enclosed air over.

L. TENV: Totally enclosed nonventilating.

1.03 ACTION SUBMITTALS

A. Product Data: For each type of product.

1.04 INFORMATIONAL SUBMITTALS

A. Certificates: For certification required in "Quality Assurance" Article.

B. Shop Drawings: Complete set of manufacturer's prints of water chiller 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. Size and location of piping and wiring connections.

5. Diagrams for power, signal, and control wiring.

C. Installation instructions.

D. Source quality-control reports.

E. Startup service reports.

F. Sample warranty.

1.05 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.06 QUALITY ASSURANCE

A. All proposals for chiller performance must include an AHRI approved selection method. Verification of date and version of computer program selection or catalog is available through AHRI.

1.07 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.

1. Provide a full parts, labor, and refrigerant warranty for two years.

2. Provide a 5 year compressor parts warranty

3. During the first 12 months of operation, the original equipment manufacturer (OEM) shall perform quarterly on-site operating inspections to confirm the chiller's operational performance. The manufacturer shall provide the owner with a report describing the condition of the equipment, current operating log, any issues found needing to be addressed, and recommended corrective actions.

PART 2 -PRODUCTS

2.01 PERFORMANCE REQUIREMENTS

A. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.

B. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.

C. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.

D. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

E. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.

F. Comply with NFPA 70.

G. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.

H. Outdoor Installations:

1. Chiller shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a 25 year period with minimal degradation due to exposure to outdoor ambient conditions.

2. Low ambient operation: Chiller shall be able to start and operate in ambient conditions down to 0ºF and up to 115ºF. Low ambient operation is accomplished with factory installed and tested protection. If field installed low ambient solution is used this shall be purchased and installed at contractor expense.

3. Chiller shall be capable of starting up with 95ºF (35ºC) entering fluid temperature to the evaporator. Maximum water temperature that can be circulated with the Chiller not operating is 125ºF (52ºC)

4. Chiller shall provide evaporator freeze protection and low limit control to avoid low evaporator refrigerant temperature trip-outs during critical periods of chiller operation. Whenever this control is in effect, the controller shall indicate that the chiller is in adaptive limit. If the condition exists for more than 30 seconds, a limit warning alarm relay shall energize.

I. The Chiller shall be capable of starting in 45 seconds after power restoration.

2.02 MANUFACTURERS

A. Subject to compliance with the requirements, provide products manufactured by one of the following:

1. Trane

2. Daikin

3. Johnson Controls

4. Carrier

2.03 MANUFACTURED UNITS

A. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser with fans, electrical power, controls, and indicated accessories.

B. The contractor shall furnish and install air-cooled water chiller with scroll compressors as shown as scheduled on the contract documents. The chillers shall be installed in accordance with this specification and perform at the specified conditions as scheduled.

2.04 CABINET

A. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.

B. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.

C. Casing: Galvanized steel.

D. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B117.

2.05 COMPRESSOR-DRIVE ASSEMBLIES

A. Compressors:

1. Description: Positive-displacement direct drive with hermetically sealed casing.

2. Operating Speed: Nominal 3600 rpm for 60-Hz applications.

3. Capacity Control: On-off compressor cycling.

a. Digital compressor unloading is an acceptable alternative to achieve capacity control.

4. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.

a. Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.

5. Vibration Isolation: Mount individual compressors on vibration isolators.

a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.

B. Compressor Motors:

1. Hermetically sealed and cooled by refrigerant suction gas.

2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.

C. Compressor Motor Controllers:

1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

2.06 REFRIGERATION

A. Refrigerant: R-410A. Classified as Safety Group A1 according to ASHRAE 34.

B. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.

C. Refrigerant Circuit: Each chiller shall have a minimum of 2 refrigeration circuits, each with no more than three (manifolded) compressors on each circuit. Each circuit shall include an electronic expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.

D. Pressure Relief Device:

1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.

3. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

2.07 EVAPORATOR

A. Remote-mounted.

B. Brazed Plate:

1. Direct-expansion, single-pass, brazed-plate design.

2. Type 304 or 316 stainless-steel construction.

3. Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.

4. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping.

5. Inlet Strainer: Factory-furnished, 40-mesh strainer for field installation in supply piping to evaporator. Manufacturer has option to factory install strainer.

C. Insulate the evaporator with a minimum of 0.75 inch (K=0.28) insulation.

D. Flow Switch: Factory-furnished and -installed, flow switch wired to chiller operating controls.

2.08 AIR-COOLED CONDENSER

A. Coil(s) with integral subcooling on each circuit.

B. Aluminum Microchannel Coils:

1. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.

2. Single- or multiple-pass arrangement.

3. Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.

C. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.

D. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge. All condenser fans shall have integrated drives to provide variable speed for optimized efficiency and lower part load sound. See specified sound requirements on schedule.

E. Fan Motors: TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.

1. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.

F. Fan Guards: Removable steel safety guards with corrosion-resistant PVC coating.

2.09 INSULATION

A. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.

2.10 ELECTRICAL

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.

C. House in a unit-mounted, NEMA 250, Type 3R enclosure with hinged access door with lock and key or padlock and key.

D. Wiring shall be numbered and color-coded to match wiring diagram.

E. Factory wiring shall be located outside of an enclosure in a metal raceway. Terminal connections shall be made with not more than a 24-inch length of liquid-tight conduit.

F. Field power interface shall be to circuit breaker. Minimum SCCR according to UL 508 shall be as required by electrical power distribution system, but not less than scheduled value.

G. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:

1. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.

H. Each motor shall have overcurrent protection.

I. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.

J. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.

K. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.

L. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.

2.11 CONTROLS

A. Factory installed and wired, and functionally tested at factory before shipment.

B. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.

C. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.

D. Operator Interface: Pressure-sensitive touch screen. Multiple-character, digital display. Display shall consist of a menu driven interface with easy touch screen navigation to organized sub-system reports for compressor and evaporator information as well as associated diagnostics. The chiller control panel shall provide password protection of all setpoints. Provide user interface on the front of the panel. If display is on the inside of the panel, then a control display access door shall be provided to allow access to the display without removal of panels. Provide user interface with a minimum of the following features:

1. The front of the chiller control panel shall display the following in clear language, without the use of codes, look-up tables, or gauges:

a. Run time.

b. Number of starts.

c. Current chiller operating mode.

d. Chilled water set point and set point source.

e. Demand current limit set point and set point source.

f. Entering and leaving evaporator water temperatures.

g. Saturated evaporator and condenser refrigerant temperatures.

h. Evaporator and condenser refrigerant pressure.

i. Phase reversal/unbalance/single phasing and over/under voltage protection.

j. Low chilled water temperature protection.

k. High and low refrigerant pressure protection.

l. Load limit thermostat to limit compressor loading on high return water temperature.

m. Condenser fan sequencing to automatically cycle fans in response to load, expansion valve pressure, condenser pressure, and differential pressure to optimize chiller efficiency.

n. Display diagnostics.

o. Compressors: Status (on/off), anti-short cycle timer, and automatic compressor lead-lag.

E. Control Functions:

1. Provide the following operating controls:

a. A variable compressor staging method to control capacity in order to maintain leaving chilled water temperature based on PI algorithms. Five minute solid state anti-recycle timer to prevent compressor from short cycling. Compressor minimum stop-to-start time limit shall be 2 minutes. If a greater than 5 minute start-to-start, or greater than 2 minute stop-to-start timer is included.

b. Chilled water pump output relay that closes when the chiller is given a signal to start.

c. Load limit thermostat to limit compressor loading on high return water temperature to prevent nuisance trips.

d. High ambient unloader pressure controller that unloads compressors to keep head pressure under control and help prevent high pressure nuisance trip outs on days when outside ambient is above design.

e. Low ambient lockout control with adjustable setpoint.

f. Condenser fan sequencing which adjusts the speed of all fans automatically in response to ambient, condensing pressure and expansion valve pressure differential thereby optimizing chiller efficiency.

F. Safety Controls:

1. The chiller controller shall utilize a microprocessor that will automatically take action to prevent chiller shutdown due to abnormal operating conditions associated with: evaporator refrigerant temperature, high condensing pressure and motor current overload.

2. Provide the following safety controls with indicating lights or diagnostic readouts:

a. Low chilled water temperature protection.

b. High refrigerant pressure.

c. Loss of chilled water flow.

d. Contact for remote emergency shutdown.

e. Motor current overload.

f. Phase reversal/unbalance/single phasing.

g. Over/under voltage.

h. Failure of water temperature sensor used by controller.

i. Compressor status (on or off).

3. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:

a. Low evaporator pressure or high condenser pressure.

b. Low chilled-water temperature.

c. Refrigerant high pressure.

d. High or low oil pressure.

e. High oil temperature.

f. Loss of chilled-water flow.

g. Control device failure.

G. BAS System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.

1. Hardwired I/O Points:

a. Monitoring: On/off status, common trouble alarm.

b. Control: On/off operation, chilled-water discharge temperature set-point adjustment.

2. Communication Interface: ASHRAE 135 (BACnet) communication interface shall enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.

H. Factory-installed wiring outside of enclosures shall be in NFPA 70-complaint raceway. Make terminal connections with liquid-tight

2.12 ACCESSORIES

A. Chiller shall have full architectural louvers panels that cover and protect the condenser coils and the compressors.

B. Factory-furnished spring isolators for field installation.

C. Sound Control:

1. Acoustics: Manufacturer must provide both sound power and sound pressure data in decibels, per AHRI 370. A-weighted sound pressure at 30 feet should be provided at 100%, 75%, 50% and 25% load points to identify the full operational noise envelope.

2. Provide condenser fan speed control for sound reduction.

3. Provide compressor sound wraps.

2.13 MATERIALS

A. Steel:

1. ASTM A36/A36M for carbon structural steel.

2. ASTM A568/A568M for steel sheet.

B. Stainless Steel:

1. Manufacturer's standard grade for casing.

2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.

C. Galvanized Steel: ASTM A653/A653M.

D. Aluminum: ASTM B209.

2.14 SOURCE QUALITY CONTROL

A. Chiller shall have a tarp covering full chiller to protect the chiller during shipment.

B. Perform functional test of water chillers before shipping.

C. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.

D. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

PART 3 EXECUTION

3.01 WATER CHILLER INSTALLATION

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

B. Equipment Mounting:

1. Install water chillers on cast-in-place concrete equipment bases. Comply with requirements for equipment bases and foundations specified in Section 033000 "Cast-in-Place Concrete."

2. Level the chiller using the base rail as a reference. The chiller must be level within 1/2 in over the entire length and width. Use shims as necessary to level the chiller.

C. Maintain manufacturer's recommended clearances for service and maintenance.

D. Maintain clearances required by governing code.

E. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.

F. Install separate devices furnished by manufacturer and not factory installed.

1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

3.02 PIPING CONNECTIONS

A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.

B. Where installing piping adjacent to chillers, allow space for service and maintenance.

C. Connect each drain connection with a drain valve, full size of drain connection.

D. Connect each chiller vent connection with a manual vent, full size of vent connection.

3.03 ELECTRICAL POWER CONNECTIONS

A. Connect wiring according to Section 260519 "Conductors and Cables for Electrical."

B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

3.04 CONTROLS CONNECTIONS

A. Install control and electrical power wiring to field-mounted control devices.

B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.

C. Connect control wiring between chiller control interface and DDC system for remote monitoring and control of chillers. Comply with requirements in Section 230900 "Instrumentation and Control for HVAC."

D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

3.05 STARTUP SERVICE

A. Startup - Provide all labor and materials to perform startup. Startup shall be performed by the original equipment manufacturer (OEM). Technician shall confirm that equipment has been correctly installed and passes specification checklist prior to equipment becoming operational and covered under OEM warranty. This shall be done in strict accordance with manufacturer's specifications and requirements. Third-party service agencies, including installing contractor, are not permitted.

1. A start-up log shall be furnished by the factory approved start-up technician to document the chiller's start-up date and shall be signed by the owner or his authorized representative prior to commissioning the chillers.

B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.

C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:

1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.

2. Verify that pumps are installed and functional.

3. Verify that thermometers and gages are installed.

4. Operate water chiller for run-in period.

5. Check bearing lubrication and oil levels.

6. Verify that refrigerant pressure relief device for chillers installed indoors is vented outside.

7. Verify proper motor rotation.

8. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.

9. Verify and record performance of chilled-water flow and low-temperature interlocks.

10. Verify and record performance of water chiller protection devices.

11. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.

D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.

E. Prepare a written startup report that records results of tests and inspections.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers. Video record the training sessions and provide electronic copy to Owner.

1. Instructor shall be factory trained and certified.

2. Provide not less than one day of training.

3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.

4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.

5. Obtain Owner sign-off that training is complete.

6. Location: At manufacturer's training facility; include travel expenses for one member of Owner's staff.

END OF SECTION 236423

SECTION 237413 - ROOF MOUNTED CUSTOM AIR HANDLING UNIT

PART 1 GENERAL

1.01 SUMMARY

1.02 THIS SECTION INCLUDES CUSTOM, OUTDOOR, CENTRAL-STATION AIR-HANDLING UNITS (ROOFTOP UNITS) WITH THE FOLLOWING COMPONENTS AND ACCESSORIES:

A. Return Fan

B. Economizer outdoor- and return-air damper section.

C. Air Blender.

D. How Water Heating Coil.

E. Humidifier.

F. Chilled Water Cooling Coil.

G. UV Lights.

H. Supply Fans.

1.03 DEFINITIONS

A. DDC: Direct-digital controls.

B. ECM: Electrically commutated motor.

C. RTU: Rooftop unit. As used in this Section, this abbreviation means packaged, outdoor, central-station air-handling units. This abbreviation is used regardless of whether the unit is mounted on the roof or on a concrete base on ground.

D. Supply-Air Fan: The fan providing supply air to conditioned space. "Supply air" is defined as the air entering a space from air-conditioning, heating, or ventilating apparatus.

1.04 SUBMITTALS

A. Product Data: Include manufacturer's technical data for each RTU, including rated capacities, dimensions, required clearances, characteristics, furnished specialties, and accessories.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Wiring Diagrams: Power, signal, and control wiring.

D. Coordination Drawings: Plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

E. Structural members to which RTUs will be attached.

F. Roof openings

G. Roof curbs and flashing.

H. Field quality-control test reports.

I. Operation and Maintenance Data: For RTUs to include in emergency, operation, and maintenance manuals.

1.05 QUALITY ASSURANCE

A. Manufacturer shall be a company specializing in the design and manufacture of commercial/industrial custom HVAC equipment. Manufacturer shall have been in production of custom HVAC equipment for a minimum of 5 years.

B. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for RTUs.

2. Comply with ARI 270 for testing and rating sound performance for RTUs.

3. ASHRAE Compliance:

a. Comply with ASHRAE 15 for refrigeration system safety.

b. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

c. Comply with applicable requirements in ASHRAE 62.1-2004, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."

4. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6 - "Heating, Ventilating, and Air-Conditioning."

5. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

6. UL Compliance: Comply with UL 1995.

7. 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.

8. WARRANTY

a. The complete unit shall be covered by a parts warranty issued by the manufacturer covering the first year of operation. This warranty period shall start upon receipt of start-up forms for the unit or eighteen months after the date of shipment, whichever occurs first.

b. The installing contractor shall provide labor warranty during the unit’s first year of operation.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Temtrol

2. Annexair

3. Buffalo

2.02 UNITS

A. Configuration: Fabricate as detailed on prints and drawings:

1. Return fan.

2. Return plenum / economizer section.

3. Air blender.

4. Pre-filter section.

5. How water heating coil.

6. Humidifier.

7. Chilled water cooling coil.

8. UV lights.

9. Supply fan.

10. Final filter section.

B. The complete unit shall be cETLus listed.

C. Each unit shall be specifically designed for outdoor rooftop application and include a weatherproof cabinet. Each unit shall be completely factory assembled and shipped in one piece. Packaged units shall be shipped fully charged with R-410 Refrigerant and oil.

D. The unit shall undergo a complete factory run test prior to shipment. The factory test shall include a refrigeration circuit run test, a unit control system operations checkout, a unit refrigerant leak test and a final unit inspection.

E. All units shall have decals and tags to indicate caution areas and aid unit service. Unit nameplates shall be fixed to the main control panel door. Electrical wiring diagrams shall be attached to the control panels. Installation, operating and maintenance bulletins and start-up forms shall be supplied with each unit.

F. Performance: All scheduled EER, IEER, capacities and face areas are minimum accepted values. All scheduled amps, kW, and HP are maximum accepted values that allow scheduled capacity to be met.

2.03 CABINET, CASING, AND FRAME

A. General: Provide factory-fabricated air handling units with capacity as indicated on the schedule. Units shall have overall dimensions as indicated and fit into the space available with adequate clearance for service as determined by the Engineer. Units shall be completely assembled. Multiple sectioned units shall be shipped as a single factory assembled piece (except where shipping limitations prevent) de-mounted into modular sections in the field by the contractor. Units shall be furnished with sufficient gasket and bolts for reassembly in the field by the contractor. Unit manufacturer shall provide certified ratings conforming to the latest edition of AMCA 210, 310, 500 and AHRI 410. All electrical components and assemblies shall comply with NEMA standards. Unit internal insulation must have a flame spread rating not over 25 and smoke developed rating no higher than 50 complying with NFPA 90A, “Standard for the Installation of Air Conditioning and Ventilating Systems.” Units shall comply with NFPA 70, “National Electrical Code,” as applicable for installation and electrical connections of ancillary electrical components of air handling units. Tags and decals to aid in service or indicate caution areas shall be provided. Electrical wiring diagrams shall be attached to the control panel access doors. Operation and maintenance manuals shall be furnished with each unit. Units shall be UL or ETL listed.

B. Rigging Provision: Multiple Piece Units: Units shipped in multiple sections shall be engineered for field assembly. The base frame shall have integral lifting lugs. The lifting lugs shall be fabricated from structural steel with an appropriate rigging hole. Lifting lugs shall be located at the corner of each section (and along the sides if required) and sized to allow rigging and handling of the unit. All gasket and necessary assembly hardware shall ship loose with unit. Junction boxes with a factory supplied numbered terminal strip shall be supplied at each shipping split for reconnection of control wiring.

C. Unit Base: Unit perimeter base rail shall be fabricated using heavy gauge steel. C-Channel cross supports shall be welded to perimeter base steel and located on maximum 24” centers to provide support for internal components. Base rails shall include lifting lugs at the corner of the unit or each section if de-mounted. Internal walk-on floor shall be 16-gauge galvanized steel. The outer sub-floor of the unit shall be made from 20-gauge galvanized steel. The floor cavity shall be spray foam insulated with floor seams gasketed for thermal break and sealed for airtight / watertight construction. Where access is provided to the unit interior, floor openings shall be covered with walk on phenolic coated steel safety grating. Single wall floors with glued and pined insulation and no sub floor are not acceptable. Base frame shall be attached to the unit at the factory.

D. Unit Casing – The construction of the air handling unit shall consist of a (1” x 2”) steel frame with formed 20-gauge galvanized steel exterior casing panels. The exterior casing panels shall be attached to the gasketed (1 x 2) steel frame with corrosion resistant fasteners. All casing panels shall be completely removable from the unit exterior without affecting the unit’s structural integrity. (Units without framed type of construction shall be considered, provided the exterior casing panels are made from 16-gauge galvanized steel, maximum panel center lines are less than 20 inches and deflection is less than L/200 @ 8” positive pressure). The air handling unit casing shall be of the “no-through-metal” design. The casing shall incorporate insulating thermal breaks as required so that, when fully assembled, there’s no path of continuous unbroken metal to metal conduction from inner to outer surfaces. All panel seams shall be caulked and sealed for an airtight unit.

E. Insulation – Unit shall be provided wih minimum 3” thick Walls. Entire unit to be insulated with foam injected panels (R-20) 3” thick closed cell foam insulation. All insulation edges shall be encapsulated within the panel. All field penetrations must be completely sealed by installing contractor.

F. Access Doors - The unit shall be equipped with a solid double wall insulated (same as the unit casing), hinged access doors as shown on the plans. The doorframe shall be extruded aluminum, foam filled with a built-in thermal break barrier and full perimeter gasket. The door hinge assembly shall be stainless steel. There shall be a minimum of two heavy duty handles per door. Provide ETL, UL 1995, and CAL-OSHA approved tool operated safety latch on all fan section access doors.

2.04 EXHAUST FAN

A. Exhaust fan shall be a single width, single inlet (SWSI) airfoil centrifugal fan. The fan wheel shall be Class II construction with aluminum fan blades that are continuously welded to the hub plate and end rim. The exhaust fan shall be a direct drive fan mounted to the motor shaft

B. The fan motor shall be a totally enclosed EC motor that is speed controlled by the rooftop unit controller. The motor shall include thermal overload protection and protect the motor in the case of excessive motor temperatures. The motor shall have phase failure protection and prevent the motor from operation in the event of a loss of phase. Motors shall be premium efficiency.

C. Fan assembly shall be a slide out assembly for servicing and maintenance.

D. The unit DDC controller shall provide building static pressure control. The unit controller shall provide proportional control of the exhaust fans from 25% to 100% of the supply air fan designed airflow to maintain the adjustable building pressure setpoint. The field shall mount the required sensing tubing from the building to the factory mounted building static pressure sensor.

2.05 FILTERS

A. Unit shall be provided with a draw-through filter section. The filter rack shall be designed to accept a 2” prefilter and a 4” final filter. The unit design shall have a hinged access door for the filter section. The manufacturer shall ship the rooftop unit with 2” construction filters. The contractor shall furnish and install, at building occupancy, the final set of filters per the contract documents.

2.06 COOLING COIL

A. The indoor coil section shall be installed in a draw through configuration, upstream of the supply air fan. The coil section shall be complete with a factory piped cooling coil and an ASHRAE 62.1 compliant double sloped drain pan.

B. The direct expansion (DX) cooling coils shall be fabricated of seamless high efficiency copper tubing that is mechanically expanded into high efficiency aluminum plate fins. Coils shall be a multi-row, staggered tube design with a minimum of 3 rows. All cooling coils shall have an interlaced coil circuiting that keeps the full coil face active at all load conditions. All coils shall be factory leak tested with high pressure air under water.

C. The cooling coil shall have an electronic controlled expansion valve. The unit controller shall control the expansion valve to maintain liquid subcooling and the superheat of the refrigerant system.

D. The refrigerant suction lines shall be fully insulated from the expansion valve to the compressors.

E. The drain pan shall be stainless steel and positively sloped. The slope of the drain pan shall be in two directions and comply with ASHRAE Standard 62.1. The drain pan shall have a minimum slope of 1/8" per foot to provide positive draining. The drain pan shall extend beyond the leaving side of the coil. The drain pan shall have a threaded drain connection extending through the unit base.

2.07 FANS

A. All fans shall meet the air flow performance specified and shall not exceed the break horsepower or sound power levels specified on the mechanical equipment schedule. Fan performance shall be based on testing and be in accordance with AMCA Standards 210 and 300. All fans shall have a steep pressure/volume curve. Fan shaft shall be turned, ground and polished solid steel rated at maximum RPM below critical speed. Fan wheel and sheaves shall be keyed to the shaft. Fan shall be balanced per ANSI / AMCA 204-96 fan application category BV-3. Fan assemblies shall be designed for heavy-duty industrial applications. Fan framing assemblies shall be fabricated from structural steel. Formed load bearing members are not acceptable. The structural steel shall be electrically welded together to form a rigid integral base. Fan assemblies shall be independently isolated with spring-type vibration isolators. Inlet cones shall be precision spun or die formed. Inlet cones shall be aerodynamically matched to the wheel side plate to provide streamlined airflow in the wheel and ensure full loading of the blades.

B. Provide airflow monitoring device equal to TemFLO device at the inlet of all supply fans. Air monitoring device shall consist of an array of differential pressure flow sensors mounted at opposing 90° positions around the inlet of the plenum fan. Flow sensors shall be manifolded together with pneumatic tubing to form a piezometric ring. Each fan assembly and air monitoring device shall have been tested for airflow vs. differential pressure and calibrated in an AMCA Accredited Laboratory throughout the fans range of operation. 4-20ma low pressure transducer with accuracy of ±1% full span and temperature compensated from 25 to 150°F, shall be mounted on fan inlet plate or fan bulk head wall to provide feedback. Air monitoring device shall not obstruct the fan inlet, be directly mounted across the fan inlet or have any effect on fan air performance or sound power levels.

C. Motors shall be NEMA Design B; T-FRAME mounted on an adjustable steel base. All motors shall be tested to IEEE standard 112 test method B and rated per NEMA MG1, Part 31 “Inverter Fed Motors”. All motors shall be specifically designed to meet or exceed all (EPAct) requirements for energy efficiency and include Class ‘F’ insulation. Motors shall be as manufactured by Baldor, Toshiba, Reliance or equal. Motors shall meet the electrical characteristics as specified for voltage, rpm, and efficiencies in Section 230513 Common Motor Requirements for Mechanical.

D. VFDs - Each variable air volume supply and return fan shall be provided with separate variable frequency drives. Drives shall be factory mounted with adequate ventilation provided. The variable frequency drive shall convert 460 volt +/ 10%, three phase, 60 hertz (+/ 2 Hz.) utility power to adjustable voltage/frequency, three phase, A C power step less motor control from 5% to 105% of base speed. The variable frequency drive (VFD) shall produce an adjustable A C voltage/frequency output of complete motor speed control and an input power factor near unity over the entire speed range. The VFD shall be automatically controlled by an control signal. The VFD shall be self contained, totally enclosed in a NEMA 1 ventilated cabinet and capable of operation between 0 and 40 °C. The VFD shall be UL listed. Components used in all options shall be UL listed. The VFD shall have a hand/off/auto operator switch, drive switch with run or stop command and panel mounted digital display capable of indicating unit status, frequency, and fault diagnostics.

E.

F. The 2x2 multiple fan wall systems shall include multiple, direct driven, arrangement for plenum fans constructed per AMCA requirements for the duty specified class III as required. Fans shall be rated in accordance with and certified by AMCA for performance. All fans shall be selected to deliver the specified airflow quantity at the specified operating Total Static Pressure and specified fan/motor speed. The fan array shall be selected to operate at a system Total Static Pressure that does not exceed 90% of the specified fan's peak static pressure producing capability at the specified fan/motor speed. Each fan/motor cube or cell shall include a minimum 10-gauge, G 90 Galvanized steel intake wall, .100 aluminum spun fan inlet funnel, and an 10 gauge G90 Galvanized steel motor support plate rail and structure. All motors shall be standard foot mounted type TEAO selected at the specified operating voltage, RPM, and efficiency as scheduled. Motors shall meet the requirements of NEMA MG-1 Part 30 and 31, section 4.4.2. Motors shall be as manufactured by Baldor, Siemens, or Toshiba for use in multiple fan arrays that operate at varying synchronous speeds as driven by an approved VFD. Motor HP shall not exceed the scheduled HP as indicated in the AHU equipment schedule(s). All motors shall include permanently sealed (L10-500,000 hr) bearings and shaft grounding to protect the motor bearings from electrical discharge machining due to stray shaft currents. Each fan/motor assembly shall be dynamically balanced to meet AMCA standard 204-96. Copies of the certified balancing reports shall be provided with the unit O&M manuals at the time of shipment. Submittals that do not include a statement of compliance with this requirement will be returned to the contractor without review.

G. The 2x2 fan wall shall consist of multiple fan and motor "cubes" or "cells", spaced in the air way tunnel cross section to provide a uniform air flow and velocity profile across the entire air way tunnel cross section and components contained therein. In order to assure uniform velocity profile in the AHU cross section, the fan cube dimensions must be variable, such that each fan rests in an identically sized cube or cell, and in a spacing that must be such that the submitted array dimensions fill a minimum of 90% of the cross-sectional area of the AHU air way tunnel. There shall be no blank off plates or "spacers" between adjacent fan columns or rows to position the fans across the air way tunnel. The array shall produce a uniform air flow profile and velocity profile within the airway tunnel of the air handling unit to equal the specified cooling coil and/or filter bank face velocity by +/- 10% when measured at a point 36" from the intake side of the fan array intake plenum wall, and at a distance of 72" from the discharge side of the fan array intake plenum wall.

H. Each fan motor shall be sized for N+1 redundancy meaning if one fan fails the other 3 fans can make up the required full airflow.

I. Each fan & motor assembly shall be removable through a 24" wide, free area, access door located on the discharge side of the fan wall array without removing the fan wheel from the motor. All fan/motor access doors shall open against pressure.

J. Backdraft Damper: Each individual cube or cell in the multiple fan arrays shall be provided with an integral back flow prevention device that prohibits recirculation of air in the event a fan or multiple fans become disabled.

2.08 WATER COILS

A. All coil assemblies shall be leak tested under water at 315 PSIG and performance is to be certified under AHRI Standard 410.

B. Round seamless 5/8" O.D. copper tubes with 0.020" wall thickness mechanically expanded into fin collars of the secondary surface. Tubes shall be mechanically expanded to provide a permanent metal-to-metal bond for efficient heat transfer. Manufacturer may only use staggered tubes in direction of airflow with tube wall hairpin bends. 10 rows maximum

C. Cooling coils shall be mounted on stainless steel support rack to permit coils to slide out individually from the unit. Provide intermediate drain pans on all stacked cooling coils. The intermediate pan shall drain to the main drain pan through a copper downspout. Water coils shall be constructed of seamless copper tubing mechanically expanded into fin collars. All fins shall be continuous within the coil casing to eliminate carryover inherent with a split fin design. Fins are die formed Plate type.

D. Headers are to be seamless copper with die formed tube holes.

E. Connections shall be male pipe thread (MPT) Schedule 40 Red Brass with 1/8" vent and drain provided on coil header for coil drainage. All coil connections shall be extended to the exterior of the unit casing by the manufacturer. Coils shall be suitable for 250 PSIG working pressure. Intermediate tube supports shall be supplied on coils over 44" fin length with an additional support every 42" multiple thereafter.

F. Water coils shall have the following construction:

1. Standard 1/2"

a. 1/2" o.d. x .017" wall copper tube with .025 return bends

b. .006" aluminum fins

c. 16 gauge galvanized steel casing

2. Standard 5/8"

a. 5/8" o.d. x .020" wall copper tube with .028 return bends.

b. .008" aluminum fins

c. 16 gauge galvanized steel casing

2.09 CONDENSATE / DRAIN PANS

A. IAQ style drain pans shall be provided under all cooling coils as shown on the drawings. The drain pan shall be fabricated from 16-gauge 304 stainless steel. All pans are to be triple pitched for complete drainage with no standing water in the unit. They shall be insulated minimum 3-inch "Double Bottom" construction with welded corners. Provide stainless steel, 1-1/4” MPT drain connection extended to the exterior of the unit base rail. Units in excess of 159 inches shall have drain connections on both sides. All drain connections shall be piped and trapped separately for proper drainage.

2.10 FILTERS

A. Provide filters of the type indicated on the schedule. Factory fabricated filter sections shall be of the same construction and finish as the unit. Face loaded pre and final filters shall have Type 8 frames as manufactured by AAF, FARR or equal. Side service filter sections shall include hinged access doors on both sides of the unit. Internal blank-offs shall be provided by the air unit manufacturer as required to prevent air bypass around the filters. The filters shall be as manufactured by Farr, Purolator, AAF or equal. Filters shall be in compliance with ANSI/UL 900 – Test Performance of Air Filters.

1. Filter Gauge: Each Filter bank shall be furnished with: (Magnehelic / Photohelic) filter gauge with a 4 ¾" OD white static pressure dial with black figures and zero pointer adjustment. / Dwyer Series 2000 Air filter gauge Dwyer Mark 25 Inclined manometer (DWYER 250 AF).

2. Medium Efficiency Pleated Filters - Filters shall be 2" thick, 30% efficient. Filter media shall be 100% synthetic. The filter shall have an average efficiency of 25 30% and an average arrestance of 90 92%. The filters shall be listed as Class II under UL Standard 900. Filters shall be tested per ASHRAE Standard 52-76. The effective media shall not be less than 4.6 square feet of media per 1.0 square foot of filter face area, and shall contain not less than 15 pleats per linear foot. Initial resistance at 500 fpm approach shall not exceed 0.28" wg.

2.11 DAMPERS

A. Temtrol TD-6 or approved equal. Provide Class 1 rated, ultra low leak dampers (less than 3 cfm/sq ft. @ 1" w.g.) as indicated on the unit drawings. Low leakage dampers shall have extruded aluminum airfoil blades. Flat or formed metal blades are not acceptable. The damper blade shall incorporate santoprene rubber edge seals and zinc plated or stainless-steel tubular steel shaft for a non-slip operation. Shaft bearings shall be spherical – noncorrosive nylon to eliminate friction and any metal-to-metal contact. Damper jamb seals shall be UV rated, nylon glass reinforced or stainless-steel spring arcs designed for a minimum air leakage and smooth operation. Damper linkage shall be concealed within a 16-gauge galvanized steel frame.

2.12 ELECTRICAL POWER

A. All electrical and automatic control devices not previously called out or listed below are to be furnished and installed in the field by others.

B. The unit shall feature a mounted permanent nameplate displaying at a minimum the manufacturer, serial number, model number and current and amps voltage. The unit must have an ETL or UL Listing and bear the appropriate mark.

C. Conduit shall consist of a combination of EMT or flexible metal conduit as required. Liquid tight flexible metal conduit may be used outside the air tunnel for wet locations.

D. The unit shall feature a main non-fused disconnect of the proper amp rating to allow shutoff of all electrical motors and control items.

E. Minimum 60" wide Service Vestibule with same construction and performance of overall unit shall be provided with doors and lights see unit detail

F. Unit Convenience Features

1. Each section with door shall be equipped with a vapor- proof 100 watt service light with guard.

2. Lights shall be controlled by one light switch mounted adjacent to the supply air fan access door.

3. Each light shall have its own light switch mounted adjacent to the access door.

4. All lights, switches and outlets shall be wired to a fused or non-fused disconnect for a separate 120-volt external source.

5. Lights, switches and outlets shall be wired through a transformer fused disconnect package.

2.13 CONTROLS

A. Refer to 230900 Direct Digital Controls (DDC) System for HVAC

PART 3 EXECUTION

3.01 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of RTUs.

B. Examine roughing-in for RTUs to verify actual locations of piping and duct connections before equipment installation.

C. Examine roofs for suitable conditions where RTUs will be installed.

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

3.02 INSTALLATION

3.03 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

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

C. Duct installation requirements are specified in other Division 23 Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Install ducts to termination at top of roof curb.

2. Remove roof decking only as required for passage of ducts. Do not cut out decking under entire roof curb.

3. Connect supply ducts to RTUs with flexible duct connectors.

4. Install return-air duct continuously through roof structure.

3.04 FIELD QUALITY CONTROL

A. Contractor to provide appropriate allowance in base bid to supply necessary pulley changes on fans during balancing and any necessary internal perforated baffle sections as needed to accommodate stratification.

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

3.05 TESTS AND INSPECTIONS:

A. After installing RTUs and after electrical circuitry has been energized, test units for compliance with requirements.

B. Inspect for and remove shipping bolts, blocks, and tie-down straps.

C. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

D. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

3.06 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

B. Complete installation and startup checks according to manufacturer's written instructions. Submit report stating units are fully functionable, calibrated, and defect free.

3.07 CLEANING AND ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to site during other-than-normal occupancy hours for this purpose.

B. After completing system installation and testing, adjusting, and balancing RTU and air-distribution systems, clean filter housings and install new filters.

3.08 DEMONSTRATION

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

END OF SECTION 237413

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SECTION 237416 - PACKAGED ROOFTOP AIR-CONDITIONING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Packaged, large-capacity, rooftop air-conditioning units.

1.02 RELATED REQUIREMENTS

A. Section 230548 - Vibration and Seismic Controls for HVAC.

B. Section 230900 Direct Digital Controls (DDC) for HVAC: Control components, time clocks.

C. Section 260583 - Wiring Connections: Installation and wiring of thermostats and other control components; wiring from unit terminal strip to remote panel.

D. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2023.

B. AHRI 270 - Sound Performance Rating of Outdoor Unitary Equipment 2015, with Addendum (2016).

C. AMCA 611 - Certified Ratings Program - Product Rating Manual for Airflow Measurement Stations 2015.

D. ASHRAE Std 90.1 I-P - Energy Standard for Buildings Except Low-Rise Residential Buildings Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

E. ASHRAE Std 135 - A Data Communication Protocol for Building Automation and Control Networks 2020, with Errata (2023).

F. IEEE 802.11 - IEEE Standard for Information Technology--Telecommunications and Information Exchange between Systems - Local and Metropolitan Area Networks--Specific Requirements - Part 11: Wireless LAN Medium Access Control (MAC) and Physical Layer (PHY) Specifications 2020 (Corrigendum 2022).

G. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum) 2020.

H. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

1.04 SUBMITTALS

A. Product Data: Provide capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

B. Sustainable Design Documentation: Submit manufacturer's product data on refrigerant used, showing compliance with specified requirements.

C. Shop Drawings: Indicate capacity and dimensions of manufactured products and assemblies required for this project. Indicate electrical service with electrical characteristics and connection requirements, and duct connections.

D. Manufacturer's Instructions: Indicate assembly, support details, connection requirements, and include start-up instructions.

E. Warranty: Submit manufacturer's warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Protect units from physical damage by storing off site until roof mounting curbs are in place and ready for immediate installation of units.

PART 2 PRODUCTS

2.01 PACKAGED, LARGE-CAPACITY, ROOFTOP AIR-CONDITIONING UNITS

A. Manufacturers:

1. Klimor
2. Johnson Controls International.
3. Trane.

B. Casing

1. Modular construction. Posts made from anodized aluminum profiles with thermal break. 2" thick double walls with thermal break. Insulation shall be R=13. Designed for outdoor use.

C. Fans

1. All units shall be equipped with direct driven plenum Fans, with air foil backward-curved impellers with 5-7 blades made of steel; the impellers are installed directly on the motor shafts. All power and sound ratings have been tested & rated according to applicable AMCA Standards & Publications. All Fan Assemblies are belt-less, AMCA Arrangement 4.
2. Bearings shall be rated for L10 = 150,000 hours.

3. Single point power connection with manual disconnect.

    a. Single power supply connection for each fan section. Built in short circuit protection (circuit breakers) and main switch. Enclosure class: NEMA 4

D. Filters

1. Pre-filter shall be MERV 8

2. Final filter shall be MERV 14

E. Dampers

1. Provide external motorized opposed blade dampers. Dampers shall have aluminum blades with rubber gaskets on the edges. Dampers shall comly with AMCA 500 standard, class 1.

F. Water Coils

1. How Water Coils

    a. Coil casing: Hot-dip galvanized steel

    b. Material: Copper pipes

    c. Fins: Aluminum, mechanically bonded to the pipes spaced 10 fins per inch, 0.006” thick

    d. Tube wall thickness: 0.02”

    e. Tube spacing: 1 1/4”

    f. Row spacing: 1.08”

    g. Tube diameter: 1/2"

    h. Threaded connection, NPT

    i. Maximum operating/tested pressure: 232 PSI

    j. Entering medium minimum/maximum temperature: 68°F/302°F

    k. Maximum glycol content: 50%

2. Chilled Water Coils

    a. Coil casing: Stainless steel

    b. Material: Copper pipes

    c. Fins: Aluminum, mechanically bonded to the pipes spaced 10 fins per inch, 0.006” thick

    d. Tube wall thickness: 0.02”

    e. Tube spacing: 1 1/4”

f. Row spacing: 1.08”

g. Tube diameter: 1/2”

h. Threaded connection, NPT

i. Number of rows available: 4, 6, 8,10,12

j. Maximum operating/tested pressure: 232 PSI

k. Entering medium minimum/maximum temperature: 36°F/65°F

l. Maximum glycol content: 50%

G. Drain Pan

1. Drain pan shall be stainless steel construction. Triple sloped toward condesnsate drainage point. 1" NPT threaded connection point

H. Roof Curb

1. Roof mounting curb: 14 inches high, galvanized steel, channel frame with gaskets, nailer strips.

PART 3 EXECUTION

3.01 EXAMINATION

A. Verify that roof is ready to receive work and opening dimensions are as required by manufacturer.

B. Verify that proper power supply is available.

3.02 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Install in accordance with NFPA 90A.

C. Mount units on factory built roof mounting curb providing watertight enclosure to protect ductwork and utility services. Install roof mounting curb level.

3.03 SYSTEM STARTUP

A. Prepare and start equipment. Adjust for proper operation.

3.04 CLOSEOUT ACTIVITIES

A. Demonstrate proper operation of equipment to Owner's designated representative.

3.05 MAINTENANCE

A. See Section 017000 - Execution and Closeout Requirements for additional requirements relating to maintenance service.

B. Provide service and maintenance of packaged rooftop units for one year from Date of Substantial Completion.

C. Provide routine maintenance service with a two-month interval as maximum time period between calls.

D. Include maintenance items as outlined in manufacturer's operating and maintenance data, including minimum of six filter replacements, minimum of one fan belt replacement, and controls check-out, adjustments, and recalibration.

E. After each service call, submit copy of service call work order or report that includes description of work performed.

END OF SECTION 237416

SECTION 238126.13 - SMALL-CAPACITY SPLIT-SYSTEM AIR CONDITIONERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Air cooled condensing units.

B. Indoor air handling (fan and coil) units for ductless systems.

C. Controls.

1.02 RELATED REQUIREMENTS

A. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections and installation and wiring of thermostats and other controls components.

1.03 REFERENCE STANDARDS

A. AHRI 210/240 - Performance Rating of Unitary Air-Conditioning and Air-Source Heat Pump Equipment 2023.

B. ASHRAE Std 23 - Methods for Performance Testing Positive Displacement Refrigerant Compressors and Compressor Units 2022.

C. NFPA 90A - Standard for the Installation of Air-Conditioning and Ventilating Systems 2024.

D. NFPA 90B - Standard for the Installation of Warm Air Heating and Air-Conditioning Systems 2021.

E. UL 207 - Standard for Refrigerant-Containing Components and Accessories, Nonelectrical Current Edition, Including All Revisions.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide rated capacities, weights, accessories, electrical nameplate data, and wiring diagrams.

C. Shop Drawings: Indicate assembly, required clearances, and location and size of field connections.

D. Manufacturer's Instructions: Indicate rigging, assembly, and installation instructions.

E. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions, installation instructions, maintenance and repair data, and parts listing.

F. Warranty: Submit manufacturers warranty and ensure forms have been filled out in Owner's name and registered with manufacturer.

1.05 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Mitsubishi

B. Samsung.

C. Trane Inc

2.02 SYSTEM DESIGN

A. Split-System Heating and Cooling Units: Self-contained, packaged, matched factory-engineered and assembled, pre-wired indoor and outdoor units; UL listed.

1. Provide refrigerant lines internal to units and between indoor and outdoor units, factory cleaned, dried, pressurized and sealed, with insulated suction line.

B. Performance Requirements: See Drawings for additional requirements.

C. Electrical Characteristics:

1. ____ kW.

2. ____ volts, single phase, 60 Hz.

3. ____ amperes maximum fuse size.

4. Disconnect Switch: Factory mount disconnect switch on equipment under provisions of Section 260583.

2.03 INDOOR AIR HANDLING UNITS FOR DUCTLESS SYSTEMS

A. Manufacturers:

1. Mitsubishi.

2. Sansung.

3. Trane Inc.

B. Indoor Units: Self-contained, packaged, factory assembled, pre-wired unit consisting of cabinet, supply fan, evaporator coil, and controls; wired for single power connection with control transformer.

C. Evaporator Coils: Copper tube aluminum fin assembly, galvanized or polymer drain pan sloped in all directions to drain, drain connection, refrigerant piping connections, restricted distributor or thermostatic expansion valve.

1. Construction and Ratings: In accordance with AHRI 210/240 and UL 207.

2. Manufacturer: System manufacturer.

2.04 OUTDOOR UNITS

A. Outdoor Units: Self-contained, packaged, pre-wired unit consisting of cabinet, with compressor and condenser.

1. Construction and Ratings: In accordance with AHRI 210/240 with testing in accordance with ASHRAE Std 23 and UL 207.

B. Accessories: Filter drier, high-pressure switch (manual reset), low pressure switch (automatic reset), service valves and gauge ports, thermometer well (in liquid line).

1. Provide thermostatic expansion valves.

C. Operating Controls:

1. Control by room thermostat to maintain room temperature setting.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with NFPA 90A and NFPA 90B.

END OF SECTION 238126.13

SECTION 238413 - HUMIDIFIERS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Humidifier Units.

B. Spray Pumps.

1.02 RELATED REQUIREMENTS

A. Section 232123 - Hydronic Pumps: Spray pumps.

B. Section 260583 - Wiring Connections: Electrical characteristics and wiring connections.

1.03 REFERENCE STANDARDS

A. AHRI 610 (I-P) - Standard for Performance Rating of Central System Humidifiers for Residential Applications 2014.

1.04 SUBMITTALS

A. See Section 013000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide catalog sheets indicating general assembly, dimensions, weights, materials, and certified performance ratings.

C. Shop Drawings: Indicate general assembly, dimensions, weights, and materials.

D. Operation Data: Include assembly instructions, float adjustment, bleed rates, and electrical requirements.

E. Warranty: Submit manufacturer warranty and ensure forms have been completed in Owner's name and registered with manufacturer.

1.05 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing the type of products specified in this section, with minimum three years of documented experience.

1.06 WARRANTY

A. See Section 017800 - Closeout Submittals, for additional warranty requirements.

B. Provide five year manufacturer warranty for units.

PART 2 PRODUCTS

2.01 MANUFACTURERS

A. Carel.

B. Approved equal.

2.02 MANUFACTURED UNITS

A. Units: AHRI 610 (I-P); factory assembled consisting of casing, tank, filters, spray pumps, water and drain connections.

2.03 CASING

A. Assembly: Galvanized steel, minimum 0.0635 inch (1.6 mm) thick, reinforced and braced with galvanized steel angles and corrosion resistant cap screws.

2.04 DRAIN TANK

A. Tank: Welded black steel 4 inches (100 mm) deep, 0.1345 inch (3.4 mm) thick, finished inside and out with zinc chromate, iron oxide phenolic resin paint and coated inside with asphalt coating.

2.05 FILTERS

A. Filters: Two rows of neoprene coated filter mats in removable frames.

2.06 PUMPS

A. Spray Assembly: Moisture resistant motor with built-in overload protection, brass impeller and cut-off blade, in galvanized well.

B. Spray Pump: Refer to Section 232123.

PART 3 EXECUTION

3.01 INSTALLATION

A. Install in accordance with manufacturer's instructions.

B. Connect unit to water supply. Provide gate valve on water supply line. Provide 3/4 inch (20 mm) hose bibb accessible from interior.

C. Pipe drain and overflow to nearest floor drain.

END OF SECTION 238413

SECTION 26 00 00 - GENERAL ELECTRICAL REQUIREMENTS

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

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

B. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

1.02 SUBMITTALS

A. None.

1.03 CLOSEOUT

A. None.

1.04 WARRANTIES

A. The Contractor shall warrant all materials, workmanship, and equipment against defects for a period of one year after the date of substantial completion. Certain equipment shall be warranted beginning at the time of final acceptance or for longer periods of time as specified in those divisions of the Project Manual. The Contractor shall repair or replace, at no additional cost to the Owner, any item which may become defective within the warrant period. Any manufacturers' warranties concerning any item installed will run to the benefit of the Owner. The Contractor agrees not to void or impair, or to allow Sub-Contractors to void or impair, any warranties regarding products or items installed as part of this project. The repair of faulty workmanship shall be considered to be included in the contract.

1.05 QUALITY ASSURANCE

A. Source Limitations: To fullest extent possible, provide products of same kind, from a single source.

1. When specified product is available only from sources that do not, or cannot, produce a quantity adequate to complete Project requirements in a timely manner, consult with Architect and Owner to determine most important product qualities before proceeding. Qualities may include attributes, such as visual appearance, strength, durability, or compatibility. When a determination has been made, select products from sources producing products that possess these qualities, to fullest extent possible.

B. Compatibility of Options: If Contractor is given option of selecting between two or more products for use on Project, product selected shall be compatible with products previously selected, even if previously selected products were also options.

1. Each contractor is responsible for providing products and construction methods compatible with products and construction methods of other contractors.

2. If a dispute arises between contractors over concurrently selectable but incompatible products, Architect shall determine which products shall be used.

C. Contractor shall comply with all State, and local codes and ordinances.

D. Contractor shall make application for, obtain, and pay for all required permits and certificates of inspection of the work.

E. Required access for servicing and maintenance shall be provided for all equipment. Provide architectural access panels as required.

F. Manufacturer's Qualifications: Firms regularly engaged in manufacture of equipment of types, materials, and sizes required for the project, whose products have been in satisfactory use in similar service for not less than five (5) years.

G. Installers Qualifications: Firm with at least three (3) years of successful installation experience on projects with equipment installation work similar to that required for project.

1.06 INTERPRETATION OF DOCUMENTS

A. All questions from contractors or subcontractors as it pertains to contract documents during the bidding phase or construction shall be submitted to the Engineer for clarification. Clarification will be issued through official written correspondence. Verbal interpretation or explanation not issued in the form of an addendum or supplemental instruction shall not be considered part of the bidding documents or contract. The Engineer shall be the sole judge regarding interpretations of conflicts within contract documents.

B. If any ambiguities should appear in the contract documents, the Contractor shall request clarification from the Engineer before proceeding with the work. Failure to obtain clarification may result in work not being accepted by the Engineer. Should a conflict occur within the contract documents, the Contractor is deemed to have estimated the more expensive way of doing the work.

1.07 PERMITS, FEES, AND NOTICES

A. Contractor shall secure and pay for permits and governmental fees, licenses, and inspections necessary for proper execution and completion of the Work, and for Owner to occupy space and operate systems.

B. Contractor shall comply with and file notices required by laws, ordinances, rules, regulations, and lawful orders of public authorities applicable.

1.08 CODES

A. The work shall be performed by persons skilled in the trade involved and shall be done in a manner consistent with normal industry standards. All work shall conform to all applicable sections of currently adopted editions of all applicable codes. The contractor is responsible for verifying the local codes in the jurisdiction with which the work is performed and installing the work as listed by said codes.

1.09 PROJECT COORDINATION AND LAYOUT

A. The contractor is responsible for laying out and coordinating all work prior to installation. The contractor shall produce coordination documents incorporating all mechanical and electrical trades in conjunction with the building structure and architectural features. The contractor shall coordinate all routing of systems prior to installation. Payment for changes due to pre-fabricating or moving of piping, ductwork, conduit, cable trays, equipment, or any other mechanical, electrical, plumbing, or technology system due to lack of coordination will not be approved.

B. Documents produced by Specialized Engineering Solutions are diagrammatical in nature. Not all system offsets are shown to accommodate final elevations and avoid interference with all other building structural, architectural, mechanical, electrical, fire protection, and technology systems. Contractor shall include in his base scope of work, offsets necessary to negotiate the building appropriately.

C. Contractor shall review and incorporate the following into the Project prior to bidding:

1. Obtain utility metering specification.

2. Review all associated project documents including but not limited to the following:

a. Mechanical plans and equipment connections.

b. Architectural drawings.

c. Vendor drawings for Owner-furnished equipment.

d. Door hardware schedule and shop drawings including fire alarm connections.

D. Contractor shall review approved mechanical shop drawings prior to rough-in to verify equipment connection requirements.

E. Provide all necessary components for a complete and functioning system.

F. Contractor shall submit a request for information for conflicts related to device locations, including items specified by other disciplines.

G. Contractor shall coordinate system outages with the Owner prior to outage in an effort to minimize disruption of services. Systems shall not be taken offline without Owner approval. Contractor shall be responsible for all schedule delays resulting from lack of coordination.

1.10 EQUIPMENT ELECTRICAL CONNECTIONS

A. Electrical connections identified are for the specific equipment manufacturer and model scheduled, and includes equipment furnished by this trade or furnished by other trades under these contract documents. If the Contractor chooses to provide equipment found acceptable from a different manufacturer or model than that scheduled but listed as equivalent in the specifications, or otherwise accepted by the Architect/Engineer, the Contractor shall include electrical connection revisions associated with that manufacturer’s electrical connection requirements in their bid. Upon approval of a manufacturer and model other than that specifically scheduled, the Contractor shall request clarification of the required electrical connection revision from the Engineer for incorporation into the electrical design and construction documents. If the necessary revision is found to require extensive design modification by the Engineer, the Contractor shall provide the Engineer reasonable compensation for incorporation of the selected manufacturer’s equipment into the project design.

1.11 BASIS OF DESIGN

A. Basis-of-Design Product Specification: Where a specific manufacturer's product is named and accompanied by the words "basis of design," including make or model number or other designation, to establish the significant qualities related to type, function, dimension, in-service performance, physical properties, appearance, and other characteristics for purposes of evaluating comparable products of other named manufacturers.

1.12 OPERATION AND MAINTENANCE MANUALS

A. Manuals to be provided in pdf format and include:

1. Title page with project name and location and date of submittal.

2. Title, Name, address, and telephone number all contractors and suppliers.

3. Table of contents with corresponding tabs to mark sections.

B. Manual to contain the following:

1. Equipment record document submittal.

2. Warranty details, expiration dates, and contacts.

3. Licensing requirements including inspection and renewal dates.

4. Equipment location.

5. Operating manuals including wiring and control diagrams.

6. Operating procedures.

7. Precautions against improper use.

8. Startup shutdown and switchover procedures.

9. Emergency procedures.

10. Schedule for routine cleaning and maintenance.

C. Provide the Operation and Maintenance manuals as hardcopy and electronically on a disk. Provide a disk of the scanned as-built redlines, in addition to the hardcopy.

1.13 OPERATOR TRAINING

A. The contractor shall schedule complete owner training for every system and piece of equipment. Operating and maintenance manuals shall be complete and accepted by owner and engineer prior to training. The contractor shall coordinate a training session which will include the Owner/Owner's Representatives, Engineer, and all Subcontractors or equipment representatives needed to explain and train on the system. A training agenda shall be submitted prior to training. The agenda shall be reviewed and amended as necessary by the Engineer and Owner. The Contractor shall cover all information submitted in the operation and maintenance manual.

1.14 COORDINATION OF WORK

A. Refer to drawings for Coordination of Work matrix.

END OF SECTION 260000

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SECTION 26 05 00 - COMMON WORK RESULTS FOR ELECTRICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes:

1. Equipment coordination and installation.

2. Common electrical installation requirements.

B. Related Sections include the following:

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

2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. None.

1.04 EQUIPMENT CONNECTION

A. Incidental Equipment:

1. Contractor shall provide electrical connections and disconnects for incidental equipment. Connections include required line voltage branch circuits and fire alarm. “Incidental Equipment” shall mean equipment furnished by this trade, or furnished by other trades under these project documents, and that are not specifically identified or located on the plans. Examples include, but are not limited to, building management control panels, fire alarm remote power supplies, medical gas alarm panels, chemical treatment equipment, interconnections between packaged mechanical equipment with split interior/exterior equipment components. Each piece of equipment shall have a local disconnecting means, either by cord or plug or by disconnect switch. Where equipment is located in a public area, the disconnect switch shall be concealed from public access, shall be within sight of the equipment, and the location shall be identified within or on the equipment served. Coordinate requirements with equipment provided and other associated trades.

B. Scheduled Equipment:

1. Prior to ordering and installing material and electrical equipment, verify that scheduled connection requirements are consistent with equipment being provided. This shall include equipment furnished by this trade or furnished by other trades under these project documents. Verification is necessary due to the uncertainty of final equipment selection provided by other trades; including, but not limited to: Elevators, mechanical equipment, etc.

PART 2 -PRODUCTS (RESERVED)

PART 3 -EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment Location: Install to facilitate service, maintenance, and repair or replacement of components associated with equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

F. Equipment Dimensions: Equipment illustrated on drawings reflect equipment dimensions for one of the manufacturer's specified. These dimensions were utilized to coordinate a general mounting location that accommodates required clearances and available space for the equipment and in consideration of adjacent equipment/systems. Contractor shall provide equipment with similar dimensions. Where equipment is not provided with similar dimensions, Contractor shall provide necessary accommodations to maintain required clearances for the equipment and shall consider adjacent equipment/systems.

3.02 ELECTRICAL DEVICE MOUNTING HEIGHTS

A. Electrical devices' mounting heights specified on Architectural documents or specific mounting heights indicated on plans shall take precedence. See plans for typical electrical device mounting heights detail. Typical Mounting Heights (measured to the center of the device):

1. Wall Switches: 48 inches.

2. Wall Switches (Serving Undercabinet Task Lighting): Match receptacle outlet height above countertop/backsplash.

3. Receptacle Outlets (general): 18 inches.

4. Receptacle Outlets (above work surfaces): 4 inches above countertop/backsplash.

5. Special-Purpose Outlets: Within 72 inches of intended use.

6. Communications Outlets: 18 inches.

7. Fire Alarm Manual Station: 48 inches.

8. Fire Alarm Notification Appliance: 82 inches to center of strobe. If this height would result in being within 6 inches off the ceiling, coordinate height with authority having jurisdiction.

9. Push Buttons: 48 inches.

10. Exit Signs: 4 inches between top of door frame and bottom of exit sign where possible (when wall mounted).

11. Wall Phones: 48 inches.

12. Medical Gas Storage Room Devices: 66 inches (required to be above 60 inches).

13. Nurse Call:

    a. Wall Stations: 48 inches.

    b. Pull Cords:
        1) Toilets: Required between 36 inches to 48 inches and within 12 inches of the front of the toilet bowl. Coordinate exact location with Architect.

    c. Device at Patient Headwalls: Coordinate exact location with Architect.

    d. Dome Lights: Wall mounted with 4 inches between top of door frame and bottom of dome light where possible, or ceiling mounted. Coordinate exact location with Architect.

B. Coordination: Coordinate exact location of devices to serve equipment indicated and to accommodate architectural construction and finishes.

1. Devices shall not be located directly above or below alcohol antiseptic dispensers, and shall be a minimum 1 inch from the sides of alcohol antiseptic dispensers. Verify dispenser locations with Owner.

3.03 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Through-Penetration Firestop Systems."

END OF SECTION 260500

SECTION 26 05 19 - CONDUCTORS AND CABLES FOR ELECTRICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes:

1. Building wires and cables rated 600 V and less.

2. Connectors, splices, and terminations rated 600 V and less.

B. Related Sections include the following:

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

2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

3. Division 26 Section “Grounding and Bonding for Electrical” for grounding conductors, electrodes, and connectors.

4. Division 26 Section “Raceways and Boxes for Electrical” for raceway and metal-clad cable application.

5. Division 27 Section "Voice and Data Communication Cabling" for cabling used for voice and data circuits.

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. None.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 -PRODUCTS

2.01 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70 and UL rating.

B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

2.02 CONNECTORS AND SPLICES

A. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 -EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper.

B. Branch Circuits: Copper. Solid for #10 AWG and smaller, stranded for #8 AWG and larger.

C. Solid for #10 AWG and smaller, stranded for #8 AWG and larger.

D. Fire Alarm Circuits: Power-limited, fire protective, signaling circuit cable or other cable as recommended by fire alarm manufacturer.

E. Hospital Isolation Power System Branch Circuits: Type XHHW single conductors in raceway.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Feeders and Branch Circuits: Type THHN-THWN, single conductors in raceway.

C. Class 1 Control Circuits: Type THHN-THWN, in raceway.

D. Class 2 Control Circuits: Class 2 control cable suitable for the application.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated. Route cables in conduit when required by the applicable specification section.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer`s recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members and follow surface contours where possible.

E. Identify and color-code conductors and cables according to Division 26 Section "Electrical Identification."

F. Branch Circuit Size: #12 AWG unless noted otherwise.

1. Where 20A, 120V branch circuit conductor length from the overcurrent device to the furthest outlet exceeds 75’, all branch circuit conductors shall be #10 AWG.

2. Where 20A, 120V receptacle branch circuit conductor length from the overcurrent device to the furthest receptacle exceeds 150`, all branch circuit conductors shall be #8 AWG.

G. Provide dedicated neutrals for all branch circuits.

3.04 CONNECTIONS

A. 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.

B. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors. Existing aluminum conductors shall not be spliced or extended.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.05 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. After installing conductors and cables and before electrical circuitry has been energized, test for compliance with requirements.

2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

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

END OF SECTION 260519

SECTION 26 05 26 - GROUNDING AND BONDING FOR ELECTRICAL

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment.

B. Related Sections include the following:

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

2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. Field quality-control test reports.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 -PRODUCTS

2.01 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.

2. Stranded Conductors: ASTM B 8.

3. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.

4. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

5. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Ground Bar: Rectangular bars of annealed copper, 1/4-by-4 inches in cross section, unless otherwise indicated; with insulators. Length as required to accommodate terminations.

2.02 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Connectors for Conductors: Mechanical crimp type, cast silicone bronze, long crimp barrel and two-bolt connection to ground bar.

C. Connectors for Pipes:

1. Pipe Connectors: Copper or copper alloy. Bolted, clamp type, sized for pipe.

D. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

E. Aluminum bolted to cable type are not acceptable.

2.03 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch in diameter by 10 feet in length.

PART 3 -EXECUTION

3.01 APPLICATIONS

A. Ground Bar: Install in electrical and telecommunications rooms, housing service equipment, satellite telephone equipment rooms, and elsewhere as indicated.

1. Install bar on insulated spacers 1 inch, minimum, from wall 6 inches above finished floor, unless otherwise indicated.

2. Interconnect electrical and telecommunications ground bars per plans.

B. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded or bolted connectors (listed for the application), except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Welded or bolted connectors.

3.02 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Air-Duct Equipment Circuits: Install insulated equipment grounding conductor to duct-mounted electrical devices operating at 120 V and more, including air cleaners, heaters, dampers, humidifiers, and other duct electrical equipment. Bond conductor to each unit and to air duct and connected metallic piping.

C. Water Heater, Heat-Tracing, and Antifrost Heating Cables: Install a separate insulated equipment grounding conductor to each electric water heater and heat-tracing cable. Bond conductor to heater units, piping, connected equipment, and components.

D. Metal Poles Supporting Outdoor Lighting Fixtures: Bond equipment grounding conductor installed with branch-circuit conductors to pole.

3.03 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible, unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade, unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating, if any.

2. For grounding electrode system, install one or more rods to meet NFPA 70 requirements, spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance, except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.

2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install so vibration is not transmitted to rigidly mounted equipment.

3. Use exothermic-welded connectors for outdoor locations, but if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building`s main electrical service equipment, or Ground Bar, 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. Gas Piping: Bond each aboveground portion of gas piping system downstream from equipment shutoff valve. Where flexible gas piping is utilized, bond gas piping at building entrance to the building's main electrical service equipment utilizing an insulated #6 AWG copper grounding conductor in conduit.

E. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install bonding jumper to bond across flexible duct connections to achieve continuity.

F. Ufer Ground (Concrete-Encased Grounding Electrode/Building Footing): Fabricate according to NFPA 70, by using a minimum of 20 feet of either bare copper conductor not smaller than No. 4 AWG for one or more bare or zinc galvanized or other electrically conductive coated steel reinforcing bars of not less than 1/2-inch diameter.

1. If concrete foundation is less than 20 feet long, coil excess conductor within base of foundation.

2. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building grounding grid or to grounding electrode external to concrete.

G. Where structural metal of a building addition is isolated from the original facility's structural metal, provide a bonding jumper sized to match the grounding electrical conductor between the existing and new structural metal.

3.04 FIELD QUALITY CONTROL

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

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. 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. Make tests at ground rods before any conductors are connected.

a. 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.

3. Prepare dimensioned drawings locating each test well, ground rod and ground rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

B. Submit report for any instances where measured ground resistances exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 10 ohms.

2. Power and Lighting Equipment or System with Capacity 500 to 1000 kVA: 5 ohms.

3. Power and Lighting Equipment or System with Capacity More Than 1000 kVA: 3 ohms.

4. Patient Care Areas: Voltage and ground impedance measurements for the patient care vicinity as required by NFPA 99.

C. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

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SECTION 26 05 29 - HANGERS AND SUPPORTS FOR ELECTRICAL

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.

2. Construction requirements for concrete bases.

B. Related sections include the following:

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

2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

1.02 SUBMITTALS

A. None

1.03 CLOSE-OUTS

A. None

1.04 QUALITY ASSURANCE

A. Comply with NFPA 70.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

PART 2 -PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

2. Channel Dimensions: Selected for applicable load criteria.

B. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

C. Conduit and Cable Support Devices: Steel and malleable-iron hangers, clamps, and associated fittings, designed for types and sizes of raceway or cable to be supported.

D. Support for Conductors in Vertical Conduit: Factory-fabricated assembly consisting of threaded body and insulating wedging plug or plugs for non-armored electrical conductors or cables in riser conduits. Plugs shall have number, size, and shape of conductor gripping pieces as required to suit individual conductors or cables supported. Body shall be malleable iron.

E. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

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

2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.

3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.

4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.

5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.

7. Hanger Rods: Threaded steel.

PART 3 -EXECUTION

3.01 APPLICATION

A. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for conduit as required by NFPA 70. Minimum rod size shall be 1/4 inch in diameter.

B. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted support system, sized so capacity can be increased by at least 25 percent in future without exceeding specified design load limits.

1. Secure raceways and cables to these supports with two-bolt conduit clamps.

3.02 SUPPORT INSTALLATION

A. Strength of Support Assemblies: 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.

B. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. 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.

5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or spring-tension clamps.

6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

C. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 CONCRETE BASES

A. Provide concrete bases for floor-mounted Division 26 equipment. Construct concrete bases 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. Coordinate exact dimensions with equipment to provide support and accommodate required equipment access and operation.

B. Use 3000-psi, 28-day compressive-strength concrete.

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer`s setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

2. Install anchor bolts to elevations required for proper attachment to supported equipment.

3. Install anchor bolts according to anchor-bolt manufacturer`s written instructions.

4. Install base and equipment level.

3.04 PAINTING

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

END OF SECTION 260529

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SECTION 26 05 33 - RACEWAYS AND BOXES FOR ELECTRICAL

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

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

2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. None.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Drawings are diagrammatic. All bends, boxes, fittings, couplings are not necessarily shown. Supply as necessary to comply with the NFPA 70.

1.05 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. FMC: Flexible metal conduit.

D. IMC: Intermediate metal conduit.

E. LFMC: Liquidtight flexible metal conduit.

F. RMC: Rigid metallic conduit.

G. RNC: Rigid nonmetallic conduit.

1.06 COORDINATION

A. Set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.

PART 2 -PRODUCTS

2.01 METAL CONDUIT AND TUBING

A. Rigid Steel Conduit: ANSI C80.1.

B. IMC: ANSI C80.6.

C. EMT: ANSI C80.3.

D. FMC: Zinc-coated steel.

E. LFMC: Flexible steel conduit with PVC jacket.

F. Fittings for Conduit (Including all Types and Flexible and Liquidtight), EMT, and Cable: NEMA FB 1; listed for type and size raceway with which used, and for application and environment in which installed.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886.

2. Fittings for EMT: Steel or die-cast, compression type.

2.02 NONMETALLIC CONDUIT AND TUBING

A. RNC: NEMA TC 2, Type EPC-40-PVC, unless otherwise indicated.

B. HDPE: High density polyethylene.

C. Fittings for RNC: NEMA TC 3; match to conduit or tubing type and material.

2.03 BOXES, ENCLOSURES, AND CABINETS

A. Sheet Metal Outlet and Device Boxes: NEMA OS 1.

B. Metal Floor Boxes: Cast or sheet metal, fully adjustable, rectangular.

C. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

D. 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.

2. Hinged door in front cover with flush latch and concealed hinge.

3. Key latch to match panelboards.

4. Metal barriers to separate wiring of different systems and voltage.

5. Accessory feet where required for freestanding equipment.

2.04 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, galvanized steel, plain ends.

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.

b. For sleeve cross-section rectangle perimeter equal to or greater than 50 inches and 1 or more sides equal to or greater than 16 inches, thickness shall be 0.138 inch.

2.05 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway.

1. Manufacturers: Subject to compliance with requirements.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of raceway.

3. Pressure Plates: Plastic. Include two for each sealing element.

4. 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.

2.06 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

2.07 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, Grade B, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time. Design mix: 5000-psi, 28-day compressive strength.

2.08 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below:

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.

B. Silicone Foams: Multi-component, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

2.09 INFORMATION

A. All materials shall be approved and labeled by UL or approved equal.

PART 3 -EXECUTION

3.01 RACEWAY APPLICATION

A. Outdoors: Comply with the following applications. Conceal conduit within finished walls, ceilings, floors, and below exterior grades unless surface mounting is specifically indicated on plans.

1. Exposed Conduit: Rigid steel conduit.

2. Concealed Conduit, Aboveground: Rigid steel conduit.

3. Underground Conduit:

a. Direct Buried (by Excavation): RNC, Type EPC-40-PVC.

b. Direct Buried (by Directional Bore): Type HDPE.

c. Engine Generator Conduits (Direct Buried by Excavation): RNC, Type EPC-80-PVC.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoor: Comply with the following applications. Conceal conduit within finished walls, ceilings, floors, and below exterior grades unless surface mounting is specifically indicated on plans.

1. Exposed, Not Subject to Physical Damage: EMT.

2. Concealed in Ceilings and Interior Walls and Partitions: EMT.

3. Below Floor Conduit: RNC, Type EPC-40-PVC.

a. Only applicable to below-floor distribution feeders, equipment connections, site branch circuits, and floor boxes. General branch circuits shall not be routed within concrete slabs or below slab-on-grade surfaces.

4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFMC.

5. Damp or Wet Locations: Rigid steel conduit.

6. Raceways for Optical Fiber or Communications Cable: EMT.

7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, nonmetallic in damp or wet locations.

8. Surface Raceways: Only where specifically indicated on plans.

9. Connection to Undercabinet and Wall-Mounting Lighting Fixtures: Multi-conductor metal clad cable (Type HCF) may be used where installed concealed with lengths not exceeding 6 feet, if acceptable to Authority Having Jurisdiction for application and system branch. This wiring method only applies to this specific light fixture application.

10. Patient Care Areas: Branch circuits shall be installed in a metal raceway system (suitable as a ground path in addition to an insulated equipment grounding conductor) to comply with NFPA 70 and NFPA 99. Where branch circuits serving patient care areas are installed within concrete slabs or below slab-on-grade surfaces, threaded (thick wall), rigid metal conduit and metal floor boxes shall be used. Patient care areas shall be those areas defined by NFPA and shall include patient toilets.

C. Minimum Raceway Size:

1. All conduit systems: 3/4-inch trade size. 1/2" may be used for switches and receptacles located in the walls and for 120V lighting circuits.

2. Voice and Data Communications: 1-inch trade size.

D. Raceway Fittings: Compatible with raceways and suitable for use and location.

1. Rigid and Intermediate Steel Conduit: Use threaded rigid steel conduit fittings, unless otherwise indicated.

E. Conduit & Junction Box Color Code:

1. Provide conduits with the following manufacturer applied finishes by Branch/system. Paint junction boxes and box covers to match conduit.

a. Voice/Data/Video/Optical Fiber: Blue

b. Overhead Paging: Black

c. Nurse Call/Code

d. Fire Alarm: Red

e. Security Ssytems/Access Control/BAS Controls: Purple

f. Life Safety Branch: Yellow

g. Critical Branch: Orange

h. Equipment Branch: Green

i. Normal Branch: Gray (Standard Galvanized Finish)

F. Below Grade Elbows:

1. Stub-ups: Provide rigid steel conduit elbows for all below grade or below floor conduit stub-ups. Extend elbows to above grade or above floor with rigid steel conduit stub-ups, conduits, and required fittings. Not required for concrete light pole bases.

2. Other Elbows: Provide sweeping bends of minimum 48 inch radius.

G. Exposed Raceway in Finished Spaces: Exposed raceway in finished spaces is only permitted where indicated on plans. Paint to match adjacent surface installed on. If plans indicate raceway is not to be painted, remove stickers from raceway before installation.

3.02 INSTALLATION

A. Comply with NECA 1 for installation requirements applicable to products specified in Part 2 except where requirements on Drawings or in this Article are stricter.

B. Keep raceways at least 6 inches away from parallel runs of flues and steam or hot-water pipes. Install horizontal raceway runs above water and steam piping.

C. Complete raceway installation before starting conductor installation.

D. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

E. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

F. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb tensile strength. Leave at least 12 inches of slack at each end of pull wire.

G. Raceways for Optical Fiber and Communications Cable: Install as follows:

1. Install raceways in maximum lengths of 100 feet.

2. Install with a maximum of two 90-degree bends or equivalent for each length of raceway 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.

H. Install raceway sealing fittings at suitable, approved, and accessible locations and fill them with listed sealing compound. For concealed raceways, install each fitting in a flush steel box with a blank cover plate having a finish similar to that of adjacent plates or surfaces. Install raceway sealing fittings at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.

2. Where otherwise required by NFPA 70.

I. Flexible Conduit Connections: Use maximum of 72 inches of flexible conduit from fixed junction box to recessed and semi-recessed lighting fixtures; equipment subject to vibration, noise transmission, or movement; and for transformers and motors.

J. 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. Adjust mounting height to match coursing on exposed block or brick.

K. Set metal floor boxes level and flush with finished floor surface.

L. Adjacent boxes installed within common wall stud space shall not be installed back-to-back.

M. Maintain fire rating of wall, floor, and ceiling assemblies as required by UL and applicable building codes. Space boxes or provide putty backing as required.

N. Provide back supports on device boxes.

O. Coordinate device box and associated plaster ring selection to accommodate device/fixture served and to accommodate wall construction, wall finish, and casework/cabinets.

P. Coordinate device and junction box knockouts to accommodate conduits specified.

Q. Minimum two securing screws on stud mounted device boxes.

R. Cable Protection: Where conduits are utilized for routing of low voltage cables, provide plastic bushings as required to avoid bare conduit edges.

S. Building Expansion Joints: Provide conduit expansion fittings at building expansion joints.

3.03 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified for pipe less than 6 inches in nominal diameter.

2. Install backfill as specified.

3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified.

4. Install manufactured duct elbows for stub-ups at poles and equipment and at building entrances through the floor, unless otherwise indicated. Encase elbows for stub-up ducts throughout the length of the elbow.

5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.

   a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches of concrete.

   b. For stub-ups at equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches from edge of equipment pad or foundation. Install insulated grounding bushings on terminations at equipment.

   c. Stub-ups at concrete pads shall extend vertically a minimum of 3” above top of concrete pad.

6. Refer to Specification Section “Earthwork” for additional requirements.

7. Warning Tape: Apply per Specification Section “Electrical Identification”.

8. Directional bore may be utilized in lieu of trenching.

3.04 SLEEVE INSTALLATION

A. Electrical penetrations occur when pathways, raceways, cables, wireways, or cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. 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.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated Assemblies: Install sleeves for penetrations of fire-rated floor and wall assemblies unless openings compatible with firestop system used are fabricated during construction of floor or wall.

E. Cut sleeves to length for mounting flush with both surfaces of walls.

F. Extend sleeves installed in floors 4 inches above finished floor level.

G. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.

2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway. Install sleeves and seal raceway sleeves with firestop materials. Comply with requirements in Section "Through-Penetration Firestop Systems."

K. Roof-Penetration Sleeves: Seal penetration of individual raceway with flexible boot-type flashing units applied in coordination with roofing work.

L. 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.

M. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway and sleeve for installing mechanical sleeve seals.

3.05 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway material and size. Position raceway in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.06 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.

3.07 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Through-Penetration Firestop Systems."

END OF SECTION 260533

LITTLE
DIVERSIFIED ARCHITECTURAL CONSULTING

SECTION 26 05 53 - ELECTRICAL IDENTIFICATION

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Identification for conductors.
2. Wiring device wall plate labels
3. Equipment identification labels.
4. Underground-line warning tape.
5. Fire/smoke barrier/penetration labeling.

B. Related Sections include the following:

1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
2. The requirements listed in this document are applicable to Divisions 26, 27, and 28 specifications.
3. Refer to Raceway and Boxes for Electrical Specification for conduit and box color code.

1.02 SUBMITTALS

A. None.

1.03 CLOSE-OUTS

A. None.

1.04 QUALITY ASSURANCE

A. Comply with NFPA 70.

1.05 COORDINATION

A. Coordinate identification names, colors, and other features with requirements in the Contract Documents, and with those required by codes. Use consistent designations throughout Project. Match existing Owner standards where applicable.

PART 2 -PRODUCTS

2.01 CONDUCTOR IDENTIFICATION MATERIALS

A. Colored Tape: Vinyl, self-adhesive type.

2.02 WIRING DEVICE WALL PLATE LABELS

A. Machine-printed, adhesive tape label, clear with black letters.

1. In lieu of machine printed, adhesive tape labels, provide engraved labels for device plates in the following rooms (black lettering for normal branch, red lettering for essential branches):

a. Surgery Department:
1) Operating rooms/procedure rooms.
2) Pre-op/post-op/recovery rooms and bed locations.
3) Sterile corridors, sterile supply rooms, and sub-sterilization rooms.

b. Sterile Processing Department: Clean processing/sterile supply rooms.

2.03 EQUIPMENT IDENTIFICATION LABELS

A. Engraved or Melamine Label: Adhesive backed, with white or black letters on a colored background. Minimum letter height shall be 3/8 inch.

1. Nameplate Color:

a. 208Y/120V Equipment: Blue with white core

b. 480Y/277V Equipment: Black with white core

c. Fire alarm: White with red core

d. Security: Dark red (burgundy) with white core

e. Essential Electrical System: Red with white core

f. Telephone Systems: Orange with white core

g. Data Systems: Brown with white core

h. Paging Systems: White with black core

B. Service Entrance: Adhesive label containing the following information:

1. Nominal system voltage.

2. Available fault current at the service overcurrent protective devices.

3. The clearing time of services overcurrent protective devices based on the available fault current at the service equipment.

4. The date the label was applied.

C. Install adhesive arc flash warning labels on all equipment as required by NFPA 70E. Label shall indicate the arc hazard boundary (inches), working distance (inches), arc flash incident energy at the working distance (calories/cm2), required PPE category and description including the glove rating, voltage rating of the equipment, limited approach distance (inches), restricted approach distance (inches), prohibited approach distance (inches), equipment/bus name, date prepared, and manufacturer name and address.

2.04 UNDERGROUND-LINE WARNING TAPE

A. Permanent, bright-colored, continuous-printed, vinyl tape.

1. Compounded for permanent direct-burial service.

2. Embedded continuous metallic strip or core.

3. Printed legend indicating type of underground line.

2.05 FIRE/SMOKE BARRIER PENETRATION

A. Provide sticker complying with facility standard and penetration sealant product requirement listing product, date, company name, and initials of installer. Sticker to be minimum 3 by 5 and red in color.

PART 3 -EXECUTION

3.01 APPLICATION

A. Equipment Identification Labels:

1. On each unit of equipment, install unique designation label that is consistent with plans.

2. Labeling Instructions:

a. Indoor Equipment: Provide label per Part 2 requirements.

b. Outdoor Equipment: Provide label per Part 2 requirements, pre-drilled for screw attachment.

c. Elevated Components: Increase sizes of labels and legend to those appropriate for viewing from the floor.

3. Equipment to Be Labeled:

a. Panelboards, electrical cabinets, and enclosures.

b. Electrical switchgear and switchboards.

c. Transfer Switches.

d. Transformers.

e. Disconnect switches.

f. Enclosed circuit breakers.

g. Motor starters.

h. Push-button stations.

i. Power transfer equipment.

j. Lighting control panels.

k. Ground bars.

l. Control cabinets.

m. Power supplies.

n. Factory generated Mimic bus for multi-section switchboards.

o. Variable speed drives and other line-voltage motor controllers.

B. Wiring Device Wall Plate Labels:

1. On each wall plate, cover plate, and faceplate, install label per Part 2 requirements.

3.02 INSTALLATION

A. Verify identity of each item before installing identification products.

B. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

C. Apply identification devices to surfaces that require finish after completing finish work.

D. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

E. Attach nonadhesive signs and plastic labels with screws and auxiliary hardware appropriate to the location and substrate.

F. Receptacle Wall Plates: List panel and branch circuit number. Where served from a GFCI circuit breaker, indicate letter “G” at the end of the circuit number designation.

G. Conduits Out of Panels: Label conduits with marker indicating circuit number on conduits exiting switchboards, motor control centers, distribution panels, and lighting panels. Label at the source as they exit the enclosure.

H. Light Switch Wall Plates: Where two or more switches are ganged together, provide description of area or function for each switch.

I. Fire Alarm: Label control modules, monitoring modules, relays, and remote test/indicating devices to identify their associated function. Label addressable devices with their associated system address, visible without removal of the device. Coordinate exact label format with Owner.

J. Mechanical Equipment: Provide label indicating equipment name as well as panel name and circuit number feeding the equipment. For new fused disconnects and existing fused disconnects modified in the project include fuse size on equipment label. Locate on equipment disconnect. Locate label within sight of the equipment.

K. Conductor Color-Coding for Phase Identification:

1. Color shall be factory applied.

2. Colors for 208/120-V Circuits:

a. Phase A: Black.

b. Phase B: Red.

c. Phase C: Blue.

d. Neutral: White.

3. Colors for 480/277-V Circuits:

a. Phase A: Brown.

b. Phase B: Orange.

c. Phase C: Yellow.

d. Neutral: Gray.

4. Colors for Isolated Power Systems:

a. Phase A: Orange with black stripe.

b. Phase B: Brown with black stripe.

5. Neutral Identification:

a. Where individual (dedicated) neutral conductors are required for single-phase 120 volt and 277 volt branch circuits, neutral conductor shall have factory applied color stripe (tracer) along the length of the conductor, with tracer color to match associated phase conductor.

L. Junction Box Covers:

1. Label junction box covers located above accessible ceilings or in unfinished spaces with black permanent ink marker indicating panel and circuit number, or equivalent system information. Provide labeling of system name on covers for systems enclosed in conduit. For example, “Nurse Call” label cover Nurse Call. Where conduit is exposed and painted, provide label on inside of junction box cover.

2. In additional to labeling, paint junction box covers. Refer to Raceway and Boxes for Electrical Specification for color code.

M. Circuits More Than 600V: Identify raceway and boxes with “Danger-High Voltage” at 10 foot intervals.

N. Panelboards, Switchboards, Switchgear, Transfer Switches, Enclosed Circuit Breakers, and Motor Control Centers: Label shall identify equipment name, system branch, voltage, and source “fed from”.

O. Transformers: Label shall identify equipment name, system branch, and source “fed from”.

1. Distribution panels, switchboards, switchgear, and motor control centers shall include engraved labels at circuit breakers.

P. Path of Underground Electrical Lines:

1. During trench backfilling, for exterior underground power, control signal, and communication lines, install continuous underground plastic line marker located directly above line at 6 to 8 inches below finished grade. Where width of multiple lines installed in a common trench or concrete envelope does not exceed 16 inches overall, use a single line marker.

Q. Ground Bars: Provide polyester write-on tag for each grounding conductor attached to ground bars external to equipment enclosures. Identify remote connection point of conductor on tag with permanent black ink marker and attach to conductor with nylon tie.

3.03 FIRE/SMOKE BARRIER PENETRATION LABELING

A. Affix label at every rated fire/smoke barrier penetrated with electrical systems, conduit, and systems pathways.

END OF SECTION 260553

SECTION 26 05 73 - POWER SYSTEM STUDIES

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes computer-based, fault current, overcurrent protective device coordination, and arc flash studies. Protective devices shall be set based on results of the protective device coordination study.

1.02 SUBMITTALS

A. Other Action Submittals: The following submittals shall be made before the approval process for system protective devices has been completed. Submittals shall be in digital form.

1. Coordination-study input data, including completed computer program input data sheets.

2. Study and Equipment Evaluation Reports.

3. Coordination-Study Report.

4. Arc Flash Study Report.

1.03 QUALITY ASSURANCE

A. Studies shall use computer programs that are distributed nationally and are in wide use. Software algorithms shall comply with requirements of standards and guides specified in this Section. Manual calculations are not acceptable.

B. Coordination-Study Specialist Qualifications: An entity experienced in the application of computer software used for studies, having performed successful studies of similar magnitude on electrical distribution systems using similar devices.

1. Professional engineer, licensed in the state where Project is located, shall be responsible for the study. All elements of the study shall be performed under the direct supervision and control of engineer.

C. Comply with IEEE 242 for fault current and coordination analysis.

D. Comply with IEEE 1584 for arc flash analysis.

E. Comply with IEEE 399 for general study procedures.

1.04 SCOPE OF ANALYSIS

A. The entire electrical distribution system, including all new and all existing equipment shall be included in the studies and data gathering.

PART 2 -PRODUCTS

2.01 COMPUTER SOFTWARE DEVELOPERS

A. Computer Software Developers: Subject to compliance with requirements, utilize products by one of the following:

1. CGI CYME.

2. EDSA Micro Corporation.

3. ESA Inc.

4. Operation Technology, Inc.

5. SKM Systems Analysis, Inc.

2.02 COMPUTER SOFTWARE PROGRAM REQUIREMENTS

A. Comply with IEEE 399.

B. Analytical features of fault-current-study computer software program shall include "mandatory," "very desirable," and "desirable" features as listed in IEEE 399.

C. Computer software program shall be capable of plotting and diagramming time-current-characteristic curves as part of its output. Computer software program shall report device settings and ratings of all overcurrent protective devices and shall demonstrate selective coordination by computer-generated, time-current coordination plots.

PART 3 -EXECUTION

3.01 POWER SYSTEM DATA

A. Gather and tabulate the following input data to support studies:

1. Product Data for overcurrent protective devices specified in other Division 26 Sections and involved in overcurrent protective device coordination studies. Use equipment designation tags that are consistent with electrical distribution system diagrams, overcurrent protective device submittals, input and output data, and recommended device settings.

2. Impedance of utility service entrance.

3. Electrical Distribution System Diagram: In hard-copy and electronic-copy formats, showing the following:

a. Circuit-breaker and fuse-current ratings and types.

b. Relays and associated power and current transformer ratings and ratios.

c. Transformer kilovolt amperes, primary and secondary voltages, connection type, impedance, and X/R ratios.

d. Generator kilovolt amperes, size, voltage, and source impedance.

e. Cables: Indicate conduit material, sizes of conductors, conductor material, insulation, and length.

f. Busway ampacity and impedance.

g. Motor horsepower and code letter designation according to NEMA MG 1.

4. Data sheets to supplement electrical distribution system diagram, cross-referenced with tag numbers on diagram, showing the following:

a. Special load considerations, including starting inrush currents and frequent starting and stopping.

b. Transformer characteristics, including primary protective device, magnetic inrush current, and overload capability.

c. Motor full-load current, locked rotor current, service factor, starting time, type of start, and thermal-damage curve.

d. Generator thermal-damage curve.

e. Ratings, types, and settings of utility company's overcurrent protective devices.

f. Special overcurrent protective device settings or types stipulated by utility company.

g. Time-current-characteristic curves of devices indicated to be coordinated.

h. Manufacturer, frame size, interrupting rating in amperes rms symmetrical, ampere or current sensor rating, long-time adjustment range, short-time adjustment range, and instantaneous adjustment range for circuit breakers.

i. Manufacturer and type, ampere-tap adjustment range, time-delay adjustment range, instantaneous attachment adjustment range, and current transformer ratio for overcurrent relays.

j. Panelboards, switchboards, motor-control center ampacity, and interrupting rating in amperes rms symmetrical.

3.02 FAULT-CURRENT STUDY

A. Calculate the maximum available short-circuit current in amperes rms symmetrical at circuit-breaker positions of the electrical power distribution system. The calculation shall be for a current immediately after initiation and for a three-phase bolted short circuit at each of the following:

1. Switchgear and switchboard bus.

2. Medium-voltage controller.

3. Motor-control center.

4. Distribution panelboard.

5. Branch circuit panelboard.

6. Automatic transfer switch.

B. Study electrical distribution system from normal and alternate power sources throughout electrical distribution system for Project. Include studies of system-switching configurations and alternate operations that could result in maximum fault conditions.

C. Calculate momentary and interrupting duties on the basis of maximum available fault current.

D. Calculations to verify interrupting ratings of overcurrent protective devices shall comply with IEEE 241 and IEEE 242.

1. Transformers:

a. ANSI C57.12.22.

b. IEEE C57.12.00.

c. IEEE C57.96.

2. Medium-Voltage Circuit Breakers: IEEE C37.010.

3. Low-Voltage Circuit Breakers: IEEE 1015 and IEEE C37.20.1.

4. Low-Voltage Fuses: IEEE C37.46.

E. Study Report:

1. Show calculated X/R ratios and equipment interrupting rating (1/2-cycle) fault currents on electrical distribution system diagram.

F. Equipment Evaluation Report:

1. For 600-V overcurrent protective devices, ensure that interrupting ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

2. For devices and equipment rated for asymmetrical fault current, apply multiplication factors listed in the standards to 1/2-cycle symmetrical fault current.

3. Verify adequacy of phase conductors at maximum three-phase bolted fault currents; verify adequacy of equipment grounding conductors and grounding electrode conductors at maximum ground-fault currents. Ensure that short-circuit withstand ratings are equal to or higher than calculated 1/2-cycle symmetrical fault current.

G. Provide equipment with interrupting duties required as a result of the study.

3.03 COORDINATION STUDY

A. Perform coordination study using approved computer software program. Prepare a written report using results of fault-current study. Comply with IEEE 399.

1. Calculate the maximum and minimum 1/2-cycle short-circuit currents.

2. Calculate the maximum and minimum interrupting duty (5 cycles to 2 seconds) short-circuit currents.

3. Calculate the maximum and minimum ground-fault currents.

B. Comply with IEEE 241 and IEEE 242 recommendations for fault currents and time intervals.

C. Transformer Primary Overcurrent Protective Devices:

1. Device shall not operate in response to the following:

a. Inrush current when first energized.

b. Self-cooled, full-load current or forced-air-cooled, full-load current, whichever is specified for that transformer.

c. Permissible transformer overloads according to IEEE C57.96 if required by unusual loading or emergency conditions.

2. Device settings shall protect transformers according to IEEE C57.12.00, for fault currents.

D. Conductor Protection: Protect cables against damage from fault currents according to ICEA P-32-382, ICEA P-45-482, and conductor melting curves in IEEE 242. Demonstrate that equipment withstands the maximum short-circuit current for a time equivalent to the tripping time of the primary relay protection or total clearing time of the fuse. To determine temperatures that damage insulation, use curves from cable manufacturers or from listed standards indicating conductor size and short-circuit current.

E. Coordination-Study Report: Prepare a written report indicating the following results of coordination study:

1. Tabular Format of Settings Selected for Overcurrent Protective Devices:

a. Device tag.

b. Relay-current transformer ratios; and tap, time-dial, and instantaneous-pickup values.

c. Circuit-breaker sensor rating; and long-time, short-time, and instantaneous settings.

d. Fuse-current rating and type.

e. Ground-fault relay-pickup and time-delay settings.

2. Coordination Curves: Prepared to determine settings of overcurrent protective devices to achieve selective coordination. Graphically illustrate that adequate time separation exists between devices installed in series, including power utility company's upstream devices. Prepare separate sets of curves for the switching schemes and for emergency periods where the power source is local generation. Show the following information:

a. Device tag.

b. Voltage and current ratio for curves.

c. Three-phase and single-phase damage points for each transformer.

d. No damage, melting, and clearing curves for fuses.

e. Cable damage curves.

f. Transformer inrush points.

g. Maximum fault-current cutoff point.

F. Completed data sheets for setting of overcurrent protective devices.

3.04 ARC FLASH STUDY

A. Perform arc flash study for all equipment in the fault study and all transformers in scope using approved computer software program. Prepare a written report using results of the fault-current and coordination studies.

B. Comply with IEEE 1584.

C. Arc-Flash Study Report: Prepare a written report indicating the following results of the arc flash study:

1. Tabular Format of Arc Flash Warning/Danger Labels for Distribution Equipment

a. Arc hazard boundary (inches)

b. Working distance (inches)

c. Arc flash incident energy at working distance (calories/cm2)

d. PPE category and description including the glove rating

e. Voltage rating of the equipment

f. Limited approach distance (inches)

g. Restricted approach distance (inches)

h. Prohibited approach distance (inches)

i. Equipment/bus name

j. Date prepared

k. Supplier name and address

3.05 DISTRIBUTION EQUIPMENT SELECTION AND LABELING:

A. To accommodate required equipment selection as indicated below, studies required by this section shall be submitted and approved prior to submittal of equipment containing overcurrent protection devices.

B. Overcurrent protective device manufacturer shall provide equipment (switchboards, panelboards, motor control centers, transformers, enclosed switches/circuit breakers, etc.) with interrupting duties required as a result of the fault current study.

C. Manufacturer shall also provide overcurrent device types (circuit breaker frame size, plug rating, adjustability, fuse selection, etc.) required to achieve coordination to 0.1 seconds per NEC Article 517 as a result of the coordination study

D. Manufacturer shall provide arc flash warning/danger labels for each piece of distribution equipment, listing details derived from the arc flash analysis.

END OF SECTION 260573

SECTION 26 08 00 - COMMISSIONING OF ELECTRICAL SYSTEMS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes requirements for commissioning the HVAC system and its subsystems and equipment. This Section supplements the general requirements specified in Division 01 Section "General Commissioning Requirements."

B. Related Sections include the following:

1. Division 01 1810 "General Commissioning Requirements" for general requirements for commissioning processes that apply to this Section.

2. Division 23 Section “Commissioning of HVAC Systems” for electrical systems commissioning requirements.

1.02 DEFINITIONS

A. Architect: Includes Architect identified in the Contract for Construction between Owner and Contractor, plus consultant/design professionals responsible for design of HVAC, electrical, communications, controls for HVAC systems, and other related systems.

B. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources, and documentation requirements of the commissioning process.

C. BoD: Basis of Design.

D. CxA: Commissioning Authority.

E. OPR: Owner`s Project Requirements.

F. Systems, Subsystems, and Equipment: Where these terms are used together or separately, they shall mean "as-built" systems, subsystems, and equipment.

G. TAB: Testing, Adjusting, and Balancing.

1.03 CONTRACTOR`S RESPONSIBILITIES

A. The following responsibilities are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Contractor:

1. Perform commissioning tests at the direction of the CxA as defined in the Commissioning Plan.

2. Attend Construction phase controls coordination meeting.

3. Participate in Electrical systems, assemblies, equipment, and component maintenance orientation and inspection as directed by the CxA.

4. Provide information requested by the CxA for final commissioning documentation.

5. Provide training to Owner’s personnel on system operations, preventive maintenance, sequence of operations, and function on systems.

6. Attend TAB review & coordination meeting for TAB Work.

C. Electrical Contractor:

1. Provide measuring instruments and logging devices to record test data, and data acquisition equipment to record data for the complete range of testing for the required test period.

2. With the Mechanical Contractor & Subcontractors, coordinate installations and connections between and among electrical and HVAC systems, subsystems, and equipment.

1.04 COMMISSIONING DOCUMENTATION

A. The following are in addition to documentation specified in Division 01 Section "General Commissioning Requirements."

B. Provide the following information to the CxA for inclusion in the commissioning plan:

1. Plan for delivery and review of submittals, systems manuals, and other documents and reports.

2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.

3. Process and schedule for completing construction checklists and manufacturer’s prestart and startup checklists for Electrical systems, assemblies, equipment and components to be verified and tested.

4. Certificate of completion certifying that installation, prestart checks, and startup procedures have been completed.

5. Certificate of readiness certifying that Electrical systems, subsystems equipment and associated controls are ready for testing.

6. Test and inspection reports and certificates.

7. Corrective action documents.

C. Test Checklists: CxA, shall develop test checklists for Electrical systems, subsystems, and equipment, including interfaces and interlocks with other systems. CxA shall prepare separate checklists for each mode of operation and provide space to indicate whether the mode under test responded as required. Contractors shall complete test checklists. In addition to the requirements specified in Division 01 Section "General Commissioning Requirements," checklists shall include, but not be limited to, the following:

1. Calibration of sensors and sensor function.

2. Testing conditions under which test was conducted, including (as applicable) ambient conditions, set points, override conditions, and status and operating conditions that impact the results of test.

3. Expected performance of systems, subsystems, and equipment at each step of test.

4. Narrative description of observed performance of systems, subsystems, and equipment. Notation to indicate whether the observed performance at each step meets the expected results.

5. Interaction of auxiliary equipment.

6. Issues log.

1.05 SUBMITTALS

A. The following submittals are in addition to those specified in Division 01 Section "General Commissioning Requirements."

B. Testing Procedures: CxA shall submit detailed testing plan, procedures, and checklists for each series of tests. Submittals shall include samples of data reporting sheets that will be part of the reports.

C. Certificate of Readiness: CxA shall compile certificates of readiness from each Contractor certifying that systems, subsystems, equipment, and associated controls are ready for testing.

D. Certificate of Completion of Installation, Prestart, and Startup: CxA shall certify that installation, prestart, and startup activities have been completed.

E. Test and Inspection Reports: CxA shall compile and submit test and inspection reports and certificates and shall include them in systems manual and commissioning report.

F. Corrective Action Documents: CxA shall submit corrective action documents.

PART 2 -PRODUCTS(NOT USED)

PART 3 -EXECUTION

3.01 TESTING PREPARATION

A. Prerequisites for Testing: (Completed by Contractor)

1. Certify that Electrical systems, subsystems, and equipment have been completed, calibrated, and started; are operating according to the OPR, BoD, and Contract Documents; and that Certificates of Readiness are signed and submitted.

2. Test systems and intersystem performance after approval of test checklists for systems, subsystems, and equipment.

3. Set systems, subsystems, and equipment into operating mode to be tested (e.g., normal shut down, normal auto position, normal manual position, unoccupied cycle, emergency power- if applicable, and alarm conditions).

4. Verify each operating cycle after it has been running for a specified period and is operating in a steady-state condition.

5. Inspect and verify the position of each device and interlock identified on checklists. Sign off each item as acceptable or failed. Repeat this test for each operating cycle that applies to system being tested.

6. Check safety cutouts, alarms, and interlocks with smoke control and life-safety systems during each mode of operation.

7. Annotate checklist or data sheet when a deficiency is observed.

3.02 TESTING VERIFICATION

A. Prior to performance of testing, provide copies of reports, sample forms, checklists, and certificates to the CxA.

B. Verification of Report:

1. Provide technicians, instrumentation, and tools to verify testing & balancing of HVAC and Plumbing systems at the direction of CxA.

2. CxA shall select up to 100 percent of report for field verification.

3. CxA shall notify Electrical Contractor 10 days in advance of the date of field verification; however, notice shall not include data points to be verified. The Electrical Contractor shall use the same instruments (by model and serial number) that were used when original data were collected.

C. If deficiencies are identified during verification testing, CxA shall notify the Electrical Contractor, Construction Manager and Architect, and shall take action to remedy the deficiency. Architect shall review final tabulated checklists and data sheets to determine if verification is complete and that system is operating according to the Contract Documents.

D. CxA shall certify that Testing has been successfully completed.

3.03 GENERAL TESTING REQUIREMENTS

A. Scope of electrical testing shall include lighting system, motor controls and fire alarm system.

B. Test all operating modes, interlocks, control, responses, and responses to abnormal conditions, and verify proper response of building automation system controllers and sensors.

C. The CxA along with the electrical contractor shall prepare detailed testing plans, procedures, and checklists for the electrical systems, subsystems, and equipment.

D. Test systems and intersystem performance after test checklists for systems, subsystems, and equipment have been approved.

E. Perform tests using design conditions whenever possible.

1. Simulate conditions by imposing an artificial condition when it is not practical to test under design conditions and when written approval for simulated conditions is received from CxA. Before simulating conditions, calibrate testing instruments. Set and document simulated conditions and methods of simulation. After tests, return settings to normal operating conditions.

2. Alter set points when simulating conditions is not practical and when directed by CxA.

3. Alter sensor values with a signal generator when design or simulating conditions and altering set points are not practical. Do not use sensor to act as signal generator to simulate conditions or override values.

F. Deferred Testing:

1. If tests cannot be completed because of a deficiency outside the scope of the Electrical system, the deficiency shall be documented and reported to Owner. Deficiencies shall be resolved and corrected by appropriate parties and test rescheduled.

2. If the testing plan indicates specific seasonal testing, appropriate initial performance tests shall be completed and documented, and additional tests scheduled.

3.04 ELECTRICAL SYSTEMS, SUBSYSTEMS, AND EQUIPMENT TESTING PROCEDURES

A. Lighting Controls Testing and Acceptance Procedures: Testing requirements are specified in Division 26 lighting control sections. Provide Submittals and test data to the CxA.

B. Motor Controls Testing and Acceptance Procedures: Testing requirements are specified in Division 26 enclosed controllers sections. Provide submittals and test data to the CxA.

C. Fire Alarm Testing and Acceptance Procedures: Testing requirements are specified in Division 28 fire alarm sections. Provide submittals and test data to the CxA.

END OF SECTION 260800

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SECTION 26 09 43 - ADDRESSABLE NETWORK LIGHTING CONTROLS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes addressable networked digital lighting controls.

1.02 SUBMITTALS

A. Product Data: For each type of product (general device descriptions, dimensions, individual wiring details, nomenclature).

B. Bill of Materials: Complete list of all parts needed to fully install selected system components.

C. Shop Drawings:

1. Floor Plans: Location, orientation, and coverage area of each sensor; groups; zones; scenes, and other specific design symbols and designations as required to define the installation, location, and configuration of all control devices.

2. Point List and Data Bus Devices: Summary list of all control devices, sensors, and other devices connected to each data bus. Include remaining future device capacity of data bus.

3. Wire Termination Diagrams and Schedules: Coordinate nomenclature and presentation with Drawings and block diagram. Differentiate between manufacturer-installed and field-installed wiring.

D. Coordination Drawings: Submit evidence that lighting controls are compatible with connected monitoring and control devices and systems specified in other Sections.

1. Show interconnecting signal and control wiring, and interface devices that prove compatibility of inputs and outputs.

E. Room Interconnection Diagrams: Typical per room type (detailed drawings showing device interconnectivity of devices).

F. Example Contractor Startup/Commissioning Worksheet: Must be completed prior to factory start-up.

G. Field quality-control reports.

H. Software licenses and upgrades required by and installed for operation and programming of digital and analog devices.

1.03 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.

2. Program Software Backup: On magnetic media or compact disk, complete with data files.

3. Device address list.

4. Printout of software application and graphic screens.

1.04 QUALITY ASSURANCE

A. All applicable products must be UL/CUL Listed or other acceptable national testing organization.

B. Contractor shall ensure that lighting system control devices and assemblies are fully compatible and can be integrated into a system that operates as described in the lighting control notes on drawings and as described within this specification. Any incompatibilities between devices, fixtures, and system controllers shall be resolved between the Contractor and the system provider, as required to ensure proper system operation and maintainability.

C. System startup shall be performed by manufacturer's authorized service representative.

1.05 COORDINATION

A. Coordinate lighting control components to form an integrated interconnection of compatible components.

B. Coordinate lighting controls with BAS either through IP based intercommunication of system or hardwired auxiliary relay outputs.

C. The installing contractor shall be responsible for a complete and functional system in accordance with all applicable local and national codes.

D. Comply with 47 CFR, Subparts A and B, for Class A digital devices.

E. Comply with protocol described in IEC 60929, Annexes E and G, for lighting control devices, wiring, and computer hardware and software.

F. Comply with UL 916.

1.06 WARRANTY

A. Manufacturer`s Warranty: Manufacturer agrees to repair or replace components of lighting controls that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Software: Failure of input and output to execute switching or dimming commands.

b. Failure of modular relays to operate under manual or software commands.

c. Device failure.

d. Damage of electronic components due to transient voltage surges.

2. Warranty Periods:

a. Control Components: Three years from date of Substantial Completion.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

1. Digital Lighting Management (DLM) from WattStopper.

2. Encelium Energy Management System from Osram Sylvania.

3. nLight® Network Control System from Sensor Switch.

4. Quantum Total Light Management from Lutron.

5. Green Light from Crestron.

6. NX by Hubbell.

7. Approval prior to bid required for other manufacturers.

2.02 SYSTEM REQUIREMENTS

A. Operation: Input signal from digital signal sources, switches, sensors, or other devices associated with signal input.

1. Each input and control device is connected to a digital data bus.

2. Each device has a digital address and can be operated by a digital signal.

3. Each device can be assigned to any or all groups connected to a single data bus.

4. Each dimming device may have as many as 20 lighting levels in 5 percent increments.

5. Scenes can be programmed to devices and may be applied to groups.

B. System Requirements:

1. Components: Individually addressable control devices (such as relays, dimmers, and switches) that are operated from digital signals received through a data bus, from data-entry and -retrieval devices (such as PCs, hand-held infrared programming devices, and wired network connections). Devices also report status to data-entry and -retrieval devices though the bus.

2. Fixture Independence: Addressable control devices shall be mounted separately from the fixture and shall not be integrated into the fixture in manufacturing/assembly. Future removal of the addressable control device shall not require removal of the fixture, and future removal of the fixture shall not require removal of the addressable control device.

3. Digital Control: Use peer-to-peer communication and distributed logic, where the failure of any single component within a scope shall be automatically isolated and not affect function of other spaces.

C. System shall have an architecture that is based upon three main concepts:

1. Intelligent lighting control device.

2. Standalone lighting control zones.

3. Network backbone for remote or time based operation.

D. Lighting control zones shall consist of one or more intelligent lighting control components, be capable of stand-alone operation, and be capable of being connected to a higher level network backbone.

E. Each lighting control zone shall be capable of automatically configuring itself for default stand-alone operation without any start-up programming.

F. Individual lighting zones must continue to provide a user defined default level of lighting control in the event of a system communication failure with the backbone network or the management software becoming unavailable.

G. System shall be capable of operating a lighting control zone according to several sequences of operation. System shall be able to change a spaces sequence of operation according to a time schedule so as to enable customized time-of-day, day-of-week utilization of a space. Note operating modes should be utilized only in manners consistent with local energy codes.

1. Auto-On/Auto-Off (via occupancy sensors):

   a. Zones with occupancy sensors automatically turn lights on when occupant is detected.

   b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.

   c. Pressing a switch will turn lights off. The lights will remain off regardless of occupancy until switch is pressed again or the occupancy sensor times out, restoring the sensor to Automatic On functionality.

2. Manual-On/Auto-Off (also called Semi-Automatic):

   a. Pushing a switch will turn lights on.

   b. Zones with occupancy and/or photocell sensors turn lights off when vacancy or sufficient daylight is detected.

3. Manual-On to Auto-On/Auto-Off:

   a. Pushing a switch will turn lights on.

   b. After initial lights on, zones with occupancy and/or photocell sensors turn lights on/off according to occupancy/vacancy and/or daylight conditions.

   c. Sequence can be reset via scheduled (ex. daily each morning) events

4. Auto-to-Override On:

   a. Zones with occupancy sensors automatically turn lights on when occupant is detected.

   b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.

   c. Sequence can be reset via scheduled (ex. daily each morning) events

5. Manual-to-Override On:

    a. Pushing a switch will turn lights on.

    b. Zone lighting then goes into an override on state for a set amount of time or until the next time event returns the lighting to an auto-off style of control.

    c. Sequence can be reset via scheduled (ex. daily each morning) events

H. Control software shall enable logging of system performance data and presenting useful information in a web-based graphical format and downloadable to .CSV files.

I. System software interface shall have the ability to notify communication failures to system users via system and e-mail messages. E-mail messages shall be available in html and text formats.

J. Surge Suppression: Factory installed as an integral part of control components or field-mounted surge suppressors complying with UL 1449, SPD Type 2.

K. All system devices shall be capable of being given user defined names.

L. All devices within the network shall be able to have their firmware reprogrammed remotely and without being physically uninstalled for purposes of upgrading functionality at a later date.

M. All sensor devices shall have the ability to detect improper communication wiring and blink it's LED in a specific cadence as to alert installation/startup personnel.

2.03 BUS POWER SUPPLY

A. Description: Supply power to data bus as an NFPA 70, Class 2 control circuit.

1. Primary Power: Field selectable, 120 and 277 V.

2. Power Supply: Regulated to maintain the operating voltage under full load, and rated for full capacity of connected devices.

3. Pilot Lights: Indicate data bus ground fault and data bus traffic.

2.04 CONTROLLER/GATEWAYS

A. Description: The controller/gateways link the distributed data buses to all other data buses with a dedicated lighting control network included with the system. A link is also provided for the Owner's Ethernet network to provide computer configuration, control, analysis, and maintenance. The controller/gateways operate independently and continue to process local inputs and schedules when disconnected from the dedicated lighting control network or Owner's Ethernet network. The controller/gateways shall provide local intelligence and features including the following:

1. Integrated real-time clock with automatic daylight savings adjustment and leap-year correction.

2. Integrated sunrise/sunset support based on the site location (latitude and longitude).

3. Automatic time schedules, to control groups for scheduled occupancy with support for holiday exceptions.

4. Digital outputs for additional control and interlocking with external equipment such as fans, valves, and security panels.

5. Support data bus(es).

6. Computer Monitoring and Configuration: The controller/gateway shall allow configuration, monitoring, and analysis from PCs on the Owner's Ethernet LAN.

B. Each data bus shall have the capacity to control connected addressable devices, using NFPA 70, Class 2 control circuit.

1. Each data bus shall have the capacity to control groups and scenes.

2. LED indicator lights for Ethernet status (link, send, and receive), power-on, and network failure.

3. Linking of switch and sensor inputs to control device outputs.

4. Viewing control device output status.

5. Controlling control device outputs.

6. Setting device addresses.

7. Assigning switch and sensor inputs and control device output modes.

C. Allow connection of the following addressable control devices:

1. Fluorescent fixture switching and dimming, for linear and compact lamps.

2. Incandescent fixture switching and dimming.

3. HID and HPS fixture switching and dimming.

4. LED fixture switching and dimming.

5. Occupancy and photoelectric sensors.

6. Emergency lighting interface complying with UL 924.

D. Stores system programming in nonvolatile memory.

1. Switch to enable or disable software programming.

2.05 USER INTERFACE

A. Workstation:

1. Lighting control system management software installed on Owner's PC, with Microsoft Windows operating system.

2. Include licenses, documentation, and storage media and licensing for a minimum of one user.

B. Infrared Programming Assistant: Handheld, with custom graphical user-interface software, supplied by the controller/gateway supplier to program the manual switches.

2.06 LIGHTING CONTROL SYSTEM MANAGEMENT SOFTWARE

A. The software shall provide for programming, configuring, and monitoring all devices connected to all data buses of the lighting control system, using application-specific software with Microsoft Windows-based, user-friendly software with graphical user-interface designed screens.

1. The software shall be object oriented with pop-up menus and built-in help screens. All specified features of the data-bus-connected devices and those associated with controller/gateways shall be included in the software.

2.07 LED FIXTURE SWITCHING AND DIMMING

A. Each device or zone shall be addressable and shall include on/off, fade, dimming, scene settings, and other standard control functions as required to meet the Lighting Control Schedule functions. Control outlet and wiring shall be compatible with fixtures specified.

B. Drivers: Comply with requirements in Division 26 “Interior Lighting” for LED and the following:

1. Dimming Range: 100 to 5 percent of rated lumens, unless fixture specified is capable of lower outlet (match fixture).

2. Input Voltage Range: 108 to 305V.

2.08 SENSORS

A. Sensors may be powered directly from the lighting control network or with a standalone power supply. Units powered with a standalone power supply shall interface with the lighting control system through an electrically isolated digital input.

B. General Description: Ceiling-mounting, solid-state low voltage units.

1. Operation: Unless otherwise indicated, turn lights on when covered area is occupied and off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 20 minutes. Automatic sensitivity adjustment.

2. Sensor Type: Sensors shall be dual-technology type (unless noted otherwise).

a. Corridors and Vestibules: PIR type sensors are acceptable.

3. Sensor Output: Contacts rated to operate the connected power pack, complying with UL 773A. Sensor shall be powered from the power pack.

4. Mounting:

a. Sensor: Suitable for mounting on a standard outlet box.

b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind accessible cover.

5. Indicator: LED, to show when motion is being detected during testing and normal operation of the sensor.

6. Bypass Switch: Override the on function in case of sensor failure.

C. PIR Type: Ceiling mounting; detect occupancy by sensing a combination of heat and movement in area of coverage.

1. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in.

D. Dual-Technology Type: Ceiling mounting; detect occupancy by using a combination of PIR and ultrasonic/microphonic detection methods in area of coverage. Particular technology or combination of technologies that controls on-off functions shall be selectable in the field by operating controls on unit.

1. Sensitivity Adjustment: Separate for each sensing technology.

2. Detector Sensitivity: Detect occurrences of 6-inch- minimum movement of any portion of a human body that presents a target of not less than 36 sq. in., and detect a person of average size and weight moving not less than 12 inches in either a horizontal or a vertical manner at an approximate speed of 12 inches.

2.09 INDOOR PHOTOELECTRIC SENSORS

A. Photo sensor shall be sensitive to all waveforms within the visible light spectrum.

B. Spectral response of sensor shall match the sensitivity of the human eye.

C. Full Range Dimming: Photo sensor shall be capable of controlling associated luminaires over their full dimming range. Daylight harvesting shall be capable of turning associated luminaires off.

D. Daylight harvesting sequence shall include a minimum 2 minute time delay to avoid cycling from rapidly changing sky conditions.

E. Fade Rate: Fade rate from maximum to minimum light output shall be a minimum of 1 minute.

F. Closed Loop Photosensor: Setpoint adjustable from 20-60 foot candles.

G. Open Loop Photosensor: Minimum light sensor range of 20-700 foot candles.

H. Photosensor function may be integral to occupancy sensor.

2.10 RELAYS

A. Relays: Electrically operated, mechanically held single-pole switch, rated at 20 A at 277 V. Short-circuit current rating shall be not less than 5 kA. With pilot light indicating when relay is closed and latched. Control shall be by digital data bus. Relay status shall be displayed when queried by lighting management software.

B. Relay Panel: A single enclosure with incoming lighting branch circuits, relays, and connection to the digital control network.

1. Enclosure: NEMA 250, Type 1, unless otherwise indicated.

2. Barriers to separate low-voltage and line-voltage components.

3. Directory: Cover mounted, identifying each relay with its device address and naming the load controlled.

C. Individually Mounted Relays:

1. Enclosure: Standard outlet box or NEMA 250, Type 1, unless otherwise indicated.

2. Directory: Cover mounted, identifying each relay with its device address.

2.11 MANUAL SWITCHES AND PLATES

A. Push-Button Switches: Modular, operating over the digital data bus.

1. Each switch shall control the following functions, in coordination with lighting control schedule functions:

a. On.

b. Off.

c. Dimming, increase light level.

d. Dimming, decrease light level.

e. Return to preset light level.

2. On/off function may be combined into single button.

3. Where switch includes dimming functionality, distinct raise and lower buttons shall be provided. Dimming accomplished via holding down on/off button(s) or similar is not allowed.

4. Match color and style specified in Division 26 Section "Wiring Devices."

B. Wall Plates: Single and multigang plates as specified in Division 26 Section "Wiring Devices."

2.12 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Class 2 Power Source: Not smaller than No. 12 AWG, complying with Division 26 Section "Conductors and Cables for Electrical."

B. Class 2 Control Cables: Multiconductor cable with copper conductors sized per manufacturer for circuit load and voltage conditions.

C. Class 1 Control Cables: Multiconductor cable with copper conductors sized per manufacturer for circuit load and voltage conditions.

D. Digital and Multiplexed Signal Cables: Unshielded, twisted-pair cable with copper conductors, complying with TIA/EIA-568-B.2, for horizontal copper cable. Manufacturer may select cable Category (5e, 6, etc.).

E. All cables shall be plenum rated.

F. Where composite cables require more than two conductors, provide manufacturer’s factory pre-terminated cable to connected lighting control devices. Cabling shall be plenum rated.

G. Cable Color Code: Coordinate cable color to be unique from other building systems and match existing when applicable.

H. Provide minimum 8 ft. slack in each cable segment for flexibility of device location adjustment.

2.13 EMERGENCY SHUNT RELAY

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Lighting Control and Design, Inc.

2. Watt Stopper (The).

B. Description: Normally closed, electrically held relay, arranged for wiring in parallel with manual or automatic switching contacts; complying with UL 924.

1. Coil Rating: Coordinate coil voltage.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Engage manufacturer's representative to select devices, quantities, locations, and interconnecting cabling to achieve the control sequence specified in the lighting control schedule.

B. Wiring:

1. Comply with NECA 1.

2. Wiring Method: Install cables in raceways except where installed in accessible ceilings. Conceal raceway and cables except in unfinished spaces. Support cables at intervals not exceeding 60". Cable shall not be run in contact with structural members, pipes, ducts, or other potentially damaging items.

3. Route all low voltage cables separate from line-voltage conductors.

4. Conductor/Cable Coordination: Verify and coordinate quantity and configuration of line voltage conductors and/or low voltage cables needed to interconnect dimming control devices with associated lighting fixtures. Control method shall match. Note that dimming methods may require different conductor/cable configurations be used for different fixtures.

C. Wall Devices:

1. Provide junction box in wall with conduit stubbed up above nearest accessible ceiling space.

2. Where cabling is routed in inaccessible locations (above hard ceilings, within floors, within walls), provide conduit routed from device to nearest accessible ceiling space.

D. Sensors:

1. Select, install, and aim sensors to achieve not less than 90 percent coverage of installed areas. Do not exceed coverage limited specified in manufacturer's written instructions.

2. Adjust location of sensors to minimize activation of interior rooms from adjacent corridor activity per manufacturer's direction.

3. Arrange control zones per plans and details. Individual rooms (defined by full height wall partitions or doors) shall be controlled independent of adjacent rooms. Multiple occupancy sensors in the same room or zone shall control all lighting fixtures associated with that room or zone. Rooms or zones shown with multiple branch circuits shall be provided with multiple control devices to accommodate control sequence.

E. Emergency Lighting Interface:

1. Install emergency relay on life safety lighting circuits indicated with automatic controls. Relay shall bypass automatic controls and illuminate life safety lighting circuit upon loss of adjacent normal branch lighting circuit source voltage. Locate in associated source electrical room within NEMA-1 enclosure.

3.02 IDENTIFICATION

A. Identify system components, wiring, cabling, boxes, cabinets, and terminals. Comply with identification requirements specified in Division 26 Section "Electrical Identification."

B. Identify field-installed conductors, interconnecting wiring, and components; install warning signs complying with Division 26 Section "Electrical Identification."

C. Identify all ceiling-mounted controls with data bus number and device address.

D. Label each device cable within 6 inches of connection to wiring terminals/ports.

3.03 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test continuity of each circuit.

B. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer`s written instructions.

2. Test each bus controller using a portable PC.

3. Activate light fixtures and verify that all fixtures are operating at 100 percent.

4. Confirm correct communications wiring, initiate communications between devices and controller/gateways, and program the lighting control system according to approved configuration schedules, time-of-day schedules, and input override assignments.

5. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Field Test Reports:

1. Printed list of all points created from actual queries of all addressed control points to include ballasts, manual controls, and sensors.

2. Event log verifying the performance of all devices generating event messages to include occupancy sensors, control buttons, alarm messages, and any other change of value messages.

3. Trend data for all daylight zones covering a period of not less than one week and demonstrating performance consistent with the submitted computer models for those spaces.

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

E. Upon completion of initial programming, engage engineer, architect, and Owner while onsite to confirm time and scene controls/adjustments prior to final programming. Provide 2 weeks' notice. Time may be required outside of normal business hours to confirm lighting for those hours of operation.

3.04 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting sensors to suit occupied conditions and to assist Owner’s personnel in making program changes. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

3.05 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for three years.

B. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within three years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule and access the system and to upgrade computer equipment if necessary.

3.06 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner`s maintenance personnel to adjust, operate, and maintain the control unit and operator interface.

END OF SECTION 260943

SECTION 26 22 00 - LOW-VOLTAGE TRANSFORMERS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the following types of dry-type transformers rated 600 V and less, with capacities up to 1000 kVA:

1. Distribution transformers.

1.02 SUBMITTALS

A. Product Data: Include rated nameplate data, capacities, weights, dimensions, minimum clearances, installed devices and features, and performance for each type and size of transformer indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1. Wiring Diagrams: Power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For transformers to include in emergency, operation, and maintenance manuals. Provide transformer voltage test results and tap settings.

1.03 CLOSE-OUTS

A. Operation and maintenance data.

B. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain each transformer type through one source from a single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

C. Comply with IEEE C57.12.91, "Test Code for Dry-Type Distribution and Power Transformers."

D. Ratings and Coordination: Withstand ratings and selective coordination shall meet the requirements of Division 26 Section “Power System Studies.”

1.05 DELIVERY, STORAGE, AND HANDLING

A. Temporary Heating: Apply temporary heat according to manufacturer`s written instructions within the enclosure of each ventilated-type unit, throughout periods during which equipment is not energized and when transformer is not in a space that is continuously under normal control of temperature and humidity.

1.06 COORDINATION

A. Coordinate installation of wall-mounting and structure-hanging supports with actual transformer provided. Installation shall be coordinated with the manufacturer and/or a structural engineer.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Products.

2. ABB/GE.

3. Siemens Energy & Automation, Inc.

4. Square D; Schneider Electric.

2.02 GENERAL TRANSFORMER REQUIREMENTS

A. Description: Factory-assembled and -tested, air-cooled units for 60-Hz service.

B. Cores: Grain-oriented, non-aging silicon steel.

C. Coils: Continuous windings without splices except for taps.

1. Internal Coil Connections: Brazed or pressure type.

2. Coil Material: Copper.

2.03 DISTRIBUTION TRANSFORMERS

A. Comply with 10 CFR 431, and list and label as complying with UL 1561.

B. Cores: One leg per phase.

C. Enclosure: Ventilated, NEMA 250, Type 2.

1. Core and coil shall be encapsulated within resin compound, sealing out moisture and air.

D. Ratings required on transformer shall not be achieved through the addition of a secondary cooling fan.

E. Transformer Enclosure Finish: Comply with NEMA 250.

1. Finish Color: Gray.

F. Taps for Transformers Smaller Than 3 kVA: One 5 percent tap above normal full capacity.

G. Taps for Transformers 7.5 to 24 kVA: One 5 percent tap above and one 5 percent tap below normal full capacity.

H. Taps for Transformers 25 kVA and Larger: Two 2.5 percent taps above and two 2.5 percent taps below normal full capacity.

I. Insulation Class: 220 deg C, UL-component-recognized insulation system with a maximum of 115 deg C rise above 40 deg C ambient temperature.

J. Energy Efficiency for Transformers:

1. Comply with DOE 2016 Efficiency.

2.04 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 26 Section "Electrical Identification."

2.05 SOURCE QUALITY CONTROL

A. Test and inspect transformers according to IEEE C57.12.91.

PART 3 -EXECUTION

3.01 EXAMINATION

A. Examine conditions for compliance with enclosure- and ambient-temperature requirements for each transformer.

B. Verify that field measurements are as needed to maintain working clearances required by NFPA 70 and manufacturer`s written instructions.

C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.

D. Verify that ground connections are in place and requirements in Division 26 Section "Grounding and Bonding for Electrical" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.

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

3.02 INSTALLATION

A. Install transformers on concrete bases. Construct concrete bases according to Division 26 “Hangers and Supports for Electrical”.

B. Provide heat shielding where stacking or suspending transformers above one another.

C. Locate primary disconnection within sight of the transformer, unless the location of the disconnect is field-marked on the transformer and the disconnect is lockable (NEC 450.14).

3.03 CONNECTIONS

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

B. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

3.04 FIELD QUALITY CONTROL

3.05 ADJUSTING

A. Record transformer secondary voltage at each transformer upon completion of project but before occupancy. Using recorded voltages, adjust transformer taps to provide optimum voltage conditions at secondary terminals. Optimum is defined as not exceeding nameplate voltage plus 10 percent and not being lower than nameplate voltage minus 3 percent. Submit recording and tap settings as test results.

B. Output Settings Report: Prepare a written report recording output voltages and tap settings.

3.06 CLEANING

A. Vacuum dirt and debris; do not use compressed air to assist in cleaning.

END OF SECTION 262200

SECTION 26 24 13 - SWITCHBOARDS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes service and distribution switchboards rated 1000 V and less.

1. Coordination: Overcurrent protective device coordination (Reference Division 26 Section “Power System Studies”) shall be submitted and approved prior to submittal of switchboards in order to accommodate equipment selection required by that section.

1.02 SUBMITTALS

A. Product Data: For each type of switchboard, overcurrent protective device, transient voltage suppression device, ground-fault protector, accessory, and component indicated. Include dimensions and manufacturers` technical data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: For each switchboard and related equipment.

1. Dimensioned plans, elevations, sections, and details, including required clearances and service space around equipment. Show tabulations of installed devices, equipment features, and ratings.

a. Mimic-bus diagram.

1.03 CLOSE-OUTS

A. Operation and maintenance data.

1.04 DELIVERY, STORAGE, AND HANDLING

A. Deliver in sections or lengths that can be moved past obstructions in delivery path. Quantity and dimensions of shipping splits shall accommodate the final building path available for future removal and replacement.

B. Store indoors in clean dry space with uniform temperature to prevent condensation. Protect from exposure to dirt, fumes, water, corrosive substances, and physical damage.

C. Handle switchboards according to NEMA PB 2.1 and NECA 400.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NEMA PB 2, "Deadfront Distribution Switchboards."

C. Comply with NFPA 70.

D. Ratings and Coordination: Withstand ratings and selective coordination shall meet the requirements of Division 26 Section “Power System Studies.”

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.

2.02 MANUFACTURED UNITS

A. Manufacturers:

1. Eaton Corporation; Cutler-Hammer Products.
2. ABB/GE.
3. Siemens Energy & Automation, Inc.
4. Square D.

B. Front-Connected, Front-Accessible Switchboard: Panel-mounted main device, panel-mounted branches, front and rear sections align.

C. Main-Bus Continuous: As indicated on drawings.

D. Enclosure: Steel, NEMA 250, Type 1.

E. Enclosure Finish: Factory-applied finish in manufacturer`s standard gray finish over a rust-inhibiting primer on treated metal surface.

F. Barriers: Between adjacent switchboard sections.

G. Bus Transition and Incoming Pull Sections: Matched and aligned with basic switchboard.

H. Buses and Connections: Three phase, four wire, unless otherwise indicated. Hard-drawn copper of 98 percent conductivity with feeder circuit-breaker line connections.

1. Ground Bus: 1/4-by-2-inch- minimum-size, hard-drawn copper of 98 percent conductivity, equipped with pressure connectors for feeder and branch-circuit ground conductors. For busway feeders, extend insulated equipment grounding cable to busway ground connection and support cable at intervals in vertical run.
2. Main Phase Buses, Neutral Buses, and Equipment Ground Buses: Uniform capacity for entire length of switchboard`s main and distribution sections. Provide for future extensions from both ends.
3. Isolation Barrier Access Provisions: Permit checking of bus-bolt tightness.
4. Neutral Buses: 100 percent of the ampacity of phase buses, unless otherwise indicated, equipped with pressure connectors for outgoing circuit neutral cables. Bus extensions for busway feeder neutral bus are braced.

I. Surge Protective Devices (SPD): On all Emergency and Life Safety Switchboards, provide SPD, meeting the requirements of Division 26 Section “Surge Protection for Low Voltage Electrical Power Circuits”.

2.03 OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker: NEMA AB 3, with interrupting capacity to meet available fault currents.

1. Electronic trip-unit circuit breakers shall have RMS sensing, field-replaceable rating plug, and the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

d. Ground-fault pickup level, time delay, and I2t response.

2. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

3. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

B. Molded-Case Circuit-Breaker Features and Accessories: Standard frame sizes, trip ratings, and number of poles.

1. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor material.

2. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HACR for heating, air-conditioning, and refrigerating equipment.

3. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.

4. Zone-Selective Interlocking: Integral with electronic trip unit; for interlocking ground fault and short time protection function.

C. GFP: Provide ground fault protection per NEC.

D. Coordination: Electronic trip circuit breakers may be required in lieu of thermal magnetic to achieve overcurrent protective device coordination (Reference Division 26 Section “Power System Studies”). Manufacturer to provide devices accordingly.

2.04 INSTRUMENTATION

A. Instrument Transformers: NEMA EI 21.1, IEEE C57.13, and the following:

1. Potential Transformers: Secondary voltage rating of 120 V and NEMA accuracy class of 0.3 with burdens of W, X, and Y.

2. Current Transformers: Ratios shall be as required with accuracy class and burden suitable for connected relays, meters, and instruments.

3. Control-Power Transformers: Dry type, mounted in separate compartments for units larger than 3 kV.

B. Multifunction Digital-Metering Monitor: Microprocessor-based unit suitable for three- or four-wire systems and with the following features:

1. Switch-selectable digital display of the following values with maximum accuracy tolerances as indicated:

a. Phase Currents, Each Phase: Plus or minus 1 percent.

b. Phase-to-Phase Voltages, Three Phase: Plus or minus 1 percent.

c. Phase-to-Neutral Voltages, Three Phase: Plus or minus 1 percent.

d. Kilowatts: Plus or minus 2 percent.

e. Kilovars: Plus or minus 2 percent.

f. Power Factor: Plus or minus 2 percent.

g. Frequency: Plus or minus 0.5 percent.

h. Kilowatt Demand (Instantaneous and Recorded Maximum): Plus or minus 2 percent; demand interval programmable from 5 to 60 minutes.

i. Accumulated Energy, Kilowatt Hours: Plus or minus 2 percent. Accumulated values unaffected by power outages up to 72 hours.

2. Mounting: Display and control unit flush or semiflush mounted in instrument compartment door.

2.05 ACCESSORY COMPONENTS AND FEATURES

A. Furnish tools required to adjust settings of solid-state trip devices.

2.06 OVERCURRENT PROTECTIVE DEVICE COORDINATION

A. Overcurrent protective device manufacturer shall provide overcurrent device types (circuit breaker frame size, plug rating, adjustability, fuse selection, etc.) required to achieve coordination to 0.1 seconds per NEC Article 517.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Install switchboards and accessories according to NEMA PB 2.1 and NECA 40.

B. Install floor-mounted switchboards on concrete bases. Construct concrete bases according to Division 26 Section “Hangers and Supports for Electrical”.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from switchboard units and components.

D. Operating Instructions: Frame and mount the printed basic operating instructions for switchboards, including control and key interlocking sequences and emergency procedures. Fabricate frame of finished wood or metal and cover instructions with clear acrylic plastic. Mount on front of switchboards.

E. Install overcurrent protective devices, surge protection devices, and instrumentation.

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

3.02 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide labels as specified in Division 26 Section "Common Work Results for Electrical". Provide warning signs required by NEC.

B. Switchboard Nameplates: Label each switchboard compartment. Use engraved nameplates as specified in Division 26 Section "Electrical Identification."

C. Branch Device Nameplates: Provide identification for each branch device. Use engraved nameplates as specified in Division 26 Section "Electrical Identification."

3.03 FIELD QUALITY CONTROL

A. Perform acceptance tests as follows:

1. Test insulation resistance for each switchboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

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

1. Perform each electrical test and visual and mechanical inspection stated in NETA ATS, Sections 7.1, 7.5, 7.6, 7.9, 7.10, 7.11, and 7.14 as appropriate. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

END OF SECTION 262413

SECTION 26 24 16 - PANELBOARDS

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Distribution panelboards.

2. Lighting and appliance branch-circuit panelboards.

1.02 SUBMITTALS

A. Coordination: Overcurrent protective device coordination (Reference Division 26 Section “Power System Studies”) shall be submitted and approved prior to submittal of panelboards in order to accommodate equipment selection required by that section.

B. Product Data: For each type of panelboard, overcurrent protective device, surge protection device, accessory, and component indicated. Include dimensions and manufacturers` technical data on features, performance, electrical characteristics, ratings, and finishes.

C. Shop Drawings: For each panelboard and related equipment.

1. Include dimensioned plans, elevations, sections, and details. Show tabulations of installed devices, equipment features, and ratings.

2. Detail enclosure types and details for types other than NEMA 250, Type 1.

3. Detail bus configuration, current, and voltage ratings.

4. Short-circuit current rating of panelboards and overcurrent protective devices.

5. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices and auxiliary components.

1.03 CLOSE-OUTS

A. Operation and Maintenance Data: For panelboards and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Manufacturer`s written instructions for testing and adjusting overcurrent protective devices.

B. Panelboard Schedules: For installation in panelboards.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories from single source from single manufacturer.

B. Product Selection for Restricted Space: Drawings represent maximum dimensions for panelboards including clearances between panelboards and adjacent surfaces and other items. Coordinate and comply with required maximum dimensions.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

D. Comply with NEMA PB 1 and NECA 407.

E. Comply with NFPA 70.

F. Ratings and Coordination: Withstand ratings and selective coordinatino shall meet the requirements of Division 26 Section “Power System Studies.”

1.05 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; store in a dry environment or install temporary electric heating (250 W per panelboard) as required to prevent condensation.

1.06 PROJECT CONDITIONS

A. Environmental Limitations:

1. Do not deliver or install panelboards until spaces are enclosed and weathertight, wet work in spaces is complete and dry, work above panelboards is complete, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

B. Service Conditions: NEMA PB 1, usual service conditions, as follows:

1. Ambient temperatures within limits specified.

2. Altitude not exceeding 6600 feet.

1.07 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances, dedicated electrical space, and required clearances for equipment access doors and panels.

B. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.08 EXTRA MATERIALS

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

1. Keys: Two spares for each type of panelboard cabinet lock.

PART 2 -PRODUCTS

2.01 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. ABB/GE.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Enclosures:

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Hinged Front Cover (Door-in-Door or Hinged Trim Construction): Entire front trim hinged to box and with standard door within hinged trim cover.

3. Door:

a. Distribution panelboards.
1) Secured with vault-type latch with tumbler lock; keyed alike.
(a) For doors more than 36 inches high, provide two latches, keyed alike.

b. Lighting and appliance branch circuit panelboards.
1) Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

4. Finishes:

a. Panels and Trim: Steel, factory finished immediately after cleaning and pretreating with manufacturer`s standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: Galvanized steel.

5. Directory Card: Inside panelboard door, with transparent protective cover.

6. Mounting Configuration: Coordinate flush and surface mounting types as scheduled or as required to accommodate construction.

C. Phase, Neutral, and Ground Buses:

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Equipment Ground Bus: Adequate for feeder and branch-circuit equipment grounding conductors; bonded to box.

3. Neutral Bus: Adequate for dedicated branch circuit neutrals.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Main and Neutral Lugs: Mechanical type.

3. Ground Lugs and Bus-Configured Terminators: Mechanical type.

E. Surge Protective Devices (SPD) On all Life Safety and other indicated panelboards, provide SPD, meeting the requirements of Division 26 Section "Surge Protective Devices for Low Voltage Electrical Power Circuits".

2.02 PANELBOARD SHORT-CIRCUIT RATING

A. Fully rated to interrupt symmetrical short-circuit current available at terminals. Coordinate with drawings and Overcurrent Protective Device Coordination study.

2.03 DISTRIBUTION PANELBOARDS

A. Panelboards: NEMA PB 1, power and feeder distribution type.

1. Lighting and appliance branch panelboards with sub-feed breakers are not acceptable as a substitute to distribution panelboards.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.04 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

1. Load centers will not be accepted for lighting and appliance branch circuit panelboards.

B. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

2.05 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with interrupting capacity to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

2. Adjustable Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

3. Electronic trip circuit breakers with rms sensing; field-replaceable rating plug or field-replicable electronic trip; and the following field-adjustable settings:

a. Instantaneous trip.

b. Long- and short-time pickup levels.

c. Long- and short-time time adjustments.

4. GFCI Circuit Breakers: Class A ground-fault protection (6-mA trip).

5. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

   a. Standard frame sizes, trip ratings, and number of poles.

   b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.

   c. Provide the following features where indicated on drawings or panel schedules.
      1) Ground-Fault Protection: Integrally mounted relay and trip unit with push-to-test feature, and ground-fault indicator.
      2) Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in on or off position.
      3) Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

B. Coordination: Electronic trip circuit breakers may be required in lieu of thermal magnetic to achieve overcurrent protective device coordination (Division 26 Section “Power System Studies”). Manufacturer to provide devices accordingly.

2.06 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

B. Portable Test Set: For testing functions of solid-state trip devices without removing from panelboard. Include relay and meter test plugs suitable for testing panelboard meters and switchboard class relays.

2.07 OVERCURRENT PROTECTIVE DEVICE COORDINATION

A. Overcurrent protective device manufacturer shall provide overcurrent device types (circuit breaker frame size, plug rating, adjustability, fuse selection, etc.) required to achieve “coordinated short-circuit protection” per NEC Articles 240.12 and 700.27.

PART 3 -EXECUTION

3.01 EXAMINATION

A. Receive, inspect, handle, and store panelboards according to NECA 407 and NEMA PB 1.1.

B. Examine panelboards before installation. Reject panelboards that are damaged or rusted or have been subjected to water saturation.

C. Examine elements and surfaces to receive panelboards for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Equipment Mounting: Install full-height, floor-mounted distribution panelboards on concrete bases, 4-inch nominal thickness. Comply with requirements for concrete base specified in Division 03.

1. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around full perimeter of base.

2. For panelboards, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.

3. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

4. Install anchor bolts to elevations required for proper attachment to panelboards.

5. Attach panelboard to the vertical finished or structural surface behind the panelboard.

C. Temporary Lifting Provisions: Remove temporary lifting eyes, channels, and brackets and temporary blocking of moving parts from panelboards.

D. Mount top of trim 74 inches above finished floor unless panel height exceeds this. Maintain NEC accessibility requirements for highest mounted device.

E. Mount panelboard cabinet plumb and rigid without distortion of box. Mount recessed panelboards with fronts uniformly flush with wall finish and mating with back box.

F. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

G. Install filler plates in unused spaces.

H. Recessed Panelboards: Stub four 1-inch empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Provide with pull strings.

I. Comply with NECA 1.

3.03 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide labels complying with Division 26 Section "Electrical Identification." Provide warning signs required by NEC.

B. Create a directory to indicate installed circuit loads; incorporate Owner`s final room designations. Obtain approval before installing. Use a computer to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Division 26 Section "Electrical Identification."

D. Branch Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Electrical Identification."

3.04 FIELD QUALITY CONTROL

A. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

C. Panelboards will be considered defective if they do not pass tests and inspections.

D. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

E. Test and Inspection Report:

1. Perform test/inspections and submit report prior to Engineer’s final punch inspection.

2. Report shall consist of any developed test result data and shall, at minimum, include a copy of this “Field Quality Control” Section of the specification to illustrate Contractor acknowledgement of tests and inspections.

a. Contractor shall indicate successful completion by initialing individual test and inspection requirements listed above on the copy. Initialing indicates that tests and inspections were performed for specified work with a successful outcome. Work not found to be in compliance was corrected and retested/reinspected successfully or has been specifically clarified and noted above by the Contractor.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Power System Studies".

END OF SECTION 262416

SECTION 26 24 21 - HOSPITAL ISOLATION POWER PANELBOARDS

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Operating rooms ungrounded panelboards including shielded isolation transformer, line isolation monitor, and load circuit breakers.

1.02 DEFINITION

A. Basis of Design Product: Where Specifications name a product and include a list of manufacturers, provide the specified product or a comparable product by one of the other named manufacturers. Drawings and Specifications indicate sizes, profiles, dimensions, and other characteristics that are based on the product named.

1.03 REFERENCES

A. NFPA 70 – National Electrical Code, Article 517.

B. NFPA 99 – Health Care Facilities.

C. UL 1022 – Line Isolation Monitors.

D. UL 1047 – Isolated Power System Distribution Equipment.

1.04 SUBMITTALS

A. Product Data: Provide dimensions, knockout sizes and locations, materials, fabrication details, finishes, and accessories. Provide manufacturer’s technical data on features, performance, electrical characteristics, wiring diagrams, and ratings.

B. Manufacturer’s Instructions: Indicate application, conditions and limitations of use stipulated by product testing agency specified under Regulatory Requirements. Include instructions for storage, handling, protection, examination, preparation, and installation of Product.

C. Test results that comply with requirements.

D. Operation and Maintenance Data:

1. Manufacturer’s written instructions for testing.

1.05 QUALITY ASSURANCE

A. Perform work in accordance with NECA Standard of Installation.

1.06 REGULATORY REQUIREMENTS

A. Conform to requirements of ANSI/NFPA 70.

B. Furnish products listed and classified by Underwriters Laboratories, Inc. as suitable for purpose specified as shown.

1.07 COORDINATION

A. Coordinate layout and installation of panelboards and components with other construction that penetrates walls or is supported by them, including electrical and other types of equipment, raceways, piping, encumbrances to workspace clearance requirements, and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

PART 2 -PRODUCTS

2.01 MANUFACTURERS – UNGROUNDED PANELBOARDS

A. Basis of Design Product: Square D products are used as the basis of design. Subject to compliance with requirements, provide comparable product by one of the following:

1. Square D; A Brand of Schneider Electric.

2. Post Glover.

3. Isoltrol.

B. Manufacturers: Approved manufacturer for the various components of a complete isolated power distribution system shall be as listed herein.

1. Transformer shall be a shielded low leakage isolating transformer, specifically manufactured for the use in hospital isolated systems, Class 7450 Isolating Transformer manufactured by the Square D Company.

C. The ungrounded panels shall be located as indicated on the drawings. The LIM used in these units shall indicate alarm when the total hazard current exceeds 5 mA. The remote indicator alarm unit shall be located in the operating room and connected to the panel supplying power to the circuits in that room.

2.02 COMPONENTS

A. The following components shall be provided by the manufacturer of the ungrounded panels as one integral unit.

B. Isolation Transformer:

1. The isolation transformer shall be wound with an electrostatic shield between the primary and secondary windings which shall be grounded to the enclosure. The electrostatic shield will be of such design that it will prevent direct shorting of the primary winding to the secondary winding and reduce the coupling of harmonic distortions between the primary circuit and secondary circuits.

2. The total leakage current to ground from the transformer secondary winding shall not exceed values shown in Table 29.2 of UL 1047.

3. Regulation to be certified not to exceed 2.6% at 0.8 PF at 20 deg C above the full load continuous operating temperature in accordance with NEMA-ANSI Standards.

4. The transformer is to be single phase, 60 Hz, with primary and secondary voltages as listed in the drawings and/or schedule.

5. Class H rated insulation shall be used in the manufacture of the transformer and the temperature rise will be limited to 55 deg C above ambient under full load conditions when tested in accordance with NEMA-ANSI Standards.

6. Transformers must have a 220 deg C, UL recognized insulation system. The core and coil shall be vacuum impregnated and shall have a final wrap of insulating materials so as not to expose any bare conductor.

7. The core shall be of stacked design and securely clamped and bolted. The core and coils shall be internally isolated from the enclosure by means of a suitable vibration dampening system. The design sound level of the completed units shall not be in excess of 27 dB. Certified sound level reports shall be furnished for each individual unit upon the request of the Consulting Engineer.

C. Circuit Breakers:

1. The panel shall be equipped with a 2-pole circuit breaker to protect the primary windings of the isolation transformer.

2. The rating of the primary circuit breaker shall be in accordance with Article 450-3 (b) (1) of the National Electrical Code (NFPA 70).

3. The panel shall have at least eight factory installed secondary branch circuit breakers rated at 20 amperes. All secondary branch breakers are to be 2-pole and shall utilize a combination thermal and magnetic trip mechanism.

4. The panel shall be designed to allow field conversion for up to 16 2-pole branch circuit breakers. The conversion shall not require the use of any special tools or punches.

5. Refer to the panelboard schedule for quantity and sizes of secondary branch circuit breakers.

6. Square D Type QO, QOB, Q1, FAL, ORKAL.

D. Line Isolation Monitor (LIM):

1. The LIM shall be the Square D ISO-GARD® Series D.

2. The LIM shall use microprocessor-based digital signal processing to continually monitor the impedance from all secondary conductors of the isolated power systems to ground.

3. The LIM shall be capable of measuring all combinations of capacitive and resistive faults including balanced, unbalanced, and hybrid faults.

4. LIMs which internally switch between either line and ground will not be accepted.

5. The LIM shall not contribute more than 15 uA to the total hazard current of the system being monitored.

6. The LIM shall have the following specifications:

a. Operating Voltage: 85 to 265 VAC.

b. Accuracy: 5% or better.

c. Alarm Level: 2 or 5 mA (selectable).

d. Alarm Bandwidth: Zero (0).

e. Alarm Hysteresis (On/Off): 50 xA.

f. Mode: Single- or three-phase.

g. Monitor Hazard Current: 50 xA.

h. Operating Frequency: 50 or 60 Hz.

7. All of the listed specifications shall be contained within one unit and be user selectable thus allowing the LIM to be interchanged from system to system.

8. The LIM shall incorporate a momentary test switch. When pressed, it shall check and recalibrate the unit. Additionally, the test switch shall perform a complete test of all indicating lamps and meters on the face of the LIM and at any remote indicating stations.

9. The LIM shall use digital signal processing to determine the hazard current of the system being monitored. The microprocessor within the LIM shall be #MC68HC16Z1 as manufactured by Motorola. The algorithms used to determine the system hazard current shall be preprogrammed into the LIM's microprocessor. At least every 65 minutes, the unit shall recheck its calibration and recalibrate the system to original performance specifications. Additionally, by pressing the LIM's momentary test switch, an immediate check and recalibration of the LIM shall be performed.

10. If internal components are more than 30% out of original specifications because of aging or failure, the LIM shall notify the user by displaying a unique error code thus eliminating the need for periodic manual testing to determine the unit's integrity. LIMs which use analog signal processing technology and/or require manual testing or recalibration will not be accepted.

11. The LIM shall provide both analog and digital indication of the isolated power system's hazard current. Digital indication shall be provided by a digital meter and analog indication shall be provided by an LED bar graph type meter calibrated from 0 (zero) to 160% of the alarm setting of the LIM.

12. The LIM shall have a green safe light and red hazard light on the front panel. The red hazard light shall remain illuminated for the duration when the isolated power system hazard current is above the selected alarm level of the LIM. An audible alarm shall be incorporated into the unit and shall activate in conjunction with the red hazard light. The audible alarm shall have high, low, and off settings. A silence button shall be provided on the face of the unit to silence the audible alarm during fault conditions. Upon silencing the audible alarm, a yellow indicating light shall illuminate to indicate the audible alarm has been silenced. The red hazard light and yellow silence light shall automatically reset when the fault condition is eliminated. During fault conditions, the red hazard light and all red segments to the LED bar graph shall blink at a constant rate. All lamps shall be long life LED type.

13. A set of normally open and normally closed contacts, rated 3 amperes at 120 VAC shall be provided on the LIM for use with external alarm systems. The LIM shall also provide a 12 VAC output signal rated at 10 VA to power remote indicator alarm units. This 12 VAC output signal shall not increase the hazard current of the system being monitored. Provisions for connection of the remote metering shall also be provided as part of the LIM. These connections shall have the ability to operate either an analog or digital type remote meter.

14. The LIM shall incorporate a loss-of-ground feature which will activate the audible and visual alarms when connection is lost with the reference ground of the isolated power system being monitored. In addition to activating the alarm, the unit shall display an error code in the digital display of the LIM.

15. All switches, meters, and indicating lamps shall be flush with the face of the LIM. The entire front face of the unit shall have a polymer overlay that protects the unit from the intrusion of housekeeping cleaning agents.

16. The design of the LIM shall consist of two circuit boards interconnected by a ribbon connector. The two boards shall contain all of the unit's electrical components and be mounted in the rear housing of the LIM. A phenolic cover shall complete the assembly. The unit shall not contain any components, such as circuit breakers, meter, switches, or indicating lamps, which are mounted on or attached to the front cover of the LIM. Access to the inside of the LIM shall be through the front of the unit thus eliminating the need to remove the unit from its mounting position to change any of the settings. Unique fasteners shall attach to the front cover of the unit to prevent unauthorized access to the interior of the LIM.

17. The LIM shall be manufactured by Square D Company, UL component recognized under UL 1022 Standard for Line Isolation Monitors, and UL recognized as meeting CSA 22.2 the Canadian Standard for Line Isolation Monitors.

E. Ground Bus Bar:

1. The ungrounded panel shall contain a ground bus to which the ground bar from the ground wire from all receptacles and the ground wire from the LIM are connected. The ground bus bar is to serve as the reference ground point for the operating room. The ground bus bar shall contain a sufficient number of points to allow termination of all internal ground wires and the termination of all ground leads from permanently installed metal objects in the surgery area.

2.03 CONSTRUCTION

A. Enclosure:

1. The enclosure shall be 12 gauge steel which is degreased, phosphatized, primed, and finish painted with a coat of baked enamel, except for the front trim which is to be of type 304 stainless steel with a No. 4 brushed finish. The enclosure will be flush mounting unless otherwise stated on the plans; units shall have a maximum depth of 8 in (12 in for 7.5 kVA and 10 kVA panels). The front trim shall be mounted on a continuous length piano-type hinge for access to field wiring compartments.

2. The front panel shall not contain any type of grille or louver for the purpose of Isolation Transformer ventilation. The panel and transformer shall be so designed that the heat generated by the transformers under full load conditions shall not affect the normal operation of the circuit breakers and ground detector. The maximum front panel temperature shall not exceed 30 deg C rise under full load continuous operation.

3. Panelboard typed directories.

B. Wiring:

1. Wiring within all panels shall be in accordance with applicable NEC Code Standards. Low leakage insulation shall be used on all wire. The total panel leakage for a 3 or 5 kVA panel shall not exceed 30 microamperes when energized and assembled. The manufacturer of the panel shall provide certified test data on each individual panel as to maximum leakage of each complete assembly.

2. The contractor shall wire all external receptacles to the panels using copper stranded conductor having a cross-linked polyethylene insulation or equivalent with a dielectric constant of 3.5 or less. Minimum insulation wall thickness shall be 3/64 in for #10 and #12 AWG and 5/64 in for #8 AWG and larger conductor. Under no circumstances shall wire pulling compound be used when pulling the wire for isolated circuits. All wiring shall be color-coded in accordance with NEC and appropriate NFPA standards.

3. The shortest possible routing to the isolated circuits shall be used to minimize total wire length. Run these conduits as far as possible from metal structures or pipes and minimize wherever possible, parallel runs to metal pipes.

2.04 OVERCURRENT PROTECTIVE DEVICE COORDINATION

A. Overcurrent protective device manufacturer shall provide overcurrent device types (circuit breaker frame size, plug rating, adjustability, fuse selection, etc.) required to achieve “coordinated short-circuit protection” per NEC Articles 240.12 and 700.27.

PART 3 -EXECUTION

3.01 INSTALLATION

A. The contractor shall furnish and install ungrounded isolated distribution system panels for operating rooms as indicated on the drawings. In addition, portable laser outlets within these locations shall be powered from separate isolated distribution panels as shown on the drawings. Locations of panels are indicated on the drawings and cannot be changed without written permission from the consulting electrical engineer and architect.

B. The panel(s) shall be factory wired and tested and include a shielded low leakage isolation transformer, primary and secondary circuit breakers, and LIM.

3.02 TESTING BY THE MANUFACTURER

A. The contractor shall include the cost of, and make all arrangements for, testing all ungrounded isolated systems in the hospital by a qualified factory technician provided by the manufacturer of the isolation systems. The testing shall include a complete inspection of all connections and materials used. The contractor shall be prepared to demonstrate to the factory technician that proper polarity was observed, and installation practices were in accordance with the drawings and specifications for these systems.

B. The factory technician shall check and record system current leakages. The factory technician shall further simulate faults on the isolated system of a magnitude high enough to bring the total system leakage, which the LIM detects, above the calibrated point, thus verifying correct operation of the LIM. The faults simulated shall be combinations of resistive and capacitive faults.

C. The factory technician shall check the resistance between the ground point of each receptacle and the reference point, and it shall be less than 0.1 ohms. The voltage potential difference between any exposed conductive surfaces in the patient vicinity shall be checked, the difference to be no more than 40 millivolts. These tests are required by NFPA No. 99 for new construction areas.

D. The factory technician shall instruct the hospital maintenance staff in the use of the following:

1. The panel and LIM as a leakage measuring device.

2. How instrument leakage areas can be measured and labeled.

3. How to perform leakage tests.

E. The technician shall also test the system impedance of the entire isolated power system to ensure compliance with the applicable sections of NFPA No. 99, Chapter 3. The measured system impedance shall become part of the permanent logged records of each panel.

F. After all tests are complete, a letter shall be given to the hospital and the consulting engineer. The letter shall state that the system conforms with all codes, good installation practices, and the specifications.

G. Upon completion of all tests, the factory technician shall meet with hospital medical and maintenance staff to thoroughly explain the operation of the equipment installed, and the need and procedure for periodically testing and logging test results. The technician shall furnish log books to the maintenance department, enter the first readings of all panels in these log books, and clearly instruct the hospital maintenance staff how to enter future readings.

END OF SECTION 262421

SECTION 26 27 26 - WIRING DEVICES

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, receptacles with integral USB chargers, and associated device plates.

2. Snap switches.

B. See Division 26 Section "Conductors and Cables for Electrical " for workstation outlets.

C. See Division 26 Section "Electrical Identification" for device labeling requirements.

1.02 SUBMITTALS

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

1.03 CLOSE-OUTS

A. Operation and Maintenance Data: For wiring devices to include in all manufacturers` packing label warnings and instruction manuals that include labeling conditions.

B. Test reports.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NFPA 70.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers` Names: Shortened versions (shown in parentheses) of the following manufacturers` names are used in other Part 2 articles:

1. Cooper Wiring Devices; a division of Cooper Industries, Inc. (Cooper).

2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).

3. Leviton Mfg. Company Inc. (Leviton).

4. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.02 STRAIGHT BLADE RECEPTACLES

A. Hospital Grade:

1. Receptacles shall be Hospital grade at the following locations:

a. Throughout (all receptacle locations).

2. Hospital grade receptacles shall be the hospital-grade equivalent to straight blade receptacles listed below.

B. Tamper Resistant

1. Receptacles shall be tamper resistant at the following locations:

a. Throughout (all receptacle locations).

2. Tamper resistant receptacles shall be the tamper resistant equivalent to straight blade receptacles listed below.

C. Weather Resistant

1. Receptacles shall be weather resistant at all wet locations.

2. Weather resistant receptacles shall be the weather resistant equivalent to straight blade receptacles listed below.

D. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 configuration 5-20R, and UL 498.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper; 5351 (single), 5352 (duplex).

b. Hubbell; HBL5351 (single), CR5352 (duplex).

c. Leviton; 5891 (single), 5352 (duplex).

d. Pass & Seymour; 5381 (single), 5362 (duplex).

2. GFCI RECEPTACLES

a. General Description: Straight blade, non-feed-through type. Comply with NEMA WD 1, NEMA WD 6, UL 498, and UL 943, Class A, and include indicator light that is lighted when device is tripped.

b. Duplex GFCI Convenience Receptacles, 125 V, 20 A:
1) Products: Subject to compliance with requirements. Provide GFCI equivalent to Straight Blade Receptacles indicated above.
(a) Cooper; GF20.
(b) Hubbell; GFRST20.
(c) Leviton; G5362.
(d) Pass & Seymour; 2095.

3. USB CHARGING RECEPTACLES

a. Duplex Convenience Receptacles, 125V, 20A, with two USB charging ports, USB Type A, 5 V dc, and minimum 2.1 A per receptacle.
   1) Subject to compliance with requirements. Provide one of the following:
      (a) Cooper TR7756
      (b) Hubbell USB20X
      (c) Leviton T5832

2.03 TWIST-LOCKING RECEPTACLES

A. Single Receptacles: Comply with NEMA WD 1, NEMA WD 6 configuration as indicated, and UL 498.

2.04 SWITCHES

A. Comply with NEMA WD 1 and UL 20.

B. Switches, 120/277 V, 20 A:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Cooper/Eaton/Arrowhart; CSB120 (single pole), CSB220 (two pole), CSB320 (three way), CSB420 (four way).

b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).

c. Leviton; 1221-2 (single pole), 1222-2 (two pole), 1223-2 (three way), 1224-2 (four way).

d. Pass & Seymour/Legrand; CS20AC1 (single pole), CS20AC2 (two pole), CS20AC3 (three way), CS20AC4 (four way).

2.05 WALL PLATES

A. Single and combination types to match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.

2. Material for Finished Spaces: 0.035-inch-thick, satin-finished stainless steel.

3. Material for Unfinished Spaces: Galvanized steel.

4. Material for Damp Locations: Cast aluminum enclosure with spring-loaded lift cover, and listed and labeled for use in "wet locations."

5. Material for Wet-Location, Weatherproof Cover Plates: NEMA 250 enclosure, complying with Type 3R weather-resistant, die-cast aluminum with lockable, in-use style cover.

B. FINISHES

1. Color: Wiring device catalog numbers in Section Text do not designate device color.

a. Wiring Devices Connected to Normal Power System: Ivory device, unless otherwise indicated.

b. Wiring Devices Connected to Generator-Supplied Power System: Red device.

PART 3 -EXECUTION

3.01 COORDINATION

A. Coordinate receptacles for Owner-furnished equipment. Match equipment requirements.

3.02 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers that are guided by riding against outside of the boxes.

2. Keep outlet boxes free of plaster, drywall joint compound, mortar, cement, concrete, dust, paint, and other material that may contaminate the raceway system, conductors, and cables.

3. Install device boxes in brick or block walls so that the wall or cover plate does not cross a joint unless the joint is troweled flush with the face of the wall.

4. Install wiring devices after all wall preparation, including painting, is complete.

C. Conductors:

1. Do not strip insulation from conductors until just before they are spliced or terminated on devices.

2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.

3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.

4. Existing Conductors:

a. Cut back and pigtail or replace all damaged conductors.

b. Straighten conductors that remain and remove corrosion and foreign matter.

c. Pigtailing existing conductors is permitted provided the outlet box is large enough.

5. Receptacles shall be grounded with an equipment grounding conductor, sized per NEC, but not smaller than #12, routed with the branch circuit and connected to the equipment ground bus in the branch circuit panelboard. The equipment ground conductor shall also be bonded to the outlet box in which the receptacle is mounted.

D. Device Installation:

1. Replace all devices that have been in temporary use during construction or that show signs that they were installed before building finishing operations were complete.

2. Keep each wiring device in its package or otherwise protected until it is time to connect conductors.

3. Do not remove surface protection, such as plastic film and smudge covers, until the last possible moment.

4. Connect devices to branch circuits using pigtails that are not less than 6 inches in length.

5. When there is a choice, use side wiring with binding-head screw terminals. Wrap solid conductor tightly clockwise, 2/3 to 3/4 of the way around terminal screw.

6. Use a torque screwdriver when a torque is recommended or required by the manufacturer.

7. When conductors larger than No. 12 AWG are installed on 15- or 20-A circuits, splice No. 12 AWG pigtails for device connections.

8. Tighten unused terminal screws on the device.

9. When mounting into metal boxes, remove the fiber or plastic washers used to hold device mounting screws in yokes, allowing metal-to-metal contact.

10. GFCI devices shall not protect downstream devices. Individual GFCI devices shall be installed.

11. Do not connect under cabinet lighting downstream of a GFCI device.

12. Provide physical barrier between adjacent 120 and 277 volt circuit conductors in ganged wall switch installations.

13. Provide separate device boxes for normal power system and emergency power system devices to maintain proper system wiring separation.

E. Device Plates: Do not use oversized or extra-deep plates. Repair wall finishes and remount outlet boxes when standard device plates do not fit flush or do not cover rough wall opening.

F. Dimmers:

1. Install dimmers within terms of their listing.

2. Verify that dimmers used for fan speed control are listed for that application.

3. Install unshared neutral conductors on line and load side of dimmers according to manufacturers` device listing conditions in the written instructions.

4. Install dimmers in individual device box to avoid derating requirements.

G. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical. Group adjacent switches under single, multigang wall plates.

3.03 IDENTIFICATION

A. Comply with Division 26 Section "Electrical Identification."

1. Receptacles: Identify panelboard and circuit number from which served.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Test Instruments: Use instruments that comply with UL 1436.

2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated LED indicators of measurement.

B. Tests for Convenience Receptacles (comply with testing requirements of NFPA 99):

1. Physical Integrity: Visually inspect.

2. Retention Force: Not less than 115 g (4 oz.)

3. Line Voltage: Acceptable range is 105 to 132 V. Verify polarity.

4. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.

5. Ground Impedance: Values of up to 2 ohms are acceptable.

6. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.

7. Using the test plug, verify that the device and its outlet box are securely mounted.

8. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new, and retest as specified above.

C. Test and Inspection Report:

1. Perform test/inspections and submit report prior to Engineer’s final punch inspection.

2. Report shall consist of any developed test result data and shall, at minimum, include a copy of this “Field Quality Control” Section of the specification to illustrate Contractor acknowledgement of tests and inspections.

a. Contractor to indicate successful completion by initialing individual test and inspection requirements listed above on the copy. Initialing indicates that tests and inspections were performed for specified work with a successful outcome. Work not found to be in compliance was corrected and retested/reinspected successfully or has been specifically clarified and noted above by the Contractor.

b. Acknowledgement of Tests and Inspections:

“Tests and inspections have been successfully completed as specified, or have been clarified/noted above.
1) Representative Company Name: _____
2) Representative Personnel Name: _____
3) Representative Personnel Signature: _____
4) Date of Report: _____”

END OF SECTION 262726

SECTION 26 28 16 - ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.
4. Molded-case circuit breakers (MCCBs).

1.02 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.03 SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated. Include dimensioned elevations, sections, weights, and manufacturers` technical data on features, performance, electrical characteristics, ratings, accessories, and finishes.

1. Enclosure types and details for types other than NEMA 250, Type 1.
2. Current and voltage ratings.
3. Short-circuit current ratings (interrupting and withstand, as appropriate).
4. Detail features, characteristics, ratings, and factory settings of individual overcurrent protective devices, accessories, and auxiliary components.

B. Operation and Maintenance Data: For enclosed switches and circuit breakers 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. Manufacturer`s written instructions for testing and adjusting enclosed switches and circuit breakers.

1.04 QUALITY ASSURANCE

A. Source Limitations: Obtain enclosed switches and circuit breakers, overcurrent protective devices, components, and accessories, within same product category, from single source from single manufacturer.

B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. Comply with NFPA 70.

D. Ratings and Coordination: Withstand ratings and selective coordination shall meet the requirements of Division 26 section “Power System Studies.”

1.05 PROJECT CONDITIONS

A. Environmental Limitations: Rate equipment for continuous operation under the following conditions unless otherwise indicated:

1. Ambient Temperature: Not less than minus 22 deg F and not exceeding 104 deg F.

2. Altitude: Not exceeding 6600 feet.

1.06 COORDINATION

A. Coordinate layout and installation of switches, circuit breakers, and components with equipment served and adjacent surfaces. Maintain required workspace clearances and required clearances for equipment access doors and panels.

1.07 EXTRA MATERIALS

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

1. Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than three of each size and type.

PART 2 -PRODUCTS

2.01 FUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate required fuses, lockable handle with capability to accept three padlocks, lockable cover latch, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open, when used as a motor disconnect on motors served from a VFD.

4. Hookstick Handle: Allows use of a hookstick to operate the handle.

5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.02 NONFUSIBLE SWITCHES

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240 or 600-V ac: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, lockable cover latch, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Auxiliary Contact Kit: One NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open, when switch is used as a motor disconnect on motors served from VFD.

4. Hookstick Handle: Allows use of a hookstick to operate the handle.

5. Lugs: Mechanical type, suitable for number, size, and conductor material.

2.03 MOLDED-CASE CIRCUIT BREAKERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. General Requirements: Comply with UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents.

C. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 150 A and larger.

D. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Mechanical type, suitable for number, size, trip ratings, and conductor material.

3. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge lighting circuits.

2.04 ENCLOSURES

A. Enclosed Switches and Circuit Breakers: NEMA AB 1, NEMA KS 1, NEMA 250, and UL 50, to comply with environmental conditions at installed location.

1. Indoor, Dry and Clean Locations: NEMA 250, Type 1.

2. Outdoor Locations: NEMA 250, Type 3R.

3. Hazardous Areas Indicated on Drawings: NEMA 250, Type 7.

2.05 OVERCURRENT PROTECTIVE DEVICE COORDINATION

A. Overcurrent protective device manufacturer shall provide overcurrent device types (circuit breaker frame size, plug rating, adjustability, fuse selection, etc.) required to achieve “coordinated short-circuit protection” per NEC Article s 240.12 and 700.27.

PART 3 -EXECUTION

3.01 EXAMINATION

A. Examine elements and surfaces to receive enclosed switches and circuit breakers for compliance with installation tolerances and other conditions affecting performance of the Work.

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

3.02 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Install fuses in fusible devices.

C. Comply with NECA 1.

D. Where enclosed switches are installed as a motor disconnect on motors served from a VFD, provide connection between switch auxiliary contacts and VFD. Coordinate to disable VFD when disconnect is open.

3.03 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Electrical Identification."

1. Identify field-installed conductors, interconnecting wiring, and components.

2. Label each enclosure with laminated-plastic nameplate.

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.

2. Test continuity of each circuit.

C. Tests and Inspections:

1. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

2. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. Enclosed switches and circuit breakers will be considered defective if they do not pass tests and inspections.

3.05 ADJUSTING

A. Adjust moving parts and operable components to function smoothly and lubricate as recommended by manufacturer.

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

END OF SECTION 262816

SECTION 26 32 13 - ENGINE GENERATORS

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes packaged engine-generator sets with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Outdoor enclosure.

B. See Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.02 SUBMITTALS

A. Product Data: For each type of packaged engine generator and accessory indicated.

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.

C. Source quality-control test reports.

1.03 CLOSE-OUTS

A. Field quality-control test reports.

B. Operation and maintenance data.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer`s authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

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 ASME B15.1.

E. Comply with NFPA 37.

F. Comply with NFPA 70.

G. Comply with NFPA 99.

H. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

I. Comply with UL 2200, all components as assembled.

J. Engine Exhaust Emissions: Comply with applicable state and local government requirements. Packaged unit shall be EPA emissions certified prior to shipment.

K. Noise Emission: Comply with applicable state and local government requirements for maximum noise level at adjacent property boundaries due to sound emitted by generator set including engine, engine exhaust, engine cooling-air intake and discharge, and other components of installation.

1.05 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 15 to plus 40 deg C.

2. Relative Humidity: 0 to 95 percent.

3. Altitude: Sea level to 1000 feet.

1.06 PERMITS, FEES, AND NOTICES

A. Contractor shall secure and pay for permits and governmental fees, licenses, and inspections necessary for proper execution and completion of the Work, and for Owner to occupy and operate.

B. Contractor shall comply with and file notices required by laws, ordinances, rules, regulations, and lawful orders of public authorities applicable.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Caterpillar; Engine Div.

2. MTU Onsite Energy

3. Onan/Cummins Power Generation; Industrial Business Group.

2.02 ENGINE-GENERATOR SET

A. Factory-assembled and -tested, engine-generator set.

B. Mounting Frame: Maintain alignment of mounted components without depending on concrete foundation; and have lifting attachments.

C. Communication: Integrate generator status, alarms, and control into the Novant Health BAS system via BACnet MS/TP. Provide all necessary cards and cabling to integrate with BAS system. Confirm exact parameters to integrate with Novant Health.

D. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated.

2. Rated Operating Condition: Standby.

3. Output Connections: Three-phase, four wire.

4. Nameplates: For each major system component to identify manufacturer`s name and address, and model and serial number of components.

E. Generator-Set Performance:

1. Steady-State Voltage Operational Bandwidth: 3 percent of rated output voltage from no load to full load.

2. Transient Voltage Performance: Not more than 20 percent variation for 50 percent step-load increase or decrease. Voltage shall recover and remain within the steady-state operating band within three seconds.

3. Steady-State Frequency Operational Bandwidth: 0.5 percent of rated frequency from no load to full load.

4. Steady-State Frequency Stability: When system is operating at any constant load within the rated load, there shall be no random speed variations outside the steady-state operational band and no hunting or surging of speed.

5. Transient Frequency Performance: Less than 5 percent variation for 50 percent step-load increase or decrease. Frequency shall recover and remain within the steady-state operating band within five seconds.

6. Output Waveform: At no load, harmonic content measured line to line or line to neutral shall not exceed 5 percent total and 3 percent for single harmonics. Telephone influence factor, determined according to NEMA MG 1, shall not exceed 50 percent.

7. Sustained Short-Circuit Current: For a 3-phase, bolted short circuit at system output terminals, system shall supply a minimum of 250 percent of rated full-load current for not less than 10 seconds and then clear the fault automatically, without damage to generator system components.

8. Start Time: Comply with NFPA 110, Type 10, system requirements. From the moment of normal source failure, the transfer switch(es) and generator(s) shall restore suitable power source to the load within 10 seconds per NFPA 110 (and NFPA 99 as applicable). Coordinate with and accommodate transfer switch performance.

2.03 ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm.

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.

2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.

3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.

2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

1. Provide branch circuit from generator enclosure panelboard.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.

2. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer`s engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.

2. Sound level measured at a distance of 10 feet from exhaust discharge after installation is complete shall be 85 dBA or less.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.

2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.

3. Cranking Cycle: As required by NFPA 110 for system level specified.

4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.

5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

   a. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236.
      1) Provide branch circuit from generator enclosure panel.

2.04 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.

2. Capacity: Fuel for 12 hours` continuous operation at 100 percent rated power output, plus 33% reserve.

3. Vandal-resistant fill cap.

4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

2.05 CONTROL AND MONITORING

A. Automatic Starting System Sequence of Operation: When mode-selector switch on the control and monitoring panel is in the automatic position, remote-control contacts in one or more separate automatic transfer switches initiate starting and stopping of generator set. When mode-selector switch is switched to the on position, generator set starts. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level 1 system, and the following:

1. AC voltmeter.

2. AC ammeter.

3. AC frequency meter.

4. DC voltmeter (alternator battery charging).

5. Engine-coolant temperature gage.

6. Engine lubricating-oil pressure gage.

7. Running-time meter.

8. Ammeter-voltmeter, phase-selector switch(es).

9. Generator-voltage adjusting rheostat.

10. Fuel tank derangement alarm.

11. Fuel tank high-level shutdown of fuel supply alarm.

12. Generator overload.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.

2. Coolant low-temperature alarm.

3. Control switch not in auto position.

4. Battery-charger malfunction alarm.

5. Battery low-voltage alarm.

G. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

1. Location:

a. Nurse Station

b. Emergency Electrical Room

H. Independent Monitoring: Include alarm contacts to report alarm conditions for independent monitoring.

1. Fire Alarm:

a. Generator not in “Auto”.

b. Generator low fuel.

c. Generator general alarm.

2.06 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic or electronic LSI type; complying with NEMA AB 1 and UL 489.

1. Tripping Characteristic: Designed specifically for generator protection.

2. Trip Rating: Matched to generator rating.

3. Shunt Trip: Connected to trip breaker when generator set is shut down by other protective devices.

4. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.07 GENERATOR, EXCITER, AND VOLTAGE REGULATOR

A. Comply with NEMA MG 1.

B. Drive: Generator shaft shall be directly connected to engine shaft. Exciter shall be rotated integrally with generator rotor.

C. Electrical Insulation: Class H.

D. Maximum Temperature Rise: 105 deg C.

E. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

F. Construction shall prevent mechanical, electrical, and thermal damage due to vibration, overspeed up to 125 percent of rating, and heat during operation at 110 percent of rated capacity.

G. Enclosure: Dripproof.

H. Instrument Transformers: Mounted within generator enclosure.

I. Voltage Regulator: Solid-state type, separate from exciter, providing performance as specified.

1. Adjusting rheostat on control and monitoring panel shall provide plus or minus 5 percent adjustment of output-voltage operating band.

J. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

1. Provide branch circuit from generator enclosure panelboard.

K. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

L. Subtransient Reactance: 12 percent, maximum.

2.08 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Custom, sound-attenuated reach-in style enclosure. Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph. Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

1. Attenuation: Max 85 dBA at 50 feet from enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.

2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

3. Ducting: Turning vanes and associated duct to direct discharge air up and out to top of enclosure. Storm-proof and drainable.

C. Unit Heater: Maintain minimum 40 deg F ambient temperature within enclosure when generator is not running.

1. Provide branch circuit from generator enclosure panel.

D. Silencer: Located within enclosure.

E. Panelboard: Line-voltage panelboard mounted within enclosure and factory wired with generator accessory branch circuits and enclosure accessory branch circuits. Arrange for feeder source connection from building electrical power system.

F. Fuel Fill: Fuel tank fill station accessible from exterior of enclosure.

2.09 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer`s standard finish over corrosion-resistant pretreatment and compatible primer.

2.10 SOURCE QUALITY CONTROL

A. Prototype Testing: Factory test engine-generator set using same engine model, constructed of identical or equivalent components and equipped with identical or equivalent accessories.

1. Tests: Comply with NFPA 110, Level 1 Energy Converters and with IEEE 115.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Comply with packaged engine-generator manufacturers` written installation and alignment instructions and with NFPA 110.

B. Install packaged engine generator to provide access, without removing connections or accessories, for periodic maintenance.

C. Install Schedule 40, black steel piping with welded joints and connect to engine muffler. Install thimble at wall. Piping shall be same diameter as muffler outlet. Flexible connectors and steel piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

1. Install condensate drain piping to muffler drain outlet full size of drain connection with a shutoff valve, stainless-steel flexible connector, and Schedule 40, black steel pipe with welded joints. Flexible connectors and piping materials and installation requirements are specified in Division 23 Section "Hydronic Piping."

D. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

1. For outdoor enclosures furnished with factory wired accessory panelboard, provide feeder source connection from building electrical system.

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

F. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

G. Connect engine exhaust pipe to engine with flexible connector.

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

I. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

J. Identify system components according to Division 23 Section "HVAC Identification" and Division 26 Section "Electrical Identification."

K. Remote Annunciator: Provide cable in conduit to remote annunciator location.

L. Start Signal: Provide cable in conduit from automatic transfer switches to generator.

M. Fire Alarm Monitoring: Provide cable in conduit and fire alarm modules for monitoring of generator alarm conditions.

N. Remote Shutdown Switch: Provide remote shutdown switch with tamper-resistant weather-proof cover. Provide with engraved label stating “Generator Shutdown”. Coordinate exact location with Engineer. Provide conductors in conduit and connect to shutdown generator.

1. Location:

a. Emergency Electrical Room

O. Battery Charger: Provide conductors in conduit from batteries to local or remote battery charger.

3.02 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

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. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection (except those indicated to be optional) for "AC Generators and for Emergency Systems" specified in NETA Acceptance Testing Specification. Certify compliance with test parameters.

2. NFPA 110 Acceptance Tests: Perform tests required by NFPA 110 that are additional to those specified here including, but not limited to, single-step full-load pickup test.

3. Battery Tests: Equalize charging of battery cells according to manufacturer`s written instructions. Record individual cell voltages.

a. Measure charging voltage and voltages between available battery terminals for full-charging and float-charging conditions. Check electrolyte level and specific gravity under both conditions.

b. Test for contact integrity of all connectors. Perform an integrity load test and a capacity load test for the battery.

c. Verify acceptance of charge for each element of the battery after discharge.

d. Verify that measurements are within manufacturer`s specifications.

4. Battery-Charger Tests: Verify specified rates of charge for both equalizing and float-charging conditions.

5. System Integrity Tests: Methodically verify proper installation, connection, and integrity of each element of engine-generator system before and during system operation. Check for air, exhaust, and fluid leaks.

6. Voltage and Frequency Transient Stability Tests: Use recording oscilloscope to measure voltage and frequency transients for 50 and 100 percent step-load increases and decreases, and verify that performance is as specified.

7. Harmonic-Content Tests: Measure harmonic content of output voltage under 25 percent and at 100 percent of rated linear load. Verify that harmonic content is within specified limits.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

F. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

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

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.03 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner`s maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Division 01 Section "Demonstration and Training."

3.04 IDENTIFICATION

A. Identify system components according to Division 23 Section "HVAC Identification" and Division 26 Section "Electrical Identification.

B. Emergency Sources: A sign shall be placed at the service-entrance equipment, indicating type and location of on-site emergency power sources.

END OF SECTION 263213

SECTION 26 36 00 - TRANSFER SWITCHES

PART 1 -GENERAL

1.01 SUMMARY

A. This Section includes transfer switches rated 600 V and less, including the following:

1. Automatic transfer switches.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1.03 CLOSE-OUTS

A. Field quality-control test reports.

B. Operation and Maintenance Data: For each type of product 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. Features and operating sequences, both automatic and manual.

2. List of all factory settings of relays; provide relay-setting and calibration instructions, including software, where applicable.

1.04 QUALITY ASSURANCE

A. Manufacturer Qualifications: Maintain a service center capable of providing training, parts, and emergency maintenance repairs within a response period of less than eight hours from time of notification.

B. Source Limitations: Obtain automatic transfer switches and engine-generator set through one source from a single manufacturer.

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 NEMA ICS 1.

E. Comply with NFPA 70.

F. Comply with NFPA 99.

G. Comply with NFPA 110.

H. Comply with UL 1008 unless requirements of these Specifications are more stringent.

I. Ratings and Coordination: Withstand ratings and selective coordination shall meet the requirements of Division 26 section “Overcurrent Protective Device Coordination.”

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. Contactor Transfer Switches:

a. Caterpillar; Engine Div.

b. Emerson; ASCO Power Technologies, LP.

c. GE Zenith Controls.

d. Onan/Cummins Power Generation; Industrial Business Group.

e. Russelectric, Inc.

2.02 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Communication: Integrate transfer switch status, metering, and control into the Novant Health BAS system via BACnet MS/TP. Provide all necessary cards and cabling to integrate with BAS system. Confirm exact parameters to integrate with Novant Health.

B. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, unless otherwise indicated.

C. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

D. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

E. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

F. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

G. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Switch Action: Double throw; mechanically held in both directions.

2. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

H. Neutral Switching. Where four-pole switches are indicated, provide neutral pole switched simultaneously with phase poles.

I. Factory Wiring: Train and bundle factory wiring and label, consistent with Shop Drawings, either by color-code or by numbered or lettered wire and cable tape markers at terminations. Color-coding and wire and cable tape markers are specified in Division 26 Section "Electrical Identification."

1. Designated Terminals: Pressure type, suitable for types and sizes of field wiring indicated.

2. Power-Terminal Arrangement and Field-Wiring Space: Suitable for top, side, or bottom entrance of feeder conductors as indicated.

3. Control Wiring: Equipped with lugs suitable for connection to terminal strips.

J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

K. Digital Power Meter:

1. Display indicating volts, amps, and frequency.

L. In-Phase Monitor: Factory-wired, internal relay controls transfer so contacts close only when the two sources are synchronized in phase and frequency. Relay shall compare phase relationship and frequency difference between normal and emergency sources and initiate transfer when both sources are within 15 electrical degrees, and only if transfer can be completed within 60 electrical degrees. Transfer shall be initiated only if both sources are within 2 Hz of nominal frequency and 70 percent or more of nominal voltage. From the moment of normal-source failure, the transfer switch(es) and generator(s) shall restore suitable power source to the load within 10 seconds per NFPA 110 (and NFPA 99 as applicable). Coordinate with and accommodate generator performance.

2.03 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110, for healthcare occupancy.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Manual Switch Operation: Under load, with door closed and with either or both sources energized. Transfer time is same as for electrical operation. Control circuit automatically disconnects from electrical operator during manual operation.

D. Manual Switch Operation: Unloaded. Control circuit automatically disconnects from electrical operator during manual operation.

E. Integral Bypass/Isolation: In addition to manual controls of the automatic switch, provide separate manual bypass/isolation switch mounted integral to the automatic transfer switch. See Bypass/Isolation article below for requirements.

F. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 60 seconds.

G. Automatic Closed-Transition Transfer Switches: Include the following functions and characteristics:

1. Fully automatic make-before-break operation.

2. Load transfer without interruption, through momentary interconnection of both power sources not exceeding 100 ms.

3. Initiation of No-Interruption Transfer: Controlled by in-phase monitor and sensors confirming both sources are present and acceptable.

   a. Initiation occurs without active control of generator.

   b. Controls ensure that closed-transition load transfer closure occurs only when the 2 sources are within plus or minus 5 electrical degrees maximum, and plus or minus 5 percent maximum voltage difference.

4. Failure of power source serving load initiates automatic break-before-make transfer.

H. Automatic Transfer-Switch Features:

1. Under voltage/over voltage Sensing and under/over frequency sensing for each phase of normal source and emergency sources: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.

2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from 0 to 120 seconds, and factory set for one second.

3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.

4. Time delay for transfer to emergency source field adjustable 0 to 120 seconds and factory set at 3 seconds.

5. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.

6. Time Delay Stop: A time delay provided to allow generator set to operate unloaded for an adjustable period of 0 to 30 minimum and factory set at 5 minutes.

7. Test Switch: Simulate normal-source failure. Selector shall be provided for testing either with or without load.

8. Switch-Position Pilot Lights: Indicate source to which load is connected.

9. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

   a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."

   b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

10. Unassigned Auxiliary Contacts: One normally open and one normally closed, single-pole double throw contacts for each switch position, rated 10 A at 240-V ac.

11. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.

12. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.

13. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at engine-generator controls after retransfer of load to normal source.

14. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.

    b. Push-button programming control with digital LED display of all calibrations, settings, and date time stamp event log of the last 50 events. Voltage and frequency metering of each phase normal and emergency loads.

    c. Integral battery operation of time switch when normal control power is not available.

15. Manual operating handle permanently mounted on transfer switches through 1000 ampere and removable on switches 1200 amps through 4000 amps.

16. For transfer switches feeding elevator loads; provide a pre-signal module that is time delay adjustable 0 to 60 seconds to prevent interruption of power during elevator operation. Relay outputs include: Source 1 connected and available, Source 2 connected and available, not in auto, test/exercise active, failed to disconnect, failed to disconnect, failed to synchronized, failed to transfer/retransfer and transfer pre-signal (elevator signal).

2.04 BYPASS/ISOLATION SWITCHES

A. Comply with requirements for Level 1 equipment according to NFPA 110.

B. Description: Manual type, arranged to select and connect either source of power directly to load, isolating transfer switch from load and from both power sources. Include the following features for each combined automatic transfer switch and bypass/isolation switch:

1. Means to lock bypass/isolation switch in the position that isolates transfer switch with an arrangement that permits complete electrical testing of transfer switch while isolated. While isolated, interlocks prevent transfer-switch operation, except for testing or maintenance.

2. Drawout Arrangement for Transfer Switch: Provide physical separation from live parts and accessibility for testing and maintenance operations.

3. Bypass/Isolation Switch Current, Voltage, Closing, and Short-Circuit Withstand Ratings: Equal to or greater than those of associated automatic transfer switch, and with same phase arrangement and number of poles.

4. Contact temperatures of bypass/isolation switches shall not exceed those of automatic transfer-switch contacts when they are carrying rated load.

5. Operability: Constructed so load bypass and transfer-switch isolation can be performed by 1 person in no more than 2 operations in 15 seconds or less.

6. Legend: Manufacturer's standard legend for control labels and instruction signs shall describe operating instructions.

7. Maintainability: Fabricate to allow convenient removal of major components from front without removing other parts or main power conductors.

C. Interconnection of Bypass/Isolation Switches with Automatic Transfer Switches: Factory-installed copper bus bars; plated at connection points and braced for the indicated available short-circuit current.

2.05 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Floor-Mounting Switch: Install floor-mounted transfer switches on concrete bases. Construct concrete bases according to Division 26 “Electrical Supports”.

B. Identify components according to Division 26 Section "Electrical Identification."

C. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.02 CONNECTIONS

A. Wiring to Remote Components: Match type and number of cables and conductors to control and communication requirements of transfer switches as recommended by manufacturer. Increase raceway sizes at no additional cost to Owner if necessary to accommodate required wiring.

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

C. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

D. Start Signal: Provide cable in conduit from transfer switches to generator.

3.03 FIELD QUALITY CONTROL

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

B. Perform tests and inspections and prepare test reports.

1. Manufacturer`s Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installation, including connections, and to assist in testing.

2. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.

3. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.

4. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Include external annunciation and control circuits. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer`s specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.

    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.

    c. Verify that manual transfer warnings are properly placed.

    d. Perform manual transfer operation.

5. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.

    b. Simulate loss of phase-to-ground voltage for each phase of normal source.

    c. Verify time-delay settings.

    d. Verify pickup and dropout voltages by data readout or inspection of control settings.

    e. Test automatic transfer-switch operations.

    f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

6. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

    a. Verify grounding connections and locations and ratings of sensors.

C. Test and Inspection Report:

1. Perform test/inspections and submit report prior to Engineer’s final punch inspection.

2. Report shall consist of any developed test result data and shall, at minimum, include a copy of this “Field Quality Control” Section of the specification to illustrate Contractor acknowledgement of tests and inspections.

a. Contractor shall indicate successful completion by initialing individual test and inspection requirements listed above on the copy. Initialing indicates that tests and inspections were performed for specified work with a successful outcome. Work not found to be in compliance was corrected and retested/reinspected successfully or has been specifically clarified and noted above by the Contractor.

b. Acknowledgement of Tests and Inspections:

c. “Tests and inspections have been successfully completed as specified or have been clarified/noted above.
   1) Representative Company Name: _____
   2) Representative Personnel Name: _____
   3) Representative Personnel Signature: _____
   4) Date of Report: _____”

D. Coordinate tests with tests of generator and run them concurrently.

E. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

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

3.04 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner`s maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Division 1 Section "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 263600

SECTION 26 41 13 - LIGHTNING PROTECTION FOR STRUCTURES

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes lightning protection for structures.

1.02 SUBMITTALS

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

B. Shop Drawings: For air terminals and mounting accessories.

1. Layout of the lightning protection system, along with details of the components to be used in the installation.

a. Include indications for use of raceway, data on how concealment requirements will be met, and calculations required by NFPA 780 for bonding of grounded and isolated metal bodies.

1.03 CLOSE-OUTS

A. Field quality-control reports.

1.04 QUALITY ASSURANCE

A. Installer Qualifications: Certified by UL or LPI as a Master Installer/Designer, trained and approved for installation of units required for this Project.

B. System Certificate:

1. UL Master Label.

2. LPI System Certificate.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 780, "Definitions" Article.

PART 2 -PRODUCTS

2.01 LIGHTNING PROTECTION SYSTEM COMPONENTS

A. Comply with UL 96 and NFPA 780.

B. Roof-Mounted Air Terminals: NFPA 780, Class I, aluminum.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. East Coast Lightning Equipment Inc.

b. ERICO International Corporation.

c. Harger.

d. Heary Bros. Lightning Protection Co. Inc.

e. Independent Protection Co.

f. Preferred Lightning Protection.

g. Robbins Lightning, Inc.

h. Thompson Lightning Protection, Inc.

i. VFC Group

2. Air Terminals More than 24 Inches Long: With brace attached to the terminal at not less than half the height of the terminal.

3. Single-Membrane, Roof-Mounted Air Terminals: Designed specifically for single-membrane roof system materials. Comply with requirements in Division 07 roofing Sections.

C. Roof and Cross-Run Conductors: Aluminum.

D. Down Conductors: Copper

E. Ground Loop Conductor: Tinned copper.

F. Ground Rods: Copper-clad steel, sectional type; 3/4 inch in diameter by 10 feet long.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Install lightning protection components and systems according to UL 96A and NFPA 780.

B. Conceal the following conductors:

1. System conductors.

2. Down conductors (conceal with building interior).

3. Interior conductors.

4. Conductors within normal view of exterior locations at grade within 200 feet of building.

C. Cable Connections: Use crimped or bolted connections for all conductor splices and connections between conductors and other components. Use exothermic-welded connections in underground portions of the system.

D. Air Terminals on Single-Ply Membrane Roofing: Comply with roofing membrane and adhesive manufacturer`s written instructions.

E. Bond extremities of vertical metal bodies exceeding 60 feet in length to lightning protection components.

F. Ground Loop: Install ground-level, potential equalization conductor and extend around the perimeter structure.

1. Bury ground ring not less than 24 inches from building foundation.

2. Bond ground terminals to the ground loop.

3. Bond grounded building systems to the ground loop conductor within 12 feet of grade level.

G. Bond lightning protection components with intermediate-level interconnection loop conductors to grounded metal bodies of building at 60-foot intervals.

3.02 CORROSION PROTECTION

A. Do not combine materials that can form an electrolytic couple that will accelerate corrosion in the presence of moisture unless moisture is permanently excluded from junction of such materials.

B. Use conductors with protective coatings where conditions cause deterioration or corrosion of conductors.

3.03 FIELD QUALITY CONTROL

A. Notify Architect at least 48 hours in advance of inspection before concealing lightning protection components.

B. System Inspection: Meet requirements to obtain an LPI System Certificate or UL Master Label.

END OF SECTION 264113

SECTION 26 43 13 - SURGE PROTECTIVE DEVICES FOR LOW VOLTAGE ELECTRICAL POWER CIRCUITS

PART 1 -GENERAL

1.01 SUMMARY

A. Section includes integral SPD for low-voltage (120 to 600 V) power distribution and control equipment. These specifications describe the electrical and mechanical requirements for a high-energy surge protective device (SPD). The specified system shall provide effective, high-energy surge current diversion and be suitable for use as Type 1 or Type 2, 20kA device per ANSI/UL 1449 Fourth Edition.

1.02 SUBMITTALS

A. Product Data: For each type of product indicated. Include the following:

1. Manufacturer and model numbers.
2. Short Circuit Current Rating (SCCR).
3. I nominal rating (In).
4. Maximum Continuous Operating Voltage (MCOV).
5. Voltage Protection Ratings (VPRs) for all modes.
6. Type 1 or Type 2 device listing.

1.03 CLOSE-OUTS

A. Operation and maintenance manual.

1. The manufacturer shall furnish an installation manual with installation, startup, and operating instructions for the specified system.

1.04 STANDARDS

A. The specified system shall be designed, manufactured, tested and installed in compliance with the following codes and standards:

B. Underwriters Laboratories; ANSI/UL 1449 4th Edition 2014 Revision

C. Underwriters Laboratories; UL 1283 5th Edition 2015 (complimentary listing for Type 2 locations)

D. American National Standards Institute and Institute of Electrical and Electronic Engineers (ANSI/IEEE C62.34, C62.41, C62.45, C62.62, C62.72)

E. Institute of Electrical and Electronic Engineers 1100 Emerald Book

F. Federal Information Processing Standards Publication 94 (FIPS PUB 94)

G. National Fire Protection Association (NFPA 20, 70, 75 and 780)

H. International Standards Organization (ISO) Company certified ISO 9001 for manufacturing, design and service

I. The system shall be UL listed and labeled under ANSI/UL 1449 Fourth Edition and the voltage protection ratings (VPRs) shall be permanently affixed to the SPD. Type 2 units of the product family shall be listed and labeled to UL1283 Standard for Electromagnetic Interference Filters.

J. International Electrotechnical Commission (IEC)

1.05 SYSTEM DESCRIPTION

A. The system shall be constructed using single or multiple surge current diversion modules utilizing thermally protected metal oxide varistors (TPMOV). The surge current circuit shall be designed and constructed in a manner that ensures surge current sharing. Use of gas tubes, silicon avalanche diodes or selenium cells are unacceptable unless documentation from a nationally recognized laboratory demonstrates current sharing of all dissimilar components at all surge current levels.

B. Maximum Continuous Operating Voltage (MCOV): The SPD and all components in the suppression path (including all current diversion components) maximum continuous operating voltage (MCOV) shall be greater than 115% of the nominal system operating voltage to ensure the ability of the system to withstand temporary RMS over-voltage (swell conditions).

C. Operating Frequency: The operating frequency range of the system shall be at least 47 - 63 Hz.

1.06 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a testing agency, and marked for intended location and application.

B. Comply with IEEE C62.41.1 – 2002, C62.41.2 – 2002, and comply and test devices according to IEEE C62.45 – 2002, C62.62-2010, C62.72-2016.

1. Component Testing and Monitoring: The proposed product shall be single pulsed surge current tested in all modes at the rated surge currents by an industry recognized independent test laboratory. The test shall include a surge impulse (6kV 1.2x50µs, 500 amp 8x20µs waveform) to benchmark the unit’s suppression voltage. The applied impulse is followed by a single pulse surge of the maximum rated surge current magnitude, followed by a second 6kV 1.2x50µs, 500 amp 8x20µs impulse as a means of measuring clamping deviation (component degradation). Compliance is achieved if the two measured suppression voltage do not vary by more than 5%.

C. Comply with UL 1283 and UL 1449, Fourth Edition or most recent edition.

D. Comply with NFPA 70.

E. Ratings and Coordination: Withstand ratings and selective coordination shall meet the requirements of Division 26 section “Power System Studies.”

1.07 WARRANTY

A. The manufacturer shall provide a full ten year warranty from date of shipment against any part failure when installed in compliance with manufacturer`s written instructions, UL listing requirements, and any applicable national or local electrical codes. Manufacturer shall make available (local, national) field engineering service support. Where direct factory employed service engineers are not locally available, travel time from the factory or nearest dispatch center shall be stated.

PART 2 -PRODUCTS

2.01 SERVICE ENTRANCE SUPPRESSORS

A. Manufacturers: Provide integral surge suppressor where indicated in drawings by same manufacturer as service entrance equipment.

B. Surge Protection Devices:

1. Non-modular.

2. SPD shall have an integral status circuit that monitors the operational status of all modes of protection, including Line to Neutral, Line to Ground and Neutral to Ground. No manual testing shall be required to confirm the integrity of the suppression system. SPD shall be equipped with at minimum a red and green solid-state indicators mounted within the enclosure and be externally visible.

3. SPD shall be UL labeled with Type 1, 200kA Short Circuit Current Rating (SCCR) and 20kA I nominal. Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD.

4. Redundant suppression circuits.

5. Arrangement with bus connections or wire connections to phase buses, neutral bus, and ground bus.

6. SPD shall be UL labeled as Type 1, intended for use without need for external or supplemental overcurrent controls. The SPD shall provide protection as follows: All modes, L-N or L-L, L-G and N-G (where applicable). Note: L = Line, G = Ground, N = Neutral. All suppression components shall be thermally protected and rated to allow maximum specified surge current capacity. Devices that utilize a single fuse to protect two or more suppression paths are not accepted. Individual surge components shall be UL listed to be capable of interrupting up to 200 kA symmetrical fault current with 480 VAC applied. Replaceable fusing is unacceptable. Overcurrent protection that limits specified surge currents is not acceptable.

C. Peak Single-Impulse Surge Current Rating: 150kA per mode/300kA per phase.

2.02 PANELBOARD SUPPRESSORS

A. Manufacturers: Provide integral surge suppressor where indicated in drawings by same manufacturer as panelboards.

B. Surge Protection Devices:

1. Non-modular.

2. LED indicator lights for power and protection status.

3. SPD shall be UL labeled with Type 2, 200kA Short Circuit Current Rating (SCCR) and 20kA I nominal. Fuse ratings shall not be considered in lieu of demonstrated withstand testing of SPD.

4. Redundant suppression circuits.

5. Arrangement with wire connections to phase buses, neutral bus, and ground bus.

C. Peak Single-Impulse Surge Current Rating: 50kA per mode/100kA per phase.

D. Protection modes and UL 1449, Fourth Edition, or most recent edition, VPRs for grounded wye circuits with 480Y/277 V, 208Y/120 V, and 600Y/347 V, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.

2. Line to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.

3. Neutral to Ground: 1200 V for 480Y/277 V and 700 V for 208Y/120 V.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Install SPD at service entrance on load side, with ground lead bonded to service entrance ground.

1. Provide multi-pole, circuit breaker (sized per manufacturer’s recommendations) as a dedicated disconnecting means for SPD unless otherwise indicated.

B. Install SPD for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer`s recommended lead length. Do not bond neutral and ground. Install the parallel SPD with short and straight conductors as practically possible. Twist the SPD input conductors together to reduce input conductor inductance. Follow the SPD manufacturer’s recommended installation practices as found in the installation, operation and maintenance manual and comply with all applicable codes.

3.02 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, Section "Surge Arresters, Low-Voltage Surge Protection Devices". Certify compliance with test parameters.

2. After installing SPD but before electrical circuitry has been energized, test for compliance with requirements.

3. Complete startup checks according to manufacturer`s written instructions.

C. The SPD will be considered defective if it does not pass tests and inspections.

D. Test and Inspection Report:

1. Perform test/inspections and submit report prior to Engineer's final punch inspection.

2. Report shall consist of any developed test result data and shall, at minimum, include a copy of this "Field Quality Control" Section of the specification to illustrate Contractor acknowledgement of tests and inspections.

a. Indicate successful completion by initialing individual test and inspection requirements listed above on the copy. Initialing indicates that tests and inspections were performed for specified work with a successful outcome. Work not found to be in compliance was corrected and retested/reinspected successfully or has been specifically clarified and noted above by the Contractor.

b. Acknowledgement of Tests and Inspections:

"Tests and inspections have been successfully completed as specified, or have been clarified/noted above.
1) Representative Company Name: _____
2) Representative Personnel Name: _____
3) Representative Personnel Signature: _____
4) Date of Report: _____"

3.03 STARTUP SERVICE

A. Do not energize or connect service entrance equipment or panelboards to their sources until SPD are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the SPD installed. Disconnect before conducting insulation resistance tests and reconnect immediately after the testing is over.

3.04 DEMONSTRATION

A. Train Owner`s maintenance personnel to maintain SPD.

END OF SECTION 264313

LITTLE
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SECTION 26 51 19 - LED INTERIOR LIGHTING

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Interior solid-state luminaires that use LED technology.

2. Lighting fixture supports.

B. Related Sections:

1. Division 26 Section "Wiring Devices" for manual wall-box dimmers.

2. Division 26 Section “Addressable Network Lighting Controls” for automatic control of lighting.

1.02 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color Rendering Index.

C. Fixture: See "Luminaire."

D. LED: Light-emitting diode.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.03 SUBMITTALS

A. Product Data: For each type of product, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.

2. Projected lifetime (L70), output (lumens, CCT, and CRI), wattage, and efficacy.

B. Shop Drawings: For nonstandard or custom luminaires.

1. Include plans, elevations, sections, and mounting and attachment details.

2. Include details of luminaire assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

3. Include diagrams for power, signal, and control wiring.

C. Product Schedule: For luminaires. Use same designations indicated on Drawings.

1.04 CLOSE-OUTS

A. Operation and maintenance data.

1.05 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.06 COORDINATION

A. Coordinate layout and installation of lighting fixtures and suspension system with other construction that penetrates ceilings or is supported by them, including HVAC equipment, fire-suppression system, and partition assemblies.

1.07 EXTRA MATERIALS

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

1. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.08 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

B. Warranty Period: Five year(s) from date of Substantial Completion.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Lighting Fixtures: Subject to compliance with requirements, provide lighting fixture product indicated on Drawings. Substitutions will only be allowed where specifically indicated on drawings.

2.02 LUMINAIRE 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. LED luminaires shall be Reduction of Hazardous Substances (RoHS) compliant.

C. Recessed Fixtures: Comply with NEMA LE 4.

D. Dimmable from 100 percent to 10 percent of maximum light output unless otherwise indicated.

E. Internal driver unless otherwise indicated.

F. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

G. Comply with UL 1598 and UL 8750.

H. Each luminaire shall be rated for a minimum operational life (L70) of 50,000 hours as defined by IES LM-80 and TM-21.

I. Absolute photometrics shall be available for each luminaire based on IES LM-79.

J. Individual LEDs within the luminaire shall be connected such that loss or failure of a single LED will not result in the loss of the entire array.

K. LEDs shall have a minimum CRI of 90 unless otherwise indicated.

L. Each LED luminaire type shall be binned within a three-step MacAdam Ellipse to ensure color consistency among luminaires.

M. Luminaire Power Factor: 0.90 or higher.

N. Total Harmonic Distortion Rating: Less than 20 percent.

2.03 MATERIALS

A. Metal Parts:

1. Free of burrs and sharp corners and edges.

2. Sheet metal components shall be steel unless otherwise indicated.

3. Form and support to prevent warping and sagging

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit relamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during relamping and when secured in operating position.

C. Diffusers, and Globes:

1. Acrylic: One hundred percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2. Glass: Annealed crystal glass unless otherwise indicated.

3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

2.04 EXIT SIGNS

A. General Requirements for Exit Signs: Comply with UL 924; for sign colors, visibility, luminance, and lettering size, comply with authorities having jurisdiction.

B. Internally Lighted Signs:

1. LEDs: 50,000 hours minimum rated life.

2.05 METAL FINISHES

A. Variations in finishes are unacceptable in the same piece. Variations in finishes of adjoining components are acceptable if they are within the range of approved Samples and if they can be and are assembled or installed to minimize contrast.

2.06 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical " for channel and angle iron supports and nonmetallic channel and angle supports.

PART 3 -EXECUTION

3.01 INSTALLATION

A. Comply with NECA 1.

B. Install luminaires level, plumb, and square with ceilings and walls unless otherwise indicated.

C. Supports: Sized and rated for luminaire weight.

D. Wall-mounted Fixtures: Attach to studs or backing in the walls. Lighting fixtures shall not be attached directly to gypsum board.

E. Comply with requirements in Division 26 Section "Conductors and Cables for Electrical" for wiring connections.

F. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

G. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.

H. Two by Two Lighting Fixtures:

1. Unless otherwise indicated, install fixtures such that linear components are perpendicular to the long dimension of the room.

I. Remote Mounting of Driver: Distance between the driver and fixture shall not exceed that recommended by driver manufacturer. Verify, with driver manufacturers, maximum distance between driver and luminaire. Remote mount only where indicated on plans. Remote mount location shall be concealed from view and accessible without the need for architectural access panel unless specifically noted.

1. Where not indicated on plans, locate concealed within nearest accessible indoor ceiling space.

J. Lay-in Ceiling Lighting Fixtures Supports: Use grid as a support element.

1. Support Clips: Fasten to lighting fixtures and to ceiling grid members at or near each fixture corner with clips that are UL listed for the application.

2. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on architectural reflected ceiling plans, and support fixtures independently with at least two 3/4-inch metal channels spanning and secured to ceiling tees.

K. Suspended Lighting Fixture Support:

1. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

L. Connect wiring according to Division 26 Section "Conductors and Cables for Electrical."

M. Fixture Whip Conductor Coordination:

1. Coordinate conductor quantity within fixture whips with fixture selection and lighting control requirements.

a. 0-10 V dimming fixtures require additional conductors for lighting control.

3.02 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation.

1. Local Battery Lighting or Central Battery Inverter Supply: Verify transfer from normal power to battery and retransfer to normal. Test shall be 90 minutes on battery source only and shall maintain illumination. Replace units/batteries that fail testing.

B. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

C. Luminaire will be considered defective if it does not pass operation tests and inspections.

3.03 ADJUSTING

A. Adjust aimable luminaires in the presence of Architect.

END OF SECTION 265119

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SECTION 26 56 19 - LED EXTERIOR LIGHTING

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Exterior solid-state luminaires that are designed for and exclusively use LED technology.

2. Poles and accessories.

B. Related Sections:

1. Division 26 Section "Interior LED Lighting" for exterior luminaires normally mounted on exterior surfaces of buildings.

1.02 SUBMITTALS

A. Product Data: For each type of luminaire, pole, and support component, arranged in order of lighting unit designation Include data on features, accessories, finishes, and the following:

1. Physical description of luminaire, including materials, dimensions, effective projected area, and verification of indicated parameters.

2. Luminaire materials.

3. Projected lifetime (L70), output (lumens, CCT, and CRI), and efficacy.

4. Materials, dimensions, and finishes of poles.

B. Pole and Support Component Certificates: Signed by manufacturers of poles, certifying that products are designed for indicated load requirements in AASHTO LTS-4-M and that load imposed by luminaire and attachments has been included in design. The certification shall be based on design calculations by a professional engineer.

1.03 CLOSE-OUTS

A. Operation and maintenance data.

1.04 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

1.05 DEFINITIONS

A. CCT: Correlated color temperature.

B. CRI: Color rendering index.

C. Fixture: See "Luminaire."

D. IP: International Protection or Ingress Protection Rating

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting unit, including lamp, reflector, and housing.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Package aluminum poles for shipping according to ASTM B 660.

B. Store poles on decay-resistant-treated skids at least 12 inches above grade and vegetation. Support poles to prevent distortion and arrange to provide free air circulation.

C. Immediately remove all packing and shipping materials to prevent accelerated finish deterioration.

D. Handle poles with web fabric straps.

1.07 STRUCTURAL ANALYSIS CRITERIA FOR POLE SELECTION

A. Dead Load: Weight of luminaire and its horizontal and vertical supports, lowering devices, and supporting structure, applied as stated in AASHTO LTS-4-M.

B. Live Load: Single load of 500 lbf, distributed as stated in AASHTO LTS-4-M.

C. Ice Load: Load of 3 lbf/sq. ft., applied as stated in AASHTO LTS-4-M Ice Load Map.

D. Wind Load: Pressure of wind on pole and luminaire and banners and banner arms, calculated and applied as stated in AASHTO LTS-4-M.

1. Basic wind speed for calculating wind load for poles 50 feet high or less is 100 mph.

a. Wind Importance Factor: 1.3.

b. Minimum Design Life: 25 years.

c. Velocity Conversion Factors: 1.0.

1.08 EXTRA MATERIALS

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

1. Glass and Plastic Lenses, Covers, and Other Optical Parts: One for every 100 of each type and rating installed. Furnish at least one of each type.

1.09 FIELD CONDITIONS

A. Mark locations of exterior luminaires for approval by Architect prior to the start of luminaire installation.

1.10 WARRANTY

A. Warranty: Manufacturer and Installer agree to repair or replace components of luminaires that fail in materials or workmanship within specified warranty period.

1. Warranty Period: 2 year(s) from date of Substantial Completion.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.02 LED LUMINAIRE 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. UL Compliance: Comply with UL 1598 and listed for wet location.

C. In-line Fusing: Separate in-line fuse for each luminaire.

D. Fixture Rating: Fixture marked for outdoor use and in enclosed locations.

E. Comply with UL 1598 and UL 8750.

F. Each luminaire shall be rated for a minimum operational life (L70) of 70,000 hours as defined by IES LM-80 and TM-21.

G. Absolute photometrics shall be available for each luminaire based on IES LM-79.

H. Individual LEDS within the luminaire shall be connected such that loss or failure of a single LED will not result in the loss of the entire array.

I. LEDs shall have a minimum CRI of 70.

J. Luminaire Power Factor: 0.90 or higher.

K. Total Harmonic Distortion Rating: Less than 20 percent.

2.03 MATERIALS

A. Metal Parts: Free of burrs and sharp corners and edges.

B. Doors, Frames, and Other Internal Access: Smooth operating, free of light leakage under operating conditions, and designed to permit re-lamping without use of tools. Designed to prevent doors, frames, lenses, diffusers, and other components from falling accidentally during re-lamping and when secured in operating position. Doors shall be removable for cleaning or replacing lenses.

C. Diffusers and Globes:

1. Acrylic Diffusers: 100 percent virgin acrylic plastic, with high resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

2. Glass: Annealed crystal glass unless otherwise indicated.

3. Lens Thickness: At least 0.125 inch minimum unless otherwise indicated.

D. Lens and Refractor Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

E. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.

2. Specular Surfaces: 83 percent.

3. Diffusing Specular Surfaces: 75 percent.

F. Housings:

1. Rigidly formed, weather- and light-tight enclosure that will not warp, sag, or deform in use.

2. Provide filter/breather for enclosed luminaires.

2.04 FINISHES

A. Variations in Finishes: Noticeable variations in same piece are unacceptable. Variations in appearance of adjoining components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

B. Luminaire Finish: Manufacturer`s standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

C. Comply with NAAMM`s "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

2.05 LUMINAIRE SUPPORT COMPONENTS

A. Comply with requirements in Division 26 Section "Hangers and Supports for Electrical" for channel and angle iron supports and nonmetallic channel and angle supports.

2.06 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady wind speeds of 110 mph.

2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers` mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.

2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.

3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches, with cover secured by stainless-steel captive screws. Provide on all, except wood poles.

E. Finish: Manufacturer's standard paint applied over primer or over galvanization before shipping.

F. Vibration Damper: Provide manufacturer's vibration damper on all square poles unless otherwise indicated.

G. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified in Division 03 Section "Cast-in-Place Concrete."

2.07 POLE ACCESSORIES

A. Duplex Receptacle: 120 V, 20 A in a weatherproof assembly complying with Division 26 Section "Wiring Devices" for ground-fault circuit-interrupter type.

1. Recessed, verify mounting height above finished grade.

2. Cast metal, weatherproof in use, cover, Insert color to match pole that when mounted results in NEMA 250, Type 3R enclosure.

3. With cord opening.

4. With lockable hasp and latch that complies with OSHA lockout and tag-out requirements.

B. Base Covers: Manufacturers` standard metal units, arranged to cover pole`s mounting bolts and nuts. Finish same as pole.

PART 3 -EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Comply with NECA 1.

B. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Fasten luminaire to structural support.

D. Supports:

1. Sized and rated for luminaire weight.

2. Able to maintain luminaire position after cleaning and re-lamping.

3. Support luminaires without causing deflection of finished surface.

4. Luminaire-mounting devices shall be capable of supporting a horizontal force of 100 percent of luminaire weight and a vertical force of 400 percent of luminaire weight.

E. Wiring Method: Install cables in raceways. Conceal raceways and cables.

F. Install luminaires level, plumb, and square with finished grade unless otherwise indicated.

G. Coordinate layout and installation of luminaires with other construction.

H. Adjust luminaires that require field adjustment or aiming.

I. Comply with requirements in Division 26 Sections "Conductors and Cables for Electrical" and "Raceways and Boxes for Electrical" for wiring connections and wiring methods.

3.02 INSTALLATION OF INDIVIDUAL GROUND-MOUNTED LUMINAIRES

A. Aim as indicated on Drawings.

B. Install on concrete base with top 4 inches above finished grade or surface at luminaire location. Cast conduit into base, and finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Division 03 Section "Cast-in-Place Concrete."

3.03 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches.

2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet.

3. Trees: 15 feet from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Division 03 Section "Cast-in-Place Concrete."

D. Foundation-Mounted Poles: Mount pole with leveling nuts and tighten top nuts to torque level recommended by pole manufacturer.

1. Use anchor bolts and nuts selected to resist seismic forces defined for the application and approved by manufacturer.

2. Grout void between pole base and foundation. Use nonshrink or expanding concrete grout firmly packed to fill space.

3. Install base covers unless otherwise indicated.

4. Use a short piece of 1/2-inch-diameter pipe to make a drain hole through grout. Arrange to drain condensation from interior of pole.

E. Raise and set poles using web fabric slings (not chain or cable).

3.04 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 4 inches above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth.

3.05 CORROSION PREVENTION

A. Aluminum: Do not use in contact with earth or concrete. When in direct contact with a dissimilar metal, protect aluminum by insulating fittings or treatment.

B. Steel Conduits: Comply with Division 26 Section "Raceways and Boxes for Electrical." In concrete foundations, wrap conduit with 0.010-inch-thick, pipe-wrapping plastic tape applied with a 50 percent overlap.

3.06 GROUNDING

A. Ground metal poles and support structures according to Division 26 Section "Grounding and Bonding for Electrical."

1. Install grounding electrode for each pole unless otherwise indicated.

2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

3.07 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

3.08 FIELD QUALITY CONTROL

A. Inspect each installed luminaire for damage. Replace damaged luminaires and components.

B. Perform the following tests and inspections:

1. Operational Test: After installing luminaires, switches, and accessories, and after electrical circuitry has been energized, test units to confirm proper operation.

C. Luminaire will be considered defective if it does not pass tests and inspections.

D. Illumination Observations: Verify normal operation of lighting units after installing luminaires and energizing circuits with normal power source.

END OF SECTION 265619

SECTION 27 00 00 - GENERAL COMMUNICATION REQUIREMENTS

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 00 00 for requirements.

END OF SECTION 270000

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SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 05 00 for requirements.

END OF SECTION 270500

SECTION 27 05 26 - GROUNDING AND BONDING FOR COMMUNICATIONS

PART 1 - GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 05 26 for requirements.

END OF SECTION 270526

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SECTION 27 05 29 - HANGERS AND SUPPORTS FOR COMMUNICATIONS

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 05 29 for requirements.

END OF SECTION 270529

SECTION 27 05 33 - RACEWAYS AND BOXES FOR COMMUNICATIONS

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 05 33 for requirements.

END OF SECTION 270533

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SECTION 27 05 53 - COMMUNICATIONS IDENTIFICATION

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 05 53 for requirements.

END OF SECTION 270553

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SECTION 28 00 00 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 00 00 for requirements.

END OF SECTION 280000

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SECTION 28 05 00 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 05 00 for requirements.

END OF SECTION 280500

SECTION 28 05 19 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 05 19 for requirements.

END OF SECTION 280519

SECTION 28 05 26 - GROUNDING AND BONDING FOR ELECTRONIC SAFETY AND SECURITY

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 05 26 for requirements.

END OF SECTION 280526

SECTION 28 05 29 - HANGERS AND SUPPORTS FOR ELECTRONIC SAFETY AND SECURITY

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 05 29 for requirements.

END OF SECTION 280529

SECTION 28 05 33 - RACEWAYS AND BOXES FOR ELECTRONIC SAFETY AND SECURITY

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 05 33 for requirements.

END OF SECTION 280533

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SECTION 28 05 53 - ELECTRONIC SAFETY AND SECURITY IDENTIFICATION

PART 1 -GENERAL

1.01 RELATED DOCUMENTS

A. Refer to Section 26 05 53 for requirements.

END OF SECTION 280553

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SECTION 28 46 21 - DIGITAL, ADDRESSABLE, FIRE-ALARM SYSTEM

PART 1 -GENERAL

1.01 SUMMARY

A. Section Includes:

1. Fire alarm control panel.
2. Manual pull stations.
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Magnetic door holders.
7. Remote annunciator.
8. Addressable interface device.
9. Digital alarm communicator transmitter.

1.02 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

1.03 SYSTEM DESCRIPTION

A. Noncoded, UL-certified addressable system, with automatic sensitivity control of smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

B. Source Limitations for Fire-Alarm System and Components: Provide system manufacturer’s certification that all components provided have been tested as and will operate as a system.

C. Each duct smoke detector installed concealed in a shaft or above ceiling shall be provided with remote alarm indicator/key-operated test switch.

D. UL-certified addressable system, with multiplexed signal transmission and voice/strobe evacuation.

E. Automatic sensitivity control of certain smoke detectors.

F. All components provided shall be listed for use with the selected system.

G. Electrical components, Devices, and Accessories: listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.04 SUBMITTALS

A. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect. Submittal of product data and shop drawings to Architect shall be provided together and shall show evidence of review by authorities having jurisdiction.

2. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire-alarm system design.

b. NICET-certified fire-alarm technician, Level III minimum.

c. Licensed or certified by authorities having jurisdiction.

B. Bill of Materials: Complete list of all parts needed to fully install selected system components.

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

1. Include construction details, material descriptions, dimensions, profiles, and finishes.

2. Include rated capacitates, operating characteristic, and electrical characteristics.

D. Shop Drawings: For fire-alarm system. Include plans and details.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72.

2. Include plans, elevations, sections, details, and attachments to other work.

3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.

4. Detail assembly and support requirements.

5. Include voltage drop calculations for notification appliance circuits.

6. Include battery-size calculations.

7. Include input/output matrix.

8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this specification and in NFPA 72.

9. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

E. Delegated-Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria; Including analysis data signed and sealed by the qualified fire alarm designer responsible for their preparation.

1. Drawings showing the location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the device.

2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.

3. Indicate audible appliances required to produce square wave signal per NFPA 72.

1.05 CLOSE-OUTS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Comply with the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

2. Provide "Record of Completion Documents" according to NFPA 72 article "Permanent Records" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter.

3. Complete wiring diagrams showing connections between all devices and equipment. Each conductor shall be numbered at every junction point with indication of origination and termination points.

4. Riser diagram.

5. Device addresses.

6. Air-sampling system sample port locations and modeling program report showing layout meets performance criteria.

7. Record copy of site-specific software.

8. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

a. Frequency of testing of installed components.

b. Frequency of inspection of installed components.

c. Requirements and recommendations related to results of maintenance.

d. Manufacturer`s user training manuals.

9. Manufacturer`s required maintenance related to system warranty requirements.

10. Abbreviated operating instructions for mounting at fire alarm control panel.

B. Field quality-control reports.

1.06 QUALITY ASSURANCE

A. Installer Qualifications: Personnel shall be trained and certified by manufacturer for installation of units required for this Project, and shall be directly supervised by a NICET Level III technician.

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. NFPA Certification: Obtain certification according to NFPA 72 by a UL-listed alarm company.

PART 2 -PRODUCTS

2.01 MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. NOTIFIER; a Honeywell company.

2.02 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire alarm system shall report to the Novant Health Corporate Monitoring Location. Coordinate requirements with Novant Health.

B. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.

2. Smoke detectors (verified automatic alarm operation).

3. Duct smoke detectors.

4. Automatic sprinkler system water flow.

5. Chemical or dry fire-suppression system operation.

C. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.

2. Identify alarm at fire alarm control panel and remote annunciators.

3. Transmit an alarm signal to the remote alarm receiving station.

4. Unlock electric door locks in designated egress paths.

5. Release fire and smoke doors held open by magnetic door holders.

6. Close smoke dampers in air ducts of air-conditioning duct systems and shutdown associated fans.

7. Record events in the system memory.

D. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.

2. Low-air-pressure switch of a chemical or dry fire suppression system.

3. User disabling of zones or individual devices.

E. System trouble signal initiation shall be by one or more of the following devices and actions:

1. Open circuits, shorts, and grounds in designated circuits.

2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.

3. Loss of communication with any addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.

4. Loss of primary power at fire alarm control panel and remote panels.

5. Ground or a single break in fire alarm control panel and remote panel internal circuits.

6. Abnormal ac voltage at fire alarm control panel and remote panels.

7. Break in standby battery circuitry.

8. Failure of battery charging.

9. Abnormal position of any switch at fire alarm control panel or annunciator.

10. Low-air-pressure switch operation on a dry-pipe or preaction sprinkler system.

11. Emergency Generator: Individually addressed trouble alarm for each of the following:

    a. Generator running.

    b. Generator fault.

    c. Generator switch in non-automatic position.

    d. Generator low fuel.

12. Opening of building rapid entry key boxes (Knox-Box).

F. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire alarm control panel and remote annunciators. Record the event in system memory log.

G. Equipment: Provide fire alarm equipment, devices, conductors, connections, etc. to achieve the above functions. Where monitoring and control points are located on equipment furnished by others, the fire alarm system shall extend to those equipment locations.

2.03 FIRE ALARM CONTROL PANEL

A. General Requirements for Fire alarm control panel:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.

    a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.

    b. Include a real-time clock for time annotation of events on the event recorder

    c. Provide communication between the FACP and remote circuit interface panels, annunciators, and displays.

d. The FACP shall be listed for connection to a central-station signaling system service.

e. Provide nonvolatile memory system database, logic, and operating system and event history. The system shall require no manual input to initialize in the event of a complete power down condition. The FACP shall provide a minimum 500-eveny history log.

2. Addressable initiation devices that communicate device identity and status.

a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire alarm control panel.

b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.

3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire alarm control panel and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 80 characters, minimum.

2. Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into the system for control of smoke-detector sensitivity and other parameters.

C. Initiating Device, Notification Appliance, and Signaling Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.

2. Pathway Survivability: Level 1.

3. Limit the quantity of installed addressable devices to 80 percent of the signaling line circuit capacity.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire alarm control panel.

2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire alarm control panel and detector.

3. Record events in system memory log.

4. Sound general alarm if the alarm is verified.

5. Cancel fire alarm control panel indication and system reset if the alarm is not verified.

E. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.

2. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.

F. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke barrier walls shall be connected to fire-alarm system.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

H. Primary Power: 24-V dc obtained from 120-V ac service and a power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, supervisory signals and digital alarm communicator transmitters shall be powered by 24-V dc source.

1. Alarm current draw of entire fire-alarm system shall not exceed 80 percent of the power-supply module rating.

I. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed, valve-regulated, recombinant lead acid.

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

K. Fire Alarm Document Storage: Provide document storage cabinet adjacent to fire alarm control panel. Label as “Fire Alarm Document Storage”. Cabinet enclosure shall be constructed similar to fire alarm control panel with similar finish, mounting, and secure key access.

2.04 MANUAL PULL STATIONS

A. General Requirements for Manual Pull Stations: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. Where device cannot be flush mounted, provide manufacturer`s surface back box.

1. Single-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire alarm control panel.

2. Station Reset: Key- or wrench-operated switch.

2.05 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire alarm control panel.

3. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

4. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

5. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

6. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire alarm control panel for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire alarm control panel.

   a. Rate-of-rise temperature characteristic shall be selectable at fire alarm control panel for 15 or 20 deg F per minute.

   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire alarm control panel to operate at 135 or 155 deg F.

   c. Provide multiple levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire alarm control panel and shall be able to identify the detector`s location within the system and its sensitivity setting.

2. An operator at fire alarm control panel, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.

   b. Device type.

   c. Present average value.

   d. Present sensitivity selected.

   e. Sensor range (normal, dirty, etc.).

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

1. Detector address shall be accessible from fire alarm control panel and shall be able to identify the detector`s location within the system and its sensitivity setting.

2. An operator at fire alarm control panel, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.

   b. Device type.

   c. Present average value.

   d. Present sensitivity selected.

   e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector.

4. Each sensor shall have multiple levels of detection sensitivity.

5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.

6. Relay Fan Shutdown: Rated to interrupt fan motor-control circuit. Interconnect to shutdown associated fan.

2.06 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned as required, equipped for mounting as specified and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated and with screw terminals for system connections.

2. Device Color: Factory finished, red.

B. Horns:

1. Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille.

2. Horns shall comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet from the horn, using the coded signal prescribed in UL 464 test protocol.

3. Mounting: Per plans.

4. Face Plate Label: The word “FIRE” is engraved in minimum 1-inch-high letters on the device.

C. Strobes:

1. LED strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate.

2. Rated Light Output:

a. 15/30/75/110 cd, selectable in the field. Set to required values identified on shop drawings.

3. Mounting: Per plans.

4. Face Plate Label: The word “FIRE” is engraved in minimum 1-inch-high letters on the device.

5. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.

6. Flashing shall be in a temporal pattern, synchronized with other units.

7. Strobe Leads: Factory connected to screw terminals.

2.07 MAGNETIC DOOR HOLDERS

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

1. Electromagnet: Requires no more than 3 W to develop 25-lbf holding force.

2. Wall-Mounted Units: Flush mounted unless otherwise indicated.

3. Rating: 24-V ac or dc.

4. Rating: 120-V ac.

B. Material and Finish: Match door hardware.

2.08 REMOTE ANNUNCIATOR

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

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

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

C. Location:

1. Main Entry

2.09 ADDRESSABLE INTERFACE DEVICE

A. General:

1. Include address-setting means on the module.

2. Store an internal identifying code for control panel use to identify the module type.

3. Listed for controlling HVAC fan motor controllers.

B. Monitor Module: Microelectronic module providing a system address for alarm-initiating devices for wire applications with normally open contacts.

C. Integral Relay: capable of providing a direct signal to elevator controller to initiate elevator recall and to circuit-breaker shunt trip for power shutdown.

1. Allow the control panel to switch the relay contacts on command.

2. Have a minimum of two normally open and two normally closed contacts available for field wiring.

D. Control Module:

1. Operate notification devices.

2. Operate solenoids for use in sprinkler service.

2.10 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 864 and be listed and labeled by an NRTL.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire alarm control panel and automatically capture one telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.

2. Programming device.

3. LED display.

4. Manual test report function and manual transmission clear indication.

5. Communications failure with the central station or fire alarm control panel.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.

2. Address of the supervisory signal.

3. Address of the trouble-initiating device.

4. Loss of ac supply or loss of power.

5. Low battery.

6. Abnormal test signal.

7. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger unless served from the fire alarm control panel.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

2.11 FIRE ALARM WIRE AND CABLE

A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:

1. Comtran Corp.

2. Draka USA.

3. Genesis Cable Products; Honeywell International, Inc.

4. Rockbestos-Suprenany Cable Corporation.

5. West Penn Wire/CDT; a division of Cable Design Technologies.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, not less than size as recommended by system manufacturer:

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited-fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No 16. AWG, minimum.

2. Line-Voltage Circuits: No. 12 AWG, minimum.

PART 3 -EXECUTION

3.01 EQUIPMENT INSTALLATION

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

1. Devices placed in service before all other trades have completed cleanup shall be replaced.

2. Devices installed but not yet placed in service shall be protected from construction dust, debris, dirt, moisture, and damage according to manufacturer’s written storage instructions.

B. Install wall-mounted equipment, with tops of cabinets not more than 72 inches above the finished floor.

C. Smoke- or Heat-Detector Spacing:

1. Comply with NFPA 72, "Smoke-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for smoke-detector spacing.

2. Comply with NFPA 72, "Heat-Sensing Fire Detectors" Section in the "Initiating Devices" Chapter, for heat-detector spacing.

3. Smooth ceiling spacing shall not exceed 30 feet.

4. Spacing of detectors for irregular areas, for irregular ceiling construction and for high ceiling areas shall be determined according to Annex A in NFPA 72.

5. HVAC: Locate detectors not closer than 3 feet from air-supply diffuser or return-air opening.

D. Install a cover on each smoke detector that is not placed in service during construction. Cover shall remain in place except during system testing. Remove cover prior to system turnover.

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

1. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.

F. Duct Smoke Detectors and HVAC Shutdown/Closure:

1. Fans: Provide duct smoke detectors at supply and return ducts of HVAC fans in excess of 2000 cfm. Provide with individual addressable control module at motor controller/starter and connect to shutdown fan.

2. Return Risers: Provide duct smoke detector on each floor at connections to common air return risers of HVAC fans in excess of 15,000 cfm. Detection shall shutdown fan.

3. Smoke Dampers: Provide duct smoke detector within 5 feet of each smoke damper or combination fire/smoke damper. Include remote status indicator and test station for detector. Circuit smoke dampers to 20A, 120V life safety branch circuits in local life safety branch panel of the associated construction phase (install circuit breaker lock on branch breaks). Provide individual circuits for each air handling unit zone. Refer to mechanical plans for associated zones. Control each damper individually with addressable control modules from fire alarm system.

G. Manual Pull Stations: Install manual fire-alarm box in the normal path of egress within 60 inches of the exit doorway. Mount manual fire-alarm box on a background of contrasting color. The operable part of manual fire-alarm box shall be between 42 inches and 48 inches above floor level. All devices shall be mounted at the same height unless otherwise indicated.

H. Remote Status Indicators and Test Switch: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position or not readily accessible.

I. Smoke Detection at Fire Alarm Control Panel: Provide smoke detector within 5 feet of fire alarm control panel.

J. Smoke Detector Protection: Avoid installing detection heads until final cleanup of all trades is complete. If this is unavoidable, protect detectors and provide cleaning prior to final fire alarm testing.

K. Audible Alarm-Indicating Devices: Install not less than 6 inches below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

L. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches below the ceiling. Install all devices at the same height unless otherwise indicated.

M. Device Location-Indicating Lights: Locate in public space near the device they monitor.

N. Annunciator: Install with top of panel not more than 72 inches above the finished floor.

O. Each duct smoke detector installed concealed in a shaft or above ceiling shall be provided with remote alarm indicator/key-operated test switch.

3.02 FIRE ALARM WIRING INSTALLATION

A. Comply with requirements in Division 26. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install cables in metal conduit throughout. Comply with additional pathway survivability requirements of NFPA 72 for the application.

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.

2. All cabling shall be installed in EMT conduit, minimum size 3/4”. A junction box and flexible conduit drop shall be provided at each ceiling smoke detector or speaker. Provide red colored low voltage signal cable.

3. Signaling Line Circuits: Power-limited fire alarm cables may be installed in the same cable or raceway as signaling line circuits. All signal cable shall be red.

4. Conceal conduit and wiring except in unfinished spaces.

C. Cable terminations shall consist of no more than two wires per terminal point.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system’s wiring diagrams. Make al connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks of plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different colors for visible alarm indicating devices. Paint fire alarm system junction boxes and covers red.

G. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.03 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Division 08 Section "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are NRTL listed for use with fire-alarm system in this Section before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of air-conditioning duct systems.

2. Magnetically held-open doors.

3. Electrically locked doors and access gates.

4. Alarm-initiating connection to automatic sprinkler system water flow alarm devices.

5. Supervisory connections at valve supervisory switches.

6. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.

7. Data communication circuits for connection to building management system.

8. Supervisory connections at fire-extinguisher locations.

C. Provide two analog voice line connections of digital alarm communication transmitter to building voice service demarcation point for central station monitoring.

D. Fire Sprinkler Alarm Devices: Coordinate exact quantity and location with Fire Sprinkler Contractor.

E. Selective Shutdown: Fire alarm shutdown/closure sequences shall be isolated to only initiate shutdown/closure for components directly associated with the specific location/zone/area where fire/smoke has been detected. Where allowed by code, and not in conflict with smoke control sequences, shutdown/closure shall not be initiated in adjacent locations/zones/areas until fire/smoke has been detected there.

F. Line Voltage Source Connections: Provide dedicated 120 volt line voltage branch circuit and connection to each fire alarm equipment item or device requiring a line voltage source. In buildings with an emergency generator, branch circuit shall be served from a life safety branch source. Serve from new circuit breaker in nearest available panel.

3.04 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Division 26 Section "Electrical Identification."

B. Install framed instructions in a location visible from fire alarm control panel.

C. Provide breaker locks on circuit breakers within source panels serving fire alarm equipment. Include red marking and label as “Fire Alarm Circuit”.

D. Provide address labeling on all devices that are addressable. Match facility colors.

3.05 GROUNDING

A. Ground fire alarm control panel and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.06 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. 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.

C. Tests and Inspections:

1. Visual Inspection: Conduct visual inspection prior to testing.

a. Inspection shall be based on completed Record Drawings and system documentation that is required by NFPA 72 in its "Completion Documents, Preparation" Table in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter.

b. Comply with "Visual Inspection Frequencies" Table in the "Inspection" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72; retain the "Initial/Reacceptance" column and list only the installed components.

2. System Testing: Comply with "Test Methods" Table in the "Testing" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

3. Factory-authorized service representative shall prepare the "Fire Alarm System Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire Alarm Systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

D. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

E. Fire-alarm system will be considered defective if it does not pass tests and inspections.

F. Test and Inspection Report:

1. Perform test/inspections and submit report prior to Engineer’s final punch inspection.

2. Report shall consist of any developed test result data and shall, at minimum, include a copy of this “Field Quality Control” Section of the specification to illustrate Contractor acknowledgement of tests and inspections.

a. Contractor shall indicate successful completion by initialing individual test and inspection requirements listed above on the copy. Initialing indicates that tests and inspections were performed for specified work with a successful outcome. Work not found to be in compliance was corrected and retested/reinspected successfully or has been specifically clarified and noted above by the Contractor.

b. Acknowledgement of Tests and Inspections:

c. “Tests and inspections have been successfully completed as specified, or have been clarified/noted above.
   1) Representative Company Name: _____
   2) Representative Personnel Name: _____
   3) Representative Personnel Signature: _____
   4) Date of Report: _____”

3.07 DEMONSTRATION

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

END OF SECTION 284621

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SECTION 31 31 16 - TERMITE CONTROL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes soil treatment with termiticide.

1.3 SUBMITTALS

A. Product Data: For each type of product indicated. Include the EPA-Registered Label for termiticide products.

B. Product certificates.

C. Soil Treatment Application Report: Include the following:

1. Date and time of application.
2. Moisture content of soil before application.
3. Termiticide brand name and manufacturer.
4. Quantity of undiluted termiticide used.
5. Dilutions, methods, volumes used, and rates of application.
6. Areas of application.
7. Water source for application.

D. Warranties: Sample of special warranties.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: A specialist who is licensed according to regulations of authorities having jurisdiction to apply termite control treatment and products in jurisdiction where Project is located and who employs workers trained and approved by manufacturer to install manufacturer's products.

B. Regulatory Requirements: Formulate and apply termiticides and termiticide devices according to the EPA-Registered Label.

1.5 PROJECT CONDITIONS

A. Environmental Limitations: To ensure penetration, do not treat soil that is water saturated or frozen. Do not treat soil while precipitation is occurring. Comply with requirements of the EPA-Registered Label and requirements of authorities having jurisdiction.

B. Coordinate soil treatment application with excavating, filling, grading, and concreting operations. Treat soil under footings, grade beams, and ground-supported slabs before construction.

1.6 WARRANTY

A. Soil Treatment Special Warranty: Manufacturer's standard form, signed by Applicator and Contractor, certifying that termite control work, consisting of applied soil termiticide treatment, will prevent infestation of subterranean termites. If subterranean termite activity or damage is discovered during warranty period, re-treat soil and repair or replace damage caused by termite infestation.

1. Warranty Period: Five years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SOIL TREATMENT

A. Termiticide: Provide an EPA-Registered termiticide, complying with requirements of authorities having jurisdiction, in an aqueous solution formulated to prevent termite infestation. Provide quantity required for application at the label volume and rate for the maximum termiticide concentration allowed for each specific use, according to product's EPA-Registered Label.

1. Products: Subject to compliance with requirements, provide one of the following:

a. BASF Corporation, Agricultural Products; Termidor.
b. Bayer Environmental Science; Premise 75.
c. FMC Corporation, Agricultural Products Group; Dragnet FT.
d. Syngenta; Demon TC.

2. Service Life of Treatment: Soil treatment termiticide that is effective for not less than five years against infestation of subterranean termites.

PART 3 - EXECUTION

3.1 APPLICATION, GENERAL

A. General: Comply with the most stringent requirements of authorities having jurisdiction and with manufacturer's EPA-Registered Label for products.

3.2 APPLYING SOIL TREATMENT

A. Examine substrates, areas, and conditions, with Applicator present, for compliance with requirements for interfaces with earthwork, slab and foundation work, landscaping, utility installation, and other conditions affecting performance of termite control.

B. Proceed with application only after unsatisfactory conditions have been corrected.

C. Soil Treatment Preparation: Remove foreign matter and impermeable soil materials that could decrease treatment effectiveness on areas to be treated. Loosen, rake, and level soil to be treated except previously compacted areas under slabs and footings. Termiticides may be applied before placing compacted fill under slabs if recommended in writing by termiticide manufacturer.

1. Fit filling hose connected to water source at the site with a backflow preventer, complying with requirements of authorities having jurisdiction.

D. Application: Mix soil treatment termiticide solution to a uniform consistency. Provide quantity required for application at the label volume and rate for the maximum specified concentration of termiticide, according to manufacturer's EPA-Registered Label, to the following so that a continuous horizontal and vertical termiticidal barrier or treated zone is established around and under building construction. Distribute treatment evenly.

1. Slabs-on-Grade and Basement Slabs: Under ground-supported slab construction, including footings, building slabs, and attached slabs as an overall treatment. Treat soil materials before concrete footings and slabs are placed.
2. Masonry: Treat voids.
3. Penetrations: At expansion joints, control joints, and areas where slabs will be penetrated.

E. Avoid disturbance of treated soil after application. Keep off treated areas until completely dry.

F. Protect termiticide solution, dispersed in treated soils and fills, from being diluted until ground-supported slabs are installed. Use waterproof barrier according to EPA-Registered Label instructions.

G. Post warning signs in areas of application.

H. Reapply soil treatment solution to areas disturbed by subsequent excavation, grading, landscaping, or other construction activities following application.

END OF SECTION 31 31 16

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