PROJECT MANUAL
FOR
NOYES LIBRARY FOR YOUNG CHILDREN REHABILITATION AND RENOVATION
10237 CARROLL PLACE
KENSINGTON
Montgomery County, Maryland

RFP No. 1169193

Volume 2 of 2
Bidding and Contracting Requirements and Division 21 through Division 32

Owner/Manager:
Division of Building Design & Construction
Department of General Services
110 Monroe Street
Rockville, Maryland 20850

Tenant/User Agency
Montgomery County Public Libraries

Architect of Record: Wiedemann Architects, LLC
Consulting Architect: Grimm + Parker
Civil Engineer: Adtek Engineers, Inc.
Structural Engineer: Columbia Engineering, Inc.
MEP Engineer: Gipe Associates, Inc.

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SECTION 21 05 00
COMMON WORK RESULTS FOR FIRE SUPPRESSION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

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

1.3 REFERENCES:

A. ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

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

C. ASME B16.21.

D. ASME B18.2.1.

E. ASTM A 53

F. ASTM B 32

G. ASTM B 813.

H. ASTM C 1107

I. AWS D1.1, "Structural Welding Code--Steel."

J. AWWA C110.

1.4 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Mechanical sleeve seals.

2. Escutcheons.

B. Welding certificates.

1.6 QUALITY ASSURANCE

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

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

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

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

1.7 DELIVERY, STORAGE, AND HANDLING

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

1.8 COORDINATION

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

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

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPE, TUBE, AND FITTINGS

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

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

2.3 JOINING MATERIALS

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

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

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

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

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

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

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

2.4 MECHANICAL SLEEVE SEALS

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

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

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

3. Pressure Plates: Carbon steel. 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.

2.5 SLEEVES

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

B. 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.

2.6 ESCUTCHEONS

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

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

C. Plastic Escutcheons plates will not be accepted.

2.7 GROUT

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

1. Characteristics: Post-hardening, volume-adjusting, nonstaining, noncorrosive, nongaseous, and recommended for interior and exterior applications.

2. Design Mix: 5000-psi, 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

A. Install piping according to the following requirements and Division 21 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, and other design considerations. Install piping as indicated unless deviations to layout are approved on Coordination Drawings.

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

D. Install piping right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

c. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

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

N. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

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

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors of mechanical equipment areas or other wet areas 2-inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are large enough to provide 1/4-inch annular clear space between sleeve and pipe or pipe insulation. Use the following sleeve materials:

a. Steel Pipe Sleeves: For pipes smaller than 6-inch.

b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2-inches above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing.

1) Seal space outside of sleeve fittings with grout.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

P. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials.

Q. Verify final equipment locations for roughing-in.

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

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 21 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. Threaded Joints: Thread pipe with tapered pipe threads according to ASME B1.20.1 for piping 2-1/2” and less. 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.

E. Mechanical Joints: Use for piping 3” and larger.

3.3 PAINTING

A. Painting of fire-suppression systems, equipment, and components is specified in Division 09.

B. Damage and Touchup: Repair marred and damaged factory-painted finishes with materials and procedures to match original factory finish.

3.4 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 fire-suppression materials and equipment.

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

3.5 GROUTING

A. Mix and install grout for fire-suppression equipment base bearing surfaces, 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

SECTION 21 13 13
FIRE PROTECTION SPRINKLER SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Pipes, fittings, and specialties.
2. Fire-protection valves.
3. Fire-department connections.
4. Sprinklers.
5. Alarm devices.
6. Pressure gauges.

1.3 REFERENCES

A. ASME 16.1.

B. ASME B1.20.1.

C. ASME B16.5

D. ASME B16.9

E. ASME B31.9.

F. ASME B36.10M

G. ASTM A 135

H. ASTM A 234/A 234M.

I. ASTM A 795/A 795M

J. AWWA C606

K. NFPA 13

L. NFPA 291

M. NFPA 1963

N. UL 199

O. UL 213

P. UL 262

Q. UL 312

R. UL 346

S. UL 405

T. UL 464

U. UL 860.

V. UL 1091.

W. UL 1767

1.4 DEFINITIONS

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

1.5 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.

1.6 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.

1. Available fire-hydrant flow test records shall indicate the following conditions:

a. Date: Within one year of Contract.

b. Time:

c. Performed by:

d. Location of Residual Fire Hydrant R:

e. Location of Flow Fire Hydrant F:

f. Static Pressure at Residual Fire Hydrant R:

g. Measured Flow at Flow Fire Hydrant F:

h. Residual Pressure at Residual Fire Hydrant R:

C. Sprinkler system design shall be stamped and signed by a registered fire protection engineer and approved by local fire marshal.

1. 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.

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

3. Maximum Protection Area per Sprinkler:

a. Office Spaces: 120 sq. ft.

b. Storage Areas: 130 sq. ft.

c. Mechanical Equipment Rooms: 130 sq. ft.

d. Electrical Equipment Rooms: 130 sq. ft.

e. Other Areas: According to NFPA 13 recommendations unless otherwise indicated.

4. Total Combined Hose-Stream Demand Requirement: According to NFPA 13.

1.7 SUBMITTALS

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

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

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

D. Fire-hydrant flow test report approved by the authority having jurisdiction.

E. 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."

1.8 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 qualified professional engineer.

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

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

1.9 COORDINATION

A. Coordinate layout and installation of sprinklers with other construction that penetrates ceilings, including light fixtures, HVAC equipment, and partition assemblies. Coordination shall be in accordance with service and removal requirements for all other components in the system.

1.10 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

2.1 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.

2.2 STEEL PIPE AND FITTINGS

A. Schedule 40, Galvanized- and Black-Steel Pipe: ASTM A 135; ASTM A 795/A 795M, Type E; or ASME B36.10M, wrought steel; with wall thickness not less than Schedule 40. Pipe ends may be factory or field formed to match joining method.

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

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

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

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

F. Grooved-Joint, Steel-Pipe Appurtenances:

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

a. Anvil International, Inc.

b. Corcoran Piping System Co.

c. Tyco Fire & Building Products LP.

d. Victaulic Company.

2. Pressure Rating: 175 psig minimum.

3. 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.

2.3 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.

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 1-1/2-inch and Smaller: Bronze-body with threaded ends.

4. Valves 2-inch and 2-1/2-inch: Bronze-body with threaded ends or 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. Check 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; Jenkins Valves.
   c. Crane Co.; Crane Valve Group; Stockham Division.
   d. Fire-End & Croker Corporation.
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.

E. 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. Kennedy Valve; a division of McWane, Inc.
   c. Mueller Co.; Water Products Division.
   d. 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.

2.4 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.

2.5 FIRE-DEPARTMENT CONNECTIONS

A. Flush-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. GMR International Equipment Corporation.
   c. Guardian Fire Equipment, Inc.
   d. Potter Roemer.
2. Standard: UL 405.
3. Type: Flush, 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: Rectangular, brass, wall type.
9. Outlet: With pipe threads.
10. Body Style: Horizontal.
11. Number of Inlets: Two.
12. Outlet Location: Back.
13. Escutcheon Plate Marking: Similar to "AUTO SPKR."
14. Finish: Polished chrome plated.
15. Outlet Size: 4-inch.

2.6 SPRINKLERS

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

1. Reliable Automatic Sprinkler Co., Inc.
2. Tyco Fire & Building Products LP.
3. 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. 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.

3. Concealed Sprinkler heads.

D. Dry Sprinklers:

1. Sprinkler heads for areas subject to freezing small loading docks, small canopies, and similar spaces shall be Victaulic Model V36 dry sprinkler or approved equal. Dry sprinkler shall be standard or expose pendant type with matching escutcheon plate. Sprinkler and escutcheon plate shall be chrome plated. Frangible glass bulb shall be temperature rated for specific area hazard. Length of heads shall be as required to suit field conditions. Provide adjustable surface mounted escutcheon plate with each head. Provide flush ceiling plate. For small systems, per NFPA-13, glycol loops shall be acceptable at Contractor's option, subject to the approval of the authority having jurisdiction.

E. Attic Sprinklers:

1. Sprinkler heads for attic areas shall be Central Attic type or approved equal wet or dry sprinkler specifically listed for attic applications. Model and deflection type shall be as required to accommodate dual directional, single directional, back-to-back, and hip applications. Sprinklers and escutcheon shall be Natural Brass finish. Fusible links shall be temperature rated for specific application. Fast response glass bulb or fusible link shall be furnished.

F. Sprinkler Finishes:

1. Chrome plated.

G. 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.

H. 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. Viking Corporation.
2. Standard: UL 199.
3. Type: Wire cage with fastening device for attaching to sprinkler.

2.7 ALARM DEVICES

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

B. 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.

C. 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.

D. Pressure Switches:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Barksdale, Inc.
    b. Detroit Switch, Inc.
    c. Potter Electric Signal Company.
    d. System Sensor; a Honeywell company.
    e. Tyco Fire & Building Products LP.
    f. United Electric Controls Co.
    g. 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.

E. 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.

2.8 PRESSURE GAUGES

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 Gauge Range: 0 to 250 psig minimum.

E. Water System Piping Gauge: Include "WATER" label on dial face.

2.9 DRY PIPE VALVE AND AIR COMPRESSOR

A. UL 260; differential type; 300-psig (2070-kPa) working pressure; with ductile-iron grooved inlet and outlet, brass seat with Nitrile O-ring seals, and single-hinge pin and latch design. Include UL 1486, quick-opening devices, trim sets for air supply, drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment. Minimum required air pressure is 13 psi with Series 776 low pressure actuator with pneumatic activation. Valve internal components shall be replaceable without removing the valve from the installed position and shall be externally resettable. Victaulic FireLock NXT Series 768.
1. Option: Grooved-end connections for use with keyed couplings.
2. Air-Pressure Maintenance Devices: Automatic device to maintain correct air pressure in piping. Include shutoff valves to permit servicing without shutting down sprinkler piping, bypass valve for quick filling, pressure regulator or switch to maintain pressure, strainer, pressure ratings with 14- to 60-psig (95- to 410-kPa) adjustable range, and 175-psig (1200-kPa) maximum inlet pressure. Victaulic FireLock Series 757P.
3. Air Compressor: Tank type, electrical characteristics as indicated in Division 26.
4. Air Maintenance/Compressor Assembly: Consisting of a rise-mounting compressor, Series 757P air maintenance device and flexible hoses for installation. Assembly shall be designed to ensure the valve system can achieve operational air pressure within 30 minutes of discharge in accordance with NFPA-13 requirements. Where an accelerator is required, a tank-mounted compressor with a regulated air maintenance device should be used. Victaulic Series 7C7.

PART 3 EXECUTION

3.1 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. Flow Test Data indicated on the drawings is for information only unless acceptable to the authority having jurisdiction.

B. Report test results promptly and in writing.

3.2 SERVICE-ENTRANCE PIPING

A. Connect sprinkler piping to water-service piping for service entrance to building. Comply with requirements for exterior piping in Division 33 Section "Water Distribution System."

B. Install shutoff valve, pressure gauge, drain, and other accessories indicated at connection to water-service piping.

C. Install shutoff valve, check valve, pressure gage, and drain at connection to water service.

3.3 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. Install shutoff valve, pressure gauge, drain, and other accessories indicated at connection to water-distribution piping.

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

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

D. Install unions adjacent to each valve in pipes 2-inch and smaller.

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

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

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

H. 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.

I. Install alarm devices in piping systems.

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

K. Install pressure gauges on riser or feed main, at each sprinkler test connection, and where indicated. Include pressure gages with connection not less than 1/4-inch 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.

L. Fill sprinkler system piping with water.

M. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 21 Section "Common Work Results for Fire-Suppression Piping."

N. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 21 Section "Common Work Results for Fire-Suppression Piping."

O. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 21 Section "Common Work Results for Fire-Suppression Piping."

3.5 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 2-inch and smaller.

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

3.6 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. Deluge Valves: Install in vertical position, in proper direction of flow, and in main supply to deluge system. Install trim sets for drain, priming level, alarm connections, ball drip valves, pressure gages, priming chamber attachment, and fill-line attachment.

3.7 SPRINKLER INSTALLATION

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

B. Install dry-type sprinklers with water supply from heated space. Do not install pendent or sidewall, wet-type sprinklers in areas subject to freezing unless served by a dry system.

C. Install sprinklers into flexible, sprinkler hose fittings and install hose into bracket on ceiling grid.

3.8 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.

3.9 DRY PIPE SYSTEM

A. All non-heated areas or any location where water will freeze shall be protected throughout with a dry pipe sprinkler system.

B. System components shall include, but not be limited to flow control valves, electrical connection to central fire alarm system, dry pipe alarm valve, dry pipe air compressor, check valves, main piping, branch piping, inspectors test drains, dry pipe sprinkler heads, signs, relief valve, air maintenance device, automatic drain, accelerator, sensing line, pressure switch, flexible hose, etc., and all other incidental appurtenances as required.

3.10 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 "Identification for Electrical Systems."

3.11 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. Start and run excess-pressure pumps.

6. Coordinate with fire-alarm 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.

3.12 CLEANING

A. Clean dirt and debris from sprinklers.

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

3.13 PIPING SCHEDULE

A. Sprinkler specialty fittings may be used, downstream of control vales, instead of specified fittings.

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: Concealed sprinklers.
3. Wall Mounting: Sidewall sprinklers.
4. Atriom Water Curtain: Water Curtain type sprinklers.

3.15 COMMISSIONING

A. The fire suppression system shall be commissioned in accordance with the commission (Cx) Plan.

B. The fire protection contractors are responsible for supporting all commissioning activities and testing as outlined in the Cx Plan. These activities include but are not limited to the following:

1. Respond to all comments provided on the fire suppression system submittals by the commissioning agent (CxA).
2. Attend Cx related meetings as outlined in the Cx Plan.
3. Ensure the fire protection suppression system is operational in accordance with the contract drawings prior to start of functional performance testing (FPT).
4. Provide copies of the completed start up reports and pre-functional checklists to the CxA prior to the start of EPT.
5. Promptly rectify all issues related to the fire suppression system that are recorded in the Cx Issue Log. Submit written notification to the owner, CxA, and Engineer that this has been done. (Note: The CxA does not provide any directives so any deviation from original scope must be approved by the Owner or Engineer prior to performing work).

END OF SECTION

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SECTION 22 05 00
COMMON WORK RESULTS FOR PLUMBING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

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

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all mechanical work.

C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.

D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with "Submittals" specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.

E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

F. Coordinate the work under Division 22 with the work of all other construction trades.

G. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

1.3 DEFINITIONS

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

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

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

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

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

F. The following are industry abbreviations for plastic materials:

1. ABS: Acrylonitrile-butadiene-styrene plastic.
2. CPVC: Chlorinated polyvinyl chloride plastic.
3. PE: Polyethylene plastic.
4. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

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

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.
2. Dielectric fittings.
3. Mechanical sleeve seals.
4. Escutcheons.
5. Sleeves and all sealing/stopping materials.

B. Welding certificates.

1.5 QUALITY ASSURANCE

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

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

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

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

1.7 COORDINATION

A. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction, to allow for plumbing installations. Coordinate the work under Division 22 with work of all other construction trades. Conform to the requirements of all rules, regulations, and Codes of local, state, and Federal Authorities Having Jurisdiction.

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

C. Coordinate requirements for access panels and doors for plumbing items requiring access that are concealed behind finished surfaces.

1.8 PERMITS AND FEES

A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.

B. Permits and fees shall comply with the General Requirements of the specification.

1.9 EXAMINATION OF SITE:

A. Examine the site, determine all conditions and circumstances under which the work must be done, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor's failure to do so.

1.10 CONTRACTOR QUALIFICATION

A. Any Contractor or Subcontractor performing work under Division 22 shall be fully qualified and acceptable to the Architect. Submit the following evidence if requested.

1. A list of not less than five comparable projects that the Contractor completed.

2. Letter of reference from not less than three registered professional engineers, Contractors or building owners.

3. Local and/or State License, where required.

4. Membership trade or professional organizations where required.

B. A Contractor is any individual, partnership, or corporation, performing work by contract or subcontract on this project.

C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.11 MATERIALS AND EQUIPMENT

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality. This Contractor shall be responsible for connecting all utilities as shown on the drawings, to equipment identified as "under another Division”.

B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal only of other manufacturers who are indicated in this specification, subject to approval by the Engineer and the Owner. Alternate manufacturers or items other than the first-named shall be equal or better in quality and performance and must be suitable for available space, required arrangement, and application. Submit all data necessary to determine suitability of substituted items, for approval.

C. The suitability of named item only has been verified. Where more than one item is named, only the first named item has been verified as suitable. Alternate manufacturers/items are items

other than first named which shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement and application. Manufacturers not named are not acceptable and shall not be submitted.

D. Substitution will not be permitted for specified items of material or equipment where only one manufacturer is identified.

E. The Contractor shall only submit those manufacturers indicated in the specification. Proposed alternate manufacturers must be approved by the Owner and be included into the specifications by Addenda. Substitutions are for materials or manufacturers not listed in this specification. For each substitution proposed by the Contractor, the Contractor shall clearly indicate all differences from the specified item, change in Contract cost, benefit to the Owner and a brief description why the substitution is being proposed. Refer to the General Conditions for additional information. The Owner shall ultimately accept/reject all substitution requests. Refer to the General Conditions of this specification for additional information.

1.12 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA OR ASTM Standards for Fire Safety with Smoke and Fire Hazard Rating not exceeding flame spread of 25 and smoke developed of 50. All fire safe materials shall meet or exceed the requirements of the authority having jurisdiction.

1.13 REFERENCED STANDARDS, CODES AND SPECIFICATIONS:

A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.

AABC	-	Associated Air Balance Council
ABMA	-	American Boiler Manufacturers Association
ACCA	-	Air Conditioning Contractors of America
ACGIH	-	American Conference of Governmental Industrial Hygienist
ADC	-	Air Diffusion Council
AIHA	-	American Industrial Hygiene Association
AGA	-	American Gas Association
AMCA	-	Air Movement and Control Association
ANSI	-	American National Standards Institute
ARI	-	Air Conditioning and Refrigeration Institute
ASA	-	Acoustical Society of America
ASHRAE	-	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	-	American Society of Mechanical Engineers
ASTM	-	American Society for Testing and Materials
AWWA	-	American Water Works Association
CABO	-	Council of American Building Officials
CAGI	-	Compressed Air and Gas Institute
CS	-	Commercial Standard
CSA	-	Canadian Standards Association
CTI	-	Cooling Tower Institute

HEI - Heat Exchanger Institute

HI - Hydraulic Institute

HYDI - Hydronics Institute

IAPMO - International Association of Plumbing and Mechanical Officials

IBC - International Building Code

IBR - Institute of Boiler and Radiator Manufacturers

ICBO - International Conference of Building Officials

IEEE - Institute of Electrical and Electronics Engineers

IFCI - International Fire Code Institute

IMC - International Mechanical Code

IPC - International Plumbing Code

MSSP - Manufacturers Standards Society of the Valve and Fittings Industry

NEC - National Electrical Code

NEMA - National Electrical Manufacturers Association

NFPA - National Fire Protection Association

NSF International- National Sanitation Foundation

SMACNA - Sheet Metal and Air Conditioning Contractors National Association

TEMA - Tubular Exchanger Manufacturers Association

UL - Underwriters' Laboratories

B. All plumbing equipment and materials shall comply with the Codes and Standards listed in the latest ASHRAE Handbook.

C. Plumbing system shall be lead free and comply with Maryland House Bill 372, NSF/ANSI 61 compliant including Annex G and NSF/ANSI 372. Provide documentation on all submittals regarding compliance of this requirement for all applicable materials. Products shall be marked with both NSF/ANSI 61 and NSF/ANSI 372.

1.14 SUBMITTALS, REVIEW AND ACCEPTANCE:

A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Engineer to be in best interest of Owner.

B. With 30 calendar days after award of contract, submit a complete Material and Equipment List for approval. List all proposed materials and equipment, indicating proposed manufacturer, type, class, model and other general identifying information.

C. After acceptance of Material and Equipment List, submit complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project.

D. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals. Each piece of equipment and its associated components (e.g., relays, fuses, disconnects, etc.) shall be clearly identified.

E. Submittals will be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.

F. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs where applicable. Clearly indicate exact type, model number, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For items other than first-named, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action (or replacement with the specified item) while maintaining the specification requirements if differences have not been clearly indicated in the submittal.

G. Submit actual operating conditions or characteristics, including NC Levels, for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable.

H. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted.

1.15 SHOP DRAWINGS:

A. Prepare and submit shop drawings for all specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.

B. Submit data and shop drawings as listed below, in addition to provisions of Paragraph A above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number.

Items and Systems

Access Doors.

Backflow Preventer.

Backwater Valves.

Domestic Hot Water Heater.

Electric Water Coolers.

Expansion Tanks and Accessories.

Fire Stopping - Methods and Materials.

Floor & Roof Drains.

Flowmeters and Primary Elements. (Flow Fittings)

Wall Hydrants.

Identification System.

Mixing Valve/Temperature Limiting Devices.

Pipe Guides and Anchors.

Plumbing Fixtures & Trim.

Pressure Regulating Valve.

Pressure Reducing Valve.

Pressure Relief Valve.

Pumps, Circulators, Multi-Purpose Valves.

Sleeves.

Strainers.

Thermal Insulation Materials.

Thermometers and Gauges.

Trap Priming Station.

Valves - Globe, Angle, Check, Plug, Butterfly, and Ball types.

Vibration Isolation.

C. The Contractor, additionally, shall submit for approval any other shop drawings as required by the Architect. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Architect.

1.16 SUPERVISION AND COORDINATION:

A. Provide complete supervision, direction, scheduling, and coordination of all work under the Contract, including that of subcontractors.

B. Coordinate rough-in of all work and installation of sleeves, anchors, and supports for piping, and other work performed under Division 22.

C. Coordinate electrical work required under Division 22 with that under Division 26. Coordinate all work under Division 22 with work under all other Divisions.

1.17 CUTTING AND PATCHING:

A. Accomplish all cutting and patching necessary for the installation of work under Division 22. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, saw-cut or core drill only, and perform work in neat and workmanlike manner. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval.

1.18 PENETRATION OF WATERPROOF CONSTRUCTION:

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight.

B. Where plumbing vents or other pipes penetrate roofs, flash pipe with All American, Inc., or approved equal, roof flashing assemblies, with 4-pound lead, 6-inch skirt, lead cap, and caulked counterflashing sleeve.

C. Furnish and install pitch pockets where required.

D. Furnish and install roof drains, curbs, vent assemblies, and duct sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions, The National Roofing Contractors Association, SMACNA and as required by other divisions of this specification. The Contractor shall be responsible for sleeve sizes and locations.

1.19 VIBRATION ISOLATION

A. Furnish and install vibration isolators, flexible connections, supports, anchors, and/or foundations required to prevent transmission of vibration from equipment or piping to building structure.

1.20 ACCESSIBILITY

A. All equipment shall be installed in such a way that all components requiring access are so located and installed that they may be serviced, reset, replaced, recalibrated, etc., by service

technicians in accordance with the Manufacturer's recommendations. If any equipment or components are located in such a position that this Contractor cannot comply with the above, the Contractor shall notify the Engineer in writing before equipment is installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

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

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

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

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

2.3 JOINING MATERIALS

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

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

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

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

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

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

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

G. Solvent Cements for Joining Plastic Piping:

1. ABS Piping: ASTM D 2235.

2. CPVC Piping: ASTM F 493.

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

4. PVC to ABS Piping Transition: ASTM D 3138.

2.4 TRANSITION FITTINGS

A. AWWA Transition Couplings: Same size as, and with pressure rating at least equal to and with ends compatible with, piping to be joined.

1. Manufacturers:
    a. Cascade Waterworks Mfg. Co.
    b. Dresser Industries, Inc.; DMD Div.
    c. Ford Meter Box Company, Incorporated (The); Pipe Products Div.
    d. JCM Industries.
    e. Smith-Blair, Inc.
    f. Viking Johnson.
2. Underground Piping NPS 1-1/2 (DN 40) and Smaller: Manufactured fitting or coupling.
3. Underground Piping NPS 2 (DN 50) and Larger: AWWA C219, metal sleeve-type coupling.
4. Aboveground Pressure Piping: Pipe fitting.

B. Plastic-to-Metal Transition Fittings: PVC one-piece fitting with manufacturer's Schedule 80 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
    a. Eslon Thermoplastics.
    b. Charlotte Pipe.

C. Plastic-to-Metal Transition Adaptors: One-piece fitting with manufacturer's SDR 11 equivalent dimensions; one end with threaded brass insert, and one solvent-cement-joint end.
1. Manufacturers:
    a. Thompson Plastics, Inc.
    b. Charlotte Pipe**.**

D. Plastic-to-Metal Transition Unions: MSS SP-107, PVC four-part union. Include brass end, solvent-cement-joint end, rubber O-ring, and union nut.
1. Manufacturers:
    a. NIBCO INC.
    b. NIBCO, Inc.; Chemtrol Div.
    c. Charlotte Pipe**.**

E. Flexible Transition Couplings for Underground Non-pressure Drainage Piping: ASTM C 1173 with elastomeric sleeve, ends same size as piping to be joined, and corrosion-resistant metal band on each end.
1. Manufacturers:
    a. Cascade Waterworks Mfg. Co.
    b. Fernco, Inc.
    c. Mission Rubber Company.
    d. Plastic Oddities, Inc.

2.5 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: Dielectric unions are prohibited. Provide dielectric couplings or nipples in lieu of dielectric unions. Provide standard unions where required.

D. Dielectric Flanges: Factory-fabricated, companion-flange assembly, for 150- or 300-psig (1035- or 2070-kPa) minimum working pressure as required to suit system pressures.

1. Manufacturers:

a. Epco Sales, Inc.

b. Watts Industries, Inc.; Water Products Div.

c. Flowset.

E. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Manufacturers:

a. Calpico, Inc.

b. Lochinvar Corp.

F. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Manufacturers:

a. Perfection Corp.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Co., Inc.

d. Victaulic Co. of America.

2.6 MECHANICAL SLEEVE SEALS

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

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

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

3. Pressure Plates: Reinforced nylon polymer. Include two for each sealing element.

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

5. Wall Sleeve: Galvanized steel with 2-inch collar (water stop) continuously welded on both sides.

2.7 SLEEVES

A. Galvanized Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.

B. 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.

C. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

D. Provide a mock-up of every sleeve type, including sealing systems. Mock up shall be reviewed and accepted by the Construction Manager and authority having jurisdiction and left on site for inspector's reference.

2.8 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, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

C. One-Piece, Floor-Plate Type: Cast-iron floor plate.

D. Plastic Escutcheon plates will not be accepted.

2.9 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 (34.5-MPa), 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 PIPING SYSTEMS - COMMON REQUIREMENTS

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

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

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

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

N. Install sleeves for pipes passing through concrete and masonry walls, gypsum-board partitions, and concrete floor and roof slabs.

1. Cut sleeves to length for mounting flush with both surfaces.

a. Exception: Extend sleeves installed in floors 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.

2. Install sleeves in new walls and slabs as new walls and slabs are constructed.

3. Install sleeves that are two pipe sizes larger than pipe or pipe insulation.

a. Galvanized Steel Pipe Sleeves: For pipes through walls and floors except where noted through membrane waterproofing.

b. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 for flashing. Seal space outside of sleeve fittings with grout.

c. Provide galvanized steel sheet sleeves for interior stud partitions.

d. Provide galvanized steel wall sleeves with sleeve seal system for walls below grade and concrete slabs on grade. Select sleeve size to allow one-inch annular clear space between piping and sleeve for installing sleeve seal system. Select type, size and number of sealing elements required for piping material and size for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve system components and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a water-tight seal.

4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 for materials and installation.

O. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size two pipe sizes larger than pipe and sleeve for installing mechanical sleeve seals.

P. Underground, Exterior-Wall Pipe Penetrations: Install galvanized wall sleeves with water stop. Seal pipe penetrations using mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) 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.

Q. Fire-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07. Provide shop drawings indicating all materials and details associated with the UL listed assembly including the drawing detail stamped and signed by a registered Engineer by the manufacturer. Mock up shall be left on site for inspector's reference.

R. Verify final equipment locations for roughing-in.

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

3.2 PIPING JOINT CONSTRUCTION

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

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

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

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

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

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

1. Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

2. Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

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

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

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

1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.

2. ABS Piping: Join according to ASTM D 2235 and ASTM D 2661 Appendixes.

3. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.

4. PVC Non-pressure Piping: Join according to ASTM D 2855.

5. PVC to ABS Non-pressure Transition Fittings: Join according to ASTM D 3138 Appendix.

J. Plastic Non-pressure Piping Gasketed Joints: Join according to ASTM D 3212.

3.3 PIPING CONNECTIONS

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

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric unions and flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

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

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

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

3.5 PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 23 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed.

F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exposed ductwork, piping, equipment, etc. shall be painted. Colors shall be as stated in this division or as selected by the Architect and/or Owner and conform to ANSI Standards.

H. All exposed ductwork, piping, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

I. All exposed ductwork, piping, equipment, etc., in Mechanical Rooms, Fire Pump Rooms, Equipment Platforms where PVC jacketed, shall not require painting. Label and identify and color code as specified.

3.6 CONCRETE BASES

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

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

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

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 5000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Division 05 Section for structural steel.

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

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

3.8 GROUTING

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

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

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

G. Place grout around anchors.

H. Cure placed grout.

3.9 SUPPORTS AND HANGERS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint.

For uninsulated copper piping/tubing provide copper hanger with wool or felt insert to prevent contact of dissimilar metals. All exterior hangers shall be constructed of stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

3.10 PROVISIONS FOR ACCESS:

A. The contractor shall provide access panels and doors for all concealed equipment, valves, controls, control devices, cleanouts and other devices requiring maintenance, service, adjustment, balancing or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L
3. Masonry or Dry Wall: Style M

C. Where access is by means of lifting out ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Access panels in security or detention areas shall be security type.

F. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

3.11 PROTECTION OF WORK:

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in piping and equipment to prevent the entrance of water, dirt, debris, or other foreign matter. Deliver pipes and tubes with factory applied end caps.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside.

3.12 OPERATION OF EQUIPMENT:

A. Clean all systems and equipment prior to initial operation for testing, balancing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing and balancing work. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.

D. Do not use plumbing systems for temporary services or temporary conditioning during construction. Refer to Division 01 for temporary plumbing during construction.

E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items such as filters.

3.13 IDENTIFICATIONS, FLOW DIAGRAMS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS

A. Contractor shall submit for approval schematic piping diagrams of each piping system installed in the building. Diagrams shall indicate the location and the identification number of each valve in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under safety glass and hung in each Mechanical Room where directed. Contractor shall deliver the tracing or sepia from which the diagrams were reproduced to the Owner.

B. All valves shall be plainly tagged. For any bypass valves, install sign indicating valve position as “Normally Open” or “Normally Closed” as required.

C. All items of equipment, including motor starters and disconnects shall be furnished with white on black plastic permanent identification cards. Lettering shall be a minimum of ¼ inch high. Identification plates shall be secured, affixed to each piece of equipment, starters, disconnects, panels by screw or adhesive (tuff bond #TB2 or as approved equal). Equipment identification and room name or area served shall be on each panel.

D. Provide three (3) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the *Operations and Maintenance Manuals* as hereinafter specified.

E. All piping installed under this contract shall be stenciled with *direction of flow* arrows and with stenciled letters naming each pipe and service. Color code all direction of flow arrows and labels. In finished spaces omit labeling and direction of flow arrows. Paint in color as selected by Architect.

F. Submit list of wording, symbols, letter size, and color coding for plumbing identification. Submit samples of equipment identification cards, piping labels, labels, and valve tags to Engineer for review prior to installation.

G. Provide at least 16 hours of straight time instruction to the operating personnel. Time of instruction shall be designated by the Owner.

H. All plumbing equipment in presence of Owner’s representative, Engineer.

3.14 WALL AND FLOOR PENETRATION:

A. All penetrations of partitions, ceilings, roofs and floors by piping or conduit under Division 22 shall be sleeved, sealed, and caulked airtight for sound and air transfer control. Penetrations of mechanical room partitions, ceilings, and floors shall be as specified in Division 23.

B. All penetration of fire rated assemblies shall be sleeved, sealed, caulked and protected to maintain the rating of the wall, roof, or floor. Fire Marshal approved U.L. assemblies shall be utilized. See Division 07.

C. Where piping extends through exterior walls or below grade, provide waterproof pipe penetration seals, as specified in another division of these specifications.

D. Provide pipe escutcheons and duct flanges for sleeved pipes and ducts in finished areas.

E. Piping sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.
2. Twenty-two (22) gauge galvanized steel elsewhere.

3.15 RECORD DRAWINGS:

A. Upon completion of the mechanical installations, the Contractor shall deliver to the Architect and/or Engineer one complete set of prints of the mechanical contract drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering to Architect.

3.16 WARRANTY:

A. Contractor's attention is directed to warranty obligations contained in the *General Conditions and Supplementary Conditions*.

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer’s warranties shall be included in the operations and maintenance manuals.

C. The contractor guarantees for a two-year period from the time of final acceptance by the Owner.
1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
3. That the contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.
4. That the entire work shall be water-tight and leak-proof.

3.17 LUBRICATION

A. All bearings, motors, and all equipment requiring lubrication shall be provided with accessible fittings for same. Before turning over the equipment to the Owner, the Contractor shall fully lubricate each item of equipment, shall provide one year's supply of lubricant for each, and shall provide Owner with complete written lubricating instructions, together with diagram locating the points requiring lubrication. Include this information in the Operations and Maintenance Manuals.

B. In general, all motors and equipment shall be provided with grease lubricated roller or ball bearings with Alemite or equal accessible or extended grease fittings and drain plugs.

C. Provide remote grease fittings with copper lube lines for bearings/motors where grease fittings are situated in locations inconvenient/inaccessible for lubrication.

D. Provide pressure relief fittings at all grease lubrication locations designed to automatically vent within the range of 1/4 to 1 psi, automatically reset below this range, or another pressure relief range if the preceding differs from the manufacturer’s recommended pressure range.

3.18 OPERATIONS AND MAINTENANCE MANUAL:

A. The Contractor shall have prepared three (3) copies of the Operations and Maintenance Manuals and deliver these copies of the booklet to the Owner. The booklet shall be as specified herein. The booklet must be approved and will not be accepted as final until so stamped.

B. The booklet shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manual – Noyes Library for Young Children - Plumbing*. No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the booklet:
   1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
   2. Maintenance operation and lubrication instructions on each piece of equipment furnished.
   3. Complete catalog data on each piece of heating and air conditioning equipment furnished including approved shop drawing.
   4. Chart form indicating frequency and type of routine maintenance for all mechanical equipment. The chart shall also indicate model number of equipment, location and service.
   5. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
   6. Provide supplier and subcontractor's names, address, and phone number.
   7. Catalog data of all equipment, valves, etc. shall include wiring diagrams, parts list and assembly drawing.
   8. Provide and install in locations as directed by the Owner, valve charts including valve tag number, valve type, valve model number, valve manufacturer, style, service and location. Each valve chart shall be enclosed in a durable polymer-based frame with a cover safety glass.
   9. Copy of the approved balancing report including duct leakage data.
   10. ATC systems including as-built ATC drawings of systems including internal of all panels.
   11. Access panel charts with index illustrating the location and purpose of access panels.
   12. Approved Health and Electrical Certificates.
   13. Start-up reports for equipment.
   14. Water treatment test reports.
   15. Filter charts indicating equipment served, size, and type of filter required.
   16. Documentation of strainer pulling and cleaning.

D. Submit Operations and Maintenance Manuals prior to anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that Operations and Maintenance Manuals s be reviewed and approved.

3.19 TESTS, GENERAL:

A. The entire new plumbing systems shall be tested hydrostatically for a duration of four (4) hours before insulation covering is applied and provided tight under the following gauge pressures:

SYSTEM	**TEST PRESSURE**
Domestic Water & Coil Drain Piping	100 psi
Sanitary & Storm Water Piping	As specified below

B. All storm, waste, vent and water piping shall be tested by the Contractor and approved by the Engineer before acceptance. All storm, soil, and waste piping, located underground, shall be

tested before backfilling. The costs of all equipment required for tests are to be included under the contract price.

C. The entire new drainage system and venting system shall have all necessary openings plugged and filled with water to the level of the highest stack above or at the roof. The system shall hold this water for thirty (30) minutes without showing a drop greater than 1inch. Where a portion of the system is to be tested, the test shall be conducted in the same manner as described for the entire system, except a vertical stack 10 feet above the highest horizontal line to be tested may be installed and filled with water to maintain sufficient pressure, or a pump may be used to supply the required pressure. The pressure shall be maintained for thirty (30) minutes. All testing shall be in accordance with the local Plumbing Code and witnessed by the Plumbing Inspector or authority having jurisdiction.

D. Upon completion of roughing-in and before setting equipment and fixtures, the entire new water piping system shall be tested at a hydrostatic pressure of not less than one hundred (100) pounds per square inch gauge and proven tight at this pressure. Where a portion of the water piping system is to be concealed before completion, this portion shall be tested separately in a manner described for the entire system.

E. Testing and acceptance thereof shall be in accordance with local requirements and shall meet approval of authority having jurisdiction. Submit certificates and approved permits and insert one (1) copy in the *Operations and Maintenance Manuals*.

3.20 LINTELS:

A. Under this Section, provide lintels not provided elsewhere which are required for openings for the installation of plumbing work. Lintels shall meet the requirements of the Architectural and Structural Sections and The Architectural Drawings and Specifications.

3.21 EQUIPMENT BY OTHERS

A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of this equipment to furnish complete instructions for connections. Failure to do so will relieve this Contractor of any responsibility for improper equipment operation.

C. Typical equipment refers to, but is not limited to: Kitchen equipment, kitchen and fume hoods, storage cabinets and all other lab equipment.

3.22 FASTENERS:

A. All fasteners located in public space, including classrooms, offices, etc., shall be provided with tamper-proof type fasteners.

3.23 WIRING DIAGRAMS

A. Obtain and submit wiring diagrams for all equipment provided under this Contract.

B. Wiring diagrams shall be provided with Shop Drawings for similar to, but not limited to, the following:

1. All equipment.

C. The Contractor shall submit any additional wiring diagrams as requested by the Engineer.

D. Provide wiring diagrams and identify all termination points, connections, and interface points for all major mechanical equipment to the Electrical Contractor and the ATC Subcontractor for coordination.

3.24 INSTALLATION AND COORDINATION DRAWINGS;

A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following: Complete Ductwork, Plumbing, Sprinkler and HVAC Piping Drawings showing coordination with approved equipment, approved casework drawings, lights, electrical equipment and structural. The Mechanical Contractor is responsible for coordinating with all trades to ensure systems will fit in the available space. If conflicts exist after fabrication and/or installation of systems prior to preparing a coordinated drawing of the area, the Contractor shall remove, re-fabricate, and re-install all such work at their own cost, except for the difference in cost, if any, from the originally designed system to the revised design. If no design changes were made, and clarifications were required, it shall be at no expense to the Owner.

B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, piping and ductwork in areas involved. Fully dimension all work including fume hoods, casework and associated utilities, valve boxes, lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, telecommunications equipment, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.

C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.

D. All coordination drawings shall be prepared in AutoCAD or Revit format and submitted in color. Different colors shall be used to determine different building components. In addition to the composite coordination drawings, simultaneously submit individual plumbing coordination drawings.

3.25 FACTORY START-UP

A. Provide factory authorized start-up service for all plumbing equipment.

B. Provide one copy of all start-up reports to the Owner and include a copy in the O&M Manual.

C. Tempering Valves: Provide factory-authorized individual to review installation and develop a report to submit to the Engineer. Report submission shall be prior to Engineer’s Punch-Out and Building Commissioning.

D. The Contractor shall be required to start up all systems in an orderly, organized, and coordinated manner to ensure that all systems are functioning as designed. The Contractor shall provide a detailed start-up, testing and demonstration plan for all systems in a coordinated manner that is documented in writing at least forty-five (45) days prior to start-up. Start-up, testing, and demonstration plans shall include detailed point-by-point check list that clearly shows that systems are in face functioning as designed. Under this Contract, modifications to the standard AIA definition of substantial completion are to include all Mechanical/Electrical Systems are not substantially complete until all systems are started, tested, balanced, and O&M Manuals are received by the Owner. Above listed items must be completed in time to allow for system demonstrations to County Personnel with all O&M Manuals in hand at the time of demonstration. Contractors will be required to provide system demonstrations and training for County Personnel for each system. At minimum, the Contractors shall provide eight (8) hours of demonstration and eight (8) hours of systems operation training for each system prior to County acceptance of any given system.

3.26 PLUMBING INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of plumbing systems, materials, and equipment including, but not limited to, the following:

1. Coordinate plumbing systems, equipment and materials installation with other building components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.
4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.
5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.
6. Where mounting heights are not detailed, noted, or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.
8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished space.
10. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of equipment components in accordance with manufacturers' recommendations. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.
11. Install access panels or doors where units are concealed behind finished surfaces.
12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.
13. Install above-ceiling equipment requiring servicing and/or maintenance within 48" of accessible ceilings/access panels.

END OF SECTION

SECTION 22 05 13
COMMON MOTOR REQUIREMENTS FOR PLUMBING EQUIPMENT

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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

1.3 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 supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

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

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

2.2 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.

2.3 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.

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

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

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

E. 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.

2.4 POLYPHASE MOTORS

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

B. Efficiency: Premium efficient, 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. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Re-greaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. 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.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.5 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. 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.

B. 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.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

PART 3 EXECUTION (Not Applicable)

END OF SECTION

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SECTION 22 05 19
METERS AND GAUGES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Liquid-in-glass thermometers.
2. Dial-type pressure gauges.
3. Gauge attachments.
4. Test plugs.
5. Test-plug kits.
6. Sight flow indicators.

B. Related Sections:

1. Division 21 fire-suppression piping Sections for fire-protection pressure gauges.
2. Division 22 Section "Facility Water Distribution Piping" for domestic water meters and combined domestic and fire-protection water-service meters outside the building.
3. Division 22 Section " Domestic Water Piping" for water meters inside the building.

1.3 SUBMITTALS

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

B. Product Certificates: For each type of meter and gauge, from manufacturer.

C. Operation and Maintenance Data: For meters and gauges to include in operation and maintenance manuals.

PART 2 PRODUCTS

2.1 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. Trerice, H. O. Co.
   b. Weiss Instruments, Inc.
   c. Ernst Gage Company.
   d. Weksler Instruments.
2. Standard: ASME B40.200.
3. Case: Cast aluminum; 9-inch (229-mm) nominal size unless otherwise indicated.
4. Case Form: Adjustable angle unless otherwise indicated.
5. Tube: Glass with magnifying lens and blue organic liquid.

6. Tube Background: Nonreflective aluminum with permanently etched scale markings graduated in deg F and deg C.
7. Window: Acrylic.
8. Stem: Aluminum and of length to suit installation.
    a. Design for Thermowell Installation: Bare stem.
9. Connector: 1-1/4 inches (32 mm), 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.

2.2 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: Brass.
5. Type: Stepped shank unless straight or tapered shank is indicated.
6. External Threads: NPS 1/2, NPS 3/4, or NPS 1, (DN 15, DN 20, or NPS 25,) ASME B1.20.1 pipe threads.
7. Internal Threads: 1/2, 3/4, and 1-inch (13, 19, and 25 mm), 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 thermowells internal screw thread to size of thermometer connection.

B. Heat-Transfer Medium: Mixture of graphite and glycerin.

2.3 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. Ashcroft Inc.
    b. Ernst Flow Industries.
    c. Trerice, H. O. Co.
    d. Weiss Instruments, Inc.
    e. WIKA Instrument Corporation - USA.
2. Standard: ASME B40.100.
3. Case: Sealed type; cast aluminum or drawn steel, 4-1/2-inch (114-mm) nominal diameter.
4. Pressure-Element Assembly: Bourdon tube unless otherwise indicated.

5. Pressure Connection: Brass, with NPS 1/4 (DN 8), 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 (kPa).
8. Pointer: Dark-colored metal.
9. Window: Glass.
10. Ring: Stainless steel.
11. Accuracy: Grade A, plus or minus 1 percent of middle half of scale range.

2.4 GAUGE ATTACHMENTS

A. Snubbers: ASME B40.100, brass; with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads and piston -type surge-dampening device. Include extension for use on insulated piping.

B. Valves: Stainless steel ball, stem and trim, brass body, with NPS 1/4 (DN 8), ASME B1.20.1 pipe threads.

2.5 TEST PLUGS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Trerice, H. O. Co.
2. Weiss Instruments, Inc.
3. Peterson Equipment Company.
4. Flow Design, Inc.
5. Sisco Manufacturing Company, Inc.
6. Nutech
7. Griswold

B. Description: Test-station fitting made for insertion into piping tee fitting.

C. Body: Brass or stainless steel with core inserts and gasketed and threaded cap. Include extended stem on units to be installed in insulated piping.

D. Thread Size: NPS 1/4 (DN 8) or NPS 1/2 (DN 15), ASME B1.20.1 pipe thread.

E. Core Inserts: Chlorosulfonated polyethylene synthetic and EPDM self-sealing rubber.

2.6 TEST-PLUG KITS

A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Flow Design, Inc.
2. Sisco Manufacturing Company, Inc.
3. Peterson Equipment Company.
4. Trerice, H.O. Company.
5. Weiss Instruments, Inc.
6. Nutech.
7. Griswold.

B. Furnish one test-plug kit(s) containing two thermometer(s), one pressure gauge and adapter, and carrying case. Thermometer sensing elements, pressure gauge, and adapter probes shall be of diameter to fit test plugs and of length to project into piping.

C. High-Range Thermometer: Small, bimetallic insertion type with 1- to 2-inch- (25- to 51-mm-) diameter dial and tapered-end sensing element. Dial range shall be at least 0 to 220 deg F (minus 18 to plus 104 deg C).

D. Pressure Gauge: Small, Bourdon-tube insertion type with 2- to 3-inch- (51- to 76-mm-) diameter dial and probe. Dial range shall be at least 0 to 200 psig (0 to 1380 kPa).

E. Carrying Case: Metal or plastic, with formed instrument padding.

2.7 SIGHT FLOW INDICATORS

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

1. Dwyer Instruments, Inc.

2. Ernst Flow Industries.

3. KOBOLD Instruments, Inc. - USA; KOBOLD Messring GmbH.

B. Description: Piping inline-installation device for visual verification of flow.

C. Construction: Bronze or stainless-steel body, with sight glass and ball**,** flapper, or paddle wheel indicator, and threaded or flanged ends.

D. Minimum Pressure Rating: 150 psig (1034 kPa).

E. Minimum Temperature Rating: 200 deg F (93 deg C).

F. End Connections for NPS 2 (DN 50) and Smaller: Threaded.

G. End Connections for NPS 2-1/2 (DN 65) and Larger: Flanged.

PART 3 EXECUTION

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

G. Install valve and snubber in piping for each pressure gauge for fluids.

H. Install test plugs in piping tees.

I. Install thermometers in the following locations:

1. Inlet and outlet of each water heater.

2. Where indicated on the Drawings.

J. Install pressure gauges in the following locations:

1. Building water service entrance into building.

2. Inlet and outlet of each pressure-reducing valve.
3. Suction and discharge of each domestic water pump.
4. Where indicated on the Drawings.

3.2 CONNECTIONS

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

3.3 ADJUSTING

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

3.4 THERMOMETER SCHEDULE

A. Thermometers at inlet and outlet of each domestic water heater and where indicated on the drawings shall be one of the following:
1. Compact, industrial-style, liquid-in-glass type.
2. Test plug with chlorosulfonated polyethylene synthetic self-sealing rubber inserts.

B. Thermometer stems shall be of length to match thermowell insertion length.

3.5 THERMOMETER SCALE-RANGE SCHEDULE

A. Scale Range for Domestic Cold-Water Piping: 0 to 100 deg F (Minus 20 to plus 50 deg C).

B. Scale Range for Domestic Hot-Water Piping: 30 to 240 deg F (0 to plus 115 deg C); 30 to 240 deg F and 0 to plus 115 deg C.

3.6 PRESSURE-GAUGE SCHEDULE

A. Pressure gauges at discharge of each water service into building and where indicated on the drawings shall be selected so that the normal readings are at the approximate mid-point and maximum pressures. Do not exceed full scale.

END OF SECTION

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SECTION 22 05 23
GENERAL-DUTY VALVES FOR PLUMBING PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Brass ball valves.
2. Bronze ball valves.
3. High performance butterfly valves.
4. Bronze lift check valves.
5. Bronze swing check valves.
6. Iron swing check valves.
7. Bronze globe valves.

B. Related Sections:

1. Division 22 plumbing piping Sections for specialty valves applicable to those Sections only.
2. Division 22 Section "Identification for Plumbing Piping and Equipment" for valve tags and schedules.

1.3 DEFINITIONS

A. CWP: Cold working pressure.

B. EPDM: Ethylene propylene copolymer rubber.

C. NBR: Acrylonitrile-butadiene, Buna-N, or nitrile rubber.

D. NRS: Non-rising stem.

E. OS&Y: Outside screw and yoke.

F. RS: Rising stem.

G. SWP: Steam working pressure.

1.4 SUBMITTALS

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

1.5 QUALITY ASSURANCE

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

B. ASME Compliance:

1. ASME B16.10 and ASME B16.34 for ferrous valve dimensions and design criteria.
2. ASME B31.1 for power piping valves.
3. ASME B31.9 for building services piping valves.

C. NSF Compliance: NSF 61 Annex G for valve materials for potable-water service.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Prepare valves for shipping as follows:

1. Protect internal parts against rust and corrosion.

2. Protect threads, flange faces, grooves, and weld ends.

3. Set angle, gate, and globe valves closed to prevent rattling.

4. Set ball and plug valves open to minimize exposure of functional surfaces.

5. Block check valves in either closed or open position.

B. Use the following precautions during storage:

1. Maintain valve end protection.

2. Store valves indoors and maintain at higher than ambient dew point temperature. If outdoor storage is necessary, store valves off the ground in watertight enclosures.

C. Use sling to handle large valves; rig sling to avoid damage to exposed parts. Do not use handwheels or stems as lifting or rigging points.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR VALVES

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

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

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

D. Valve Actuator Types:

1. Gear Actuator: For quarter-turn valves NPS 4-inch and larger.

2. Handwheel: For valves other than quarter-turn types.

3. Hand lever: For quarter-turn valves NPS 3-inch and smaller.

4. Wrench: For plug valves with square heads. Furnish Owner with 1 wrench for every 2 plug valves, for each size square plug-valve head.

E. Valves in Insulated Piping: With 2-inch (50-mm) stem extensions and the following features:

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

F. Valve-End Connections:

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

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

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

G. Valve Bypass and Drain Connections: MSS SP-45.

2.2 BRASS BALL VALVES

A. Lead Free Two-Piece, Full-Port, Brass Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide Watts Model LFB 6080/6081 or equal products by one of the following:

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

b. Crane Co.; Crane Valve Group; Jenkins Valves.
c. Flow-Tek, Inc.; a subsidiary of Bray International, Inc.
d. Hammond Valve.
e. Jamesbury; a subsidiary of Metso Automation.
f. Kitz Corporation.
g. Milwaukee Valve Company.
h. Watts Regulator Company.

2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Lead free brass.
f. Ends: Threaded or soldered.
g. Seats: PTFE.
h. Stem: Stainless steel.
i. Ball: 316 Stainless-steel, vented.
j. Port: Full.
k. Size: ½-inch to 2-inch

2.3 BRONZE BALL VALVES

A. Lead Free Two-Piece, Regular-Port, Brass or Bronze Ball Valves with Stainless-Steel Trim:

1. Manufacturers: Subject to compliance with requirements, provide Watts Model LFB 6000/6001 or equal products by one of the following:
a. Conbraco Industries, Inc.; Apollo Valves.
b. Crane Co.; Crane Valve Group; Crane Valves.
c. Hammond Valve.
d. Milwaukee Valve Company.
e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:
a. Standard: MSS SP-110.
b. SWP Rating: 150 psig (1035 kPa).
c. CWP Rating: 600 psig (4140 kPa).
d. Body Design: Two piece.
e. Body Material: Lead Free Brass or Bronze.
f. Ends: Threaded.
g. Seats: PTFE or TFE.
h. Stem: Stainless steel.

i. Ball: Stainless steel, vented.

j. Port: Regular.

k. Size: 2-1/2-inch to 4-inch

2.4 SINGLE-FLANGE BUTTERFLY VALVES

A. Lead Free ANSI Class 150, lug style, high performance:

1. Manufacturers: Subject to compliance with requirements, provide Dezurik Model BHP or equal products by one of the following:

a. Bray/McCannalock:

b. DeZurik Water Controls:

c. Tyco Flow Control:

2. Description:

a. Standard: MSS SP-61, Type I.

b. CWP Rating: 200 psig (1380 kPa).

c. Body Design: Stainless steel construction (body, disc, shaft, pins) Lug type; suitable for bidirectional dead-end service at rated pressure without use of downstream flange. Extended neck to allow for 2-inches of insulation.

d. Body Material: Stainless steel.

e. Seat: Reinforced PTFE.

f. Stem: Blow-out-proof one- or two-piece stainless steel.

g. Disc: 316 stainless steel, ASTM A351, Grade CF8M.

h. Operator: Memo Stop; three-inches and less- lever style; four-inches and greater--gear operator.

i. Size: 6-inches and larger.

2.5 BRONZE LIFT CHECK VALVES

A. Lead Free Class 125, Lift Check Valves with Bronze Disc:

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; Jenkins Valves.

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

2. Description:

a. Standard: MSS SP-80, Type 1.

b. CWP Rating: 200 psig (1380 kPa).

c. Body Design: Vertical flow.

d. Body Material: ASTM B 61 or ASTM B 62, bronze.

e. Ends: Threaded.

f. Disc: Bronze.

g. Size: ½-inch to 4-inch.

2.6 BRONZE SWING CHECK VALVES

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

1. Manufacturers: Subject to compliance with requirements, provide Watts Model LFCV/LFCVS products by one of the following:

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

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

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

d. Hammond Valve.

e. Milwaukee Valve Company.

f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 3.

b. CWP Rating: 200 psig (1380 kPa).

c. Body Design: Horizontal flow.

d. Body Material: ASTM B 62, bronze.

e. Ends: Threaded.

f. Disc: Bronze.

g. Size: ½-inch to 4-inch

2.7 IRON SWING CHECK VALVES

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

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

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

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

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

d. Hammond Valve.

e. Milwaukee Valve Company.

f. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-71, Type I.

b. CWP Rating: 200 psig (1380 kPa).

c. Body Design: Clear or full waterway.

d. Body Material: ASTM A 126, gray iron with bolted bonnet.

e. Ends: Flanged.

f. Trim: Bronze.

g. Gasket: Asbestos free.

2.8 BRONZE GLOBE VALVES

A. Lead Free Class 125, Bronze Globe Valves with Bronze Disc:

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. Hammond Valve.

d. Milwaukee Valve Company.

e. Watts Regulator Co.; a division of Watts Water Technologies, Inc.

2. Description:

a. Standard: MSS SP-80, Type 1.

b. CWP Rating: 200 psig (1380 kPa).

c. Body Material: ASTM B 62, bronze with integral seat and screw-in bonnet.

d. Ends: Threaded or solder joint.

e. Stem and Disc: Bronze or stainless steel.

f. Packing: Asbestos free.

g. Handwheel: Malleable iron**,** bronze, or aluminum.

PART 3 EXECUTION

3.1 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.

3.2 VALVE INSTALLATION

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

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

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

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

E. Install chainwheels on operators for butterfly valves NPS 4 (DN 100) and larger and more than 96 inches (2400 mm) above floor. Extend chains to 60 inches (1520 mm) above finished floor.

F. Install check valves for proper direction of flow and as follows:

1. Swing Check Valves: In horizontal position with hinge pin level.

2. Lift Check Valves: With stem upright and plumb.

3.3 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.

3.4 GENERAL REQUIREMENTS FOR VALVE APPLICATIONS

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

1. Shutoff Service: NPS 4 (DN 100) and smaller, Ball; or NPS 6 (DN 150) and larger, butterfly valves.

2. Butterfly Valve Dead-End Service: Single-flange (lug) type.

3. Throttling Service: Globe**,** ball, or butterfly valves.

4. Pump-Discharge Check Valves:

a. NPS 2 (DN 50) and Smaller: Bronze swing check valves with bronze disc.

B. 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.

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

1. For Copper Tubing, NPS 2 (DN 50) and Smaller: Threaded ends except where solder-joint valve-end option is indicated in valve schedules below.

2. For Copper Tubing, NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Flanged ends except where threaded valve-end option is indicated in valve schedules below.

3. For Copper Tubing, NPS 5 (DN 125) and Larger: Flanged ends.

3.5 DOMESTIC, HOT- AND COLD-WATER VALVE SCHEDULE

A. Pipe NPS 4 and Smaller:

1. Bronze and Brass Valves: May be provided with solder-joint ends instead of threaded ends.

2. Ball Valves: Two piece, NPS 2 (DN 50) and less, full port, brass with stainless steel trim and NPS 2-1/2 (DN 65) and larger, standard port, bronze with stainless-steel trim.

3. Bronze Swing Check Valves: Class 125, bronze disc.

4. Bronze Globe Valves: Class 125, bronze disc.

5. Iron Swing Check Valves: Class 125, metal seats.

END OF SECTION

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

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Sections:

1. Division 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment" for vibration isolation devices.

1.3 DEFINITIONS

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

1.4 PERFORMANCE REQUIREMENTS

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

1. Design supports for multiple pipes, 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.

1.5 SUBMITTALS

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

B. Welding certificates.

1.6 QUALITY ASSURANCE

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

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

PART 2 PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel, or be cadmium plated.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components. Provide felt or wool inserts.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel, or be cadmium plated.

2.2 TRAPEZE PIPE HANGERS

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

2.3 THERMAL-HANGER SHIELD INSERTS

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

1. Clement Support Services.
2. ERICO International Corporation.
3. National Pipe Hanger Corporation.
4. PHS Industries, Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) or ASTM C 591, type VI, Grade 1 polyisocyanurate with 125 psig (862 kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water-repellent treated, ASTM C 533, Type I calcium silicate with 100-psig (688-kPa) or ASTM C 591, type VI, Grade 1 polyisocyanurate with 125 psig (862 kPa) minimum compressive strength.

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

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

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.4 FASTENER SYSTEMS

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

B. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated 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.

2.5 PIPE STANDS

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

B. Low-Type, Single-Pipe Stand: One-piece plastic base unit with plastic roller, for roof installation without membrane penetration.

C. Curb-Mounting-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb. Supports shall be hot-dipped galvanized construction. All fasteners, washers, etc., shall be stainless steel.

2.6 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.

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

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

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

1. Properties: Non-staining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

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

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) 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.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.
2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.

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

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

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

J. 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.

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

L. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

N. Pipe hangers and supports shall be attached to the panel point at the top chord of bar joist or at a location approved by the structural engineer. Do not support all parallel piping from the same bar joist (4” pipe and larger) or truss, unless approved by structural engineer.

O. 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.

P. Insulated Piping:

1. Attach clamps and spacers to piping.
   a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.
   b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.
   c. Do not exceed pipe stress limits allowed by ASME B31.9 for building services piping.
2. Install MSS SP-58, Type 39, protection saddles if insulation without vapor barrier is indicated. Fill interior voids with insulation that matches adjoining insulation.
   a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

3. Install MSS SP-58, Type 40, protective shields on cold piping with vapor barrier. Shields shall span an arc of 180 degrees.
    a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.
4. Shield Dimensions for Pipe: Not less than the following:
    a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.
    b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.
    c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.
    d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.
5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.
6. Thermal-Hanger Shields: Install with insulation same thickness as piping insulation.

3.2 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

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

C. Field Welding: Comply with AWS D1.1/D1.1M procedures for shielded, metal arc welding; appearance and quality of welds; and methods used in correcting welding work; and with the following:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. Finish welds at exposed connections so no roughness shows after finishing and so contours of welded surfaces match adjacent contours.

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

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

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

3.6 HANGER AND SUPPORT SCHEDULE

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

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

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

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

E. Use painted or galvanized carbon-steel pipe hangers and supports and metal framing systems and attachments for general service applications. Use stainless steel pipe hangers and attachments for exterior 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 (DN 15 to DN 750).

2. Steel Pipe Clamps (MSS Type 4): For suspension of cold and hot pipes NPS 1/2 to NPS 24 (DN 15 to DN 600) if little or no insulation is required.

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

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

b. 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.

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).

2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) 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 Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.

2. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.

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

1. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape at the panel point.

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

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

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

1. Protection Shields (MSS Type 40): Of length recommended in writing by manufacturer to prevent crushing insulation.

2. Thermal-Hanger Shield Inserts: For supporting insulated pipe.

L. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system sections.

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

N. Use powder-actuated fasteners or mechanical-expansion anchors instead of building attachments where required in concrete construction.

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

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

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. 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. Seismic snubbers.
12. Restraining braces and cables.
13. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

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

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.

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. 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- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).

6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

E. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with 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- (6-mm-) 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: Limit-stop as required for equipment and authorities having jurisdiction.

3. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.

4. Minimum Additional Travel: 50 percent of the required deflection at rated load.

5. Lateral Stiffness: More than 80 percent of rated vertical stiffness.

6. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.

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

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

1. Frame: Steel, fabricated for connection to threaded hanger rods and to allow for a maximum of 30 degrees of angular hanger-rod misalignment without binding or reducing isolation efficiency.
2. Outside Spring Diameter: Not less than 80 percent of the compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of the required deflection at rated load.
4. Lateral Stiffness: More than 80 percent of rated vertical stiffness.
5. Overload Capacity: Support 200 percent of rated load, fully compressed, without deformation or failure.
6. Elastomeric Element: Molded, oil-resistant rubber or neoprene. Steel-washer-reinforced cup to support spring and bushing projecting through bottom of frame.
7. Self-centering hanger rod cap to ensure concentricity between hanger rod and support spring coil.

H. 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.

I. Pipe Riser Resilient Support: All-directional, acoustical pipe anchor consisting of 2 steel tubes separated by a minimum of 1/2-inch- (13-mm-) 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 (3.45 MPa) and for equal resistance in all directions.

J. Resilient Pipe Guides: Telescopic arrangement of 2 steel tubes or post and sleeve arrangement separated by a minimum of 1/2-inch- (13-mm-) 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.

2.2 VIBRATION ISOLATION EQUIPMENT BASES

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

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

1. Amber/Booth Company, Inc.
2. Kinetics Noise Control.
3. Mason Industries.

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

1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) 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.

D. 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 (25-mm) 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.

2.3 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-control devices to indicate capacity range.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-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.

3.2 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.

3.3 VIBRATION-CONTROL AND SEISMIC-RESTRAINT DEVICE INSTALLATION

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

B. 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.

C. 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.

D. 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.

3.4 ADJUSTING

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

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

C. Adjust active height of spring isolators.

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

END OF SECTION

SECTION 22 05 53
IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Stencils.
5. Valve tags.
6. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

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

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/16-inch (1.6 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by ¾-inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm),

and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate. VOC content shall not exceed 250 g/L.

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

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) 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.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate. VOC content shall not exceed 250 g/L.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

A. General Requirements for Manufactured Pipe Labels: Pretensioned, 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 for pipe sizes four-inches and less. For larger pipe sizes (six-inches and greater), markers shall be strapped around using nylon ties.

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

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME (ANSI) A13.1 for piping; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Fiberboard or metal.

2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, alkyd enamel in colors according to ASME (ANSI) A13.1 unless otherwise indicated.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) black-filled letters for piping system abbreviation and 1/2-inch (13-mm) black-filled numbers, 2-inch diameter.

1. Tag Material: Brass, 19-gauge minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass jack chain.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) 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.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: Approximately 4 by 7 inches (100 by 178 mm).

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding: Green background with white letters.

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 (ANSI) 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 or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.
2. Near each branch connection, excluding short takeoffs for fixtures and terminal units. Where flow pattern is not obvious, mark each pipe at branch.
3. Near penetrations through walls, floors, ceilings, and inaccessible enclosures.
4. At access doors, manholes, and similar access points that permit view of concealed piping.
5. Near major equipment items and other points of origination and termination.
6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet (7.6 m) in areas of congested piping and equipment.
7. On piping above removable acoustical ceilings. Omit intermediately spaced labels.
8. Where pipes are adjacent to each other, markings shall be neatly lined up. All markings shall be located in such a manner to be easily legible from the floor.
9. For piping less than 3/4 inch, provide permanently legible tag as specified hereinbefore for valve identification.
10. For buried piping, provide 2-inch minimum width with plastic identification/detection tape with metallic core. Install 4 to 6-inches below-grade.

D. Pipe Label Color Schedule:

1. Domestic Water Piping:
   a. Background Color: Green.
   b. Letter Color: White.
2. Sanitary Waste and Storm Drainage Piping:
   a. Background Color: Green.
   b. Letter Color: White.

3.4 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; and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule. Valve tags shall include system abbreviation (CW, HW, HWC, etc.) and valve number.

B. 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:
   a. Cold Water: 2 inches (50 mm), round.
   b. Hot Water: 2 inches (50 mm), round.
2. Valve-Tag Color:
   a. Cold Water: Natural.

b. Hot Water: Natural.

3. Letter Color:

a. Cold Water: Black.

b. Hot Water: Black.

3.5 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

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SECTION 22 07 00
PLUMBING INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Insulation Materials:
    a. Calcium silicate.
    b. Flexible elastomeric.
    c. Mineral fiber.
2. Insulating cements.
3. Adhesives.
4. Mastics.
5. Lagging adhesives.
6. Sealants.
7. Factory-applied jackets.
8. Field-applied fabric-reinforcing mesh.
9. Field-applied cloths.
10. Field-applied jackets.
11. Tapes.
12. Securements.
13. Corner angles.

B. Related Sections include the following:

1. Division 23 Section "HVAC Insulation."

1.3 SUBMITTALS

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

B. Shop Drawings:

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail insulation application at pipe expansion joints for each type of insulation.
4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
5. Detail field application for each equipment type.

C. Qualification Data: For qualified Installer.

D. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

E. Field quality-control reports.

1.4 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, tapes, and cement material containers, with appropriate markings of applicable testing and inspecting agency.

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

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

1.5 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.6 COORDINATION

A. Coordinate size and location of supports, hangers, and insulation shields specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

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

C. Coordinate installation and testing of heat tracing.

1.7 SCHEDULING

A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

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

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

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

F. Calcium Silicate:

1. Products: Subject to compliance with requirements, provide the following:

a. Owens-Corning.

b. Johns Mansville.

2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

3. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

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

1. Products: Subject to compliance with requirements, provide the following:

a. Johns Mansville.

b. Armacell LLC; AP Armaflex.

c. Aeroflex USA, Inc.; Aerocel.

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

H. Mineral-Fiber, Preformed Pipe Insulation:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Micro-Lok.

b. Knauf Insulation; 1000(Pipe Insulation.

c. Owens Corning; Fiberglas Pipe Insulation.

2. Type I, 850 deg F (454 deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

I. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied ASJ complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, provide one of the following:

a. CertainTeed Corp.; CrimpWrap.

b. Johns Manville; MicroFlex.

c. Knauf Insulation; Pipe and Tank Insulation.

d. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Insulco, Division of MFS, Inc.; Triple I.

b. P. K. Insulation Mfg. Co., Inc.; Super-Stik.

2.3 ADHESIVES

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

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-97.

b. Foster Products Corporation, H. B. Fuller Company; 81-27/81-93.

c. Marathon Industries, Inc.; 290.

2. For indoor applications, use adhesive that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

C. M ineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-82.

b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.

d. Marathon Industries, Inc.; 225.

2. For indoor applications, use adhesive that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-82.

b. Foster Products Corporation, H. B. Fuller Company; 85-20.

c. ITW TACC, Division of Illinois Tool Works; S-90/80.

d. Marathon Industries, Inc.; 225.

2. For indoor applications, use adhesive that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one of the following or equal products:

a. Dow Chemical Company (The); 739, Dow Silicone.

b. Speedline Corporation; Speedline Vinyl Adhesive.

2. For indoor applications, use adhesive that has a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.4 MASTICS

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

1. For indoor applications, use mastics that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-35.

b. Foster Products Corporation, H. B. Fuller Company; 30-90.

c. ITW TACC, Division of Illinois Tool Works; CB-50.

d. Marathon Industries, Inc.; 590.

e. Mon-Eco Industries, Inc.; 55-40.

f. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.

3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).

4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.

5. Color: White.

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; CP-30.

b. Foster Products Corporation, H. B. Fuller Company; 30-35.

c. ITW TACC, Division of Illinois Tool Works; CB-25.

d. Marathon Industries, Inc.; 501.

e. Mon-Eco Industries, Inc.; 55-10.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.

3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).

4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.

5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Products: Subject to compliance with requirements, provide one of the following or equal products:

a. Foster Products Corporation, H. B. Fuller Company; 60-95/60-96.

b. Mon-Eco Industries, Inc.; 55-70.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.

3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-10.
b. Foster Products Corporation, H. B. Fuller Company; 35-00.
c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
d. Marathon Industries, Inc.; 550.
e. Mon-Eco Industries, Inc.; 55-50.
f. Vimasco Corporation; WC-1/WC-5.
2. Water-Vapor Permeance: ASTM F 1249, 3 perms (2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 200 deg F (Minus 29 to plus 93 deg C).
4. Solids Content: 63 percent by volume and 73 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.
1. For indoor applications, use lagging adhesives that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-52.
b. Foster Products Corporation, H. B. Fuller Company; 81-42.
c. Marathon Industries, Inc.; 130.
d. Mon-Eco Industries, Inc.; 11-30.
e. Vimasco Corporation; 136.
3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment and pipe insulation.
4. Service Temperature Range: Minus 50 to plus 180 deg F (Minus 46 to plus 82 deg C).
5. Color: White.

2.6 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-76-8.
b. Foster Products Corporation, H. B. Fuller Company; 95-44.
c. Mon-Eco Industries, Inc.; 44-05.
d. Vimasco Corporation; 750.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:
1. Products: Subject to compliance with requirements, provide one of the following:
a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.7 FACTORY-APPLIED JACKETS

A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms (0.013 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
a. Products: Subject to compliance with requirements, provide the following:
1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
5. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms (0.007 metric perms) when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
a. Products: Subject to compliance with requirements, provide the following:
1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
6. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.
a. Products: Subject to compliance with requirements, provide the following:

1) Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

2.8 FIELD-APPLIED CLOTHS

A. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd. (271 g/sq. m).

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

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.9 FIELD-APPLIED JACKETS

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

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. Johns Manville; Zeston.

b. P.I.C. Plastics, Inc.; FG Series.

c. Proto PVC Corporation; LoSmoke.

d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer. VOC content shall not exceed 250 g/L.

3. Color: White.

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

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

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

C. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products, Division of ITW; Metal Jacketing Systems.

b. PABCO Metals Corporation; Surefit.

2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005, Temper H-14.

a. Sheet and roll stock ready for shop or field sizing.

b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.

d. Moisture Barrier for Outdoor Applications: 3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper.

e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.

2) Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.

3) Tee covers.

4) Flange and union covers.

5) End caps.

6) Beveled collars.

7) Valve covers.

8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

D. Underground Direct-Buried Jacket: 125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

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

a. Pittsburgh Corning Corporation; Pittwrap.

b. Polyguard; Insulrap No Torch 125.

2.10 TAPES

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.

b. Compac Corp.; 104 and 105.

c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.

d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: 3 inches (75 mm).

3. Thickness: 11.5 mils (0.29 mm).

4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.

5. Elongation: 2 percent.

6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.

7. ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

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

1. Products: Subject to compliance with requirements, provide one of the following:

a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.

b. Compac Corp.; 110 and 111.

c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.

d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.

2. Width: 3 inches (75 mm).

3. Thickness: 6.5 mils (0.16 mm).

4. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
5. Elongation: 2 percent.
6. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
7. FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

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

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
   b. Compac Corp.; 130.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
   d. Venture Tape; 1506 CW NS.
2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
   b. Compac Corp.; 120.
   c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
   d. Venture Tape; 3520 CW.
2. Width: 2 inches (50 mm).
3. Thickness: 3.7 mils (0.093 mm).
4. Adhesion: 100 ounces force/inch (1.1 N/mm) in width.
5. Elongation: 5 percent.
6. Tensile Strength: 34 lbf/inch (6.2 N/mm) in width.

E. PVDC Tape: White vapor-retarder PVDC tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include, but are not limited to, the following:
   a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
2. Width: 3 inches (75 mm).
3. Film Thickness: 6 mils ((0.15 mm)).
4. Adhesive Thickness: 1.5 mils (0.04 mm).
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.11 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one of the following:

a. Childers Products; Bands.

b. PABCO Metals Corporation; Bands.

c. RPR Products, Inc.; Bands.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 inch (0.38 mm) thick, 3/4 inch (19 mm) wide with wing or closed seal.

3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, 3/4 inch (19 mm) wide with wing or closed seal.

4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated.

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; CWP-1.

2) GEMCO; CD.

3) Midwest Fasteners, Inc.; CD.

4) Nelson Stud Welding; TPA, TPC, and TPS.

2. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.135-inch- (3.5-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; CWP-1.

2) GEMCO; Cupped Head Weld Pin.

3) Midwest Fasteners, Inc.; Cupped Head.

4) Nelson Stud Welding; CHP.

3. Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

a. Products: Subject to compliance with requirements, provide one of the following:

1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.

2) GEMCO; Perforated Base.

3) Midwest Fasteners, Inc.; Spindle.

b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.

c. Spindle: Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) GEMCO; Nylon Hangers.

      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

   b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.

   c. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).

   d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

5. Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.

      2) GEMCO; Press and Peel.

      3) Midwest Fasteners, Inc.; Self Stick.

   b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.

   c. Spindle: Stainless steel, fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

   d. Adhesive-backed base with a peel-off protective cover.

6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, stainless-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

   a. Products: Subject to compliance with requirements, provide one of the following:

      1) AGM Industries, Inc.; RC-150.

      2) GEMCO; R-150.

      3) Midwest Fasteners, Inc.; WA-150.

      4) Nelson Stud Welding; Speed Clips.

   b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

7. Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.
    a. Products: Subject to compliance with requirements, provide one of the following:
        1) GEMCO.
        2) Midwest Fasteners, Inc.

C. Staples: Outward-clinching insulation staples, nominal 3/4-inch- (19-mm-) wide, stainless steel or Monel.

D. Wire: 0.062-inch (1.6-mm) soft-annealed, stainless steel.
    1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        a. C & F Wire.
        b. Childers Products.
        c. PABCO Metals Corporation.
        d. RPR Products, Inc.

2.12 CORNER ANGLES

A. Aluminum Corner Angles: 0.040 inch (1.0 mm) thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105 or 5005; Temper H-14.

B. Stainless-Steel Corner Angles: 0.024 inch (0.61 mm) thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel accord.

PART 3 EXECUTION

3.1 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.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:
    1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). 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 (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.

C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

G. Keep insulation materials dry during application and finishing.

H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

I. Install insulation with least number of joints practical.

J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor-barrier mastic.

3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

L. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.

3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). 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 (50 mm) o.c.

a. For below ambient services, apply vapor-barrier mastic over staples.

4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.

5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

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

1. Vibration-control devices.

2. Testing agency labels and stamps.

3. Nameplates and data plates.

4. Manholes.

5. Handholes.

6. Cleanouts.

3.4 PENETRATIONS

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

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.

4. Seal jacket to roof flashing with flashing sealant.

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

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

1. Seal penetrations with flashing sealant.

2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).

4. Seal jacket to wall flashing with flashing sealant.

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

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

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

F. Insulation Installation at Floor Penetrations:

1. Pipe: Install insulation continuously through floor penetrations.

2. Seal penetrations through fire-rated assemblies. Comply with requirements in Division 07 Section "Penetration Firestopping."

3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

A. Mineral Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces.

2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

3. Protect exposed corners with secured corner angles.

4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

a. Do not weld anchor pins to ASME-labeled pressure vessels.

b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.

c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.

d. Do not overcompress insulation during installation.

e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.

f. Impale insulation over anchor pins and attach speed washers.

g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.

6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least 3 inches (75 mm).

8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.

2. Seal longitudinal seams and end joints.

3.6 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity, unless otherwise indicated.

2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.

6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.

2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.

3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.

4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches (50 mm) 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.

3.7 CALCIUM SILICATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation materials.

2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) 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 (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

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 block insulation of same material and thickness as pipe insulation.

4. Finish flange insulation same as pipe insulation.

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 insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.

3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

2. Install insulation to flanges as specified for flange insulation application.

3. Finish valve and specialty insulation same as pipe insulation.

3.8 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install mitered sections of pipe insulation.

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

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.

2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.

4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 MINERAL-FIBER INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.

2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches (150 mm) o.c.

4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.

2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.

4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch (25 mm), and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.

2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

4. Install insulation to flanges as specified for flange insulation application.

3.10 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.

2. Embed glass cloth between two 0.062-inch- (1.6-mm-) 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 (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.

5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) 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 (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

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 (50 mm) 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 (850 mm) or less. The 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) 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.

3.11 FINISHES

A. 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: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.12 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to one location(s) for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.13 EQUIPMENT INSULATION SCHEDULE

A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.

3.14 PIPING INSULATION SCHEDULE, GENERAL

A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.

B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

1. Drainage piping located in crawl spaces.

2. Underground piping.

3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

3.15 INDOOR PIPING INSULATION SCHEDULE

PIPING INSULATION THICKNESS SCHEDULE SERVICES	THICKNESS
Above Grade Trap Priming Lines	½ -inch thickness
All Above Grade Floor Drain Piping Serving AHU Condensate Drains include Drain Sumps and Auxiliary Drain Pipes from Auxiliary Pans	1-inch thickness
All Domestic Hot and Cold-Water Piping, including Recirculating Piping	1-inch thickness
All Drain Piping from Cooling Coils/Evaporators	½-inch thickness
Electric Water Cooler Drains	1-inch thickness
Emergency Fixture Tepid Water Piping	1-inch thickness

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

1. All Pipe Sizes: Insulation shall be Truebro Lav Guard-ADA approved under sink pipe insulation cover system. Refer to Section 224000 for additional information on protective shielding guards.

B. Floor Drains, Traps, and Sanitary Drain Piping within 10 feet (3m) of drain receiving condensate and equipment drain water below 60 degrees F (16 degrees C):

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

a. Mineral-Fiber, Preformed Pipe Insulation, Type I: 1-inch (25 mm) thick.

3.16 INDOOR, FIELD-APPLIED JACKET SCHEDULE

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

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

C. Equipment, Exposed, up to 48 inches (1200 mm) in Diameter or with Flat Surfaces up to 72 inches (1800 mm):

1. PVC: 30 mils (0.8 mm) thick.

D. Equipment, Exposed, Larger than 48 inches (1200 mm) in Diameter or with Flat Surfaces Larger than 72 inches (1800 mm):

1. Aluminum with 0.040 inch (1.0 mm) thick.

E. Piping, Concealed:

1. None.

F. Piping, Exposed:

1. PVC: 20 mils (0.5 mm) thick.

2. In lieu of providing the PVC jacket for all exposed piping, at the Contractor's option, provide Owens Corning paper-free ASJ: Evolution for all piping insulation (concealed and exposed).

END OF SECTION

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SECTION 22 11 16
DOMESTIC WATER PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

1.3 SUBMITTALS

A. Product Data: For the following products:

1. Specialty valves.
2. Transition fittings.
3. Dielectric fittings.
4. Flexible connectors.
5. Backflow preventers and vacuum breakers.
6. Water penetration systems.

B. Water Samples: Specified in "Cleaning" Article.

C. Coordination Drawings: For all piping, draw to 3/8” scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Fire-suppression-water piping.
2. Domestic water piping.
3. HVAC hydronic piping.
4. Equipment.
5. Ductwork.

D. Field quality-control reports.

1.4 QUALITY ASSURANCE

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

B. Comply with NSF 61 including Annex G and State of Maryland requirements (House Bill 372) for potable domestic water piping and components. All piping and components shall be labeled as compliant.

1.5 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

PART 2 PRODUCTS

2.1 PIPING MATERIALS

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

2.2 COPPER TUBE AND FITTINGS

A. Hard Copper Tube Above-Ground: ASTM B 88, Type L (ASTM B 88M, Type B) 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.

2.3 DUCTILE IRON PIPE AND FITTINGS

A. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, 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.
3. Lining: AWWA C104, cement mortar.
4. Gaskets: AWWA C111, rubber.

2.4 GALVANIZED-STEEL PIPE AND FITTINGS

A. Galvanized-Steel Pipe:

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

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

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

D. Malleable-Iron Unions:

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

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

F. Appurtenances for Grooved-End, Galvanized-Steel Pipe:

1. Fittings for Grooved-End, Galvanized-Steel Pipe: Galvanized, ASTM A 47/A 47M, malleable-iron casting; ASTM A 106/A 106M, steel pipe; or ASTM A 536, ductile-iron casting; with dimensions matching steel pipe.
2. Fittings for Grooved-End, Galvanized-Steel Pipe:
    a. AWWA C606 for steel-pipe dimensions.
    b. Ferrous housing sections.
    c. EPDM-rubber gaskets suitable for hot and cold water.
    d. Bolts and nuts.
    e. Minimum Pressure Rating:
        1) NPS 8 (DN 200) and Smaller: 600 psig (4137 kPa)

2.5 PIPING JOINING MATERIALS

A. Pipe-Flange Gasket Materials: AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) 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.

2.6 TRANSITION FITTINGS

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

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

C. Sleeve-Type Transition Coupling: AWWA C219.
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Cascade Waterworks Manufacturing.
    b. Dresser, Inc.; Dresser Piping Specialties.
    c. Smith-Blair, Inc; a Sensus company.
    d. Viking Johnson; c/o Mueller Co.

2.7 DIELECTRIC FITTINGS

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

B. Dielectric Unions: Dielectric unions are prohibited. Use dielectric couplings or nipples and provide standard unions.

C. Dielectric Flanges:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. EPCO Sales, Inc.
    b. Watts Regulator Co.; a division of Watts Water Technologies, Inc.
    c. Hart Industries International, Inc.
2. Description:
    a. Factory-fabricated, bolted, companion-flange assembly.
    b. Pressure Rating: 150 psig (1035 kPa).
    c. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Couplings:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Calpico, Inc.
    b. Lochinvar Corporation.
    c. EPCO.
2. Description:
    a. Galvanized-steel coupling.
    b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
    c. End Connections: Female threaded.
    d. Lining: Inert and noncorrosive, thermoplastic.

E. Dielectric Nipples:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Perfection Corporation; a subsidiary of American Meter Company.
    b. Precision Plumbing Products, Inc.
    c. Victaulic Company.
2. Description:
    a. Electroplated steel nipple complying with ASTM F 1545.
    b. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
    c. End Connections: Male threaded or grooved.
    d. Lining: Inert and noncorrosive, propylene.

2.8 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. Metraflex, Inc.

4. Universal Metal Hose; a Hyspan company
5. Mason Industries.

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

1. Working-Pressure Rating: Minimum 200 psig (1380 kPa).
2. End Connections NPS 2 (DN 50) and Smaller: Threaded steel-pipe nipple.
3. End Connections NPS 2-1/2 (DN 65) and Larger: Flanged steel nipple.

2.9 WATER SUB-METERS

A. Displacement-Type Water Meters (1-1/2” and Smaller):

1. Manufacturers: Subject to compliance with requirements, provide Emon C700 Series or products by one of the following:
   a. Badger Meter, Inc.
   b. Sensus Metering Systems.
   c. Hersey Meter.
2. Description:
   a. Standard: AWWA C700.
   b. Pressure Rating: 150-psig (1035-kPa) working pressure.
   c. Body Design: Nutating disc; totalization meter.
   d. Registration: In gallons or cubic feet as required by utility. In gallons for make-up water and other building sub-metering requirements.
   e. Case: Bronze.
   f. End Connections: Threaded.
   g. Energy Management: Connection to the Building Management System (BACNET MSTP).

B. Turbine-Type Water Meters (2” and Larger):

1. Manufacturers: Subject to compliance with requirements, provide Emon T4000 Series or products by one of the following:
   a. Badger Meter, Inc.
   b. Sensus Metering Systems.
   c. Hersey Meter.
2. Description:
   a. Standard: AWWA C701.
   b. Pressure Rating: 150-psig (1035-kPa) working pressure.
   c. Body Design: Turbine; totalization meter.
   d. Registration: In gallons or cubic feet as required by utility company. In gallons for make-up water and other building sub-metering requirements.
   e. Case: Bronze.
   f. End Connections for Meters NPS 2 (DN 50) and Smaller: Threaded.

g. End Connections for Meters NPS 2-1/2 (DN 65) and Larger: Flanged.

h. Energy Management: Connection to the Building Management System (BACNET MSTP).

PART 3 EXECUTION

3.1 EARTHWORK

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

3.2 PIPING INSTALLATION

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

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

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

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

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

F. Install 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 with 0.25 percent slope downward toward drain and plumb.

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

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

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

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

L. Install piping to permit valve servicing.

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

N. Install piping free of sags and bends.

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

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

Q. Install pressure gauges on suction and discharge piping from each plumbing pump. Comply with requirements in Division 22.

R. Install thermostats in hot-water circulation piping. Comply with requirements in Division 22.

S. Install thermometers on inlet and outlet piping from each water heater. Comply with requirements in Division 22.

T. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 22.

U. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 22.

V. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 22.

W. Install underground copper tube and ductile iron pipe in PE encasement according to ASTM A674 or AWWA C105.

3.3 JOINT CONSTRUCTION

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

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

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

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

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

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

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

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

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

H. Ductile-Iron-Piping Grooved Joints: Cut groove end of pipe. Assemble coupling with housing, gasket, lubricant, and bolts. Join ductile-iron pipe and grooved-end fittings according to AWWA C606 for ductile-iron-pipe, cut-grooved joints.

I. Steel-Piping Grooved Joints: 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.

J. 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.

3.4 VALVE INSTALLATION

A. General-Duty Valves: Comply with requirements in Division 22.

B. Install shutoff valve close to water main on each branch and riser serving plumbing fixtures or equipment, on each water supply to equipment, for each branch serving toilet room(s), for each branch pipe serving two or more fixtures, and on each water supply to plumbing fixtures that do not have supply stops. Use ball valves for piping NPS 4 (DN 100) and smaller. Use butterfly or ball valves for piping NPS 6 (DN 150) and larger.

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

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 combination balancing/shut-off valve in each hot-water circulation return branch and discharge side of each pump and circulator. Set balancing valves partly open to restrict but not stop flow. Comply with requirements in Division 22.

3.5 TRANSITION FITTING INSTALLATION

A. Install transition couplings at joints of dissimilar piping.

B. Transition Fittings in Underground Domestic Water Piping:

1. NPS 1-1/2 (DN 40) and Smaller: Fitting-type coupling.

2. NPS 2 (DN 50) and Larger: Sleeve-type coupling.

3.6 DIELECTRIC FITTING INSTALLATION

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

B. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric couplings or nipples.

C. Dielectric Fittings for NPS 2-1/2 and larger: Use dielectric flanges.

3.7 FLEXIBLE CONNECTOR INSTALLATION

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

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

3.8 WATER METER INSTALLATION

A. Rough-in domestic water piping and install water meters according to utility company's requirements and/or as required for building sub-metering.

B. Install water meters according to AWWA M6 and/or the utility company's requirements

C. Install displacement-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.

D. Install turbine-type water meters with shutoff valve on water-meter inlet. Install valve on water-meter outlet and valved bypass around meter unless prohibited by authorities having jurisdiction.

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

F. Provide remote reading for integration with the Building Control System (BACNET-MSTP).

G. Provide building water usage submetering for:

1. Total Building Water Usage.

2. Domestic Hot Water Usage.

3. Make-Up Water Usage.

3.9 HANGER AND SUPPORT INSTALLATION

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

1. Vertical Piping: MSS Type 8 or 42, clamps.
2. Individual, Straight, Horizontal Piping Runs:
    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m) If Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

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

C. Rod diameter may be reduced one size for double-rod hangers, to a minimum of 3/8 inch (10 mm).

D. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 3/4 (DN 20) and Smaller: 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 1 and NPS 1-1/4 (DN 25 and DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
3. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
4. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
5. NPS 3 (DN 80): 10 feet (3 m) with 1/2-inch (13-mm) rod.
6. NPS 4 (DN 150): 12 feet (3 m) with 5/8-inch (16-mm) rod.
7. NPS 6 (DN 200): 12 feet (3 m) with 3/4-inch (19-mm) rod.

E. Install supports for vertical copper tubing every 10 feet (3 m).

F. Install hangers for steel piping with the following maximum horizontal spacing and minimum rod diameters:
1. NPS 1-1/4 (DN 32) and Smaller: 60 inches with 3/8-inch rod.
2. NPS 1-1/2 (DN 40): 96 inches with 3/8-inch rod.
3. NPS 2 (DN 50): 8 feet with 3/8-inch rod.
4. NPS 2-1/2 (DN 65): 10 feet with 1/2-inch rod.
5. NPS 3 and NPS 3-1/2 (DN 80 and DN 90): 12 feet (3.7 m) with 1/2-inch (13-mm) rod.
6. NPS 4 (DN 100): 14 feet with 5/8-inch rod.
7. NPS 6 (DN 150): 16 feet with 3/4-inch rod.
8. NPS 8 to NPS 12 (DN 200 to DN 300): 20 feet with 7/8-inch (22-mm) rod.

G. Install supports for vertical steel piping every 15 feet (4.5 m).

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

3.10 CONNECTIONS

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

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

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

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

1. Water Heaters: Cold-water inlet and hot-water outlet piping in sizes indicated, but not smaller than sizes of water heater connections.

2. Plumbing Fixtures: Cold- and hot-water supply piping in sizes indicated, but not smaller than required by plumbing code. Comply with requirements in Division 22 plumbing fixture Sections for connection sizes.

3. 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 (DN 65) and larger.

3.11 IDENTIFICATION

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

B. Label pressure piping with system operating pressure.

3.12 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Piping Inspections:

1. Do not enclose, cover, or put piping into operation until it has been inspected and approved by authorities having jurisdiction.

2. During installation, notify authorities having jurisdiction at least one day before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction:

a. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

b. Final Inspection: Arrange final inspection for authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

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

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

C. Piping Tests:

1. Fill domestic water piping. Check components to determine that they are not air bound and that piping is full of water.

2. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit a separate report for each test, complete with diagram of portion of piping tested.

3. Leave new, altered, extended, or replaced domestic water piping uncovered and unconcealed until it has been tested and approved. Expose work that was covered or concealed before it was tested.

4. Cap and subject piping to static water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test

source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

5. Repair leaks and defects with new materials and retest piping or portion thereof until satisfactory results are obtained.

6. Prepare reports for tests and for corrective action required.

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

E. Prepare test and inspection reports.

3.13 ADJUSTING

A. Perform the following adjustments before operation:

1. Close drain valves, hydrants, and hose bibbs.

2. Open shutoff valves to fully open position.

3. Open throttling valves to proper setting.

4. Adjust balancing valves in hot-water-circulation return piping to provide adequate flow.

a. Manually adjust ball-type balancing valves in hot-water-circulation return piping to provide flow of hot water in each branch.

b. Adjust calibrated balancing valves to flows indicated.

5. Remove plugs used during testing of piping and for temporary sealing of piping during installation.

6. Remove and clean strainer screens. Close drain valves and replace drain plugs.

7. Remove filter cartridges from housings and verify that cartridges are as specified for application where used and are clean and ready for use.

8. Check plumbing specialties and verify proper settings, adjustments, and operation.

3.14 CLEANING

A. Clean and disinfect potable 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 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.

c. Flush system with clean, potable water until chlorine level is <1.0 ppm 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.

3.15 PIPING SCHEDULE

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

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

C. Under-building slab, domestic water or combined domestic water, building-service, and fire-service-main piping, shall be the following:

1. Mechanical-joint, ductile-iron pipe; standard-pattern mechanical-joint fittings; and mechanical joints.

D. All aboveground domestic water piping shall be the following:

1. For Piping 3 inches and smaller: Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) or wrought- copper solder-joint fittings; and soldered joints.

2. For Pipping 4 inches and larger: Galvanized-steel pipe and nipples; galvanized, gray-iron threaded fittings; and threaded joints.

3.16 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 4 (DN 100) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 6 (DN 150) and larger.

2. Throttling Duty: Use ball valves for piping NPS 2 (DN 50) and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 (DN 65) and larger.

3. Hot-Water Circulation Piping, Balancing Duty: Memory-stop 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.

END OF SECTION

SECTION 22 11 19
DOMESTIC WATER PIPING SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

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

1. Vacuum breakers.
2. Backflow preventers.
3. Water pressure-reducing valves.
4. Balancing valves.
5. Temperature-actuated water mixing valves.
6. Strainers.
7. Hose bibbs.
8. Wall hydrants.
9. Drain valves.
10. Water hammer arresters.
11. Air vents.
12. Trap-seal primer systems.
13. Outlet boxes.

B. Related Sections include the following:

1. Division 22 Section "Meters and Gauges for Plumbing Piping" for thermometers, pressure gauges, and flow meters in domestic water piping.
2. Division 22 Section "Domestic Water Piping" for water meters.
3. Division 22 Section "Emergency Plumbing Fixtures" for water tempering equipment.
4. Division 22 Section "Drinking Fountains and Water Coolers" for water filters for water coolers.

1.3 PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure for Domestic Water Piping Specialties: 125 psig (860 kPa), unless otherwise indicated.

1.4 SUBMITTALS

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

B. Shop Drawings: Diagram power, signal, and control wiring.

C. Field quality-control test reports.

D. Operation and Maintenance Data: For domestic water piping specialties to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. NSF Compliance:

1. Comply with NSF 61, "Drinking Water System Components - Health Effects; Sections 1 through 9" including Annex G in accordance with State of Maryland House Bill 372.

PART 2 PRODUCTS

2.1 VACUUM BREAKERS

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

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

a. Ames Company.

b. Cash Acme.

c. Conbraco Industries, Inc.

d. Watts Industries, Inc.; Water Products Division.

e. Zurn Plumbing Products Group; Wilkins Division.

2. Standard: ASSE 1001.

3. Size: NPS 1/4 to NPS 3 (DN 8 to DN 80), 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. MIFAB, Inc.

b. Watts Industries, Inc.; Water Products Div.

c. Conbraco Industries, Inc.

d. Zurn Plumbing Products Group; Wilkins Div.

e. Josam.

f. Chicago.

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 Company.
   b. Conbraco Industries, Inc.
   c. Watts Industries, Inc.; Water Products Division.
   d. Zurn Plumbing Products Group; Wilkins Division.
2. Standard: ASSE 1020.
3. Operation: Continuous-pressure applications.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Accessories: 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 Division.
2. Standard: ASSE 1056.
3. Operation: Continuous-pressure applications.
4. Accessories: Valves-Ball type, on inlet and outlet.

2.2 BACKFLOW PREVENTERS

A. Reduced-Pressure-Principle Backflow Preventers:

1. Basis-of-Design Product: Subject to compliance with requirements, provide a product by one of the following:
   a. Ames Co.
   b. Conbraco Industries, Inc.
   c. Watts Industries, Inc.; Water Products Div.
   d. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1013.

B. Double-Check Backflow-Prevention Assemblies:

1. Basis-of-Design Product: Subject to compliance with requirements, provide the product indicated on Drawings or a comparable product by one of the following:
   a. Ames Co.
   b. Watts Industries, Inc.; Water Products Div.
   c. Zurn Plumbing Products Group; Wilkins Div.
2. Standard: ASSE 1015.
3. Operation: Continuous-pressure applications, unless otherwise indicated.
4. Pressure Loss: 5 psig (35 kPa) maximum, through middle 1/3 of flow range.
5. Size: As shown on plans.

6. Body: Bronze for NPS 2 (DN 50) and smaller; stainless steel for NPS 2-1/2 (DN 65) and larger.
7. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
8. Configuration: Designed for horizontal, straight through flow.
9. Accessories:
    a. Valves: Ball type with threaded ends on inlet and outlet of NPS 2 (DN 50) and smaller; butterfly type with flanged ends on inlet and outlet of NPS 2-1/2 (DN 65) and larger.

2.3 WATER PRESSURE-REDUCING VALVES

A. Water Regulators:
1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Wilkins.
    b. Bell and Gossett.
    c. Watts Industries, Inc.; Water Products Div.
    d. Armstrong.
2. Standard: ASSE 1003.
3. Pressure Rating: Initial working pressure of 150 psig (1035 kPa).
4. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or that is FDA approved for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).
5. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 and NPS 3 (DN 65 and DN 80).

2.4 BALANCING VALVES

A. Memory-Stop Balancing Valves:
1. Manufacturers: Subject to compliance with requirements, provide Xylem Bell & Gosset Model No. CB-LF or approved equal products by one of the following:
    a. Conbraco Industries, Inc.
    b. Crane Co.; Crane Valve Group; Crane Valves.
    c. Crane Co.; Crane Valve Group; Jenkins Valves.
    d. Crane Co.; Crane Valve Group; Stockham Div.
    e. Hammond Valve.
    f. Milwaukee Valve Company.
    g. Watts.
2. Standard: MSS SP-110 for two-piece, copper-alloy ball valves.
3. Pressure Rating: 400-psig (2760-kPa) minimum CWP.
4. Size: NPS 2 (DN 50) or smaller.
5. Body: Copper alloy.
6. Port: Standard or full port.

7. Ball: Stainless steel.
8. Seats and Seals: Replaceable.
9. End Connections: Solder joint or threaded.
10. Handle: Vinyl-covered steel with memory-setting device.

2.5 TEMPERATURE-ACTUATED WATER MIXING VALVES

A. Manifold, Thermostatic, Water-Mixing-Valve Assemblies:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Lawler Valve Company.
   b. Powers; a Watts Industries Co.
   c. Symmons Industries, Inc.
   d. Leonard Valve Company.
2. Description: Factory-fabricated, exposed-mounting, thermostatically controlled, water-mixing-valve assembly in two -valve parallel arrangement.
3. Thermostatic Mixing Valves: Comply with ASSE 1017. Include check stops on hot- and cold-water inlets and shutoff valve on outlet.
4. Water Regulator(s): Comply with ASSE 1003. Include pressure gauge on inlet and outlet.
5. Component Pressure Ratings: 125 psig (860 kPa) minimum, unless otherwise indicated.
6. Capacities and size as indicated on the Drawings
7. Thermostatic Mixing Valve and Water Regulator Finish: Rough bronze.
8. Piping Finish: Copper.

B. Individual-Fixture, Water Tempering Valves:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Chicago.
   b. Lawler Manufacturing Company, Inc.
   c. Powers; a Watts Industries Co.
   d. Symmons Industries.
   e. Leonard Valve Company.
2. Standard: ASSE 1016, thermostatically controlled water tempering valve.
3. Pressure Rating: 125 psig (860 kPa) 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.
8. Tempered-Water Setting: 105 deg F.
9. Tempered-Water Design Flow Rate: 1.5 gpm.

C. Water Temperature Limiting Devices (WTD-1):

1. Manufacturers: Subject to compliance with requirements, provide products by the following:
2. Leonard Valve Company.
3. Powers: a Division of Watts Water Technologies, Inc.
4. Symmons Industries, Inc.
5. Zurn Industries, LLC; Plumbing Products Group; Wilkins Water Control Products.
6. Lawler Manufacturing Company.
7. Standard: ASSE 1070.
8. Pressure Rating: 125 psig (860 kPa).
9. Type: Thermostatically controlled, water mixing valve.
10. Material: Bronze body with corrosion-resistant interior components.
11. Connections: Threaded union inlets and outlet.
12. Accessories: Check stops on hot and cold-water supplies, and adjustable, temperature-control handle.
13. Tempered-Water Setting: 110 F (deg C).
14. Tempered Water Design Flow Rate: Down to 0.5 gpm.
15. Valve Finish: Chrome-plated.

2.6 STRAINERS FOR DOMESTIC WATER PIPING

A. Y-Pattern Strainers:

1. Pressure Rating: 125 psig (860 kPa) minimum, unless otherwise indicated.
2. Body: Bronze for NPS 2 (DN 50) and smaller; cast iron with interior lining complying with AWWA C550 or FDA-approved, epoxy coating and for NPS 2-1/2 (DN 65) and larger.
3. End Connections: Threaded for NPS 2 (DN 50) and smaller; flanged for NPS 2-1/2 (DN 65) and larger.
4. Screen: Stainless steel with round perforations, unless otherwise indicated.
5. Perforation Size:
   a. Strainers NPS 2 (DN 50) and Smaller: 0.033 inch (0.84 mm) or 0.062 inch (1.57 mm).
   b. Strainers NPS 2-1/2 to NPS 4 (DN 65 to DN 100): 0.045 inch (1.14 mm).
6. Drain: Factory-installed, hose-end ball-type drain valve.

2.7 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. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

d. Watts Drainage Products Inc.

e. Zurn Plumbing Products.

2. Standard: ASME A112.21.3M for concealed-outlet, self-draining wall hydrants.

3. Pressure Rating: 125 psig (860 kPa).

4. Operation: Loose key.

5. Casing and Operating Rod: Of length required to match wall thickness. Include wall clamp.

6. Inlet: NPS 3/4 (DN 20).

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): Two with each wall hydrant.

2.8 DRAIN VALVES

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

1. Standard: MSS SP-110 for standard-port, two-piece ball valves.

2. Pressure Rating: 400-psig (2760-kPa) minimum CWP.

3. Size: NPS 3/4 (DN 20).

4. Body: Copper alloy.

5. Ball: Stainless steel.

6. Seats and Seals: Replaceable.

7. Handle: Vinyl-covered steel.

8. Inlet: Threaded or solder joint.

9. Outlet: Threaded, short nipple with garden-hose thread complying with ASME B1.20.7 and cap with brass chain.

2.9 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. Sioux Chief Manufacturing Company, Inc.

e. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

f. Watts Drainage Products.

g. Zurn Plumbing Products.

2. Standard: ASSE 1010 or PDI-WH 201.

3. Type: Metal bellows or copper tube with piston.

4. Size: ASSE 1010, Sizes AA and A through F or PDI-WH 201, Sizes A through F.

2.10 AIR VENTS

A. Welded-Construction Automatic Air Vents:

1. Body: Stainless steel.

2. Pressure Rating: 150-psig (1035-kPa) minimum pressure rating.

3. Float: Replaceable, corrosion-resistant metal.

4. Mechanism and Seat: Stainless steel.

5. Size: NPS 1/2 (DN 15) minimum inlet.

6. Inlet and Vent Outlet End Connections: Threaded.

2.11 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.

b. Sloan.

2. Standard: ASSE 1044,

3. Piping: NPS 3/4, ASTM B 88, Type L (DN 20, ASTM B 88M, Type B); 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: Per job conditions.

8. Size Outlets: NPS 1/2 (DN 15).

2.12 OUTLET BOXES

A. Cold Water 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 (DN 15) or smaller copper tube outlet.

5. Supply Shutoff Fitting: NPS 1/2 (DN 15) gate, globe, or ball valve and NPS 1/2 (DN 15) copper, water tubing.

PART 3 EXECUTION

3.1 INSTALLATION

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

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

1. Locate backflow preventers in same room as connected equipment or system.

2. Install drain for backflow preventers with atmospheric-vent drain connection with air-gap fitting, fixed air-gap fitting, or equivalent positive pipe separation of at least two pipe diameters in drain piping and pipe to floor drain. Locate air-gap device attached to or under backflow preventer. Simple air breaks are not acceptable for this application.

3. Do not install bypass piping around backflow preventers.

C. Install water regulators with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

D. Install water control valves with inlet and outlet shutoff valves. Install pressure gauges on inlet and outlet.

E. Install balancing valves in locations where they can easily be adjusted.

F. Install temperature-actuated water mixing valves with check stops or shutoff valves on inlets and with shutoff valve on outlet.

1. Install thermometers and water regulators if specified.

2. Install cabinet-type units recessed in or surface mounted on wall as specified.

G. Install Y-pattern strainers for water on supply side of each water pressure-reducing valve, and pump.

H. Install outlet boxes recessed in wall. Install 2-by-4-inch (38-by-89-mm) fire-retardant-treated-wood blocking wall reinforcement between studs. Fire-retardant-treated-wood blocking is specified in Division 06 Section "Rough Carpentry."

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

J. Install air vents at high points of water piping. Install drain piping and discharge onto floor drain.

K. 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.

3.2 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 Systems."

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

3.3 LABELING AND IDENTIFYING

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

1. Pressure vacuum breakers.
2. Reduced-pressure-principle backflow preventers.
3. Double-check backflow-prevention assemblies.
4. Reduced-pressure-detector, fire-protection backflow-preventer assemblies.
5. Water pressure-reducing valves.
6. Calibrated balancing valves.
7. Primary, thermostatic, water mixing valves.
8. Water tempering valves/temperature limiting devices.
9. Trap-seal primer systems.

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

3.4 FIELD QUALITY CONTROL

A. Perform the following tests and prepare test reports:

1. Test each double-check backflow-prevention assembly according to authorities having jurisdiction and the device's reference standard.

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

3.5 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 and temperature limiting devices.

END OF SECTION

SECTION 22 13 16
SANITARY WASTE AND VENT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. 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 metal piping.

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. LLDPE: Linear, low-density polyethylene plastic.

D. NBR: Acrylonitrile-butadiene rubber.

E. PE: Polyethylene plastic.

F. PVC: Polyvinyl chloride plastic.

G. TPE: Thermoplastic elastomer.

1.4 PERFORMANCE REQUIREMENTS

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

1. Soil, Waste, and Vent Piping: 10-foot head of water (30 kPa).

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

B. Field quality-control inspection and test reports.

1.6 QUALITY ASSURANCE

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

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUB-LESS CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

1. Heavy-Duty, Shielded, Stainless-Steel Couplings: With stainless-steel shield, stainless-steel bands and tightening devices, and ASTM C 564, rubber sleeve.

a. Available Manufacturers:

1) ANACO.

2) Clamp-All Corp.

3) Ideal Div.; Stant Corp.

4) Mission Rubber Co.

5) Tyler Pipe; Soil Pipe Div.

6) Charlotte.

C. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Available Manufacturers:

a. ANACO.

2.4 SPECIAL PIPE FITTINGS

A. Flexible, Non-pressure 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. Fernco, Inc.

b. Logan Clay Products Company (The).

c. NDS, Inc.

d. Plastic Oddities, Inc.

2. Sleeve Materials:

a. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

b. For cast iron soil pipes: ASTM C564 rubber.

c. For dissimilar pipes: ASTM D 1460, elastomeric or rubber sleeve with full length, corrosion-resistant outer shield and corrosion-resistant metal tension band and tightening mechanism on each end.

B. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:
    a. EBAA Iron Sales, Inc.
    b. Romac Industries, Inc.
    c. Star Pipe Products; Star Fittings Div.

PART 3 EXECUTION

3.1 EXCAVATION

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

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground, soil and waste piping shall be the following:

1. Hubless cast iron soil pipe and fittings; heavy duty shielded stainless steel couplings and hubless coupling joints.

C. Aboveground, vent piping shall be the following:

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 shall be the following:

1. Hubless cast iron soil pipe and fittings; heavy duty shielded stainless steel couplings and hubless coupling joints

E. Aboveground & Underground Radon vent piping shall be the following:

1. Polyvinyl Chloride (PVC) plastic pipe (Type DWV), NSF Schedule 40; ASTM D2665; ASTM D 2949; ASTM F 891; CSA CAN/CSA-B181.2 with polyvinyl chloride (PVC) fittings, ASTM D3311. Mechanical joints shall be made with an elastomeric seal conforming to ASTM C 1173, ASTM D 3212 or CSA CAN/USA-B602. Joints between different materials shall be made with a mechanical joint of the compression or mechanical sealing type. Connectors or adaptors shall have an elastomeric seal conforming to ASTM C425, ASTM C443, ASTM C564, ASTM C1173, ASTM D18969, ASTM F477, CSA A257.3 or CSA CAN/CSA-B602. All joints shall be installed in accordance with the Manufacturer’s instruction.

3.3 PIPING INSTALLATIONS

A. Sanitary sewer piping outside the building is specified in Division 22 Section "Facility Sanitary Sewers."

B. Basic piping installation requirements are specified in Division 22 Section "Common Work Results for Plumbing."

C. Install seismic restraints on piping. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

D. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers.

E. 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.”

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

F. 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 two (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.

G. 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.

H. Install soil and waste drainage and vent piping at the following minimum slopes, unless otherwise indicated:

1. Sanitary Drainage Piping: Two (2) percent downward in direction of flow.

2. Vent Piping: One (1) percent down toward vertical fixture vent or toward vent stack.

I. Sleeves are not required for cast-iron soil piping passing through concrete slabs-on-grade if slab is without membrane waterproofing.

J. Install PVC soil and waste drainage and vent piping according to ASTM D 2665.

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.

M. Install sleeves for piping penetrations of walls, ceilings, and floors.

N. Install sleeve seals for piping penetrations of concrete walls and slabs.

O. Install escutcheons for piping penetrations of walls, ceilings, and floors.

P. Video tape sanitary lines during and after construction.

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

B. PVC Non-pressure Piping Joints: Join piping according to ASTM D 2665.

C. Join hubless cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-coupling joints.

D. 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.

3.5 VALVE INSTALLATION

A. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

B. Backwater Valves: Install backwater valves in piping subject to sewage backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated. Provide full-sized manhole to grade/finished floor.

2. Floor Drains: Drain outlet backwater valves, unless drain has integral backwater valve.

3. Install backwater valves in accessible locations.

4. Backwater valve are specified in Division 22 Section "Sanitary Waste Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

1. Vertical Piping: MSS Type 8 or Type 42, clamps.
2. Install individual, straight, horizontal piping runs according to the following:
    a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.
    c. Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.
3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.
4. Base of Vertical Piping: MSS Type 52, spring hangers.

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

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

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.
2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.
3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.
4. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.
5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.

G. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 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 (DN 65) and larger.

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in and before setting fixtures.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

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

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction 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 (30 kPa). 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 (250 Pa). 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.

E. Test force-main piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Leave uncovered and unconcealed new, altered, extended, or replaced force-main piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

2. Cap and subject piping to static-water pressure of 50 psig (345 kPa) above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow to stand for four hours. Leaks and loss in test pressure constitute defects that must be repaired.

3. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

4. Prepare reports for tests and required corrective action.

3.9 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

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SECTION 22 13 19
SANITARY WASTE PIPING SPECIALTIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following sanitary drainage piping specialties:

1. Cleanouts.
2. Floor drains.
3. Roof flashing assemblies.
4. Through-penetration firestop assemblies.
5. Miscellaneous sanitary drainage piping specialties.
6. Flashing materials.
7. Plumbing vent cap.

B. Related Sections include the following:

1. Division 22 Section "Storm Drainage Piping Specialties" for trench drains for storm water, channel drainage systems for storm water, roof drains, and catch basins.

1.3 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.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and accessories for the following:

1. Drains.
2. Plumbing vent cap.

1.5 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.

1.6 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate size and location of roof penetrations.

PART 2 PRODUCTS

2.1 CLEANOUTS

A. Exposed Metal Cleanouts – Unfinished areas:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 4228 Series or a comparable product by one of the following:

a. Josam Company; Josam Div.

b. MIFAB, Inc.

c. Tyler Pipe; Wade Div.

d. Watts Drainage Products Inc.

e. Zurn Plumbing Products Group; Specification Drainage Operation.

f. Josam Company; Blucher-Josam Div.

2. Standard: ASME A112.3.1 for stainless steel for cleanout test tee.

3. Size: Same as connected drainage piping

4. Body Material: Stainless-steel tee with side cleanout as required to match connected piping.

5. Closure: Countersunk brass plug.

6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

7. Closure: Stainless-steel plug with seal.

B. Metal Floor Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Series 4188C (terrazzo-recessed); Series 4168C (composition tile – recessed); Series 4048C (ceramic tile – non-recessed) and Series 4026C-Y (carpet with clean-out marker) or a comparable product by one of the following:

a. Josam Company; Josam Div.

b. Smith, Jay R. Mfg. Co.; Division of Smith Industries, Inc.

c. Tyler Pipe; Wade Div.

d. Watts Drainage Products Inc.

e. Zurn Plumbing Products Group.

2. Standard: ASME A112.36.2M for cast-iron soil pipe with cast-iron ferrule cleanout.

3. Size: Same as connected branch.

4. Type: Cast-iron soil pipe with cast-iron ferrule.

5. Body or Ferrule: Cast iron.

6. Clamping Device: Not required.

7. Outlet Connection: Inside calk.

8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round, Square, or as determined by floor type.
12. Top Loading Classification: Heavy Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

C. Wall Cleanouts:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith Series 5432 (unfinished areas, Series 4558 (plaster/drywall) and Series 4532 (tile/CMU) or a comparable product 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.
2. Standard: ASME A112.36.2M. Include wall access.
3. Size: Same as connected drainage piping.
4. Body: Hubless, cast-iron soil pipe test tee as required to match connected piping.
5. Closure: Countersunk brass 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: Square, stainless-steel wall-installation frame and cover. Refer to Series type.

D. Yard Cleanouts: Cleanout with round cast iron access from with anchor flanges, heavy-duty secured, galvanized cast iron parts.

2.2 FLOOR DRAINS

A. Cast-Iron Floor Drains – FD-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide J. R. Smith Series 2230, or a comparable product 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.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.

4. Body Material: Cast iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Epoxy-Coated.
11. Sediment Bucket: Slotted sediment bucket.
12. Top or Strainer Material: Cast iron.
13. Top of Body and Strainer Finish: Galvanized cast iron.
14. Top Shape: Round.
15. Dimensions of Top or Strainer: Twelve-inches round.
16. Top Loading Classification: Heavy Duty.
17. Funnel: Required where receiving piped waste.
18. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
19. Trap Material: Cast iron.
20. Trap Pattern: Standard Seal P-trap.
21. Trap Features: Trap-seal primer valve drain connection.

B. Cast-Iron Floor Drains – FD-2:

1. Basis-of-Design Product: Subject to compliance with requirements, provide J. R. Smith Series 2005, or a comparable product 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.
2. Standard: ASME A112.6.3.
3. Pattern: Floor drain.
4. Body Material: Cast iron.
5. Seepage Flange: Required.
6. Anchor Flange: Required.
7. Clamping Device: Required.
8. Outlet: Bottom.
9. Backwater Valve: Not required.
10. Coating on Interior and Exposed Exterior Surfaces: Not required.

11. Sediment Bucket: Not required.
12. Top or Strainer Material: Nickel bronze.
13. Top of Body and Strainer Finish: Nickel bronze.
14. Top Shape: Round.
15. Dimensions of Top or Strainer: Six-inches round (3-inch outlet), 8-inches round (4-inch outlet).
16. Top Loading Classification: Light Duty.
17. Funnel: Not required.
18. Inlet Fitting: Gray iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
19. Trap Material: Cast iron.
20. Trap Pattern: Standard P-trap.
21. Trap Features: Trap-seal primer valve drain connection.

2.3 ROOF FLASHING ASSEMBLIES

A. Roof Flashing Assemblies:
   a. Acorn Engineering Company; Elmdor/Stoneman Div.
   b. Thaler Metal Industries Ltd.
   c. All American Metal Products, Inc.

B. Description: Manufactured assembly made of 6.0-lb/sq. ft. (30-kg/sq. m), 0.0938-inch- (2.4-mm) thick, lead flashing collar or 0.032” mill finish 110-OT alloy aluminum with removable cap, EPDM base seal and skirt extending at least 18 inches from pipe, with galvanized-steel boot reinforcement and counter flashing fitting. Provide 20-year warranty against leaks, condensation, and defects in materials and/or manufacturing.

C. Vent Cap: Vandal-proof hooded vent cap, dura-coated cast iron body and hooded dome cap, vandal-proof securing device same size as vent stack as manufactured by Zurn or J.R. Smith or Josam.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:
   1. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
      a. ProSet Systems Inc.
   2. Standard: UL 1479 assembly of sleeve and stack fitting with firestopping plug.
   3. Size: Same as connected soil, waste, or vent stack.
   4. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
   5. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
   6. Special Coating: Corrosion resistant on interior of fittings.
   7. Provide mock-up of all assembly systems.

2.5 MISCELLANEOUS SANITARY DRAINAGE PIPING SPECIALTIES

A. Open Drains – (OHD w/BWV):

1. Description: Shop or field fabricate from ASTM A 74, Service class, hub-and-spigot, cast-iron, soil-pipe fittings. Include P-trap, hub-and-spigot riser section; and where required, increaser fitting joined with ASTM C 564, rubber gaskets.
2. Size: Same as connected waste piping with increaser fitting of size indicated.
3. Check Valve: Removable ball float.
4. Open hub drain shall be Josam 67100A Series, coated cast iron with ball float, 1/2" trap priming connection or comparable product of J. R. Smith, Zurn, or Wade.

B. Deep-Seal Traps:

1. Description: Cast-iron or bronze casting, with inlet and outlet matching connected piping and cleanout trap-seal primer valve connection.
2. Size: Same as connected waste piping.
   a. NPS 2 (DN 50): 4-inch- (100-mm-) minimum water seal.
   b. NPS 2-1/2 (DN 65) and Larger: 5-inch- (125-mm-) minimum water seal.

C. Floor-Drain, Trap-Seal Primer Fittings:

1. Description: Cast iron, with threaded inlet and threaded or spigot outlet, and trap-seal primer valve connection.
2. Size: Same as floor drain outlet with NPS 1/2 (DN 15) side inlet.

D. 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.
5. Size: Same as connected waste piping and with inlet large enough for associated indirect waste piping.

E. 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 (51 mm) above finished floor and galvanized-steel pipe extension in bottom of fitting that will extend through floor slab.
2. Size: As required for close fit to riser or stack piping.

F. Stack Flashing Fittings:

1. Description: Counterflashing-type, cast-iron fitting, with bottom recess for terminating roof membrane, and with threaded or hub top for extending vent pipe.
2. Size: Same as connected stack vent or vent stack.

G. Expansion Joints:

1. Standard: ASME A112.21.2M.
2. Body: Cast iron with bronze sleeve, packing, and gland.

3. End Connections: Matching connected piping.
4. Size: Same as connected soil, waste, or vent piping.

2.6 FLASHING MATERIALS

A. Lead Sheet: ASTM B 749, Type L51121, copper bearing, with the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Use: 4.0-lb/sq. ft. (20-kg/sq. m), 0.0625-inch (1.6-mm) thickness.
   2. Vent Pipe Flashing: 6.0-lb/sq. ft. (30-kg/sq. m) thickness.
   3. Burning: 0.0938-inch (2.4-mm) thickness.

B. Copper Sheet: ASTM B 152/B 152M, of the following minimum weights and thicknesses, unless otherwise indicated:
   1. General Applications: 12 oz./sq. ft. (3.7 kg/sq. m or 0.41-mm) thickness.
   2. Vent Pipe Flashing: 8 oz./sq. ft. (2.5 kg/sq. m or 0.27-mm) thickness.

PART 3 EXECUTION

3.1 INSTALLATION

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

B. Install cleanouts in aboveground piping and building drain piping according to the following, unless otherwise indicated:
   1. Size same as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) for larger drainage piping unless larger cleanout is indicated.
   2. Locate at each change in direction of piping greater than 45 degrees.
   3. Locate at minimum intervals of 50 feet (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.
   4. Locate at base of each vertical soil and waste stack.
   5. Locate at all piping prior to penetrating exterior building walls.

C. For floor cleanouts for piping below floors, install cleanout deck plates with top flush with finished floor.

D. For cleanouts located in concealed piping, install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall.

E. Install floor drains at low points of surface areas to be drained. Set grates of drains flush with finished floor, unless otherwise indicated.
   1. Position floor drains for easy access and maintenance.
   2. Set floor drains below elevation of surrounding finished floor to allow floor drainage. Set with grates depressed according to the following drainage area radii:
      a. Radius, 30 Inches (750 mm) or Less: Equivalent to 1 percent slope, but not less than 1/4-inch (6.35-mm) total depression.
      b. Radius, 30 to 60 Inches (750 to 1500 mm): Equivalent to 1 percent slope.
      c. Radius, 60 Inches (1500 mm) or Larger: Equivalent to 1 percent slope, but not greater than 1-inch (25-mm) total depression.
   3. Install floor-drain flashing collar or flange so no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes where penetrated.

4. Install individual traps for floor drains connected to sanitary building drain, unless otherwise indicated.

F. Install fixture air-admittance valves where indicated on the Drawings.

G. Install roof flashing assemblies on sanitary stack vents and vent stacks that extend through roof.

H. Install flashing fittings on sanitary stack vents and vent stacks that extend through roof.

I. Install through-penetration firestop assemblies in plastic conductors and stacks at floor penetrations.

J. Assemble open drain fittings and install with top of hub 2 inches (51 mm) above floor.

K. Install deep-seal traps on floor drains and other waste outlets, if indicated.

L. 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.

M. Install air-gap fittings on draining-type backflow preventers and on indirect-waste piping discharge into sanitary drainage system.

N. Install sleeve flashing device with each riser and stack passing through floors with waterproof membrane.

O. Install frost-resistant vent terminals on each vent pipe passing through roof. Maintain 1-inch (25-mm) clearance between vent pipe and roof substrate.

P. Install expansion joints on vertical stacks and conductors. Position expansion joints for easy access and maintenance.

Q. Install wood-blocking reinforcement for wall-mounting-type specialties.

R. Install traps on plumbing specialty drain outlets. Omit traps on indirect wastes unless trap is indicated.

S. Install hooded caps on all plumbing vents extending through the roof.

3.2 CONNECTIONS

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

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

3.3 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. Lead Sheets: Burn joints of lead sheets 6.0-lb/sq. ft. (30-kg/sq. m), thickness or thicker. Solder joints of lead sheets 4.0-lb/sq. ft. (20-kg/sq. m) thickness or thinner.

2. 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 (250 mm), and skirt or flange extending at least 8 inches (200 mm) around pipe.

2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.

3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) 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.

3.4 LABELING AND IDENTIFYING

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

1. Solids interceptors.

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

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

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

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

3.6 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.

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SECTION 22 13 29
SANITARY SEWERAGE PUMPS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Sanitary Sewerage pumps.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

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

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

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

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 PRODUCTS

2.1 SANITARY SEWERAGE PUMPS

A. Duplex Submersible Pumps with Basin:

1. Manufacturers: Subject to compliance with requirements, provide basis-of-design product or comparable products by:

a. Barnes

b. Weil

c. Bell and Gossett

d. Gould

2. Furnish and install a duplex submersible sump of the size, capacity and electrical characteristics as shown on the drawings. System shall include two (2) submersible pumps, 2-1/2-inch discharge flange/piping, basin with cover, float switches, remote mounted control panel and control system

3. Pump Design: Each pump shall be capable of handling clean water waste. The pump(s) shall be capable of handling liquids with temperatures to 104 degrees F continuous, 160 degrees F intermittent, and shall be capable of running dry for extended periods.

4. Pump Construction; The volute, seal plates, impeller and motor housing shall be constructed of high-quality ASTM A-48 class 30 cast iron. The pump(s) shall be painted with a water-based air dry enamel of 2.0 mil minimum thickness. All exposed hardware shall be 300 series stainless steel. The pump construction shall contain no points of critical clearance nor require periodic adjustment or replacement to maintain operating efficiency. Discharge connection shall be a standard 2-inch NPT in the vertical position. All gaskets shall be of the compression square ring type eliminating critical slip fits and the possibility of damage during service associated with sliding O-ring sealing arrangements.

5. The impeller shall be of the non-clog design with pump out vanes on the back side. The impeller shall be dynamically balanced to ISO G6.3 specifications.

6. The unit shall utilize a single mechanical shaft seal which shall operate in an oil atmosphere. The materials of construction shall be carbon for the rotating face and ceramic for the stationary face, lapped and polished to a tolerance of one light band, 300 series stainless steel hardware, and all elastomer parts to be of Buna-N . The seal shall be commercially available and not a proprietary design of the manufacture.

7. The pump shall be designed to be non-overloading throughout the entire pump curve. The rotor and stator assembly shall be of the standard frame design and secured to the pump seal plate by four threaded fasteners allowing for easy serviceability. Motor designs incorporating shrink or press fit assembly between the stator and motor housing shall not be acceptable. The motor shall be constructed with the windings operating in a sealed environment containing clean dielectric oil, making it capable of operating in a totally, partially or non-submerged condition for extended periods of time without damage due to the heat being generated. Air-filled motors shall not be acceptable. The motor windings shall be of Class "F" insulation. The motor shall meet the standard NEMA design L for single phase and NEMA design B for three-phase. The motor shaft shall be of 416 stainless-steel. The lower bearing shall be of the single ball type to accept radial and thrust loads, and the upper bearing of the sleeve or ball design, for radial loads. Bearings shall operate in an oil bath atmosphere for superior life. Permanently lubricated bearings are not acceptable.

8. Thermal sensors shall be used on three phase units to monitor stator temperatures. The stator shall be equipped with a thermal switch embedded in the end coil of the stator winding. This shall be used in conjunction with external motor overload protection and wired to the control panel. Single phase shall have an overload switch on the motor windings and do not require any external protection.

9. The pump shall be equipped with 15 Ft of type neoprene jacketed power cable and connected to the motor via quick disconnect spade terminals. Crimp connected cords are not acceptable. Heat shrink tubes shall be used to connect power cord leads with motor leads. A master heat shrink tube shall be provided and filled with epoxy to seal the outer cable jacket and the individual strands to prevent water from entering the motor housing. A secondary rubber pressure grommet shall be provided as an additional sealing point and strain relief at the point of cable entry. Cable entry designs utilizing terminal boards to connect power cord leads with motor leads shall not be acceptable.

10. Pump Test:

    a) The pump manufacturer shall perform the following inspections and tests in accordance with Hydraulic Institute type B standards before shipment from the factory. A check of the motor voltage and frequency shall be made as shown on the name plate.

b) A motor and cable insulation test for moisture contents or insulation defects shall be made per UL criteria.

c) The pump shall be completely submerged and run to determine that the unit meets three pre-determined hydraulic performance points.

d) A written report shall be available showing the aforementioned tests have been performed in accordance with the specifications.

11. Start-Up: The pump(s) shall be tested at start-up by a qualified representative of the manufacturer. A start-up report as provided by the manufacturer shall be completed before final acceptance of the pump(s).

12. Warranty: Two (2) years from date of substantial completion.

B. Pump Basin with Cover:

1. Provide and install Barnes or equal fiberglass basin with ballast support flange. Basin construction shall be custom molded fiberglass reinforced polyester resin. The wall thickness shall be sufficient to withstand a water-saturated sand load of 120 lbs per cubic foot with a safety factor of two (2) at all depths. The ballast support flange shall extend a minimum of three inches (3-inches) on the radius of the basin. The flange shall be fiber glassed to the bottom of the basin. Basin shall withstand a maximum temperature of 150 degrees F. Basins shall be provided with inlet hubs, and electrical conduit couplings.

2. Pump basin shall be provided with Barnes model 36D steel basin cover. Basin cover shall be finished in enamel paint. Basin cover shall include gaskets, vent and discharge couplings, inspection cover with grommets for floats, pump covers, and stainless-steel hardware.

3. Float Level Controls: Provide and install four (4) mechanically activated narrow angle float switch controls as detailed on the drawings. Three (3) level controls shall be utilized for the pump operation and the remaining level control shall be utilized for high water level alarm. Level controls shall be provided in a pipe mounted configuration with 30 feet of cable. Float switches shall be mechanically activated, snap action contacts and shall be pilot duty devices which shall control the function of motor load devices, contactors, motor starters and power relays, to automatically cycle pumps. Float switches shall be rated at 4.5 Amps at 115 VAC RES, Provide pole and stainless-steel clamps and hardware.

4. Valves: Provide and install discharge valves on each pump as detailed on the drawings. Ball check valves shall be provided with removable threaded plug and natural rubber ball. Valve body shall be ASTM class 30. Cast iron valve shall be able to withstand 150 psig.

5. Ball Valves: Ball valves shall be True Union Type manufactured of Type 1 Schedule 80 PVC with EPDM O-rings for superior chemical and corrosion resistance. Valves shall be quick disconnect type for ease of maintenance. Ball valves shall be suitable for pressures up to 150 psig.

6. Duplex Control Panel:

a) The pump manufacturer shall supply a completely self-contained duplex motor control panel. The control panel shall be provided short circuit and overload protection for the pumps. An alternator shall be provided to alternate the lead pump duty between the two pumps on successive cycles.

b) The duplex motor controls shall be housed in a NEMA 3R enclosure. The enclosure shall be formed of 16- or 14-gauge, G-90 galvanized steel, with all surfaces phosphoresced then finished inside and out with ANSI 61 gray polyester powder finish. A full width drip shield shall be formed into the top cap to prevent standing water from dripping into the interior when the door is opened. This drip shield and the formed edges of the enclosure shall provide a seating

surface for the full door gasket. The door shall be equipped with two galvanized hinges with stainless steel hinge pins. Two pad-lockable draw-pull latches shall hold the door closed. Weld nuts support the removable steel component mounting panel. The removable panel shall be white enamel and shall be drilled and tapped for component mounting. The enclosure shall have external mounting tabs for wall mounting. The enclosure must be rated NEMA 3R RAINTIGHT and shall be suitable for outdoor mounting.

c) A thermal magnetic circuit breaker shall be provided to protect each motor from short circuits and to serve as a motor branch circuit disconnect as required by the National Electrical Code (NEC). Control panel shall include single point power connection with main fused disconnect switch, pre-wired.

d) A magnetic starter shall be provided for each pump motor. The starter shall be equipped with a three (3) pole bi-metallic overload relay with ambient compensation and Class 10, quick trip heaters. Heaters must be properly sized for motor load. The overload relay shall provide the terminals for connection of the pump motor cable.

e) A control transformer shall be provided to supply 115 volts for the control circuit. The transformer shall be continuous duty machine tool type, size to meet the load requirements of the control circuit. The transformer primary shall be connected to the load side of the circuit breaker. One side of the secondary winding shall be grounded to the component mounting panel.

f) A two (2) pole, 600 VAC, 30 ampere rated fuse block shall be provided for transformer primary winding; a one (1) pole, 250 VAC, 30 ampere fuse block shall be provided for the secondary winding. Fuses shall be sized to protect the transformer in accordance with requirements of the NEC.

g) An electromechanical automatic alternator shall be provided which shall alternate the lead and lag pumps at the shut-off of each pumping cycle. The alternator circuitry shall provide means to start the lag pump in event the lead pump capacity is less than the inflow or the lead pump fails.

h) A terminal block shall be provided for connection of level controls and other control wiring as required for proper pump installation.

i) The control panel shall be equipped with a Hand-Off-Auto selector switch and an amber run light mounted on an aluminum plate under cover of the enclosure door. The selector switch shall be a toggle type with screw terminals rated 250 VAC, three (3) amperes. The run light shall be 1/3-watt 115-volt neon type.

j) The control panel shall be wired in accordance with all applicable requirements of the National Electrical Code. Control wiring shall be sixteen (16) AWG red for control circuits and white for neutral grounded conductors. Power wiring shall be a minimum of 14 AWG black. Each conductor shall be numbered. The ends of all wires shall be tinned with 60/40 lead tin alloy solder. All wiring shall be performed in a neat and orderly manner.

PART 3 EXECUTION

3.1 EARTHWORK

A. For installation, requirements and procedures for excavation and filling are specified in Section 312300 “Excavating and Filling."

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

A. Pump Installation Standards: Comply with HI 1.4 for installation of sump pumps.

B. Pump installation:

1. Provide check valve and ball valve on pump discharge.

2. Provide PVC conduit with long radius bends per Electrical drawings and specifications for power cable, on-off control, and high liquid alarm cable.

3. Provide a minimum of 5 feet extra of each cable rolled and clamped to the discharge pipe to allow for the removal of the pump from the pit.

4. Provide water-tight pipe sleeves at all vault wall penetrations.

5. Pump discharge piping: Field fabricated, Type L copper water tube.

6. Controls: Connect to Chiller Plant control systems and integrate with the BAS for Pump Status and Alarm notification.

3.4 CONNECTIONS

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

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Perform each visual and mechanical inspection.

2. Leak Test: After installation, charge system 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. Pumps and controls will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain the pumps and controls.

END OF SECTION

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SECTION 22 14 13
FACILITY STORM DRAINAGE PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following storm drainage piping inside the building:

1. Pipe, tube, and fittings.

2. Special pipe fittings.

B. Related Sections include the following:

1. Section 22 14 29 "Sump Pumps."

1.3 DEFINITIONS

A. ABS: Acrylonitrile-butadiene-styrene plastic.

B. LLDPE: Linear, low-density polyethylene plastic.

C. PE: Polyethylene plastic.

D. PVC: Polyvinyl chloride plastic.

E. TPE: Thermoplastic elastomer.

1.4 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 (30 kPa).

2. Storm Drainage, Force-Main Piping: 50 psig (345 kPa).

1.5 SUBMITTALS

A. Product Data: For pipe, tube, fittings, and couplings.

1.6 QUALITY ASSURANCE

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

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

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

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

2.2 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, tube, fitting, and joining materials.

2.3 HUBLESS CAST IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Shielded Couplings: ASTM C 1277 assembly of metal shield or housing, corrosion-resistant fasteners, and rubber sleeve with integral, center pipe stop.

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

a. Available Manufacturers:

1) ANACO.

2) Fernco, Inc.

3) Ideal Div.; Stant Corp.

4) Mission Rubber Co.

5) Tyler Pipe; Soil Pipe Div.

C. Rigid, Unshielded Couplings: ASTM C 1461, sleeve-type, reducing- or transition-type mechanical coupling molded from ASTM C 1440, TPE material with corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Available Manufacturers:

a. ANACO, or equal.

2.4 SPECIAL PIPE FITTINGS

A. Flexible, Non-pressure 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).

2. Sleeve Materials:

a. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

b. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

B. Shielded Non-pressure Pipe Couplings: ASTM C 1460, elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Mission Rubber Co.

C. Pressure Pipe Couplings: AWWA C219 metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

1. Manufacturers:

a. Cascade Waterworks Mfg. Co.

b. Dresser, Inc.; DMD Div.

c. EBAA Iron Sales, Inc.

d. Ford Meter Box Company, Inc. (The); Pipe Products Div.

e. JCM Industries, Inc.

f. Romac Industries, Inc.

g. Smith-Blair, Inc.

h. Viking Johnson.

2. Gasket Material: Natural or synthetic rubber.

3. Metal Component Finish: Corrosion-resistant coating or material.

D. Expansion Joints: Two or three-piece, ductile-iron assembly consisting of telescoping sleeve(s) with gaskets and restrained-type, ductile-iron, bell-and-spigot end sections complying with AWWA C110 or AWWA C153. Select and assemble components for expansion indicated. Include AWWA C111, ductile-iron glands, rubber gaskets, and steel bolts.

1. Manufacturers:

a. EBAA Iron Sales, Inc.

b. Romac Industries, Inc.

c. Star Pipe Products; Star Fittings Div.

PART 3 EXECUTION

3.1 EXCAVATION

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

3.2 PIPING APPLICATIONS

A. Flanges and unions may be used on aboveground pressure piping, unless otherwise indicated.

B. Aboveground storm drainage piping shall be the following:

1. Hubless cast iron soil pipe and fittings: Standard, shielded, stainless steel couplings and coupled joints in exposed areas only.

2. Dissimilar pipe material couplings: Rigid, unshielded non-pressure pipe couplings for joining dissimilar pipe materials with small difference in OD.

C. Underground storm drainage piping shall be the following:

1. Hubless cast iron soil pipe and fittings: Standard, shielded, stainless steel couplings and coupled joints in exposed areas only.

D. Underground foundation drainage piping shall be the following:

1. Slotted corrugated polyethylene tubing according to ASTM F-405 with maximum 1/8-inch slot width for the lower 120 degrees F sector. Advanced drainage system, Certain-Teed Corp. Or approved equal. Couplings shall be manufacturer’s standard band type.

3.3 PIPING INSTALLATION

A. Storm sewer and drainage piping 5-feet 0-inches and beyond, outside the building are specified in Division 33.

B. Basic piping installation requirements are specified in Section 22 05 00 "Common Work Results for Plumbing."

C. Install cleanouts at grade and extend to where building storm drains connect to building storm sewers. Cleanouts are specified in Division 22 Section "Storm Drainage Piping Specialties."

D. Install cleanout fitting with closure plug inside the building in storm drainage force-main piping.

E. 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."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105.

F. 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.

G. 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.

H. Install storm drainage piping at the following minimum slopes, unless otherwise indicated:

1. Building Storm Drain: 2 percent downward in direction of flow for piping NPS 3 (DN 80) and smaller; 2 percent downward in direction of flow for piping NPS 4 (DN 100) and larger.

2. Horizontal Storm-Drainage Piping: 2 percent downward in direction of flow.

I. Install force mains at elevations indicated.

J. Install PVC storm drainage piping according to ASTM D 2665.

K. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

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

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

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

3.4 JOINT CONSTRUCTION

A. Basic piping joint construction requirements are specified in Division 22 Section "Common Work Results for Plumbing."

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.

3.5 VALVE INSTALLATION

A. General valve installation requirements are specified in Division 22 Section "General-Duty Valves for Plumbing Piping."

B. Backwater Valves: Install backwater valves in piping subject to backflow.

1. Horizontal Piping: Horizontal backwater valves. Use normally closed type, unless otherwise indicated.

2. Install backwater valves in accessible locations.

3. Backwater valve are specified in Division 22 Section "Storm Drainage Piping Specialties."

3.6 HANGER AND SUPPORT INSTALLATION

A. Seismic-restraint devices are specified in Division 22 Section "Vibration and Seismic Controls for Plumbing Piping and Equipment."

B. Pipe hangers and supports are specified in Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment." Install the following:

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

2. Individual, Straight, Horizontal Piping Runs: According to the following:

a. 100 Feet (30 m) and Less: MSS Type 1, adjustable, steel clevis hangers.

b. Longer Than 100 Feet (30 m): MSS Type 43, adjustable roller hangers.

c. Longer Than 100 Feet (30 m), if Indicated: MSS Type 49, spring cushion rolls.

3. Multiple, Straight, Horizontal Piping Runs 100 Feet (30 m) or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

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

C. Install supports according to Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."

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

E. Rod diameter may be reduced 1 size for double-rod hangers, with 3/8-inch (10-mm) minimum rods.

F. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 60 inches (1500 mm) with 3/8-inch (10-mm) rod.

2. NPS 3 (DN 80): 60 inches (1500 mm) with 1/2-inch (13-mm) rod.

3. NPS 4 and NPS 5 (DN 100 and DN 125): 60 inches (1500 mm) with 5/8-inch (16-mm) rod.

4. NPS 6 (DN 150): 60 inches (1500 mm) with 3/4-inch (19-mm) rod.

5. NPS 8 to NPS 12 (DN 200 to DN 300): 60 inches (1500 mm) with 7/8-inch (22-mm) rod.

6. Spacing for 10-foot (3-m) lengths may be increased to 10 feet (3 m). Spacing for fittings is limited to 60 inches (1500 mm).

G. Install supports for vertical cast-iron soil piping every 15 feet (4.5 m).

H. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.7 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.

3.8 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

1. Roughing-in Inspection: Arrange for inspection of piping before concealing or closing-in after roughing-in.

2. Final Inspection: Arrange for final inspection by authorities having jurisdiction to observe tests specified below and to ensure compliance with requirements.

B. Reinspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for reinspection.

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

D. 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, 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 (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. 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.

3.9 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

SECTION 22 14 23
STORM DRAINAGE PIPING SPECIALTIES

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Drains.
2. Cleanouts.
3. Backwater valves.
4. Through-penetration firestop assemblies.
5. Flashing materials.

1.3 SUBMITTALS

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

1.4 QUALITY ASSURANCE

A. Drainage piping specialties shall bear label, stamp, or other markings of specified testing agency.

PART 2 - PRODUCTS

2.1 DRAINS

A. Stairwell Trench Drains: Furnish and install Zurn Model Z-886, 6-inch-wide trench drains in lengths as indicated on the Architectural drawings. Trench drains shall be modular type, HDPE channels with bottom outlet. Furnish extension sections as required. Top shall be secured with vandal proof screws; perforated stainless steel grate – Class A rating. Outlet pipe size shall be as indicated on the contract drawings.

B. Areaway Drain: Zurn FD-2200-NH4-VP; minimum 5-inch diameter round top drain, dura coated 2-1/2-inch-deep cast iron body with bottom outlet, vandal-proof top.

C.

2.2 CLEANOUTS

A. Floor Cleanouts:

1. Basis of Design Product: Subject to the compliance with requirements, provide Jay R. Smith Series 4188C (terrazzo-recessed), Series 4168C (composition tile –recessed), Series 4048C (Ceramic tile –Non-recessed), and Series 40266-Y (carpet with clean-out marker0 or comparable products of one of the following:
    a. Josam Company.
    b. Smith, Jay R. Mfg. Co.
    c. Zurn Plumbing Products Group; Specification Drainage Operation.
    d. Wade Manufacturing Co.
    e. Watts Water Technologies, Inc.
2. Standard: ASME A112.36.2M, cast iron soil pipe with cast iron ferrule.

3. Size: Same as connected branch.
4. Type: Cast iron soil pipe with cast iron ferrule.
5. Body or Ferrule Material: Cast iron.
6. Clamping Device: Not required.
7. Outlet Connection: Inside calk.
8. Closure: Brass plug with tapered threads.
9. Adjustable Housing Material: Cast iron with threads.
10. Frame and Cover Material and Finish: Nickel-bronze, copper alloy.
11. Frame and Cover Shape: Round or square as determined by floor type.
12. Top-Loading Classification: Light Duty.
13. Riser: ASTM A 74, Service class, cast-iron drainage pipe fitting and riser to cleanout.

B. Test Tees:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Josam Company.
    b. Smith, Jay R. Mfg. Co.
    c. Watts Water Technologies, Inc.
    d. Zurn Plumbing Products Group; Specification Drainage Operation.
    e. Wade Manufacturing Co.
2. Standard: ASME A112.36.2M and ASTM A 74, ASTM A 888, or CISPI 301, for cleanout test tees.
3. Size: Same as connected drainage piping.
4. Body Material: Cast-iron soil-pipe T-branch or hubless, cast-iron soil-pipe test tee as required to match connected piping.
5. Closure Plug: Countersunk.
6. Closure Plug Size: Same as or not more than one size smaller than cleanout size.

C. Wall Cleanouts:

1. Basis of Design Product: Subject to compliance with requirements, provide Jay R. Smith Series 5432 (unfinished areas), Series 4558 plaster/drywall) and Series 4532 (tile and CMU) or comparable product of one of the following:
    a. Josam Company.
    b. Smith, Jay R. Mfg. Co.
    c. Wade Manufacturing Co.
    d. Watts Water Technologies, Inc.
    e. Zurn Plumbing Products Group; Specification Drainage Operation.
2. Standard: ASME A112.36.2M, for cleanouts. Include wall access.
3. Size: Same as connected drainage piping.
4. Body Material: Hubless, cast-iron soil-pipe test tee as required to match connected piping.

5. Closure: Countersunk brass 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. Refer to Series type.
8. Wall Access: Square stainless steel wall installation frame and cover.

D. Downspout Boot Cleanouts:

1. Smith, Zurn, Josam, Neenah or approved equal cast iron body downspout boot with strap. Furnish unit with cast holes and galvanized flat head bolts. Refer to the Architectural Contract documents for exact size. Downspout boots shall discharge into coated cast iron cleanout tee with bronze plug. All components shall be painted in color as selected by Architect.

2.3 BACKWATER VALVES

A. Cast-Iron, Horizontal Backwater Valves:

1. Basis of Design Product: Subject to compliance with requirements, provide Jay R. Smith Series 7022S or comparable product of one of the following:
   a. Josam Company.
   b. Smith, Jay R. Mfg. Co.
   c. Watts Water Technologies, Inc.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.
   e. Wade Manufacturing Co.
2. Standard: ASME A112.14.1, for backwater valves.
3. Size: Same as connected piping.
4. Body Material: Cast iron.
5. Cover: Cast iron with bolted access check valve.
6. End Connections: hubless.
7. Check Valve: Removable, bronze, swing check, factory assembled or field modified to hang closed.
8. Extension: ASTM A 74, Service class; full-size, cast-iron soil-pipe extension to field-installed cleanout at floor; replaces backwater valve cover.

B. Cast-Iron, Drain-Outlet Backwater Valves:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Jay R. Smith 7080 Series or comparable product by one of the following:
   a. Josam Company.
   b. Smith, Jay R. Mfg. Co.
   c. Watts Water Technologies, Inc.
   d. Zurn Plumbing Products Group; Specification Drainage Operation.
   e. Wade Manufacturing Co.
2. Size: Same as floor drain or no huboutlet.
3. Body Material: Cast iron or bronze made for vertical installation in bottom outlet of floor drain.

4. Check Valve: Removable ball float.
5. Inlet: Threaded.
6. Outlet: Threaded or spigot.

2.4 THROUGH-PENETRATION FIRESTOP ASSEMBLIES

A. Through-Penetration Firestop Assemblies:

1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the work include, but are not limited to, the following:
   a. ProSet Systems Inc.
2. Standard: ASTM E 814, for through-penetration firestop assemblies.
3. Certification and Listing: Intertek Testing Service NA for through-penetration firestop assemblies.
4. Size: Same as connected pipe.
5. Sleeve: Molded PVC plastic, of length to match slab thickness and with integral nailing flange on one end for installation in cast-in-place concrete slabs.
6. Stack Fitting: ASTM A 48/A 48M, gray-iron, hubless-pattern, wye branch with neoprene O-ring at base and gray-iron plug in thermal-release harness. Include PVC protective cap for plug.
7. Special Coating: Corrosion resistant on interior of fittings.
8. Provide mock-up of firestop assembly.

2.5 FLASHING MATERIALS

A. Copper Sheet: ASTM B 152/B 152M, 1203/sq.ft.

B. Zinc-Coated Steel Sheet: ASTM A 653/A 653M, with 0.20 percent copper content and 0.04-inch (1.01-mm) minimum thickness unless otherwise indicated. Include G90 (Z275) 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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install roof drains at low points of roof areas according to roof membrane manufacturer's written installation instructions. Roofing materials are specified in Division 07 Sections.

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 adapters on outlet of back-outlet parapet roof drains and connect to sheet metal downspouts.

C. Install downspout boots at grade with top a minimum of 18 inches (Refer to Architectural Drawings) above grade. Secure to building wall.

D. Install conductor nozzles at exposed end of conductors where they spill onto grade.

E. Install cleanouts in aboveground piping and building drain piping according to the International Plumbing Code, Baltimore County requirements, and where indicated.

1. Use cleanouts the same size as drainage piping up to NPS 4 (DN 100). Use NPS 4 (DN 100) 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 (15 m) for piping NPS 4 (DN 100) and smaller and 100 feet (30 m) for larger piping.

4. Locate cleanouts 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 horizontal backwater valves in floor with cover flush with floor.

I. Install drain-outlet backwater valves in outlet of drains and accessible for service and replacement.

J. Install test tees in vertical conductors and near floor.

K. Install wall cleanouts in vertical conductors. Install access door in wall if indicated.

L. Install trench drains at low points of surface areas to be drained. Set grates of drains flush with finished surface unless otherwise indicated.

M. Assemble channel drainage system components according to manufacturer's written instructions. Install on support devices so that top will be flush with adjacent surface.

N. Install through-penetration firestop assemblies in plastic conductors at concrete floor penetrations.

O. Install sleeve flashing device with each conductor passing through floors with waterproof membrane.

P. Install backwater valves for all storm water lines collecting clear water condensate drain lines from air handling units, heat pumps and cooling units. Provide drain outlet backwater valves when they can be installed for easy removal and replacement. Provide horizontal type backwater valves when located in the floor slab on grade. A floor drain with integral deep sediment bucket, backwater valve, trap with primary connection and flush access cover (J.R. Smith figure 2510) is acceptable for in slab applications.

3.2 CONNECTIONS

A. Comply with requirements for piping specified in Division 22 Sections. Drawings indicate general arrangement of piping, fittings, and specialties.

3.3 FLASHING INSTALLATION

A. Fabricate flashing from single piece of metal unless large pans, sumps, or other drainage shapes are required. Join flashing according to the following if required:

1. Lead Sheets: Burn joints of 6.0-lb/sq. ft. (30-kg/sq. m) lead sheets. Solder joints of 4.0-lb/sq. ft. (20-kg/sq. m) lead sheets, 0.0625-inch (1.6-mm) thickness or thinner.

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 the pipe size, with a minimum length of 10 inches (250 mm) and with skirt or flange extending at least 8 inches (200 mm) around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8 inches (200 mm) 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. Fabricate and install flashing and pans, sumps, and other drainage shapes.

F. Support/anchor all storm drain piping elbows connecting roof drains and overflow drains to structure.

3.4 PROTECTION

A. Protect drains during remainder of construction period to avoid clogging with dirt or debris and to prevent damage from traffic or construction work.

B. Place plugs in ends of uncompleted piping at end of each day or when work stops.

END OF SECTION

SECTION 22 14 29
SUMP PUMPS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Submersible sump pumps.

B. Related Sections:

1. 22 14 13 - Facility Storm Drainage Piping.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

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

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pumps and controls, to include in operation and maintenance manuals.

1.5 QUALITY ASSURANCE

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

B. UL Compliance: Comply with UL 778 for motor-operated water pumps.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Retain shipping flange protective covers and protective coatings during storage.

B. Protect bearings and couplings against damage.

C. Comply with pump manufacturer's written rigging instructions for handling.

PART 2 PRODUCTS

2.1 SUBMERSIBLE SUMP PUMPS

A. Submersible Sump Pumps for Elevator Pit:

1. Manufacturers: Subject to compliance with requirements, provide basis-of-design product or comparable products by:

a. Stancor, Inc.

b. Little Giant

c. Zoller

d. Gould

2. Description: Factory-assembled and -tested sump-pump unit.

3. Pump Type: Submersible, end-suction, single-stage, close-coupled, overhung-impeller, centrifugal sump pump as defined in Hydraulic Institute (HI) 1.1-1.2 and 1.3 with oil sensor.

4. Pump Casing: Stainless steel, with stainless steel inlet strainer, legs that elevate pump to permit flow into impeller, and vertical discharge with companion flange suitable for piping connection.
5. Impeller: Statically and dynamically balanced, ASTM A 532/A 532M, abrasion-resistant stainless-steel design for clear wastewater handling, and keyed and secured to shaft.
6. Pump and Motor Shaft: Stainless steel, with factory-sealed, grease-lubricated ball bearings.
7. Seal: Mechanical.
8. Motor: Hermetically sealed, capacitor-start type; with built-in overload protection; lifting eye or lug; and three-conductor, waterproof power cable of length required and with grounding plug and cable-sealing assembly for connection at pump.
9. Controls:
    a. Enclosure: NEMA 4X Type 1.
    b. Switch Type: Integral float switches for pump on-off and high-water alarm.
    c. Control panel with selector switch, pilot lights, audio-visual alarms, control transformer, and additional contacts for remote alarm bell and BAS interface.
10. Control-Interface Features:
    a. Remote Alarm Contacts: For remote alarm interface.
    b. Building Automation System Interface: Auxiliary contacts in pump controls for interface to building automation system and capable of providing the following:
        1) On-off status of pump.
        2) Alarm status.
        3) Pump shut-down.

2.2 MOTORS

A. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 22 Section "Common Motor Requirements for Plumbing Equipment."
    1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.
B. Motors for submersible pumps shall be hermetically sealed.

PART 3 EXECUTION

3.1 EARTHWORK

A. For sump installation, requirements and procedures for excavation and filling are specified in Division 31.

3.2 EXAMINATION

A. Examine roughing-in for plumbing piping to verify actual locations of storm drainage piping connections before sump pump installation.

3.3 INSTALLATION

A. Pump Installation Standards: Comply with Hydraulic Institute (HI) 1.4 for installation of sump pumps.
B. Elevator Sump Pump installation:
    1. Provide check valve and ball valve on pump discharge.

2. Provide 4” Schedule 40 PVC conduit with long radius bends between pump and control panel for power cable, on-off control, and high liquid alarm cable.
3. Provide a minimum of 5 feet extra of each cable rolled and clamped to the discharge pipe to allow for the removal of the pump from the pit.
4. Provide water-tight pipe sleeve at all elevator shaft wall penetrations.
5. Pump discharge piping: Field fabricated, Type L copper water tube.
6. Controls: Connect to Building Automation System for Pump Status and Alarm notification.

3.4 CONNECTIONS

A. Comply with requirements for piping specified in Section 22 14 13 "Facility Storm Drainage Piping." Drawings indicate general arrangement of piping, fittings, and specialties.

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

3.5 FIELD QUALITY CONTROL

A. Tests and Inspections:
1. Perform each visual and mechanical inspection.
2. Leak Test: After installation, charge system 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. Pumps and controls will be considered defective if they do not pass tests and inspections.

C. Prepare test and inspection reports.

3.6 STARTUP SERVICE

A. Perform startup service.
1. Complete installation and startup checks according to manufacturer's written instructions.

3.7 ADJUSTING

A. Adjust pumps to function smoothly, and lubricate as recommended by manufacturer.

B. Adjust control set points.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain the pumps and controls.

END OF SECTION

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SECTION 22 33 00
ELECTRIC DOMESTIC-WATER HEATERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Flow-control, electric, tankless, point of use domestic-water heaters.

B. Related Sections:

1. Section 22 11 16 "Domestic Water Piping."

1.3 ACTION SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings:

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

1.4 INFORMATIONAL SUBMITTALS

A. Product Certificates: For commercial, electric domestic-water heater, from manufacturer.

B. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

C. Source quality-control reports.

D. Field quality-control reports.

E. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For electric, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.6 QUALITY ASSURANCE

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

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV, Part HLW.

D. ANSI compliance: Follow safety and construction requirements of ANSI Z21.10.

E. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.7 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of electric, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.

b. Faulty operation of controls.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Electric, tankless, Domestic-Water Heaters:

1) Electric Element, Controls and Other Components: Five (5) years.

PART 2 PRODUCTS

2.1 ELECTRIC, TANKLESS, DOMESTIC-WATER HEATERS

A. Commercial, Electric, Storage, Domestic-Water Heaters:

1. Manufacturers: Subject to compliance with requirements, provide basis-of-design product by:

a. Chronomite

b. Bock Water Heaters, Inc.

c. A.O. Smith

2. Standard: UL 499 for electric, tankless, (domestic-water heater) heating appliance.

3. Construction: Copper piping or tubing complying with NSF 61 Annex G barrier materials for potable water, without storage capacity.

a. Connections: ASME B1.20.1 pipe thread.

b. Pressure Rating: 150 psig.

c. Heating Element: Resistance heating system.

d. Temperature Control: Flow-control fitting.

e. Safety Control: High-temperature-limit cutoff device or system.

f. Jacket: Aluminum or steel with enameled finish or plastic.

4. Support: Bracket for wall mounting.

5. Capacity and Characteristics:

a. Flow Rate: As Scheduled.

b. Maximum Temperature Setting: 104 deg F.

c. Power Demand: As Scheduled.

d. Electrical Characteristics:

1) Volts: 208

2) Phases: Single.

3) Hertz: 60.

4) Full-Load Amperes: As Scheduled.

5) Minimum Circuit Ampacity: As Scheduled.

6) Maximum Overcurrent Protection: As Scheduled.

2.2 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters and storage tanks specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 for retesting and reinspecting requirements and for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 EXECUTION

3.1 DOMESTIC-WATER HEATER INSTALLATION

A. Electric, Tankless, Domestic-Water Heater Mounting: Install electric, tankless, domestic-water heaters at least 18 inches (457 mm) above floor on wall bracket.

1. Maintain manufacturer's recommended clearances.

2. Arrange units so controls and devices that require servicing are accessible.

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

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

5. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Division 23 Section "General-Duty Valves for Mechanical Piping."

A. Install combination temperature-and-pressure relief valves in water piping for electric, domestic-water heaters without storage. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

B. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains. Comply with requirements for hose-end drain valves specified in Section 22 11 19 "Domestic Water Piping Specialties."

C. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Division 23 Section "Meters and Gages for Mechanical Piping."

D. Fill domestic-water heaters with water.

3.2 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 22 11 16 "Domestic Water Piping."

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

C. Where installing piping adjacent to domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.3 IDENTIFICATION

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

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

2. Leak Test: After installation, charge system 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 operation.

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

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 01 for retesting and reinspecting requirements.

C. Prepare test and inspection reports.

3.5 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain commercial, electric, storage, domestic-water heaters.

END OF SECTION

SECTION 22 42 13.13
COMMERCIAL WATER CLOSETS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Water closets.
2. Flushometer valves.
3. Toilet seats.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for water closets.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For flushometer valves to include in operation and maintenance manuals.

1.5 MAINTENANCE MATERIAL SUBMITTALS

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

1. Flushometer-Valve Repair Kits: Equal to 10 percent of amount of each type installed, but no fewer than one of each type.

PART 2 PRODUCTS

2.1 WATER CLOSETS

A. Water Closets P-1: Floor mounted, bottom outlet, top spud (ADA Compliant).

1. Basis-of-Design Product: Subject to compliance with requirements, provide Kohler Highcliff Ultra model K-96057 or comparable product by one of the following:
   a. American Standard
   b. Sloan.
2. Bowl:
   a. Standards: ASME A112.19.2/CSA B45.1 and ASME A112.19.5.
   b. Material: Vitreous china.
   c. Type: Siphon jet.
   d. Style: Flushometer valve.
   e. Height: 17” handicapped complying with ICC/ANSI A117.1.
   f. Rim Contour: Elongated.
   g. Water Consumption: 1.28 gal. (4.8 L) per flush.

h. Spud Size and Location: NPS 1-1/2 (DN 40); top.

i. Color: White.

1. Flushometer Valve: (FV-1).
2. Toilet Seat: (TS-1).
3. Support: See “Fixture Supports” article.

2.2 FLUSHOMETER VALVES

A. Manual Lever-Handle, Diaphragm Flushometer Valves FV-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Sloan Royal 111-1.28 Manual Flushometer or comparable product by the following:

a. Zurn

b. TOTO

c. Moen

d. Delany

2. Standard: ASSE 1037.
3. Minimum Pressure Rating: 125 psig (860 kPa).
4. Features: Include integral check stop and backflow-prevention device.
5. Material: Brass body with corrosion-resistant components.
6. Exposed Flushometer-Valve Finish: Chrome plated.
7. Panel Finish: Polished Chrome.
8. Style: Exposed.
9. Consumption: 1.28 gpf per flush.
10. Minimum Inlet: NPS 1 (DN 25).
11. Minimum Outlet: NPS 1-1/2 (DN 40).

2.3 TOILET SEATS

A. Toilet Seats TS-1:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Kohler Stronghold model K-4731-CA or comparable product by one of the following:

a. American Standard America.

b. Bemis Manufacturing Company.

c. Church Seats.

d. Olsonite Seat Co.

e. Zurn Industries, LLC; Commercial Brass and Fixtures.

2. Standard: IAPMO/ANSI Z124.5.
3. Material: Plastic.
4. Type: Commercial (Heavy duty).
5. Shape: Elongated rim, open front.
6. Hinge: Self-sustaining, check.

7. Hinge Material: Noncorroding metal.
8. Seat Cover: Not required.
9. Color: White.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before water-closet installation.

B. Examine walls and floors for suitable conditions where water closets will be installed.

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

3.2 INSTALLATION

A. Water-Closet Installation:

1. Install level and plumb according to roughing-in drawings.
2. Install floor-mounted water closets on bowl-to-drain connecting fitting attachments to piping or building substrate.
3. Install accessible, wall-mounted water closets at mounting height according to ICC/ANSI A117.1.

B. Support Installation:

1. Install supports, affixed to building substrate, for floor-mounted, bottom-outlet water closets.
2. Use carrier supports with waste-fitting assembly and seal.
3. Install floor-mounted, back-outlet water closets attached to building floor substrate, onto waste-fitting seals; and attach to support.

C. Flushometer-Valve Installation:

1. Install flushometer-valve, water-supply fitting on each supply to each water closet.
2. Attach supply piping to supports or substrate within pipe spaces behind fixtures.

D. Install toilet seats on water closets.

E. Wall Flange and Escutcheon Installation:

1. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations and within cabinets and millwork.
2. Install deep-pattern escutcheons if required to conceal protruding fittings.
3. Comply with escutcheon requirements specified in Section 22 05 00 "Common Work Results for Plumbing."

F. Joint Sealing:

1. Seal joints between water closets and walls and floors using sanitary-type, one-part, mildew-resistant silicone sealant.
2. Match sealant color to water-closet color.
3. Comply with sealant requirements specified in Division 07.

3.3 CONNECTIONS

A. Connect water closets with water supplies and soil, waste, and vent piping. Use size fittings required to match water closets.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

D. Where installing piping adjacent to water closets, allow space for service and maintenance.

3.4 ADJUSTING

A. Operate and adjust water closets and controls. Replace damaged and malfunctioning water closets, fittings, and controls.

B. Adjust water pressure at flushometer valves to produce proper flow.

3.5 CLEANING AND PROTECTION

A. Clean water closets and fittings with manufacturers' recommended cleaning methods and materials.

B. Install protective covering for installed water closets and fittings.

C. Do not allow use of water closets for temporary facilities unless approved in writing by Owner.

END OF SECTION

SECTION 22 42 16.13
COMMERCIAL LAVATORIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Lavatories.

2. Faucets.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for lavatories.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring of automatic faucets.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For lavatories and faucets to include in operation and maintenance manuals.

1. Servicing and adjustments of automatic faucets.

1.6 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. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.

2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 PRODUCTS

2.1 VITREOUS-CHINA, WALL-HUNG LAVATORIES

A. Lavatory P-2: Rectangular, vitreous china, wall hung.

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

2. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard Decorum Wall-Hung Lavatory model 9024.011 EC or comparable product by one of the following:

a. Crane Plumbing, L.L.C.

b. Kohler Co.

c. TOTO USA, INC.

3. Fixture:

a. Standard: ASME A112.19.2M/CSA B45.

b. Type: Wall-Hung

c. Nominal Size: 20 x 18.

d. Faucet-Hole Punching: One.

e. Faucet-Hole Location: Center Hole with right-hand soap dispenser

f. Color: White.

g. Mounting Kit: 047194-0070A with template.

4. Faucet: (LF-1)

2.2 SOLID-BRASS, MANUALLY OPERATED LAVATORY FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet materials that will be in contact with potable water.

B. Lavatory Faucets LF-1: Manual type, ADA two knob mixing, solid-brass valve.

1. Basis-of-Design Product: Subject to compliance with requirements, provide American Standard 1340.827 or comparable product by one of the following:

a. Central Brass – a division of Pioneer Industries, Inc.
b. Kohler Co.
c. Moen

2. Standards: ASME A112.18.1/CSA B125.1.

3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and fixture receptor.

4. Body Type: wide spread faucet – 8” centers.

5. Body Material: Commercial, solid brass.

6. Finish: Polished chrome plate.

7. Maximum Flow Rate: 0.5 gpm (1.5 L/min.).

8. Mounting Type: Deck, concealed.

9. Valve Handles: Push Button.

10. Spout: Rigid type.

11. Spout Outlet: Spray.

12. Drain: Refer below.

C. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for supply-fitting materials that will be in contact with potable water.

D. Standard: ASME A112.18.1/CSA B125.1.

E. Supply Piping: Chrome-plated-brass pipe or chrome-plated copper tube matching water-supply piping size. Include chrome-plated-brass or stainless-steel wall flange.

F. Supply Stops: Chrome-plated-brass, one-quarter-turn, ball-type or compression valve with inlet connection matching supply piping.

G. Operation: Loose key.

H. Risers:

1. NPS 3/8 (DN 10).
2. Chrome-plated, rigid-copper-pipe and brass straight or offset tailpieces riser.

2.3 WASTE FITTINGS

A. Standard: ASME A112.18.2/CSA B125.2.

B. Drain: Kohler K-7129-A, polished chrome with NPS 1-1/4 (DN 32) offset and straight tailpiece.

C. Trap:

1. Size: NPS 1-1/2 by NPS 1-1/4 (DN 40 by DN 32).
2. Material: Chrome-plated, two-piece, cast-brass trap and swivel elbow with 0.032-inch- (0.83-mm-) thick brass tube to wall and chrome-plated, brass or steel wall flange.
3. Material: Stainless-steel, two-piece trap and swivel elbow with 0.012-inch- (0.30-mm-) thick stainless-steel tube to wall; and stainless-steel wall flange.

PART 3 EXECUTION

3.1 INSTALLATION

A. Assemble fixtures, accessories, and associated fittings and trim in accordance with manufacturer's instructions.

B. Install fixture supports firmly attached to building structure.

C. Install fixtures level, plumb, and in accordance with manufacturer's rough-in instructions.

D. Install water supply piping. Provide stop on each supply in readily-serviceable location. Fasten supply piping to supports or substrate.

E. Install trap and waste piping to each fixture.

F. Install escutcheons at exposed piping penetrations in finished locations and within cabinets. Comply with escutcheon requirements specified in Section 22 05 00 "Common Work Results for Plumbing."

G. Seal joints between fixtures and walls, floors, and countertops with mildew-resistant silicone sealant meeting requirements in Division 07.

3.2 CLEANING AND PROTECTION

A. Repair or replace defective work, including damaged fixtures and components.

B. At time of Substantial Completion:

1. Clean unit surfaces, test fixtures, and leave in ready-to-use condition.
2. Install new batteries in battery-operated devices.
3. Fill soap dispensers.
4. Turn over keys, tools, maintenance instructions, and maintenance stock to Owner.

C. Protect units with water-resistant temporary covering. Do not allow temporary use of plumbing fixtures. Remove protection at Substantial Completion and dispose.

3.3 TESTING AND ADJUSTING

A. Set field-adjustable temperature set points of temperature-actuated water mixing valves. Adjust set point within allowable temperature range.

B. Test and adjust installation.

END OF SECTION

SECTION 22 42 16.16
COMMERCIAL SINKS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Service Basins/Mop Sinks.
2. Sinks.
3. Sink faucets.
4. Supply fittings.
5. Waste fittings.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for sinks.
2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

1.4 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Counter cutout templates for mounting of counter-mounted lavatories.

1.5 CLOSEOUT SUBMITTALS

A. Maintenance Data: For sinks to include in maintenance manuals.

1.6 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. Faucet Washers and O-Rings: Equal to 10 percent of amount of each type and size installed.
2. Faucet Cartridges and O-Rings: Equal to 5 percent of amount of each type and size installed.

PART 2 PRODUCTS

2.1 SERVICE BASINS/MOP SINKS

A. Service Basin P-3: Floor mounted.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Fiat Model MSB2424 or comparable product by one of the following:
   a. Elkay
   b. Acorn Engineering Company.
   c. Stern Williams.
   d. Florestone Products Co., Inc.

2. Fixture:
    a. Material: Molded Stone.
    b. Shape: Rectangular.
    c. Nominal Size: 24 x 24 inches.
    d. Height: 10-inches.
    e. Rim Guard: Stainless-steel guard on all top surfaces.
    f. Finish: N/A
    g. Drain: Integral drain, Fiat STRID1000 stainless-steel strainer with Fiat QIC3XH gasket.
3. Mounting: On floor and flush to wall.
4. Options: Stainless-steel wall guard, Fiat MSG2424.
5. Faucet: (SF-1)

2.2 UTILITY SINKS:

A. Counter Sink P-5 (ADA):
1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay model ELUHAD191650 or a comparable product by one of the following:
    a. Advance Tabco.
    b. Just Manufacturing Company.
2. Fixture:
    a. Standard: ASME A112.19.3/CSA B45.4.
    b. Type: Undermount.
    c. Material: 304 Stainless-steel
    d. Number of Compartments: One.
    e. Overall Dimensions: 21-1/2” X 18-1/2” X 4-7/8”
    f. Metal Thickness: 18 gauge.
    g. Compartment:
        1) Dimensions: 19” x 16” x 4-7/8”
        2) Drain: Grid with NPS 3-1/2 tailpiece and twist drain.
        3) Drain Location: Rear Center
3. Faucet(s): SF-2.
    a. Number Required: One.
    b. Mounting: On ledge.
4. Supply fittings:
    a. Standard: ASME A112.18.1/CSA B125.1.
    b. Supplies: Chrome-plated brass compression stop with inlet connection matching water-supply piping type and size.
        1) Operation: Loose key.
        2) Risers: NPS 1/2 (DN 15, chrome-plated, soft-copper flexible tube.

5. Waste Fittings:
   a. Standard: ASME A 112.18.2/CSA B125.2.
   b. Drain: Elkay LK99 – 3-1/2" basket strainer, stainless-steel with chrome finish, 1-1/2" OD x 4" tailpiece.
   c. Trap(s):
      1) Size: NPS 1-1/2 (DN 40).
      2) Material: Chrome-plated two-piece, cast-brass trap and swivel elbow with 0.032-inch (0.83-mm) thick brass tube to wall and chrome-plated brass or steel wall flange.
   d. Continuous Waste:
      1) Size: NPS 1-1/2 (DN 40).
      2) Material: Chrome-plated, 0.032-inch- (0.83-mm) thick brass tube.
6. Mounting: On counter with sealant.
7. Accessories: Deck mounted commercial soap dispenser. ADA compliant. 34-ounce capacity, polished chrome finish.

2.3 SINK FAUCETS

A. NSF Standard: Comply with NSF/ANSI 61, "Drinking Water System Components - Health Effects," for faucet-spout materials that will be in contact with potable water. Comply with NSF 61, Annex G and NSF 372.

B. Sink Faucets SF-1: Manual type, two-lever-handle mixing valve.
   1. Basis-of-Design Product: Subject to compliance with requirements, provide Fiat Model 803AA or comparable product by one of the following:
      a. American Standard America.
      b. Bradley Corporation.
      c. Chicago Faucets.
      d. Delta Faucet Company.
      e. GROHE America, Inc.
      f. Kohler Co.
   2. Standard: ASME A112.18.1/CSA B125.1.
   3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.
   4. Body Type: Widespread.
   5. Body Material: Commercial, solid brass.
   6. Finish: Chrome-plated.
   7. Maximum Flow Rate: 4 gpm (15 L/min.).
   8. Handle(s): Lever.
   9. Mounting Type: Back/wall exposed.
   10. Spout Type: Rigid, solid brass with wall brace.
   11. Vacuum Breaker: Required for hose outlet.
   12. Spout Outlet: ¾" Hose thread.

C. Sink Faucets SF-2: Manual type, two-lever-handle mixing valve.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay Model LKGT1041or comparable product by one of the following:

a. American Standard America.

b. Bradley Corporation.

c. Chicago Faucets.

d. Delta Faucet Company.

e. Kohler Co.

2. Standard: ASME A112.18.1/CSA B125.1.

3. General: Include hot- and cold-water indicators; coordinate faucet inlets with supplies and fixture hole punchings; coordinate outlet with spout and sink receptor.

4. Body Material: Commercial, solid brass.

5. Base: Mid-Rise and Hi-Rise options.

6. Finish: Polished chrome-plate.

7. Maximum Flow Rate: 1.5 gpm (5.7 L/min.).

8. Handle(s): level handle.

9. Mounting Type: Deck mount, exposed, single hole drilling.

10. Spout Type: Pull-out spray style, 10-1/8” spout reach, 11” high.

11. Vacuum Breaker: Not required for hose outlet.

12. Spout Outlet: Aerator.

2.4 GROUT

A. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

B. Characteristics: Non-shrink; recommended for interior and exterior applications.

C. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

D. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in of water supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before sink installation.

B. Examine walls, floors, and counters for suitable conditions where sinks will be installed.

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

3.2 INSTALLATION

A. Install sinks level and plumb according to roughing-in drawings.

B. Install supports, affixed to building substrate, for wall-hung sinks.

C. Install accessible wall-mounted sinks at handicapped/elderly mounting height according to ICC/ANSI A117.1.

D. Set floor-mounted sinks in leveling bed of cement grout.

E. Install water-supply piping with stop on each supply to each sink faucet.

1. Exception: Use ball, gate, or globe valves if supply stops are not specified with sink. Comply with valve requirements specified in Section 22 05 23 "General-Duty Valves for Plumbing Piping."

2. Install stops in locations where they can be easily reached for operation.

F. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons if required to conceal protruding fittings. Comply with escutcheon requirements specified in Section 22 05 00 "Common Work Results for Plumbing."

G. Seal joints between sinks and counters, floors, and walls using sanitary-type, one-part, mildew-resistant silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 07.

H. Install protective shielding pipe covers and enclosures on exposed supplies and waste piping of accessible sinks. Comply with requirements in Section 22 07 00 "Plumbing Insulation."

3.3 CONNECTIONS

A. Connect sinks with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with water piping requirements specified in Section 22 11 16 "Domestic Water Piping."

C. Comply with soil and waste piping requirements specified in Section 22 13 16 "Sanitary Waste and Vent Piping."

3.4 ADJUSTING

A. Operate and adjust sinks and controls. Replace damaged and malfunctioning sinks, fittings, and controls.

B. Adjust water pressure at faucets to produce proper flow.

3.5 CLEANING AND PROTECTION

A. After completing installation of sinks, inspect and repair damaged finishes.

B. Clean sinks, faucets, and other fittings with manufacturers' recommended cleaning methods and materials.

C. Provide protective covering for installed sinks and fittings.

D. Do not allow use of sinks for temporary facilities unless approved in writing by Owner.

END OF SECTION

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SECTION 22 47 16
PRESSURE WATER COOLERS

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 pressure water coolers and related components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of pressure water cooler.

1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes.

2. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Maintenance Data: For pressure water coolers to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Regulatory Requirements: Comply with requirements in ICC A117.1, "Accessible and Usable Buildings and Facilities"; Public Law 90-480, "Architectural Barriers Act"; and Public Law 101-336, "Americans with Disabilities Act"; for fixtures for people with disabilities.

C. NSF Standard: Comply with NSF 61, "Drinking Water System Components--Health Effects," and Annex G in accordance with State of Maryland House Bill 372 for fixture materials that will be in contact with potable water.

D. ARI Standard: Comply with ARI's "Directory of Certified Drinking Water Coolers" for style classifications.

E. ARI Standard: Comply with ARI 1010, "Self-Contained, Mechanically Refrigerated Drinking-Water Coolers," for water coolers and with ARI's "Directory of Certified Drinking Water Coolers" for type and style classifications.

F. ASHRAE Standard: Comply with ASHRAE 34, "Designation and Safety Classification of Refrigerants," for water coolers. Provide HFC 134a (tetrafluoroethene) refrigerant, unless otherwise indicated.

PART 2 PRODUCTS

2.1 PRESSURE WATER COOLERS

A. Drinking Fountains (P-4): Stainless steel, high-low dual bowl wall mounted.

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

2. Basis-of-Design Product: Subject to compliance with requirements, provide Elkay LZWS-LRPBM28K or comparable product by one of the following:

a. Haws, Inc.

b. Halsey Taylor.

c. Crane Plumbing, L.L.C.

d. Kohler Co.

3. Standards: Comply with ASME A112.19.3/CSA B45.4 & NSF 61.

4. Type Receptor: On horizontal support.

5. Receptor Shape: Oval, oval.

6. Back Panel: Stainless-steel wall plate behind drinking fountain.

7. Bubblers: Two (2) with adjustable stream regulator, located on deck.

8. Bottle Filler: Yes.

9. Water Filter: Yes.

10. Control: Push button.

11. Drain: Grid type with NPS 1-1/4 (DN 32) tailpiece.

12. Supply: NPS 3/8 (DN 10) with shutoff valve.

13. Waste Fitting: ASME A112.18.2/CSA B125.2, NPS 1-1/4 (DN 32) chrome-plated brass P-trap and waste.

14. Support: ASME A112.6.1M, Type III lavatory carrier, w/universal mounting plate.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine roughing-in for water-supply and sanitary drainage and vent piping systems to verify actual locations of piping connections before fixture installation.

B. Examine walls and floors for suitable conditions where fixtures will be installed.

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

3.2 INSTALLATION

A. Install fixtures level and plumb according to roughing-in drawings.

B. Install off-the-floor carrier supports, affixed to building substrate, for wall-mounted fixtures.

C. Install water-supply piping with shutoff valve on supply to each fixture to be connected to domestic-water distribution piping. Use ball, gate, or globe valve. Install valves in locations where they can be easily reached for operation. Valves are specified in Division 22 "General-Duty Valves for Plumbing Piping."

D. Install trap and waste piping on drain outlet of each fixture to be connected to sanitary drainage system.

E. Install wall flanges or escutcheons at piping wall penetrations in exposed, finished locations. Use deep-pattern escutcheons where required to conceal protruding fittings.

F. Seal joints between fixtures and walls using sanitary-type, one-part, mildew-resistant, silicone sealant. Match sealant color to fixture color. Comply with sealant requirements specified in Division 7.

3.3 CONNECTIONS

A. Connect fixtures with water supplies, stops, and risers, and with traps, soil, waste, and vent piping. Use size fittings required to match fixtures.

B. Comply with soil, water and water piping requirements specified in Division 22.

C. Install ball, gate, or globe shutoff valve on water supply to each fixture. Comply with valve requirements specified in Division 22 "General-Duty Valves for Plumbing Piping."

3.4 ADJUSTING

A. Adjust fixture flow regulators for proper flow and stream height.

3.5 CLEANING

A. After installing fixtures, inspect unit. Remove paint splatters and other spots, dirt, and debris. Repair damaged finish to match original finish.

B. Clean fixtures, on completion of installation, according to manufacturer's written instructions.

C. Provide protective covering for installed fixtures.

D. Do not allow use of fixtures for temporary facilities unless approved in writing by Owner.

END OF SECTION

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SECTION 23 05 00
COMMON WORK RESULTS FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

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

B. Provide all labor, materials, equipment, and services necessary for and incidental to the complete installation and operation of all mechanical work.

C. Unless otherwise specified, all submissions shall be made to, and acceptances and approvals made by the Architect and the Engineer.

D. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange piping, ductwork, equipment, and other work generally as shown on the contract drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed shop drawings for approval in accordance with "Submittals" specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.

E. Conform to the requirements of all rules, regulations and codes of local, state and federal authorities having jurisdiction.

F. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the contract documents.

G. Indicate as separate line items in the Schedule of Values the following:

1. Coordination Drawings.
2. O & M Manuals.
3. Record Drawings/As-Builts.

H. Coordinate the work under Division 23 with work of all other construction trades.

1.3 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.

F. The following are industry abbreviations for plastic materials:

1. CPVC: Chlorinated polyvinyl chloride plastic.

2. PE: Polyethylene plastic.

3. PVC: Polyvinyl chloride plastic.

G. The following are industry abbreviations for rubber materials:

1. EPDM: Ethylene-propylene-diene terpolymer rubber.

2. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For the following:

1. Transition fittings.

2. Dielectric fittings.

3. Mechanical sleeve seals.

4. Escutcheons.

5. Sleeve assemblies including stopping (fire, smoke, water) materials.

B. Welding certificates.

1.5 QUALITY ASSURANCE

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

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

1. Comply with provisions in ASME B31 Series, "Code for Pressure Piping."

2. Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

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

1.6 DELIVERY, STORAGE, AND HANDLING

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

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

1.7 COORDINATION

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

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

C. Coordinate requirements for access panels and doors for HVAC items requiring access that are concealed behind finished surfaces. Access panels and doors are specified in Division 23.

D. Refer to installation and coordination drawings for additional information.

1.8 PERMITS AND FEES:

A. Obtain all permits and pay taxes, fees and other costs in connection with the work. File necessary plans, prepare documents, give proper notices and obtain necessary approvals. Deliver inspection and approval certificates to Owner prior to final acceptance of the work.

B. Permits and fees shall comply with the General Requirements of the specifications.

1.9 EXAMINATION OF SITE:

A. Examine the site, determine all conditions and circumstances under which the work must be performed, and make all necessary allowances for same. No additional cost to the Owner will be permitted for Contractor’s failure to do so.

1.10 CONTRACTOR QUALIFICATION:

A. Any Contractor or subcontractor performing work under Division 23 shall be fully qualified and acceptable to the Architect. Submit the following evidence if requested.

1. A list of not less than five comparable projects that the Contractor completed.

2. Letter of reference form not less than three registered professional engineers, general contractors or building owners.

3. Local and/or State License, where required.

4. Membership in trade or professional organizations where required.

B. A Contactor is any individual, partnership, or corporation, performing work by Contract or subcontract on this project.

C. Acceptance of a Contractor or Subcontractor will not relieve the Contractor or subcontractor of any contractual requirements or his responsibility to supervise and coordinate the work, of various trades.

1.11 MATERIALS AND EQUIPMENT:

A. Materials and equipment installed as a permanent part of the project shall be new, unless otherwise indicated or specified, and of the specified type and quality.

B. Where material or equipment is identified by proprietary name, model number and/or manufacturer, furnish named item, or its equal of manufacturer indicated in this specification.

C. The suitability of named item only has been verified. Where more than one Manufacturer is named, only the first named Manufacturer has been verified as suitable. Manufacturers and items other than first named shall be equal or better in quality and performance to that of

specified items, and must be suitable for available space, required arrangement and application. Provide all information to confirm these requirements including associated power requirements and controls integration.

D. Substitution will not be permitted for specified items of material or equipment.

E. The Contractor shall only submit those manufacturers indicated in the specification. Proposed alternate manufacturers will not be considered unless the specific item indicates "or as approved equal". Submit in a paragraph-by-paragraph format, all data necessary to determine suitability of alternative manufacturers' items for approval. Failure to do so will result in a "Revise and Resubmit" response.

F. Refer to the General Conditions of this specification for additional information, including substitution request. Substitutions are for materials or manufacturers not listed in this specification. For each substitution proposed by the Contractor, the Contractor clearly identifies all differences (i.e., paragraph-by-paragraph, performance differences, etc.) from the specified item, changes in Contract cost, benefits to the Owner and a brief description why the substitution is being proposed. Substitutions request will only be considered if there is a substantial benefit to the owner.

1.12 FIRE SAFE MATERIALS

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA or ASTM Standards for fire safety with smoke and fire hazard rating not exceeding flame spread of 25 and smoke developed of 50. Fire safe materials shall comply with the requirements by the authority having jurisdiction.

1.13 REFERENCED STANDARDS, CODES AND SPECIFICATIONS:

A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.

AABC - Associated Air Balance Council

ABMA - American Boiler Manufacturers Association

ACCA - Air Conditioning Contractors of America

ACGIH - American Conference of Governmental Industrial Hygienist

AIHA - American Industrial Hygiene Association

ASA - Acoustical Society of America

ADC - Air Diffusion Council

AGA - American Gas Association

AMCA - Air Movement and Control Association

ANSI - American National Standards Institute

ARI - Air Conditioning and Refrigeration Institute

ASHRAE- American Society of Heating, Refrigerating and Air Conditioning Engineers

ASME - American Society of Mechanical Engineers

ASTM - American Society for Testing and Materials

AWWA - American Water Works Association

CABO - Council of American Building Officials

CAGI - Compressed Air and Gas Institute

CS - Commercial Standard

CSA - Canadian Standards Association
CISPI - Cast Iron Soil Pipe Institute
IBC - International Building Code, Latest Edition.
IBR - Institute of Boiler and Radiator Manufacturers
IEEE - Institute of Electrical and Electronics Engineers
IMC - International Mechanical Code, Latest Edition
IFGC - International Fuel Gas Code
ICC - International Energy Conservation Code
IBC - International Building Code
IPC - International Plumbing Code
MSSP - Manufacturers Standards Society of the Valve and Fittings Industry
NEC - National Electrical Code
NEMA - National Electrical Manufacturers Association
NFPA - National Fire Protection Association
NSPC - National Standard Plumbing Code, Latest Edition
SMACNA- Sheet Metal and Air Conditioning Contractors National Association
TEMA - Tubular Exchanger Manufacturers Association
UL - Underwriters' Laboratories

B. All mechanical equipment and materials shall comply with the codes and standards listed in the latest edition of ASHRAE HVAC Applications Handbook, Chapter entitled *Codes and Standards*.

1.14 SUBMITTALS REVIEW AND ACCEPTANCE:

A. Equipment, materials, installation, workmanship and arrangement of work are subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Engineer to be in the best interest of the Owner.

B. Within 15 calendar days after award of contract, submit Material and Equipment List for approval. List all materials and equipment, indicating manufacturer, type, class, model, curves, and other general identifying information.

C. After acceptance of Material and Equipment List, submit complete descriptive data for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, specific electrical/wiring requirements and connections including control and interlock wiring, installation instructions, and any other information necessary to indicate complete compliance with Contract Documents. Edit submittal data specifically for application to this project or submittal shall be rejected.

D. Thoroughly review and stamp all submittals to indicate compliance with contract requirements prior to submission. Coordinate installation requirements and all electrical requirements for equipment submitted. Submit the Electrical Connection information specified in Division 26 for each piece of equipment requiring electrical connections. Each piece of equipment and its associated components (fuses, relays, disconnects, etc.) shall be clearly identified. Failure to include this schedule in the submittal will result in the submittal being returned to the Contractor for resubmission due to incompleteness of the submittal. If the Contractor submits equipment

other than that used for the basis of design, and if the electrical connection requirements are different, the Contractor shall be responsible for any associated increase in cost (e.g., wiring, conduits, starters, disconnects, etc.). Maintain and submit a summary of all electrical connection schedules of approved equipment. All mechanical equipment must be reviewed and coordinated with the electrical contractor before electrical distribution equipment is released for fabrication (i.e., MC, switchboard, emergency generator, distribution panels, etc.) Contractor shall be responsible for correctness of all submittals and the associated coordination with the electrical contractor.

E. Submittals shall be reviewed for general compliance with design concept in accordance with contract documents, but dimensions, quantities, or other details will not be verified.

F. Identify submittals, indicating intended application, location and service of submitted items. Refer to specification sections or paragraphs where applicable. Clearly indicate exact type, model number, manufacturer, style, size and special features of proposed item. Submittals of a general nature will not be acceptable. For all items clearly list on the first page of the Submittal all differences between the specified product and the submitted product. Additionally, for items other than first-named or indicated as the Basis of Design, clearly list on the first page of the submittal all differences between the specified item and the proposed item. This includes a paragraph-by-paragraph comparison from the Specification, performance differences from that scheduled and/or indicated on the Drawings, including power connection requirements, sound, etc., and physical differences (size, weight, etc.) based on published data (i.e., including Web sites.) The Contractor shall be responsible for corrective action (or replacement with the specified item) while maintaining the specification requirements if differences have not been clearly indicated in the submittal.

G. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable.

H. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted.

I. Pre-submittal Meetings: After approval of the material and equipment list and prior to submitting equipment which directly or indirectly has to interface with the building's energy management system (e.g.: pumps—all air handling units/ERV's, VRF system variable speed drives, building automatic temperature control system and remote energy management system) Shop drawings, pre-submittal coordination meeting(s) shall be held at the Engineer's Office. The attendees shall include at the minimum:

- Construction Manager
- Equipment Sales Representative responsible for preparing the Shop Drawings.
- Mechanical Contractor
- Electrical Contractor
- ATC Contractor (Sales Representative, Control Engineer, and Lead Project Installation Technician)
- Owner
- Mechanical Engineer
- Commissioning Agent

J. The Equipment Representative and/or the Mechanical Contractor shall be responsible for e-mailing, a minimum of seven (7) days in advance, a copy of the Preliminary Submittal to all named parties. The purpose of the meeting is to coordinate requirements and gain a full understanding from all parties as to what is required for a fully turnkey installation as well as to minimize potential rejection of shop drawings. The Construction Manager shall coordinate these meetings and shall document and publish minutes of all meetings.

1.15 SHOP DRAWINGS:

A. Prepare and submit shop drawings within thirty (30) calendar days after award of contract for all specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on contract drawings.

B. Submit data and shop drawings as listed below, in addition to provisions of paragraph 1 above. Identify all shop drawings by the name of the item and system and the applicable specification paragraph number.

Items and Systems:

Access Doors.

Air Distribution Systems.

Air Handling Units.

Automatic Air Vents.

Automatic Temperature Control & Energy Management System & Equipment.

Backflow Preventer.

Baseboard Radiation.

Capacitors.

Chemical Feed Systems.

Combination Fire/Smoke Dampers.

Condensing Units

Ductless Split A/C Units.

Energy Recovery Dehumidification Units (DOAS).

Fans.

Fire Dampers.

Fire Stopping - Methods and Materials.

Flowmeters and Primary Elements. (Flow Fittings)

Grilles, Registers, Diffusers, and Fire Dampers.

Identification System.

Manual Air Vents.

Pipe Guides, Anchors, Hangers, and Supports.

Pipe Sleeves.

Pressure Relief Valve.

Pressure Reducing Valve.

Pressure Regulating Valve.

Pumps, Circulators, Suction Diffusers, Multi-Purpose Valves.

Smoke Dampers.

Strainers.

Thermal Insulation Materials.

Thermometers and Gauges.

Unit/Wall Heaters.

Valves - Globe, Angle, Check, Plug, Butterfly, Ball, Shut Off/Balancing.

Variable Speed Drives.

Variable Refrigerant Flow (VRF) System.

Vibration Isolation.

C. Contractor, additionally, shall submit for approval any other shop drawings as required by the Architect. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Architect/Owner.

1.16 SUPERVISION AND COORDINATION

A. Provide complete supervision, direction, scheduling, and coordination of work under the Contract, including that of subcontractors.

B. Arrange for pipe spaces, chases, slots, and openings in building structure during progress of construction to allow for mechanical installations.

C. Coordinate electrical work required under Division 23 with that under Division 26. Coordinate all work under Division 23 with work under all other Divisions.

D. Supply services of an experienced (10 year minimum) and competent Project Manager to be in constant charge of work at site.

E. Where a discrepancy exists within the specifications or drawings or between the specifications and drawings, the more stringent (or costly) requirement shall apply until clarification can be obtained from the Engineer. Failure to clarify such discrepancies with the Engineer will not relieve the Contractor of the responsibility of conforming to the requirements of the Contract.

F. Failure of contractor to obtain a full and complete set of contract documents (either before or after bidding) will not relieve the contractor of the responsibility of complying with the intent of the contract documents.

G. Coordinate installation of large equipment requiring positioning before closing in building.

1.17 CUTTING AND PATCHING

A. Accomplish cutting and patching necessary for the installation of work under Division 15. Damage resulting from this work to other work already in place, shall be repaired at Contractor's expense. Where cutting is required, perform work in neat and workmanlike manner. Restore disturbed work to match and blend with existing, using materials compatible with the original. Use mechanics skilled in the particular trades required.

B. Do not cut structural members without approval from the A/E.

1.18 PENETRATION OF WATERPROOF CONSTRUCTION:

A. Coordinate the work to minimize penetration of waterproof construction, including roofs, exterior walls, and interior waterproof construction. Where such penetrations are necessary, furnish and install all necessary curbs, sleeves, flashings, fittings and caulking to make penetrations absolutely watertight. Refer to details on the drawings for additional information.

B. Where vents or other pipes penetrate roofs, flash pipe with All American Metal, Inc., or approved equal, roof flashing assemblies, with 4-pound lead, 6-inch skirt and caulked counterflashing sleeve with lead cap.

C. Furnish and install roof curbs, vent assemblies, and duct sleeves specifically designed for application to the particular roof construction, and install in accordance with the manufacturer's instructions, The National Roofing Contractors Association, SMACNA and as required by other

divisions of this specification. The Contractor shall be responsible for sleeve sizes and locations.

1.19 VIBRATION ISOLATION

A. Furnish and install vibration isolators, flexible connections, supports, anchors, and/or foundations required to prevent transmission of vibration from equipment, piping, or ductwork to building structure. See Section 230548, VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT.

1.20 ACCESSIBILITY

A. All equipment shall be installed in such a way that all components requiring access (such as panels, disconnect switches, circuit breakers, starters, and accessories) are so located and installed that they may be serviced, reset, replaced, recalibrated, etc., by service technicians in accordance with the Manufacturer's recommendations. If any equipment or components are located in such a position that this Contractor cannot comply with the above, the Contractor shall notify the engineer in writing before equipment is installed.

1.21 CONCRETE AND MASONRY WORK:

A. Furnish and install concrete and masonry work for equipment foundations, supports, pads, and other items required under Division 23. Perform work in accordance with requirements of other applicable Divisions of these specifications. Coordinate size and location of all sleeves, concrete inserts, etc., with other Divisions, equipment connections, and approved casework Shop Drawings.

B. Concrete shall test not less than 5,000 psi compressive strength after 28 days.

C. Grout shall be non-shrink, high strength mortar, free of iron of chlorides and suitable for use in contact with all metals, without caps or other protective finishes. Apply in accordance with manufacturer's instructions and standard grouting practices.

1.22 DRIVE GUARDS

A. Provide safety guards on all exposed belt drives, motor couplings, and other rotating machinery. Provide fully enclosed guards where machinery is exposed from more than one direction.

B. Fabricate guards of heavy gauge steel, rigidly brace, removable, and finish to match equipment served. Provide openings for tachometers. Guards shall meet O.S.H.A. and Authorities Having Jurisdiction requirements.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

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

2. Manufacturers: Subject to compliance with requirements, provide products by the manufacturers specified.

2.2 PIPE, TUBE, AND FITTINGS

A. Refer to individual Division 23 piping Sections for pipe, tube, and fitting materials and joining methods.

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

2.3 JOINING MATERIALS

A. Refer to individual Division 23 piping Sections for special joining materials not listed below.

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

1. ASME B16.21, nonmetallic, flat, asbestos-free, 1/8-inch (3.2-mm) maximum thickness unless thickness or specific material is indicated.

a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.

b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.

2. AWWA C110, rubber, flat face, 1/8 inch (3.2 mm) thick, unless otherwise indicated; and full-face or ring type, unless otherwise indicated.

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

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

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

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

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

2.4 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 are prohibited. Provide dielectric couplings and/or nipples. Provide standard unions where unions are required.

D. Dielectric Flanges: Dielectric unions are prohibited. Provide dielectric couplings or nipples in conjunction with standard unions.

E. Dielectric-Flange Kits: Companion-flange assembly for field assembly. Include flanges, full-face- or ring-type neoprene or phenolic gasket, phenolic or polyethylene bolt sleeves, phenolic washers, and steel backing washers.

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Central Plastics Company.

d. Pipeline Seal and Insulator, Inc.

2. Separate companion flanges and steel bolts and nuts shall have 150- or 300-psig (1035- or 2070-kPa) minimum working pressure where required to suit system pressures.

F. Dielectric Couplings: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining; threaded ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Manufacturers:

a. Calpico, Inc.

b. Lochinvar Corp.

G. Dielectric Nipples: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining; plain, threaded, or grooved ends; and 300-psig (2070-kPa) minimum working pressure at 225 deg F (107 deg C).

1. Manufacturers:

a. Perfection Corp.

b. Precision Plumbing Products, Inc.

c. Sioux Chief Manufacturing Co., Inc.

d. Victaulic Co. of America.

2.5 MECHANICAL SLEEVE SEALS

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

1. Manufacturers:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

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

3. Pressure Plates: Stainless Steel. Include two for each sealing element.

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

2.6 SLEEVES

A. Galvanized Steel Pipe: ASTM A53, Type E, Grade B, Schedule 40, galvanized, plain ends.

B. 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.

C. Galvanized-Steel Sheet: 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint.

D. Provide mock-ups of all sleeves and each of their associated sealing systems for review with the Architect/Engineer, Construction Manager and Authorities Having Jurisdiction. Mock-up shall be left on site for reference by the authority having jurisdiction.

2.7 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, Cast-Brass Type: With set screw.

1. Finish: Polished chrome-plated.

C. One-Piece, Floor-Plate Type: Cast-iron floor plate.

D. Plastic escutcheon plates will not be accepted.

2.8 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 (34.5-MPa), 28-day compressive strength.

3. Packaging: Premixed and factory packaged.

PART 3 EXECUTION

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

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

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

F. Install piping to permit valve servicing.

G. Install piping at indicated slopes.

H. Install piping free of sags and bends.

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

J. Install piping to allow application of insulation.

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

L. Install escutcheons for penetrations of walls, ceilings, and floors according to the following:

1. New Piping:

a. Piping with Fitting or Sleeve Protruding from Wall: One-piece, deep-pattern type.

b. Chrome-Plated Piping: One-piece, cast-brass type with polished chrome-plated finish.

c. Insulated Piping: One-piece, stamped-steel type with spring clips.

d. Bare Piping at Wall and Floor Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

e. Bare Piping at Ceiling Penetrations in Finished Spaces: One-piece, cast-brass type with polished chrome-plated finish.

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

N. Install sleeves for pipes passing through concrete and masonry walls and concrete floor and roof slabs.

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

1. Cut sleeves to length for mounting flush with both surfaces.
    a. Exception: Extend sleeves installed in floors 2 inches above finished floor level. Extend cast-iron sleeve fittings below floor slab as required to secure clamping ring if ring is specified.
2. Install sleeves in new walls and slabs as new walls and slabs are constructed.
3. Install sleeves that are two pipe sizes larger than pipe or pipe insulation.
    a. Galvanized Steel Pipe Sleeves: For pipes penetrating floors, walls and roofs except where noted through membrane waterproofing.
    b. Galvanized steel sheet sleeves: For pipes penetrating gypsum-board partitions.
    c. Stack Sleeve Fittings: For pipes penetrating floors with membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches (50 mm) above finished floor level. Refer to Division 07 Section "Sheet Metal Flashing and Trim" for flashing. Seal space outside of sleeve fittings with grout.
    d. Provide galvanized steel sheet sleeves for interior stud partitions.
    e. Provide galvanized steel wall sleeves with sleeve seal system for walls below grade and concrete slabs on grade. Select sleeve size to allow one-inch annular clear space between piping and sleeve for installing sleeve seal system. Select type, size and number of sealing elements required for piping material and size for sleeve ID or hole size. Position piping in center of sleeve. Center piping in penetration, assemble sleeve system components and install in annular space between piping and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make a water-tight seal.
4. Except for underground wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using joint sealants appropriate for size, depth, and location of joint. Refer to Division 07 Section "Joint Sealants" for materials and installation.

P. Aboveground, Exterior-Wall Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Select sleeve size two pipe sizes larger than pipe and sleeve for installing mechanical sleeve seals.

Q. 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 (25-mm) 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.

R. Fire and Smoke Barrier Penetrations: Maintain indicated fire and smoke rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials. Refer to Division 07 Section "Penetration Firestopping" for materials. Provide shop drawings indicating all materials and details associated with each type of listed assembly including the drawing detail stamped and signed by a registered professional Engineer by the product manufacturer. Provide a mock-up of each assembly type for review by the Construction Manager and authority having jurisdiction. Mock-up shall be left on site for reference by the authority having jurisdiction.

S. Verify final equipment locations for roughing-in.

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

3.2 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and Division 23 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.

3.3 PIPING CONNECTIONS

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

1. Install unions, in piping NPS 2 (DN 50) and smaller, adjacent to each valve and at final connection to each piece of equipment.

2. Install flanges, in piping NPS 2-1/2 (DN 65) and larger, adjacent to flanged valves and at final connection to each piece of equipment.

3. Dry Piping Systems: Install dielectric flanges to connect piping materials of dissimilar metals.

4. Wet Piping Systems: Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.4 EQUIPMENT INSTALLATION - COMMON REQUIREMENTS

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

B. Install equipment according to approved submittal data. Portions of the work are shown only in diagrammatic form. Refer conflicts to Architect and/or Engineer.

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

D. 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.

E. Install equipment giving right of way to piping installed at required slope.

F. Install flexible connectors on equipment side of shutoff valves, horizontally and parallel to equipment shafts if possible.

3.5 PAINTING AND FINISHES

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc. shall be stainless steel.

B. Clean surfaces prior to application of insulation, adhesives, coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pretreatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 23 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed.

F. Remove all construction marking and writing from exposed equipment, ductwork, piping and building surfaces. Do not paint manufacturer's labels or tags.

G. All exposed ductwork, piping, equipment, etc. shall be painted. Colors shall be as stated in this division or as selected by the Architect and/or Owner and conform to ANSI Standards.

H. All exposed ductwork, piping, equipment, etc. in finished spaces shall be painted. Colors shall be as selected by the Architect and conform to ANSI Standards.

I. All exposed ductwork, piping, equipment, etc., in Mechanical Rooms, Fire Pump Rooms, Equipment Platforms where PVC jacketed, shall not require painting. Label and identify and color code as specified.

3.6 CONCRETE BASES

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

1. Construct concrete bases of dimensions indicated, but not less than 4 inches (100 mm) larger in both directions than supported unit.

2. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch (450-mm) centers around the full perimeter of the base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.

4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

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

6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

7. Use 5000-psi, 28-day compressive-strength concrete and reinforcement as specified in Division 03 Section “Miscellaneous Cast-in-Place Concrete."

8. Housekeeping pads for air handling units and central plant generation equipment shall be a minimum of 6-inches thick. All other equipment pads shall be a minimum of 4-inches thick.

3.7 ERECTION OF METAL SUPPORTS AND ANCHORAGES

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

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

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

3.8 GROUTING

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

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

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

G. Place grout around anchors.

H. Cure placed grout.

3.9 SUPPORTS, HANGERS, AND FOUNDATIONS

A. Provide supports, hangers, braces, attachments and foundations required for the work. Support and set the work in a thoroughly substantial and workmanlike manner without placing strains on materials, equipment, or building structure, submit shop drawings for approval. Coordinate all work with the requirements of the structural division.

B. Supports hangers, braces, and attachments shall be standard manufactured items or fabricated structural steel shapes. All interior hangers shall be galvanized or steel with rust inhibiting paint. For uninsulated copper piping/tubing provide copper hanger with wool or felt insert to prevent contact of dissimilar metals. All exterior hangers shall be constructed of galvanized steel or stainless steel utilizing stainless steel rods, nuts, washers, bolts, etc.

C. No support or hanger shall attach to the metal roof deck.

3.10 PROVISIONS FOR ACCESS:

A. The Contractor shall provide access panels and doors for all concealed equipment, valves, strainers, manual, gravity and automatic dampers, filters, controls, control devices, cleanouts, fire dampers, smoke dampers, combination fire and smoke dampers, damper operators, traps, and other devices requiring maintenance, service, adjustment, balancing or manual operation.

B. Where access doors are necessary, furnish and install manufactured painted steel door assemblies consisting of hinged door, key locks, and frame designed for the particular wall or ceiling construction. Properly locate each door. Door sizes shall be a 12 inches x 12 inches for hand access, 18 inches x 18 inches for shoulder access and 24 inches x 24 inches for full body access where required. Review locations and sizes with Architect prior to fabrication. Mark each access door within finished spaces with a small color coded and numbered tab. Provide a chart or index for identification. Provide U.L. approved and labeled access doors where installed in fire rated walls or ceilings. Doors shall be Milcor Metal Access Doors as manufactured by Inland-Ryerson, Mifab, or approved equal.

1. Acoustical or Cement Plaster: Style B
2. Hard Finish Plaster: Style K or L
3. Masonry or Dry Wall: Style M

C. Where access is by means of lift-out ceiling tiles or panels, mark each ceiling grid using small color-coded and numbered tabs. Provide a chart or index for identification. Place markers within ceiling grid not on ceiling tiles.

D. Access panels, doors, etc. described herein shall be furnished under the section of specifications providing the particular service and to be turned over to the pertinent trade for installation. Coordinate installation with installing contractor. All access doors shall be painted in baked enamel finish to match ceiling or wall finish.

E. Access panels in security or detention areas shall be security type.

F. Submit shop drawings indicating the proposed location of all access panels/doors. Access doors in finished spaces shall be coordinated with air devices, lighting and sprinklers to provide a neat and symmetrical appearance.

3.11 PROTECTION OF WORK:

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in piping, ductwork, and equipment to prevent the entrance of water, dirt, debris, or other foreign matter.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

E. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. Do not exceed structural capacity of floor, where stored inside

3.12 OPERATION OF EQUIPMENT:

A. Clean all systems and equipment prior to initial operation for testing, balancing, or other purposes. Lubricate, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment. Where factory start-up of equipment is not specified, provide field start-up by qualified technician.

C. Submit factory start-up sheets or field start-ups sheets for all equipment prior to the commencement of testing and balancing work. Testing and balancing work shall not commence until start-up reports have been completed, reviewed by Engineer and forwarded to Testing and Balancing Agency.

D. Do not use mechanical systems for temporary services or temporary conditioning during construction, unless approved by Owner in writing. Refer to Division 01 Section *"Temporary Facilities and Controls"* for temporary heating/cooling during construction.

E. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items such as filters.

3.13 IDENTIFICATIONS, FLOW DIAGRAMS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS:

A. Contractor shall submit for approval schematic piping diagrams of each piping system installed in the building. Diagrams shall indicate the location and the identification number of each valve in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under safety glass and hung in each Mechanical Room where directed. Contractor shall deliver the tracing or sepia from which the diagrams were reproduced to the Owner.

B. All valves shall be plainly tagged. For any bypass valves, install sign indicating valve position as “Normally Open” or “Normally Closed” as required.

C. All items of equipment, including motor starters, disconnects and ATC panels shall be furnished with white on black plastic permanent identification cards. Lettering shall be a minimum of ¼

inch high. Identification plates shall be secured, affixed to each piece of equipment, starters, disconnects, panels by screw or adhesive (Tuff Bond or as approved equal).

D. Provide three (3) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the *Operations and Maintenance Manual* as hereinafter specified.

E. All piping and ductwork installed under this contract shall be stenciled with *direction of flow* arrows and with stenciled letters naming each pipe and ductwork and service. In finished spaces omit labeling and direction of flow arrows. Paint in color as selected by Architect.

F. Submit list of wording, symbols, letter size, and color coding for mechanical identification. Submit samples of equipment identification cards, piping labels, ductwork labels, and valve tags to Engineer for review prior to installation.

G. Provide at least 16 hours of straight time instruction to the operating personnel. Time of instruction shall be designated by the Owner. Additional instruction time for the automatic temperature control (ATC) system is specified in Division 23 Section, *Automatic Temperature Controls*.

H. Contractor shall demonstrate Sequences of Operation of all equipment in presence of Owner's representative/Engineer

3.14 WALL AND FLOOR PENETRATIONS

A. Provide sleeves for pipes and ducts passing through roofs, floors, ceiling, walls, partitions, air handling unit casings, structural members, and other building parts. Sleeves shall extend 2" above finished floor.

B. Provide escutcheons for sleeved pipes in finished areas.

C. Piping sleeves:

1. Galvanized steel pipe, standard weight where pipes are exposed and, roofs and concrete and masonry walls. On exterior walls provide anchor flange welded to perimeter.

2. Twenty-two (22) gauge galvanized steel elsewhere (i.e., stud walls).

3. Hydrostatic sleeves with anchor flange for all below-grade exterior wall or floor penetrations and all plastic pipe penetrations.

D. Ductwork sleeves: 20-gauge galvanized steel at masonry walls, rated walls, at wall penetrations exposed to view, floors and roof. Provide mock-up of all sleeve assemblies for review by the Architect/Engineer and Authorities Having Jurisdiction as specified herein before.

E. Penetrations shall be sealed and caulked airtight for sound and air transfer control. Voids where ducts and pipes penetrate floors or other fire-rated and smoke rated assemblies shall be appropriately additionally fire-sealed and smoke sealed the full depth with an approved fire sealant (3M or Dow Corning Fire Sealant Foam and Caulk). For piping, provide floor plate. Provide mock-up of sleeves/penetrations as specified herein before.

F. Where piping extends through exterior walls, provide link-seal water-proof sleeves or equivalent.

3.15 RECORD DRAWINGS

A. Upon completion of the mechanical installations, the Contractor shall deliver to the Architect and/or Engineer one complete set of prints of the mechanical contract drawings which shall be legibly marked in red pencil to show all changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings.

B. Contractor shall incorporate all sketches, addendums, value engineering, change orders, etc., into record drawings prior to delivering to Architect.

3.16 WARRANTY:

A. Contractor's attention is directed to warranty obligations contained in the *GENERAL CONDITIONS*.

B. The above shall not in any way void or abrogate equipment manufacturer's guarantee or warranty. Certificates of equipment manufacturer's warranties shall be included in the operations and maintenance manuals.

C. The Contractor guarantees for a two-year period from the time of final acceptance by the Owner.

1. That the work contains no faulty or imperfect material or equipment or any imperfect, careless, or unskilled workmanship.
2. That all work, equipment, machines, devices, etc. shall be adequate for the use to which they are intended, and shall operate with ordinary care and attention in a satisfactory and efficient manner.
3. That the contractor will re-execute, correct, repair, or remove and replace with proper work, without cost to the Owner, any work found to be deficient. The contractor shall also make good all damages caused to their work or materials in the process of complying with this section.
4. That the entire work shall be water-tight and leak-proof.

3.17 LUBRICATION:

A. All bearings, motors, and all equipment requiring lubrication shall be provided with accessible fittings for same. Before turning over the equipment to the Owner, the Contractor shall fully lubricate each item of equipment, shall provide one year's supply of lubricant for each, and shall provide Owner with complete written lubricating instructions, together with diagram locating the points requiring lubrication. Include this information in the Operations and Maintenance Manual. Project shall not be considered "Substantially Completed" until instructions are included in the Operations and Maintenance Manual.

B. In general, all motors and equipment shall be provided with grease-lubricated roller or ball bearings with Alemite or equal accessible or extended grease fittings and drain plugs.

C. Provide remote grease fittings with copper lube lines for air handling units and for bearings/motors where grease fittings are situated in locations inconvenient/inaccessible for lubrication.

D. Provide pressure relief fittings at all grease lubrication locations designed to automatically vent within the range of 1/4 to 1 psi, automatically reset below this range, or another pressure relief range if the preceding differs from the manufacturer's recommended pressure range.

3.18 OPERATIONS AND MAINTENANCE MANUAL:

A. The Contractor shall have prepared three (3) copies of the Operations and Maintenance Manual and deliver these approved copies of the booklet to the Owner a minimum of three (3) weeks before Demonstrations. The booklet shall be as specified herein. The booklet must be approved and will not be accepted as final until so stamped. The project shall not be considered "Substantially Completed" until approved.

B. The booklet shall be bound in a three-ring loose-leaf binder similar to National No. 3881 with the following title lettered on the front: *Operations and Maintenance Manual – Noyes Library for Young Children - Mechanical.* No sheets larger than 8-1/2 inches x 11 inches shall be used, except sheets that are neatly folded to 8-1/2 inches x 11 inches and used as a pull-out. Provide divider tabs and table of contents for organizing and separating information.

C. Provide the following data in the booklet:

1. As first entry, an approved letter indicating the starting/ending time of Contractor's warranty period.
2. Maintenance operation and lubrication instructions on each piece of equipment furnished.

3. Complete catalog data on each piece of heating and air conditioning equipment furnished including approved shop drawing.
4. Chart form indicating frequency and type of routine maintenance for all mechanical equipment. The chart shall also indicate model number of equipment, location and service.
5. Provide sales and authorized service representatives names, address, and phone numbers of all equipment and subcontractors.
6. Provide supplier and subcontractor's names, address, and phone number.
7. Catalog data of all equipment, valves, etc. shall include wiring diagrams, parts list and assembly drawing.
8. Provide and install in locations as directed by the Owner, valve charts including valve tag number, valve type, valve model number, valve manufacturer, style, service and location. Each valve chart shall be enclosed in a durable polymer-based frame with a cover safety glass.
9. Copy of the approved balancing report including duct leakage data.
10. ATC systems including as-built ATC drawings of systems including internal of all panels.
11. Access panel charts with index illustrating the location and purpose of access panels.
12. Approved Health and Electrical Certificates.
13. Start-up reports for equipment.
14. Water treatment test reports.
15. Filter charts indicating equipment served, size, and type of filter required.
16. Documentation of strainer pulling and cleaning.

D. Submit Operations and Maintenance Manual prior to anticipated date of substantial completion for Engineer review and approval. Substantial completion requires that Record and Information booklets be reviewed and approved.

3.19 TESTS, GENERAL:

A. The entire new HVAC piping systems shall be tested hydrostatically before insulation covering is applied and proven tight under the following gauge pressures for a duration of four (4) hours. Testing to be witnessed by Owner's representative and documented in writing.

SYSTEM	**TEST PRESSURE**
Refrigerant Piping	550 psig with Nitrogen
Compressed Air Piping	150 psig

B. Ductwork pressure testing shall be as specified in another division of these specifications.

C. Testing and acceptance thereof shall be in accordance with local requirements and shall meet approval of authority having jurisdiction. Submit certificates and approved permits and insert one (1) copy in the *Operations and Maintenance Manuals*.

D. Refrigerant piping shall be tested utilizing nitrogen per equipment manufacturer's requirements. Test shall comply with ASME B31.5 Chapter V Art.538.4.3, ASME BPVC Sec IX Part QB Art. XI and XII.

3.20 LINTELS:

A. Under this Section, provide lintels not provided elsewhere which are required for openings for the installation of mechanical and plumbing work. Lintels shall meet the requirements of the Architectural and Structural Sections and The Architectural Drawings and Specifications.

3.21 EQUIPMENT BY OTHERS:

A. This Contractor shall make all system connections required to equipment furnished and installed under other divisions. Connections shall be complete in all respects to render this equipment functional to its fullest intent.

B. It shall be the responsibility of the supplier of this equipment to furnish complete instructions for connections. Failure to do so will relieve this Contractor of any responsibility for improper equipment operation.

C. Typical equipment refers to, but is not limited to, storage cabinets and all other lab equipment.

3.22 FASTENERS:

A. All fasteners located in public space, including classrooms, offices, etc., shall be provided with tamper-proof type fasteners.

3.23 WIRING DIAGRAMS

A. Obtain and submit wiring diagrams for all equipment provided under this Contract.

B. Wiring diagrams shall be provided with Shop Drawings, but not limited to, the following:

1. All equipment.

2. ATC System.

C. The Contractor shall submit any additional wiring diagrams as requested by the Engineer.

D. Provide wiring diagrams for all major mechanical equipment to the Electrical Contractor and the ATC Subcontractor for coordination.

3.24 INSTALLATION AND COORDINATION DRAWINGS

A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following: Complete Ductwork, Plumbing, Sprinkler and HVAC Piping Drawings showing coordination with approved equipment, approved casework drawings, lights, electrical equipment and structural. The Mechanical Contractor is responsible for coordinating with all trades to ensure systems will fit in the available space. If conflicts exist after fabrication and/or installation of systems prior to preparing a coordinated drawing of the area, the Contractor shall remove, re-fabricate, and re-install all such work at their own cost, except for the difference in cost, if any, from the originally designed system to the revised design. If no design changes were made, and clarifications were required, it shall be at no expense to the Owner.

B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment, piping and ductwork in areas involved. Fully dimension all work including fume hoods, casework and associated utilities, valve boxes, lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, telecommunications equipment, walls, doors, ceilings, columns, beams, joists and other architectural and structural work.'

C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.

D. All coordination drawings shall be prepared in AutoCAD or Revit format and submitted in color. Different colors shall be used to determine different building components. In addition to the composite coordination drawings, simultaneously submit individual sheet-metal, piping, and sprinkler coordination drawings.

E. Prepare separate coordinated reflected ceiling plans in 1/8", 1/4", or 3/8" scale showing grid systems, lighting fixtures, communication system components, TV brackets, sprinkler heads, air devices, and all other ceiling-mounted items.

F. The Mechanical Contractor shall schedule weekly Coordination Drawing Reviews with the Owner, Mechanical Engineer, Construction Manager, and all associated subcontractors, including—but not limited to—the following:

1. Mechanical Contractor
2. Finishes Contractor
3. Sheet Metal Contractor
4. Sprinkler Contractor
5. Electrical Contractor
6. Plumbing Contractor
7. Commissioning Agent.
8. Note: A Foreman or Project Manager responsible for Decision-Making of each company shall attend all Coordination Meetings.

G. The purpose of these meetings is to coordinate proposed installations of systems and equipment, including clearances, routings, penetrations, as well as to review potential conflicts. The Mechanical Contractor shall base preliminary equipment sizes and connections on proposed products and the final coordination drawing for review shall reflect approved/reviewed products. Coordination Meetings shall be held at the Construction Manager's Field Office.

3.25 FACTORY START-UP

A. Provide factory authorized start-up service for all mechanical equipment (e.g., variable speed drives, energy recovery units, fans, VRV System, etc.).

B. Provide one copy of all start-up reports to the Owner and include a copy in the Operations and Maintenance Manual.

C. Pre-Installation /Start-Up Conference:

1. The Equipment Unit Manufacturer (each) shall include in their Bid a Pre-Installation Conference, including Factory Representative(s) to review installation, EMS Integration, Sequence to Operation, and Start-Up. Coordinate all controls with the Controls Contractor prior to energizing any unit, including final commissioning of each unit with the ATC/EMS Contractor, Test & Balance Contractor, Commissioning Agent, and Engineer. All controls and start-ups shall be by the factory (i.e., not factory-authorized start-up company).
2. The Mechanical Contractor shall include in their Bid an on-site pre-installation conference for the main mechanical equipment room to review layout and coordination of all equipment and subcontractors involved in working in the mechanical equipment room. As a minimum, the attendees need to include the following:

a. Mechanical Contractor
b. Electrical Contractor
c. Building ATC Contractor
d. Sheet Metal Contractor
e. Owner
f. Mechanical Engineer
g. Plumbing Contractor.
h. Sprinkler Contractor.
i. Commissioning Agent

j. Construction Manager

3. The Contractor(s) shall mark on the floors, walls, and/or ceilings, the locations of major equipment and/or penetration of systems.

4. Prior to the start of construction, the Mechanical Engineer, Owner and Architect shall review design goals, design intent, project summary, and past construction issues which should be avoided. The Mechanical Contractor shall coordinate, document, and issue minutes of the meeting. As a minimum, and in addition to the Mechanical Engineer, Owner and Architect, the attendees shall include:

   a. Mechanical Contractor

   b. Project Superintendent/Construction Manager.

   c. 9A Contractor

   d. Electrical Contractor

   e. Building ATC Contractor

   f. Plumbing Contractor

   g. Major Equipment Manufacturers' Representative(s)

   h. Sprinkler Contractor

   i. Commissioning Agent

   j. Sheet Metal Contractor

D. The Contractor shall be required to start up all systems in an orderly, organized, and coordinated manner to ensure that all systems are functioning as designed. The Construction Manager shall provide a detailed start-up, testing and demonstration plan for all systems in a coordinated manner that is documented in writing at least forty-five (45) days prior to start-up. Start-up, testing, and demonstration plans shall include detailed point-by-point check list that clearly shows that systems are in face functioning as designed. Modifications to the standard AIA definition of substantial completion state that Mechanical/Electrical Systems are not substantially complete until all systems are started, tested, balanced, and O&M Manuals are received by the Owner. Above listed items must be completed in time to allow for system demonstrations to BOE Personnel with all O&M Manuals in hand at the time of demonstration. Contractors will be required to provide system demonstrations and training for BOE Personnel for each system. At minimum, the Contractors shall provide eight (8) hours of demonstration and eight (8) hours of systems operation training for each system prior to BOE acceptance of any given system.

3.26 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment including, but not limited to, the following:

1. Coordinate mechanical systems, equipment, and materials installation with other building components.

2. Verify all dimensions by field measurements.

3. Arrange for chases, slots, and openings in other building components during progress of construction, to allow for mechanical installations.

4. Coordinate the installation of required supporting devices and sleeves to be set in poured-in-place concrete and other structural components, as they are constructed.

5. Sequence, coordinate, and integrate installations of mechanical materials and equipment for efficient flow of the work. Give particular attention to large equipment requiring positioning prior to closing in the building.

6. Where mounting heights are not detailed, noted, or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.

7. Coordinate connection of mechanical systems with exterior underground and overhead utilities and services. Comply with requirements of governing regulations, franchised service companies, and controlling agencies. Provide required connection for each service.

8. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the work are shown only in diagrammatic form.

9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished space.

10. Install mechanical equipment to facilitate service, maintenance, and repair or replacement of equipment components in accordance with manufacturers' recommendations. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

11. Install access panels or doors where units are concealed behind finished surfaces.

12. Install systems, materials, and equipment giving right-of-way priority to systems required to be installed at a specified slope.

13. Provide a mock-up of a typical single and double heat pump closet including all piping, ductwork, controls, electrical and plumbing systems for review by the Architect, Owner, Commissioning Agent and Construction Manager. The Contractor shall incorporate all comments assembled by the Architect prior to installing equipment and associated systems for all other heat pump closets.

3.27 CLEANING OF SYSTEMS:

A. Thoroughly clean systems after satisfactory completion of pressure tests and before permanently connecting fixtures, equipment, traps, strainers, and other accessory items. Shut-off valves serving equipment where by-pass valves have been provided shall be closed to the equipment and by-pass valves shall be open during flushing. Blow out and flush piping until interiors are free of foreign matter. Restore valves to their normal operating positions after flushing has been completed. Flushing, chemicals, sterilization, etc., shall comply with EPA Regulations and authorities having jurisdiction.

B. Flush piping in recirculating water systems to remove cutting oil, excess pipe joint compound and other foreign materials. Do not use system pumps until after cleaning and flushing has been accomplished to the satisfaction of the Engineer. Employ chemical cleaners, including a non-foaming detergent, not harmful to system components. After cleaning operation, final flushing and refilling, the residual alkalinity shall not exceed 300 parts per million. Submit a certificate of completion to Engineer stating name of service company used. Project shall not be considered "substantially completed" until certificate is incorporated in the "Operations and Maintenance Manual".

C. Leave strainers and dirt pockets in clean condition.

D. Clean fans, ductwork, enclosures, registers, grilles, and diffusers at completion of work.

E. Install filters of equal efficiency to those specified in permanent air systems operated for temporary heating or cooling during construction. Replace with clean filters as specified prior to acceptance and after cleaning of system.

F. Pay for labor and materials required to locate and remove obstructions from systems clogged with construction refuse after acceptance. Replace and repair work disturbed during removal of obstructions.

G. Leave systems clean, and in complete running order.

3.28 LOUVERS:

A. Louvers in exterior walls are specified under another division. Louver shop drawings shall be submitted to the Engineer to verify sizes and free area requirements. The Contractor shall blank-off unused portions of louver with insulated (double wall) blank-off panels.

3.29 FILTERS:

A. Provide one (1) set of clean filters for balancing. One (1) complete set of additional filters shall be turned over to the Owner upon final acceptance of the building by the Owner. Provide correspondence documenting that additional filters have been turned over to the Owner.

B. All terminal unit filters shall be 2-inches thick, low static, MERV-13 filters. All air handling unit pre-filters shall be 2-inches thick, MERV 8, All final filters shall be 4-inches thick, MERV 13,

C. Provide MERV 13 filters for all intakes (return air grilles, outside air louvers, all AHU and terminal unit filters, etc.), if for any reason (start-up, testing and balancing, commissioning, etc.) the units are started prior to final building cleaning. Replace filters weekly.

D. Provide one (1) differential pressure gauge across each air handling unit filter bank. Differential pressure gauge shall be diaphragm activated, dial type, +/-2% accuracy of full scale, static pressure tips, aluminum tubing, vent valves, etc. Differential pressure gauge shall be Series 2000 Magnehelic with air filter kit as manufactured by Dwyer or equal.

3.30 BELT GUARDS/CAGES/BELTS

A. Provide safety guards on all exposed belt drives, motor couplings, and other rotating machinery (pump coupling, plenum fans, propeller fans, etc.) Provide fully enclosed guards where machinery is exposed form more than one direction.

B. Fabricate guards of heavy gauge steel, rigidly braced, removable, and finished to match equipment served. Provide openings for tachometers. Guards shall meet OSHA and MOSHA requirements.

C. Provide one (1) spare set of belts for each piece of equipment. Belts shall be labeled with unit number and location. Belts shall be mounted as directed by the Owner.

3.31 ACCESS FOR INSPECTION, CLEANING AND MAINTENANCE

A. Individual finned-tube coils or multiple finned-tube coils in series without adequate intervening access space(s) of at least 18 inches (457 mm) shall be selected to result in no more than 0.75 inches wc (187 Pa) combined pressure drop when dry coil face velocity is 500 fpm (2.54 m/s). Exception: When clear and complete instructions for access and cleaning of both upstream and downstream coil surfaces are provided.

B. Equipment Clearance: Ventilation equipment shall be installed with sufficient working space for inspection and routine maintenance (e.g., filter replacement and fan belt adjustment and replacement).

C. Ventilation Equipment Access: Access doors, panels, or other means shall be provided and sized to allow convenient and unobstructed access sufficient to inspect, maintain, and calibrate all ventilation system components for which routine inspection, maintenance, or calibration is necessary. Ventilation system components comprise, for example, air-handling units, fan-coil units, water-source heat pumps, other terminal units, controllers, and sensors.

D. Air Distribution System: Access doors, panels, or other means shall be provided in ventilation equipment, duct-work, and plenums, located and sized to allow convenient and unobstructed access for inspection, cleaning, and routine maintenance of the following:

1. Outdoor air intake areaways or plenums

2. Mixed air plenums

3. Upstream surface of each heating, cooling, and heat-recovery coil or coil assembly having a total of four rows or less
4. Both upstream and downstream surface of each heating, cooling, and heat-recovery coil having a total of more than four rows and air washers, evaporative coolers, heat wheels, and other heat exchangers
5. Air cleaners
6. Drain pans and drain seals
7. Fans

3.32 ERECTION OF WOOD SUPPORTS AND ANCHORAGES

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

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

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

3.33 TRAINING

A. Training shall be provided for the VRV system, boilers, energy recovery units, and all geothermal heat pump unit types and shall consist of the following:
1. Controlling, operating, and navigating programs.
2. Maintenance, diagnosis, and trouble-shooting.
3. Service repairs.

END OF SECTION

SECTION 23 05 13
COMMON MOTOR REQUIREMENTS FOR HVAC EQUIPMENT

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 general requirements for single-phase and polyphase, general-purpose, horizontal, small and medium, squirrel-cage induction motors for use on ac power systems up to 600 V and installed at equipment manufacturer's factory or shipped separately by equipment manufacturer for field installation.

B. Furnish and install control and interlock wiring for the equipment furnished. In general, power wiring and motor starting equipment will be provided under Division 26. Carefully review the contract documents to coordinate the electrical work under Division 23 with the work under Division 26. Where the electrical requirements of the equipment furnished differ from the provisions made under Division 26, make the necessary allowances under Division 23. Where no electrical provisions are made under Division 26, include all necessary electrical work under Division 23.

C. All electrical work performed under Division 23 shall conform to the applicable requirements of Division 26 and conforming to the National Electrical Code. All wiring, conduit, etc., installed in ceiling plenums must be plenum rated per NFPA and the International Building Code.

D. Provide wiring diagrams with electrical characteristics and connection requirements.

E. Test Reports: Indicate test results verifying nominal efficiency and power factor for three phase motors larger than five (5) horsepower.

F. Protect motors stored on site from weather and moisture by maintaining factory covers and suitable weatherproof covering. For extended outdoor storage, remove motors from equipment and store separately.

G. All motors shall be furnished with visible nameplate indicating motor horsepower, voltage, phase, cycles, RPM, full load amps, locked rotor amps, frame size, manufacturer’s name and model number, service factor, power factor and efficiency.

H. Motors located in exterior locations, wet air streams, air cooled condensers, humidifiers air streams, and outdoors shall be totally enclosed weatherproof epoxy-treated type.

I. Nominal efficiency and power factor shall be as scheduled at full load and rated voltage when tested in accordance with IEEE 112.

J. Brake horsepower load requirement at specified duty shall not exceed 85 percent of nameplate horsepower times NEMA service factor for motors with 1.0 and 1.15 service factors.

K. All single-phase motors shall be provided with thermal protection: Internal protection shall automatically open power supply circuit to motor when winding temperature exceeds a safe value calibrated to temperature ratings of motor insulation. Thermal protection device shall automatically reset when motor temperature returns to normal range, unless otherwise indicated.

L. Install equipment and accessories to maintain minimum Working Space clearances as required by the National Electric Code (NEC) per Table 110.26(A)(1).

Table 110.26(A)(1) Working Space			
Voltage-to-Ground	Condition 1	Condition 2	Condition 3
0–150V	3 ft	3 ft	3 ft
151–600V	3 ft	3½ft	4 ft

- *Condition 1—Exposed live parts on one side of the working space and no live or grounded parts, including concrete, brick, or tile walls are on the other side of the working space.*
- *Condition 2—Exposed live parts on one side of the working space and grounded parts, including concrete, brick, or tile walls are on the other side of the working space.*
- *Condition 3—Exposed live parts on both sides of the working space.*

1.3 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 supply circuit and required control sequence.
4. Ambient and environmental conditions of installation location.

PART 2 PRODUCTS

2.1 GENERAL MOTOR REQUIREMENTS

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

B. Comply with NEMA MG 1 unless otherwise indicated.

C. Comply with IEEE 841 for severe-duty motors.

D. Motors and controls shall conform to the latest requirements of IEEE, NEMA, NFPA-70 and shall be UL listed. Motor sizes are specified with the driven equipment. Motor starting and control equipment is specified either with the motor which is controlled or in an electrical specification section. The Contractor is advised to consult all specification sections to determine responsibility for motors and controls.

E. Motors shall be designed, built and tested in accordance with the latest revision of NEMA Standard MG l.

F. Motors used with variable-frequency controllers shall have ratings, characteristics, and features coordinated with and approved by the variable frequency controller (drive) manufacturer. As a minimum the following shall apply to variable frequency-controlled motors:

1. Motors shall be manufactured to withstand peak voltages of 1600 volts with .1 microsecond rise time per NEMA MG-1.
2. Critical vibration frequencies of motor shall not be within operating range of variable frequency controller output.
3. Temperature rise: Match rating for Class B insulation.
4. Insulation: Class F.
5. Thermal Protection: Conform to MG1 requirements for thermally protected motors.

G. Motors shall be suitable for use under the conditions and with the equipment to which applied, and designed for operation on the electrical systems specified or indicated.

1. Motor capacities shall be such that the horsepower rating and the rated full-load current will not be exceeded while operating under the specified operating conditions. Under no condition shall the motor current exceed that indicated on the nameplates.

2. Motor sizes noted in the individual equipment specifications are minimum requirements only. It is the responsibility of the equipment manufacturers and of the Contractor to furnish motors, electrical circuits and equipment of ample capacity to operate the equipment without overloading, exceeding the rated full-load current, or overheating at full-load capacity under the most severe operating service of this equipment. Motors shall have sufficient torque to accelerate the total WR^2 of the driven equipment to operating speed.

3. Motors shall be continuous duty type and shall operate quietly at all speeds and loads.

4. Motors shall be designed for operation on 60 hertz power service. Unless otherwise specified or shown, motors less than ½ horsepower shall be single phase, and motors ½ horsepower and larger shall be three-phase unless otherwise noted.

5. Motors shall be mounted so that the motor can be removed without removing the entire driven unit.

H. Single phase motors, smaller than 1/20 horsepower shall be ball or sleeve bearing; drip-proof, totally enclosed or explosion proof, as specified; 120 volts; permanent-split capacitor or shaded pole type. These motors shall not be used for general power purposes, and shall only be provided as built-in components of such mechanical equipment as fans, unit heaters, humidifiers and damper controllers. When approved by the Engineer, deviations from the specifications will be permitted as follows:

1. Open motors may be installed as part of an assembly where enclosure within a cabinet provides protection against moisture.

2. Motors used in conjunction with low voltage control systems may have a voltage rating less than 115 volts.

I. Single phase motors, greater than 1/20 horsepower and less than ½ horsepower shall be ball bearing; drip-proof, totally enclosed or explosion proof, as specified, with Class A or B insulation, as standard with the motor manufacturer; 115 or 120/208/240 volts as required; capacitor start-induction run, permanent split capacitor, or repulsion start-induction run type with minimum efficiency of 70 percent and a minimum full load power of 77 percent.

J. Three Phase Motors:

1. Except as otherwise specified in the various specification sections, 3 phase motors 60 horsepower and smaller shall be NEMA design B squirrel cage induction type meeting the requirements of this paragraph. Motors shall be drip-proof, totally enclosed or explosion proof, as specified or indicated. Insulation shall be Class B or F, at 40 degrees C ambient temperature. Drip-proof motors shall have a 1.15 service factor and totally enclosed and explosion proof motors shall have a service factor of 1.00 or higher. Motors specified for operation at 480, 240, and 208 volts shall be nameplated 460, 230, 200 volts, respectively. Efficiencies and percent power factor at full load for three phase motors shall be not less than the values listed below for premium efficiency motors:

MOTOR NAMEPLATE	MINIMUM PERCENT EFFICIENCY AT NOMINAL SPEED AND RATED LOAD	MINIMUM PERCENT POWER FACTOR
1HP and above to	85.5 percent	84 percent

MOTOR NAMEPLATE	MINIMUM PERCENT EFFICIENCY AT NOMINAL SPEED AND RATED LOAD	MINIMUM PERCENT POWER FACTOR
1-½ HP	86.5 percent	85 percent
2HP	86.5 percent	85 percent
3HP	89.5 percent	86 percent
5HP	89.5 percent	87 percent
7½ HP	91 percent	86 percent
10HP	91.7 percent	85 percent
15HP	93.0 percent	85 percent

K. Three-phase motors ½ HP or greater shall be the Duty Master XE by Reliance Electric Company, Super-E Premium Efficiency of Baldor Motor and Drives, E-plus Efficient Standard Duty Motor of the Electric Motor Division of Gould, Inc., the MAC II High Efficiency motor of Westinghouse Electric Corp., the equivalent product of General Electric, or approved equal.

L. For motors serving equipment being controlled by a variable speed drive, motor shall be premium efficiency inverter duty rated, minimum Class H insulation.

M. Where a motor disconnect is used downstream of a variable frequency drive (VFD) provide an auxiliary contact on the disconnect and provide and interlock from the auxiliary contact on the disconnect to the VFD to stop the VFD when the disconnect is opened.

N. Motor frames shall be NEMA Standard T-Frames of steel, aluminum, or cast iron with end brackets of cast-iron or aluminum with steel inserts.

O. Control of each motor shall be manual or automatic as specified for each in the various mechanical sections. In general, and unless otherwise specified for a particular item in the various mechanical sections of the specifications, motor starters and controls shall be specified and provided under the various electrical sections of these specifications.

2.2 MOTOR CHARACTERISTICS

A. Duty: Continuous duty at ambient temperature of 40 deg C and at altitude of 3300 feet (1000 m) 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.

2.3 POLYPHASE MOTORS

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

B. Efficiency: Premium efficient, 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. Multispeed Motors: Separate winding for each speed.

F. Rotor: Random-wound, squirrel cage.

G. Bearings: Re-greaseable, shielded, antifriction ball bearings suitable for radial and thrust loading.

H. Temperature Rise: Match insulation rating.

I. Insulation: Class F.

J. 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.

K. Enclosure Material: Cast iron for motor frame sizes 324T and larger; rolled steel for motor frame sizes smaller than 324T.

2.4 POLYPHASE MOTORS WITH ADDITIONAL REQUIREMENTS

A. 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.

B. 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.

C. Severe-Duty Motors: Comply with IEEE 841, with 1.15 minimum service factor.

2.5 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.

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

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

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

E. 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.

2.6 CAPACITORS:

A. Capacitors for power factor correction shall be provided for motors indicated on the electrical drawings and on all motors 3 HP and above. Submit capacitors with equipment which the capacitor is to be connected to. Capacitors shall be connected at the motor terminals and raise

the motor power factor to a minimum of 90%. Capacitors shall be sized by motor manufacturer. Capacitors shall have integral fusing and indicating lights on all phases to give visible indication that a fuse has blown.

B. Capacitors shall not use Polychlorinated Biphenyl's (PCB) or mineral oil as a cooling medium. All capacitors shall have NEMA 1 enclosures for indoor mounting and NEMA 3R enclosures for exterior mounting.

C. Coordinate wiring connections to capacitors and motors with the electrical contractor.

D. Do not provide capacitors for motors utilizing variable speed drives.

2.7 VARIABLE SPEED DRIVE:

A. Provide variable speed controllers for geothermal system water pumps; supply, return, and relief air fans; and as indicated on the Drawings.

B. The Adjustable Frequency Controller (AFC) shall convert three-phase 60 Hertz utility power to adjustable voltage and frequency, three phase, AC power. The AFC shall use two 32-bit microprocessors with 12-bit resolution for stepless motor control from 5% to 110% of base speed.

C. The AFC shall be a fully digital Pulse Width Modulated (PWM) output type utilizing IGBT transistors. 1-150 HP 460 Volt AFC's and 1-100 HP 208 Volt AFC's shall be current rated at 8 Khz carrier frequency. In cases where motor audible noise is not critical to the installation, an alternate 4 Khz 75 150 HP 460 Volt AFC may be supplied. All HP ratings shall meet or exceed Table 430-150 of the NEC, 3 Phase Motor Full Load Currents. HP, Maximum Current, and Rated Voltage shall appear on the AFC nameplate.

D. The AFC, together with all options and modifications, shall mount within a standard NEMA 1 enclosure suitable for continuous operation at ambient temperature of 0 to 40 deg C at elevations up to 3300 feet altitude with relative humidity to 95% non-condensing. All high voltage components within the enclosure shall be isolated with steel or polycarbonate covers. The complete unit shall be UL approved and UL 508 labeled. The AFC and options shall comply with the applicable requirements of the latest standards of ANSI, NEMA, NEC, NEPU-70, IEEE519-1992, FCC Part 15, Subpart J, CE96. The AFC Manufacturer shall be ISO 9001 certified.

E. Circuits shall provide DV/DT and DI/DT protection for semi-conductors. AFC shall be capable of starting into a rotating load without delay. Protective circuits shall cause instantaneous trip (IET) should any of the following faults occur:

1. Motor current exceeds 110% of controller maximum sine wave current rating for longer than one minute.
2. Motor current exceeds 200% of controller maximum sine wave current rating.
3. Output phase-to-phase short circuit condition.
4. Total ground fault under any operating condition.
5. High input line voltage.
6. Low input line voltage.
7. Loss of input or output phase.
8. External fault. This protective circuit shall permit, by means of the terminal strip, wiring of remote NC safety contacts such as high static, firestat, etc., to shut down the drive.

F. The following adjustments shall be available in the controller and retained in non-volatile memory:

1. Maximum frequency (15 to 120 Hz), factory set at 60 Hz.
2. Minimum frequency (5 to 60 Hz).

3. Acceleration (0.1 to 999.9 seconds).
4. Deceleration (0.1 to 999.9 seconds).
5. Volts/Hertz ratio, factory set for 460 V at 60 Hz or 208 volts at 60 Hz.
6. Current limit (50% to 110% sine wave current rating), factory set at 100% current.

G. The AFC shall have the following basic features:

1. Door-mounted operator controls consisting of a membrane command center which allows manual stop/start and speed control, local/remote status indication, manual or automatic speed control selection, and run/jog selection. In addition, the command center will serve as a means to configure controller parameters such as minimum speed, maximum speed, acceleration and deceleration times, volts/Hz ratio, torque boost, slip compensation, over-frequency limit, and current limit. Potentiometers will not be allowed for these settings. The controller shall have an internal means of deactivating keypad parameter adjustments to eliminate unauthorized data entry.
2. Main input disconnect to provide a positive disconnect of all phases of the incoming A-C line to the controller and to the bypass circuitry when bypass is provided. This disconnect shall be mounted inside the controller enclosure and have through-the-door interlocking toggle with provisions for padlocking.
3. Electronic motor overload relay.
4. Automatic restart after power outage or drive fault, with drive-in automatic mode. The circuit shall allow the user to select up to (10) restart attempts as well as the dwell time between attempts. The reset time between fault occurrences shall also be selectable. All settings shall be via the membrane command center.
5. Door-mounted LED display for digital indication of:
    a. Frequency output.
    b. Voltage output.
    c. Current output.
    d. Time-stamped fault indication.
    e. Motor RPM.
    f. Input kW.
    g. Elapsed time.
    h. DC bus volts.
6. Relay contacts for remote indication of drive fault and motor running.
7. Smoke purge circuit to enable user-supplied contacts to force controller to a preset adjustable speed when energized.
8. Three critical frequency avoidance bands, field programmable via the membrane command center. Each critical frequency avoidance band shall have a bandwidth adjustable via keypad entry of up to 10 Hz.
9. Eight programmable present speeds which will force the AFD to a preset speed upon a user contact closure.
10. Electronic isolated process follower to enable VFD to follow a 0-20 mA, 4-20 mA or 0-4, 0-8, 0–10-volt D-C grounded or ungrounded signal.
11. The AFC shall have the capability to ride through power dips up to 10 seconds without a controller trip depending on load and operating condition.

12. Isolated 0-10 V or 4-20 mA output signal, selectable for speed or current.
13. RS-232 Port for configuration, control, and monitoring.
14. A slip compensation circuit for accurate 1% speed regulation without the need of a tachometer.
15. Capability for direct communications with BACnet Building Automation Systems. Fault diagnostics, start/stop, speed commands, and all drive feedbacks shall be available over a single communications module. Discrete signals such as Bypass Run or Interlock Open shall be mapped through the drive terminal strip to the BAS.
16. Manual bypass-to-line with magnetic contactors to transfer motor from the variable frequency controller to full speed operation on utility supplied input power, or from utility power to the controller, while the motor is at zero speed. Two motor contactors, electrically interlocked shall be utilized, one contactor between the controller output and the motor and the other between the bypass power line and the motor, providing across-the-line starting.
17. Provide a BACNET-Certified interface card for integrating with the Energy Management System. Provide interface requirements to meet sequence of operation and I/O Summary requirements.

H. Motor protection per National Electrical Code shall be provided in both the "controller" mode and the "bypass" mode by a single bi-metallic motor overload relay. The 1156-volt A-C relay control logic, allowing common Start/Stop commands in the "controller" mode and the "bypass" mode shall also be included within the enclosure.

I. The bypass shall include a door interlocked main power input disconnect providing positive shutdown of all power to both the bypass circuitry and the VFD. The bypass circuit shall also include a second input disconnect to the VFD. This disconnect shall provide the ability to safely trouble shoot and test the controller, both energized and de-energized, while operating the bypass mode.

J. Input line fuses to provide protection for the input rectification circuit, using Class J fuses with interrupting rating of 200,000 AIC. The series interrupting rating of the AFC and fuses shall be a minimum of 30,000 AIC and shall be stated in the AFC Instruction Manual as required by UL.

K. Three percent impedance Input Line Reactor to minimize line surges, line notching, and voltage distortions.

L. The VFD and all components shall be supplied in a NEMA 1 enclosure and shall be UL Listed as a single unit.

M. The VFD Manufacturer shall maintain and staff nationwide service centers. These service engineers shall be employed by the Manufacturer and provide start-up service including physical inspection of drive and connected wiring and final adjustments to meet specified performance requirements.

N. The VFD and motor shall carry a full parts and labor warranty for five (5) years from the date of Owner acceptance.

O. The variable speed drive manufacturer shall be the manufacturer of the motors supplied with the associated equipment, to assure single source responsibility for compatibility of the motor with the VFD. Motors shall be premium efficiency and specifically designed for operation with VFD’s. Coordinate with equipment manufacturers.

P. The variable speed drive shall be manufactured by ABB Model ACH-550 or Danfoss Model VLT-HVAC.

PART 3 EXECUTION (Not Applicable)

END OF SECTION

SECTION 23 05 29
HANGERS AND SUPPORTS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

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

B. Related Sections:

1. Division 05 for structural-steel shapes and plates for trapeze hangers for pipe and equipment supports.
2. Division 23 for vibration isolation devices and duct hangers and supports.

1.3 DEFINITIONS

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

1.4 SUBMITTALS

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

B. Shop Drawings: Show fabrication and installation details and include calculations for the following; include Product Data for components:

1. Trapeze pipe hangers.
2. Metal framing systems.
3. Pipe stands.
4. Equipment supports.

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

1. Detail fabrication and assembly of trapeze hangers.
2. Design Calculations: Calculate requirements for designing trapeze hangers.

D. Welding certificates.

1.5 QUALITY ASSURANCE

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

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

PART 2 PRODUCTS

2.1 METAL PIPE HANGERS AND SUPPORTS

A. Carbon-Steel Pipe Hangers and Supports:

1. Description: MSS SP-58, Types 1 through 58, factory-fabricated components.
2. Galvanized Metallic Coatings: Pre-galvanized or hot dipped.
3. Nonmetallic Coatings: Plastic coating, jacket, or liner.
4. Padded Hangers: Hanger with fiberglass or other pipe insulation pad or cushion to support bearing surface of piping.
5. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel or zinc-plated carbon steel.

B. Copper Pipe Hangers:

1. Description: MSS SP-58, Types 1 through 58, copper-coated-steel, factory-fabricated components. Provide felt or wool inserts.
2. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel or copper-coated steel.

2.2 TRAPEZE PIPE HANGERS

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

2.3 METAL FRAMING SYSTEMS

A. MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   a. Allied Tube & Conduit.
   b. Cooper B-Line, Inc.
   c. Flex-Strut Inc.
   d. GS Metals Corp.
   e. Thomas & Betts Corporation.
   f. Unistrut Corporation; Tyco International, Ltd.
   g. Wesanco, Inc.
2. Description: Shop- or field-fabricated pipe-support assembly for supporting multiple parallel pipes.
3. Standard: MFMA-4.
4. Channels: Continuous slotted steel channel with inturned lips.
5. Channel Nuts: Formed or stamped steel nuts or other devices designed to fit into channel slot and, when tightened, prevent slipping along channel.
6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel or zinc-coated stainless steel.
7. Metallic Coating: Hot-dipped galvanized.

8. Paint Coating: Rust-inhibiting paint.

B. Non-MFMA Manufacturer Metal Framing Systems:

1. Manufacturers: Subject to compliance with requirements, provide products by Anvil International, Figure 45 Channel Assembly or comparable product by one of the following:

a. Empire Industries, Inc.

b. ERICO International Corporation.

c. Haydon Corporation; H-Strut Division.

d. PHD Manufacturing, Inc.

e. PHS Industries, Inc.

2. Description: Shop- or field-fabricated pipe-support assembly made of steel channels, accessories, fittings, and other components for supporting multiple parallel pipes.

3. Standard: Comply with MFMA-4.

4. Channels: Continuous steel channel assembly with inturned lips.

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

6. Hanger Rods: Continuous-thread rod, nuts, and washer made of stainless steel or zinc-coated carbon steel.

7. Coating: Rust-inhibiting paint or galvanized.

2.4 THERMAL-HANGER SHIELD INSERTS

A. Manufacturers: Subject to compliance with requirements, provide products by Anvil International, Figure 45 Channel Assembly, or comparable product by one of the following:

1. Carpenter & Paterson, Inc.

2. Clement Support Services.

3. ERICO International Corporation.

4. National Pipe Hanger Corporation.

5. PHS Industries, Inc.

6. Pipe Shields, Inc.; a subsidiary of Piping Technology & Products, Inc.

7. Rilco Manufacturing Co., Inc.

B. Insulation-Insert Material for Cold Piping: ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength and vapor barrier.

C. Insulation-Insert Material for Hot Piping: Water repellant-treated, ASTM C 533, Type 1, with 100 psig minimum compressive strength or ASTM C 552, Type II cellular glass with 100-psig (688-kPa) minimum compressive strength.

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

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

F. Insert Length: Extend 2 inches (50 mm) beyond sheet metal shield for piping operating below ambient air temperature.

2.5 FASTENER SYSTEMS

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

B. Mechanical-Expansion Anchors: Insert-wedge-type, 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.

2.6 PIPE STANDS

A. General Requirements for Pipe Stands: Shop- or field-fabricated assemblies made of manufactured corrosion-resistant components (galvanized or stainless-steel supports and stainless-steel fasteners, rods, nuts, washers, attachments, etc.) to support roof-mounted piping.

B. Compact Pipe Stand: One-piece plastic unit with integral-rod roller, pipe clamps, or V-shaped cradle to support pipe, for roof installation without membrane penetration.

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

D. Curb-Mounted-Type Pipe Stands: Shop- or field-fabricated pipe supports made from structural-steel shapes, continuous-thread rods, and rollers, for mounting on permanent stationary roof curb.

2.7 EQUIPMENT SUPPORTS

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

2.8 MISCELLANEOUS MATERIALS

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

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

1. Properties: Non-staining, noncorrosive, and nongaseous.

2. Design Mix: 5000-psi (34.5-MPa), 28-day compressive strength.

2.9 EQUIPMENT AND PIPE CURBS

A. General:

1. Provide roof curbs, roof-mounted piping, pipe penetrations, and equipment curbs, etc., as indicated and detailed on the Drawings.

2. All roof curbs and supports shall be coordinated with and installed in accordance with the roof manufacturer’s recommendations.

3. Provide multiple section roof curbs where indicated on the Drawings and complying with the specification requirements.

4. All roof curbs shall be provided by one manufacturer.

5. Manufacturer shall be Thycurb Fabricating Division of Thybar Corporation, the Pate Company, or equal.

B. Insulated Prefabricated Roof Curb: Prefabricated roof curbs to be galvanized steel construction with aluminum flashing, meeting with welded corners and seams joined by continuous welds. Curbs to be internally reinforced, factory insulated with 1-1/2” thick 3# density fiberglass insulation, and factory-installed chemically treated wood nailers fastened from underside with

Tek screws. Height to be 18-inches above the roof or as detailed. Top of all roof curbs shall be level with pitch built into curb when deck slopes one quarter of an inch per foot, or greater. Thycurb Model TC-3, Pate PC-2, or equal.

C. Equipment support and curbs for stack guys shall be Thycurb Model TEMS-3, 14 gauge galvanized steel shell and pretreated wood nailer.

PART 3 EXECUTION

3.1 HANGER AND SUPPORT INSTALLATION

A. Metal Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Install hangers, supports, clamps, and attachments as required to properly support piping from the building structure.

B. Metal Trapeze Pipe-Hanger Installation: Comply with MSS SP-58 and MSS SP-89. Arrange for grouping of parallel runs of horizontal piping, and support together on field-fabricated trapeze pipe hangers.

1. Pipes of Various Sizes: Support together and space trapezes for smallest pipe size or install intermediate supports for smaller diameter pipes as specified for individual pipe hangers.

2. Field fabricate from ASTM A 36/A 36M, carbon-steel shapes selected for loads being supported. Weld steel according to AWS D1.1/D1.1M.

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

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

E. Fastener System Installation:

1. Install powder-actuated fasteners for use in lightweight concrete or concrete slabs less than 4 inches (100 mm) 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.

F. Pipe Stand Installation:

1. Pipe Stand Types except Curb-Mounted Type: Assemble components and mount on smooth roof surface. Do not penetrate roof membrane.

2. Curb-Mounted-Type Pipe Stands: Assemble components or fabricate pipe stand and mount on permanent, stationary roof curb. See Division 07 Section "Roof Accessories" for curbs.

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

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

I. 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.

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

K. Install building attachments within concrete slabs or attach to structural steel. Install additional attachments at concentrated loads, including valves, flanges, and strainers, NPS 2-1/2 (DN 65) and larger and at changes in direction of piping. Install concrete inserts before concrete is placed; fasten inserts to forms and install reinforcing bars through openings at top of inserts.

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

M. 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.

N. Insulated Piping:

1. Attach clamps and spacers to piping.

a. Piping Operating above Ambient Air Temperature: Clamp may project through insulation.

b. Piping Operating below Ambient Air Temperature: Use thermal-hanger shield insert with clamp sized to match OD of insert.

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

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

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

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

a. Option: Thermal-hanger shield inserts may be used. Include steel weight-distribution plate for pipe NPS 4 (DN 100) and larger if pipe is installed on rollers.

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

a. NPS 1/4 to NPS 3-1/2 (DN 8 to DN 90): 12 inches (305 mm) long and 0.048 inch (1.22 mm) thick.

b. NPS 4 (DN 100): 12 inches (305 mm) long and 0.06 inch (1.52 mm) thick.

c. NPS 5 and NPS 6 (DN 125 and DN 150): 18 inches (457 mm) long and 0.06 inch (1.52 mm) thick.

d. NPS 8 to NPS 14 (DN 200 to DN 350): 24 inches (610 mm) long and 0.075 inch (1.91 mm) thick.

e. NPS 16 to NPS 24 (DN 400 to DN 600): 24 inches (610 mm) long and 0.105 inch (2.67 mm) thick.

5. Pipes NPS 8 (DN 200) and Larger: Include wood or reinforced calcium-silicate-insulation inserts of length at least as long as protective shield.

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

3.2 EQUIPMENT SUPPORTS

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

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

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

3.3 METAL FABRICATIONS

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

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

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

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

3.4 ADJUSTING

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

B. Trim excess length of continuous-thread hanger and support rods to 1-1/2 inches (40 mm).

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide a minimum dry film thickness of 2.0 mils (0.05 mm).

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

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

3.6 HANGER AND SUPPORT SCHEDULE

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

B. Comply with MSS SP-58 for pipe-hanger selections and applications that are not specified in piping system Sections.

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

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

E. Use painted or zinc-coated carbon-steel pipe hangers and supports, metal trapeze pipe hangers, and metal framing systems and attachments for general interior service applications. Use galvanized or stainless-steel pipe hangers and supports, trapeze pipe hangers, and framing systems and attachments for exterior service applications.

F. Use copper-plated pipe hangers with wool or felt inserts and copper attachments for copper piping and tubing.

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

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

I. 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 (DN 15 to DN 750).

2. U-Bolts (MSS Type 24): For support of heavy pipes NPS 1/2 to NPS 30 (DN 15 to DN 750).
3. Clips (MSS Type 26): For support of insulated pipes not subject to expansion or contraction.
4. Pipe Saddle Supports (MSS Type 36): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate.
5. Pipe Stanchion Saddles (MSS Type 37): For support of pipes NPS 4 to NPS 36 (DN 100 to DN 900), with steel-pipe base stanchion support and cast-iron floor flange or carbon-steel plate, and with U-bolt to retain pipe.
6. Adjustable Pipe Saddle Supports (MSS Type 38): For stanchion-type support for pipes NPS 2-1/2 to NPS 36 (DN 65 to DN 900) if vertical adjustment is required, with steel-pipe base stanchion support and cast-iron floor flange.
7. Adjustable Roller Hangers (MSS Type 43): For suspension of pipes NPS 2-1/2 to NPS 24 (DN 65 to DN 600), from single rod if horizontal movement caused by expansion and contraction might occur.
8. Complete Pipe Rolls (MSS Type 44): For support of pipes NPS 2 to NPS 42 (DN 50 to DN 1050) if longitudinal movement caused by expansion and contraction might occur but vertical adjustment is not necessary.
9. Pipe Roll and Plate Units (MSS Type 45): For support of pipes NPS 2 to NPS 24 (DN 50 to DN 600) if small horizontal movement caused by expansion and contraction might occur and vertical adjustment is not necessary.
10. Adjustable Pipe Roll and Base Units (MSS Type 46): For support of pipes NPS 2 to NPS 30 (DN 50 to DN 750) if vertical and lateral adjustment during installation might be required in addition to expansion and contraction.

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

1. Extension Pipe or Riser Clamps (MSS Type 8): For support of pipe risers NPS 3/4 to NPS 24 (DN 24 to DN 600).
2. Carbon- or Alloy-Steel Riser Clamps (MSS Type 42): For support of pipe risers NPS 3/4 to NPS 24 (DN 20 to DN 600) if longer ends are required for riser clamps.

K. 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 (150 mm) for heavy loads.
2. Steel Clevises (MSS Type 14): For 120 to 450 deg F (49 to 232 deg C) piping installations.
3. Malleable-Iron Sockets (MSS Type 16): For attaching hanger rods to various types of building attachments.
4. Steel Weldless Eye Nuts (MSS Type 17): For 120 to 450 deg F (49 to 232 deg C) piping installations.

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

1. Steel or Malleable Concrete Inserts (MSS Type 18): For upper attachment to suspend pipe hangers from concrete ceiling.

2. Top-Beam C-Clamps (MSS Type 19): For use under roof installations with bar-joist construction, to attach to top flange of structural shape.
3. Side-Beam or Channel Clamps (MSS Type 20): For attaching to bottom flange of beams, channels, or angles.
4. Center-Beam Clamps (MSS Type 21): For attaching to center of bottom flange of beams.
5. Welded Beam Attachments (MSS Type 22): For attaching to bottom of beams if loads are considerable and rod sizes are large.
6. C-Clamps (MSS Type 23): For structural shapes.
7. 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 (340 kg).
    b. Medium (MSS Type 32): 1500 lb (680 kg).
    c. Heavy (MSS Type 33): 3000 lb (1360 kg).
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.

M. 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.

N. Spring Hangers and Supports: Unless otherwise indicated and except as specified in piping system Sections, install the following types:
1. Restraint-Control Devices (MSS Type 47): Where indicated to control piping movement.
2. Spring Sway Braces (MSS Type 50): To retard sway, shock, vibration, or thermal expansion in piping systems.
3. 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.
4. 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.

5. 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.

6. 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.

O. Comply with MSS SP-58 for trapeze pipe-hanger selections and applications that are not specified in piping system Sections.

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

Q. Use powder-actuated fasteners instead of building attachments where required in concrete construction.

END OF SECTION

SECTION 23 05 48
VIBRATION AND SEISMIC CONTROLS FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. 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. Freestanding and restrained air-mounting system.
12. Restrained vibration isolation roof-curb rails.
13. Seismic snubbers.
14. Restraining braces and cables.
15. Steel and inertia, vibration isolation equipment bases.

1.3 DEFINITIONS

A. IBC: International Building Code.

B. ICC-ES: ICC-Evaluation Service.

C. OSHPD: Office of Statewide Health Planning and Development for the State of California.

1.4 PERFORMANCE REQUIREMENTS

A. Wind-Restraint Loading:

1. Minimum 10 lb/sq. ft. (48.8 kg/sq. m) 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.

1.5 SUBMITTALS

A. Product Data: For the following:

1. Include rated load, rated deflection, and overload capacity for each vibration isolation device.
2. Interlocking Snubbers: Include ratings for horizontal, vertical, and combined loads.

B. Welding certificates.

C. Qualification Data: For engineer and testing agency.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For air-mounting systems to include in operation and maintenance manuals.

1.6 SUMMARY

A. Provide all labor and materials necessary to furnish and install vibration control systems on this project as herein specified and/or shown on the drawings.

B. Mount all mechanical equipment on suitable vibration isolators so as to prevent transmission of vibration into or through the building structure. Isolators shall be as manufactured by Mason Industries, Inc., Amber/Booth, or Peabody, and shall be selected by the isolator manufacturer for each item of equipment in accordance with requirements hereinafter specified.

C. The equipment manufacturer shall supply all pump and motor bases, fan and motor bases, cradles, pipe/duct hangers, spring and/or neoprene isolators, neoprene pads, flexible connectors, etc., as a coordinated package by a single manufacturer.

D. Select isolators for uniform static deflections according to distribution of weight; and for not less than the indicated isolation efficiency with the lowest rotational speed of equipment as the disturbing frequency.

E. Isolators and bases shall be stable during stopping and starting of equipment without transverse or eccentric movement of equipment, and shall be designed to resist horizontal forces of equipment which may operate unbalanced.

F. In general, select isolators on the basis of criteria as specified in the ASHRAE Applications Handbook, Latest Edition.

PART 2 PRODUCTS

2.1 VIBRATION ISOLATORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Indusries, or a comparable product by one of the following:

1. Amber/Booth Company, Inc.

2. Kinetics Noise Control.

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 rubber, Mason Super W.

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, Mason Type No.

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 – Mason Model SLF: 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- (6-mm-) thick, rubber isolator pad attached to baseplate underside. Baseplates shall limit floor load to 500 psig (3447 kPa).

6. Top Plate and Adjustment Bolt: Threaded top plate with adjustment bolt and cap screw to fasten and level equipment.

F. Restrained Spring Isolators – Mason Type SLR: 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- (6-mm-) 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 (6-mm) travel up or down before contacting a resilient collar.

H. Elastomeric Hangers Mason Type HD: 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 Mason Type 30N: 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 – Mason Type PC30N: 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- (13-mm-) 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 (3.45 MPa) 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- (13-mm-) 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.

2.2 THRUST RESTRAINTS

A. Adjustable spring thrust restraints, able to resist the thrust force with at least 25 percent unused capacity. The operating spring deflection shall be not less than 50 percent of the static deflection of the isolation supporting the machinery. The spring element shall be contained within a steel frame and designed so it can be preset for thrust at the factory and adjusted in the field to allow for a maximum of 1/4" movement at start and stop. The assembly shall be furnished with one rod and angle bracket for attachment to both the equipment and ductwork or the equipment and the structure. Horizontal restraints shall be attached at the centerline of thrust and symmetrically on either side of the unit. Horizontal thrust restraints shall be Type WB.

2.3 FLEXIBLE CONNECTORS FOR PIPING

A. General: Straight flexible connectors rated for temperatures, pressures, and fluids to be conveyed. Provide flexible connectors with the strength 4 times operating pressure at highest system operating temperature. Provide elbow flexible connectors with a permanently set angle.

B. Metal Flexible Connectors: Fabricated of grade E phosphor bronze, monel or corrugated stainless steel tube covered with comparable bronze or stainless-steel braid restraining and pressure cover. Sizes 3" and larger shall be flanged. Sizes 2-1/2" and smaller shall have male nipples. Lengths shall be as indicated:

NOMINAL DIAMETER (INCHES)	LENGTH (INCHES)
1/2”	9”
3/4”	10”
1”	11”
1-1/4”	12”
1-1/2”	12”
2”	12”
2-1/2”	12”
3”	18”
4”	18”
5”	24”
6”	24”
8”	24”

C. Hoses shall be installed on the equipment side of the shut-off valves horizontally and parallel to the equipment shafts wherever possible. Hoses shall be Type BSS.

2.4 VIBRATION ISOLATION EQUIPMENT BASES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Mason Industries or a comparable product by one of the following:

1. Amber/Booth Company, Inc.

2. Kinetics Noise Control.

B. Steel Base: Factory-fabricated, welded, structural-steel bases and rails. Mason Type WF and Mason Type ICS.

1. Design Requirements: Lowest possible mounting height with not less than 1-inch (25-mm) 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- Mason Industries BMK/KSL bases with modular corners: 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 (25-mm) 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 modular corner brackets on frame for 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.

2.5 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.

2.6 ACOUSTICAL FLOOR, CEILING AND WALL SEAL:

A. Provide acoustical floor, ceiling, and wall seal where piping passes through mechanical equipment room/fan and air handling unit room walls, floors, or ceilings, and any noise-sensitive areas. The vibration isolator manufacturer shall provide a split seal consisting of two bolted pipe halves with 3/4” or thicker neoprene sponge bonded to the inner faces. The seal shall be tightened around the pipe to eliminate clearance between the inner sponge face and the piping. Concrete may be packed around the seal to make it integral with the floor, wall or ceiling if the seal is not already in place around the pipe prior to the construction of the building member. Seals shall project a minimum of 1" past either face of the wall. Where temperatures exceed 240^{o}F, 10# density fiberglass shall be used in lieu of the sponge. Seals shall be Type SAWS.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and equipment to receive vibration isolation and seismic-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.

3.2 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.

3.3 VIBRATION-CONTROL 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 HVAC 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 (3.2 mm).

C. Piping Restraints:

1. Comply with requirements in MSS SP-127.

2. Space lateral supports a maximum of 40 feet (12 m) o.c., and longitudinal supports a maximum of 80 feet (24 m) o.c.

3. Brace a change of direction longer than 12 feet (3.7 m).

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.

3.4 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. Test and adjust air-mounting system controls and safeties.

10. 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.

3.5 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.

3.6 GENERAL PROVISIONS

A. Install vibration-and-noise isolation materials and equipment as indicated and in accordance with machinery manufacturer's instructions.

B. Where neoprene elements of vibration isolator may be subjected to high pipe temperatures above 160 deg F, provide metal heat shields or thermal isolators.

C. A minimum of 4" thick concrete housekeeping pads shall be provided under all floor mounted equipment. A minimum of 6" thick concrete housekeeping pads shall be provided under all air handling units/ERV’s, water-to-water heat pumps, boilers and where indicated. Rest sub-bases on structural floor and reinforce with steel rods interconnected with floor reinforcing bars by tie bars hooked at both ends. Provide at least one (1) inch clearance between sub-bases and inertia bases, steel bases, and steel saddles with machinery in operation.

D. All vibration isolators exposed to weather shall be hot dipped galvanized with springs coated with neoprene.

E. Concrete inertia bases shall be a minimum of two (2) times the weight supported. Clearance between the underside of the inertia base and the housekeeping pad below shall not be less than 1 inch. Concrete shall be 3000 psi. Install inertia bases in accordance with the recommendations of the machinery manufacturer and the inertia base manufacturer.

F. Anchor Bolts and Grout: Secure machinery to foundations and inertia bases with anchor bolts. Grout equipment with baseplates, the full area under baseplates with premixed non-shrinking grout. After grout has set, remove wedges, shims, and jack bolts and fill spaces with grout.

G. Common Machinery Foundations: Mount electrical motors on the same foundations as driven machinery. Support piping connections, strainers, valves, and risers on the same foundation as the pumps.

H. Vertical Stops: For machinery affected by wind pressure or having an operational weight different from installed weight, provide resilient vertical limit stops which prevent spring extension when weight is removed. Provide vertical stops for machinery containing liquid, such as water chillers, evaporative coolers, boilers, and cooling towers. Spring isolated or protected spring isolated machinery must rock and move freely within limits of stops or seismic restraint devices.

I. Thrust Restraints: Where required, provide pairs of thrust restraints, symmetrically installed on both sides of the steady state line of thrust.

J. Machinery: Provide vibration isolators, flexible connectors and seismic snubbers in accordance with manufacturer's recommendations. Machinery with spring isolators or protected spring isolators shall rock or move freely within limits of stops or seismic snubber restraints.

K. Stability: Isolators shall be stable during starting and stopping of machinery without traverse and eccentric movement of machinery that would damage or adversely affect the machinery or attachments.

L. Lateral Motion: The installed vibration isolation systems for each piece of floor or ceiling mounted machinery shall have a maximum lateral motion under machinery start up and shut down conditions of not more than 1/4-inch. Restrain motions in excess by approved spring mountings.

M. Unbalanced Machinery: Provide foundation suspension systems specifically designed to resist horizontal forces for machinery with large unbalanced horizontal forces. Vibration isolator systems shall conform to the machinery manufacturer's recommendations.

N. Non-Rotating Machinery: Mount non-rotating machinery in systems which include rotating or vibrating machinery on isolators having the same deflection as the hangers and supports for the pipe connected to.

O. Unitized Machinery Assemblies: Unitized assemblies such as chillers with evaporator and condenser, and top mounted centrifugal compressor or unitized absorption refrigeration machines, structurally designed with end supports, may be mounted on steel rails and springs in lieu of steel bases and springs. Where the slab or deck is less than 4 inches thick, provide spring isolation units with the deflection double that of the vibration isolation schedule, up to a maximum static deflection of 5 inches.

P. Roof and Upper Floor Mounted Machinery: On the roof or upper floors, mount machinery on isolators with vertical stops. Rest isolators on beams or structures designed and installed in accordance with the SMACNA ASMM Plate 61.

Q. Vibration isolation ceiling hangers shall be installed so that the hanger rods do not touch the sides of the isolator housing, thereby seriously degrading the vibration isolation performance. Vibration isolation ceiling hangers shall be located so that the hanger housing may rotate 360^{o} without touching any object.

R. Electrical Connections: Provide flexible conduit or multiple conductor cable connections for machinery with sufficient extra length to permit 2-inch minimum displacement in any direction without damage.

S. Systems Not to be Vibration Isolated: Do not provide vibration isolation for electrical raceways and conduits or for fire protection, storm, sanitary, and domestic water piping systems which do not include pumps or other vibrating, rotating, or pulsating equipment including control and pressure reducing valves.

3.7 PIPE ISOLATION:

A. Horizontal Pipe Isolation

1. Pre-compressed Suspension Spring Isolators: The first three pipe hangers in the main lines near the mechanical equipment provide pre-compressed suspension spring isolators. Floor supported piping shall rest on trained spring isolators. All pre-compressed suspension spring isolators hangers or the first three trained spring isolators mounts as noted above, will have the same static deflection as specified for the mountings under the connected equipment. If piping is connected to equipment located in basements and hangs from ceiling under occupied spaces, the first three hangers shall have 0.75" deflection for pipe sizes up to and including 3", 1.5" deflection for pipe sizes up to and including 6" and 2.5" deflection thereafter. All other hangers and mounts will have a minimum steel spring deflection of 0.75". Hangers shall be located as close to the overhead supports as practical.

2. Combination Spring and Neoprene Suspension Hanger: For horizontal runs in Mechanical Equipment Rooms (including Air Handling Unit Rooms) other than those hereinbefore specified, provide suspension spring hangers (combination spring and neoprene) with .75" minimum steel spring deflection.

B. Floor-Supported Piping:

1. Floor supports for piping in equipment rooms and adjacent to isolated equipment shall use vibration isolators as described hereinbefore and selected to the guidelines of hangers.

2. The first three adjacent floor supports shall be the restrained spring type with a blocking feature that prevents load transfer to equipment flanges as the piping is filled and drained.

3. Where piping is subject to larger thermal movement a slide plate shall be installed on the top of the isolator. Slide plate shall be teflon, graphite or steel.

4. Provide a thermal barrier where neoprene products are installed directly beneath steam or hot water lines.

C. Pipe Risers: Provide pipe riser supports with bearing plates and two layers of 1/4" thick ribbed or waffled neoprene pad loaded to not more than 50 psi. Separate isolation pads with 1/4" steel plate. Weld pipe riser clamps at anchor points to the pipe and to pairs of vertical acoustical pipe anchor mountings which shall be rigidly fastened to the steel framing.

D. Supports at Base of Pipe Risers: Piping isolation supports at the base of risers shall be two layers of 1/2" thick heavy-duty neoprene pad separated by 1/4" thick steel plate. Use bearing plates sized to provide a pad loading of not more than 500 psi. Weld the stanchion between the pipe and isolation support to the pipe and weld or bolt to the isolation support. Bolt isolation support to the floor slab with resilient sleeves and washers. Where supplementary steel is required to support piping, provide a maximum deflection of 0.08 inches at the mid-span of this steel under the load. Rigidly support piping from the supplementary steel with the supplementary steel isolated from the building structure with isolators.

E. Pipe Anchors: Attach each end of the pipe anchor to an omni-directional pipe isolator which in turn shall be rigidly fastened to the steel framing or structural concrete. Provide a telescoping pipe isolator of two sizes of steel tubing separated by a minimum 1/2" thick pad of heavy-duty neoprene or heavy-duty neoprene and canvas. Provide vertical restraints by similar material to

prevent vertical travel in either direction. The load on the isolation material shall not exceed 500 psi.

3.8 EQUIPMENT ROOM SOUND ISOLATION:

A. Do not allow direct contact between pipes or ducts and walls, floor slabs, roofs, ceilings or partitions of equipment rooms.

B. Pipe Penetrations: All piping passing through Mechanical Equipment Room and Fan/Air Handling Unit Room walls, floors and ceilings shall be protected against sound leakage by means of an acoustical wall seal as described hereinbefore.

C. Duct Penetrations: Provide with sound insulation equal to the sound attenuation value of the wall, floor, or ceiling penetrated.

3.9 FLEXIBLE PIPE CONNECTORS:

A. Provide flexible connectors in accordance with Manufacturers instructions where piping systems serving vibration isolated equipment and as shown on the drawings. Flexible connectors shall be installed near the connection to the equipment. Where liquid pulsation dampening is required, flexible connectors with spherical configuration may be used. Provide restraints for pipe connectors at pumps to prevent connector failure upon pump start-up.

3.10 ISOLATION FOR SPECIFIC EQUIPMENT:

A. The vibration isolator manufacture shall provide isolators for all pieces of equipment provided for the job. Isolator shall be selected by the isolator manufacturer on the basis of criteria as specified in the latest edition of ASHRAE Applications Handbook, unless a more stringent requirement is indicated on the drawings.

B. Pumps:

1. All base-mounted pumps shall be mounted on concrete inertia blocks supported on stable steel springs in series with ribbed neoprene pads selected for not less than .75 inch static deflection under full operating load.

2. Floor support of the initial pipe elbows at the pump discharge and suction diffuser at the pump intake shall be made from the isolated inertia base, not from the equipment room floor.

3. Provide flexible pipe connections at pump suction and discharge.

C. Cabinet/In-Line Fan(s): Suspended – Provide combination spring and neoprene type isolator with a minimum deflection of 1.00"; Mason Industries Type 30N, or approved equal.

3.11 DUCTWORK

A. All ductwork 50 feet from air handling unit connection shall be provided with spring deflection hangers. Spring deflection shall be a minimum of 0.75”.

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SECTION 23 05 53
IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Equipment labels.
2. Warning signs and labels.
3. Pipe labels.
4. Duct labels.
5. Stencils.
6. Valve tags.
7. Warning tags.

1.3 SUBMITTALS

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

B. Samples: For color, letter style, and graphic representation required for each identification material and device.

C. Equipment Label Schedule: Include a listing of all equipment to be labeled with the proposed content for each label.

D. Valve numbering scheme.

E. Valve Schedules: For each piping system to include in maintenance manuals.

1.4 COORDINATION

A. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

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

C. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 EQUIPMENT LABELS

A. Plastic Labels for Equipment:

1. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.
2. Letter Color: White.
3. Background Color: Black.
4. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).
5. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).
6. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm),

and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

7. Fasteners: Stainless-steel rivets or self-tapping screws.

8. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate. VOC content shall not exceed 250 g/L.

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

C. Equipment Label Schedule: For each item of equipment to be labeled, on 8-1/2-by-11-inch (A4) 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.

2.2 WARNING SIGNS AND LABELS

A. Material and Thickness: Multilayer, multicolor, plastic labels for mechanical engraving, 1/8 inch (3.2 mm) thick, and having predrilled holes for attachment hardware.

B. Letter Color: White.

C. Background Color: Red.

D. Maximum Temperature: Able to withstand temperatures up to 160 deg F (71 deg C).

E. Minimum Label Size: Length and width vary for required label content, but not less than 2-1/2 by 3/4 inch (64 by 19 mm).

F. Minimum Letter Size: 1/4 inch (6.4 mm) for name of units if viewing distance is less than 24 inches (600 mm), 1/2 inch (13 mm) for viewing distances up to 72 inches (1830 mm), and proportionately larger lettering for greater viewing distances. Include secondary lettering two-thirds to three-fourths the size of principal lettering.

G. Fasteners: Stainless-steel rivets or self-tapping screws.

H. Adhesive: Contact-type permanent adhesive, compatible with label and with substrate. VOC content shall not exceed 250 g/L.

I. Label Content: Include caution and warning information, plus emergency notification instructions.

2.3 PIPE LABELS

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

B. Pretensioned Pipe Labels: Pre-coiled, Snap-On semi-rigid plastic formed to cover full circumference of pipe and to attach to pipe without fasteners or adhesive (4” and less). For larger pipe (sizes 6” and greater) markers shall be strapped around using nylon ties.

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

1. Flow-Direction Arrows: Integral with piping system service lettering to accommodate both directions, or as separate unit on each pipe label to indicate flow direction.

2. Lettering Size: At least 1-1/2 inches (38 mm) high.

2.4 STENCILS

A. Stencils: Prepared with letter sizes according to ASME (ANSI) A13.1 for piping; minimum letter height of 1-1/4 inches (32 mm) for ducts; and minimum letter height of 3/4 inch (19 mm) for access panel and door labels, equipment labels, and similar operational instructions.

1. Stencil Material: Aluminum.

2. Stencil Paint: Exterior, gloss, alkyd enamel black unless otherwise indicated. Paint may be in pressurized spray-can form.

3. Identification Paint: Exterior, alkyd enamel in colors according to ASME (ANSI) A13.1 unless otherwise indicated.

B. Duct Identification Contents: Include identification of duct service using same designations or abbreviations as used on 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 1-1/2 inches (38 mm) high.

2.5 VALVE TAGS

A. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) black-filled letters for piping system abbreviation and 1/2-inch (13-mm) numbers; 2-inch diameter.

1. Tag Material: Brass, 19-gauge, minimum thickness, and having predrilled or stamped holes for attachment hardware.

2. Fasteners: Brass jack chain and/or brass S Hook.

B. Valve Schedules: For each piping system, on 8-1/2-by-11-inch (A4) 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.

2.6 WARNING TAGS

A. Warning Tags: Preprinted or partially preprinted, accident-prevention tags, of plasticized card stock with matte finish suitable for writing.

1. Size: 4 by 7 inches minimum.

2. Fasteners: Brass grommet and wire.

3. Nomenclature: Large-size primary caption such as "DANGER," "CAUTION," or "DO NOT OPERATE."

4. Color: Yellow background with black lettering.

PART 3 EXECUTION

3.1 PREPARATION

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

3.2 EQUIPMENT LABEL INSTALLATION

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

B. Locate equipment labels where accessible and visible.

3.3 PIPE LABEL INSTALLATION

A. Piping Color-Coding -- Gas Piping: Yellow.

B. Stenciled Pipe Label Option: Stenciled labels may be provided instead of manufactured pipe labels, at Installer's option. Install stenciled pipe labels, complying with ASME (ANSI) 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 or above accessible ceilings in finished spaces; machine rooms; accessible maintenance spaces such as shafts, tunnels, and plenums; and exterior exposed locations as follows:

1. Near each valve and control device.

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

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

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

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

6. Spaced at maximum intervals of 25 feet along each run. Reduce intervals to 15 feet in areas of congested piping and equipment.

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

8. Where pipes are adjacent to each other, markings shall be neatly lined up. All markings shall be located in such a manner to be easily legible from the floor.

9. For piping less than 3/4-inch, provide permanently legible tag as specified hereinbefore for valve identification.

10. For buried piping, provide 2-inch minimum width plastic identification/detection tape with metallic core. Install 4-6-inches below-grade.

D. Pipe Label Color Schedule:

1. Refrigerant Piping:

a. Background Color: Black.

b. Letter Color: White.

3.4 DUCT LABEL IDENTIFICATION

A. Stenciled Duct Label Option: Stenciled labels, showing service and flow direction, shall be provided.

B. Locate labels near points where ducts enter into concealed spaces and at maximum intervals of 25 feet in each space where ducts are exposed or concealed by removable ceiling system.

3.5 VALVE-TAG INSTALLATION

A. Install tags on valves and control devices in piping systems, except check valves; valves within factory-fabricated equipment units; shutoff valves; faucets; convenience and lawn-watering hose connections; and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. List tagged valves in a valve schedule.

B. 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:
    a. Refrigerant: 2 inches (50 mm), round.
2. Valve-Tag Color:
    a. Refrigerant: Black.
3. Letter Color:
    a. Refrigerant: White.

3.6 WARNING-TAG INSTALLATION

A. Write required message on, and attach warning tags to, equipment and other items where required.

END OF SECTION

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SECTION 23 05 93
TESTING, ADJUSTING, AND BALANCING FOR HVAC

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Balancing Air Systems:

a. Constant-volume air systems.

1.3 DEFINITIONS

A. AABC: Associated Air Balance Council.

B. NEBB: National Environmental Balancing Bureau.

C. TAB: Testing, adjusting, and balancing.

D. TABB: Testing, Adjusting, and Balancing Bureau.

E. TAB Specialist: An entity engaged to perform TAB Work.

1.4 SUBMITTALS

A. Qualification Data: Within 30 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.

B. Contract Documents Examination Report: Within 30 days of Contractor's Notice to Proceed, submit the Contract Documents review report as specified in Part 3.

C. Strategies and Procedures Plan: Within 30 days of Contractor's Notice to Proceed, submit TAB strategies and step-by-step procedures as specified in "Preparation" Article.

D. Certified TAB reports.

E. Sample report forms.

F. Instrument calibration reports, to include the following:

1. Instrument type and make.

2. Serial number.

3. Application.

4. Dates of use.

5. Dates of calibration.

1.5 QUALITY ASSURANCE

A. TAB Contractor Qualifications: Engage a TAB entity certified by AABC.

1. TAB Field Supervisor: Employee of the TAB contractor and certified by AABC.

2. TAB Technician: Employee of the TAB contractor and who is certified by AABC as a TAB technician.

B. TAB Conference: Meet with Architect and Owner for approval of the TAB strategies and procedures plan to develop a mutual understanding of the details. Require the participation of

the TAB field supervisor and technicians. Provide 14 days' advance notice of scheduled meeting time and location.

1. Agenda Items:
    a. The Contract Documents examination report.
    b. The TAB plan.
    c. Coordination and cooperation of trades and subcontractors.
    d. Coordination of documentation and communication flow.

C. 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.

D. TAB Report Forms: Use standard TAB contractor's forms approved by Architect and Owner.

E. Instrumentation Type, Quantity, Accuracy, and Calibration: As described in ASHRAE 111, Section 5, "Instrumentation."

1.6 PROJECT CONDITIONS

A. Full Owner Occupancy: Owner will occupy the site and existing building during entire TAB period. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

B. Partial Owner Occupancy: Owner may occupy completed areas of building before Substantial Completion. Cooperate with Owner during TAB operations to minimize conflicts with Owner's operations.

1.7 COORDINATION

A. Notice: Provide fourteen days' advance notice for each test. Include scheduled test dates and times.

B. Perform TAB after leakage and pressure tests on air and water distribution systems have been satisfactorily completed.

PART 2 PRODUCTS (Not Applicable)

PART 3 EXECUTION

3.1 TAB SPECIALISTS

A. Subject to compliance with requirements, engage one of the following available TAB contractors that may be engaged include, but are not limited to, the following:
    1. Baltimore Air Balance Company.
    2. Baumgartner, Inc.
    3. American Testing, Inc.
    4. Chesapeake Testing and Balancing Engineers, Inc.
    5. Weisman, Inc.
    6. Butler Balancing Company, Inc.
    7. Flood and Sterling, Inc.

3.2 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 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.

F. Examine system and equipment installations and verify that field quality-control testing, cleaning, and adjusting specified in individual Sections have been performed.

G. Examine test reports specified in individual system and equipment Sections.

H. 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.

I. Examine terminal units and verify that they are accessible and their controls are connected and functioning.

J. Examine operating safety interlocks and controls on HVAC equipment.

K. Report deficiencies discovered before and during performance of TAB procedures. Observe and record system reactions to changes in conditions. Record default set points if different from indicated values.

3.3 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. Automatic temperature-control systems are operational.

3. Equipment and duct access doors are securely closed.

4. Balance, smoke, and fire dampers are open.

5. Isolating and balancing valves are open and control valves are operational.

6. Ceilings are installed in critical areas where air-pattern adjustments are required and access to balancing devices is provided.

7. Windows and doors can be closed so indicated conditions for system operations can be met.

3.4 GENERAL PROCEDURES FOR TESTING AND BALANCING

A. Perform testing and balancing procedures on each system according to the procedures contained in AABC's "National Standards for Total System Balance", ASHRAE 111, SMACNA's "HVAC Systems - Testing, Adjusting, and Balancing" and in this Section.

1. Comply with requirements in ASHRAE 62.1-2004, Section 7.2.2, "Air Balancing."

B. Cut insulation, ducts, pipes, and equipment cabinets for installation of test probes to the minimum extent necessary for TAB procedures.

1. After testing and balancing, patch probe holes in ducts with same material and thickness as used to construct ducts.

2. After testing and balancing, install test ports and duct access doors that comply with requirements in Division 23 Section "Air Duct Accessories."

3. Install and join new insulation that matches removed materials. Restore insulation, coverings, vapor barrier, and finish according to Division 23 Section "HVAC Insulation."

C. 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.

D. Take and report testing and balancing measurements in inch-pound (IP) units.

3.5 GENERAL PROCEDURES FOR BALANCING AIR SYSTEMS

A. Prepare test reports for both fans and outlets. Obtain manufacturer's outlet factors and recommended testing procedures. Crosscheck the summation of required outlet volumes with required fan volumes.

B. Prepare schematic diagrams of systems' "as-built" duct layouts.

C. For variable-air-volume systems, develop a plan to simulate diversity.

D. Determine the best locations in main and branch ducts for accurate duct-airflow measurements.

E. Check airflow patterns from the outdoor-air louvers and dampers and the return- and exhaust-air dampers through the supply-fan discharge and mixing dampers.

F. Locate start-stop and disconnect switches, electrical interlocks, and motor starters.

G. Verify that motor starters are equipped with properly sized thermal protection.

H. Check dampers for proper position to achieve desired airflow path.

I. Check for airflow blockages.

J. Check condensate drains for proper connections and functioning.

K. Check for proper sealing of air-handling-unit components.

L. Verify that air duct system is sealed as specified in Division 23 Section "Metal Ducts."

3.6 PROCEDURES FOR CONSTANT-VOLUME AIR SYSTEMS

A. Adjust fans to deliver total indicated airflows within the maximum allowable fan speed listed by fan manufacturer.

1. Measure total airflow.

a. Where sufficient space in ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow.

2. Measure fan static pressures as follows to determine actual static pressure:

a. Measure outlet static pressure as far downstream from the fan as practical and upstream from restrictions in ducts such as elbows and transitions.

b. Measure static pressure directly at the fan outlet or through the flexible connection.

c. Measure inlet static pressure of single-inlet fans in the inlet duct as near the fan as possible, upstream from the flexible connection, and downstream from duct restrictions.

d. Measure inlet static pressure of double-inlet fans through the wall of the plenum that houses the fan.

3. Measure static pressure across each component that makes up an air-handling unit, rooftop unit, and other air-handling and -treating equipment.

a. Report the cleanliness status of filters and the time static pressures are measured.

4. Measure static pressures entering and leaving other devices, such as sound traps and heat-recovery equipment, under final balanced conditions.

5. Review Record Documents to determine variations in design static pressures versus actual static pressures. Calculate actual system-effect factors. Recommend adjustments to accommodate actual conditions.

6. Obtain approval from Architect and Owner for adjustment of fan speed higher or lower than indicated speed. Comply with requirements in Division 23 Sections for air-handling units for adjustment of fans, belts, and pulley sizes to achieve indicated air-handling-unit performance.

7. Do not make fan-speed adjustments that result in motor overload. Consult equipment manufacturers about fan-speed safety factors. Modulate dampers and measure fan-motor amperage to ensure that no overload will occur. Measure amperage in full-cooling, full-heating, economizer, and any other operating mode to determine the maximum required brake horsepower.

B. Adjust volume dampers for main duct, submain ducts, and major branch ducts to indicated airflows within specified tolerances.

1. Measure airflow of submain and branch ducts.

a. Where sufficient space in submain and branch ducts is unavailable for Pitot-tube traverse measurements, measure airflow at terminal outlets and inlets and calculate the total airflow for that zone.

2. Measure static pressure at a point downstream from the balancing damper, and adjust volume dampers until the proper static pressure is achieved.

3. Remeasure each submain and branch duct after all have been adjusted. Continue to adjust submain and branch ducts to indicated airflows within specified tolerances.

C. Measure air outlets and inlets without making adjustments.

1. Measure terminal outlets using a direct-reading hood or outlet manufacturer's written instructions and calculating factors.

D. Adjust air outlets and inlets for each space to indicated airflows within specified tolerances of indicated values. Make adjustments using branch volume dampers rather than extractors and the dampers at air terminals.

1. Adjust each outlet in same room or space to within specified tolerances of indicated quantities without generating noise levels above the limitations prescribed by the Contract Documents.

2. Adjust patterns of adjustable outlets for proper distribution without drafts.

3.7 PROCEDURES FOR MOTORS

A. Motors, 1/2 HP and Larger: Test at final balanced conditions and record the following data:

1. Manufacturer's name, model number, and serial number.
2. Motor horsepower rating.
3. Motor rpm.
4. Efficiency rating.
5. Nameplate and measured voltage, each phase.
6. Nameplate and measured amperage, each phase.
7. Starter thermal-protection-element rating.

B. Motors Driven by Variable-Frequency Controllers: Test for proper operation at speeds varying from minimum to maximum. Test the manual bypass of the controller to prove proper operation. Record observations including name of controller manufacturer, model number, serial number, and nameplate data.

3.8 PROCEDURES FOR HEAT-TRANSFER COILS

A. Measure, adjust, and record the following data for each refrigerant coil:

1. Dry-bulb temperature of entering and leaving air.
2. Wet-bulb temperature of entering and leaving air.
3. Airflow.
4. Air pressure drop.
5. Refrigerant suction pressure and temperature.

3.9 TOLERANCES

A. Set HVAC system's air flow rates within the following tolerances:

1. Supply, Return, and Exhaust Fans and Equipment with Fans: Plus or minus 5 percent.
2. Air Outlets and Inlets: Plus or minus 5 percent.

3.10 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 biweekly progress reports to describe completed procedures, procedures in progress, and scheduled procedures. Include a list of deficiencies and problems found in systems being tested and balanced. Prepare a separate report for each system and each building floor for systems serving multiple floors.

3.11 FINAL REPORT

A. General: Prepare a certified written report; tabulate and divide the report into separate sections for tested systems and balanced systems.

1. Include a certification sheet at the front of the report's binder, signed and sealed by the certified testing and balancing engineer.
2. Include a list of instruments used for procedures, along with proof of calibration.

B. Final Report Contents: In addition to certified field-report data, include the following:
   1. Pump curves.
   2. Fan curves.
   3. Manufacturers' test data.
   4. Field test reports prepared by system and equipment installers.
   5. Other information relative to equipment performance; do not include Shop Drawings and product data.

C. General Report Data: In addition to form titles and entries, include the following data:
   1. Title page.
   2. Name and address of the TAB contractor.
   3. Project name.
   4. Project location.
   5. Architect's name and address.
   6. Engineer's name and address.
   7. Contractor's name and address.
   8. Report date.
   9. Signature of TAB supervisor who certifies the report.
   10. Table of Contents with the total number of pages defined for each section of the report. Number each page in the report.
   11. Summary of contents including the following:
      a. Indicated versus final performance.
      b. Notable characteristics of systems.
      c. Description of system operation sequence if it varies from the Contract Documents.
   12. Nomenclature sheets for each item of equipment.
   13. Data for terminal units, including manufacturer's name, type, size, and fittings.
   14. Notes to explain why certain final data in the body of reports vary from indicated values.
   15. Test conditions for fans and pump performance forms including the following:
      a. Settings for outdoor-, return-, and exhaust-air dampers.
      b. Conditions of filters.
      c. Cooling coil, wet- and dry-bulb conditions.
      d. Face and bypass damper settings at coils.
      e. Fan drive settings including settings and percentage of maximum pitch diameter.
      f. Inlet vane settings for variable-air-volume systems.
      g. Settings for supply-air, static-pressure controller.
      h. Other system operating conditions that affect performance.

D. System Diagrams: Include schematic layouts of air and hydronic distribution systems. Present each system with single-line diagram and include the following:

1. Quantities of outdoor, supply, return, and exhaust airflows.
2. Water flow rates.
3. Duct, outlet, and inlet sizes.
4. Pipe and valve sizes and locations.
5. Terminal units.
6. Balancing stations.
7. Position of balancing devices.

E. Air-Handling-Unit Test Reports: For air-handling units with coils, include the following:

1. Unit Data:
    a. Unit identification.
    b. Location.
    c. Make and type.
    d. Model number and unit size.
    e. Manufacturer's serial number.
    f. Unit arrangement and class.
    g. Discharge arrangement.
    h. Sheave make, size in inches (mm), and bore.
    i. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
    j. Number, make, and size of belts.
    k. Number, type, and size of filters.
2. Motor Data:
    a. Motor make, and frame type and size.
    b. Horsepower and rpm.
    c. Volts, phase, and hertz.
    d. Full-load amperage and service factor.
    e. Sheave make, size in inches (mm), and bore.
    f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).
3. Test Data (Indicated and Actual Values):
    a. Total air flow rate in cfm (L/s).
    b. Total system static pressure in inches wg (Pa).
    c. Fan rpm.
    d. Discharge static pressure in inches wg (Pa).
    e. Filter static-pressure differential in inches wg (Pa).
    f. Preheat-coil static-pressure differential in inches wg (Pa).
    g. Cooling-coil static-pressure differential in inches wg (Pa).
    h. Heating-coil static-pressure differential in inches wg (Pa).

i. Outdoor airflow in cfm (L/s).
j. Return airflow in cfm (L/s).
k. Outdoor-air damper position.
l. Return-air damper position.
m. Vortex damper position.

F. Apparatus-Coil Test Reports:
1. Coil Data:
a. System identification.
b. Location.
c. Coil type.
d. Number of rows.
e. Fin spacing in fins per inch (mm) o.c.
f. Make and model number.
g. Face area in sq. ft. (sq. m).
h. Tube size in NPS (DN).
i. Tube and fin materials.
j. Circuiting arrangement.
2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm (L/s).
b. Average face velocity in fpm (m/s).
c. Air pressure drop in inches wg (Pa).
d. Outdoor-air, wet- and dry-bulb temperatures in deg F (deg C).
e. Return-air, wet- and dry-bulb temperatures in deg F (deg C).
f. Entering-air, wet- and dry-bulb temperatures in deg F (deg C).
g. Leaving-air, wet- and dry-bulb temperatures in deg F (deg C).
h. Water flow rate in gpm (L/s).
i. Water pressure differential in feet of head or psig (kPa).
j. Entering-water temperature in deg F (deg C).
k. Leaving-water temperature in deg F (deg C).
l. Refrigerant expansion valve and refrigerant types.
m. Refrigerant suction pressure in psig (kPa).
n. Refrigerant suction temperature in deg F (deg C).
o. Inlet steam pressure in psig (kPa).

G. Fan Test Reports: For supply, return, and exhaust fans, include the following:
1. Fan Data:
a. System identification.
b. Location.

c. Make and type.

d. Model number and size.

e. Manufacturer's serial number.

f. Arrangement and class.

g. Sheave make, size in inches (mm), and bore.

h. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

2. Motor Data:

a. Motor make, and frame type and size.

b. Horsepower and rpm.

c. Volts, phase, and hertz.

d. Full-load amperage and service factor.

e. Sheave make, size in inches (mm), and bore.

f. Center-to-center dimensions of sheave, and amount of adjustments in inches (mm).

g. Number, make, and size of belts.

3. Test Data (Indicated and Actual Values):

a. Total airflow rate in cfm (L/s).

b. Total system static pressure in inches wg (Pa).

c. Fan rpm.

d. Discharge static pressure in inches wg (Pa).

e. Suction static pressure in inches wg (Pa).

H. Round, Flat-Oval, and Rectangular Duct Traverse Reports: Include a diagram with a grid representing the duct cross-section and record the following:

1. Report Data:

a. System and air-handling-unit number.

b. Location and zone.

c. Traverse air temperature in deg F (deg C).

d. Duct static pressure in inches wg (Pa).

e. Duct size in inches (mm).

f. Duct area in sq. ft. (sq. m).

g. Indicated air flow rate in cfm (L/s).

h. Indicated velocity in fpm (m/s).

i. Actual air flow rate in cfm (L/s).

j. Actual average velocity in fpm (m/s).

k. Barometric pressure in psig (Pa).

I. System-Coil Reports: For reheat coils and water coils of terminal units, include the following:

1. Unit Data:

a. System and air-handling-unit identification.
b. Location and zone.
c. Room or riser served.
d. Coil make and size.
e. Flowmeter type.

2. Test Data (Indicated and Actual Values):
a. Air flow rate in cfm (L/s).
b. Entering-water temperature in deg F (deg C).
c. Leaving-water temperature in deg F (deg C).
d. Water pressure drop in feet of head or psig (kPa).
e. Entering-air temperature in deg F (deg C).
f. Leaving-air temperature in deg F (deg C).

J. Pump Test Reports: Calculate impeller size by plotting the shutoff head on pump curves and include the following:

1. Unit Data:
a. Unit identification.
b. Location.
c. Service.
d. Make and size.
e. Model number and serial number.
f. Water flow rate in gpm (L/s).
g. Water pressure differential in feet of head or psig (kPa).
h. Required net positive suction head in feet of head or psig (kPa).
i. Pump rpm.
j. Impeller diameter in inches (mm).
k. Motor make and frame size.
l. Motor horsepower and rpm.
m. Voltage at each connection.
n. Amperage for each phase.
o. Full-load amperage and service factor.
p. Seal type.

2. Test Data (Indicated and Actual Values):
a. Static head in feet of head or psig (kPa).
b. Pump shutoff pressure in feet of head or psig (kPa).
c. Actual impeller size in inches (mm).
d. Full-open flow rate in gpm (L/s).
e. Full-open pressure in feet of head or psig (kPa).

f. Final discharge pressure in feet of head or psig (kPa).

g. Final suction pressure in feet of head or psig (kPa).

h. Final total pressure in feet of head or psig (kPa).

i. Final water flow rate in gpm (L/s).

j. Voltage at each connection.

k. Amperage for each phase.

K. Instrument Calibration Reports:

1. Report Data:

a. Instrument type and make.

b. Serial number.

c. Application.

d. Dates of use.

e. Dates of calibration.

3.12 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 5 percent of air outlets.

b. Measure water flow of at least 5 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 Architect and Owner.

2. The TAB contractor's test and balance engineer shall conduct the inspection in the presence of Architect and Owner.

3. Architect, Owner 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.

3.13 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.

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SECTION 23 07 01
HVAC INSULATION

PART 1. GENERAL

1.1. REFERENCE

A. The Conditions of the Contract and other General Requirements apply to the work specified in this Section. All work under this Section shall be subject to the requirements of Division 23 Section, *Common Work Results for HVAC*.

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

1.2. DESCRIPTION

A. All piping, ductwork and equipment installed under this Contract shall be covered as specified.

1.3. SCOPE

A. The work covered by this specification consists of furnishing all labor, equipment, materials and accessories, and performing all operations required, for the correct fabrication and installation of thermal insulation applied to all piping, equipment, and duct systems, in accordance with applicable project specifications and drawings, subject to the terms and conditions of the contract.

1.4. STANDARDS

A. Thermal insulation materials shall meet the property requirements of one or more of the following specifications as applicable to the specific product or use:

1. American Society for Testing of Materials Specifications:

a. ASTM C 547, "Standard Specification for Mineral Fiber Preformed Pipe Insulation".

b. ASTM C 533, "Standard Specification for Calcium Silicate Pipe & Block Insulation".

c. ASTM C 55, "Standard Specification for Mineral Fiber Blanket and Felt Insulation".

d. ASTM E 96, “Standard Test Methods for Water Vapor Transmission of Material”.

e. ASTM C 585, "Recommended Practice for Inner and Outer Diameters of Rigid Pipe Insulation for Nominal Sizes of Pipe and Tubing (NPS System)".

f. ASTM C 612, "Standard Specification for Mineral Fiber Block and Board Thermal Insulation".

g. ASTM C 1136, "Standard Specification for Barrier Material, Vapor, "Type 1 or 2 (Jacket only).

h. ASHRAE 90.1 "Energy efficient design of new buildings except low-rise residential buildings", latest edition.

B. Insulation materials, including all weather and vapor barrier materials, closures, hangers, supports, fitting covers, and other accessories, shall be furnished and installed in strict accordance with project drawings, plans, and specifications.

1.5. SYSTEM PERFORMANCE

A. Insulation materials furnished and installed hereunder should meet the minimum economic insulation thickness requirements of the North American Insulation Manufacturers'

Association (NAIMA) (formerly known as TIMA), to ensure cost-effective energy conservation performance. Alternatively, materials should meet the minimum thickness requirements of National Voluntary Consensus Standard 90.1, (latest edition) and "Energy Efficient Design of New Buildings," of the American Society of Heating, Refrigeration, and Air-Conditioning Engineers (ASHRAE), latest edition. However, if other factors such as condensation control or personnel protection are to be considered, the selection of the thickness of insulation should satisfy the controlling factor. As minimum, all insulation thicknesses shall be as hereinafter specified.

B. Insulation materials furnished and installed hereunder shall meet the fire hazard requirements of any one of the following specifications:

1. American Society for Testing of Materials - ASTM E 84
2. Underwriters' Laboratories, Inc. - UL 723
3. National Fire Protection Association - NFPA 255
4. ASTM E 96, “Standard Test Methods for Water Vapor Transmission of Materials”.

C. Calcium silicate products shall include a visual identification system to permit positive field determination of their asbestos-free characteristics.

1.6. QUALITY ASSURANCE

A. Insulation materials and accessories furnished and installed hereunder shall, where required, be accompanied by manufacturers' current submittal or data sheets showing compliance with applicable specifications above.

B. Insulation materials and accessories shall be installed in a workmanlike manner by skilled and experienced workers who are regularly engaged in commercial insulation work.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.

1.7. DELIVERY AND STORAGE OF MATERIALS

A. All of the insulation materials and accessories covered by this specification shall be delivered to the job site and stored in a safe, dry place with appropriate labels and/or other product identification.

B. The Contractor shall use whatever means are necessary to protect the insulation materials and accessories before, during, and after installation. No insulation material shall be installed that has become damaged in any way. The Contractor shall also use all means necessary to protect work and materials installed by other trades.

C. If any insulation material has become wet because of transit or job site exposure to moisture or water, the Contractor shall not install such material, and shall remove it from the job site. An exception may be allowed in cases where the Contractor is able to demonstrate that wet insulation when fully dried out (either before installation, or afterward following exposure to system operating temperatures) will provide installed performance that is equivalent in all respects to new, completely dry insulation. In such cases, consult the insulation manufacturer in writing for technical assistance.

D. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics, and insulation cements. Protect all insulation from water, construction traffic, dirt, chemical and mechanical damage.

1.8. ALTERNATES

A. Refer to Division 01 Section, *Alternates* for description of work under this section affected by alternates.

PART 2. PRODUCTS

2.1. GENERAL

A. All materials to be insulated shall be thoroughly cleaned, after completion of successful tests, and shall be covered as specified below. Fiberglass insulation shall be Owens-Corning, Manville, Armstrong, or P.P.G, or as approved equal.

2.2. PIPE INSULATION MATERIALS

A. Unless otherwise noted, insulation shall be one piece or half sectional molded fibrous glass with "K" rating of .23 at 75 degrees Fahrenheit mean temperature, for service temperatures between -60 degrees Fahrenheit and +450 degrees Fahrenheit with all service jacket. Pipe insulation shall be fiberglass SSL II with double closure system as manufactured by Owens Corning, Johns Manville, Knauf or approved equal.

B. Exterior refrigerant pipe insulation**,** fume hood exhaust fan drain/trap insulation shall be Armacell, or approved equal, foam insulation with exterior field applied aluminum jacketing. Interior refrigerant piping shall be Armacell or approved equal foam insulation. Where interior refrigerant piping is exposed also install field applied PVC jacketing.

C. Unless otherwise noted, pipe insulation jacket shall be factory-applied vinyl coated, embossed and reinforced vapor barrier laminate, with a perm rating of not more than 0.02 perms. All hot and cold, concealed and exposed butt strips shall be of the same material as the jacket. Jacket and butt strips shall be sealed with field-applied Foster 85-20/85-60 or Childers CP-82 (5 gal cans only) adhesive. Jacket and butt strips shall be off-white color and shall be equivalent to Owens-Corning Fiberglass 25-ASJ.

D. For fittings on all piping, valves and flanges, apply fiberglass molded or segmented insulation equal in thickness to the adjoining insulation and securely fasten in place using wire. Cold piping: Apply a tack coat of vapor barrier coating and reinforcing mesh. After ½ hour, apply second coat of same vapor barrier coating, UL labeled, Type C, for cold water piping, Hot piping Type H for hot water piping: Apply tack of breather mastic. Wrap fitting with fiberglass reinforcing cloth overlapping adjoining sections of pipe insulation by 2-inches. Apply a second coat of breather mastic over the reinforcing cloth, working it to a smooth finish.

1. Vapor Barrier Coating: Foster 30-65; Childers CP-34 or Vimasco 749. Permeanie shall be 0.03 perms or less at 45 mils dry as test by ASTM E96.
2. Breather mastic: Foster 46-50; Childers CP-10/11 or Vimasco WC-5
3. Reinforcing Mesh: Foster Mast a Fab; Childers Chil Glas #10 or Vimasco Elastafab

E. All pipe insulation, jackets, or facings, and adhesives used to adhere jacket or facing to the insulation, including fittings and butt strips, shall have non-combustible fire and smoke hazard system rating and label as tested by ASTM E-84, NFPA 225, and UL 73, not exceeding Flame Spread 25, Fuel Contributed 50, Smoke Developed 50. Accessories such as adhesives, mastic cements, tapes and cloth for fittings shall have the same ratings as listed above. All products or their shipping cartons shall bear the Underwriter's label indicating that flame and smoke ratings do not exceed the above criteria.

F. For piping having a vapor barrier insulation and for all insulated piping requiring supports, hangers and supports shall be installed outside the insulation. Wherever hangers and supports are installed outside the insulation, pipe insulation protecting shields shall be provided. Where insulation is a load bearing material, of sufficient strength to support the weight of the piping, pipe shields one-third the circumference of the insulation and of a length not less than three times the diameter of the insulation (maximum length 24-inches) shall be provided. Insulation of 7-1/4 pound or greater density will be considered as load bearing for pipe sizes up to and including 2-inches. Where insulation is not of sufficient strength to

support the weight of the piping, a half section of high-density fiberglass or foam inserts, shall be provided. Vapor barrier and finish shall be applied as required to match adjoining insulation. In addition, shields shall be furnished as specified above.

G. For piping located outside of the building, and corrugated aluminum weatherproof jacketing system shall be provided. This system shall be Micro-Lot ML as manufactured by Manville, Polyweld by Pabco Metals Corp., Childers, or as approved equal, and installed per the manufacturer's recommendations. Where outdoor piping is receiving electric heat tape, the insulation shall be oversized so that the heat tape is not compressed tightly to the pipe. Pipe jacketing shall be corrugated (3/16-inch) deep aluminum, 0.016-inch thickness of H-14 temper with aluminum strapping of .75-inch width and 0.020-inch thickness with moisture barrier. Aluminum jacketing elbows shall be smooth, .016-inch thickness and 1100 alloy. All jacketing shall have an integrally bonded moisture barrier over the entire surface in contact with the insulation. Longitudinal joints shall be applied so they will shed water and shall be sealed completely with metal jacketing sealant. Sealant shall be Foster 95-44 or Childers CP-76. Circumferential joints shall be closed using preformed butt strips following manufacturer's recommendations for securement. Jacket seams shall be located on the bottom side of the horizontal piping.

H. On cold systems such as refrigerant piping and cooling coil drain piping vapor barrier performance is extremely important. All penetrations and seams of the ASJ and exposed ends of insulation must be sealed with vapor barrier coating. The ASJ must be protected with either a coating or a suitable vapor retarding outer jacket. Vapor seals at butt joints shall be applied at every fourth pipe section joint and at each fitting to provide isolation of water incursion. Vapor Barrier Coating: Foster 30-65; Childers CP-34 or Vimasco 749. Permeance shall be 0.03 perms or less at 45 mils dry as test by ASTM E96.

I. Fittings and valves shall be insulated with pre-formed fiberglass fittings, fabricated sections of fiberglass pipe insulation, Fiberglass pipe and tank insulation, Fiberglass blanket insulation, or insulating cement. Thickness shall be equal to adjacent pipe insulation. Finish shall be with pre-formed PVC fitting covers or as otherwise specified on contract drawings. Where applicable, Victaulic PVC fitting valve and coupling covers shall be utilized. Victaulic PVC covers shall be installed with matching pipe insulation jacketing material, vinyl tape solvent weld adhesive and appropriate fasteners.

1. Flanges, couplings and valve bonnets shall be covered with an oversized pipe insulation section sized to provide the same insulation thickness as on the main pipe section. An oversized insulation section shall be used to form a collar between the two insulation sections with low density blanket insulation being used to fill gaps. Jacketing shall match that used on straight pipe sections. Rough cut ends shall be coated with a suitable weather or vapor-resistant mastic as dictated by the system location and service. Finish valve installation with a Tyvek jacket with ends that secure to adjacent piping.

2. On hot systems where fittings are to be left exposed, insulation ends should be beveled away from bolts for easy access.

3. On cold systems, particular care must be given to vapor sealing the fitting cover or finish to the pipe insulation vapor barrier. All valve stems must be sealed with caulking which allows free movement of the stem but provides a seal against moisture incursion. All gauge and thermometer penetrations and extensions shall be correctly sealed and insulated to prevent surface condensation. Install oversized hangers to prevent penetrations of pipe insulation vapor barrier.

J. All piping shall be supported in such a manner that neither the insulation or the vapor/weather barrier is compromised by the hanger or the effects of the hanger. In all cases, hanger spacing must be such that the circumferential joint may be made outside the hanger. On cold systems, vapor barrier must be continuous, including material covered by the hanger saddle.

1. Piping systems 3-inches (7.5cm) in diameter or less, insulated with Fiberglass insulation, may be supported by placing saddles of the proper length and spacing, as designated in Owens-Corning Pub. 1-IN-12534, under the insulation. Hanger/saddles shall be minimum 16 gauge with a saddle arc of 120 degrees minimum.
2. For hot or cold piping systems larger than 3-inches (7.5 cm) in diameter, operating at temperatures less than +200 degrees F (93 degrees C) and insulated with fiber glass, high density inserts such as foam or wood blocks with sufficient compressive strength shall be used to support the weight of the piping system. At temperatures exceeding± 200 degrees F (93 degrees C), Owens-Corning Pink Calcium Silicate, IIG, or approved equal pipe insulation shall be used for high density inserts.
3. Owens-Corning Pink Calcium Silicate pipe insulation may be used to support the entire weight of the piping system provided the hanger saddle is designed so the maximum compressive load does not exceed 100 psi (7kg/cm).
4. Where pipe shoes and roller supports are required, insulation shall be inserted in the pipe shoe to minimize pipe heat loss. Where possible, the pipe shoe shall be sized to be flush with the outer pipe insulation diameter.
5. Thermal expansion and contraction of the piping and insulation system shall generally be taken care of by utilizing double layers of insulation and staggering both longitudinal and circumferential joints. Where long runs are encountered, expansion joints may be required where single layers of insulation are being used and should be so noted on the contract drawings.
6. On vertical runs, insulation support rings shall be used.

2.3. PIPING INSULATION THICKNESSES SCHEDULE

A. All piping shall be insulated with pipe insulation of the thicknesses indicted below:

PIPING INSULATION THICKNESS SCHEDULE SERVICES	THICKNESS
All Drain Piping from Cooling Coils/Evaporators	½-inch thickness
All Refrigerant Piping	1 ½ -inch thickness

2.4. DUCTWORK INSULATION MATERIALS AND THICKNESSES

A. Insulate all supply, return, exhaust and outside air intake ductwork with fiberglass exterior duct insulation with factory-applied foil facing. All exposed fiberglass duct insulation shall be 1-inch rigid or non-flexible board "K" factor at 75 degrees F mean temperature, with white vinyl A.S.J. vapor barrier facing. All concealed fiberglass duct insulation shall be 1-1/2-inch flexible blanket type, 1.0 pcf minimum density. All concealed insulation shall be 0.27 max. "K" factor at 75 degrees F mean temperature with reinforced foil-scrim Kraft vapor barrier facing.

B. Refer to Division 23 Section, *HVAC Air Distribution System,* and contract drawings for location of all sound-lined ductwork. Sound-lined ductwork from the discharge or supply side of all air handling units, H&V units shall require external insulation in addition to internal lining specified hereinafter. All other ducts indicated to be provided with interior lining shall not require additional exterior insulation.

C. Where exhaust ducts carrying moisture-laden air are routed in unconditioned spaces, insulation is required as described above. Insulation shall be continuous through the unconditioned area. The vapor barrier shall be tightly sealed to prevent condensation.

Exhaust ducts located within conditioned spaces do not require insulation unless otherwise noted.

D. Where a vapor barrier is required, all joints, seams, tears, punctures, and other penetrations shall be closed with 3-inch (7.5cm) pressure-sensitive tape matching the facing or with vapor barrier coating reinforced with 3-inch (7.5cm) glass scrim tape.

E. Contractor-applied internal linings shall be as specified and installed as hereinafter specified.

F. For exposed fiberglass duct insulation, tightly butt all edges and seams. Secure insulation with flush mechanical fasteners spaced not less than one per square foot. Insulation may be secured with 100 percent coverage of adhesive with mechanical fasteners on the underside of the duct only, in addition to adhesive. Adhesive shall be water-based Foster 85-60 or Childers CP-127. Cover all seams, joints and fasteners with not less than 3-inch-wide tape matching the insulation facing. Pre-finished white fastener caps may be left exposed if the spacing and pattern is uniform in appearance. Staples will not be permitted.

G. All pre-manufactured dual wall exterior ductwork shall be externally insulated with 2-inch rigid type, R-8, .25 max "K" factor with white vinyl A.S.J. vapor barrier facing. 1-inch flexible duct liner insulation shall be sandwiched between inner galvanized ductwork and exterior aluminum ductwork. Refer to specification section 23300 for duct lining.

H. All supply air diffusers and supply air registers shall be fully insulated on the rear exposed surface to prevent condensation. Insulation shall be 1-1/2-inch flexible blanket type 1 ½ pcf minimum density with reinforced foil-scrim-Kraft vapor barrier facing, .25 max "k" factor.

I. All airflow monitoring stations shall be externally insulated similar to adjacent ductwork as hereinbefore specified.

2.5. ACCESSORY MATERIALS

A. Accessory materials installed as part of insulation work under this section shall include, but not be limited to:

1. Closure Materials - Butt strips, bands, wires, staples, mastics, adhesives; pressure-sensitive tapes.

2. Field-applied jacketing materials - sheet metal, plastic, canvas, fiber glass cloth, insulating cement; PVC fitting covers, PVC jacketing.

3. Support Materials - Hanger straps, hanger rods, saddles.

4. Fasteners, weld pins/studs, speed clips, insulation washers.

5. Metal mesh or expanded metal lagging.

B. All accessory materials shall be installed in accordance with project drawings and specifications, manufacturer's instructions, and/or in conformance with the current edition of the Midwest Insulation Contractors Association (MICA) "Commercial & Industrial Insulation Standards."

2.6. FIELD-APPLIED JACKET

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

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

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

a. Johns Manville; Zeston.

b. P.I.C. Plastics, Inc.; FG Series.

c. Proto PVC Corporation; LoSmoke.

d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.

3. Color: Color-code jackets based on system.

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.

2.7. HANGER BLOCKS

A. For all pipes larger than 3 inches in diameter the hanger blocks shall be high compressive strength foam or wood blocks. Wood blocks shall be precision cut thickness to match specified insulation and shall include flared edge hanger saddle as manufactured by Buckaroo.

B. The wood blocks shall be suitable for temperatures from -120 degrees Fahrenheit to 200 degrees Fahrenheit. Do not utilize the wood blocks for piping systems operating outside of the indicated temperature range.

PART 3. EXECUTION

3.1. WORKMANSHIP

A. The Contractor shall take special care to prevent soiling equipment below or adjacent to areas being insulated. He shall be completely responsible for removing insulation cement splashes and smears and all surfaces that he mars or otherwise soils or defaces, and he will be totally responsible for restoring these damaged surfaces to their like-new condition when delivered to the site.

3.2. SITE INSPECTION

A. Before starting work under this section, carefully inspect the site and installed work of other trades and verify that such work is complete to the point where installation of materials and accessories under this section can begin.

B. Verify that all materials and accessories can be installed in accordance with project drawings and specifications and material manufacturers' recommendations.

C. Verify, by inspecting product labeling, submittal data, and/or certifications which may accompany the shipments, that all materials and accessories to be installed on the project comply with applicable specifications and standards and meet specified thermal and physical properties.

3.3. PREPARATION

A. Ensure that all pipe and equipment surface over which insulation is to be installed are clean and dry.

B. Ensure that insulation is clean, dry, and in good mechanical condition with all factory-applied vapor or weather barriers intact and undamaged. Wet, dirty, or damaged insulation shall not be acceptable for installation.

C. Ensure that pressure testing of piping or duct systems has been completed prior to installing insulation.

3.4. INSTALLATION

A. Piping Systems

1. General:
    a. Install all insulation materials and accessories in accordance with manufacturer's published instructions and recognized industry practices to ensure that it will serve its intended purpose.
    b. Install insulation on piping subsequent to installation of heat tracing, painting, testing, and acceptance tests.
    c. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with single cut piece to complete run. Do not use cut pieces or scraps abutting each other. Butt insulation joints firmly to ensure complete, tight fit over all piping surfaces.
    d. Maintain the integrity of factory-applied vapor barrier jacketing on all pipe insulation, protecting it against puncture, tear or other damage. Seal all tears, punctures, and other penetrations of the pipe insulation vapor barrier coating.
    e. On exposed piping, locate insulation and cover seams in least visible location.
2. Fittings: Cover valves, fittings, unions, flanges, strainers, flexible connections, expansion joints, pump bodies, strainers, blowdowns, backflow preventers, autoflow valves and similar items in each piping system using one of the following:
    a. Mitered sections of insulation equivalent in thickness and composition to that installed on straight pipe runs.
    b. Cold pipe fittings: Apply a tack coat of vapor barrier coating and reinforcing mesh to produce a smooth surface. After ½ hour, apply a second coat of same vapor barrier coating, UL labeled, Type C, for cold water piping.
    c. Hot pipe fittings and Type H for hot water piping: Apply tack of breather mastic. Wrap fitting with fiberglass reinforcing cloth overlapping adjoining sections of pipe insulation by 2-inches. Apply a second coat of Type C or Type H breather mastic over the reinforcing cloth, working it to a smooth finish.
    d. Insulation cement equal in thickness to the adjoining insulation.
    e. PVC fitting covers insulated with material equal in thickness and composition to adjoining insulation.
3. Penetrations: Extend piping insulation without interruption through walls, floors, and similar piping penetrations, except where otherwise specified.
4. Joints:
    a. Butt pipe insulation against hanger inserts. For hot pipes, apply 3-inch (7.5cm) wide vapor barrier tape or bank over butt joints. For cold piping, apply wet coat of vapor barrier lap cement on butt joints, and seal joints with 3-inch (7.5cm) wide vapor barrier tape or band.
    b. All pipe insulation ends shall be tapered and sealed, regardless of service.
5. Exterior above ground piping shall not be insulated with vapor wick insulation. Fiberglass insulation with aluminum jacketing shall be utilized for exterior above ground applications. Seal all aluminum jacketing laps with 1/8” bead of metal jacketing sealant to prevent water entry.

B. Ductwork Insulation:

1. General:
    a. Before installing insulation, ensure that all seams and joints in ductwork have been sealed and leak tested by the contractor responsible for the duct system. Before applying duct insulation, air ducts shall be clean and dry.

b. Install insulation in accordance with manufacturer's published instructions and recognized industry practice to ensure that it will serve its intended purpose.

c. Install insulation materials with smooth and even surfaces. Butt joints firmly together to ensure complete and tight fit over surfaces to be covered.

d. Maintain the integrity of factory-applied vapor barrier jacketing on all insulation, protecting it against puncture, tears or other damage. All staples used on ductwork insulation shall be coated with suitable sealant to maintain vapor barrier integrity and covered with pressure sensitive vapor barrier tape and vapor barrier coating as specified.

e. Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and exposed joints. All portions of duct designated to receive duct wrap shall be completely covered with duct wrap.

f. To ensure installed thermal performance, duct wrap insulation shall be cut to "stretch-out" dimensions. Maintain specified duct insulation thickness and vapor barrier at all fittings, obstructions, and duct flanges.

g. A 2-inch piece of insulation shall be removed from the facing at the end of the piece of duct wrap to form an overlapping stapling and taping flap.

h. Install duct wrap insulation with facing outside so that the tape flap overlaps the insulation and facing at the other end of the piece of duct wrap. Adjacent sections of duct wrap insulation shall be tightly butted with the 2-inch stapling and taping flap overlapping. If ducts are rectangular or square, install so insulation is not excessively compressed at corners. Seams shall be stapled approximately 6-inches on center with 2-inch (min) steel outward clinching staples.

i. Seams, joints and staples shall be sealed with pressure-sensitive tape matching the insulation facing (either plain foil or FRK backing stock) and glass fabric and vapor barrier coating. Cloth duct tape of any color or finish using reclaimed rubber adhesives shall not be utilized on duct wrap insulation. Adjacent sections of duct wrap shall be tightly butted with the 2-inch (50mm) tape flap overlapping.

j. Where rectangular ducts are 24-inch (600mm) in width or greater, duct wrap insulation shall be additionally secured to the bottom of the duct with mechanical fasteners such as pins and speed clip washers, spaced on 18-inch (425mm) centers (maximum) to prevent sagging of insulation.

k. Seal all tears, punctures and other penetrations of the duct wrap facing using one of the above methods to provide a vapor tight system.

l. Upon completion of installation of duct wrap and before operation is to commence, visually inspect the system and verify that it has been correctly installed.

m. Open all system dampers and turn on fans to blow all scraps and other loose pieces of material out of the duct system. Allow for a means for removal of such material.

n. Check the duct system to ensure that there are no air leaks through joints.

o. No ductwork insulation shall be supported utilizing tie wire or bailing wire. Penetrations of ductwork insulation vapor barrier are prohibited.

p. Bevel and terminate insulation at access doors. Paint edges with vapor barrier mastic.

q. Install insulation board between volume dampers and sheet metal standoffs.

r. Provide removable insulation section at all pitot tube traverse points. Insulation section shall contain tether that attaches to adjacent ductwork.

2. Penetrations: Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise specified.

3. Rigid Insulation:

a. Rigid duct insulation may be impaled over welded pins and secured with insulation caps and washers matching the color of the vapor barrier facing. All seams shall be firmly butted and sealed with pressure-sensitive vapor barrier tape matching the facing and vapor barrier coating.

b. Corner angles shall be installed on all external corners of rigid duct insulation in exposed finished areas before jacketing, except oven and hood exhaust duct insulation, which shall have no corner angles.

4. Duct Wrap Insulation: Duct wrap insulation shall be applied with all joints butted firmly together. All joints in the insulation covering shall be sealed with adhesive. Duct wrap insulation shall be secured to bottom of rectangular or oval ducts over 24inches (60cm) wide with mechanical fasteners on 16-inch (40 cm) (approx.) centers to prevent sagging.

5. Duct Lining Insulation: Duct liner insulation shall be applied with all joints tightly butted using 90 percent coverage of adhesive meeting the requirements of ASTM C 916 plus mechanical fasteners spaced according to the liner manufacturer's schedule for the interior width of the plenum, housing, or air shaft. (Also refer to Division 23 Section, *HVAC Air Distribution System*.)

6. Exposed ductwork in occupied spaces does not require external insulation. Exposed ductwork shall be double wall pre-insulated.

3.5. FIELD QUALITY ASSURANCE

A. Upon completion of all insulation work covered by this specification, visually inspect the work and verify that it has been correctly installed. This may be done while work is in progress, to assure compliance with requirements herein to cover and protect insulation materials during installation.

3.6. PROTECTION

A. Replace damaged insulation which cannot be satisfactorily repaired, including insulation with vapor barrier damage and moisture-saturated insulation.

B. The insulation contractor shall advise the general and/or the mechanical contractor as to requirements for protection of the insulation work during the remainder of the construction period, to avoid damage and deterioration of the finished insulation work.

3.7. SAFETY PRECAUTIONS

A. Insulation contractor's employees shall be properly protected during installation of all insulation. Protection shall include proper attire when handling and applying insulation materials and shall include (but not be limited to) disposable dust respirators, gloves, hard hats, and eye protection.

B. The insulation contractor shall conduct all job site operations in compliance with applicable provisions of the Occupational Safety and Health Act, as well as with all state and/or local safety and health codes and regulations that may apply to the work.

3.8. INSULATION COVERING

A. Unless otherwise noted, all exposed duct and equipment insulation shall have a field applied PVC jacket cover neatly cut and pasted over ductwork and equipment insulation. PVC shall be color coded by system and shall be 20 mils thick.

B. Unless otherwise noted, all exposed pipe insulation required to be insulated shall be jacketed with a PVC Jacketing with fitting covers. PVC jacket shall be color fade resistant, white high gloss, U.S.D.A. authorized as manufactured by Proto Corporation or approved equal. PVC jacketing shall be high impact, ultraviolet resistant PVC. Minimum thickness shall be 20 mils, roll stock ready for shop or field cutting and forming.

C. Exposed areas include, but are not limited to, all mechanical equipment rooms/fan rooms, equipment platforms, boiler rooms, electric rooms, piping and ductwork exposed in an occupied space.

D. Where PVC jackets are indicated, install with 1 inch overlap at longitudinal seams and end joints, for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

E. Exterior exposed pipe insulation required to be insulated shall be jacketed with a corrugated aluminum jacketing system as previously described. Seal all laps with 1/8” bead metal jacketing sealant.

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SECTION 23 09 00
AUTOMATIC TEMPERATURE CONTROLS

PART 1 RELATED DOCUMENTS

SUMMARY

A. All work done under this section is subject to the requirements of Section 23 05 00, "Common Work Results for HVAC".

B. The Building Automation System (BAS) manufacturer shall furnish and install a fully integrated building automation system incorporating direct digital control (DDC) for energy management, equipment monitoring and control, and subsystems on Siemens Apagee NT System (proprietary). To accomplish this effectively, system shall be capable of utilizing standard protocols as follows as well as be able to integrate with the existing Montgomery County System – Desigo Server. System shall be capable of BACnet communication according to ASHRAE standard SPC-135A/95. System shall be capable of OPC server communications according to OPC Data Access 2.0 and Alarms and Events 1.0. The system shall be able to integrate a wide variety of third-party devices and applications via existing vendor protocols and through the latest software standards. The intent is to either use the Operator Workstation provided under this contract to communicate with control systems to allow information about the system provided in this contract to be sent to another workstation. This allows the user to have a single seat from which to perform daily operation.

C. The installation of the control system shall be performed under the direct supervision of the controls manufacturer with the shop drawings, flow diagrams, bill of materials, component designation or identification number and sequence of operation all bearing the name of the manufacturer. The installing manufacturer shall certify in writing, that the shop drawings have been prepared by the equipment manufacturer and that the equipment manufacturer has supervised their installation. In addition, the equipment manufacturer shall certify, in writing, that the shop drawings were prepared by their company and that all temperature control equipment was installed under their direct supervision.

D. All materials and equipment used shall be standard components, regularly manufactured for this and/or other systems and not custom designed specifically for this project. All systems and components shall have been thoroughly tested and proven in actual use for at least two years.

E. BAS manufacturer shall be responsible for all BAS and Temperature Control wiring for a complete and operable system. All wiring shall be done in accordance with all local and national codes.

F. ISS shall furnish and/or install all equipment and systems specified herein.

G. The Contractor shall furnish and install an interface to provide integration of fire alarm and life safety system information into the BAS for centralized alarming, monitoring, maintenance reporting, graphical display, and historical data collecting.

H. Reference is hereby made for this Contractor to become familiar with Division 26 of these specifications. Familiarization is for coordination purposes only. The Control Contractor shall provide all necessary relays, contacts, interlock wiring, etc., not provided under Division 26 for the automation of the ATC and BAS Systems as required by the sequence of operation and BAS input/output schedule. The Control Contractor shall coordinate all requirements with the building Fire Alarm System, Security System, and light control system. The Control Contractor shall provide all additional devices and interlock wiring required for the automation of the ATC System and monitoring of the BAS System.

I. The control system shall include all necessary and specified control equipment properly installed in accordance with the specifications and drawings and shall include, but not be limited to the following:

1. Dedicated Outdoor Air Units
2. Domestic Hot Water Systems
3. Exhaust systems
4. Heat and Ventilation Control
5. Unit Heaters
6. Ventilation Systems
7. All remaining systems indicated on the control drawings.

1.2 WORK BY OTHERS:

A. Mechanical contractor shall install all wells, valves, taps, dampers, flow stations, etc. furnished by BAS manufacturer. It shall be the BAS Manufacturer's responsibility to ensure that the Mechanical Contractor is aware of these items and make provisions to install any items not included by the Mechanical Contractor.

B. Electrical Contractor provides:

1. 120V power to all BAS and/or Temperature control panels
2. Wiring of all power feeds through all disconnect starters to electrical motor.
3. Wiring of any remote start/stop switches and manual or automatic motor speed control devices not furnished by BAS manufacturer.
4. Wiring of any electrical sub-metering devices furnished by BAS manufacturer.

C. Products furnished but not installed under this section

1. Hydronic Piping:

   a. Control Valves
   b. Flow Switches
   c. Temperature Sensor Wells and Sockets
   d. Flow Meters

2. Refrigerant Piping:

   a. Pressure and Temperature Sensor Wells and Sockets

3. Duct Work Accessories:

   a. Air-flow Stations

D. Products installed but not furnished under this section

1. Refrigeration Equipment:

   a. Pressure Transmitters
   b. Temperature Transmitters
   c. Power Transmitters
   d. Refrigerant Leak Detectors

2. Air Handling Equipment:

    a. Thermostats
    b. Sensors
    c. Controllers

3. Fire Alarm Systems:

    a. Smoke Detectors

E. Products integrated to but not furnished or installed under this section

1. Life Safety Systems (Fire Alarm Systems)
2. Life Safety Monitoring
3. Lighting Control System
4. Access Control System

1.3 RELATED WORK

A. Division 1 - General and Special Conditions

B. Division 23 - Mechanical

C. Division 26 - Electrical

1.4 QUALITY ASSURANCE

A. The BAS system shall be designed and installed, commissioned and serviced by manufacturer employed, factory trained personnel. Manufacturer shall have an in-place support facility within 100 miles of the site with technical staff, spare parts inventory and necessary test and diagnostic equipment. Distributors or licensed installing contractors are not acceptable. The manufacturer shall provide full time, on site, experienced project manager for this work, responsible for direct supervision of the design, installation, start up and commissioning of the BMS. The Bidder shall be regularly engaged in the manufacturing, installation and maintenance of BMS systems and shall have a minimum of ten (10) years of demonstrated technical expertise and experience in the manufacture, installation and maintenance of BMS systems similar in size and complexity to this project. A maintained service organization consisting of at least ten (10) competent servicemen for a period of not less than ten years and provide a list of 10 projects, similar in size and scope to this project, completed within the last five years.

B. Materials and equipment shall be the catalogued products of manufacturers regularly engaged in production and installation of automatic temperature control systems and shall be manufacturer's latest standard design that complies with the specification requirements.

C. All BAS peer-to-peer network controllers, central system controllers and local user displays shall be UL Listed under Standard UL 916, category PAZX; Standard ULC C100, category UUKL7; and under Standard UL 864, categories UUKL, UDTZ, and QVAX and be so listed at the time of bid. All floor level controllers shall comply, at a minimum, with UL Standard UL 91 6category PAZX; Standard UL 864, Categories UDTZ, and QVAX and be so listed at the time of Bid.

D. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

E. The manufacturer of the Building Automation System shall provide documentation supporting compliance with ISO-9002 (Model for Quality Assurance in Production, Installation, and Servicing) and ISO-140001 (The application of well-accepted business management principles to the environment). The intent of this specification requirement is to ensure that the products from the manufacturer are delivered through a Quality System and Framework that will assure consistency in the products delivered for this project.

F. This system shall have a documented history of compatibility by design for a minimum of 15 years. Future compatibility shall be supported for no less than 10 years. Compatibility shall be defined as the ability to upgrade existing field panels to current level of technology, and extend new field panels on a previously installed network.

G. Compatibility shall be defined as the ability for any existing field panel microprocessor to be connected and directly communicate with new field panels without bridges, routers or protocol converters.

H. This contractor shall provide proof of experience with integration to fire alarm/life safety systems. Provide individuals experienced with the installation and startup of equipment related to this type of integration.

I. The Controls Contractor shall coordinate with Division 23 and 26 Contractors to ensure that all required items for a complete system are provided.

1. 5 SUBMITTALS

A. Submit ten (10) complete sets of documentation in the following phased delivery schedule:

1. Valve and damper schedules

2. Equipment data cut sheets

3. System schematics, including:

Sequence of Operations
Point Names
Point Addresses
Interface Wiring Diagrams
Panel Layouts.
System Riser Diagrams

4. AutoCAD compatible as-built drawings.

B. Upon project completion, submit operation and maintenance manuals, consisting of the following:

1. Index sheet, listing contents in alphabetical order

2. Manufacturer's equipment parts list of all functional components of the system, AutoCAD disk of system schematics, including wiring diagrams

3. Description of sequence of operations

4. As-Built interconnection wiring diagrams

5. Operator's Manual

6. Trunk cable schematic showing remote electronic panel locations, and all trunk data

7. List of connected data points, including panels to which they are connected and input device (ionization detector, sensors, etc.)

8. Conduit routing diagrams

1.6 WARRANTY

A. Provide all services, materials and equipment necessary for the successful operation of the entire BAS system for a period of two years after beneficial use.

B. Maintain all panels, firmware and software at the latest manufacturer's revision for a period of two years.

C. The adjustment, required testing, preventative maintenance and repair of the system includes all computer equipment, transmission equipment and all sensors and control devices.

D. The on-line support services shall allow the local BAS subcontractor to dial out over telephone lines to monitor and control the facility's Building Automation System. This remote connection to the facility shall be within 2 hours of the time that the problem is reported. This coverage shall be extended to include normal business hours, after business hours, weekends and holidays.

E. If the problem cannot be resolved on-line by the local office, the national office of the building automation system manufacturer shall have the same capabilities for remote connection to the facility. If the problem cannot be resolved with on-line support services, the BAS manufacturer shall dispatch the appropriate personnel to the job site to resolve the problem within 4 hours of the time that the problem is reported.

PART 2. PRODUCTS

1.1 CONTROL SYSTEM

A. Control manufacturer shall be Siemens (sole source).

B. Control system shall consist of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems.

C. 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.

D. Remote Interface: The automatic temperature control system shall include remote interface with the Seven Locks Maintenance Facility in Rockville MD (coordinate exact location with the using agency). All building management system control features including, but not limited to; points, alarms, scheduling, graphics, trending, etc. shall be available for control and monitoring at the Seven Locks facility from the existing workstations/servers utilizing the existing Siemens

Apogee software. The Contractor must provide the cost for the complete integrations of the new system open protocol controller and/or gateway to the existing system interface.

1.2 DDC EQUIPMENT

A. 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, anti-short 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.

B. 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 (Ethernet0 datalink/physical layer protocol.

C. 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/O: Provide software selectable binary or analog outputs.

D. 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.

E. 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.

1.3 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. Enclosure: Dustproof rated for operation at 32 to 120 deg F (0 to 50 deg C).
5. Enclosure: Waterproof rated for operation at 40 to 150 deg F (5 to 65 deg C).

1.4 ALARM PANELS

A. Unitized cabinet with suitable brackets for wall or floor mounting. Fabricate of 0.06-inch- (1.5-mm-) thick, furniture-quality steel or extruded-aluminum alloy, totally enclosed, NEMA 1, with hinged doors and keyed lock and with manufacturer's standard shop-painted finish. Provide common keying for all panels. Provide means of storing control system instructions and drawings inside cabinet for future reference. Provide UL listed cabinets for use with line voltage devices.

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.

1.5 ANALOG CONTROLLERS

A. Step Controllers: 6- or 10-stage type, with heavy-duty switching rated to handle loads and operated by electric motor.

B. Electric, Outdoor-Reset Controllers: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range, adjustable set point, scale range minus 10 to plus 70 deg F (minus 23 to plus 21 deg C), and single- or double-pole contacts.

C. Electronic Controllers: Wheatstone-bridge-amplifier type, in steel enclosure with provision for remote-resistance readjustment. Identify adjustments on controllers, including proportional band and authority.

1. Single controllers can be integral with control motor if provided with accessible control readjustment potentiometer.

D. Fan-Speed Controllers: Solid-state model providing field-adjustable proportional control of motor speed from maximum to minimum of 55 percent and on-off action below minimum fan speed. Controller shall briefly apply full voltage, when motor is started, to rapidly bring motor up to minimum speed. Equip with filtered circuit to eliminate radio interference.

1.6 ELECTRONIC SENSORS

A. Description: Vibration and corrosion resistant; for wall, immersion, or duct mounting as required.

B. Thermistor Temperature Sensors and Transmitters:

1. Available Manufacturers: Listed system manufacturers.
2. Accuracy: Plus or minus 0.5 deg F (0.3 deg C) at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 72 inches (1830 mm) long, flexible; use where prone to temperature stratification or where ducts are larger than 10 sq. ft. (1 sq. m).
6. Insertion Elements for Liquids: Brass or stainless-steel socket with minimum insertion length of 2-1/2 inches (64 mm).
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: Standard Manufacturer’s Color.
    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. Provide for Gymnasium and/or auxiliary gym spaces and room security areas.

C. RTDs and Transmitters:

1. Available Manufacturers: Listed system manufacturers.
2. Accuracy: Plus or minus 0.2 percent at calibration point.
3. Wire: Twisted, shielded-pair cable.
4. Insertion Elements in Ducts: Single point, 18 inches (460 mm) long; use where not affected by temperature stratification or where ducts are smaller than 9 sq. ft. (0.84 sq. m).
5. Averaging Elements in Ducts: 24 feet (7.3 m) long, flexible; use where prone to temperature stratification or where ducts are larger than 9 sq. ft. (0.84 sq. m); length as required.
6. Insertion Elements for Liquids: Brass socket with minimum insertion length of 2-1/2 inches (64 mm).
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: Manufacturer’s Standard Color.
    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. Smart Humidity Sensors: Bulk polymer sensor element.

1. Manufacturers: Listed system manufacturers.
2. Accuracy: 2 percent full range with linear output.
3. Room Sensor Range: 20 to 80 percent relative humidity. Vaisala Model Humicap H Sensor.

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: Manufacturer's Standard Color.
    e. Orientation: Vertical.

5. Outside-Air Sensor: 20 to 80 percent relative humidity range with mounting enclosure, (Radiation Shield Vaisala Model 2212HM) suitable for operation at outdoor temperatures of minus 22 to plus 185 deg F (minus 30 to plus 85 deg C). Provide PPS grid with stainless steel netting to protect sensor.
6. Duct and Sensors: With element guard and mounting plate, range of 0 to 100 percent relative humidity.

E. Pressure Transmitters/Transducers:

1. Available Manufacturers:

    a. Rosemount
    b. Ebtron
    c. Veris.
    d. General Eastern Instruments.
    e. MAMAC Systems, Inc.
    f. Vaisala.
    g. Foxboro.
    h. United Electric.
    i. Setra.

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 (0 to 62 Pa).
    d. Duct Static-Pressure Range: 0- to 5-inch wg (0 to 1240 Pa).

3. Water Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure; linear output 4 to 20 mA.
4. Water Differential-Pressure Transducers: Stainless-steel diaphragm construction, suitable for service; minimum 150-psig (1034-kPa) operating pressure and tested to 300-psig (2070-kPa); linear output 4 to 20 mA. – Rosemount 2051 DP sole source.
5. Differential-Pressure Switch (Air or Water): Snap acting, with pilot-duty rating and with suitable scale range and differential – United Electric H100 Series.
6. Pressure Transmitters: Direct acting for gas, liquid, or steam service; range suitable for system; linear output 4 to 20 mA.

F. Room sensor accessories include the following:

1. Insulating Bases: For sensors located on exterior walls.
2. Guards: Locking, solid metal, ventilated.
3. Adjusting Key: As required for calibration and cover screws.

1.7 STATUS SENSORS

A. Status Inputs for Fans: Differential-pressure switch with pilot-duty rating and with adjustable range of 0- to 5-inch wg (0 to 1240 Pa).

B. Status Inputs for Pumps: Differential-pressure switch with pilot-duty rating and with adjustable pressure-differential range of 8 to 60 psig (55 to 414 kPa), 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. Available Manufacturers: Listed system manufacturers.

I. 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 (0 to 40 deg C); with 2 factory-calibrated alarm levels at 50 and 100 or 35 and 200 ppm.

J. Carbon Dioxide Sensor and Transmitter: Single detectors using solid-state infrared sensors; suitable over a temperature range of 23 to 130 deg F (minus 5 to plus 55 deg C) and calibrated for 0 to 2 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting. Measurement range shall be 0-2000 ppm, accuracy shall be 20 ppm, repeatability shall be +/-1% full-scale, long-term stability shall be 5% over 5 years and response time shall be less than 60 seconds. Provide field calibration kit and turn over to Owner. Vaisala Carbocap GMD/W Series, Sole Source.

K. 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 (0 to 593 deg C) and calibrated for 0 to 5 percent, with continuous or averaged reading, 4- to 20-mA output; for wall mounting.

L. 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.

1.8 THERMOSTATS

A. Available Manufacturers: Listed system manufacturers.

B. Combination Thermostat and Fan Switches: Line-voltage thermostat with push-button or lever-operated fan switch.

1. Label switches "FAN ON-OFF"; "FAN HIGH-LOW-OFF"; or "FAN HIGH-MED-LOW-OFF".
2. Mount on single electric switch box.

C. 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 weekday, Saturday, and Sunday or 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."

D. 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 (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) maximum differential.

E. 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 (13 to 30 deg C) set-point range, and 2 deg F (1 deg C) 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.

F. 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.

G. Fire-Protection Thermostats: Listed and labeled by an NRTL acceptable to authorities having jurisdiction; with fixed or adjustable settings to operate at not less than 75 deg F (24 deg C) above normal maximum operating temperature, and the following:

1. Reset: Manual.
2. Reset: Automatic, with control circuit arranged to require manual reset at central control panel; with pilot light and reset switch on panel labeled to indicate operation.

H. Immersion Thermostat: Remote-bulb or bimetal rod-and-tube type, proportioning action with adjustable throttling range and adjustable set point.

I. Electric, Low-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, automatic-reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or below set point.

1. Bulb Length: Minimum 20 feet (6 m).
2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

J. Electric, High-Limit Duct Thermostat: Snap-acting, single-pole, single-throw, manual-automatic- reset switch that trips if temperature sensed across any 12 inches (300 mm) of bulb length is equal to or above set point.

1. Bulb Length: Minimum 20 feet (6 m).
2. Quantity: One thermostat for every 20 sq. ft. (2 sq. m) of coil surface.

K. 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 (172 kPa), and cast housing with position indicator and adjusting knob.

1.9 ACTUATORS

A. Electric Motors: Size to operate with sufficient reserve power to provide smooth modulating action or two-position action.

1. Comply with requirements in Division 23 Section "Common Motor Requirements for HVAC Equipment."
2. Permanent Split-Capacitor or Shaded-Pole Type: Gear trains completely oil immersed and sealed. Equip spring-return motors with integral spiral-spring mechanism in housings designed for easy removal for service or adjustment of limit switches, auxiliary switches, or feedback potentiometer.
3. Nonspring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
4. Spring-Return Motors for Valves Larger Than NPS 2-1/2 (DN 65): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).
5. Nonspring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running torque of 150 in. x lbf (16.9 N x m) and breakaway torque of 300 in. x lbf (33.9 N x m).
6. Spring-Return Motors for Dampers Larger Than 25 Sq. Ft. (2.3 sq. m): Size for running and breakaway torque of 150 in. x lbf (16.9 N x m).

B. Electronic Actuators: Direct-coupled type designed for minimum 60,000 full-stroke cycles at rated torque.

1. Manufacturers: Listed system manufacturers.
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. (86.8 kg-cm/sq. m) of damper.
    b. Opposed-Blade Damper with Edge Seals: 5 inch-lb/sq. ft. (62 kg-cm/sq. m) of damper.
    c. Dampers with 2- to 3-Inch wg (500 to 750 Pa) of Pressure Drop or Face Velocities of 1000 to 2500 fpm (5 to 13 m/s): Increase running torque by 1.5.
    d. Dampers with 3- to 4-Inch wg (750 to 1000 Pa) of Pressure Drop or Face Velocities of 2500 to 3000 fpm (13 to 15 m/s): 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 (Minus 30 to plus 50 deg C).

11. Temperature Rating (Smoke Dampers): Minus 22 to plus 250 deg F (Minus 30 to plus 121 deg C).

1.10 CONTROL VALVES

A. Available Manufacturers: Listed system manufacturers.

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. Valves shall be provided with a positioning relay.

C. Hydronic system globe valves shall have the following characteristics:

1. NPS 2 (DN 50) and Smaller: Class 125 bronze body, stainless steel trim, rising stem, renewable composition disc, and screwed ends with back seating capacity repackable under pressure.
2. NPS 2-1/2 (DN 65) and Larger: Class 125 iron body, stainless steel 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: 5-psig (35-kPa) 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. Ball Valves: Refer to Section 230523, General Duty Valves for HVAC Piping. Provide manufacturer's actuator.

1. Sizing: 3-psig maximum pressure drop at design flow rate.

E. Butterfly Valves: Refer to Section 230523, General Duty Valves for HVAC Piping. Provide manufacturer's actuator.

1. Sizing: 1-psig (7-kPa) maximum pressure drop at design flow rate.

F. Terminal Unit Control Valves: Bronze body, stainless steel trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
2. Sizing: 3-psig (21-kPa) maximum pressure drop at design flow rate, to close against pump shutoff head.
3. Flow Characteristics: Two-way valves shall have equal percentage characteristics; three-way valves shall have linear characteristics.

G. Self-Contained Control Valves: Bronze body, bronze trim, two or three ports as indicated, replaceable plugs and seats, and union and threaded ends.

1. Rating: Class 125 for service at 125 psig (860 kPa) and 250 deg F (121 deg C) operating conditions.
2. Thermostatic Operator: Wax or Liquid-filled remote sensor with integral adjustable dial.

H. All automatic temperature control valves in water lines shall be provided with Characterized throttling plugs and shall be sized for minimum 25% of the system pressure drop or 5 psi, whichever is less. Positive positioning relays shall be provided on pneumatic control when required to provide sufficient power for sequencing. Two position valves shall be line size. Two-way modulating valves in variable flow chilled water systems shall utilize pressure independent control valves equal to Griswold Controls PIC valve. Valve shall be sized for a maximum pressure loss of 5 psig and have full authority over the entire operating range. As designated on control diagrams.

1.11 DAMPERS

A. Available Manufacturers:

1. Air Balance Inc.
2. American Warming and Ventilating
3. Ruskin, Inc.
4. Johnson Controls, Inc.

Dampers: AMCA-rated, Class I, parallel-blade (two-position type) and opposed-blade (proportional control type) design; airfoil shaped double skin construction of 14-gauge equivalent thickness, extruded-aluminum frames with holes for duct mounting; damper blades shall not be less than 0.064-inch- (1.6-mm-) thick galvanized steel with maximum blade width of 6 inches and length of 48 inches. Provide spring returns for all dampers. Dampers shall be Ruskin Type CD60, or equal of American Warming and Ventilating or Air Balancing, Inc. Round dampers shall be Ruskin Type CER 325.

5. Secure blades to 1/2-inch- (13-mm-) 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.
6. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
7. Edge Seals, Ultra-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. (50 L/s per sq. m) of damper area, at differential pressure of 4-inch wg (1000 Pa) when damper is held by torque of 50 in. x lbf (5.6 N x m); when tested according to AMCA 500D.

1.12 CONTROL CABLE

A. Electronic and fiber-optic cables for control wiring are specified in Division 27 Section "Communications Horizontal Cabling."

B. All wiring shall be plenum rated cable where concealed. In areas exposed, wiring shall be installed in a designated EMT conduit raceway unless otherwise specified. All junction boxes shall have covers painted “Safety Green” and be rigid steel. Minimum size conduit shall be 3/4”.

C. Where it is not possible to conceal raceways in finished locations (i.e., existing masonry walls), surface raceway (wiremold) may be used as approved by the Architect.

D. Individual conductors shall be color-coded and in addition, shall be numbered in the field to identify the particular terminal to which it is attached. Field numbering shall be performed with Brady Markers wrapped around the wire near the terminal connection. All wires shall be terminated with pressure type connectors suitable for wire size, material, and terminal connection.

1.13 DASHBOARD

A. Description of DAS System: Provide the necessary hardware and software for a complete and operable system with the following functions and capabilities:

1. Display energy and water use data collected by Owner’s building automation system or energy management system (also referred to as BAS, BMS, EMS, EMCS).

2. Capability to monitor stand-alone technologies such as solar photovoltaic systems and weather monitoring using a data logger solution.
3. Provide access to an interactive web site for access via a personal computer.
4. Display default units to express resource use in kilowatt-hours, kilo-BTUs and gallons.
5. Display real-time data to show performance of the building systems using modifying parameters including:

    a. Comparison of total and per person use of resources.
    b. History using graphical display of resource usage over multiple time scales as selected by the user.
    c. Unit equivalent expression of resource use in different currencies (i.e., electricity usage expressed as dollars spent, pounds of carbon dioxide emitted or equivalent hours of light bulb usage.

6. Store and access historical data to compare trends of performance over time.
7. Provide a data download component to enable presentation of variables over any time scale into an Excel spreadsheet for benchmarking, carbon accounting and research.
8. Provide data hosting server solution with continuous uptime access to DAS information over the data network.
9. Provide scalable, modular expansion capability to add additional monitoring functions using software upgrades without requiring system redesign or display upgrades.
10. Provide automatic display upgrades at no additional cost to the Owner in accordance with the five (5) year service agreement that is established when the system is turned over to the Owner.
11. Provide web-based software that enables configuration, maintenance and upgrades to occur over the internet.
12. Integration with building automation system via IP-enabled componentry.

B. General Equipment and Material Requirements:

1. Compatibility of Components: Coordinate component features to form an integrated system. Match components and interconnections for optimum performance of specified functions.
2. Equipment: Comply with UL. Equipment shall be modular, using solid-sate components, and fully rated for continuous duty unless otherwise indicated. Select equipment for normal operation on input power usually supplied at 110 to 130V, 60 Hz.
3. Equipment Mounting: Where rack, cabinet, or console mounting is indicated, equipment shall be designed to mount in a 19-inch housing complying with TIA/EIA-310-D.
4. Weather-Resistant Equipment: Listed and labeled by a qualified testing agency for duty outdoors or in damp locations.

C. Software: Provide all software and dynamic graphics to enable the following functions:

1. Owner-specified text and graphics with touch screen menu. Program to cycle through images and texts relating to the Ice Rink Facility and its energy systems.

    a. Electricity in kW/h
        1) Lighting Load
        2) HVAC Load
        3) Plug Load
        4) Total Load

    b. Propane Gas in scf
    c. Heating/Cooling in BTUs

d. Water in gallons.
   1) Resource Modules: Values must be available through the Building Automation System (BAS) as a totalizer or accumulated value. System values include:

      a) Lighting Load
      b) HVAC Load
      c) Plug Load
      d) Total Load

   2) Provide resource modules with the capability to display energy savings costs in appropriate units or value in a variety of time frames (i.e.; daily, weekly, monthly and yearly) for user access.

   3) Payback Module: Tracks the savings and real-time payback trajectory for Thermal Systems

   4) Weather Module: Display local, real time weather conditions to building touch screen.

   5) Green Tips Module: Display rotating, randomly generated sustainability (green) tips related to the building's resources.

   6) Events Calendar: Post events to the Dashboard, allowing users to see events going on in the Building.

   7) Web Interface to all computer start-up screens within the building as well as building dashboard kiosk in main lobby. Kiosk touch screens are provided under another Division.

   8) Introduction Module.

2. Meters: Provide all meters as detailed below:

   a. FM Series Gas Meter with Pulse Output as manufactured by E-Mon.
   b. Cold Water Meter Digital Register, Model C700 by E-Mon.
   c. Hot Water Meter as manufactured by E-Mon.
      1) Sizes 1" thru 1-1/2" shall be Model #H190.
      2) Sizes 2" thru 4" shall be Model #H4400.
         Cold Water Turbine Meter High Flow Sizes 1-1/2" thru 12" shall be Model #T4000 as manufactured by E-Mon.

1.14 Portable Operator Terminal

A. For systems that do not provide full access to systems configuration and definition via the Browser Based user interface the BMS Contractor shall provide a portable operator terminal for programming purposes. The terminal shall be configured as follows:

1. Personal Laptop Computer Manufacturer
2. 6 GB RAM – Windows 10.
3. 7th Gen Intel Core i3-710U mobile processor.
4. 1 TB Hard Drive
5. (1) HDMI output
6. (2) USB 3.0 ports

7. (1) DVD-RW Drive
8. Bluetooth 4.0 Interface
9. 1 Keyboard
10. Integral 2 button Track Point or Track Ball.
11. HD resolution color display
12. Built-in media reader
13. Complete operator workstation software package, including any hardware or software.
14. Original printed manuals for all software and peripherals.
15. Original installation CD/DVD for all software, device drivers, and peripherals.
16. Software registration cards for all included software shall be provided to the Owner.
17. Carrying case.
18. Spare battery.
19. External power supply/battery charger.

B. Proprietary Portable Terminal

1. Manufacturers providing proprietary portable terminals shall submit technical data sheets for the terminal and all associated software and hardware.

2. The proprietary terminal shall meet the same operator interface software requirements as specified above.

C. Software

1. Portable operator terminals shall support all controllers within the system on a direct-connect communications basis.

2. When used to access First or Second Tier controllers, the portable operator terminal shall utilize the standard operator workstation software, as previously defined.

3. When used to access Application Specific Controllers, the portable operator terminal shall utilize either the standard operator workstation software, as previously defined, or controller-specific utility software.

PART 2 EXECUTION

2.1 EXAMINATION

A. Verify that 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.

2.2 INSTALLATION

A. Install software in control units and operator workstation(s). Implement all features of programs to specified requirements and as appropriate to sequence of operation.

B. Connect and configure equipment and software to achieve sequence of operation specified.

C. The Automatic Temperature Control System shall be designed, installed, and commissioned in a fully turnkey, fully implemented and fully operational manner.

D. Verify location of thermostats, humidistats, and other exposed control sensors with Drawings

and room details before installation.

1. Install averaging elements in ducts and plenums in crossing or zigzag pattern.

E. Install guards on all thermostats and temperature sensors.

F. Install automatic dampers according to Division 23 Section "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 Division 23 Section "Identification for HVAC Piping and Equipment."

I. Install hydronic instrument wells, valves, and other accessories according to Division 23 Section "Hydronic Piping."

J. Install refrigerant instrument wells, valves, and other accessories according to Division 23 Section "Refrigerant Piping."

K. Install duct volume-control dampers according to Division 23 Sections specifying air ducts.

L. Install electronic and fiber-optic cables according to Division 27 Section "Communications Horizontal Cabling."

M. Duct smoke detectors shall be furnished by the Electrical Contractor and installed by the Mechanical Contractor. The mechanical Contractor shall provide all interlock wiring to smoke dampers and/or AHU shutdown. The Electrical Contractor shall provide all interlock wiring to the fire alarm system and associated power wiring.

2.3 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Install building wire and cable according to Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Install signal and communication cable according to Division 27 Section "Communications Horizontal Cabling."

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

2. Install exposed cable in raceway.

3. Install concealed cable in raceway.

4. Bundle and harness multiconductor instrument cable in place of single cables where several cables follow a common path.

5. Fasten flexible conductors, bridging cabinets and doors, along hinge side; protect against abrasion. Tie and support conductors.

6. Number-code or color-code conductors for future identification and service of control system, except local individual room control cables.

7. Install wire and cable with sufficient slack and flexible connections to allow for vibration of piping and equipment.

8. All conduits and raceways shall be installed level, plumb, at right angles to the building lines, and shall follow the contours of the building line.

D. Connect manual-reset limit controls independent of manual-control switch positions. Automatic duct heater resets may be connected in interlock circuit of power controllers.

E. Connect hand-off-auto selector switches to override automatic interlock controls when switch is in hand position.

F. All Wiring and tubing shall be properly supported and run in a neat and workmanlike manner. All wiring and tubing exposed and in equipment rooms shall run parallel to or at right angles to the building structure. All piping and wiring within enclosures shall be neatly bundled and anchored to prevent restriction to devices and terminals.

G. The Control Contractor shall be responsible for all electrical installation required for a fully functional control and automation system and not shown on the electrical plans or required by the electrical specifications. All wiring shall be in accordance to all local and national codes.

1. All line voltage wiring, all wiring exposed, and all wiring in equipment rooms shall be installed in conduit in accordance to the electrical specifications.

2. All electric and electronic wiring shall be #18 AWG minimum THHN and shielded if required.

3. All wiring in the central control room shall be concealed in an approved manner.

4. Job electrician shall wire to junction box with high voltage. All control power shall be provided by the ATC Contractor. The ATC Contractor shall obtain all control power for electrical power panels. Power to the ATC System shall be dedicated circuits. Do not obtain control power for any devices through equipment control panels or any other source. All control power and wiring shall be independent.

5. Some, but not all, dedicated circuits have been identified on the Electrical Drawings. Coordinate all additional dedicated circuits with the Electrical Contractor. The ATC Contractor shall provide all additional power wiring as required for the ATC System. Coordinate locations with the Electrical Contractor for circuits identified on the Electrical Drawings.

6. For equipment connected to emergency power, the associated control panels shall be connected to emergency power.

H. Control Systems Wiring:

1. All conduit raceways, wiring, accessories and wiring connections required for the installation of the Controls Systems shall be provided by the Controls Contractor. All wiring shall comply with the requirements of applicable portions of the Electrical Trade work and all local and national electric codes and the requirements of the AHJ.

2. All Controls Systems wiring materials and installation methods shall comply with the original equipment manufacturer recommendations and standards.

3. The sizing type and provision of cable, conduit, cable trays and raceways shall be the design responsibility of the Controls Contractor.

4. Class 2 Wiring

   a. All Class 2 (24VAC or less) wiring shall be installed in conduit unless otherwise specified.
   b. Conduit is not required for Class 2 wiring in concealed accessible locations. Class 2 wiring not installed in conduit shall be supported every 5ft. from the building structure utilizing metal hangers designed for this application. Wiring shall be installed parallel to the building structural lines.

5. Class 2 signal wiring and 24VAC power may be run in the same conduit. Power wiring 120VAC and greater shall not share the same conduit with Class 2 signal wiring.

6. Perform circuit tests using qualified personnel only. Provide necessary instruments and equipment to demonstrate that:

   a. All circuits are continuous and free from short circuits and grounds.
   b. All circuits are free from unspecified grounds; that resistance to ground of all circuits is no less than 50 megaohms.
   c. All circuits are free from induced voltages.

7. Provide complete testing for all cables and wiring. Provide all equipment, tools, and personnel as necessary to conduct these tests.

8. Provide for complete grounding of all signal and communication cables, panels and equipment so as to ensure integrity of Controls Systems operation. Ground cabling and conduit at panel terminations. Do not create ground loops

I. Line Voltage Power Sources

1. 120 -volt AC circuits for the Controls Systems shall be taken by the Controls Contractor from electrical trade panelboards and circuit breakers. Coordinate locations with the Electrical Contractor.

2. Circuits used for the Controls Systems shall be dedicated to these Controls Systems and shall not be used for any other services.

3. Controls DDC terminal unit controllers may use 120-volt AC power from motor power circuits.

J. Controls Systems Raceways

1. All wiring shall be installed in conduit or raceway except as noted elsewhere in the Specification. Minimum conduit size 3/4”.

2. Where it is not possible to conceal raceways in finished locations, surface raceway (Wiremold) may be used as approved by the Architect.

3. All conduits and raceways shall be installed level, plumb, at right angles to the building

lines and shall follow the contours of the supporting surface.

4. UL//ULC Listed Flexible Metal Conduit shall be used for vibration isolation and shall be limited to 3 feet in length when terminating to vibrating equipment. Flexible Metal Conduit may be used within partition walls and for final connection to equipment.

K. Penetrations:

1. Firestopping for all penetrations used by dedicated Controls Systems conduits and raceways shall be by the ATC Contractor.

2. All openings in fire proofed or fire stopped components shall be closed by the ATC Contractor using approved fire resistive sealant.

3. All wiring passing through penetrations, including walls, shall be in sleeves, conduit or enclosed raceway.

4. No penetrations through building structural elements, slabs, ceilings and walls shall be made before receipt of written approval from the Architect.

L. Controls Systems Identification Standards:

1. Node Identification: All nodes shall be identified by a permanent label fastened to the outside of the enclosure. Labels shall be suitable for the node environmental location.

2. Cable shall be labeled at every termination with cross-referencing to record documentation.

3. Raceway Identification: Exposed covers to junction and pull boxes of the FMS raceways shall be identified at primary points.

4. Wire Identification: All low and line voltage wiring shall be identified by a number, as referenced to the associated shop and record drawing, at each termination.

5. Wires and cabling shall not be spliced between terminations. Cable shields shall be single end grounded – typically at the panel end outside the panel.

6. Suggested color coding, for use at the Contractors option, are:

a.	Analog Input Cable	Yellow
b.	Analog Output Cable	Tan
c.	Binary Input Cable	Orange
d.	Binary Output Cable	Violet
e.	24 VAC Cable	Gray
f.	General Purpose Cable	Natural
g.	Tier 1 Comm Cable	Purple
h.	Other Tier Comm Cable	Blue

M. Field Panel and Device Installations and Locations:

1. The Controls Systems panels, enclosures and cabinets shall be located as coordinated with the Architect at an elevation of not less than 2 feet from the bottom edge of the panel to the finished floor. Each cabinet shall be anchored per the manufacturer's recommendations.

2. All field devices shall be installed per the manufacturer recommendation and in accessible locations as coordinated with the Architect.

3. Panels to be located in damp areas or areas subject to condensation shall be mounted with wall standoffs.

4. Conduit configurations entering or leaving panels and devices shall be such as to preclude condensation traps.

N. Controls Specific Installation Requirements

1. The Mechanical Trade Contractor shall install all in-line mechanical devices including temperature wells, pressure taps, duct smoke detectors, airflow stations, etc.

2. The Mechanical Contractor shall install all in-line devices including control valves, dampers, etc.

3. Input flow measuring devices shall be installed in compliance with ASME Guidelines.

4. Outside Air Sensors:

   a. Sensors shall be mounted on a wall selected to minimize solar radiant heat impact or be located in a continuous intake flow adequate to monitor outside air conditions accurately.
   b. Sensors shall be installed with a rain shield and perforated cover.

5. Water Differential Pressure Sensors:

   a. Differential pressure transmitters used for flow measurement shall be sized to the flow-sensing device.
   b. Differential pressure transmitters shall be supplied with tee fittings and shut-off valves in the high and low sensing pick-up lines.
   c. The transmitters shall be installed in an accessible location wherever possible.

6. Medium to High Differential Water Pressure Applications (Over 21” wg): Air bleed units, bypass valves and compression fittings shall be provided.

7. Differential Air Pressure Applications (-1” to +1” wg):

   a. Transmitters exterior sensing tip shall be installed with a shielded static air probe to reduce pressure fluctuations caused by wind.
   b. The interior tip shall be inconspicuous and located as shown on the drawings.

8. Air Flow Measuring Station:

   a. Where the stations are installed in insulated ducts, the airflow passage of the station shall be the same size as the inside airflow dimension of the duct.
   b. Station flanges shall be two inch to three inch to facilitate matching connecting ductwork.

9. Duct Temperature Sensors:

   a. Duct mount sensors shall mount in an electrical box through a hole in the duct and be positioned so as to be easily accessible for repair or replacement.

b. The sensors shall be insertion type and constructed as a complete assembly including lock nut and mounting plate.
c. For ductwork greater in any dimension than 48 inches or where air temperature stratification exists, such as a mixed air plenum, utilize an averaging sensor.
d. The sensor shall be mounted to suitable supports using factory approved element holders.

10. Low Temperature Limit Switches:

a. Install on the discharge side of the first water or steam coil in the air stream.
b. Mount element horizontally across duct in a serpentine pattern insuring each square foot of coil is protected by 1 foot of sensor.
c. For large duct areas where the sensing element does not provide full coverage of the air stream, provide additional switches as required to provide full protection of the air stream.

11. Air Differential Pressure Status Switches: Install with static pressure tips, tubing, fittings and air filter.

12. Water Differential Pressure Status Switches: Install with shut off valves for isolation.

13. Actuators: All control actuators shall be sized capable of closing against the maximum system shut-off pressure. The actuator shall modulate in a smooth fashion through the entire stroke. When any pneumatic actuator is sequenced with another device, pilot positioners shall be installed to allow for proper sequencing.

14. Control Dampers: Shall be opposed blade for modulating control of airflow. Parallel blade dampers shall be installed for two position applications.

15. Control Valves: Shall be sized for proper flow control with equal percentage valve plugs. The maximum pressure drop for water applications shall be 5 PSI. The maximum pressure drop for steam applications shall be 7 PSI.

16. Electronic Signal Isolation Transducers: Whenever an analog output signal from the Controls Systems is to be connected to an external control system as an input (such as chiller control panel), or it is to receive as an input a signal from a remote system, provide a signal isolation transducer. Signal isolation transducer shall provide ground plane isolation between building systems. Provide optical isolation between building systems.

2.4 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. Test calibration of electronic controllers by disconnecting input sensors and stimulating

operation with compatible signal generator.

4. Test each point through its full operating range to verify that safety and operating control set points are as required.

5. Test each control loop to verify stable mode of operation and compliance with sequence of operation. Adjust PID actions.

6. Test each system for compliance with sequence of operation.

7. Test software and hardware interlocks.

8. Provide complete testing for all cables and wiring. Provide all equipment, tools and personnel as necessary to conduct these tests.

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.

2.5 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: Within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to twenty (20) visits to Project during other than normal occupancy hours for this purpose.

2.6 DEMONSTRATION

A. The manufacturer shall provide factory trained instructors to give full instruction to designated personnel in the operation of the system installed. Instructors shall be thoroughly familiar with all aspects of the subject matter. The manufacturer shall provide binders containing product specific training modules for the system installed. All training shall be held during normal working hours of 8:00am to 4:30pm.

B. Provide eight (8) hours of training for the Owner's designated operating personnel. Training shall be taped.

2.7 LOCAL CONTROL AND EMS CONTROL:

A. For the central chilled water system, central heating water system, each air handling unit system, each terminal control unit, and as required in the I/O Summary as indicated on the drawings, provide a panel-mounted Hand-Off-Automatic Switch, "Local Control" – "EMS Control" – "Off" switch that allows for the Ems or local controls to start-stop systems and/or equipment.

B. Each system shall operate automatically as described in the sequence of operations when locally controlled; i.e., in the hand position and/or when loss of communications of the remote EMS occurs.

C. Refer to Drawings for additional information.

2.8 VERIFICATION

A. Fully test and verify all aspects of the Controls Systems Contract work on a point/system/integrated operational basis for all points, features and functions specified.

B. Acceptance Check Sheet

1. Prepare a check sheet that includes all pints and functions of the Work.

2. Submit the check sheet to the Architect for approval 60 days prior to testing.

3. Complete the check sheets for all items and functions of the work. Initial each entry with time/date as record of having fully calibrated and tested the Work. Submit to the Architect as record.

4. The Architect, Engineer, Construction Manager, and Commissioning Agent will use the check sheets as the basis for Acceptance Testing with the Controls Systems Contractor.

C. Provide all necessary specialist labor, materials and tools to demonstrate to the Architect that the Controls Systems have been verified and are operating in compliance with the Controls Systems Contract. Prepare a list of noted deficiencies signed by both the Architect and the Controls Contractor. The ATC System will not be considered substantially complete until all systems and equipment air functioning correctly in accordance with the Contract requirements. After the Owner has accepted the building (i.e., and is paying for all utility costs), any above-average (per square foot) operating cost attributed with the control systems not operating as

designed (e.g., running 24/7) will be paid for by the Control/Mechanical Contractor.

D. Contractor shall submit a functional test check list including all points and sequence of operation points to be reviewed and verified during the Owner Instruction Period. All sequences shall be tested for all systems and equipment. The check list shall include columns for SATISFACTORY, UNSATISFACTORY, and COMMENTS for each line item. The check list shall be submitted and reviewed as a shop drawing prior to the instructional period. The Contractor shall include all the check lists in 3-ring binder (10 copies/sets minimum) for the representatives for the instructional procedure.

E. Promptly rectify all listed deficiencies and submit in writing to the Architect, Engineer, Construction Manager, or Commissioning Agent, a signed report that this has been done.

F. The ATC Contractor shall submit a letter on company letterhead, signed by the President of the local branch, that all systems are complete and have been inspected, tested, and provided operational/functional in all modes of operation as required by the Contract, that all deficiencies have been addressed, and the system is complete and ready for the warranty period to start. This letter shall also state the warranty period, shall be signed by the Owner's and shall be inserted into the O&M Manual.

G. The Architect, Engineer, Construction Manager, and/or Commissioning Agent will retest the deficiencies in conjunction with the Controls Contractor at the Architect's option.

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SECTION 23 23 00
REFRIGERANT PIPING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes refrigerant piping used for air-conditioning applications.

1.3 PERFORMANCE REQUIREMENTS

A. Line Test Pressure for Refrigerant R-407C:

1. Suction Lines for Air-Conditioning Applications: 230 psig (1586 kPa).
2. Suction Lines for Heat-Pump Applications: 380 psig (2620 kPa).
3. Hot-Gas and Liquid Lines: 380 psig (2620 kPa).

B. Line Test Pressure for Refrigerant R-410A:

1. Suction Lines for Air-Conditioning Applications: 300 psig (2068 kPa).
2. Suction Lines for Heat-Pump Applications: 535 psig (3689 kPa).
3. Hot-Gas and Liquid Lines: 535 psig (3689 kPa).

1.4 SUBMITTALS

A. Product Data: For each type of valve and refrigerant piping specialty indicated. Include pressure drop, based on manufacturer's test data, for the following:

1. Thermostatic expansion valves.
2. Solenoid valves.
3. Hot-gas bypass valves.
4. Filter dryers.
5. Strainers.
6. Pressure-regulating valves.

B. Shop Drawings: Show layout of refrigerant piping and specialties, including pipe, tube, and fitting sizes, flow capacities, valve arrangements and locations, slopes of horizontal runs, oil traps, double risers, wall and floor penetrations, and equipment connection details. Show interface and spatial relationships between piping and equipment.

1. Shop Drawing Scale: 3/8-inch equals 1-foot.
2. Refrigerant piping indicated on Drawings is schematic only. Size piping and design actual piping layout, including oil traps, double risers, specialties, and pipe and tube sizes to accommodate, as a minimum, equipment provided, elevation difference between compressor and evaporator, and length of piping to ensure proper operation and compliance with warranties of connected equipment.

C. Welding certificates.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For refrigerant valves and piping specialties to include in maintenance manuals.

F. Submit installing contractor’s certification and qualifications.

1.5 QUALITY ASSURANCE

A. Welding: Qualify procedures and personnel according to ASME Boiler and Pressure Vessel Code: Section IX, "Welding and Brazing Qualifications."

B. Comply with ASHRAE 15, "Safety Code for Refrigeration Systems."

C. Comply with ASME B31.5, "Refrigeration Piping and Heat Transfer Components."

1.6 PRODUCT STORAGE AND HANDLING

A. Store piping in a clean and protected area with end caps in place to ensure that piping interior and exterior are clean when installed.

1.7 COORDINATION

A. Coordinate size and location of roof curbs, equipment supports, and roof penetrations. Refer to Details on the Drawings.

1.8 INSTALLING CONTRACTOR

A. The air handling unit/air-cooled condensing unit manufacturer shall be responsible for installing all refrigerant piping, specialties, etc., and shall be fully responsible for the correct installation, operation, and maintaining the five (5) year guarantee. The installing contractor shall be certified by the equipment manufacturer.

PART 2 PRODUCTS

2.1 COPPER TUBE AND FITTINGS

A. Copper Tube: ASTM B 280, Type ACR.

B. Wrought-Copper Fittings: ASME B16.22.

C. Wrought-Copper Unions: ASME B16.22.

D. Brazing Filler Metals: AWS A5.8.

E. Flexible Connectors:

1. Body: Tin-bronze bellows with woven, flexible, tinned-bronze-wire-reinforced protective jacket.

2. End Connections: Socket ends.

3. Offset Performance: Capable of minimum 3/4-inch (20-mm) misalignment in minimum 7-inch- (180-mm-) long assembly.

4. Pressure Rating: Factory test at minimum 500 psig (3450 kPa).

5. Maximum Operating Temperature: 250 deg F (121 deg C).

2.2 VALVES AND SPECIALTIES

A. Diaphragm Packless Valves:

1. Body and Bonnet: Forged brass or cast bronze; globe design with straight-through or angle pattern.

2. Diaphragm: Phosphor bronze and stainless steel with stainless-steel spring.

3. Operator: Rising stem and hand wheel.

4. Seat: Nylon.

5. End Connections: Socket, union, or flanged.

6. Working Pressure Rating: 500 psig (3450 kPa).

7. Maximum Operating Temperature: 275 deg F (135 deg C).

B. Packed-Angle Valves:
   1. Body and Bonnet: Forged brass or cast bronze.
   2. Packing: Molded stem, back seating, and replaceable under pressure.
   3. Operator: Rising stem.
   4. Seat: Nonrotating, self-aligning polytetrafluoroethylene.
   5. Seal Cap: Forged-brass or valox hex cap.
   6. End Connections: Socket, union, threaded, or flanged.
   7. Working Pressure Rating: 500 psig (3450 kPa).
   8. Maximum Operating Temperature: 275 deg F (135 deg C).

C. Check Valves:
   1. Body: Ductile iron, forged brass, or cast bronze; globe pattern.
   2. Bonnet: Bolted ductile iron, forged brass, or cast bronze; or brass hex plug.
   3. Piston: Removable polytetrafluoroethylene seat.
   4. Closing Spring: Stainless steel.
   5. Manual Opening Stem: Seal cap, plated-steel stem, and graphite seal.
   6. End Connections: Socket, union, threaded, or flanged.
   7. Maximum Opening Pressure: 0.50 psig (3.4 kPa).
   8. Working Pressure Rating: 500 psig (3450 kPa).
   9. Maximum Operating Temperature: 275 deg F (135 deg C).

D. Service Valves:
   1. Body: Forged brass with brass cap including key end to remove core.
   2. Core: Removable ball-type check valve with stainless-steel spring.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Copper spring.
   5. Working Pressure Rating: 500 psig (3450 kPa).

E. Solenoid Valves: Comply with ARI 760 and UL 429; listed and labeled by an NRTL.
   1. Body and Bonnet: Plated steel.
   2. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
   3. Seat: Polytetrafluoroethylene.
   4. End Connections: Threaded.
   5. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24-V ac coil.
   6. Working Pressure Rating: 400 psig (2760 kPa).
   7. Maximum Operating Temperature: 240 deg F (116 deg C).
   8. Manual operator.

F. Safety Relief Valves: Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
   1. Body and Bonnet: Ductile iron and steel, with neoprene O-ring seal.

2. Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Seat Disc: Polytetrafluoroethylene.
4. End Connections: Threaded.
5. Working Pressure Rating: 400 psig (2760 kPa).
6. Maximum Operating Temperature: 240 deg F (116 deg C).

G. Thermostatic Expansion Valves: Comply with ARI 750.
1. Body, Bonnet, and Seal Cap: Forged brass or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Capillary and Bulb: Copper tubing filled with refrigerant charge.
5. Suction Temperature: 40 deg F (4.4 deg C).
6. Superheat: Adjustable.
7. Reverse-flow option (for heat-pump applications).
8. End Connections: Socket, flare, or threaded union.
9. Working Pressure Rating: 700 psig (4820 kPa).

H. Hot-Gas Bypass Valves: Comply with UL 429; listed and labeled by an NRTL.
1. Body, Bonnet, and Seal Cap: Ductile iron or steel.
2. Diaphragm, Piston, Closing Spring, and Seat Insert: Stainless steel.
3. Packing and Gaskets: Non-asbestos.
4. Solenoid Tube, Plunger, Closing Spring, and Seat Orifice: Stainless steel.
5. Seat: Polytetrafluoroethylene.
6. Equalizer: Internal or External.
7. Electrical: Molded, watertight coil in NEMA 250 enclosure of type required by location with 1/2-inch (16-GRC) conduit adapter, and 24-V ac coil.
8. End Connections: Socket.
9. Set Pressure: As required or recommended by the equipment manufacturer.
10. Throttling Range: Maximum 5 psig (34 kPa).
11. Working Pressure Rating: 500 psig (3450 kPa).
12. Maximum Operating Temperature: 240 deg F (116 deg C).

I. Straight-Type Strainers:
1. Body: Welded steel with corrosion-resistant coating.
2. Screen: 100-mesh stainless steel.
3. End Connections: Socket or flare.
4. Working Pressure Rating: 500 psig (3450 kPa).
5. Maximum Operating Temperature: 275 deg F (135 deg C).

J. Angle-Type Strainers:
1. Body: Forged brass or cast bronze.

2. Drain Plug: Brass hex plug.
3. Screen: 100-mesh monel.
4. End Connections: Socket or flare.
5. Working Pressure Rating: 500 psig (3450 kPa).
6. Maximum Operating Temperature: 275 deg F (135 deg C).

K. Moisture/Liquid Indicators:

1. Body: Forged brass.
2. Window: Replaceable, clear, fused glass window with indicating element protected by filter screen.
3. Indicator: Color coded to show moisture content in ppm.
4. Minimum Moisture Indicator Sensitivity: Indicate moisture above 60 ppm.
5. End Connections: Socket or flare.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 240 deg F (116 deg C).

L. Replaceable-Core Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell with ductile-iron cover, stainless-steel screws, and neoprene gaskets.
2. Filter Media: 10 micron, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal, as recommended by the equipment manufacturer.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig (14 kPa).
8. Rated Flow: Refer to Drawings and Equipment Characteristics.
9. Working Pressure Rating: 500 psig (3450 kPa).
10. Maximum Operating Temperature: 240 deg F (116 deg C).

M. Permanent Filter Dryers: Comply with ARI 730.

1. Body and Cover: Painted-steel shell.
2. Filter Media: 10 microns, pleated with integral end rings; stainless-steel support.
3. Desiccant Media: Activated alumina or charcoal, as recommended by the equipment manufacturer.
4. Designed for reverse flow (for heat-pump applications).
5. End Connections: Socket.
6. Access Ports: NPS 1/4 (DN 8) connections at entering and leaving sides for pressure differential measurement.
7. Maximum Pressure Loss: 2 psig (14 kPa).
8. Rated Flow: Refer to Drawings and Equipment Characteristics.

9. Working Pressure Rating: 500 psig (3450 kPa).
10. Maximum Operating Temperature: 240 deg F (116 deg C).

N. Mufflers:
1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or flare.
3. Working Pressure Rating: 500 psig (3450 kPa).
4. Maximum Operating Temperature: 275 deg F (135 deg C).

O. Receivers: Comply with ARI 495.
1. Comply with ASME Boiler and Pressure Vessel Code; listed and labeled by an NRTL.
2. Comply with UL 207; listed and labeled by an NRTL.
3. Body: Welded steel with corrosion-resistant coating.
4. Tappings: Inlet, outlet, liquid level indicator, and safety relief valve.
5. End Connections: Socket or threaded.
6. Working Pressure Rating: 500 psig (3450 kPa).
7. Maximum Operating Temperature: 275 deg F (135 deg C).

P. Liquid Accumulators: Comply with ARI 495.
1. Body: Welded steel with corrosion-resistant coating.
2. End Connections: Socket or threaded.
3. Working Pressure Rating: 500 psig (3450 kPa).
4. Maximum Operating Temperature: 275 deg F (135 deg C).

2.3 REFRIGERANTS

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

B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Atofina Chemicals, Inc.
2. DuPont Company; Fluorochemicals Div.
3. Honeywell, Inc.; Genetron Refrigerants.
4. INEOS Fluor Americas LLC.

C. ASHRAE 34, R-410A: Pentafluoroethane/Difluoromethane.

D. R-407C.

PART 3 EXECUTION

3.1 PIPING APPLICATIONS FOR REFRIGERANT R-407C

A. Suction Lines NPS 1-1/2 (DN 40) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Suction Lines NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

3.2 PIPING APPLICATIONS FOR REFRIGERANT R-410A

A. Suction Lines NPS 1-1/2 (DN 40) and Smaller or Conventional Air-Conditioning Applications: Copper, Type ACR, annealed-temper tubing and wrought-copper fittings with brazed joints.

B. Suction Lines NPS 4 (DN 100) and Smaller for Conventional Air-Conditioning Applications: Copper, Type ACR, drawn-temper tubing and wrought-copper fittings with brazed joints.

C. Safety-Relief-Valve Discharge Piping: Copper, Type ACR, annealed- or drawn-temper tubing and wrought-copper fittings with brazed joints.

3.3 VALVE AND SPECIALTY APPLICATIONS

A. Install diaphragm packless valves in suction and discharge lines of compressor.

B. Install service valves for gage taps at inlet and outlet of hot-gas bypass valves and strainers if they are not an integral part of valves and strainers.

C. Install a check valve at the compressor discharge and a liquid accumulator at the compressor suction connection.

D. Except as otherwise indicated, install diaphragm packless valves on inlet and outlet side of filter dryers.

E. Install a full-sized, three-valve bypass around filter dryers.

F. Install solenoid valves upstream from each expansion valve and hot-gas bypass valve. Install solenoid valves in horizontal lines with coil at top.

G. Install thermostatic expansion valves as close as possible to distributors on evaporators.

1. Install valve so diaphragm case is warmer than bulb.

2. Secure bulb to clean, straight, horizontal section of suction line using two bulb straps. Do not mount bulb in a trap or at bottom of the line.

3. If external equalizer lines are required, make connection where it will reflect suction-line pressure at bulb location.

H. Install safety relief valves where required by ASME Boiler and Pressure Vessel Code. Pipe safety-relief-valve discharge line to outside according to ASHRAE 15.

I. Install moisture/liquid indicators in liquid line at the inlet of the thermostatic expansion valve or at the inlet of the evaporator coil capillary tube.

J. Install strainers upstream from and adjacent to the following unless they are furnished as an integral assembly for device being protected:

1. Solenoid valves.

2. Thermostatic expansion valves.

3. Hot-gas bypass valves.

4. Compressor.

K. Install filter dryers in liquid line between compressor and thermostatic expansion valve, and in the suction line at the compressor.

L. Install receivers sized to accommodate pump-down charge.

M. Install flexible connectors at compressors.

3.4 PIPING INSTALLATION

A. 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 Shop Drawings.

B. Install refrigerant piping according to ASHRAE 15.

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

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

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

F. Install piping adjacent to machines to allow service and maintenance.

G. Install piping free of sags and bends.

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

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

J. Refer to Division 23 Sections "Instrumentation and Control for HVAC" and "Sequence of Operations for HVAC Controls" for solenoid valve controllers, control wiring, and sequence of operation.

K. Install piping as short and direct as possible, with a minimum number of joints, elbows, and fittings.

L. Arrange piping to allow inspection and service of refrigeration equipment. Install valves and specialties in accessible locations to allow for service and inspection. Install access doors or panels as required under this Division if valves or equipment requiring maintenance is concealed behind finished surfaces.

M. Install refrigerant piping in protective conduit where installed belowground.

N. Install refrigerant piping in rigid or flexible conduit in locations where exposed to mechanical injury.

O. Slope refrigerant piping as follows:

1. Install horizontal hot-gas discharge piping with a uniform slope downward away from compressor.

2. Install horizontal suction lines with a uniform slope downward to compressor.

3. Install traps and double risers to entrain oil in vertical runs.

4. Liquid lines may be installed level.

P. When brazing, remove solenoid-valve coils and sight glasses; also remove valve stems, seats, and packing, and accessible internal parts of refrigerant specialties. Do not apply heat near expansion-valve bulb.

Q. Install piping with adequate clearance between pipe and adjacent walls and hangers or between pipes for insulation installation.

R. Identify refrigerant piping and valves according to Division 23 Section "Identification for HVAC Piping and Equipment."

S. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

T. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Division 23 Section "Sleeves and Sleeve Seals for HVAC Piping."

U. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Division 23 Section "Escutcheons for HVAC Piping."

3.5 PIPE 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 pipe and fittings before assembly.

C. Fill pipe and fittings with an inert gas (nitrogen or carbon dioxide), during brazing or welding, to prevent scale formation.

D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," Chapter "Pipe and Tube."

1. Use Type BcuP, copper-phosphorus alloy for joining copper socket fittings with copper pipe.

2. Use Type BAg, cadmium-free silver alloy for joining copper with bronze or steel.

E. Threaded Joints: Thread steel 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.

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

3.6 HANGERS AND SUPPORTS

A. Hanger, support, and anchor products are specified in Division 23 Section "Hangers and Supports for HVAC Piping and Equipment."

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs less than 20 feet (6 m) long.

2. Roller hangers and spring hangers for individual horizontal runs 20 feet (6 m) or longer.

3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet (6 m) or longer, supported on a trapeze.

4. Spring hangers to support vertical runs.

5. Copper-clad hangers with neoprene inserts and supports for hangers and supports in direct contact with copper pipe.

C. Install hangers for copper tubing with the following maximum spacing and minimum rod sizes:

1. NPS 1/2 (DN 15): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).

2. NPS 5/8 (DN 18): Maximum span, 60 inches (1500 mm); minimum rod size, 1/4 inch (6.4 mm).

3. NPS 1 (DN 25): Maximum span, 72 inches (1800 mm); minimum rod size, 1/4 inch (6.4 mm).

4. NPS 1-1/4 (DN 32): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).

5. NPS 1-1/2 (DN 40): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
6. NPS 2 (DN 50): Maximum span, 96 inches (2400 mm); minimum rod size, 3/8 inch (9.5 mm).
7. NPS 2-1/2 (DN 65): Maximum span, 108 inches (2700 mm); minimum rod size, 3/8 inch (9.5 mm).
8. NPS 3 (DN 80): Maximum span, 10 feet (3 m); minimum rod size, 3/8 inch (9.5 mm).
9. NPS 4 (DN 100): Maximum span, 12 feet (3.7 m); minimum rod size, 1/2 inch (13 mm).

D. Support multifloor vertical runs at least at each floor.

3.7 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Comply with ASME B31.5, Chapter VI.
2. Test refrigerant piping, specialties, and receivers. Isolate compressor, condenser, evaporator, and safety devices from test pressure if they are not rated above the test pressure.
3. Test high- and low-pressure side piping of each system separately at not less than the pressures indicated in Part 1 "Performance Requirements" Article.
    a. Fill system with nitrogen to the required test pressure.
    b. System shall maintain test pressure at the manifold gage throughout duration of test.
    c. Test joints and fittings with electronic leak detector or by brushing a small amount of soap and glycerin solution over joints.
    d. Remake leaking joints using new materials, and retest until satisfactory results are achieved.

C. The Manufacturer of the air handling unit/condensing unit system shall provide written certification that the system has been installed properly and per their recommendations and that it is in compliance to maintain the 5-year compressor and refrigerant warranty.

3.8 SYSTEM CHARGING

A. Charge system using the following procedures:

1. Install core in filter dryers after leak test but before evacuation.
2. Evacuate entire refrigerant system with a vacuum pump to 500 micrometers (67 Pa). If vacuum holds for 12 hours, system is ready for charging.
3. Break vacuum with refrigerant gas, allowing pressure to build up to 2 psig (14 kPa).
4. Charge system with a new filter-dryer core in charging line.

3.9 ADJUSTING

A. Adjust thermostatic expansion valve to obtain proper evaporator superheat.

B. Adjust high- and low-pressure switch settings to avoid short cycling in response to fluctuating suction pressure.

C. Adjust set-point temperature of air-conditioning or chilled-water controllers to the system design temperature.

D. Perform the following adjustments before operating the refrigeration system, according to manufacturer's written instructions:

1. Open shutoff valves in condenser water circuit.
2. Verify that compressor oil level is correct.
3. Open compressor suction and discharge valves.
4. Open refrigerant valves except bypass valves that are used for other purposes.
5. Check open compressor-motor alignment and verify lubrication for motors and bearings.

E. Replace core of replaceable filter dryer after system has been adjusted and after design flow rates and pressures are established.

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SECTION 23 31 13
METAL DUCTS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Single-wall rectangular ducts and fittings.
2. Single-wall round ducts and fittings.
3. Double-wall round ducts and fittings.
4. Sheet metal materials.
5. Duct liner.
6. Sealants and gaskets.
7. Hangers and supports.

B. Related Sections:

1. Division 23 Section "Testing, Adjusting, and Balancing for HVAC" for testing, adjusting, and balancing requirements for metal ducts.
2. Division 23 Section "Air Duct Accessories" for dampers, sound-control devices, duct-mounting access doors and panels, turning vanes, and flexible ducts.

1.3 PERFORMANCE REQUIREMENTS

A. Delegated Duct Design: Duct construction, including sheet metal thicknesses, seam and joint construction, reinforcements, and hangers and supports, shall comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" and performance requirements and design criteria indicated in "Duct Schedule" Article.

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".

C. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

1.4 SUBMITTALS

A. Product Data: For each type of the following products:

1. Liners and adhesives.
2. Sealants and gaskets.

B. Shop Drawings:

1. Fabrication, assembly, and installation, including plans, elevations, sections, components, and attachments to other work.
2. Factory- and shop-fabricated ducts and fittings.
3. Duct layout indicating sizes, configuration, liner material, and static-pressure classes.
4. Elevation of top of ducts.

5. Dimensions of main duct runs from building grid lines.
6. Fittings.
7. Reinforcement and spacing.
8. Seam and joint construction.
9. Penetrations through fire-rated and other partitions.
10. Equipment installation based on equipment being used on Project.
11. Locations for duct accessories, including dampers, turning vanes, and access doors and panels.
12. Hangers and supports, including methods for duct and building attachment and vibration isolation.

C. 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:
1. Duct installation in congested spaces, indicating coordination with general construction, building components, and other building services. Indicate proposed changes to duct layout.
2. Suspended ceiling components.
3. Structural members to which duct will be attached.
4. Size and location of initial access modules for acoustical tile.
5. Penetrations of smoke barriers and fire-rated construction.
6. Items penetrating finished ceiling including the following:
a. Lighting fixtures.
b. Air outlets and inlets.
c. Speakers.
d. Sprinklers.
e. Access panels.
f. Perimeter moldings.

D. Welding certificates.

E. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel," for hangers and supports; AWS D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports; AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

B. 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 D1.2/D1.2M, "Structural Welding Code - Aluminum," for aluminum supports.
3. AWS D9.1M/D9.1, "Sheet Metal Welding Code," for duct joint and seam welding.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1

D. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1

PART 2 PRODUCTS

2.1 SINGLE-AND DOUBLE-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 1-4, "Transverse (Girth) Joints," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

C. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 1-5, "Longitudinal Seams - Rectangular Ducts," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

D. Elbows, Transitions, Offsets, Branch Connections, and Other Duct Construction: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 2, "Fittings and Other Construction," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

E. Provide 18 gauge minimum duct construction for the first ten (10) feet supply and return/relief ducts connected to air handling units. This ductwork shall be internally lined with solid inner liner and externally insulated with rigid board insulation.

2.2 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.

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

   a. Lindab Inc.

   b. McGill AirFlow LLC.

   c. SEMCO Incorporated.

   d. Sheet Metal Connectors, Inc.

   e. Spiral Manufacturing Co., Inc.

   f. OR EQUAL

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension).

C. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.

D. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support

intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

1. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
2. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.

E. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Refer to drawings for acceptable fitting types.

F. All round and flat oval ducts shall be spiral type.

G. All fittings shall have fully welded joints.

2.3 DOUBLE-WALL ROUND DUCTS AND FITTINGS

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

1. Lindab Inc.
2. McGill AirFlow LLC.
3. SEMCO Incorporated.
4. Sheet Metal Connectors, Inc.

B. Flat-Oval Ducts: Indicated dimensions are the duct width (major dimension) and diameter of the round sides connecting the flat portions of the duct (minor dimension) of the inner duct.

C. Outer Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 3, "Round, Oval, and Flexible Duct," based on static-pressure class unless otherwise indicated.

1. Transverse Joints: Select joint types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-2, "Transverse Joints - Round Duct," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    a. Transverse Joints in Ducts Larger Than 60 Inches (1524 mm) in Diameter: Flanged.
2. Longitudinal Seams: Select seam types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-1, "Seams - Round Duct and Fittings," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
    a. Fabricate round ducts larger than 90 inches (2286 mm) in diameter with butt-welded longitudinal seams.
    b. Fabricate flat-oval ducts larger than 72 inches (1830 mm) in width (major dimension) with butt-welded longitudinal seams.
3. Tees and Laterals: Select types and fabricate according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees," for static-pressure class, applicable sealing requirements, materials involved, duct-support intervals, and other provisions in

SMACNA's "HVAC Duct Construction Standards - Metal and Flexible." Refer to Drawings for acceptable fitting types.

D. Inner Duct: Minimum 0.028-inch (0.7-mm) perforated galvanized sheet steel.

E. Interstitial Insulation: Fibrous-glass liner complying with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

1. Maximum Thermal Conductivity: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.

2. Install spacers that position the inner duct at uniform distance from outer duct without compressing insulation.

3. Coat insulation with antimicrobial coating.

F. All round and flat oval ducts shall be spiral type.

G. All fittings shall have fully welded joints.

2.4 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. Provide 18-gauge minimum duct construction for the first ten (10) feet supply and return ducts connected to air handling units. This ductwork shall be internally lined and externally insulated with rigid board insulation.

C. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60 (Z180).

2. Finishes for Surfaces Exposed to View: Mill phosphatized.

D. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304 or 316, as indicated in the "Duct Schedule" Article; cold rolled, annealed, sheet. Exposed surface finish shall be No. 2B, No. 2D, No. 3, or No. 4 as indicated in the "Duct Schedule" Article.

E. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M) Alloy 3003, H14 temper; with mill finish for concealed ducts, and standard, one-side bright finish for duct surfaces exposed to view.

F. Reinforcement Shapes and Plates: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

1. Where black- and galvanized-steel shapes and plates are used to reinforce aluminum ducts, isolate the different metals with butyl rubber, neoprene, or EPDM gasket materials.

G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.5 DUCT LINER

A. Fibrous-Glass Duct Liner: Comply with ASTM C 1071, NFPA 90A, or NFPA 90B; and with NAIMA AH124, "Fibrous Glass Duct Liner Standard."

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

a. CertainTeed Corporation; Insulation Group.

b. Johns Manville.

c. Knauf Insulation.

2. Maximum Thermal Conductivity:

   a. Type I, Flexible: 0.27 Btu x in./h x sq. ft. x deg F (0.039 W/m x K) at 75 deg F (24 deg C) mean temperature.

   b. Type II, Rigid: 0.23 Btu x in./h x sq. ft. x deg F (0.033 W/m x K) at 75 deg F (24 deg C) mean temperature.

3. Antimicrobial Erosion-Resistant Coating: Apply to the surface of the liner that will form the interior surface of the duct to act as a moisture repellent and erosion-resistant coating. Antimicrobial compound shall be tested for efficacy by an NRTL and registered by the EPA for use in HVAC systems.

4. Solvent-Based Liner Adhesive: Comply with NFPA 90A or NFPA 90B and with ASTM C 916.

   a. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Insulation Pins and Washers:

1. Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

2. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm) thick aluminum; with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

C. Shop Application of Duct Liner: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-19, "Flexible Duct Liner Installation."

1. Adhere a single layer of indicated thickness of duct liner with at least 90 percent adhesive coverage at liner contact surface area. Attaining indicated thickness with multiple layers of duct liner is prohibited.

2. Apply adhesive to transverse edges of liner facing upstream that do not receive metal nosing.

3. Butt transverse joints without gaps, and coat joint with adhesive.

4. Fold and compress liner in corners of rectangular ducts or cut and fit to ensure butted-edge overlapping.

5. Do not apply liner in rectangular ducts with longitudinal joints, except at corners of ducts, unless duct size and dimensions of standard liner make longitudinal joints necessary.

6. Apply adhesive coating on longitudinal seams in ducts with air velocity of 2500 fpm (12.7 m/s).

7. Secure liner with mechanical fasteners 4 inches (100 mm) from corners and at intervals not exceeding 12 inches (300 mm) transversely; at 3 inches (75 mm) from transverse joints and at intervals not exceeding 18 inches (450 mm) longitudinally.

8. Secure transversely oriented liner edges facing the airstream with metal nosings that have either channel or "Z" profiles or are integrally formed from duct wall. Fabricate edge facings at the following locations:

   a. Fan discharges.

   b. Intervals of lined duct preceding unlined duct.

   c. Upstream edges of transverse joints in ducts where air velocities are higher than 2500 fpm (12.7 m/s) or where indicated.

9. Secure insulation between perforated sheet metal inner duct of same thickness as specified for outer shell. Use mechanical fasteners that maintain inner duct at uniform distance from outer shell without compressing insulation.

    a. Sheet Metal Inner Duct Perforations: 3/32-inch (2.4-mm) diameter, with an overall open area of 23 percent.

10. Terminate inner ducts with buildouts attached to fire-damper sleeves, dampers, turning vane assemblies, or other devices. Fabricated buildouts (metal hat sections) or other buildout means are optional; when used, secure buildouts to duct walls with bolts, screws, rivets, or welds.

11. All internally lined ducts shall have a perforated metal liner.

2.6 SEALANT AND GASKETS

A. General Sealant and Gasket Requirements: Surface-burning characteristics for sealants and gaskets shall be a maximum flame-spread index of 25 and a maximum smoke-developed index of 50 when tested according to UL 723; certified by an NRTL.

B. Two-Part Tape Sealing System:

1. Tape: Woven cotton fiber impregnated with mineral gypsum and modified acrylic/silicone activator to react exothermically with tape to form hard, durable, airtight seal.

2. Tape Width: 4 inches (102 mm).

3. Sealant: Modified styrene acrylic.

4. Water resistant.

5. Mold and mildew resistant.

6. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.

7. Service: Indoor and outdoor.

8. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum.

10. 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).

C. Water-Based Joint and Seam Sealant:

1. Application Method: Brush on.

2. Solids Content: Minimum 65 percent.

3. Shore A Hardness: Minimum 20.

4. Water resistant.

5. Mold and mildew resistant.

6. VOC: Maximum 75 g/L (less water).

7. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive and negative.

8. Service: Indoor or outdoor.

9. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

D. Solvent-Based Joint and Seam Sealant:

1. Application Method: Brush on.
2. Base: Synthetic rubber resin.
3. Solvent: Toluene and heptane.
4. Solids Content: Minimum 60 percent.
5. Shore A Hardness: Minimum 60.
6. Water resistant.
7. Mold and mildew resistant.
8. 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).
9. VOC: Maximum 395 g/L.
10. Maximum Static-Pressure Class: 10-inch wg (2500 Pa), positive or negative.
11. Service: Indoor or outdoor.
12. Substrate: Compatible with galvanized sheet steel (both PVC coated and bare), stainless steel, or aluminum sheets.

E. 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).

F. Flange Gaskets: Butyl rubber, neoprene, or EPDM polymer with polyisobutylene plasticizer.

1. Seal shall provide maximum leakage class of 3 cfm/100 sq. ft. at 1-inch wg (0.14 L/s per sq. m at 250 Pa) and shall be rated for 10-inch wg (2500-Pa) static-pressure class, positive or negative.
2. EPDM O-ring to seal in concave bead in coupling or fitting spigot.
3. Double-lipped, EPDM O-ring seal, mechanically fastened to factory-fabricated couplings and fitting spigots.

2.7 HANGERS AND SUPPORTS

A. Hanger Rods for Noncorrosive Environments: Cadmium-plated steel rods and nuts.

B. Hanger Rods for Corrosive Environments: Electrogalvanized, all-thread rods or galvanized rods with threads painted with zinc-chromate primer after installation.

C. Strap and Rod Sizes: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct."

D. Steel Cables for Galvanized-Steel Ducts: Galvanized steel complying with ASTM A 603.

E. Steel Cables for Stainless-Steel Ducts: Stainless steel complying with ASTM A 492.

F. Steel Cable End Connections: Cadmium-plated steel assemblies with brackets, swivel, and bolts designed for duct hanger service; with an automatic-locking and clamping device.

G. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws; compatible with duct materials.

H. Trapeze and Riser Supports:

1. Supports for Galvanized-Steel Ducts: Galvanized-steel shapes and plates.

2. Supports for Stainless-Steel Ducts: Stainless-steel shapes and plates.

3. Supports for Aluminum Ducts: Aluminum or galvanized steel coated with zinc chromate.

I. Exposed Round Duct Hangers: Provide split rings hangers encompassing the full circumference of the ductwork for all exposed duct in the cafeteria, gymnasium, and stage areas. Cable/wire supports for round ductwork in these areas is prohibited. Fasten hangers to top chord of steel joists/truss.

2.8 OPEN END DUCTS (OED)

A. Whether indicated on plans or not, all open-ended ducts shall be provided with a protective screen.

B. All open-ended ducts shall be furnished with a 12-gauge 1/2-inch x 1/2-inch aluminum mesh screen. Screens shall be permanently installed in a removable frame, and the frame shall be attached to the open-ended duct in a neat, workmanship-like manner without any exposed edges or sharp surfaces.

C. Screen shall be attached to a 3/4-inch x 1/8-inch continuous galvanized perimeter frame. Install duct stiffeners greater than 16 inches in any direction at open-ended ducts.

PART 3 EXECUTION

3.1 DUCT INSTALLATION

A. Drawing plans, schematics, and diagrams indicate general location and arrangement of duct system. Indicated duct locations, configurations, and arrangements were used to size ducts and calculate friction loss for air-handling equipment sizing and for other design considerations. Install duct systems as indicated unless deviations to layout are approved on Shop Drawings and Coordination Drawings.

B. Install ducts according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" unless otherwise indicated.

C. Install round ducts in maximum practical lengths.

D. Install ducts with fewest possible joints.

E. Install factory- or shop-fabricated fittings for changes in direction, size, and shape and for branch connections.

F. Unless otherwise indicated, install ducts vertically and horizontally, and parallel and perpendicular to building lines.

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Install ducts with a clearance of 1 inch (25 mm), 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 (38 mm).

K. Where ducts pass through fire-rated interior partitions and exterior walls, install fire dampers. Comply with requirements in Division 23 Section "Air Duct Accessories" for fire and smoke dampers.

L. Protect duct interiors from moisture, construction debris and dust, and other foreign materials. Comply with SMACNA's "Duct Cleanliness for New Construction Guidelines."

3.2 INSTALLATION OF EXPOSED DUCTWORK

A. Protect ducts exposed in finished spaces from being dented, scratched, or damaged.

B. Utilize self-sealing duct connectors in lieu of duct sealant systems.

C. Grind welds to provide smooth surface free of burrs, sharp edges, and weld splatter. When welding stainless steel with a No. 3 or 4 finish, grind the welds flush, polish the exposed welds, and treat the welds to remove discoloration caused by welding.

D. Maintain consistency, symmetry, and uniformity in the arrangement and fabrication of fittings, hangers and supports, duct accessories, and air outlets.

E. Repair or replace damaged sections and finished work that does not comply with these requirements.

3.3 DUCT SEALING

A. Seal ducts for duct static-pressure, seal classes, and leakage classes specified in "Duct Schedule" Article according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."

B. Seal all ducts to the following seal classes according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible":

1. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible."
2. Outdoor, Supply-Air Ducts: Seal Class A.
3. Outdoor, Exhaust Ducts: Seal Class A.
4. Outdoor, Return-Air Ducts: Seal Class A.
5. Unconditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class A.
6. Unconditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
7. Unconditioned Space, Exhaust Ducts: Seal Class A.
8. Unconditioned Space, Return-Air Ducts: Seal Class A.
9. Conditioned Space, Supply-Air Ducts in Pressure Classes 2-Inch wg (500 Pa) and Lower: Seal Class A.
10. Conditioned Space, Supply-Air Ducts in Pressure Classes Higher Than 2-Inch wg (500 Pa): Seal Class A.
11. Conditioned Space, Exhaust Ducts: Seal Class A.
12. Conditioned Space, Return-Air Ducts: Seal Class A.

3.4 HANGER AND SUPPORT INSTALLATION

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Chapter 4, "Hangers and Supports."

B. Building Attachments: Concrete inserts, powder-actuated fasteners, or structural-steel fasteners appropriate for construction materials to which hangers are being attached.

1. Where practical, install concrete inserts before placing concrete.
2. Install powder-actuated concrete fasteners after concrete is placed and completely cured.
3. Use powder-actuated concrete fasteners for standard-weight aggregate concretes or for slabs more than 4 inches (100 mm) thick.
4. Do not use powder-actuated concrete fasteners for lightweight-aggregate concretes or for slabs less than 4 inches (100 mm) thick.

C. Hanger Spacing: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 4-1 (Table 4-1M), "Rectangular Duct Hangers Minimum Size," and Table 4-2, "Minimum Hanger Sizes for Round Duct," for maximum hanger spacing; install hangers and supports within 24 inches (610 mm) of each elbow and within 48 inches (1200 mm) of each branch intersection.

D. Hangers Exposed to View: Threaded rod and angle or channel supports.

E. Support vertical ducts with steel angles or channel secured to the sides of the duct with welds, bolts, sheet metal screws, or blind rivets; support at each floor and at a maximum interval of 16-feet (5 m).

F. Install upper attachments to structures. Select and size upper attachments with pull-out, tension, and shear capacities appropriate for supported loads and building materials where used.

3.5 CONNECTIONS

A. Make connections to equipment with flexible connectors complying with Division 23 Section "Air Duct Accessories."

B. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for branch, outlet and inlet, and terminal unit connections.

3.6 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.

B. Paint all exposed metal ducts. Apply one coat of compatible galvanized steel primer. The Architect shall select paint colors for all exposed ductwork.

3.7 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 the following systems:
    a. Ducts with a Pressure Class Higher Than 3-Inch wg (750 Pa): Test representative duct sections, totaling no less than 100 percent of total installed duct area for each designated pressure class.
    b. Supply Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, totaling no less than 100 percent of total installed duct area for each designated pressure class.
    c. Return/Relief Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, totaling no less than 100 percent of total installed duct area for each designated pressure class.

d. Exhaust Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, totaling no less than 100 percent of total installed duct area for each designated pressure class.

e. Outdoor Air Ducts with a Pressure Class of 2-Inch wg (500 Pa) or Higher: Test representative duct sections, totaling no less than 50 percent of total installed duct area for each designated pressure class.

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 five days' advance notice for testing. Testing shall be witnessed by the Test and Balancing Company.

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.

3.8 DUCT CLEANING

A. Clean new duct system(s) before testing, adjusting, and balancing.

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 "Air 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. 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.

3.9 START UP

A. Air Balance: Comply with requirements in Division 23 Section "Testing, Adjusting, and Balancing for HVAC."

3.10 DUCT SCHEDULE

A. Fabricate ducts with galvanized sheet steel except as otherwise indicated and as follows:

B. Supply Ducts:

1. Ducts Connected to Energy Recovery Units:
   a. Pressure Class: Positive 2-inch wg (500 Pa).
   b. Minimum SMACNA Seal Class: A.
   c. SMACNA Leakage Class for Rectangular: 6.
   d. SMACNA Leakage Class for Round and Flat Oval: 3.
   e. Provide 18-gauge minimum duct construction for the first ten (10) feet supply and return ducts connected to air handling units. This ductwork shall be internally lined and externally insulated with rigid board insulation.

2. Ducts Connected to Equipment Not Listed Above:
    a. Pressure Class: Positive 2-inch wg (500 Pa).
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

C. Return/Relief Ducts:
1. Ducts Connected to Equipment Not Listed Above:
    a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

D. Exhaust Ducts:
1. Ducts Connected to Fans Exhausting (ASHRAE 62.1, Class 1 and 2) Air:
    a. Pressure Class: Negative 2-inch wg (500 Pa).
    b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.
2. Ducts Connected to Equipment Not Listed Above:
    a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    b. Minimum SMACNA Seal Class: A if negative pressure, and A if positive pressure.
    c. SMACNA Leakage Class for Rectangular: 3.
    d. SMACNA Leakage Class for Round and Flat Oval: 6.

E. Outdoor-Air Ducts:
1. Ducts Connected to Air-Handling Units:
    a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.
2. Ducts Connected to Equipment Not Listed Above:
    a. Pressure Class: Positive or negative 2-inch wg (500 Pa).
    b. Minimum SMACNA Seal Class: A.
    c. SMACNA Leakage Class for Rectangular: 6.
    d. SMACNA Leakage Class for Round and Flat Oval: 3.

F. Intermediate Reinforcement:
1. Galvanized-Steel Ducts: Galvanized steel.
2. PVC-Coated Ducts:

a. Exposed to Airstream: Match duct material.

b. Not Exposed to Airstream: Match duct material.

3. Stainless-Steel Ducts:

a. Exposed to Airstream: Match duct material.

b. Not Exposed to Airstream: Match duct material.

4. Aluminum Ducts: Aluminum.

G. Liner:

1. Supply Air Ducts: Fibrous glass, Type I, 1 inch (25 mm) thick.

2. Return Air Ducts: Fibrous glass, Type I, 1 inch (25 mm) thick.

3. Exhaust Air Ducts: Fibrous glass, Type I, 1 inch (25 mm) thick.

4. Supply Fan Plenums: Fibrous glass, Type II, 1 inch (25 mm) thick.

5. Return- and Exhaust-Fan Plenums: Fibrous glass, Type II, 2 inches (51 mm) thick.

6. Transfer Ducts: Fibrous glass, Type I, 1 inch (25 mm) thick.

H. Double-Wall Duct Interstitial Insulation:

1. Round and/or rectangular lined ductwork shall be installed in exposed occupied areas (i.e., areas without ceilings, etc.) and for the first ten (10) feet of ductwork from the air handling units, and to the extent shown on the drawings.

2. Round exposed ductwork shall be paintable galvanized steel, double wall construction with perforated interior liner and self-sealing duct connectors, similar to Lindab. For ductwork 36-inch diameter and greater, use Van Stone flange connectors.

3. Supply and Return Air Ducts: 1 inch (25 mm) thick.

I. Elbow Configuration:

1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."

a. Velocity 1000 fpm (5 m/s) 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 (5 to 7.6 m/s):

1) Radius Type RE 1 with minimum 1.0 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 0.5 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

c. Velocity 1500 fpm (7.6 m/s) or Higher:

1) Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.

2) Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.

3) Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."

2. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-2, "Rectangular Elbows."
    a. Radius Type RE 1 with minimum 1.5 radius-to-diameter ratio.
    b. Radius Type RE 3 with minimum 1.0 radius-to-diameter ratio and two vanes.
    c. Mitered Type RE 2 with vanes complying with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-3, "Vanes and Vane Runners," and Figure 2-4, "Vane Support in Elbows."
3. Round Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-3, "Round Duct Elbows."
    a. Minimum Radius-to-Diameter Ratio and Elbow Segments: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Table 3-1, "Mitered Elbows." Elbows with less than 90-degree change of direction have proportionately fewer segments.
        1) Velocity 1000 fpm (5 m/s) or Lower: 0.5 radius-to-diameter ratio and three segments for 90-degree elbow.
        2) Velocity 1000 to 1500 fpm (5 to 7.6 m/s): 1.0 radius-to-diameter ratio and four segments for 90-degree elbow.
        3) Velocity 1500 fpm (7.6 m/s) or Higher: 1.5 radius-to-diameter ratio and five segments for 90-degree elbow.
        4) Radius-to Diameter Ratio: 1.5.
    b. Round Elbows, 12 Inches (305 mm) and Smaller in Diameter: Stamped or pleated.
    c. Round Elbows, 14 Inches (356 mm) and Larger in Diameter: Standing seam.

J. Branch Configuration:
1. Rectangular Duct: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 2-6, "Branch Connections."
    a. Rectangular Main to Rectangular Branch: 45-degree entry.
    b. Rectangular Main to Round Branch: Spin in.
2. Round and Flat Oval: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible," Figure 3-4, "90 Degree Tees and Laterals," and Figure 3-5, "Conical Tees." Saddle taps are permitted in existing duct.
    a. Velocity 1000 fpm (5 m/s) or Lower: 90-degree tap.
    b. Velocity 1000 to 1500 fpm (5 to 7.6 m/s): Conical tap, Lo-Loss tap.
    c. Velocity 1500 fpm (7.6 m/s) or Higher: Conical 45-degree lateral.

END OF SECTION

SECTION 23 33 00
AIR DUCT ACCESSORIES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Manual volume dampers.
2. Control dampers.
3. Fire dampers.
4. Smoke dampers.
5. Combination fire and smoke dampers.
6. Corridor dampers.
7. Flange connectors.
8. Turning vanes.
9. Remote damper operators.
10. Duct-mounted access doors.
11. Flexible connectors.
12. Flexible ducts.
13. Duct accessory hardware.

1.3 SUBMITTALS

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

1. For duct silencers, include pressure drop and dynamic insertion loss data. Include breakout noise calculations for high transmission loss casings.

B. Shop Drawings: For duct accessories. Include plans, elevations, sections, details and attachments to other work.

1. 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:

a. Special fittings.

b. Manual volume damper installations.

c. Control damper installations.

d. Fire-damper, smoke-damper, combination fire- and smoke-damper, ceiling, and corridor damper installations, including sleeves; and duct-mounted access doors and remote damper operators.

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

C. 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.

D. Source quality-control reports.

E. Operation and Maintenance Data: For air duct accessories to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 90A, "Installation of Air Conditioning and Ventilating Systems," and with NFPA 90B, "Installation of Warm Air Heating and Air Conditioning Systems."

B. Comply with AMCA 500-D testing for damper rating.

1.5 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. Fusible Links: Furnish quantity equal to 10 percent of amount installed.

PART 2 PRODUCTS

2.1 MATERIALS

A. Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for acceptable materials, material thicknesses, and duct construction methods unless otherwise indicated. Sheet metal materials shall be free of pitting, seam marks, roller marks, stains, discolorations, and other imperfections.

B. Galvanized Sheet Steel: Comply with ASTM A 653/A 653M.

1. Galvanized Coating Designation: G60 (Z180).

2. Exposed-Surface Finish: Mill phosphatized.

C. Stainless-Steel Sheets: Comply with ASTM A 480/A 480M, Type 304, and having a No. 2 finish for concealed ducts and No. 4 finish for exposed ducts.

D. Aluminum Sheets: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, Temper H14; with mill finish for concealed ducts and standard, 1-side bright finish for exposed ducts.

E. Extruded Aluminum: Comply with ASTM B 221 (ASTM B 221M), Alloy 6063, Temper T6.

F. Reinforcement Shapes and Plates: Galvanized-steel reinforcement where installed on galvanized sheet metal ducts; compatible materials for aluminum and stainless-steel ducts.

G. Tie Rods: Galvanized steel, 1/4-inch (6-mm) minimum diameter for lengths 36 inches (900 mm) or less; 3/8-inch (10-mm) minimum diameter for lengths longer than 36 inches (900 mm).

2.2 MANUAL VOLUME DAMPERS

A. Standard, Steel, Manual Volume Dampers:

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

a. Air Balance Inc.; a division of Mestek, Inc.

b. American Warming and Ventilating; a division of Mestek, Inc.

c. USAIRE/METALAIRE – a Division on Metal Industries Inc.

d. Ruskin Company.

e. Pottorff

2. Standard leakage rating, with linkage outside airstream.

3. Suitable for horizontal or vertical applications.

4. Frames:

a. Hat-shaped, galvanized-steel channels, 0.064-inch (1.62-mm) minimum thickness.

b. Mitered and welded corners.

c. Flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.

b. Opposed-blade design.

c. Stiffen damper blades for stability.

d. Galvanized-steel, 0.064 inch (1.62 mm) thick.

6. Blade Axles: Galvanized steel.

7. Bearings:

a. Oil-impregnated bronze or molded synthetic.

b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Galvanized steel.

9. With insulation stand-offs.

B. Standard, Aluminum, Manual Volume Dampers:

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

a. Air Balance Inc.; a division of Mestek, Inc.

b. American Warming and Ventilating; a division of Mestek, Inc.

c. USAIRE/METALAIRE – a Division on Metal Industries Inc.

d. Ruskin Company.

e. Pottorff

2. Standard leakage rating, with linkage outside airstream.

3. Suitable for horizontal or vertical applications.

4. Frames: Hat-shaped, 0.10-inch- (2.5-mm-) thick, aluminum sheet channels; frames with flanges for attaching to walls and flangeless frames for installing in ducts.

5. Blades:

a. Multiple or single blade.

b. Parallel- or opposed-blade design.

c. Stiffen damper blades for stability.

d. Roll-Formed Aluminum Blades: 0.10-inch- (2.5-mm-) thick aluminum sheet.

e. Extruded-Aluminum Blades: 0.050-inch- (1.2-mm-) thick extruded aluminum.

6. Blade Axles: Galvanized steel.

7. Bearings:

a. Oil-impregnated bronze or molded synthetic.

b. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.

8. Tie Bars and Brackets: Aluminum.
9. With insulation stand-offs.

2.3 CONTROL DAMPERS

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. Arrow United Industries; a division of Mestek, Inc.
   3. Greenheck Fan Corporation.
   4. USAIRE/METALAIRE – a Division on Metal Industries Inc.
   5. Ruskin Company.
   6. Pottorff
B. Low-leakage rating, with linkage outside airstream, and bearing AMCA's Certified Ratings Seal for both air performance and air leakage.
C. Frames:
   1. Hat or U or Angle shaped.
   2. Galvanized -steel channels, 0.064 inch (1.62 mm) thick.
   3. Mitered and welded corners.
D. Blades:
   1. Multiple blade with maximum blade width of 8 inches (200 mm).
   2. Parallel and Opposed-blade design.
   3. Galvanized or stainless steel.
   4. 0.064 inch (1.62 mm) thick.
   5. Blade Edging: Closed-cell neoprene edging.
   6. Blade Edging: Inflatable seal blade edging, or replaceable rubber seals.
E. Blade Axles: 1/2-inch- (13-mm-) diameter; galvanized or stainless steel; blade-linkage hardware of zinc-plated steel and brass; ends sealed against blade bearings.
   1. Operating Temperature Range: From minus 40 to plus 200 deg F (minus 40 to plus 93 deg C).
F. Bearings:
   1. Stainless-steel sleeve.
   2. Dampers in ducts with pressure classes of 3-inch wg (750 Pa) or less shall have axles full length of damper blades and bearings at both ends of operating shaft.
   3. Thrust bearings at each end of every blade.

2.4 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. Prefco; Perfect Air Control, Inc.
5. Ruskin Company.
6. Pottorff

B. Type: Dynamic; rated and labeled according to UL 555 by an NRTL.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 4000-fpm (20-m/s) 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- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Mounting Sleeve: Factory- or field-installed, galvanized sheet steel.

1. Minimum Thickness: 0.052 or 0.138 inch (1.3 or 3.5 mm) thick, as indicated, and of length to suit application.
2. Exception: Omit sleeve where damper-frame width permits direct attachment of perimeter mounting angles on each side of wall or floor; thickness of damper frame must comply with sleeve requirements.

G. Mounting Orientation: Vertical or horizontal as indicated.

H. Blades: Roll-formed, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

I. Horizontal Dampers: Include blade lock and stainless-steel closure spring.

J. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

K. Heat-Responsive Device: Electric resettable link and switch package, factory installed, 165 deg F (74 deg C) rated.

2.5 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. Greenheck.
3. Ruskin Company.
4. Pottorff

B. General Requirements: Label according to UL 555S by an NRTL.

C. Smoke Detector: Integral, factory wired for single-point connection.

D. Frame: Multiple-blade type or Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

E. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

F. Leakage: Class I.

G. Rated pressure and velocity to exceed design airflow conditions.

H. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

I. Damper Motors: Two-position action.

J. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC."

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).

6. Non-spring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).

7. Electrical Connection: 24 V or 120V, single phase, 60 Hz, based on Division 26 and 27 requirements. Coordinate voltage types with the Electrical Contractor.

K. Accessories:

1. Auxiliary switches for signaling.

2. Test and reset switches, remote mounted.

2.6 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. Greenheck.

3. Ruskin Company.

4. Pottorff

B. Type: Static; rated and labeled according to UL 555 and UL 555S by an NRTL.

C. Closing rating in ducts up to 4-inch wg (1-kPa) static pressure class and minimum 4000-fpm (20-m/s) velocity.

D. Fire Rating: 1-1/2 hours.

E. Frame: Multiple-blade type and Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch-(0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

G. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

H. Smoke Detector: Integral, factory wired for single-point connection.

I. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

J. Leakage: Class I.

K. Rated pressure and velocity to exceed design airflow conditions.

L. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application with factory-furnished silicone calking.

M. Master control panel for use in dynamic smoke-management systems.

N. Damper Motors: Two-position action.

O. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC."

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).

6. Non-spring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).

7. Electrical Connection: 24 V or 120V, single phase, 60 Hz, based on Divisions 26 and 27 requirements. Coordinate voltage types with the Electrical Contractor.

P. Accessories:

1. Auxiliary switches for signaling.

2. Test and reset switches, remote mounted.

2.7 CORRIDOR 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. Greenheck.

3. Ruskin Company.

4. Pottorff

B. General Requirements: Label combination fire and smoke dampers according to UL 555 for 1-1/2-hour rating by an NRTL.

C. Heat-Responsive Device: Replaceable, 165 deg F (74 deg C) rated, fusible links.

D. Heat-Responsive Device: Electric resettable link and switch package, factory installed, rated.

E. Frame: Curtain type with blades outside airstream except when located behind grille where blades may be inside airstream; fabricated with roll-formed, 0.034-inch- (0.85-mm-) thick galvanized steel; with mitered and interlocking corners.

F. Blades: Roll-formed, horizontal, interlocking, 0.034-inch- (0.85-mm-) thick, galvanized sheet steel. In place of interlocking blades, use full-length, 0.034-inch- (0.85-mm-) thick, galvanized-steel blade connectors.

G. Mounting Sleeve: Factory-installed, 0.052-inch- (1.3-mm-) thick, galvanized sheet steel; length to suit wall or floor application.

H. Damper Motors: Two-position action.

I. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements for motors specified in Division 23 Section "Common Motor Requirements for HVAC Equipment."

1. Motor Sizes: Minimum size as indicated. If not indicated, large enough so driven load will not require motor to operate in service factor range above 1.0.

2. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in Division 23 Section "Instrumentation and Control for HVAC."

3. Permanent-Split-Capacitor or Shaded-Pole Motors: With oil-immersed and sealed gear trains.

4. Spring-Return Motors: Equip with an integral spiral-spring mechanism where indicated. Enclose entire spring mechanism in a removable housing designed for service or adjustments. Size for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 150 in. x lbf (17 N x m).

5. Outdoor Motors and Motors in Outdoor-Air Intakes: Equip with O-ring gaskets designed to make motors weatherproof. Equip motors with internal heaters to permit normal operation at minus 40 deg F (minus 40 deg C).

6. Non-spring-Return Motors: For dampers larger than 25 sq. ft. (2.3 sq. m), size motor for running torque rating of 150 in. x lbf (17 N x m) and breakaway torque rating of 300 in. x lbf (34 N x m).

7. Electrical Connection: 24 V or 120V, single phase, 60 Hz, based on Divisions 26 and 27 requirements. Coordinate voltage types with the Electrical Contractor.

2.8 FLANGE CONNECTORS

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

1. Ductmate Industries, Inc.

2. Nexus PDQ; Division of Shilco Holdings Inc.

3. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Description: Roll-formed, factory-fabricated, slide-on transverse flange connectors, gaskets, and components.

C. Material: Galvanized steel.

D. Gauge and Shape: Match connecting ductwork.

2.9 TURNING VANES

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

1. Ductmate Industries, Inc.
2. Duro Dyne Inc.
3. USAIRE/METALAIRE – a Division on Metal Industries Inc.
4. SEMCO Incorporated.
5. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Manufactured Turning Vanes for Metal Ducts: Curved blades of galvanized sheet steel; support with bars perpendicular to blades set; set into vane runners suitable for duct mounting.

1. Acoustic Turning Vanes: Fabricate airfoil-shaped aluminum extrusions with perforated faces and fibrous-glass fill.

C. General Requirements: Comply with SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-3, "Vanes and Vane Runners," and 2-4, "Vane Support in Elbows."

D. Vane Construction: Single and Double wall.

E. Vane Construction: Single wall for ducts up to 24 inches wide and double wall for larger dimensions.

2.10 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.

E. Wall-Box Mounting: Recessed, 2 inches (50 mm) deep.

F. Wall-Box Cover-Plate Material: Steel.

2.11 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. Cesco Products; a division of Mestek, Inc.
3. Nailor Industries Inc.
4. Ward Industries, Inc.; a division of Hart & Cooley, Inc.

B. Duct-Mounted Access Doors: Fabricate access panels according to SMACNA's "HVAC Duct Construction Standards - Metal and Flexible"; Figures 2-10, "Duct Access Doors and Panels," and 2-11, "Access Panels - Round Duct."

1. Door:

a. Double wall, rectangular.

b. Galvanized sheet metal with insulation fill and thickness as indicated for duct pressure class.

c. Vision panel.

d. Hinges and Latches: 1-by-1-inch (25-by-25-mm) butt or piano hinge and cam latches.

e. Fabricate doors airtight and suitable for duct pressure class.

2. Frame: Galvanized sheet steel, with bend-over tabs and foam gaskets.

3. Number of Hinges and Locks:

a. Access Doors Less Than 12 Inches (300 mm) Square: No hinges and two sash locks.

b. Access Doors up to 18 Inches (460 mm) Square: Two hinges and two sash locks.

c. Access Doors up to 24 by 48 Inches (600 by 1200 mm): Three hinges and two compression latches with outside and inside handles.

d. Access Doors Larger Than 24 by 48 Inches (600 by 1200 mm): 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 (2500 Pa).

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.

2.12 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 3-1/2 inches (89 mm) wide attached to 2 strips of 2-3/4-inch- (70-mm-) wide, 0.028-inch- (0.7-mm-) thick, galvanized sheet steel or 0.032-inch- (0.8-mm-) thick aluminum sheets. Provide metal compatible with connected ducts.

E. Indoor System, Flexible Connector Fabric: Glass fabric double coated with neoprene.

1. Minimum Weight: 26 oz./sq. yd. (880 g/sq. m).
2. Tensile Strength: 480 lbf/inch (84 N/mm) in the warp and 360 lbf/inch (63 N/mm) in the filling.
3. Service Temperature: Minus 40 to plus 200 deg F (Minus 40 to plus 93 deg C).

F. Outdoor System, Flexible Connector Fabric: Glass fabric double coated with weatherproof, synthetic rubber resistant to UV rays and ozone.

1. Minimum Weight: 24 oz./sq. yd. (810 g/sq. m).
2. Minimum Tensile Strength: 500 lbf/inch (88 N/mm) in the warp and 440 lbf/inch (77 N/mm) in the filling.
3. Service Temperature: Minus 50 to plus 250 deg F (Minus 45 to plus 121 deg C).

G. 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 (6-mm) movement at start and stop.

2.13 FLEXIBLE DUCTS

A. Where indicated, flexible ductwork shall be type M-KE as manufactured by Thermaflex, or as approved equal, insulated fully, UL listed as Class 1 Air Ducts, Standard 181, NFPA 90A and NFPA 90B with scuff-resistant polyethylene connector jacket and suitable for use in return air plenums. Flexible ductwork shall meet the following requirements: Pressure rating shall be 10 inches W.G., velocity shall be a minimum of 4000 FPM and R-Value shall be a minimum of 6.0.

B. Limit flexible duct runs to 5 feet maximum. Install flexible ducts, using all recommended fittings, couplings, and accessories. Support ducts with wide straps spaced so that horizontal runs do not sag more than 2-1/2 inches in 5 feet. Internally seal all joints and connections, cover with duct tape, and fasten with metal duct strap clamps. Bends of 180 degrees in flexible duct are prohibited.

C. Flexible Duct Connectors: Stainless-steel band clamps with cadmium-plated hex screw to tighten band with a worm-gear action in sizes 3 through 18 inches (75 through 460 mm), to suit duct size.

2.14 DUCT ACCESSORY HARDWARE

A. Instrument Test Holes: Cast iron or cast aluminum to suit duct material, including screw cap and gasket. Size to allow insertion of pitot tube and other testing instruments and of length to suit duct-insulation thickness.

B. Adhesives: High strength, quick setting, neoprene based, waterproof, and resistant to gasoline and grease.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install duct accessories according to applicable details in SMACNA's "HVAC Duct Construction Standards - Metal and Flexible" for metal ducts and in NAIMA AH116, "Fibrous Glass Duct Construction Standards," for fibrous-glass ducts.

B. Install duct accessories of materials suited to duct materials; use galvanized-steel accessories in galvanized-steel and fibrous-glass ducts, stainless-steel accessories in stainless-steel ducts, and aluminum accessories in aluminum ducts.

C. Install control dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated.

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 and smoke dampers according to UL listing.

H. 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 from duct filters.
3. At outdoor-air intakes and mixed-air plenums.
4. At drain pans and seals.
5. Downstream from manual volume dampers, control dampers, backdraft dampers, and equipment.
6. Adjacent to and close enough to fire 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.
7. Control devices requiring inspection.
8. Elsewhere as indicated.

I. Install access doors with swing against duct static pressure.

J. Minimum Access Door Sizes:

1. One-Hand or Inspection Access: 8 by 5 inches (200 by 125 mm).
2. Two-Hand Access: 12 by 6 inches (300 by 150 mm).
3. Head and Hand Access: 18 by 10 inches (460 by 250 mm).
4. Head and Shoulders Access: 21 by 14 inches (530 by 355 mm).
5. Body Access: 25 by 14 inches (635 by 355 mm).
6. Body plus Ladder Access: 25 by 17 inches (635 by 430 mm).

K. Label access doors according to Division 23 Section "Identification for HVAC Piping and Equipment" to indicate the purpose of access door.

L. Install flexible connectors to connect ducts to equipment.

M. For fans developing static pressures of 5-inch wg (1250 Pa) and more, cover flexible connectors with loaded vinyl sheet held in place with metal straps.

N. Connect heat pump units to supply ducts with maximum 4-inch (100-mm) lengths of flexible duct. Do not use flexible ducts to change directions.

O. Connect diffusers and / or diffuser boxes to ducts directly or with maximum 60-inch (1500-mm) lengths of flexible duct clamped or strapped in place.

P. Connect flexible ducts to metal ducts with metal clamps plus sheet metal screws.

Q. Install duct test holes where required for testing and balancing purposes.

R. 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 (6-mm) movement during start and stop of fans.

3.2 FIELD QUALITY CONTROL

A. Tests and Inspections:

1. Operate dampers to verify full range of movement.

2. Inspect locations of access doors and verify that purpose of access door can be performed.

3. Operate fire, smoke, and combination fire and smoke dampers to verify full range of movement and verify that proper heat-response device is installed.

4. Inspect turning vanes for proper and secure installation.

5. Operate remote damper operators to verify full range of movement of operator and damper.

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SECTION 23 37 13
DIFFUSERS, REGISTERS, AND GRILLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Diffusers and Grilles.

2. Ceiling Linear Slot Diffusers

B. Related Sections:

1. Division 08 for fixed and adjustable louvers and wall vents, whether or not they are connected to ducts.

2. Section 23 33 00 - Air Duct Accessories for fire and smoke dampers and volume-control dampers not integral to diffusers, registers, and grilles.

1.3 SUBMITTALS

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

1. Data Sheet: Indicate materials of construction, finish, and mounting details; and performance data including throw and drop, static-pressure drop, and noise ratings.

2. Diffuser, Register, and Grille Schedule: Indicate drawing designation, room location, quantity, model number, size, and accessories furnished.

B. Samples for Initial Selection: For diffusers, registers, and grilles with factory-applied color finishes.

C. Samples for Verification: For diffusers, registers, and grilles, in manufacturer's standard sizes to verify color selected.

D. Coordination Drawings: Reflected ceiling plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from Installers of the items involved:

1. Ceiling suspension assembly members.

2. Method of attaching hangers to building structure.

3. Size and location of initial access modules for acoustical tile.

4. Ceiling-mounted items including lighting fixtures, diffusers, grilles, speakers, sprinklers, access panels, and special moldings.

5. Duct access panels.

E. Source quality-control reports.

PART 2 PRODUCTS

2.1 DIFFUSERS & GRILLES

A. Architectural Square Plaque Ceiling Diffuser:

1. The manufacturer shall provide published performance data for the diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-2006. Subject to compliance with requirements, provide Titus OMNI-AA as basis of design or comparable product by one of the following:

a. Price Industries

b. Krueger.

c. USAIRE/METALAIRE – a Division on Metal Industries Inc.

d. Tuttle and Bailey.

2. Face Plate: Architectural square panel ceiling diffusers shall be of the sizes and mounting types shown on the Plans and Air Device Schedule. Diffuser shall have a heavy gauge aluminum face panel that captures a secondary heavy gauge aluminum panel to which hanger brackets are attached. The diffuser shall be all aluminum.

3. Back pan: shall be one piece precision die-stamped and shall include an integrally drawn inlet. The diffuser back pan shall be constructed of .040 thick aluminum alloy.

4. Neck: shall have a minimum of 1¼-inch depth available for duct connection.

5. Finish: Standard finish shall be #26 white.
   a. The standard finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes.
   b. The pencil hardness must be HB to H.
   c. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film.
   d. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

6. Provide molded insulation blanket. The insulation will be R-6, foil-backed, and provide an additional 1-inch gap around the neck to install insulated flex duct.

B. Aluminum Supply Air Grille:

1. The manufacturer shall provide published performance data for the diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-2006. Subject to compliance with requirements, provide Titus 301-FL as basis of design or comparable product by one of the following:

   a. Price Industries

   b. Krueger.

   c. USAIRE/METALAIRE – a Division on Metal Industries Inc.

   d. Tuttle and Bailey.

2. Face: Aluminum supply grilles shall be single deflection and of the sizes and mounting types shown on the Plans and Air Device Schedule. The deflection blades shall be available parallel to the long dimension of the grille. Construction shall be of aluminum with a 1¼-inch wide border on all sides. Sizes 24 x 24 inches and below shall have roll-formed borders with a minimum thickness of 0.032 inch. Screw holes shall be countersunk for a neat appearance.

3. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall on ¾-inch centers. Plastic blade pivots are not acceptable.

4. Provide opposed blade volume damper and shall be constructed of aluminum. Damper must be operable from the face of the grille.

5. The grille finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315° F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a

100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

C. Aluminum Return Air Grille:

1. The manufacturer shall provide published performance data for the diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-2006. Subject to compliance with requirements, provide Titus 350-FL as basis of design or comparable product by one of the following:

   a. Price Industries

   b. Krueger.

   c. USAIRE/METALAIRE – a Division on Metal Industries Inc.

   d. Tuttle and Bailey.

2. Face: Aluminum supply grilles shall be of the sizes and mounting types shown on the Plans and Air Device Schedule. The deflection blades shall be available parallel to the long dimension of the grille. Construction shall be of aluminum with a 1¼-inch wide border on all sides. Sizes 24 x 24 inches and below shall have roll-formed borders with a minimum thickness of 0.032 inch. Screw holes shall be countersunk for a neat appearance.

3. Deflection blades shall be contoured to a specifically designed and tested cross-section to meet published test performance data. Blades shall be available at 35°. Plastic blade pivots are not acceptable.

4. Provide opposed blade volume damper and shall be constructed of aluminum. Damper must be operable from the face of the grille.

5. The grille finish shall be #26 white. The finish shall be an anodic acrylic paint, baked at 315° F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

2.2 CEILING LINEAR SLOT DIFFUSERS

A. Modulinear Slot Supply Air Diffuser:

1. The manufacturer shall provide published performance data for the diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-2006. Subject to compliance with requirements, provide Titus ML Series as basis of design or comparable product by one of the following:

   a. Price Industries

   b. Krueger.

   c. USAIRE/METALAIRE – a Division on Metal Industries Inc.

   d. Tuttle and Bailey.

2. Modulinear diffusers shall be ¾-inch slot spacing of the sizes and mounting types shown on the Plans and Air Device Schedule.

3. All alignment components to be provided by the manufacturer.

4. The frame and support bars shall be constructed of heavy gauge extruded aluminum. The pattern controller shall be an aerodynamically curved “ice-tong” shaped steel deflector capable of 180° pattern adjustment from the face of the diffuser and shall allow dampering if required. Maximum pattern controller length shall be 3 feet, for diffusers longer than 3 feet pattern controllers shall be furnished in multiple sections.

5. The finish shall be #26 white on the face and #84 black on the pattern controllers. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

6. Heavy gauge extruded aluminum end borders, end caps and mitered corners shall be available to close off the ends of the diffusers. Plenums shall be manufactured by the same manufacturer of the linear slot diffusers.

B. Modulinear Slot Return Air Diffuser:

1. The manufacturer shall provide published performance data for the diffuser. The diffuser shall be tested in accordance with ANSI/ASHRAE Standard 70-2006. Subject to compliance with requirements, provide Titus MLR Series as basis of design or comparable product by one of the following:

   a. Price Industries

   b. Krueger.

   c. USAIRE/METALAIRE – a Division on Metal Industries Inc.

   d. Tuttle and Bailey.

2. Modulinear diffusers shall be ¾-inch or 1-inch slot spacing of the sizes and mounting types shown on the Plans and Air Device Schedule.

3. All alignment components to be provided by the manufacturer.

4. The frame and support bars shall be constructed of heavy gauge extruded aluminum. The pattern controller shall be an aerodynamically curved “ice-tong” shaped steel deflector capable of 180° pattern adjustment from the face of the diffuser and shall allow dampering if required. Maximum pattern controller length shall be 3 feet, for diffusers longer than 3 feet pattern controllers shall be furnished in multiple sections.

5. The finish shall be #26 white on the face and #84 black on the pattern controllers. The finish shall be an anodic acrylic paint, baked at 315°F for 30 minutes. The pencil hardness must be HB to H. The paint must pass a 100-hour ASTM B117 Corrosive Environments Salt Spray Test without creepage, blistering or deterioration of film. The paint must pass a 250-hour ASTM D870 Water Immersion Test. The paint must also pass the ASTM D2794 Reverse Impact Cracking Test with a 50-inch pound force applied.

6. Heavy gauge extruded aluminum end borders, end caps and mitered corners shall be available to close off the ends of the diffusers. Plenums shall be manufactured by the same manufacturer of the linear slot diffusers.

2.3 SOURCE QUALITY CONTROL

A. Verification of Performance: Rate diffusers, registers, and grilles according to ASHRAE 70, "Method of Testing for Rating the Performance of Air Outlets and Inlets."

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

A. Install diffusers, registers, and grilles level and plumb.

B. Ceiling-Mounted Outlets and Inlets: Drawings indicate general arrangement of ducts, fittings, and accessories. Air outlet and inlet locations have been indicated to achieve design requirements for air volume, noise criteria, airflow pattern, throw, and pressure drop. Make final locations where indicated, as much as practical. For units installed in lay-in ceiling panels, locate units in the center of panel. Where architectural features or other items conflict with installation, notify Architect for a determination of final location.

C. Install diffusers, registers, and grilles with airtight connections to ducts and to allow service and maintenance of dampers, air extractors, and fire dampers.

3.3 ADJUSTING

A. After installation, adjust diffusers, registers, and grilles to air patterns indicated, or as directed, before starting air balancing.

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SECTION 23 74 33
DEDICATED OUTDOOR AIR HANDLING UNITS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes split system dedicated outside air handling units capable of supplying up to 100 percent outdoor air and providing heating and cooling with the following components and accessories:

1. Energy Recovery Wheel.

1.3 ACTION SUBMITTALS

A. Product Data: Include manufacturer's technical data for each DOAU, 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.

1. Wiring Diagrams: Power, signal, and control wiring.

1.4 INFORMATIONAL SUBMITTALS

A. 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:

1. Structural members to which RTUs will be attached.

B. Field quality-control test reports.

C. Warranty: Special warranty specified in this Section.

1.5 CLOSEOUT SUBMITTALS

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

1.6 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. Filters: One sets of filters for each unit at time of balancing.

2. Filters: One set of filters for each unit at the time of substantial completion.

1.7 QUALITY ASSURANCE

A. ARI Compliance:

1. Comply with ARI 210/240 and ARI 340/360 for testing and rating energy efficiencies for DOAUs.

2. Comply with ARI 270 for testing and rating sound performance for DOAUs.

B. ASHRAE Compliance:

1. Comply with ASHRAE 15 for refrigeration system safety.

2. Comply with ASHRAE 33 for methods of testing cooling and heating coils.

3. Comply with applicable requirements in ASHRAE 62.1

C. ASHRAE/IESNA 90.1 Compliance: Applicable requirements in ASHRAE/IESNA 90.1

D. NFPA Compliance: Comply with NFPA 90A and NFPA 90B.

E. UL Compliance: Unit shall be certified in accordance with UL Standard 1995/CSA C22.2 No. 236, Safety Standard for Heating and Cooling Equipment.

F. ETL Compliance: Unit shall be safety certified by ETL and be ETL US listed. Unit nameplate shall include the ETL label.

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.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to replace components of DOAUs that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Compressors: Manufacturer's standard, but not less than five years from date of Substantial Completion.

2. Warranty Period for Control Boards: Manufacturer's standard, but not less than three years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 INDOOR DEDICATED OUTDOOR AIR UNITS

A. Provide and install indoor dedicated outdoor air units as shown and scheduled on the plans. The units shall be installed in a neat and workmanship like manner in strict accordance with specifications. Air handling units shall be AAON Series H3, Trane, Daikin, York, or Carrier. Provide components as detailed on the contract drawings.

B. General

1. Indoor air handling units shall include filters, supply fans, and the following:

a. DX Evaporator Coil

b. Hot Gas Reheat Coil

c. Electric Heat Coil

d. Exhaust fans & Energy Recovery Wheel

e. Unit Controls

2. Unit shall have a draw-through supply fan configuration and discharge air horizontally.

3. Unit shall be shipped in three sections and factory tested including leak testing of the coils and run testing of the supply fans and factory wired system. Run test report shall be supplied with the unit in the control compartment’s literature packet, and available electronically after the unit ships.

4. Unit shall have decals and tags to indicate lifting and rigging, service areas and caution areas for safety and to assist service personnel.

5. Unit components shall be labeled, including pipe stub outs, refrigeration system components and electrical and controls components.

6. Installation, Operation and Maintenance manual shall be supplied within the unit.

7. Laminated color-coded wiring diagram shall match factory installed wiring and shall be affixed to the interior of the control compartment's hinged access door

8. Unit nameplate shall be provided in two locations on the unit, affixed to the exterior of the unit and affixed to the interior of the control compartment's hinged access door.

C. Construction

1. All cabinet walls, access doors, and roof shall be fabricated of double wall, impact resistant, rigid polyurethane foam panels.

2. Unit insulation shall have a minimum thermal resistance R-value of 6.25. Foam insulation shall have a minimum density of 2 pounds/cubic foot and shall be tested in accordance with ASTM D1929-11 for a minimum flash ignition temperature of 610°F.

3. Unit construction shall be double wall with G90 galvanized steel on both sides and a thermal break. Double wall construction with a thermal break prevents moisture accumulation on the insulation, provides a cleanable interior, reduces heat transfer through the panel and prevents exterior condensation on the panel.

4. Unit shall be designed to reduce air leakage and infiltration through the cabinet. Sealing shall be included between panels and between access doors and openings to reduce air leakage. Piping and electrical conduit through cabinet panels shall include sealing to reduce air leakage.

5. Access doors shall be flush mounted to cabinetry.

6. Units shall include double-sloped 304 stainless steel drain pan. Drain pan connection shall be on the right-hand side of unit with a 1" MPT fitting.

7. Cooling coil shall be mechanically supported above the drain pan by multiple supports that allow drain pan cleaning and coil removal.

8. Unit shall include factory wired control panel compartment LED service lights.

D. Electrical

1. Unit shall be provided with an external control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. Both side walls of the control panel shall include louvered vents. Control panel shall be field mounted and shall include a piano hinged service access door with tooled entry.

2. Unit shall be provided with standard power block for connecting power to the unit.

3. Unit shall include a factory installed 24V control circuit transformer.

4. Unit shall have a 5kAIC SCCR.

5. Unit shall include high and low voltage quick connects for easy wiring at installation.

6. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage or on phase reversal.

7. Unit shall be provided with remote safety shutdown terminals for wiring to a field installed smoke detector, fire stat, or building safety automatic shutdown system.

8. DO NOT supply a factory non-fused disconnect. Disconnect is covered under Division 26 and will install a fused disconnect for the unit

E. Supply Fans

1. Unit shall include direct drive, unhoused, backward curved, plenum supply fans.

2. Blower and motor assembly shall be dynamically balanced.
3. Motor shall be an IE5 efficiency permanent magnet totally enclosed motor.
4. Blower and motor assembly shall utilize neoprene gasket.
5. ECM driven supply fan speed shall be controlled with the factory installed AAON controller.
6. Access to supply fan shall be through an access door with removable pin hinges and lockable quarter turn handles.

F. Exhaust Fans

1. Unit shall include direct drive, unhoused, backward curved, plenum exhaust fans.
2. Blower and motor assembly shall be dynamically balanced.
3. Motor shall be a high efficiency electronically commutated motor (ECM).
4. Blower and motor assembly shall utilize neoprene gasket.
5. Access to exhaust fan shall be through piano hinged access door with handle and prop rods. The access door shall be secured shut with two bolts that must be removed.
6. ECM driven exhaust fan speed shall be controlled with the factory installed controller.
7. Access to exhaust fan shall be through piano hinged access door with handle and prop rods. The access door shall be secured shut with two bolts that must be removed.

G. Cooling Coil

1. Access to cooling coil shall be through hinged access door with lockable quarter turn handles.
2. Access to reheat coil shall be through hinged access door with lockable quarter turn handles.

H. Evaporator Coil

1. Coil shall be designed for use with R-410A refrigerant and constructed of copper tubes with aluminum fins mechanically bonded to the tubes and aluminum end casings. Fin design shall be sine wave rippled.
2. Coil shall be high capacity and minimum 12 fins per inch.
3. Coil shall be hydrogen leak tested.
4. Coil shall be furnished with factory installed thermostatic expansion valves. The sensing bulbs shall be field installed on the suction line immediately outside the cabinet.
5. Coil shall have right hand external piping connections. Liquid and suction connections shall be sweat connection. Coil connections shall be labeled, extend beyond the unit casing, and be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.

I. Refrigeration System

1. Air handling unit and matching condensing unit shall be capable of operation as an R-410A split system air conditioner.
2. Each refrigeration circuit shall be equipped with thermostatic expansion valve type refrigerant flow control.
3. Modulating hot gas reheat shall be provided on the refrigeration circuit. Air handling unit shall be provided with hot gas reheat coil, a check valve on the liquid line, and a check valve on the hot gas reheat line. The matching condensing unit must include modulating 3-way reheat valve, liquid line receiver, electronic controller, supply air temperature

sensor and a dehumidification control signal terminal. This allows the system to have a dehumidification mode of operation and includes supply air temperature control to prevent supply air temperature swings and overcooling of the space. Reheat line connections shall be labeled, extend beyond the unit casing, and be located near the suction and liquid line connections for ease of field connection. Connections shall be factory sealed on both the interior and exterior of the unit casing to minimize air leakage.

J. Filters

1. Unit filter access shall be through service access door with piano hinges and quarter turn button fasteners.
2. Filters shall include 4-inch thick, MERV-13 final, upstream of the cooling coil. Unit shall also include 2-inch thick, MERV-9 pre, upstream of the 4-inch filters. Unit manufacturer may provide alternate MERV rating filters during shipment, however MERV-13 & MERV-9 shall be installed at start-up.
3. Magnehelic, differential pressure gages shall be factory installed and flush mounted on drive side to measure the pressure drop across the prefilter and high efficiency filters. A gauge shall be provided for each filter type.
4. Provide one additional set of filter media for each air handling unit to be delivered to the Owner's representative upon completion of the project.

K. Energy Recovery

1. Unit shall contain an energy recovery cabinet with back outside air and exhaust air opening, access side return air opening, and front supply air opening.
2. Unit shall contain a factory mounted and tested energy recovery wheel. The energy recovery wheel shall be mounted in a rigid frame containing the wheel drive motor, drive belt, wheel seals and bearings.
3. Wheel frame shall slide out for service and removal from the cabinet.
4. The energy recovery component shall incorporate a rotary wheel in an insulated cassette frame complete with seals, drive motor and drive belt.
5. Wheels shall be wound continuously with one flat and one structured layer in an ideal parallel plate geometry providing laminar flow. The layers shall be effectively captured in stainless steel wheel frames or aluminum and stainless-steel segment frames that provide a rigid and self-supporting matrix.
6. Wheels shall be provided with removable energy transfer matrix. Wheel frame construction shall be a welded hub, spoke and rim assembly of stainless, plated and/or coated steel and shall be self-supporting without matrix segments in place. Segments shall be removable without the use of tools to facilitate maintenance and cleaning. Wheel bearings shall be selected to provide an L-10 life more than 400,000 hours. Rim shall be continuous rolled stainless steel and the wheel shall be connected to the shaft by means of taper locks.
7. All diameter and perimeter seals shall be provided as part of the cassette assembly and shall be factory set. Drive belts of stretch urethane shall be provided for wheel rim drive without the need for external tensioners or adjustment.
8. The energy recovery cassette shall be an Underwriters Laboratories Recognized Component for electrical and fire safety. The wheel drive motor shall be an Underwriters Laboratory Recognized Component and shall be mounted in the cassette frame and supplied with a service connector or junction box. Thermal performance shall be certified by the manufacturer in accordance with ASHRAE Standard 84, Method of Testing Air-to-Air Heat Exchangers and AHRI Standard 1060, Rating Air-to-Air Energy Recovery Ventilation Equipment. Cassettes shall be listed in the AHRI Certified Products.

9. Energy recovery wheel cassette shall carry a 5-year non-prorated warranty, from the date of original equipment shipment from the factory. The first 12 months from the date of equipment startup, or 18 months from the date of original equipment shipment from the factory, whichever is less, shall be covered under the standard manufacturer limited parts warranty. The remaining period of the warranty shall be covered by the energy recovery wheel manufacturer. The 5-year warranty applies to all parts and components of the cassette, except for the motor, which shall carry an 18-month warranty. Warranty shall cover material and workmanship that prove defective, within the specified warranty period, written instructions for installation, operation and maintenance have been followed. Warranty excludes parts associated with routine maintenance, such as belts.
10. Final installed filters, after balancing shall be 2-inch thick, MERV-9, upstream of the wheels.
11. Total energy recovery wheels shall be coated with silica gel desiccant permanently bonded by a process without the use of binders or adhesives, which may degrade desiccant performance. The substrate shall be lightweight polymer and shall not degrade nor require additional coatings for application in marine or coastal environments. Coated segments shall be washable with detergent or alkaline coil cleaner and water. Desiccant shall not dissolve nor deliquesce in the presence of water or high humidity.
12. Unit shall include energy recovery wheel rotation detection sensors and a set of normally open and normally closed contracts for field indication of wheel rotation.
13. Unit shall include energy recovery wheel defrost control to periodically stop the wheel rotation, which allows the warm exhaust air to defrost the wheel.
14. Access to energy recovery wheel and exhaust fan shall be through hinged access door with handle and prop rods. The access door is secured shut with two bolts that must be removed. To access the outside air filters, the triangular sheet metal panel under the energy recovery wheel must first be removed by removing the two bolts. The outside air filters can then be accessed through interlocking sheet metal cover with quarter turn button fasteners. Access to return air filters shall be through removable interlocking sheet metal cover with quarter turn button fasteners on the top and side.

L. Controls

1. Unit shall be provided with a proof of airflow switch. When airflow is not detected, the supply fans will shut down.
2. Unit shall be provided with an external control panel with separate low voltage control wiring with conduit and high voltage power wiring with conduit between the control panel and the unit. Control panel shall be field mounted.
3. Access to external control panel shall be through hinged access door with tooled entry.
4. Factory Installed and Factory Provided Controller
5. Unit controller shall be capable of controlling all features and options of the unit. Controller shall be factory installed in the unit controls compartment and factory tested.
6. Controller shall be capable of standalone operation with unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling available without dependence on a building management system.
7. Controller shall have an onboard clock and calendar functions that allow for occupancy scheduling.
8. Controller shall include non-volatile memory to retain all programmed values without the use of a battery, in the event of a power failure.

M. Make Up Air Controller

1. Unit shall modulate cooling with constant airflow to meet ventilation outside air loads. Cooling capacity shall modulate based on supply air temperature.
2. Hot gas bypass shall be required on the lead refrigeration circuits of systems without variable capacity compressors.
3. Unit shall modulate heating with constant airflow to meet ventilation outside air loads. Heating capacity shall modulate based on supply air temperature.
4. Unit configuration, setpoint adjustment, sensor status viewing, unit alarm viewing, and occupancy scheduling shall be accomplished with connection to interface module with LCD screen and input keypad, interface module with touch screen, or with connection to PC with free configuration software. Controller shall be capable of connection with other factory installed and factory provided unit controllers with individual unit configuration, setpoint adjustment, sensor status viewing, and occupancy scheduling available from a single unit. Connection between unit controllers shall be with a modular cable. Controller shall be capable of communicating and integrating with BACnet network.

N. Access Sections and Access Doors

1. Fully insulated, access sections shall be provided as indicated on the drawings. Sections provide a minimum of 18-inch accessible space with full-size access doors. Access for inspection and cleaning of the unit drain pan, coils, and fans sections shall be provided.
2. Access doors shall be provided in all sections as indicated on the drawings. Access doors shall be of double wall construction.
3. Panels shall be fully removable to allow for a proper way to thoroughly clean panels of microbial growth and to access internal parts.

O. Fan-Section Source Quality Control: the following factory tests are required.

1. Sound Power Level Ratings: Comply with AMCA 301, *Methods for Calculating Fan Sound Ratings from Laboratory Test Data*. Test fans according to AMCA 300, *Reverberant Room Method for Sound Testing of Fans*. Fans shall bear AMCA-certified sound ratings seal.
2. Factory test fan performance for flow rate, pressure, power, air density, rotation speed, and efficiency. Establish ratings according to AMCA 210, *Laboratory methods of Testing Fans for Rating.*

2.2 AIR COOLED CONDENSING UNITS (COMMERCIAL UNITS)

A. General

1. Furnish and install air cooled condensing units of the size, capacity, arrangement, and electrical characteristics as shown on the contract drawings and matched to the air handling coil associated with. Condensing units shall be AAON Model CFA, Trane, Daikin, York, or Carrier.
2. Outdoor-mounted, air-cooled, split-system air conditioner unit suitable for ground installation. Unit consists of a scroll compressor, an air-cooled coil, propeller-type condenser fan, and a control box. Unit shall discharge supply air upward as shown on contract drawings. Unit shall be used in a refrigeration circuit to match up to a direct expansion air handling unit.
3. Unit shall be rated in accordance with the latest edition of ARI Standard 210 and 270. Unit shall be certified for capacity, efficiency, and sound and listed in the latest ARI directory. Unit construction shall comply with latest edition of ANSI/ASHRAE and with NEC. Unit shall be constructed in accordance with UL standards and shall carry the UL label of approval. Unit shall have c-UL

approval. Unit cabinet shall be capable of withstanding Federal Test Method Standard No. 141 (Method 6061) 500-hr salt spray test. Air-cooled condenser coils shall be leak tested at 150 psig and pressure tested at 300 psig. Unit constructed in IS09002 approved facility.

4. Unit shall be shipped as single package only and is stored and handled per unit manufacturer's recommendations.

5. Compressor shall be covered by a five-year limited warranty. Complete unit shall be covered by a two-year limited parts warranty.

B. Construction

1. Unit shall be completely factory assembled, piped, and wired and shipped in one section.

2. All cabinet walls, access doors, and roof shall be fabricated of G90 galvanized steel panels.

3. Unit shall be specifically designed for outdoor application.

4. Access to compressors and control components shall be through hinged access doors with quarter turn, lockable handles.

5. Exterior paint finish shall be capable of withstanding at least 2,500 hours, with no visible corrosive effects, when tested in a salt spray and fog atmosphere in accordance with ASTM B 117-95 test procedure.

6. Unit shall include forklift slots.

C. Electrical

1. Unit shall be provided with standard power block for connecting power to the unit.

2. Control circuit transformer and wiring shall provide 24 VAC control voltage from the line voltage provided to the unit.

3. Unit shall have a 5kAIC SCCR.

4. Unit shall be provided with factory installed and factory wired 115V, 12-amp GFI outlet in the unit control panel.

5. Unit shall be provided with phase and brown out protection which shuts down all motors in the unit if the electrical phases are more than 10% out of balance on voltage, the voltage is more than 10% under design voltage, or on phase reversal.

6. DO NOT supply a factory non-fused disconnect. Disconnect is covered under Division 26 and will install a fused disconnect for the unit.

D. Refrigeration System

1. Unit shall be provided with one independently circuited R-410A variable capacity scroll compressor with thermal overload protection. Variable capacity scroll compressor shall be capable of modulation from 10-100% of its capacity.

2. Each compressor shall be furnished with a crankcase heater.

3. Compressors shall be mounted in an isolated service compartment which can be accessed without affecting unit operation. Lockable hinged access doors shall provide access to the compressors.

4. Compressors shall be isolated from the base pan with the compressor manufacturer’s recommended rubber vibration isolators, to reduce any transmission of noise from the compressors into the building area.

5. Each refrigeration circuit shall be equipped with automatic reset low pressure and manual reset high pressure refrigerant safety controls, Schrader type service fittings on both the high pressure and low pressure sides, and service valves for liquid and suction connections. Liquid line filter driers shall be factory provided and installed. Field installed refrigerant circuits shall include the low side cooling components, refrigerant, thermal expansion valve, liquid line, insulated hot gas reheat line, and insulated suction line.

6. Unit shall include a factory holding charge of R-410A refrigerant and oil. Adjusting the charge of the system will be required during installation.

7. The factory installed controls shall include a 3 minute off delay timer to prevent compressor short cycling. The controls shall also include an adjustable, 20 second delay timer for each additional capacity stage to prevent multiple capacity stages from starting simultaneously and adjustable compressor lock out.

8. Condensing unit shall be provided with adjustable compressor lockout.

9. Units shall be provided with a suction pressure transducer on the refrigeration circuit.

E. Fans

1. Condenser fan shall be horizontal discharge, axial flow, direct drive fans.

2. Condensing unit shall be provided with an electrically commutated motor (ECM) condenser fan, condenser head pressure controller, and discharge pressure transducers for modulating head pressure control to allow cooling operation down to 35°F. Fan motor shall be weather protected, single phase, direct drive, and totally enclosed air over (TEAO) with electronic protection.

F. Coils

1. Coils shall be designed for use with R-410A refrigerant. Coils shall be multi-pass and fabricated from aluminum microchannel tubes.

2. Coils shall be designed for a minimum of 10°F of refrigerant sub-cooling.

3. Coils shall be hydrogen leak tested.

G. Controls

1. Unit shall be provided with factory supplied and factory installed controller in the matching air handling unit.

H. Accessories

1. The following factory furnished accessories shall be provided with each condensing unit.

2. Cycle Protector

Solid-state timing device which prevents compressor rapid recycling. Control provides an approximate 5-minute delay after power to the compressor has been interrupted for any reason, including normal room thermostat cycling.

3. Low Ambient Controller: Allows operation of unit at low ambient (10 degrees F) conditions.

4. Hot Gas Bypass: Furnish each condensing unit with a factory furnished hot gas bypass kit for field installation by the Contractor.

I. Field Wiring

Furnish and install all interconnecting control wiring between condenser, sensors and air handling unit to accomplish the specified sequence of operation. Furnish all required relays, wiring, and control transformers.

J. Provide the services of a factory, authorized service representative to provide start-up and to demonstrate and train the Owner's maintenance personnel.

K. Source Quality Control

1. Verification of Performance: Rate condensing units according to ARI 210/240.
2. Verification of Performance: Rate condensing unit according to ARI 340/360.
3. Coefficient of Performance: Equal to or greater than prescribed by ASHRAE 90.1, *Energy Efficient Design of New Buildings except Low-Rise Residential Buildings.*
4. Test and inspect shell and tube condensers according to ASME Boiler and Pressure Vessel Code; Section VIII, *Pressure Vessels*, Division 1.

L. Testing Requirements: Factory test sound-power-level ratings according to ARI 270.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine substrates, areas, and conditions, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance of DOAUs.

B. Examine roughing-in for DOAUs to verify actual locations of piping and duct connections before equipment installation.

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

3.2 INSTALLATION

A. Unit Support: Install unit level and plumb. DOAUs to structural support with anchor bolts.

3.3 CONNECTIONS

A. Install condensate drain, minimum connection size, with trap and indirect connection to nearest roof drain or area drain.

B. Duct installation requirements are specified in other HVAC Sections. Drawings indicate the general arrangement of ducts. The following are specific connection requirements:

1. Connect duct connections to DOAUs with flexible duct connectors specified in Section 23 33 00 "Air Duct Accessories."

3.4 FIELD QUALITY CONTROL

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

B. 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. Report results in writing.

C. Tests and Inspections:

1. After installing DOAUs and after electrical circuitry has been energized, test units for compliance with requirements.

2. Inspect for and remove shipping bolts, blocks, and tie-down straps.
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.

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

3.5 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 and do the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to heat transfer heating coils.
3. Inspect for visible damage to compressor, coils, and fans.
4. Inspect internal insulation.
5. Verify that labels are clearly visible.
6. Verify that clearances have been provided for servicing.
7. Verify that controls are connected and operable.
8. Verify that filters are installed.
9. Clean condenser coil and inspect for construction debris.
10. Clean heating coil and inspect for construction debris.
11. Remove packing from vibration isolators.
12. Inspect operation of barometric relief dampers.
13. Verify lubrication on fan and motor bearings.
14. Inspect fan-wheel rotation for movement in correct direction without vibration and binding.
15. Start unit according to manufacturer's written instructions.
    a. Start refrigeration system.
    b. Do not operate below recommended low-ambient temperature.
    c. Complete startup sheets and attach copy with Contractor's startup report.
16. Inspect and record performance of interlocks and protective devices; verify sequences.
17. Operate unit for an initial period as recommended or required by manufacturer.
18. Calibrate thermostats.
19. Adjust and inspect high-temperature limits.
20. Inspect outdoor-air dampers for proper stroke and interlock with return-air dampers.
21. Start refrigeration system and measure and record the following when ambient is a minimum of 15 deg F (8 deg C) above return-air temperature:
    a. Coil leaving-air, dry- and wet-bulb temperatures.
    b. Coil entering-air, dry- and wet-bulb temperatures.
    c. Outdoor-air, dry-bulb temperature.

d. Outdoor-air-coil, discharge-air, dry-bulb temperature.

22. Inspect controls for correct sequencing of heating, mixing dampers, refrigeration, and normal and emergency shutdown.

23. Measure and record the following minimum and maximum airflows. Plot fan volumes on fan curve.

    a. Supply-air volume.

    b. Return-air volume.

    c. Relief-air volume.

    d. Outdoor-air intake volume.

24. Simulate maximum cooling demand and inspect the following:

    a. Compressor refrigerant suction and hot-gas pressures.

    b. Short circuiting of air through condenser coil or from condenser fans to outdoor-air intake.

25. Verify operation of remote panel including failure modes. Inspect the following:

    a. Low-temperature safety operation.

    b. Filter high-pressure differential alarm.

    c. Economizer to minimum outdoor-air changeover.

    d. Relief-air fan operation.

    e. Smoke and firestat alarms.

26. After startup and performance testing and prior to Substantial Completion, replace existing filters with new filters.

3.6 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 DOAU and air-distribution systems, clean filter housings and install new filters.

3.7 DEMONSTRATION

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

END OF SECTION

SECTION 23 81 26
DUCTLESS SPLIT-SYSTEM AIR-CONDITIONERS

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 split-system air-conditioning and heat-pump units consisting of separate evaporator-fan and compressor-condenser components.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. Include performance data in terms of capacities, outlet velocities, static pressures, sound power characteristics, motor requirements, and electrical characteristics.

B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

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

C. Samples for Initial Selection: For units with factory-applied color finishes.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranty: Sample of special warranty.

1.5 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For split-system air-conditioning units to include in emergency, operation, and maintenance manuals.

1.6 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. Filters: Two set(s) for each air-handling unit.

1.7 QUALITY ASSURANCE

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

B. ASHRAE Compliance:

1. Fabricate and label refrigeration system to comply with ASHRAE 15

2. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1.

1.8 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork are specified in Section 033000 "Cast-in-Place Concrete."

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

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of split-system air-conditioning units that fail in materials or workmanship within specified warranty period.

1. Warranty Period:

a. For Compressor: Seven year(s) from date of Substantial Completion.

b. For Parts: Five year(s) from date of Substantial Completion.

c. For Labor: Five year(s) from date of Substantial Completion.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Mitsubishi Electric & Electronics USA, Inc.; HVAC Advanced Products Division.

2. Daikin.

3. LG.

2.2 INDOOR UNITS (5 TONS (18 kW) OR LESS)

A. Wall-Mounted, Evaporator-Fan Components:

1. Cabinet: Enameled steel with removable panels on front and ends in color selected by Architect, and discharge drain pans with drain connection.

2. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and thermal-expansion valve. Comply with ARI 210/240.

3. Electric Coil: Helical, nickel-chrome, resistance-wire heating elements; with refractory ceramic support bushings, automatic-reset thermal cutout, built-in magnetic contactors, manual-reset thermal cutout, airflow proving device, and one-time fuses in terminal box for overcurrent protection.

4. Fan: Direct drive, centrifugal.

5. Fan Motors:

a. Comply with NEMA designation, temperature rating, service factor, enclosure type, and efficiency requirements specified in Section 23 05 13 "Common Motor Requirements for HVAC Equipment."

b. Multi-tapped, multispeed with internal thermal protection and permanent lubrication.

c. Enclosure Type: Totally enclosed, fan cooled.

d. NEMA Premium (TM) efficient motors as defined in NEMA MG 1.

e. Controllers, Electrical Devices, and Wiring: Comply with requirements for electrical devices and connections specified in electrical Sections.

f. Mount unit-mounted disconnect switches on exterior of unit.

6. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.

7. Condensate Drain Pans:

a. Fabricated with one percent slope in at least two planes to collect condensate from cooling coils (including coil piping connections, coil headers, and return bends) and humidifiers, and to direct water toward drain connection.

1) Length: Extend drain pan downstream from leaving face to comply with ASHRAE 62.1.

2) Depth: A minimum of 1 inch (25 mm) deep.

b. Single-wall, plastic, galvanized, or stainless-steel sheet.

c. Drain Connection: Located at lowest point of pan and sized to prevent overflow. Terminate with threaded nipple on both ends of pan.

1) Minimum Connection Size: NPS 1 (DN 25).

d. Pan-Top Surface Coating: Asphaltic waterproofing compound.

8. Air Filtration Section:

a. General Requirements for Air Filtration Section:

1) Comply with NFPA 90A.

2) Minimum Arrestance: According to ASHRAE 52.1 and MERV according to ASHRAE 52.2.

3) Filter-Holding Frames: Arranged for flat or angular orientation, with access doors on both sides of unit. Filters shall be removable from one side or lifted out from access plenum.

b. Disposable Panel Filters:

1) Factory-fabricated, viscous-coated, flat-panel type.

2) Thickness: 1 inch (25 mm).

2.3 OUTDOOR UNITS (5 TONS (18 kW) OR LESS)

A. Air-Cooled, Compressor-Condenser Components:

1. Casing: Steel, finished with baked enamel in color selected by Architect, with removable panels for access to controls, weep holes for water drainage, and mounting holes in base. Provide brass service valves, fittings, and gage ports on exterior of casing.

2. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation device. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contactor.

a. Compressor Type: Scroll.

b. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

c. Refrigerant Charge: R-410A.

d. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins and liquid sub-cooler. Comply with ARI 210/240.

3. Heat-Pump Components: Reversing valve and low-temperature-air cutoff thermostat.

4. Fan: Aluminum-propeller type, directly connected to motor.

5. Motor: Permanently lubricated, with integral thermal-overload protection.

6. Low Ambient Kit: Permits operation down to 0 deg F.

7. Mounting Base: Polyethylene.

8. Wind Baffle: Required.

2.4 ACCESSORIES

A. Control equipment and sequence of operation are specified in Section 230900 "Instrumentation and Control for HVAC" and Section 230993 "Sequence and Operations for HVAC Controls."

B. Thermostat: Microprocessor based wall-mounted low voltage with subbase and LCD display to control compressor and evaporator fan.

C. Integral Condensate Pump with integral check valve rated for a minimum of 10 feet of lift.

PART 3 EXECUTION

3.1 INSTALLATION

A. Install units level and plumb.

B. Install evaporator-fan components using manufacturer's standard mounting devices securely fastened to building structure.

C. Install roof-mounted, compressor-condenser components on equipment supports. Anchor units to supports with removable, cadmium-plated fasteners.

D. Install and connect pre-charged refrigerant tubing to component's quick-connect fittings. Install tubing to allow access to unit.

3.2 FIELD QUALITY CONTROL

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

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

2. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

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

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

E. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Engage a factory-authorized service representative to perform startup service.

1. Complete installation and startup checks according to manufacturer's written instructions.

3.4 DEMONSTRATION

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

END OF SECTION

SECTION 23 81 46
DIRECT EXPANSION SPLIT SYSTEM HEAT PUMPS (DUCTED)

PART 1 - GENERAL

1.1. RELATED DOCUMENTS

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

1.2. SUMMARY

A. This Section includes Direct Expansion ducted split system Heat Pumps.

1.3. DEFINITIONS

A. *EER*: Cooling full load energy efficiency ratio.

B. *IEER*: Cooling integrated (part load) energy efficiency ratio.

C. *High Temperature COP*: Heating coefficient of performance at 42°F.

1.4. SUBMITTALS

A. Product Data: Include manufacturer's technical data for each model indicated, including rated capacities of selected model clearly indicated; dimensions; required clearances; shipping, installed, and operating weights; furnished specialties; accessories; and installation and startup instructions:

B. Product data for Heat Pump units specified, including the following:

1. Dimension and plans and elevation drawings including field piping, required clearances.
2. Certified fan-sound power ratings.
3. Certified coil-performance rating with system operating conditions indicated.
4. Motor ratings and electrical characteristics plus motor and fan accessories.
5. Filters with performance characteristics.
6. Outdoor air-cooled heat pump unit.
7. Summary of all auxiliary utility requirements such as electricity, refrigerant piping, and condensate piping.
8. Summary shall indicate quality and quantity of each required utility.
9. ARHI 1230 certification including EER, IEER, high temperature COP, low temperature COP, and SCHE.

C. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loadings, required clearances, method of field assembly, components, and location and size of each field connection. Detail mounting, securing, and flashing of roof curb to roof structure for roof mounted units. Detail mounting and securing to concrete pads for grade mounted systems. Indicate coordinating requirements with roof membrane system or concrete pads and vibration isolation.

1. Wiring Diagrams: Detail wiring for power, signal, and control systems and differentiate between manufacturer-installed and field-installed wiring.

D. Field Test Reports: Indicate results of manufacturer's startup and testing requirements. Submit copies of checklists.

E. Maintenance Data: For equipment to include in the maintenance manuals specified in Division 01.

F. Warranties Special warranties specified in this Section.

1.5. SYSTEM DESCRIPTION

A. Furnish and install where indicated, ducted split heat pump system. The system shall consist of indoor ducted units capable of either cooling or heating through direct expansion and outdoor air-cooled condensing units. The outdoor unit shall be direct expansion (DX), air-cooled heat pump, air-conditioning system with fixed speed and variable speed inverter driven compressors using R-410A refrigerant.

B. Operation of the system shall permit either cooling or heating to the group of indoor units associated with one branch. Provide all interlock wiring between system controllers and building automation system.

1.6. QUALITY ASSURANCE

A. All equipment and systems shall be tested and certified in accordance with AHRI 1230 and bear the AHRI certification seal.

B. Fabricate and label refrigeration system to comply with ASHRAE 15, *Safety Code for Mechanical Refrigeration.*

C. Listing and Labeling: Provide electrically operated components specified in this Section that are listed and labeled.

D. Comply with NFPA 70 for components and installation.

E. The units shall be tested by a Nationally Recognized Testing Laboratory (NRTL), in accordance with ANSI/UL 1995 – Heating and Cooling Equipment and bear the Listed Mark.

F. The system shall be factory tested for safety and function.

G. Coordination Coordinate layout and installation of indoor ducted units, outdoor units, refrigerant piping, and other appurtenances with piping and ductwork and with other installations.

1.7. DELIVERY, STORAGE, AND HANDLING

A. Deliver outdoor and indoor units as factory assembled units with protective crating and covering.

B. Coordinate delivery of units in sufficient time to allow movement into building or as indicated.

1.8. WARRANTY

A. General Warranty: The special warranty specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by the Contractor under requirements of the Contract Documents.

B. Special Warranty: A written warranty, executed by the manufacturer and signed by the Contractor, agreeing to replace components that fail in materials or workmanship, within the specified warranty period, provided manufacturer's written instructions for installation, operation, and maintenance have been followed.

1. Warranty Period: Compressors and Compressor Motor Contactors: Manufacturers standard, but not less than two (2) years after date of Substantial Completion.

PART 2 - PRODUCTS

2.1. MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include the following:

1. Basis of Design: Trane/Mitsubishi

2. LG

3. Daikin

B. All scheduled capacities and efficiencies must be met. Cost of any electrical piping, design, insulation, or other changes associated with other approved manufacturers shall be included in the bid and shall be the responsibility of the Contractor.

2.2. AIR-COOLED OUTDOOR UNITS (MULTIPLE ZONE)

A. The outdoor unit modules shall be air-cooled, direct expansion (DX), Trane/Mitsubishi Model NTX. The outdoor unit modules shall be equipped with a single compressor which is inverter-driven and multiple circuit boards of same manufacturer. Each outdoor unit module shall be completely factory assembled, piped, and wired and run tested at the factory.

1. Outdoor unit systems may be comprised of multiple modules with differing capacity if a brand other than basis of design is proposed. All units requiring a factory supplied twinning kits shall be piped together in the field, without the need for equalizing line(s). If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.

2. Outdoor units shall have 5 levels sound adjustment via dip switch selectable fan speed settings. If an alternate manufacturer is selected, any additional material, cost, and labor to meet published sound levels shall be incurred by the contractor.

3. Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.

4. The outdoor unit shall have an accumulator with refrigerant level sensors and controls. Units shall actively control liquid level in the accumulator via expansion valves from the heat exchanger.

5. The outdoor unit shall have a high-pressure safety switch, over-current protection, crankcase heater and DC bus protection.

6. Heat Pump system shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.

7. The outdoor unit shall be capable of operating in heating mode down to -25F ambient temperatures or cooling mode down to 23F ambient temperatures, without additional low ambient controls. If an alternate manufacturer is selected, any additional material, cost, and labor to meet low ambient operating condition and performance shall be incurred by the contractor.

8. The outdoor unit shall have a high efficiency oil separator plus additional logic controls to ensure adequate oil volume in the compressor is maintained. Oil return sequences must be enabled only during extended periods of reduced refrigerant flow to ensure no disruption to correct refrigerant flow to individual zones during peak loads. Systems which might engage oil return sequence based on hours of operation risk oil return during inopportune periods are not allowed. Systems which rely on sensors (which may fail) to engage oil return sequence are not allowed.

9. Unit must defrost all circuits simultaneously in order to resume full heating more quickly during extreme low ambient temperatures (below 23F). Partial defrost, also known as hot gas defrost which allows reduced heating output during defrost, is permissible only when ambient temperature is above 23F.

10. In reverse defrost all refrigerant shall be bypassed in the main branch controller and shall

not be sent out to the indoor units, systems that flow refrigerant through indoor units during reverse defrost shall not be allowed.

11. The outdoor unit shall be capable of operating in cooling mode down to -10°F with optional manufacturer supplied low ambient kit.
    i. Low ambient kit shall be provided with predesigned control box rated for outdoor installation and capable of controlling kit operation automatically in all outdoor unit operation modes.
    ii. Low ambient kit shall be listed by Electrical Laboratories (ETL) and bear the ETL label.
    iii. Low ambient kit shall be factory tested in low ambient temperature chamber to ensure operation. Factory performance testing data shall be available when requested.
12. The outdoor unit shall be provided with a manufacturer supplied 20-gauge hot dipped galvanized snow /hail guard. The snow/hail guard protects the outdoor coil surfaces from hail damage and snow build-up in severe climates.
13. Outdoor unit mounting systems shall be provided by manufacturer. Stand shall be made from 7-gauge plate steel with thermally fused polyester powder coat finish that meets ASTM D3451-06 standards. Stands shall be provided with galvanized mounting hardware and meets all ASCE 7 overturning safety requirement.

B. Unit Cabinet

1. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
2. Outdoor unit components shall be coated with the Seacoast Protection Coating (Brine Spray – BS coating) to protect components from premature corrosion due to a seacoast environment. Coating shall be applied to components before original outdoor unit assembly to ensure manufacturer quality standards are not compromised.
3. The outdoor unit shall be tested in compliance with ISO9277 such that no unusual rust shall develop after 960 hours of salt spray testing.
4. Panels on the outdoor unit shall be scratch free at system startup. If a scratch occurs the salt spray protection is compromised, and the panel should be replaced immediately.

C. Fan

1. Each outdoor unit module shall be furnished with direct drive, variable speed propeller type fan(s) only. Fans shall be factory set for operation at 0 in. WG. external static pressure, but capable of normal operation with a maximum of 0.32 in. WG. external static pressure via dipswitch
2. All fan motors shall have inherent protection, have permanently lubricated bearings, and be completely variable speed.
3. All fans shall be provided with a raised guard to prevent contact with moving parts.

D. Refrigerant and Refrigerant Piping:

1. R410A refrigerant shall be required for systems.

2. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.

3. Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the equipment manufacturer and installed in accordance with manufacturer recommendations.

4. All refrigerant piping must be insulated with 1” closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.

5. Refrigerant line sizing shall be in accordance with manufacturer specifications. Future changes to indoor unit styles or sizes must be possible without resizing/replacing refrigerant piping to any other branch devices or indoor units.

E. Coil:

1. Outdoor Coil shall be constructed to provide equal airflow to all coil face surface are by means of a 4-sided coil.

2. Outdoor Coil shall be elevated at least 12” from the base on the unit to protect coil from freezing and snow build up in cold climates. Manufacturers in which their coil extends to within a few inches from the bottom of their cabinet frame shall provide an additional 12” of height to their stand or support structure to provide equal protection from elements as Mitsubishi Electric basis of design. Any additional support costs, equipment fencing, and tie downs required to meet this additional height shall be responsibility of Mechanical Contractor to provide.

3. The outdoor heat exchanger shall be of zinc coated aluminum construction with turbulating flat tube construction. The coil fins shall have a factory applied corrosion resistant finish. Uncoated aluminum coils/fins are not allowed.

4. The coil shall be protected with an integral metal guard.

5. Refrigerant flow from the outdoor unit shall be controlled by means of an inverter driven compressor.

6. Unit shall have prewired plugs for optional panel heaters to prevent any residual ice buildup from defrost. Panel heaters are recommended for operating environments where the ambient temperature is expected to stay below -1F for 72 hours.

7. Condenser coil shall have active hot gas circuit direct from compressor discharge on lowest coil face area to shed defrost condensate away from coil and protect from Ice formation after returning to standard heat pump operation. While in Heat Pump operation this lower section of the Outdoor Evaporator coil shall continually run hot gas from the compressor discharge to protect the coil from ice buildup and coil rupture. Manufacturers who do not have an active hot gas circuit in the lower section of the Outdoor coil to protect coil from freezing shall not be allowed to bid on project in markets where the outdoor unit will see temperatures below freezing.

F. Compressor:

1. Each outdoor unit module shall be equipped with only inverter driven scroll hermetic compressors.

2. Each compressor shall be equipped with a multi-port discharge mechanism to eliminate over compression at part load. Manufacturer's that rely on a single compressor discharge port and provide no means of eliminating over compression and energy waste at part load shall not be allowed.

3. Crankcase heat shall be provided via induction-type heater utilizing eddy currents from motor windings. Energy-wasting type crankcase heaters are not allowed. Manufacturers that utilize belly-band crankcase heaters will be considered as alternate only.

4. Compressor shall have an inverter to modulate capacity. The capacity for each compressor shall be variable with a minimum turndown not greater than 15%.

5. The compressor shall be equipped with an internal thermal overload.

6. Field-installed oil equalization lines between modules are not allowed. Prior to bidding, manufacturers requiring equalization must submit oil line sizing calculations specific to each system and module placement for this project.

7. Manufacturers that utilize a compressor sump oil sensor to equalize compressor oil volume within a single module shall not be allowed unless they actively shut down the system to protect from compressor failure.

G. Controls:

1. Outdoor unit shall include a method of varying system evaporator (refrigerant) temperature to reduce compression ratio and power consumption during light load or mild ambient temperatures. Multiple evaporator refrigerant temperature settings shall be required to optimize efficiency within required system-specific performance and installation constraints. System shall reduce compression ratio only when/if all indoor units are within 1.8F of setpoint; reducing compression ratio based solely on ambient temperature risks discomfort and is not allowed. Variable Evaporator Temperature or comparable method shall incorporate override or disable capability based on external signal to allow for space humidity control or load demand.

2. The unit shall be an integral part of the system & control network and react to either a heating or a cooling demand as communicated from connected indoor units over the control circuit. Required field-installed control voltage transformers and/or signal boosters shall be provided by the manufacturer.

3. Each outdoor unit module shall have the capability of 4 levels of demand control based on external input.

H. Electrical:

1. The outdoor unit electrical power shall be per equipment schedule.

2. The outdoor unit shall be controlled by integral microprocessors.

3. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.

2.3. AIR-COOLED OUTDOOR UNITS (SINGLE ZONE)

A. The outdoor unit modules shall be air-cooled, direct expansion (DX), Trane/Mitsubishi Model TR(P)UY.

1. The PUY Series outdoor units are specifically designed to work with the wall mounted, ducted, 4-way cassette, ceiling suspended and multi-position air handler indoor units. The connected indoor unit shall be of the same capacity as the outdoor unit. The outdoor units must have a thermally fused powder coated finish. The outdoor unit shall be completely factory assembled, piped and wired. Each unit shall be run tested at the factory.
2. If an alternate manufacturer is selected, any additional material, cost, and labor to install additional lines shall be incurred by the contractor. Contractor responsible for ensuring alternative brand compatibility in terms of availability, physical dimensions, weight, electrical requirements, etc.
3. Outdoor unit shall have a sound rating no higher than published sound levels.
4. Refrigerant lines from the outdoor unit to the indoor units shall be insulated in accordance with the installation manual.
5. The outdoor unit shall meet performance requirements per schedule and be within piping limitations & acceptable ambient temperature ranges as described in respective manufacturers' published product catalogs. Non-published product capabilities or performance data are not acceptable.
6. Four-legged outdoor unit mounting systems shall be provided by manufacturer. Stand shall be made from 7-gauge plate steel with thermally fused polyester powder coat finish that meets ASTM D3451-06 standards. Stands shall be provided with galvanized mounting hardware and meets all ASCE 7 overturning safety requirement.

B. Unit Cabinet:

1. The casing shall be fabricated of galvanized steel, bonderized, finished with an electrostatically applied, thermally fused acrylic or polyester powder coating for corrosion protection. Assembly hardware shall be cadmium plated for weather resistance.
2. Easy access shall be afforded to all serviceable parts by means of removable panel sections.
3. Two (2) mild steel mounting feet, traverse mounted across the cabinet base pan, welded mount, providing four (4) slotted mounting holes shall be furnished. Assembly shall withstand lateral wind gust up to 155 MPH to meet applicable weather codes. The casing(s) shall be fabricated of galvanized steel, bonderized and finished.
4. Outdoor unit components shall be coated with the Seacoast Protection Coating (Brine Spray – BS coating) to protect components from premature corrosion due to a seacoast environment. Coating shall be applied to components before original outdoor unit assembly to ensure manufacturer quality standards are not compromised.
5. The outdoor unit shall be tested in compliance with JRA9002 such that no unusual rust shall develop after 960 hours of salt spray testing.
6. Panels on the outdoor unit shall be scratch free at system startup. If a scratch occurs the salt spray protection is compromised, and the panel should be replaced immediately.

C. Fan:

1. Unit shall be furnished with a single direct drive propeller type fan.
2. The outdoor unit fan motor(s) shall be a direct current (DC) motor and have permanently lubricated bearings.

3. The fan motor shall be mounted for quiet operation.
4. The fan shall be provided with a raised guard to prevent contact with moving parts.
5. The outdoor unit shall have horizontal discharge airflow.

D. Refrigerant and Refrigerant Piping

1. R410A refrigerant shall be required for systems.
2. Polyolester (POE) oil—widely available and used in conventional domestic systems—shall be required. Prior to bidding, manufacturers using alternate oil types shall submit material safety data sheets (MSDS) and comparison of hygroscopic properties for alternate oil with list of local suppliers stocking alternate oil for approval at least two weeks prior to bidding.
3. Refrigerant piping shall be phosphorus deoxidized copper (copper and copper alloy seamless pipes) of sufficient radial thickness as defined by the equipment manufacturer and installed in accordance with manufacturer recommendations.
4. All refrigerant piping must be insulated with 1” closed cell, CFC-free foam insulation with flame-Spread Index of less than 25 and a smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102. R value of insulation must be at least 3.
5. Refrigerant line sizing shall be in accordance with manufacturer specifications.

E. Coil:

1. The outdoor unit coil shall be of nonferrous construction with lanced or corrugated plate fins on copper tubing.
2. The coil shall be protected with an integral metal guard.
3. Refrigerant flow from the outdoor unit shall be regulated by means of an electronically controlled, precision, linear expansion valve.
4. All refrigerant lines between outdoor and indoor units shall be of annealed, refrigeration grade copper tubing, ARC Type, meeting ASTM B280 requirements, individually insulated in twin-tube, flexible, closed-cell, CFC-free (ozone depletion potential of zero), elastomeric material for the insulation of refrigerant pipes and tubes with thermal conductivity equal to or better than 0.27 BTU-inch/hour per Sq Ft / °F, a water vapor transmission equal to or better than 0.08 Perm-inch and superior fire ratings such that insulation will not contribute significantly to fire and up to 1” thick insulation shall have a Flame-Spread Index of less than 25 and a Smoke-development Index of less than 50 as tested by ASTM E 84 and CAN / ULC S-102.
5. All refrigerant connections between outdoor and indoor units shall be flare type.

F. Compressor:

1. The compressor shall be a high performance, hermetic, inverter driven, variable speed, dual rotary type manufactured by Mitsubishi Electric Corporation.
2. The compressor motor shall be direct current (DC) type equipped with a factory supplied and installed inverter drive package.
3. The compressor will be equipped with internal thermal overload protection.
4. To prevent liquid from accumulating in the compressor during the off cycle, a minimal amount of current shall be automatically, intermittently applied to the compressor motor windings to maintain sufficient heat to vaporize any refrigerant. No crankcase heater is to be used.
5. Filters, sight glasses, and traps shall not be used, and no additional refrigerant oil shall be required.

6. The compressor shall be mounted to avoid the transmission of vibration.
7. The outdoor unit shall have an accumulator and high-pressure safety switch.

G. Electrical:

1. The outdoor unit electrical power shall be per equipment schedule.
2. The outdoor unit shall be controlled by integral microprocessors.
3. The control circuit between the indoor units and the outdoor unit shall be 24VDC completed using a 2-conductor, twisted pair shielded cable to provide total integration of the system.
4. The outdoor unit shall be equipped with Pulse Amplitude Modulation (PAM) compressor inverter drive control for maximum efficiency with minimum power consumption.

2.4. MEDIUM STATIC INDOOR CEILING CONCEALED DUCTED HEAT PUMPS

A. General:

1. Trane/Mitsubishi Model TPEFY/TPEAD. The ceiling-concealed ducted indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in plenums in accordance with UL1995 ed 4.

B. Unit Cabinet:

1. The unit shall be ceiling-concealed, ducted—with a 2-position, field adjustable return and a fixed horizontal discharge supply.
2. The cabinet panel shall have provisions for a field installed filtered outside air intake.

C. Fan:

1. Indoor unit shall feature multiple external static pressure settings ranging from 0.14 to 0.60 in. WG.
2. The indoor unit fan shall be an assembly with statically and dynamically balanced Sirocco fan(s) direct driven by a single motor with permanently lubricated bearings.
3. The indoor fan shall consist of three (3) speeds, High, Mid, and Low plus the Auto-Fan function.

D. Filter:

1. Return air shall be filtered by means of a standard factory installed return air filter.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
2. The coils shall be pressure tested at the factory.
3. Coil shall be provided with a sloped drain pan. Units without sloped drain pans which must be installed cockeyed to ensure proper drainage are not allowed.
4. The unit shall be provided with an integral condensate lift mechanism able to raise drain water 27 inches above the condensate pan.

F. Electrical:

1. The unit electrical power shall be per equipment schedule.

G. Controls:

1. Indoor unit shall compensate for the higher temperature sensed by the return air sensor compared to the temperature at level of the occupant when in HEAT mode. Disabling of compensation shall be possible for individual units to accommodate instances when compensation is not required.
2. Control board shall include contacts for control of external heat source. External heat may be energized as second stage with 1.8°F – 9.0°F adjustable deadband from set point.
3. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
4. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.5. VERTICAL DUCTED (MULTI-POSITION AIR HANDLER)

A. General:

1. Trane/Mitsubishi Model TPVFY. The multi-position indoor unit shall be factory assembled, wired and run tested. Contained within the unit shall be all factory wiring, piping, electronic modulating linear expansion device, control circuit board and fan motor. The unit shall have a self-diagnostic function, 3-minute time delay mechanism, and an auto restart function. Indoor unit and refrigerant pipes shall be charged with dehydrated air before shipment from the factory. The unit shall be suitable for use in air handling spaces in accordance with Section 18.2 of UL 1995 4th Edition, be tested in accordance with ANSI/ASHRAE 193 and have less than 2% air leakage at maximum airflow setting.

B. Unit Cabinet:

1. The cabinet shall include a fixed bottom return, a fixed vertical discharge supply and be pre-painted, pre-insulated, 22 gauge galvanized steel.

C. Fan:

1. The indoor unit fan shall be an assembly with a single, statically and dynamically balanced direct drive fan with a high efficiency DC motor with permanently lubricated bearings.
2. The fan shall have 3-speeds with the capability to operate between 0.3-0.8 In.WG selectable.

D. Filter:

1. The unit shall have a 1” filter rack with a reusable filter.

E. Coil:

1. The indoor coil shall be of nonferrous construction with smooth plate fins on copper tubing. The tubing shall have inner grooves for high efficiency heat exchange. All tube joints shall be brazed with phos-copper or silver alloy.
2. The coils shall be pressure tested at the factory.

F. Electrical:

1. The unit electrical power shall be per equipment schedule.

G. Controls:

1. Control board shall include contacts for control of no less than two stages of external heat. The first stage of external heat may be energized when the space temperature is 2.7°F

from set point for between 10-25 minutes (user adjustable). The second stage of external heat may be energized when the first stage has been active for no less than 5 minutes and the space temperature has not risen by more than 0.9°F.

2. Indoor unit shall include no less than four (4) digital inputs capable of being used for customizable control strategies.
3. Indoor unit shall include no less than three (3) digital outputs capable of being used for customizable control strategies.

2.6. ISOLATION VALVES

A. Valves shall be compatible with R-410A and PVE (Polyvinyl Ether) oil.
B. Temperature operation range shall be between -40◦F to 300◦F.
C. Working pressure of 550 PSI, capable of handling up to 700 PSI.
D. Valves shall be full flow with zero pressure drop.
E. Valves shall be Bi-Directional flow.
F. Service port shall be in the valve body and not in the pipe.
G. Valves shall have brazed connections only, utilizing continuous Nitrogen purge.

PART 3 - EXECUTION

3.1. EXAMINATION

A. Examine space for compliance with requirements for conditions affecting installation and performance of swimming pool dehumidification units. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2. INSTALLATION

A. Mount indoor, outdoor units as detailed on contract drawings and according to manufacturer's written instructions.
B. Install all interlock and control wiring between indoor units, outdoor units, thermostats, and condensate pumps.
C. Supply initial charge of refrigerant and oil as required.
D. Install indoor ceiling ducted units on vibration isolators.
E. Install outdoor units on concrete pads as indicated on drawings.
F. Comb out fins on condensing unit where deformed or bent. Replace or repair broken fins.
G. For Concealed Ducted units: Provide external condensate pump shall be hard wired by Division 26.
H. Install system controller and interlock all indoor and outdoor units.
I. Install lockable caps on all outdoor unit refrigerant service valves to prevent tampering.

3.3. CONNECTIONS

A. Drawings indicate the general arrangement of piping, fittings, and specialties. The following are specific connection requirements:

1. High/low pressure gas line, liquid and suction lines must be individually insulated between the outdoor and indoor units.
2. Refrigerant Piping: conform to applicable requirements of Division 23 Section, *HVAC Pip-*

ing, Fittings, and Valves. Connect to supply and return coil tappings with shutoff valve and union or flange at each connection.

3. Install refrigerant piping, insulation, and control wiring as required by the manufacturer.
4. Install isolation valves on all three pipes between outdoor unit and branch selector boxes.
5. Install isolation valves on both pipes at every indoor units.

B. Electrical: Conform to applicable requirements in Division 26 Sections.

C. Ground equipment:

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

3.4. COMMISSIONING AND MANUFACTURER'S FIELD SERVICES

A. Verify that installation is as indicated and specified. Provide factory authorized start-up and training.

B. Complete manufacturer's installation and startup checks and perform the following:

1. Inspect for visible damage to unit casing.
2. Inspect for visible damage to compressor, air-cooled condenser coil, and fans.
3. Verify that clearances have been provided for servicing.
4. Check that labels are clearly visible.
5. Clean condenser and inspect for construction debris.
6. Verify that controls are connected and operable.
7. Verify that filters are installed.
8. Adjust vibration isolators.
9. Verify all piping and branch selector boxes are insulated.

C. Start unit according to manufacturer's written instructions.

1. Complete startup sheets and attach copy with Contractor's startup report.
2. Start-up units in close coordination with testing/balancing.

D. Check and record performance of interlocks and protection devices; verify sequences.

E. Operate unit for an initial period as recommended or required by manufacturer.

F. Calibrate thermostats and humidity sensors.

G. Check internal isolators.

H. Start refrigeration and measure and record the following:

1. Coil leaving-air, dry- and wet-bulb temperature.
2. Coil entering-air, dry- and wet-bulb temperatures.
3. Refrigerant suction/discharge pressures.
4. Indoor and outdoor unit amperage, voltage, and watts.
5. Fan Rotation and RPM.
6. Condensate pump operation.
7. Condensate overflow safety switch operation.

8. System controller operation.

3.5. DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel as specified below.

1. Review data in the maintenance manuals. Refer to Division 01 Section, *Contract Closeout.*

2. Review data in the maintenance manuals. Refer to Division 01 Section, *Operation and Maintenance Data.*

3. Schedule training with Owner, through Architect, with at least 7 days' advance notice.

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SECTION 23 82 33
ELECTRIC BASEBOARD RADIATOR

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Electric Base Board Radiator Units

1.3 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each type of product 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. Plans, elevations, sections, and details.
2. Details of custom-fabricated enclosures indicating dimensions.
3. Location and size of each field connection.
4. Location and arrangement of integral controls.
5. Enclosure joints, corner pieces, access doors, and other accessories.
6. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Structural members, including wall construction, to which convection units will be attached.
2. Method of attaching convection units to building structure.
3. Penetrations of fire-rated wall and floor assemblies.

D. Color Samples for Initial Selection: For units with factory-applied color finishes.

E. Color Samples for Verification: For each type of exposed finish required.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For electric base board radiator units to include in operation and maintenance manuals.

1.4 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

PART 2 PRODUCTS

2.1 ELECTRIC BASEBOARD RADIATOR

A. Basis-of-Design Product: Subject to compliance with requirements, provide Trane Model DBCF or a comparable product by one of the following:

1. Indeeco
2. Marley Engineered Products.

B. General: Provide electric wall mounted heaters as indicated of type and minimum capacity as scheduled, and as specified herein. Finned tube units shall be Trane Model DBCF. Units shall be front inlet with top discharge.

C. Heaters shall be snap fit two pre-construction, 7" high x 5" deep manufactured from 10-gauge extruded aluminum. Back plates are 10-gauge extruded aluminum.

D. Built-in comfort thermostat shall have adjustment range between 55 degrees F and 85 degrees F, with manually set *"not heat"* position. Thermostat shall be tamper-resistant; adjustment accomplished by inserting narrow blade screwdriver through front bar grille.

E. Heating elements shall be high quality nickel chromium alloy, resistant wire embedded and completely surrounded by magnesium oxide closed and swaged in an aluminum sheath.

F. Heater shall contain automatic reset thermal overheat protection to disconnect power in event of overheating due to accidental blockage.

G. Finish in color selected by Architect. Submit color samples.

H. Aluminum fins shall be mechanically banded to the sheath.

I. Furnish and install 6” long control section with built-in thermostat and disconnect.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive base board heating units for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine roughing-in to verify actual locations before convection heating unit installation.

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

3.2 ELECTRIC BASE BOARD RADIATOR INSTALLATION

A. Install units level and plumb.

B. Install radiator units to comply with NFPA 90A.

3.3 CONNECTIONS

A. Ground electric convection heating units according to Division 26 Section "Grounding and Bonding for Electrical Systems."

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

3.4 FIELD QUALITY CONTROL

A. 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 convection heating unit operation.

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

END OF SECTION

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SECTION 23 82 39
ELECTRIC UNIT HEATERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Wall-Mounted Electric Unit Heaters

1.3 DEFINITIONS

A. BAS: Building automation system.

B. CWP: Cold working pressure.

C. PTFE: Polytetrafluoroethylene plastic.

D. TFE: Tetrafluoroethylene plastic.

1.4 SUBMITTALS

A. Product Data: Include rated capacities, operating characteristics, furnished specialties, and accessories for each product 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. Plans, elevations, sections, and details.

2. Location and size of each field connection.

3. Details of anchorages and attachments to structure and to supported equipment.

4. Equipment schedules to include rated capacities, operating characteristics, furnished specialties, and accessories.

5. Location and arrangement of piping valves and specialties.

6. Location and arrangement of integral controls.

7. Wiring Diagrams: Power, signal, and control wiring.

C. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:

1. Suspended ceiling components.

2. Structural members to which unit heaters will be attached.

3. Method of attaching hangers to building structure.

4. Size and location of initial access modules for acoustical tile.

5. Items penetrating finished ceiling, including the following:

a. Lighting fixtures.

b. Air outlets and inlets.

c. Speakers.

d. Sprinklers.

e. Access panels.

6. Perimeter moldings for exposed or partially exposed cabinets.

D. Samples for Initial Selection: Finish colors for units with factory-applied color finishes.

E. Samples for Verification: Finish colors for each type of cabinet unit heater and wall and ceiling heaters indicated with factory-applied color finishes.

F. Field quality-control test reports.

G. Operation and Maintenance Data: For cabinet unit heaters to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1

C. ASHRAE/IESNA 90.1 Compliance

PART 2 PRODUCTS

2.1 WALL-MOUNTED ELECTRIC UNIT HEATERS

A. General: The Contractor shall supply and install heavy-duty, wall-mounted forced-air electric unit heaters of the wattage, voltage, and phase as indicated on the plans. The heater shall so be designed to provide an even distribution of heated air to the space by drawing return air in the periphery of the heater across the element which shall then be discharged from the center section of the heater by means of an electric motor and axial flow fan blade. Recessed type heaters shall extend no more than 1-1/2" from the finished wall; surface-mounted heaters shall extend no more than 5-3/4" from the finished wall; and semi-recessed type heaters shall extend no more than 2-1/2" from the finished wall.

B. Enclosure: Heater front shall withstand with less than 1/16" permanent distortion 10.8 ft. lbs. (324 poundals) impact and 400 lbs. static force applied to an 8 sq. in. area at center grille location. the combination return and supply grille assembly shall be constructed of 1/16" x 3/8" rounded edge horizontal steel louvers which shall be spaced for maximum opening of 1/4". Louvers shall be welded at every intersection to three evenly spaced 1/16" diameter vertical members and completely framed in a heavy-gauge, natural anodized aluminum extrusion. Front assembly shall be attached to the chassis by hidden tamper-resistant (Allen-head) machine screws. All other parts shall be 16-gauge steel, zinc-coated both sides finished in a high gloss, bronze-colored baked enamel.

C. Motor: Shall be a permanently lubricated unit bearing, totally enclosed, shaded pole type with impedance protection. Motors shall operate at no more than 1400 rpm and shall be the same voltage as the heater. A protective shield shall surround the motor to separate return air from heated air. Motor and Propeller Fan: Each unit shall have a single motor and propeller. The motor shall be totally enclosed, continuous duty, with automatic resetting, thermal-overload protection. Propeller fan shall be directly connected to the motor shaft and be statically balanced. Motor mounted to unit with rubber vibration-absorbing material.

D. Performance: Heaters shall have a rating of 245 cfm at 660 fpm with a maximum temperature rise of 73°F, capacity indicated on drawings.

E. Elements: Element assemblies shall consist of two or three corrosion-resistant steel sheathed type elements mechanically bonded to common corrosion-resistant steel fins. Each sheathed element shall consist of helically coiled nickel chromium alloy-resistant wire completely embedded in and surrounded by magnesium oxide, enclosed and wedged into corrosion-resistant steel sheaths. Elements shall have 2" cold conductor pins extending into the sheath and shall have a density of no more than 60 watts per inch.

F. Thermal Overload: Heaters shall be equipped with a "zero voltage reset" thermal overload which disconnects elements and motor in the event normal operating temperatures are exceeded. For safety, if opened due to abnormal temperatures, thermal overload shall remain open until manually reset by turning heater off for five minutes. Automatic reset thermal overloads which allow the element to continue to cycle under abnormal conditions will not be accepted.

G. Heaters shall be UL Listed.

H. Heaters shall be controlled by integrally mounted thermostats. Thermostats shall be heavy-duty, hydraulic type with a range of 40°F to 80°F and with remote sensing bulb placed in the return air. Thermostats shall be electrically rated at least 125 percent of heater rating. Thermostats shall also act as a disconnect by breaking all ungrounded conductors in the OFF position. Thermostat control knob shall be covered by a 16-gauge tamper-resistant access plate to prevent adjustment by unauthorized personnel.

I. Manufacturers: Trane, Modine, Reznor.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas to receive unit heaters for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Examine rough-in electrical connections to verify actual locations before unit heater installation.

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

3.2 INSTALLATION

A. Install wall boxes in finished wall assembly; seal and weatherproof. Joint-sealant materials and applications are specified in Division 07 Section "Joint Sealants."

B. Install unit heaters to comply with NFPA 90A.

C. Install unit heaters level and plumb.

D. Install wall-mounting thermostats and switch controls in electrical outlet boxes at heights to match lighting controls. Verify location of thermostats and other exposed control sensors with Drawings and room details before installation.

3.3 CONNECTIONS

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

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

END OF SECTION

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SECTION 26 05 00

BASIC ELECTRICAL MATERIALS AND METHODS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Electrical equipment coordination and installation.
2. Sleeves for raceways and cables.
3. Sleeve seals.
4. Grout.
5. Common electrical installation requirements.

1.3 DEFINITIONS

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of electrical equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting raceways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

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

C. Coordinate location of access panels and doors for electrical items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Through-Penetration Firestop Systems."

PART 2 PRODUCTS

2.1 SLEEVES FOR RACEWAYS AND CABLES

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

B. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

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 or cable.

3. Pressure Plates: Carbon steel. 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.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3 EXECUTION

3.1 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: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to piping systems installed at a required slope.

3.2 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. 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 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable, 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. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants".

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. Install sleeves and seal raceway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Through-Penetration Firestop Systems."

K. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

L. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel or cast-iron pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) 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 (25-mm) annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for raceway or cable material and size. Position raceway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between raceway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations 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

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SECTION 26 05 01

GENERAL ELECTRICAL REQUIREMENTS

PART 1 GENERAL

1.1 GENERAL

A. Provide all labor, materials, equipment and services necessary for and incidental to the complete installation and operation of all electrical work.

B. All work under this Division is subject to the General Conditions and Special Requirements for the entire contract.

C. Unless otherwise specified, all shop drawings and submissions required under Division 26 shall be made to, and acceptances and approvals made by, the ENGINEER.

D. Conform to the requirements of all rules, regulations, and codes of local, state, and federal authorities having jurisdiction. Conform to the National Electrical Code and all NECA – National Electrical Installation Standards (NEIS).

E. Perform the work in a first-class, substantial, and workmanlike manner. Any materials installed which do not present an orderly and neat workmanlike appearance shall be removed and replaced when so directed by the Engineer, at the Contractor's expense.

F. Coordinate the work of all trades.

G. Arrange conduit, wiring, equipment, and other work generally as shown, providing proper clearances and access. Carefully examine all contract drawings and fit the work in each location without substantial alteration. Where departures are proposed because of field conditions or other causes, prepare and submit detailed drawings for approval in accordance with “Submittals” specified below. The right is reserved to make reasonable changes in location of equipment, conduit, and wiring up to the time of rough-in or fabrication.

H. The contract drawings are generally diagrammatic and all offsets, bends, fittings, and accessories are not necessarily shown. Provide all such items as may be required to fit the work to the conditions.

I. Be responsible for all construction means, methods, techniques, procedures, and phasing sequences used in the work. Furnish all tools, equipment and materials necessary to properly perform the work in a first class, substantial, and workmanlike manner, in accordance with the full intent and meaning of the Contract Documents.

J. The Contractor shall provide other work and services not otherwise included in the Contract Documents that are customarily forwarded in accordance with generally-accepted construction practices.

1.2 PERMITS, INSPECTIONS, AND FEES:

A. The Contractor shall obtain and pay for all charges and fees, and deliver all permits, licenses, certificates of inspection, etc., required by the authorities having jurisdiction. Deliver inspection, approval, and other certificates to the Owner prior to final acceptance of the work.

B. File necessary plans, prepare documents, give proper notices, and obtain necessary approvals.

C. Permits and fees shall comply with the General Requirements of the Specification.

D. Notify Inspection Authorities to schedule inspections of work. All work shall be subject to field inspections.

E. Notify Architect in advance of scheduled inspections.

F. An electrical foreman, superintendent or other supervisor shall be in attendance for all scheduled inspections.

G. The Contractor shall provide an electrical certificate from an independent electrical inspection agency approved by the Owner and the State of Maryland Fire Marshal. The Contractor shall submit certificate prior to final payment invoice. The Contractor shall pay all fees, including filing fees.

1.3 ELECTRICAL WORK UNDER OTHER DIVISIONS:

A. Mechanical Equipment and Systems

1. In general, power wiring and motor starting equipment for mechanical equipment and systems are furnished and installed under Electrical Division 26.

2. Certain mechanical units contain starters, contacts, transformers, fuses, wiring, etc., required for fans, pumps, etc., furnished with the equipment from the factory. When this equipment is supplied from the factory, the Contractor must supply power circuit(s) to the unit and a disconnecting means. Coordinate with Contractor so that one, and only one, set of starters, fuses, switches, etc., is provided and installed.

3. In general, control and interlock equipment for HVAC systems (including associated wiring, conduit, transformers, relays, contacts, etc.) is furnished under Mechanical Divisions. Contractor shall install and connect all such equipment as necessary.

4. Controls, wiring, conduit, transformers, etc., for smoke, fire, and motor-operated dampers are provided by Mechanical. Electrical shall install and connect all such equipment.

B. Architectural Equipment: In general, any electrically operated or controlled equipment furnished under architectural divisions shall be supplied with control wiring, transformers, contacts, etc. Contractor shall provide power circuits to such equipment and install all electrical control equipment related thereto.

C. Carefully review the contract documents and coordinate the electrical work under the various Divisions.

D. Submit LEED Submittals in compliance with Division 01:

1. Product data for Credit IEQ 4.1: For adhesives and sealants applied within the building waterproofing envelope, documentation including printed statement of VOC content in g/L.

2. Product data for Credit IEQ 4.2: For paints and coatings applied within the building waterproofing envelope, documentation including printed statement of VOC content in g/L.

3. Product data for Credit IEQ 4.4: For composite wood installed in the building interior as equipment backer boards, documentation indicating no added urea formaldehyde resins.

1.4 CONTRACTOR QUALIFICATION:

A. Any Contractor performing work under this Division shall be fully qualified and acceptable to the Engineer. Submit the following evidence for approval as part of shop drawing review:

1. A list of not less than five (5) comparable projects that the Contractor completed.

2. Letters of reference from not less than three (3) registered professional engineers, contractors, or building owners, explaining Contractor proficiency, quality of work, or other attribute on projects of similar size or substance.

3. Local or State license.

4. Membership in trade or professional organization where required.

5. Copy of Master Electrician’s License.

B. Contractor is any individual, partnership, corporation, or firm performing work by Contract or subcontract on this project.

C. Acceptance of a subcontractor will not relieve the Contractor of any contractual requirements or his responsibility to supervise and coordinate the various trades.

D. Supervisory Qualifications: The electrical work on the project shall be under the direct supervision of a licensed Master Electrician.

E. Qualifications of Installers:

1. For the actual fabrication, installation, and testing of the work, the Contractor shall use only thoroughly trained and experienced personnel who are completely familiar with the requirements of this work and with the installation recommendations of the manufacturers of the specified items.

2. The Electrical Installer shall utilize a full time project foreman in charge of all electrical work. This person shall be fully qualified and experienced in such work and shall be available, on site, at all times during Construction. All problems, questions, coordination, etc., relating to electrical work shall take place through this person to the Architect.

F. Qualifications of Video Tape Technician: For videotaping specified in “Operating Instructions”, the Contractor shall provide the services of persons skilled in videotape production and editing.

1.5 FIRE SAFE MATERIALS:

A. Unless otherwise indicated, materials and equipment shall conform to UL, NFPA, or ASTM Standards for Fire Safety with Smoke and Fire Hazard Rating not exceeding flame spread of 25 and smoke developed of 50.

1.6 REFERENCED STANDARDS, CODES, ORDINANCES AND SPECIFICATIONS

A. Specifications, Codes and Standards listed below are included as part of this specification, latest edition.

ADA	Americans with Disabilities Act
ANSI	American National Standards Institute
ASHRAE	American Society of Heating, Refrigerating and Air Conditioning Engineers
ASME	American Society of Mechanical Engineers
ASTM	American Society for Testing and Materials
IBC	International Building Code
CABO	Council of American Building Officials

FM	Factory Mutual
IEEE	Institute of Electrical and Electronics Engineers
MOSHA	Maryland Occupational Safety & Health Administration
NEC	National Electrical Code
NECA	National Electrical Contractors Association
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
OSHA	Occupational Safety & Health Administration
BGE	Baltimore Gas & Electric
UL	Underwriters Laboratories
IECC	International Energy Conservation Code

B. All electrical equipment and materials shall comply with the Codes and Standards listed in the latest edition of IEEE Standard 241, *Electric Power Systems in Commercial Buildings*, Chapter 1, Section 1.6, entitled “Codes and Standards”.

C. Comply with all Codes applicable to the work:

1. Bidders shall inform themselves of all local and state codes and regulations.

2. In case of conflict between Contract Documents and governing Codes, the most stringent shall take precedence. Where, in any specific case, different sections of any applicable codes or when Drawings and Specifications specify different materials, methods of Construction, or other requirements, the most restrictive shall govern.

3. Where Contract Documents exceed minimum Code requirements, and are permitted under the Code, the Contract Documents take precedence and shall govern.

4. No extra payment will be allowed for work or changes required by local Code enforcement authorities.

D. Underwriters Laboratories Labels shall apply to all materials and devices, etc., except specified items not covered by existing UL Standards.

E. Conflicts with applicable regulations:

1. Resolve at Contractor’s expense.

2. Prepare and submit details of alternate construction:

a. Acceptable solution of conflict.

b. List of substitute materials:

For approval of inspecting authorities.

For approval of Engineer.

F. Comply with all NECA's National Electrical Installation Standards (NEIS), including NECA 1-2000 "Standard Practices for Good Workmanship in Electrical Contracting".

1.7 INTERPRETATION OF DOCUMENTS

A. Any discrepancies between Drawings, Specifications, Drawings and Specifications, or within Drawing and Specifications shall be promptly brought to the attention of the Owner during the bidding period. No allowance shall subsequently be made to the Contractor by reason of his failure to have brought said discrepancies to the attention of the Owner during the bidding period or of any error on the Contractor's part.

B. The locations of products shown on Drawings are approximate. The Contractor shall place the devices to eliminate all interference with above-ceiling ducts, piping, etc. Where any doubt exists, the exact location shall be determined by the Owner.

C. All general trades and existing conditions shall be checked before installing any outlets, power wiring, etc.

D. Equipment sizes shown on the Drawings are estimated. Before installing any wire or conduit, the Contractor shall obtain the exact equipment requirements and install wire, conduit, or other item of the correct size for the equipment actually installed. However, wire and conduit sizes shown on the Drawings shall be taken as a minimum and shall not be reduced without written approval from the Owner.

E. Where variances occur between the drawings and specifications or within either document itself, the item or arrangement of better quality, greater quality, or higher cost shall be included in the Contract Price. The Engineer will decide on the item and manner in which the work shall be installed.

F. Contract Drawings are generally diagrammatic and all offsets, fittings, transitions, and accessories are not necessarily shown. Furnish and install all such items as may be required to fit the work to the conditions encountered. Arrange conduits, equipment, and other work generally as shown on the Contract Drawings, providing proper clearance and access. Where departures are proposed because of field conditions or other causes, prepare and submit detailed Shop Drawings for approval in accordance with "submittals" specified below. The right is reserved to make reasonable changes in location of equipment, piping, and ductwork, up to the time of rough-in or fabrication.

G. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Owner.

PART 2 PRODUCTS

2.1 MATERIALS AND EQUIPMENT

A. Material and equipment installed as a part of the permanent installation shall be new, unless otherwise indicated or specified, and shall be approved by the Underwriters' Laboratories, Inc., for installation in each particular case where standards have been established.

B. Where material or equipment is identified by proprietary name, model number, and/or manufacturer, furnish the named item or equivalent thereof, subject to acceptance.

C. Material submissions shall conform to requirements outlined in SUBMITTALS, REVIEW, AND ACCEPTANCE.

D. The suitability of named item only has been verified. Where more than one Manufacturer is named, only the first named Manufacturer has been verified as suitable. Manufacturers and items other than the first named shall be equal or better in quality and performance to that of specified items, and must be suitable for available space, required arrangement, and application. The Contractor, by providing other than the first named Manufacturer, assumes responsibility for all necessary adjustments and modifications necessary for a satisfactory installation.

E. The Contractor shall only submit those manufacturers indicated in the Specification. Proposed alternate manufacturers will not be considered unless the specific item indicates “or as approved equal”. Submit all data necessary to determine suitability of substituted items for approval.

F. All items of equipment furnished shall have a service record of at least five (5) years.

G. Adhesives, sealants, paints and coatings applied within the building waterproofing envelope: Comply with low-emitting requirements in Division 01 Section “Indoor Air Quality Requirements.”

H. Compositge Wood installed in the building interior as equipment backer boards: Contain no added urea formaldehyde resins.

2.2 SUBSTITUTIONS

A. Substituted items or items other than those named shall be equal or better in quality and performance and must be suitable for the available space, required arrangement, and application. Submit any and all data necessary to determine the suitability of substituted items. The Contractor shall be responsible for correct application, placement, and installation of substituted equipment. Cost savings data shall also be submitted with submittal data for substituted items. Total cost savings or a per-unit saving to the Owner shall be clearly indicated. If a substituted item is accepted, all cost savings shall be returned to the Owner as a credit.

B. Substitutions will not be permitted for specific items of material or equipment where specifically indicated.

C. For substituted items, clearly list on the first page of the submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action (or replacement with the specified item) while maintaining the specification requirements if differences have not been clearly indicated in the submittal.

D. Where the Contractor proposes to use an item of equipment or application other than that specified or detailed on the Drawings, which requires any redesign of the structure, partitions, foundation, HVAC, piping, wiring, or any other part of the mechanical, electrical, or architectural layout, all such redesign and all new drawings and detailing required thereafter shall be prepared by the Contractor at his own expense for review by the Owner representative before any such work is implemented.

E. All Contractor-proposed changes and revisions shall be at the Contractor’s risk and expense. The Contractor shall fully coordinate all revisions, substitutions and changes with other trades. The Contractor shall provide all necessary provisions, including HVAC, ventilation, foundations, access, etc., for a complete, code compliant, and fully functional installation.

F. Where the Contractor elects to submit a substitution for equipment or materials, he shall:

1. Submit Shop Drawings that show complete compliance to each statement or requirement of the Specifications.

2. Submit certified test data from an independent testing laboratory for each product.

3. Submit one complete working sample of the equipment or materials to be furnished. In cases involving large or heavy items of equipment, the Owner may waive the requirement to submit the sample.

G. Failure to comply with the above-required submissions shall constitute an automatic rejection of the substitution.

2.3 SUBMITTALS, REVIEW, AND ACCEPTANCE

A. General:

1. The equipment, material, installation, workmanship, arrangement of work, final instruction, and final documentation is subject to review and acceptance. No substitution will be permitted after acceptance of equipment or materials except where such substitution is considered by the Engineer to be in the best interest of the Owner. Submit for review in clear and legible form the following documents:

    a. Material and Equipment List

    b. Descriptive Data

    c. Shop Drawings

    d. Installation and Coordination Drawings

    e. Contractor As-Built Drawings

    f. Owner Instructions and Manuals

    g. Construction Phasing and Outage Schedule

2. Prepare all submittals specifically for this project and stamp each submittal in a form indicating that the documents have been Contractor reviewed, are complete, and are in compliance with the requirements of the plans and specifications. Each submittal item shall be clearly identified and numbered. Each submittal shall contain a complete schedule of Manufacturer's part numbers and quantity listings of all supplied components. Each proposed item shall be highlighted and tagged with a star, an arrow, etc., including all options and accessories.

3. Coordinate the installation requirements and any mechanical requirements for the equipment submitted. Submittals will be reviewed for general compliance with design concept in accordance with the contract documents. The Contractor is responsible for the correctness of all submittals. Reviews will not verify dimensions, quantities, or other details.

4. Identify all submittals, indicating the intended application, location, or service of the submitted item. Refer to specification sections or paragraphs where applicable. Clearly indicate the exact type, model number, size, and special features of the proposed item. Clearly list on the first page of the Submittal all differences between the specified item and the proposed item. The Contractor shall be responsible for corrective action (or replacement with the specified item) while maintaining the specification requirements, if differences have not been clearly indicated in the submittal. Submittals of a general nature will not be acceptable.

5. Submit actual operating conditions or characteristics for all equipment where required capacities are indicated. Factory order forms showing only required capacities will not be acceptable. Indicate all options used to meet the specifications. It is not the responsibility of the Engineer or Owner to make selections of factory options other than colors. Submittals lacking proper selection of factory options or special features required by the specification shall be RETURNED WITHOUT REVIEW.

6. Acceptance will not constitute waiver of contract requirements unless deviations are specifically indicated and clearly noted.

7. Documents of general form indicating options shall be clearly marked to show what is specifically proposed for this project.

8. Submittals NOT IN COMPLIANCE with the requirements of this section will be RETURNED WITHOUT REVIEW.

B. Material, Equipment, Manufacturer and Subcontractor List: Within 30 calendar days after the award of contract, submit a complete MATERIAL, EQUIPMENT, MANUFACTURER AND SUBCONTRACTOR LIST for preliminary review. List all proposed materials and equipment, the associated proposed Manufacturer, and any proposed subcontractors. After the receipt of reviewed Material and Equipment List, submit complete Shop Drawings for approval. List all materials and equipment, indicating manufacturer, type, class, model, curves, and other general identifying information. Submittals shall be specific for each building as contained in the individual building Specifications and Drawings.

C. Upon approval of the List of Materials, the Contractor shall prepare a complete Master Submittal Register, listing all products and materials that will be submitted for approval. Items shall be listed by referenced specification paragraph in ascending order. This master list shall be included with each submittal, updated to reflect the status of approval for each item, and shall highlight the items pertaining to the submittal. A suggested Submittal Register Format is shown below:

SUBMITTAL REGISTER

Item/Material	Ref'd Spec. Paragraph	Specified or Substitute	Submittal Date	Status	Remarks

D. No Shop Drawing Submittals will be considered for approval until the complete List of Subcontractors and the complete List of Materials/Manufacturers and Equipment have been approved.

E. Descriptive Data: After acceptance of the MATERIAL and EQUIPMENT LIST, submit additional DESCRIPTIVE DATA for all items. Data shall consist of specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, installation instructions, and any other information necessary to indicate complete compliance with the contract documents. Where several ratings or sizes are shown or available, clearly indicate the exact size or rating relating to the particular device being proposed.

F. Submit complete descriptive data for all items. Data shall consist of Specifications, data sheets, samples, capacity ratings, performance curves, operating characteristics, catalog cuts, dimensional drawings, wiring diagrams, specific electrical/wiring requirements and connections including control and interlock wiring, installation instructions, and any other information necessary to indicate complete compliance with the Contract Documents. Edit submittal data specifically for application to this project.

G. Shop Drawings shall be submitted and approved for all materials and equipment prior to installation. If any material and/or equipment is installed prior to receipt by the Contractor of approved Shop Drawings, the Contractor is liable for its replacement at no additional cost to the Owner.

H. Data submitted shall include information on all materials and equipment to demonstrate compliance with the Contract Drawings and Specifications. Where installation procedures or any part thereof are required to be in accordance with manufacturer's recommendations, furnish printed copies of the recommendations prior to installation. Installation of the item shall not proceed until

recommendations are received. Failure to furnish recommendations shall be cause for rejection of the equipment or material.

I. Any deviation of submitted material or equipment from the Contract Drawings or Specifications shall be clearly marked in red ink on Submittals, and itemized in a transmittal letter, in order to receive consideration for approval.

J. Approval of material or equipment submittals containing deviations not specifically identified by Contractor shall not relieve the Contractor from compliance with specified requirements.

K. All major items of mechanical equipment shall be the latest standard catalog products of reputable manufacturers. Where two (2) or more items of the same kind of equipment are required, they shall be the products of a single manufacturer.

L. Thoroughly review and stamp all submittals to indicate compliance with Contract requirements prior to submission. Coordinate installation requirements and any electrical requirements for equipment submitted. Contractor shall be responsible for correctness of all submittals.

M. Submittals will be reviewed for general compliance with design concept in accordance with Contract Documents, but dimensions, quantities, or other details will not be verified.

N. Increase, by the quantity listed below, the number of electrical related Shop Drawings, product data, and samples submitted, to allow for required distribution plus two copies of each submittal required, which will be retained by the Electrical Consulting Engineer.

1. Shop Drawings - Initial Submittal: 1 additional blue- or black-line print.
2. Shop Drawings - Final Submittal: 1 additional blue- or black-line print.
3. Product Data: 1 additional copy of each item.

O. Additional copies may be required by individual sections of these Specifications.

P. Shop Drawings:

1. Prepare and submit SHOP DRAWINGS AND/OR DIAGRAMS for all specially fabricated items, modifications to standard items, specially designed systems where detailed design is not shown on the contract drawings, or where the proposed installation differs from that shown on the contract drawings.
2. Shop drawings shall include plans, elevations, sections, mounting details of component parts, point to point interconnection diagrams, elementary diagrams, single line diagrams, and any other drawings necessary to show the fabrication and connection of the complete item or system.
3. Shop drawings shall be provided for, but not limited to the following items:

Analysis and Coordination Study

Ballasts

Basic Electrical Materials

Cable - 600 volt

Cable Tray

Circuit Breakers

Conduit and Surface Raceway

Contractor and Subcontractor Qualifications

Controllers & Control Devices

Disconnects

Electrical Connection Coordination Schedule

Equipment Connections

Equipment Pads

Excavation and Backfill

Firestopping

Fuses

Ground Conductors, Rods

Identification System

Innerduct

Lamps

Lighting Control Equipment

Lighting Fixtures

Lightning Protection System

Low Voltage Fuses

Material and Equipment List

Motor Starters

Occupancy Sensors

Outlet Boxes

Panelboards

Receptacles

Record and Information Booklet

Safety Switches

Schedule of Values

Sleeves, Hangers, Supports

Submittal Schedule

Surge Suppression Devices

Switchboards

Tests and Reports

Transformers

Underground Cable

Wiring Devices

Wiring Diagrams

Q. The Contractor, additionally, shall submit for approval any other shop drawings as required by the Architect. No item listed above shall be delivered to the site, or installed, until approved. After the proposed materials have been approved, no substitution will be permitted except where approved by the Engineer.

R. The Contractor shall prepare and submit a Detail Schedule of Values indicating the Contract costs for the major work items. The Contractor shall provide additional detail and information as requested by the Engineer.

S. The Contractor shall prepare and submit a complete Submittal Schedule. The Schedule shall include a listing of all Submittals, Shop Drawings, and Coordination Drawings.

T. The Contractor shall submit the following Shop Drawings to the Utility Company for approval:

C/T Cabinets

Metering (Utility)

Switchboard

Any Other Submittals Required by BGE.

2.4 COORDINATION DRAWINGS:

A. Prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of the work. Drawings shall include, but not be limited to the following:

1. Telecommunication Rooms indicating data rack assemblies, panels, etc.

2. Electrical Rooms indicating switchboard assemblies, transformers, equipment pads, panels, etc.

3. Mechanical Equipment Rooms, including panels, transformers, starters, equipment, etc.

B. Draw plans to a scale not less than 1/4 inch equals one foot. Include plans of the proposed work, showing all equipment, major elements, conduit, and wiring in the areas involved. Fully dimension all work, horizontally and vertically. Show coordination with other work including piping, ductwork and other mechanical work, walls, doors, ceilings, columns, beams, joists, and other architectural and structural work.

C. Identify all equipment and devices on wiring diagrams. Where field connections are shown to factory-wired terminals, furnish manufacturer's literature showing internal wiring.

D. Prepare, submit, and use scaled layout drawings indicating dimensions, clearances, and actual equipment dimensions. Layout drawing shall include, but not be limited to the following:

1. Pad-mounted equipment and equipment connections.

2. Underground conduits, ductbanks, manholes, handholes, and building penetrations.

2.5 RECORD DRAWINGS:

A. As the work progresses, record on a set of white prints the installed locations, sizes of electric feeders, equipment, etc. Upon completion of the work, submit one (1) complete set of white prints with "As-Built" information neatly recorded thereon in red ink. Use other colors to distinguish between variations in separate categories of the work. Note related change-order numbers where applicable. Provide electronic copies to the owner and architect at the completion of the project.

B. Write step-by-step detailed instructions for turn-on, turn-off, seasonal changeover, and periodic checks of all systems and equipment. Include all precautions and warnings.

C. Prepare a list of the manufacturers of all major equipment, their local service representative and procedures for obtaining service.

D. Post one (1) copy of all instructions, lists, charts, and diagrams at the equipment or where indicated, mounted under glass or approved plastic cover.

E. Furnish to the Owner two (2) copies of the Manufacturer's installation and operations instructions, and an electronic copy. Include replacement parts lists where applicable. Also include copies of all posted instructions, lists and charts. Assemble the material in one or more heavy duty 8- 1/2" x 11" loose leaf binders with tab separators. Submit for approval before final delivery. Binder shall be labeled on spine and on cover with Project Name.

F. Deliver all instruction materials to the Owner prior to the formal instruction period.

G. Deliver two (2) complete sets of all approved submittals to the Owner for filing, including electronic copies.

H. Prepare record documents in accordance with the requirements in the specifications. In addition to the requirements specified, indicate installed conditions for:

1. Major raceway systems, size and location, for both exterior and interior; locations of control devices; distribution and branch electrical circuitry; and circuit breaker size and arrangements.

2. Equipment locations (exposed and concealed), dimensioned from prominent building lines.

3. Approved Substitutions, Contract Modifications, and actual equipment and materials installed.

I. The Contractor shall keep at the site at all times during construction, one set of up-to-date Contract prints for the express purpose of showing any and all changes made during construction. The Contractor shall make the prints showing each change and shall incorporate all changes in “Record/As-Built Drawings” to be submitted to the Engineer upon completion of the project.

J. The Contractor shall show proof of up-to-date record drawings to the Owner prior to submitting monthly invoice.

K. The Contractor shall conform to all drawings, including all revisions, addendums, alternates, change orders, deletions, existing conditions, and as-built conditions without extra cost to the Owner.

2.6 DEMONSTRATION AND OPERATING INSTRUCTIONS

A. Furnish the necessary technicians, skilled workers, and helpers to operate the electrical systems and equipment of the entire project. The Contractor shall provide a minimum of three 2-hour sessions of system demonstration and operation for each system including, but not limited to: lighting controls, switchboards, fire alarm system.

B. Where specified in technical sections, provide longer periods required for specialized equipment.

C. Contractor shall provide start-up of all systems in an orderly, organized, and coordinated manner to ensure that all systems are functioning as designed. The Contractor shall provide a detailed start-up, testing, and demonstration plan for all systems in a coordinated manner that is documented in writing at least 45 days prior to system start-up. Start-up, testing and demonstration plans shall include detailed point-by-point checklists that clearly show that systems are, in fact, functioning as designed. Instruct the Owner or designated personnel in operation, maintenance, lubrication, and adjustment of systems and equipment.

D. The Operating and Maintenance Manual shall be available at the time of the instructions, for use by Instructors and Owner personnel.

E. Videotape each instruction session, including both the sessions specified above and added sessions required in technical sections for specialized equipment. Provide one complete set of DVD video disks with each Operating and Maintenance Manual.

F. Schedule the general and specialized instruction periods for a time agreed upon by he Owner and Engineer. All operation training and demonstrations shall be complete prior to Owner acceptance of any given system.

PART 3 EXECUTION

3.1 EXAMINATION OF SITE, SURVEYS, AND MEASUREMENTS:

A. Examine the site, determine all conditions and circumstances under which the work must be performed, and make all necessary allowances for same. No additional cost to the Owner shall be permitted for Contractor's failure to do so.

B. Examine the site and observe the conditions under which the work will be done or other circumstances which will affect the contemplated work. No allowance will be made subsequently in this connection for any error or negligence on the Contractor's part.

C. The Contractor shall base all measurements, both horizontal and vertical, from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at the site and check the correctness of same as related to the work.

D. Any discovery of discrepancy between actual measurements and those indicated which prevents following good practice or the intent of the Drawings and Specifications shall be brought to the attention of the Owner's Representative. Work shall not proceed until receiving instructions from the Owner's Representative.

E. The Contractor shall follow Drawings in laying out the work and check Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, the Owner's Representative shall be notified before proceeding with the installation.

F. To prevent conflict with the work of other trades and for proper execution of the work, the Contractor, as directed by the Owner's Representative, shall make the necessary modifications in the layout as needed, at no extra charge to the Owner.

G. The Contractor shall be solely responsible for the proper arrangement of his conduit and equipment.

H. The Engineer shall make all final decisions as to any conditions that require the changing of any work.

I. The Contractor shall have competent supervision on the site at all times to lay out, check, coordinate, and supervise the installation of all electrical work and be responsible for the accuracy thereof. He shall plan the installation of all electrical work, giving consideration to the work of other trades, to prevent interference.

J. The Contractor shall determine the location, size, etc., of all chases, sleeve openings, etc., required for the proper installation of the electrical work and see that such are provided. All chases, sleeves, openings, etc., shall be set prior to erection of new work to prevent delay in the progress of other work or trades.

K. Conditions and/or situations that prevent the proper installation of any equipment or item where shown on the Drawings shall be called to the attention of the Engineer for instructions.

L. The Contractor shall have equipment shipped or fabricated in sections of suitable size for entering the building and being removed from the finished building in the future, if necessary.

M. The Contractor shall fully investigate all peculiarities and space limitations for all materials and equipment.

N. Outlet, pull, and junction boxes and other appliances that require operation, examination, adjustment, servicing or maintenance shall be readily accessible.

O. The Contractor shall take all field measurements necessary for this work and shall assume responsibility for their accuracy.

P. The Contractor shall coordinate the electrical work with all other sub-contractors. All work shall be so arranged that there will be no delay in the proper installation and completion of any part or parts

of electrical equipment. All electrical work shall be installed in proper sequence with other trades without any unnecessary delay.

Q. The Drawings are to some extent diagrammatic and indicate the general arrangement of the equipment, the runs of conduit, and the manner of connection.

R. The Contractor shall confer with all sub-contractors engaged in the construction of the project, regarding the work that may, in any way, affect his installation. Whenever interference occurs, before installing any of the work in question, the Contractor shall consult with all sub-contractors and shall come to an agreement with them as to the exact location and level of his conduit parts of his equipment.

S. The Contractor shall be responsible for determining exact property lines and area of work. The Contractor shall not install any equipment or conduits outside of the property lines and/or area of work without written direction from the Owner. Any work indicated diagrammatically on the Contract Documents to be installed beyond the property lines and/or area of work shall be verified with the Owner prior to installation.

3.2 GENERAL RESPONSIBILITIES:

A. The Contractor shall be responsible for systems and related damages possible, and shall hold harmless the Owner, the Architect and his consultants from malfunction of systems and equipment installed under this Contract as defined in the laws of the State of Maryland pertaining to real property for the period of time as defined by such laws.

B. It is the intent of these Specifications to fully cover without exception all required labor and materials so that the finished work will be delivered to the Owner in a complete and satisfactory working installation. Excavation, wiring, distribution, etc., shall be performed in compliance with the Contract Documents.

C. Work not specifically outlined, but reasonably incidental to the completion of the work, shall be included without additional compensation from the Owner.

D. Conflicting points in the Specifications or on the Drawings shall be called to the attention of the Architect prior to the execution of the Contract.

3.3 STORAGE AND PROTECTION OF EQUIPMENT

A. All electrical equipment to be used in the construction shall be properly stored and protected against the elements. All equipment shall be stored under cover, and shall not be stored at the construction site on the ground, in mud, water, snow, rain, sleet or dust. Large diameter cables may be stored on reels with weatherproof materials. Such weatherproof materials shall be heavy-duty, securely fastened and made impervious to the elements.

B. Conventional electrical construction materials such as building wire, outlet and junction boxes, wiring devices, conduit, lighting fixtures, fittings, etc., shall be stored in construction buildings, covered trailers or portable covered warehouses. Any equipment subject to damage or corrosion from excessive moisture shall be stored in dry, heated areas. Any equipment containing plastic or material subject to damage caused by excessive heat or sunlight shall be stored to prevent such damage. This includes plastic ducts and lenses.

C. Switchboard, motor controllers, panelboards, breakers, emergency lighting, and supervisory equipment, if delivered to the construction site before the building is under cover, shall be warehoused and protected as follows: All gear and equipment shall be covered and protected from the elements and other damage and shall be stored in a clean, dry, heated atmosphere, under cover.

D. All gear and equipment delivered to the construction site after the building is under cover shall be protected as described above and in addition shall be provided with auxiliary heat to prevent condensation damage. The gear shall also be protected against damage caused by installation of

any building systems and equipment; or damage caused by carelessness of workmen who are installing equipment connected to or adjacent to the above electrical equipment.

E. Equipment damaged as a result of the above conditions shall be properly repaired at the Contractor's expense or shall be replaced at the Contractor's expense, if, in the opinion of the Engineer the equipment has been damaged to such an extent it cannot operate properly after repairs are made.

F. All electrical enclosures exposed to construction damages such as paint spots, spackling or plaster spatter, grout splashes, waterproofing compound, tar spots or runs and pipe covering compound splashes, shall be completely covered and protected against damage.

G. In the event leakage into the building of any foreign material or fluid occurs or may occur, the Contractor shall take all steps as described above to protect any and all equipment.

H. After connections to electrical equipment are complete and the equipment is ready for operation, all construction debris shall be removed from all enclosures. Such debris includes dust, dirt, wire clippings, tape and insulation removed in order to make the connection.

3.4 ELECTRICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of electrical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate electrical systems, equipment, materials, and installation with landscape/irrigation contractor(s).

2. Verify all dimensions by field measurements.

3. Install systems, materials, and equipment to conform with approved submittal data, including coordination drawings, to greatest extent possible. Conform to arrangements indicated by the Contract Documents, recognizing that portions of the Work are shown only in diagrammatic form. Where coordination requirements conflict with individual system requirements, refer conflict to the Engineer.

4. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components where installed exposed in finished spaces.

5. Install electrical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. As much as practical, connect equipment for ease of disconnecting, with minimum of interference with other installations. All equipment and disconnects shall maintain proper working space to conform to NEC.

6. Install systems, materials, and equipment giving right-of-way priority to systems that require installation at a specified slope.

7. Arrange for chases, slots and openings in other building components during progress of construction, to allow for electrical installation.

8. Space, coordinate, and integrate installations of electrical materials and equipment for efficient flow of the work.

3.5 SUPERVISION AND COORDINATION:

A. Provide complete supervision, direction, scheduling and coordination of all work under the contract, including that of subcontractors, using full attention and the best skill. Be responsible for all work and make all subcontractors, suppliers and manufacturers fully aware of all requirements of the contract.

B. Coordinate the rough-in of all work performed under Mechanical & Electrical Divisions.

C. The Contractor shall coordinate all electrical rough-ins with approved shop drawings and coordination drawings. Any rough-in installed without complete coordination shall be at the Contractor’s risk and expense.

D. Coordinate the installation of all necessary rough-in of work, sleeves, anchors and supports for conduit, wiring, and other work performed under Divisions Mechanical and Electrical Divisions.

E. Coordinate the spacing and arrangement of lighting fixtures, diffusers, grilles and access panels in ceilings to establish a symmetrical pattern.

F. Where a discrepancy exists within the Specifications or drawings or between the Specifications and Drawings, the more stringent (or costly) requirement shall apply until a clarification can be obtained from the Engineer. Failure to clarify such discrepancies with the Engineer will not relieve the Contractor of the responsibility of conforming to the requirements of the Contract.

G. Failure of the Contractor to obtain a full and complete set of Contract Documents (either before or after bidding) will not relieve the Contractor of the responsibility of complying with the intent of the Contract Documents.

H. To insure proper electrical coordination between the electrical components supplied under the Electrical Divisions and the equipment supplied under the Mechanical Divisions, a schedule shall be submitted, prior to start of work, for review by the Engineer with the following column headings:

1.Equip or Item	2. HP or KVA	3.Voltage and Phase	4. Power Factor	5. Capacitor	6.Motor Starter	7.Discon.	8.Controls	9.Remarks

Description of Column Headings:

1. List all the approved equipment furnished under Mechanical Division that requires electrical connections and designate the equipment as it appears in the Mechanical Divisions. Indicate the quantity, if more than one, in parentheses of identical equipment being supplied.

2. Indicate the supplied horsepower of the equipment listed under Column No. 1. If equipment listed has more than one motor, indicate each motor and its respective horsepower. Indicate the kVA rating for all other equipment requiring an electrical connection, unless the electrical connection is for a control circuit only.

3. Indicate the voltage and phase requirements for equipment listed under Column No. 1. If more than one electrical circuit or voltage is required for the listed equipment, it shall be so indicated. Indicate wiring required for connection, including all phase, neutral, and ground conductors.

4. Indicate the power factor rating for all motors listed under Column No. 2.

5. Where a capacitor is to be provided, indicate specification it is supplied under and indicate the KVAR size for any capacitor provided under Division 26.

6. Where a motor starter is required, indicate the specification division it is supplied under and the type of motor starter; across-the-line, reversible, variable speed, two speed-single winding, etc. Indicate in Column No. 9 if the motor starter provided under Division 26 is not compatible with the motor specified.

7. Where a disconnect switch is required by the National Electric Code or by the contract documents for the equipment listed under Column No. 1, indicate under which Division the disconnect switch is supplied.

8. Indicate the Division under which the controls for the equipment listed under Column No. 1 are provided.

9. Indicate any discrepancies between what is indicated in the contract documents and what is actually being provided.

I. The Contractor shall fully coordinate the electrical connections to all equipment prior to installations, with the approved Shop Drawings and the trades involved. Coordination shall include voltage, phases, quantity and size of wiring, device sizes, terminations, rough-in work, and other coordination for a complete installation.

J. Coordinate Division 26 work with all trades.

K. Install work with proper clearances and access. Carefully examine all contract drawings and fit the work in each location without substantial alteration. Where departures are proposed or required, submit detailed drawings for acceptance. The right is reserved to make reasonable changes in location of equipment, conduit and wiring up to the time of rough-in or fabrication.

L. Coordinate light switch locations with door swings prior to rough-in. No switches permitted behind doors.

M. Coordinate electrical work with architectural items and equipment. Typical equipment refers to, but is not limited to, the following:

1. Countertops, Casework and Cabinets.
2. Fume and Exhaust Hoods.
3. Kitchen equipment.
4. Do not install outlets, switches, etc., behind casework, cabinets, etc.
5. Data, phone, and other low voltage system outlets shall be mounted above the counter tops to match power outlets in the same areas.
6. Coordinate counter top outlets with drilling of casework/counters.
7. Coordinate surface raceways and outlets above and below counters with approved casework shop drawings to avoid conflicts with sinks and other appurtenances.
8. Verify lab/kitchen equipment nameplates and connection requirements prior to rough-in.
9. Shop equipment connections, including busways.

N. This Contractor shall make all system connections required to equipment furnished and installed under other divisions. Connections shall be complete in all respects to render this equipment functional to its fullest intent. The Contractor shall make all system connections required to equipment furnished under other Divisions. Circuits shall be extended to all equipment which is incidental to, but not necessarily shown, for equipment specified under other divisions such as magnetic flow meters, ATC panels, liquid level controls, leak detection systems, etc. Connections shall be complete in all respects to render this equipment functional to its fullest extent.

O. It shall be the responsibility of the Contractor to obtain complete instructions for connections.

3.6 GUARANTEE:

A. Guarantee obligations shall be as hereinbefore specified in the GENERAL AND SPECIAL CONDITIONS of these specifications, except as follows:

1. Guarantee the complete electrical system free from all mechanical and electrical defects for the period of two (2) years beginning from the day of final acceptance of the work by the Owner.
2. Also, during the guarantee period, be responsible for the proper adjustments of all systems, equipment and apparatus installed by the Contractor and do all work necessary to ensure efficient and proper functioning of the systems and equipment.
3. Upon receipt of notice from the Owner of failure of any part of the electrical installation during the guarantee period, new replacement parts shall be furnished and installed promptly at no cost.

4. Warranty From the Manufacturer: Contractor shall obtain all warranty papers and records from the Original Equipment Manufacturer according to their warranty policy and deliver the same to the Owner. Contractor shall fulfill all the Original Manufacturer's requirements to validate the warranty as offered by the Original Equipment Manufacturer.

B. Provide 24-hour service for any and all warranty problems experience in the operation of the equipment provided.

C. Any equipment or system in need of warranty work whether during regular hours or on an emergency basis, shall be immediately serviced and repaired. The warranty work and guarantee shall include all parts and labor and shall be furnished at no cost to the Owner.

D. The Contractor shall guarantee to make good any and all defects in his work, exclusive of lamps, which may develop due to defective workmanship or materials, within one year from the date of final acceptance of the work by the Owner.

E. In addition to the warranty and correction of work obligations contained in the General and supplementary Conditions, correct the work of the system as embraced by the Specification, free from Mechanical and Electrical defects for the warranty period beginning from the day of acceptance of the building by the Architect for the beneficial use of the Owner.

F. During the warranty period, take responsibility for the proper adjustments of systems, equipment and apparatus installed and perform work necessary to ensure the efficient and proper functioning of the systems and equipment.

G. Certain items of equipment hereinafter specified shall be guaranteed for a longer time than the general warranty period. These guarantees shall be strictly adhered to and the Contractor shall be responsible for service or replacement required in connection with guarantee of these items. These guarantees shall commence on the same date as the final acceptance by the Architect.

H. Submission of a bid proposal for this Project warrants that the Contractor has reviewed the Contract Documents and has found them free from ambiguities and sufficient for the construction and proper operation of systems installed for this project. If discrepancies are found, have them clarified by Addendum.

I. It is possible that certain areas of the building or certain systems will be accepted at a time different than as specified. The date of acceptance by the Architect for beneficial use of the Owner for these building areas or systems will be adjusted accordingly.

3.7 SCHEDULING OF WORK:

A. The Contractor shall not be permitted to do any work in any area of any occupied building during normal hours, except in areas specifically assigned.

B. Coordination of work by the Contractor is essential such that power outages are kept to a minimum in quantity and duration. All required outages shall be approved by the Owner for optimum time scheduling. Written notice of not less than 15 calendar days shall precede all power outages.

3.8 TEMPORARY FACILITIES:

A. General: Refer to the Division 1 Sections for general requirements on temporary facilities.

B. Description: Furnish and install the necessary metering and distribution equipment or an adequate, 3-phase, 4 wire temporary service and all temporary wiring, including step-down or step-up dry-type transformers. Exact requirements for temporary service will be determined by the Contractor.

C. The Contractor’s attention is directed to the Occupational Safety and Health Act, Americans with Disabilities Act and NEC requirements for electrical work on construction sites.

D. Materials: Lights at each floor in each stair. At least one light outlet per 1200 square feet on each floor, exclusive of stairs.

1. One 20-ampere circuit for each 7500 square feet of gross floor area per floor to which various trades may attach their cords.
2. One temporary 220v power online in corridor (each elevator lobby) including connections to saws, fireproofing equipment and wood sanding equipment, if required.
3. Power for testing and operating of elevators.
4. Temporary lighting for stripping forms for all floors below grade.
5. Power for crane operation.

E. Installation: Temporary lighting shall provide minimum foot candle levels for construction as follows:

AREA	FOOT CANDLE LEVEL
General construction area lighting, corridors, hallways and exit ways.	10
Electrical equipment rooms, active storerooms, shops, locker and dressing areas	10

F. The Contractor shall pay for all material and labor to provide and maintain temporary service.

G. The Contractor shall obtain and pay for temporary electrical service for construction power.

H. Provide all underground and/or overhead equipment, transformers, overcurrent devices, wires, connections, etc., for obtaining power from utility company lines.

I. Remove all temporary power installations and connections after permanent power is established and/or prior to completion of the project.

3.9 DEMONSTRATION:

A. As a part of this contract, the Contractor shall provide for the services of equipment manufacturers or their established representatives to demonstrate to selected maintenance personnel the correct operation, safety and maintenance of all electrical equipment under this contract.

3.10 PAINTING AND FINISHES:

A. Provide protective finishes on all materials and equipment. Use coated or corrosion-resistant materials, hardware and fittings throughout the work. Paint bare, untreated ferrous surfaces with rust-inhibiting paint. All exterior components including supports, hangers, nuts, bolts, washers, vibration isolators, etc., shall be galvanized or stainless steel.

B. Clean surfaces prior to application of coatings, paint, or other finishes.

C. Provide factory-applied finishes where specified. Unless otherwise indicated factory-applied paints shall be baked enamel with proper pre-treatment.

D. Protect all finishes and restore any finishes damaged as a result of work under Division 26 to their original condition.

E. The preceding requirements apply to all work, whether exposed or concealed.

F. Remove all construction marking and writing from exposed equipment, conduit, and building surfaces. Do not paint manufacturer's labels or tags.

G. All exposed conduit, etc., shall be painted, except in electrical rooms, mechanical rooms, storage rooms, and crawl spaces. Colors shall be selected by the Architect and conform to ANSI Standards.

H. Submit color of factory-finished equipment for approval prior to ordering.

3.11 PROTECTION OF WORK:

A. Protect work, material and equipment from weather and construction operations before and after installation. Properly store and handle all materials and equipment.

B. Cover temporary openings in conduit and equipment to prevent the entrance of water, dirt, debris, or other foreign matter.

C. Cover or otherwise protect all finishes.

D. Replace damaged materials, devices, finishes and equipment.

3.12 OPERATION OF EQUIPMENT:

A. Clean all systems and equipment prior to initial operation for testing, retesting, or other purposes. Set, adjust, and test all equipment in accordance with manufacturer's instructions. Do not operate equipment unless all proper safety devices or controls are operational. Provide all maintenance and service for equipment that is authorized for operation during construction.

B. Where specified, or otherwise required, provide the services of the manufacturer's factory-trained servicemen or technicians to start up the equipment.

C. Do not use electrical systems for temporary services during construction unless authorized in writing by the Owner. Where such authorization is granted, temporary use of equipment shall in no way limit or otherwise affect warranties or guaranty period of the work.

D. Upon completion of work, clean and restore all equipment to new conditions; replace expendable items such as filters.

3.13 TESTING AND ADJUSTMENT

A. Perform all tests which are specified or required to demonstrate that the work is installed and operating properly. Where formal tests are required, give proper notices and perform all necessary preliminary tests to assure that the work is complete and ready for final test.

B. Adjust all systems, equipment and controls to operate in a safe, efficient and stable manner.

C. On all circuits, 600 volts or less, provide circuits that are free from ground faults, short circuits and open circuits.

D. Other tests of a specific nature for special equipment shall be as specified under the respective equipment.

3.14 IDENTIFICATIONS, ELECTRICAL DIAGRAMS AND OPERATING INSTRUCTIONS:

A. Contractor shall submit for approval schematic diagrams of each electrical system installed in the building. Diagrams shall indicate device location, service, type, make, model number and the identification number of each device in the particular system. Following approval by all authorities, the diagrams shall be framed, mounted under glass and hung in each Main Equipment Room where directed. Contractor shall deliver the tracing or sepia from which the diagrams were reproduced to the Owner.

B. All equipment shall be plainly tagged.

C. All items of equipment, including motor starters, panels, etc., shall be furnished with white letters and numbers on black plastic identification plates or aluminum letters and numbers on black engraved aluminum identification plates. Lettering shall be a minimum of 1/4" high. Identification plates shall be securely affixed to each piece of equipment, starters, panels, etc., by screws or adhesive (Tuff-Bond #TB2 or as approved equal). Pressure sensitive tape backing is prohibited.

D. Provide three (3) copies of operating and maintenance instructions for all principal items of equipment furnished. This material shall be bound as a volume of the "Record and Information Booklet" as hereinafter specified.

E. Provide at least 24 hours of straight time instruction to the operating personnel. This instruction period shall consist of not less than three (3) consecutive 8-hour days. Time of instruction shall be designated by the Owner. Provide two DVD video taped copies of all instructional periods/demonstrations.

3.15 RECORD DRAWINGS AND SPECIFICATIONS:

A. Upon completion of the Electrical installations, the Contractor shall deliver to the Engineer one complete set of prints of the Electrical Contract Drawings which shall be legibly marked in red pencil to show all Addenda, approved Shop Drawings, Change Orders, changes and departures of the installation as compared with the original design. They shall be suitable for use in preparation of Record Drawings. Provide electronic copies of each.

B. The Contractor shall provide a record specification including all Addenda and other modifications. Record substantial variations in actual work performed. Identify all substitutions.

3.16 RECORD AND INFORMATION BOOKLET:

A. The Contractor shall have prepared three (3) copies of the Record and Information Booklet as well as an electronic copy and deliver these copies of the booklet to the Owner. The booklet shall be as specified herein. The booklet must be approved and will not be accepted as final until so stamped.

B. The booklet shall be bound in a three-ring loose-leaf binder similar to "National" No. 3881 with the following title lettered on the front and on the spine of the binder: "Record and Information Booklet (insert name of the project)". No sheets larger than 8-1/2" x 11" shall be used, except sheets that may be neatly folded to 8-1/2" x 11" and used as a pull-out. An Index will include the section tabs for each subject included. If more than one binder is required, print covers and spines with Volume numbers. Include in the front of every binder an index to all binders.

1. Internally subdivide the binder contents with permanent page dividers, logically organized as described below; with tab titling clearly printed under reinforced laminated plastic tabs.

2. Contents: Prepare a Table of Contents for each volume, with each product or system description identified, typed on white paper.

3. Part 1: Directory, listing names, addresses, and telephone numbers of Electrical Engineers; Contractor; Electrical Subcontractors; and major Electrical equipment suppliers. Provide sales and service representative names and phone numbers of all equipment.

4. Part 2: Operation and Maintenance Instructions, arranged by Specification Section. For each category, identify names, addresses, and telephone numbers of Subcontractors and suppliers. Identify the following:

a. Significant design criteria.

b. List of equipment. Complete record of material list. Catalog brochures and product data for all components. Include all submittal comments, and corrected catalog data and shop drawings on each piece of equipment and each system.

c. Parts list for each component, including recommended spare parts list. Include motor starter overload schedules.

d. Operating instructions, including sequence of operation.

1) Description of function, normal operating characteristics and limitations, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts. Provide a description of each system installed.

2) Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; control, stopping.

e. Maintenance instructions for equipment and systems. Detailed checkout procedures to insure operation of systems and gear, including recommended cleaning methods and materials and special precautions identifying detrimental agents.

f. Servicing, diagnostic and troubleshooting instructions and procedures for systems and major equipment.

g. Recommended preventative maintenance program, including a list of items requiring inspection and servicing. Provide Chart Form indicating time and type of routine and preventative maintenance of electrical equipment, etc. The chart shall also indicate tag number, model number of equipment, location and service.

1) For replacement items, indicate type, size and quantity of the replaceable items.

2) Provide lubrication schedule, including type, grade, temperature range and frequency.

3) Provide a list of each type of lighting fixture lamp used, lamp fixture used, and source.

4) Include estimated mean time between failures for major parts.

h. Wiring Diagrams, Block Diagrams, and Assembly Drawings.

i. Panelboard Circuit Directory for each panelboard, including Panel Name, Panel Location, Panel Ratings, spare circuit breakers, spaces for additional circuit breakers.

j. List of equipment keys turned over to the Owner.

5. Part 3: Project Documents and Certificates, including the following:

a. Shop Drawings and Product Data. Record Documents of the systems.

b. Photocopies of certificates.

c. Photocopies of Manufacturers' and Contractors' warranties, guarantees.

d. Test Reports: Copies of the approved results of all tests required under all sections of specifications.

e. Inspection Certificates.

f. Manufacturer's Conformance Certificates.

6. Provide one copy (DVD video disk) of video instruction session with each booklet set. Label video disk with all pertinent information.

7. Submit one copy of completed volumes in final form 15 days prior to final Inspection. This copy will be returned with Engineer comments. Revise content of documents as required prior to final submittal.

8. Submit final volumes revised, within ten days after final inspection.

C. Upon completion of the project, the Contractor shall furnish the Owner a complete list of suppliers of equipment for parts and maintenance purposes. The list shall include the name, address, and telephone number of the parts and maintenance firm on a single 8-1/2" x 11" sheet of paper.

D. This item shall include the furnishing of a complete list of equipment installed on the project, including the Manufacturer's name, the make and model number of the equipment, and address

and telephone number of the nearest supplier who stocks maintenance and/or replacement parts. The list should be submitted along with as-built drawings and be typed in an organized manner.

3.18 INSTALLATION AND COORDINATION DRAWINGS:

A. In congested areas, prepare, submit, and use composite installation and coordination drawings to assure proper coordination and installation of work. Drawings shall include, but not be limited, to the following: Complete Electrical Drawings showing coordination with lights, electrical equipment, mechanical, plumbing, HVAC, structural, and architectural elements and provision for access.

B. Draw plans to a scale not less than 3/8-inch equals one foot. Include plans, sections, and elevations of proposed work, showing all equipment and conduit in areas involved. Fully dimension all work including lighting fixtures, conduits, pullboxes, panelboards, and other electrical work, walls, doors, ceilings, columns, beams, joists, mechanical equipment, and other architectural and structural work.

C. Identify all equipment and devices on wiring diagrams and schematics. Where field connections are shown to factory-wired terminals, include manufacturer's literature showing internal wiring.

END OF SECTION

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SECTION 26 05 19

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Building wires and cables rated 600 V and less.

2. Connectors, splices, and terminations rated 600 V and less.

1.3 REFERENCES

A. The following are useful in specifying conductors and cables. Other references may be needed for design purposes.

ASTM International

ASTM A 53/A 53M-01: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

Code of Federal Regulations

29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Subpart A - "General," Section 1910.7 - "Definition and Requirements for a Nationally Recognized Testing Laboratory." 2003.

InterNational Electrical Testing Association

NETA Acceptance Testing Specification-2003: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

National Electrical Manufacturers Association

NEMA WC 70-99: Non-Shielded Power Cable 2000 V or less

NFPA

NFPA 70-02: National Electrical Code

Underwriters Laboratories Inc.

UL 486A-98 (2001): Wire Connectors and Soldering Lugs for Use with Copper Conductors

UL 486B-98 (2001): Wire Connectors for Use with Aluminum Conductors

1.4 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.5 SUBMITTALS

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

B. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 PRODUCTS

2.1 CONDUCTORS AND CABLES

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

1. American Insulated Wire Corp.; a Leviton Company.
2. General Cable Corporation.
3. Southwire Company.

B. Copper Conductors: Comply with NEMA WC 70.

C. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for metal-clad cable, Type MC**,** with ground wire.

2.2 CONNECTORS AND SPLICES

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

1. Hubbell Power Systems, Inc.
2. O-Z/Gedney; EGS Electrical Group LLC.
3. 3M; Electrical Products Division.

B. Description: Factory-fabricated compression-type connectors and splices of size, ampacity rating, material, type, and class for application and service indicated. Connectors shall be sized for the quantity and size of conductors to be terminated thereon.

C. Split Bolt Connectors: Not Acceptable.

D. Solderless Pressure Connectors: High copper alloy terminal. May be used only for cable termination to equipment pads or terminals. Not approved for splicing.

E. Spring Wire Connectors: Solderless spring type pressure connector with insulating covers for copper wire splices and taps. Use for conductor sizes 10 AWG and smaller.

F. All wire connectors used in underground or exterior pull boxes shall be gel-filled twist connectors or a connector designed for damp and wet locations.

G. Mechanical Connectors: Bolted type tin-plated; high conductivity copper alloy; spacer between conductors; beveled cable entrances.

H. Compression (crimp) Connectors: Long barrel; seamless, tin-plated electrolytic high conductivity copper tubing, internally beveled barrel ends. Connector shall be clearly marked with the wire size and type and proper number and location of crimps.

I. Heat shrinkable tubing shall meet the requirements of ANSI C119.1-1986 for buried connections to 90°C and shall be material flame-retarded per IEEE 383 “Vertical Tray Flame Test”. Motor connection kits shall consist of heat-shrinkable, polymeric insulating material over the connection area and a high dielectric strength mastic to seal the ends against ingress of moisture and contamination. Motor connection kits shall accommodate a range of cable sizes for both in-line and stub-type configurations. Connection kits shall be independent of cable manufacturer’s tolerances.

J. Wire Nut Connectors:

1. Wire nuts install in wet locations, exterior, etc., shall be self-contained, waterproof and corrosion-proof units incorporating prefilled silicone grease to block out moisture and air.
2. Connectors shall be UL listed appropriately sized according to manufacturer's recommendation for the suitable wire sizes and voltage rating (600 volt minimum).
3. Connectors body shall have a color-coded outer shell.
4. Connectors shall be as manufactured by King Technology or approved equal.

PART 3 EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

C. Minimum conductor size No. 12 AWG for power circuits and No. 14 for control circuits.

3.2 CONDUCTOR INSULATION APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway. Exposed feeders may be provided in Mechanical, Electrical and Telecommunications Spaces only.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

E. Exposed Branch Circuits, Including in Crawlspaces: Type THHN-THWN, single conductors in raceway. Exposed branch circuits may be provided in Mechanical, Electrical and Telecommunications Spaces only.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway.

G. Branch Circuits Concealed, below Slabs-on-Grade, and Underground: Type THHN-THWN, single conductors in raceway.

H. Class 1 Control Circuits: Type THHN-THWN, in raceway.

I. Class 2 Control Circuits: Type THHN-THWN, in raceway.

J. Conductors shall be rated 75 deg C in wet locations and 90 deg C in dry locations.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Division 26 Section "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. 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.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Division 26 Section "Hangers and Supports for Electrical Systems."

G. Identify and color-code conductors and cables according to Division 26 Section "Identification for Electrical Systems."

3.4 CONNECTIONS & SPLICES

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. Make splices for power conductors in outlet, junction or pull boxes only.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.5 NEUTRAL CONDUCTORS

A. Shared neutral conductors are not acceptable. Provide dedicated neutral conductor for each branch circuit requiring a neutral conductor.

3.6 CONDUCTORS AMPERE CAPACITY DE-RATING

A. Do not combine more than three (3) current carrying conductors in single conduit raceway or wireway.

3.7 MC TYPE CABLES

A. MC type cables shall not be used, except for the last 6’-0” connection to ceiling-mounted lighting fixtures.

3.8 AC, USE and SO TYPE CABLES

A. AC, USE and SO cables shall not be used.

3.9 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Division 07 Section "Penetration Firestopping."

3.10 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Testing: On installation of wires and cables and before electrical circuitry has been energized, demonstrate product capability and compliance with requirements.

C. Procedures: Perform each visual and mechanical inspection and electrical test stated in NETA ATS Section 7.3.1. Certify compliance with test parameters.

D. Correct malfunctioning conductors and cables at Project site, where possible, and retest to demonstrate compliance; otherwise, remove and replace with new units and retest.

E. Measure tightness of bolted connections and compare torque measurements with manufacturer’s recommended values.

F. Verify continuity of each branch circuit conductor.

G. Tests: All Power & Lighting Distribution Feeders, including transformer primary and secondary feeders as well as feeders to all major mechanical equipment rated 60A and larger (i.e., chillers, AHU’s, etc.).

1. Tests shall be performed with a 1000-volt megger, and conductors shall test free from short-circuits and grounds.
2. Conductors shall be tested phase-to-phase and phase-to-ground.
3. Furnish the instruments, materials, and labor required. Perform the tests in the presence of the Contracting Officer.
4. Test readings shall be recorded and delivered to Owner and Engineer in a report.
5. Copy of Test results shall be included in O&M Manuals.

H. Demonstration: Subsequent to wire and cable hook-ups, energize circuit and demonstrate functioning in accordance with requirements. Where necessary, correct malfunctioning units, and then retest to demonstrate compliance.

I. Test and Inspection Reports: Prepare a written report to record the following:

1. Procedures used.
2. Results that comply with requirements.
3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

J. Cables will be considered defective if they do not pass tests and inspections.

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SECTION 26 05 26

ROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

B. This document applies to the work of Divisions 26, 27 and 28.

1.2 SUMMARY

A. This Section includes methods and materials for grounding systems and equipment, plus the following special applications:

1. Underground distribution grounding.

2. Common ground bonding with lightning protection system.

1.3 REFERENCES

A. The following references are useful in specifying grounding and bonding. Other references may be needed for design purposes.

ASTM International

ASTM B 3-01 (Reapproved 2007): Specification for Soft or Annealed Copper Wire

ASTM B 8-04: Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard or Soft

ASTM B 33-04: Specification for Tinned Soft or Annealed Copper Wire for Electrical Purposes

The Institute of Electrical and Electronics Engineers, Inc.

IEEE 81-1983: Guide for Measuring Earth Resistivity, Ground Impedance, and Earth Surface Potentials of a Ground System

IEEE C2-2007: National Electrical Safety Code (ANSI)

InterNational Electrical Testing Association

NETA MTS-2007: Maintenance Testing Specifications

NFPA

NFPA 70-2008: National Electrical Code

NFPA 70B-2006: Recommended Practice for Electrical Equipment Maintenance

NFPA 780-2008: Installation of Lightning Protection Systems

Telecommunications Industry Association/Alliance for Telecommunications Industry Solutions

TIA/ATIS J-STD-607-A-2002: Commercial Building Grounding (Earthing) and Bonding Requirements for Telecommunications (ANSI)

Underwriters Laboratories Inc.

UL 96-2005: Lightning Protection Components

UL 467-2007: Grounding and Bonding Equipment

UL 891-2005: Switchboards

1.4 ACTION SUBMITTALS

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

1.5 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.6 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include the following in emergency, operation, and maintenance manuals:

1. Instructions for periodic testing and inspection of grounding features at test wells and grounding connections for separately derived systems based on NETA MTS.
    a. Tests shall be to determine if ground resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if they do not.
    b. Include recommended testing intervals.

1.7 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

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

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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. Burndy; Part of Hubbell Electrical Systems.
2. ERICO International Corporation.
3. Fushi Copperweld Inc.
4. Galvan Industries, Inc.; Electrical Products Division, LLC.
5. Harger Lightning and Grounding.
6. ILSCO.
7. O-Z/Gedney; A Brand of the EGS Electrical Group.

2.2 SYSTEM DESCRIPTION

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 UL 467 for grounding and bonding materials and equipment.

2.3 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. Tinned Conductors: ASTM B 33.

4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.

5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors, terminated with copper ferrules; 1-5/8 inches (41 mm) wide and 1/16 inch (1.6 mm) thick.

C. Bare Grounding Conductor and Conductor Protector for Wood Poles:

1. No. 4 AWG minimum, soft-drawn copper.

2. Conductor Protector: Half-round PVC or wood molding. If wood, use pressure-treated fir or cypress or cedar.

D. Grounding Bus: Rectangular bars of annealed copper, 1/4 by 4 inches (6 by 50 mm) in cross section, unless otherwise indicated; with insulators.

2.4 CONNECTORS

A. Listed and labeled by a nationally recognized testing laboratory acceptable to authorities having jurisdiction for applications in which used, and for specific types, sizes, and combinations of conductors and other items connected.

B. Bolted Connectors for Conductors and Pipes: Copper or copper alloy, bolted pressure-type, with at least two bolts.

1. Pipe Connectors: Clamp type, sized for pipe.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

D. Busbar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet (19 mm by 3 m) in diameter.

PART 3 EXECUTION

3.1 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 AWG and smaller, and stranded conductors for No. 8 AWG and larger, unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.

C. Isolated Grounding Conductors: Green-colored insulation with continuous yellow stripe. On feeders with isolated ground, identify grounding conductor where visible to normal inspection, with alternating bands of green and yellow tape, with at least three bands of green and two bands of yellow.

D. Grounding Bus: Install in electrical and telephone equipment rooms, in rooms housing service equipment.

1. Install bus horizontally, on insulated spacers 1 inch (25 mm), minimum, from wall 6 inches (150 mm) above finished floor.

E. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors, except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.

4. Connections to Structural Steel: Welded connectors.

3.2 GROUNDING AT THE SERVICE

A. Equipment grounding conductors and grounding electrode conductors shall be connected to the ground bus. Install a main bonding jumper between the neutral and ground buses.

3.3 GROUNDING UNDERGROUND DISTRIBUTION SYSTEM COMPONENTS

A. Comply with IEEE C2 and PEPCO grounding requirements.

B. Grounding Manholes and Handholes: Install a driven ground rod through manhole or handhole floor, close to wall, and set rod depth so 4 inches (100 mm) will extend above finished floor. If necessary, install ground rod before manhole is placed and provide No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive insulating tape or heat-shrunk insulating sleeve from 2 inches (50 mm) above to 6 inches (150 mm) below concrete. Seal floor opening with waterproof, nonshrink grout.

C. Grounding Connections to Manhole Components: Bond exposed-metal parts such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 4 AWG minimum, stranded, hard-drawn copper bonding conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.

D. Pad-Mounted Transformers and Switches: Install four ground rods and ground ring around the pad. Ground pad-mounted equipment and noncurrent-carrying metal items associated with substations by connecting them to underground cable and grounding electrodes. Install tinned-copper conductor not less than No. 4/0 AWG for ground ring and for taps to equipment grounding terminals. Bury ground ring not less than 6 inches (150 mm) from the foundation.

3.4 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. Isolated Equipment Enclosure Circuits: For designated equipment supplied by a branch circuit or feeder, isolate equipment enclosure from supply circuit raceway with a nonmetallic raceway fitting listed for the purpose. Install fitting where raceway enters enclosure, and install a separate insulated equipment grounding conductor. Isolate conductor from raceway and from panelboard grounding terminals. Terminate at equipment grounding conductor terminal of the applicable derived system or service, unless otherwise indicated.

E. Signal and Communication Equipment: For telephone, alarm, voice and data, and other communication equipment, provide No. 4 AWG minimum insulated grounding conductor in raceway from grounding electrode system to each service location, terminal cabinet, wiring closet, and central equipment location.

1. Service and Central Equipment Locations and Wiring Closets: Terminate grounding conductor on a 1/4-by-2-by-12-inch (6-by-50-by-300-mm) grounding bus.

2. Terminal Cabinets: Terminate grounding conductor on cabinet grounding terminal.

F. Metal Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

G. Metallic Fences: Comply with requirements of IEEE C2.

1. Grounding Conductor: Bare**,** tinned copper, not less than No. 8 AWG.

2. Gates: Shall be bonded to the grounding conductor with a flexible bonding jumper.

3.5 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. Common Ground Bonding with Lightning Protection System: Comply with NFPA 780 and UL 96 when interconnecting with lightning protection system. Bond electrical power system ground directly to lightning protection system grounding conductor at closest point to electrical service grounding electrode. Use bonding conductor sized same as system grounding electrode conductor, and install in conduit.

C. Ground Rods: Drive rods until tops are 2 inches (50 mm) 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.

D. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Division 26 Section "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches (300 mm) deep, with cover.

1. Test Wells: Install at least one test well for each service, unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

E. 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.

F. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes, using a bolted clamp connector or by bolting a lug-type connector to a pipe flange, using one of the lug bolts of the flange. Where a dielectric main water fitting is installed, connect grounding conductor on street side of fitting. Bond metal grounding conductor conduit or sleeve to conductor at each end.

2. Water Meter Piping: Use braided-type bonding jumpers to electrically bypass water meters. Connect to pipe with a bolted connector.

3. Bond each aboveground portion of gas piping system downstream from equipment shutoff valve.

G. 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.

H. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet (18 m) apart.

I. Ufer Ground (Concrete-Encased Grounding Electrode): Fabricate according to NFPA 70, using a minimum of 20 feet (6 m) of bare copper conductor not smaller than No. 4 AWG.

1. If concrete foundation is less than 20 feet (6 m) 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.

3.6 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. If concrete foundation is less than 20 feet (6 m) long, coil excess conductor within base of foundation.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal**,** at ground test wells, and at individual ground rods. 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.

b. Perform tests by fall-of-potential method according to IEEE 81.

4. 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.

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

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity 500 kVA and Less: 5 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. Power Distribution Units or Panelboards Serving Electronic Equipment: 3 ohm(s).
5. Substations and Pad-Mounted Equipment: 5 ohms.
6. Manhole Grounds: 5 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION

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SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.

2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Division 26 Section "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.3 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.4 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. 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.

1.5 ACTION SUBMITTALS

A. Product Data: For the following:

1. Steel slotted support systems.

2. Nonmetallic slotted support systems.

B. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.

2. Steel slotted channel systems. Include Product Data for components.

3. Nonmetallic slotted channel systems. Include Product Data for components.

4. Equipment supports.

1.6 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.7 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.8 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Division 07 Section "Roof Accessories."

PART 2 PRODUCTS

2.1 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide slotted metal angle and U-channel systems by one of the following:

a. Thomas & Betts Corporation.

b. Alstrut.

c. Unistrut; Diversified Products

d. Power-Strut.

2. Manufacturers: Subject to compliance with requirements, provide conduit sealing bushings and accessories by one of the following:

a. Bridgeport Fittings

b. GS Metals, Corporation

c. O-Z / Gedney

d. Raco, Inc.

3. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.

4. Painted Coatings: Manufacturer's standard painted coating applied according to MFMA-4.

5. 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. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

F. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    a. Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
        1) Hilti Inc.
        2) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        3) MKT Fastening, LLC.
        4) Simpson Strong-Tie Co., Inc.; Masterset Fastening Systems Unit.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    a. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
        1) Cooper B-Line, Inc.; a division of Cooper Industries.
        2) Empire Tool and Manufacturing Co., Inc.
        3) Hilti Inc.
        4) ITW Ramset/Red Head; a division of Illinois Tool Works, Inc.
        5) MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.2 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Division 05 Section "Metal Fabrications" for steel shapes and plates.

C. Submit structural calculations for load and strength of each component and detailing of each assembly.

PART 3 EXECUTION

3.1 APPLICATION

A. Comply with NECA 1 and NECA 101 for application of hangers and supports for electrical equipment and systems except if requirements in this Section are stricter.

B. Maximum Support Spacing and Minimum Hanger Rod Size for Raceway: Space supports for EMT, IMC, and RMC as required by NFPA 70. Minimum rod size shall be 1/4 inch (6 mm) in diameter.

C. Multiple Raceways or Cables: Install trapeze-type supports fabricated with steel slotted or other 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.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lb (90 kg).

C. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:

1. To Wood: Fasten with lag screws or through bolts.

2. To New Concrete: Bolt to concrete inserts.

3. To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.

4. To Existing Concrete: Expansion anchor fasteners.

5. To Steel: Beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69.

6. To Light Steel: Sheet metal screws.

7. Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.

D. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.3 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Division 05 Section "Metal Fabrications" for site-fabricated metal supports.

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

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

3.4 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches (100 mm) larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Division 03 Section "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.5 PAINTING

A. Touchup: Clean field welds and abraded areas of shop paint. Paint exposed areas immediately after erecting hangers and supports. Use same materials as used for shop painting. Comply with SSPC-PA 1 requirements for touching up field-painted surfaces.

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils (0.05 mm).

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

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SECTION 26 05 33

RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes raceways, fittings, boxes, enclosures, and cabinets for electrical wiring.

B. Related Sections include the following:

1. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for exterior ductbanks, handholes, and underground utility construction.

1.3 REFERENCES

A. The following are useful in specifying raceways and boxes. Other references may be needed for design purposes.

American National Standards Institute

ANSI C80.1-1994: Rigid Steel Conduit - Zinc Coated (GRC)

ANSI C80.3-1994: Electrical Metallic Tubing - Zinc Coated (EMT)

ANSI C80.5-1994: Aluminum Rigid Conduit - Zinc Coated (ARC)

ANSI C80.6-1994: Intermediate Metal Conduit - Zinc Coated (IMC)

ASTM International

ASTM A 53/A 53M-01: Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless

International Organization for Standardization (1, rue de Varembe, Case postale 56, CH-1211 Geneva 20, Switzerland; +41-22-749-01-11; www.iso.ch/iso/en/ISOOnline.frontpage)

ISO 9000-00: Quality Management

ISO 10012-03: Measurement Management Systems

National Electrical Contractors Association

NECA 1-00: Standard Practice for Good Workmanship in Electrical Construction

National Electrical Manufacturers Association

NEMA 250-03: Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA FB 1-01: Fittings, Cast Metal Boxes, and Conduit Bodies for Conduit, Electrical Metallic Tubing and Cable

NEMA OS 1-96: Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports

NEMA OS 2-98: Nonmetallic Outlet Boxes, Device Boxes, Covers, and Box Supports

NEMA RN 1-98: Polyvinyl-Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit

NEMA TC 2-03: Electrical Polyvinyl Chloride (PVC) Conduit

NEMA TC 3-99: PVC Fittings for Use with Rigid PVC Conduit and Tubing

NEMA TC 13-00: Electrical Nonmetallic Tubing (ENT)

NFPA

NFPA 70-02: National Electrical Code

Society of Cable Telecommunications Engineers (140 Phillips Rd., Exton, PA 19341-1318; 800-542-5040; 610-363-6888; www.scte.org)

SCTE 77-02: Specification for Underground Enclosure Integrity

Underwriters Laboratories Inc.

UL 514B-97: Fittings for Cable and Conduit

UL 886-94: Outlet Boxes and Fittings for Use in Hazardous (Classified)

UL 1660-00 (Rev. 02): Liquid-Tight Flexible Nonmetallic Conduit

UL 2024-02: Optical Fiber Cable Raceway

1.4 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. EPDM: Ethylene-propylene-diene terpolymer rubber.

C. IMC: Intermediate metal conduit.

D. LFMC: Liquidtight flexible metal conduit.

E. NBR: Acrylonitrile-butadiene rubber.

F. RNC: Rigid nonmetallic conduit.

G. PVC: Polyvinyl Chloride.

1.5 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. LEED Submittals:

1. Product Data for Credit IEQ 4.1: For solvent cements and adhesive primers, documentation including printed statement of VOC content.

1.6 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Conduit routing plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of items involved:

1. Structural members in paths of conduit groups with common supports.

2. HVAC and plumbing items and architectural features in paths of conduit groups with common supports.

B. Seismic Qualification Certificates: For enclosures, cabinets, and conduit racks and their mounting provisions, including those for internal 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.

4. Detailed description of conduit support devices and interconnections on which the certification is based and their installation requirements.

C. Source quality-control reports.

PART 2 PRODUCTS

2.1 METAL CONDUIT AND TUBING

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

1. Allied Tube & Conduit; a Tyco International Ltd. Co.
2. O-Z Gedney; a unit of General Signal.
3. Wheatland Tube Company.

B. Rigid Steel Conduit: ANSI C80.1 and UL 6.

C. IMC: ANSI C80.6 and UL 1242.

D. EMT: ANSI C80.3 and UL 797.

E. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

A. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:
   a. Material: Steel.
   b. Type: compression.
3. Expansion Fittings: PVC or steel to match conduit type, complying with UL 651, rated for environmental conditions where installed, and including flexible external bonding jumper.
4. Coating for Fittings for PVC-Coated Conduit: Minimum thickness of 0.040 inch (1 mm), with overlapping sleeves protecting threaded joints.
5. Fasten rigid steel conduit with threaded galvanized steel fittings, double locknuts, and insulated bushings. Insulated bushings shall be "O.Z. Gedney" type "B", or equal.
6. Fasten EMT conduit with "Concretight" or "Raintight" compression fittings made from galvanized steel or malleable iron. Fittings using set screw or indentations as a means of attachment or made from cast "white metal" are prohibited. All connectors shall have insulated throats.
7. Fasten liquid-tight conduit with fittings incorporating a threaded ferrule, nylon sealing ring, and steel or malleable iron compression nut and body. Furnish Crouse Hinds metallic liquid-tight fittings, or equal.
8. Fasten flexible metallic conduit with T&B "Tite-Bite" insulated connectors, or equal.

B. Joint Compound for Rigid Steel Conduit or IMC: Listed for use in cable connector assemblies, and compounded for use to lubricate and protect threaded raceway joints from corrosion and enhance their conductivity.

2.2 NONMETALLIC CONDUIT AND TUBING

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

1. Anamet Electrical, Inc.; Anaconda Metal Hose.

2. Lamson & Sessions; Carlon Electrical Products.
3. RACO; a Hubbell Company.
4. Thomas & Betts Corporation.

B. Listing and Labeling: Nonmetallic conduits, tubing, and fittings shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

C. RNC: Type EPC-40-PVC, complying with NEMA TC 2 and UL 651 unless otherwise indicated.

D. LFNC: Comply with UL 1660.

E. Fittings for ENT and RNC: Comply with NEMA TC 3; match to conduit or tubing type and material.

F. Fittings for LFNC: Comply with UL 514B.

G. Solvent cements, adhesives, adhesive primers applied within the building waterproofing envelope: Comply with low-emitting requirements in Division 01 Section “Indoor Air Quality Requirements.”

2.3 OPTICAL FIBER/COMMUNICATIONS CABLE RACEWAY AND FITTINGS

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

1. Arnco Corporation.
2. Endot Industries Inc.
3. IPEX Inc.
4. Lamson & Sessions; Carlon Electrical Products.

B. Description: Comply with UL 2024; flexible type, approved for general-use installation.

2.4 METAL WIREWAYS AND AUXILIARY GUTTERS

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

1. Cooper B-Line, Inc.
2. Hoffman.
3. Square D; Schneider Electric.

B. Description: Sheet metal sized and shaped as indicated, NEMA 250, Type 1, unless otherwise indicated.

C. Fittings and Accessories: Include couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

D. Wireway Covers: Screw-cover type.

E. Finish: Manufacturer's standard enamel finish.

2.5 BOXES, ENCLOSURES, AND CABINETS

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

1. Cooper Crouse-Hinds; Div. of Cooper Industries, Inc.

2. Hoffman.
3. Hubbell Incorporated; Killark Electric Manufacturing Co. Division.
4. O-Z/Gedney; a unit of General Signal.
5. RACO; a Hubbell Company.
6. Thomas & Betts Corporation.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A, shall be not less than 4 inches wide, 4 inches high, and 2-1/2 inches deep with raised covers.

C. Cast-Metal Outlet and Device Boxes: NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Metal Floor Boxes: Cast metal, fully adjustable, rectangular, listed and labeled as defined in NFPA 70 by a qualified testing agency and marked for intended location and application.

E. Luminaire Outlet Boxes: Nonadjustable, designed for attachment of luminaire weighing 50 lb (23 kg). Outlet boxes designed for attachment of luminaires weighing more than 50 lb (23 kg) shall be listed and marked for the maximum allowable weight.

F. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

G. Cast-Metal Access, Pull, and Junction Boxes: NEMA FB 1, galvanized, cast iron with gasketed cover.

H. Hinged-Cover Enclosures: NEMA 250, Type 1, with continuous-hinge cover with flush latch, unless otherwise indicated.

1. Metal Enclosures: Steel, finished inside and out with manufacturer's standard enamel.

I. 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.

PART 3 EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below, unless otherwise indicated:

1. Exposed Conduit: Rigid steel conduit.
2. Concealed Conduit, Aboveground: Rigid steel conduit.
3. Underground Conduit: Type EPC-40-PVC or EPC-80-PVC, direct buried.
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.
6. Application of Handholes and Boxes for Underground Wiring:

a. Handholes and Pull Boxes in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Polymer concrete, SCTE 77, Tier 15 structural load rating.

b. Handholes and Pull Boxes in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Polymer-concrete units, SCTE 77, Tier 8 structural load rating.

c. Handholes and Pull Boxes Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced polyester resin, structurally tested according to SCTE 77 with 3000-lbf (13 345-N) vertical loading.

B. Comply with the following indoor applications, unless otherwise indicated:

1. Exposed, Not Subject to Physical Damage: EMT. Includes raceways in the following locations:

a. Electrical Rooms.

b. Telecommunications Rooms.

2. Exposed and Subject to Severe Physical Damage: Rigid steel conduit. Includes raceways in the following locations:

a. Mechanical rooms.

b. Loading Dock Area.

3. Concealed in Ceilings and Interior Walls and Partitions: EMT.

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 Risers in Vertical Shafts: EMT.

7. Raceways for Concealed General Purpose Distribution of Optical Fiber or Communications Cable: EMT.

8. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4, stainless steel in damp or wet locations.

C. Minimum Raceway Size: 3/4-inch (21-mm) 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.

3.2 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 (150 mm) 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. Support raceways as specified in Division 26 Section "Hangers and Supports for Electrical Systems."

E. Arrange stub-ups so curved portions of bends are not visible above the finished slab.

F. Install no more than the equivalent of three 90-degree bends in any conduit run except for communications conduits, for which fewer bends are allowed.

G. Conceal conduit and EMT within finished walls, ceilings, and below floors.

H. Do not embed raceways in slabs.

I. Threaded Conduit Joints, Exposed to Wet, Damp, Corrosive, or Outdoor Conditions: Apply listed compound to threads of raceway and fittings before making up joints. Follow compound manufacturer's written instructions.

J. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors, including conductors smaller than No. 4 AWG.

K. Install pull wires in empty raceways. Use polypropylene or monofilament plastic line with not less than 200-lb (90-kg) tensile strength. Leave at least 12 inches (300 mm) of slack at each end of pull wire.

L. Raceways for Optical Fiber and Communications Cable: Install raceways, metallic and nonmetallic, rigid and flexible, as follows:

1. 3/4-Inch (19-mm) Trade Size and Smaller: Install raceways in maximum lengths of 50 feet (15 m).

2. 1-Inch (25-mm) Trade Size and Larger: Install raceways in maximum lengths of 75 feet (23 m).

3. 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.

M. 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.

N. Flexible Conduit Connections: Use maximum of 72 inches (1830 mm) of flexible conduit for lighting fixtures, equipment subject to vibration, noise transmission, or movement across building expansion joints; and for transformers and motors.

1. Use LFMC in damp or wet locations subject to severe physical damage.

2. Use LFMC or LFNC in damp or wet locations not subject to severe physical damage.

O. 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.

P. Set metal floor boxes level and flush with finished floor surface.

3.3 PROTECTION

A. Provide final protection and maintain conditions that ensure coatings, finishes, and cabinets are without damage or deterioration at time of Substantial Completion.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

2. Repair damage to PVC or paint finishes with matching touchup coating recommended by manufacturer.

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SECTION 26 05 43
UNDERGROUND DUCTS AND RACEWAYS
FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Conduit, ducts, and duct accessories for direct-buried and concrete-encased duct banks, and in single duct runs.

2. Handholes and boxes.

B. Related Sections include the following:

1. Division 26 Section "Raceways and Boxes for Electrical Systems" for raceway types.

1.3 DEFINITION

A. RNC: Rigid nonmetallic conduit.

B. Trafficways: Locations where vehicular or pedestrian traffic is a normal course of events.

1.4 REFERENCES

A. The following references are useful in specifying underground ducts and utility structures. Other references may be needed for design purposes.

American Association of State Highway and Transportation Officials

AASHTO HB 17-2002 (Errata - 2005): Standard Specifications for Highway Bridges

American National Standards Institute

ANSI C80.1-2005: Electrical Rigid Steel Conduit (ERSC)

ASTM International

ASTM A 48/A 48M-03: Specification for Gray Iron Castings

ASTM A 123/A 123M-02: Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products

ASTM A 153/A 153M-05: Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware

ASTM C 270-07a: Specification for Mortar for Unit Masonry

ASTM C 387/C 387M-06a: Specification for Packaged, Dry, Combined Materials for Mortar and Concrete

ASTM C 858-07: Specification for Underground Precast Concrete Utility Structures

ASTM C 891-90 (Reapproved 2003): Practice for Installation of Underground Precast Concrete Utility Structures

ASTM C 1037-85 (Reapproved 2002): Practice for Inspection of Underground Precast Concrete Utility Structures

ASTM F 512-06: Specification for Smooth-Wall Poly(Vinyl Chloride) (PVC) Conduit and Fittings for Underground Installation

Institute of Electrical and Electronics Engineers, Inc.

IEEE C2-2007: National Electrical Safety Code

International Organization for Standardization

ISO 9000-2005: Quality Management Systems - Fundamentals and Vocabulary

ISO 10012-2003: Measurement Management Systems - Requirements for Measurement Processes and Measuring EquipmeNT

National Electrical Manufacturers Association

NEMA TC 2-2003: Electrical Polyvinyl Chloride (PVC) Tubing and Conduit

NEMA TC 3-2004: Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing

NEMA TC 6 & 8-2003: Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installations

NEMA TC 9-2004: Fittings for Polyvinyl Chloride (PVC) Plastic Utilities for Underground Installation

NFPA

NFPA 70-2008: National Electrical Code

Society of Cable Telecommunications Engineers

SCTE 77-2007: Specification for Underground Enclosure Integrity (ANSI)

Underwriters Laboratories Inc.

UL 514B-2004 (Rev. 2007): Conduit, Tubing, and Cable Fittings

UL 651-2005 (Rev. 2007): Schedule 40 and 80 Rigid PVC Conduit and Fittings

UL 651A-2000 (Rev. 2007): Type EB and A Rigid PVC Conduit and HDPE Conduit

1.5 SUBMITTALS

A. Product Data: For the following:

1. Duct-bank materials, including separators and miscellaneous components.
2. Ducts and conduits and their accessories, including elbows, end bells, bends, fittings, and solvent cement.
3. Accessories for manholes, handholes, boxes, and other utility structures.
4. Warning tape.
5. Warning planks.

B. Shop Drawings for Precast or Factory-Fabricated Underground Utility Structures: Include plans, elevations, sections, details, attachments to other work, and accessories, including the following:

1. Duct entry provisions, including locations and duct sizes.
2. Reinforcement details.
3. Grounding details.
4. Joint details.

C. Duct-Bank Coordination Drawings: Show duct profiles and coordination with other utilities and underground structures.

1. Include plans and sections, drawn to scale, and show bends and locations of expansion fittings.
2. Drawings shall be signed and sealed by a qualified professional engineer.

D. Product Certificates: For concrete and steel used in precast concrete manholes and handholes, as required by ASTM C 858.

E. Source quality-control test reports.

F. Field quality-control test reports.

1.6 QUALITY ASSURANCE

A. Comply with ANSI C2.

B. Comply with NFPA 70.

C. Testing Agency Qualifications: Qualified according to ASTM E 329 for testing indicated.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Deliver ducts to Project site with ends capped. Store nonmetallic ducts with supports to prevent bending, warping, and deforming.

B. Store precast concrete underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings are visible.

C. Lift and support precast concrete units only at designated lifting or supporting points.

1.8 PROJECT CONDITIONS

A. Interruption of Existing Electrical Service: Do not interrupt electrical service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary electrical service according to requirements indicated:

1. Notify Owner no fewer than seven days in advance of proposed interruption of electrical service.
2. Do not proceed with interruption of electrical service without Owner's written permission.

1.9 COORDINATION

A. Coordinate layout and installation of ducts, manholes, handholes, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.

B. Coordinate elevations of ducts and duct-bank entrances into manholes, handholes, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by Architect.

PART 2 PRODUCTS

2.1 CONDUIT

A. Rigid Steel Conduit: Galvanized. Comply with ANSI C80.1.

B. RNC: NEMA TC 2, Type EPC-40-PVC, UL 651, with matching fittings by same manufacturer as the conduit, complying with NEMA TC 3 and UL 514B.

2.2 NONMETALLIC DUCTS AND DUCT ACCESSORIES

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

1. ARNCO Corp.
2. CertainTeed Corp.; Pipe & Plastics Group.
3. Lamson & Sessions; Carlon Electrical Products.

B. Underground Plastic Utilities Duct: NEMA TC 2, UL 651, ASTM F 512, Type EPC-80 and Type EPC-40, with matching fittings complying with NEMA TC 3 by same manufacturer as the duct.

C. Duct Accessories:

1. Duct Separators: Factory-fabricated rigid PVC interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
2. Warning Tape: Underground-line warning tape specified in Division 26 Section "Identification for Electrical Systems."
3. Concrete Warning Planks: Nominal 12 by 24 by 3 inches (300 by 600 by 76 mm) in size, manufactured from 6000-psi (41-MPa) concrete.
    a. Color: Red dye added to concrete during batching.
    b. Mark each plank with "ELECTRIC" in 2-inch- (50-mm-) high, 3/8-inch- (10-mm-) deep letters.

2.3 PRECAST CONCRETE HANDHOLES AND BOXES

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

1. Carder Concrete Products.
2. Utility Concrete Products, LLC.
3. Utility Vault Co.

B. Comply with ASTM C 858 for design and manufacturing processes.

C. Description: Factory-fabricated, reinforced-concrete, monolithically poured walls and bottom. Frame and cover shall form top of enclosure and shall have load rating consistent with that of handhole or box.

1. Frame and Cover: Weatherproof cast-iron frame, with cast-iron cover with recessed cover hook eyes and tamper-resistant, captive, cover-securing bolts.
2. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
3. Cover Legend: Molded lettering, "ELECTRIC." and "TELEPHONE."
4. Configuration: Units shall be designed for flush burial and have closed bottom, unless otherwise indicated.
5. Windows: Precast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches (300 mm) vertically and horizontally to accommodate alignment variations.
    a. Windows shall be located no less than 6 inches (150 mm) from interior surfaces of walls, floors, or frames and covers of handholes, but close enough to corners to facilitate racking of cables on walls.
    b. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie in to concrete envelopes of duct banks.

c. Window openings shall be framed with at least two additional No. 4 steel reinforcing bars in concrete around each opening.

6. Duct Entrances in Handhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.

a. Type and size shall match fittings to duct or conduit to be terminated.

b. Fittings shall align with elevations of approaching ducts and be located near interior corners of handholes to facilitate racking of cable.

7. Handholes 12 inches wide by 24 inches long (300 mm wide by 600 mm long) and larger shall have inserts for cable racks and pulling-in irons installed before concrete is poured.

2.4 SOURCE QUALITY CONTROL

A. Test and inspect precast concrete utility structures according to ASTM C 1037.

PART 3 EXECUTION

3.1 UNDERGROUND DUCT APPLICATION

A. Ducts for Electrical Cables Over 600 V: RNC, NEMA Type EPC-40 PVC, in concrete-encased duct bank.

B. Ducts for Electrical Feeders 600 V and Less: RNC, NEMA Type EPC-40 PVC, in concrete-encased duct bank.

C. Ducts for Electrical Branch Circuits: RNC, NEMA Type EPC-40-PVC, in direct-buried duct bank.

D. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40-PVC, in concrete-encased duct bank.

3.2 UNDERGROUND ENCLOSURE APPLICATION

A. Handholes and Boxes for 600 V and Less, Including Telephone, Communications, and Data Wiring:

1. Units in Roadways and Other Deliberate Traffic Paths: Precast concrete. AASHTO HB 17, structural load rating.

2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Nondeliberate Loading by Heavy Vehicles: Precast concrete, AASHTO HB 17, H-20 structural load rating.

3. Units in Sidewalk and Similar Applications with a Safety Factor for Nondeliberate Loading by Vehicles: Precast concrete, AASHTO HB 17, H-10 structural load rating.

B. Manholes: Precast concrete.

1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.

3.3 EARTHWORK

A. Excavation and Backfill: Comply with Division 31 Section "Earth Moving," but do not use heavy-duty, hydraulic-operated, compaction equipment.

B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling is completed.

C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary topsoiling, fertilizing, liming, seeding, sodding, sprigging, and mulching. Comply with Division 32 Sections "Turf and Grasses" and "Plants."

D. Cut and patch existing pavement in the path of underground ducts and utility structures according to Division 01 Section "Cutting and Patching."

3.4 DUCT INSTALLATION

A. Slope: Pitch ducts a minimum slope of 1:300 down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions.

B. Curves and Bends: Use 5-degree angle couplings for small changes in direction. Use manufactured long sweep bends with a minimum radius of 25 feet (7.5 m), both horizontally and vertically, at other locations, unless otherwise indicated.

C. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in same plane.

D. Duct Entrances to Manholes and Concrete and Polymer Concrete Handholes: Use end bells, spaced approximately 10 inches (250 mm) o.c. for 5-inch (125-mm) ducts, and vary proportionately for other duct sizes.

1. Begin change from regular spacing to end-bell spacing 10 feet (3 m) from the end bell without reducing duct line slope and without forming a trap in the line.

2. Grout entrances in structure walls from both sides to provide watertight entrances.

E. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet (3 m) outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls as specified in Division 26 Section "Common Work Results for Electrical."

F. Sealing: Provide temporary closure at terminations of ducts that have cables pulled. Seal spare ducts at terminations. Use sealing compound and plugs to withstand at least 15-psig (1.03-MPa) hydrostatic pressure.

G. Pulling Cord: Install 100-lbf- (445-N-) test nylon cord in ducts, including spares.

H. Concrete-Encased Ducts: Support ducts on duct separators.

1. Separator Installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet (6 m) of duct. Secure separators to earth and to ducts to prevent floating during concreting. Stagger separators approximately 6 inches (150 mm) between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around ducts or duct groups.

2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.

a. Start at one end and finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.

b. If more than one pour is necessary, terminate each pour in a vertical plane and install 3/4-inch (19-mm) reinforcing rod dowels extending 18 inches (450 mm) into concrete on both sides of joint near corners of envelope.

3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank

assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct-bank application.

4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and paved areas. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups. Do not reinforce ductbanks used for BGE wiring.

5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.

6. Minimum Space between Ducts: 3 inches (75 mm) between ducts and exterior envelope wall, 2 inches (50 mm) between ducts for like services, and 4 inches (100 mm) between power and signal ducts.

7. Depth: Install top of duct bank at least 36 inches (750 mm) below finished grade in deliberate traffic paths for vehicles, unless otherwise indicated.

8. Stub-Ups: Use 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 (75 mm) of concrete.

   b. Stub-Ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of base. Install insulated grounding bushings on terminations at equipment.

9. Warning Tape: Bury warning tape approximately 12 inches (300 mm) above all concrete-encased ducts and duct banks. Align tape parallel to and within 3 inches (75 mm) of the centerline of duct bank. Provide an additional warning tape for each 12-inch (300-mm) increment of duct-bank width over a nominal 18 inches (450 mm). Space additional tapes 12 inches (300 mm) apart, horizontally.

3.5 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

A. Precast Concrete Handhole Installation:

1. Comply with ASTM C 891, unless otherwise indicated.

2. Install units level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.

3. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1-inch (25-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

B. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8 inches (98 mm) for manholes and 2 inches (50 mm) for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.

C. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover.

3.6 GROUNDING

A. Ground underground ducts and utility structures according to Division 26 Section "Grounding and Bonding for Electrical Systems."

3.7 FIELD QUALITY CONTROL

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

1. Demonstrate capability and compliance with requirements on completion of installation of underground ducts and utility structures.
2. Pull aluminum or wood test mandrel through duct to prove joint integrity and test for out-of-round duct. Provide mandrel equal to 80 percent fill of duct. If obstructions are indicated, remove obstructions and retest.
3. Test manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified in Division 26 Section "Grounding and Bonding for Electrical Systems."

B. Correct deficiencies and retest as specified above to demonstrate compliance.

3.8 CLEANING

A. Pull leather-washer-type duct cleaner, with graduated washer sizes, through full length of ducts. Follow with rubber duct swab for final cleaning and to assist in spreading lubricant throughout ducts.

B. Clean internal surfaces of manholes, including sump. Remove foreign material.

END OF SECTION

SECTION 26 05 53

IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Identification for raceways.
2. Identification of power and control cables.
3. Identification for conductors.
4. Underground-line warning tape.
5. Warning labels and signs.
6. Instruction signs.
7. Equipment identification labels.
8. Miscellaneous identification products.

1.3 REFERENCES

A. The following references are useful in specifying electrical identification. Other references may be needed for design purposes.

American National Standards Institute

ANSI A13.1-1996: Scheme for the Identification of Piping Systems

(The standard above is a short, simple set of recommendations for piping identification. It gives examples of recommended wording, in general terms, for identifying conduits and cables.)

ANSI Z535.1-2006: Safety Color Code

ANSI Z535.2-2002: Environmental and Facility Safety Signs

ANSI Z535.3-2002: Criteria for Safety Symbols

ANSI Z535.4-2002: Product Safety Sign and Label

(The last standard above provides guidelines for the design of safety signs and labels for application to products. It includes a color chart. It is referenced in NFPA 70, Article 110-16 FPN.)

ANSI Z535.5-2002: Safety Tags and Barricade Tapes

ASTM International

ASTM D 638-03: Tensile Properties of Plastics

ASTM D 882-02: Tensile Properties of Thin Plastic Sheeting

Code of Federal Regulations

29 CFR - Labor, Part 1910 - "Occupational Safety and Health Standards," Section 1910.144 - "Safety Color Code for Marking Physical Hazards." 2005.

29 CFR - Labor, Part 1910 - "Occupational Safety and Health Standards," Section 1910.145 - "Specifications for Accident Prevention Signs and Tags." 2005.

29 CFR - Labor, Part 1926 - "Safety and Health Regulations for Construction," Section 1926.403 - "General Requirements," Subpart K - "Electrical." 1996.

The Institute of Electrical and Electronics Engineers, Inc.

IEEE C2-2002: National Electrical Safety Code

NFPA

NFPA 70-2005: National Electrical Code

Underwriters Laboratories Inc.

UL 94-2003: Tests for Flammability of Plastic Materials for Parts in Devices and Appliances

UL 969-2003: Marking and Labeling Systems

1.4 SUBMITTALS

A. Product Data: For each electrical identification product indicated.

B. LEED Submittals: Product data for paints applied within the interior indicating VOC content in g/L.

C. Identification Schedule: An index of nomenclature of electrical equipment and system components used in identification signs and labels.

1.5 QUALITY ASSURANCE

A. Comply with ANSI A13.1 and IEEE C2.

B. Comply with NFPA 70.

C. Comply with 29 CFR 1910.144 and 29 CFR 1910.145.

D. Comply with ANSI Z535.4 for safety signs and labels.

1.6 COORDINATION

A. Coordinate identification names, abbreviations, colors, and other features with requirements in other Sections requiring identification applications, Drawings, Shop Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual; and with those required by codes, standards, and 29 CFR 1910.145. Use consistent designations throughout Project.

B. Coordinate installation of identifying devices with completion of covering and painting of surfaces where devices are to be applied.

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

D. Install identifying devices before installing acoustical ceilings and similar concealment.

PART 2 PRODUCTS

2.1 POWER RACEWAY IDENTIFICATION MATERIALS

A. Comply with ANSI A13.1 for minimum size of letters for legend and for minimum length of color field for each raceway size.

B. Colors for Raceways Carrying Circuits at 600 V or Less:

1. Black letters on an orange field.

2. Legend: Indicate voltage and system or service type.

C. Snap-Around Labels for Raceways Carrying Circuits at 600 V or Less: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.2 CONDUCTOR IDENTIFICATION MATERIALS

A. Snap-Around Labels: Slit, pretensioned, flexible, preprinted, color-coded acrylic sleeve, with diameter sized to suit diameter of raceway or cable it identifies and to stay in place by gripping action.

2.3 UNDERGROUND-LINE WARNING TAPE

A. Tape:

1. Recommended by manufacturer for the method of installation and suitable to identify and locate underground electrical and communications utility lines.

2. Printing on tape shall be permanent and shall not be damaged by burial operations.

3. Tape material and ink shall be chemically inert, and not subject to degrading when exposed to acids, alkalis, and other destructive substances commonly found in soils.

B. Color and Printing:

1. Comply with ANSI Z535.1 through ANSI Z535.5.

2. Inscriptions for Red-Colored Tapes: ELECTRIC LINE, HIGH VOLTAGE.

3. Inscriptions for Orange-Colored Tapes: TELEPHONE CABLE, CATV CABLE, COMMUNICATIONS CABLE, OPTICAL FIBER CABLE.

C. Tag:

1. Reinforced, detectable three-layer laminate, consisting of a printed pigmented woven scrim, a solid aluminum-foil core, and a clear protective film that allows inspection of the continuity of the conductive core, bright-colored, continuous-printed on one side with the inscription of the utility, compounded for direct-burial service.

2. Overall Thickness: 8 mils (0.2 mm).

3. Foil Core Thickness: 0.35 mil (0.00889 mm).

4. Weight: 34 lb/1000 sq. ft. (16.6 kg/100 sq. m).

5. 3-Inch (75-mm) Tensile According to ASTM D 882: 300 lbf (1334 N), and 12,500 psi (86.1 MPa).

2.4 WARNING LABELS AND SIGNS

A. Comply with NFPA 70 and 29 CFR 1910.145.

B. Self-Adhesive Warning Labels: Factory-printed, multicolor, pressure-sensitive adhesive labels, configured for display on front cover, door, or other access to equipment unless otherwise indicated.

C. Baked-Enamel Warning Signs:

1. Preprinted aluminum signs, punched or drilled for fasteners, with colors, legend, and size required for application.

2. 1/4-inch (6.4-mm) grommets in corners for mounting.

3. Nominal size, 7 by 10 inches (180 by 250 mm).

D. Warning label and sign shall include, but are not limited to, the following legends:

1. Multiple Power Source Warning: "DANGER - ELECTRICAL SHOCK HAZARD - EQUIPMENT HAS MULTIPLE POWER SOURCES."

2. Workspace Clearance Warning: "WARNING - AREA IN FRONT OF ELECTRICAL EQUIPMENT MUST BE KEPT CLEAR FOR 48 INCHES."

2.5 EQUIPMENT IDENTIFICATION LABELS

A. Engraved, Laminated Acrylic or Melamine Label: Punched or drilled for screw mounting. White letters on a dark-gray background. Minimum letter height shall be 3/8 inch (10 mm).

2.6 CABLE TIES

A. General-Purpose Cable Ties: Fungus inert, self extinguishing, one piece, self locking, Type 6/6 nylon.

1. Minimum Width: 3/16 inch (5 mm).
2. Tensile Strength at 73 deg F (23 deg C), According to ASTM D 638: 12,000 psi (82.7 MPa).
3. Temperature Range: Minus 40 to plus 185 deg F (Minus 40 to plus 85 deg C).
4. Color: Black except where used for color-coding.

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. Paint: Comply with requirements in Division 09 painting Sections for paint materials and application requirements. Select paint system applicable for surface material and location (exterior or interior).

B. Fasteners for Labels and Signs: Self-tapping, stainless-steel screws or stainless-steel machine screws with nuts and flat and lock washers.

PART 3 EXECUTION

3.1 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. Attach signs and plastic labels that are not self-adhesive type with mechanical fasteners appropriate to the location and substrate.

E. System Identification Color-Coding Bands for Raceways and Cables: Each color-coding band shall completely encircle cable or conduit. Place adjacent bands of two-color markings in contact, side by side. Locate bands at changes in direction, at penetrations of walls and floors, at 50-foot (15-m) maximum intervals in straight runs, and at 25-foot (7.6-m) maximum intervals in congested areas.

F. Underground-Line Warning Tape: During backfilling of trenches install continuous underground-line warning tape directly above line at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trench or concrete envelope exceeds 16 inches (400 mm) overall.

G. Painted Identification: Comply with requirements in Division 09 painting Sections for surface preparation and paint application.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways, 600 V or Less, for Service, Feeder, and Branch Circuits More Than **30** A, and to ground: Identify with self-adhesive vinyl label. Install labels at 30-foot (10-m) maximum intervals.

B. Accessible Raceways and Cables within Buildings: Paint covers of each junction and pull box of the following systems:

1. Fire Alarm: Red.

2. Security: Blue.
3. CCTV: Green & Yellow.
4. Telecommunication: Green.
5. 120/208 Volt Power & Lighting: Yellow.
6. 480/277 Volt Power & Lighting: Black.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in vaults, pull and junction boxes, manholes, and handholes, use color-coding conductor tape to identify the phase.

1. Color-Coding for Phase and Voltage Level Identification, 600 V or Less: Use colors listed below for ungrounded service, feeder, and branch-circuit conductors.
    a. Color shall be factory applied or field applied for sizes larger than No. 8 AWG, if authorities having jurisdiction permit.
    b. Colors for 208/120-V Circuits:
        1) Phase A: Black.
        2) Phase B: Red.
        3) Phase C: Blue.
    c. Colors for 480/277-V Circuits:
        1) Phase A: Brown.
        2) Phase B: Orange.
        3) Phase C: Yellow.
    d. Field-Applied, Color-Coding Conductor Tape: Apply in half-lapped turns for a minimum distance of 6 inches (150 mm) from terminal points and in boxes where splices or taps are made. Apply last two turns of tape with no tension to prevent possible unwinding. Locate bands to avoid obscuring factory cable markings.

D. Power-Circuit Conductor Identification, More than 600 V: For conductors in vaults, pull and junction boxes, manholes, and handholes, use nonmetallic plastic tag holder with adhesive-backed phase tags, and a separate tag with the circuit designation.

E. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

F. Auxiliary Electrical Systems Conductor Identification: Identify field-installed alarm, control, and signal connections.

1. Identify conductors, cables, and terminals in enclosures and at junctions, terminals, and pull points. Identify by system and circuit designation.
2. Use system of marker tape designations that is uniform and consistent with system used by manufacturer for factory-installed connections.
3. Coordinate identification with Project Drawings, manufacturer's wiring diagrams, and the Operation and Maintenance Manual.

G. Locations of Underground Lines: Identify with underground-line warning tape for power, lighting, communication, and control wiring and optical fiber cable.

H. Workspace Indication: Install floor marking tape to show working clearances in the direction of access to live parts. Workspace shall be as required by NFPA 70 and 29 CFR 1926.403 unless

otherwise indicated. Do not install at flush-mounted panelboards and similar equipment in finished spaces.

I. Equipment Identification Labels: On each unit of equipment, install unique designation label that is consistent with wiring diagrams, schedules, and the Operation and Maintenance Manual. Apply labels to disconnect switches and protection equipment, central or master units, control panels, control stations, terminal cabinets, and racks of each system. Systems include power, lighting, control, communication, signal, monitoring, and alarm systems unless equipment is provided with its own identification.

1. Labeling Instructions:

a. Indoor Equipment: Engraved, laminated acrylic or melamine label. Unless otherwise indicated, provide a single line of text with 1/2-inch- (13-mm-) high letters on 1-1/2-inch- (38-mm-) high label; where two lines of text are required, use labels 2 inches (50 mm) high.

b. Outdoor Equipment: Engraved, laminated acrylic or melamine label.

c. Elevated Components: Increase sizes of labels and letters to those appropriate for viewing from the floor.

d. Fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

2. Equipment to Be Labeled:

a. Panelboards: Typewritten directory of circuits in the location provided by panelboard manufacturer. Panelboard identification shall be engraved, laminated acrylic or melamine label.

b. Enclosures and electrical cabinets.

c. Access doors and panels for concealed electrical items.

d. Switchboards.

e. Transformers: Label that includes tag designation shown on Drawings for the transformer, feeder, and panelboards or equipment supplied by the secondary.

f. Emergency system boxes and enclosures.

g. Enclosed switches.

h. Enclosed circuit breakers.

i. Enclosed controllers.

j. Variable-speed controllers.

k. Push-button stations.

l. Power transfer equipment.

m. Contactors.

n. Remote-controlled switches, dimmer modules, and control devices.

o. Battery-inverter units.

p. Battery racks.

q. Power-generating units.

END OF SECTION

SECTION 26 09 23

LIGHTING CONTROL DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following lighting control devices:

1. Outdoor photoelectric switches.
2. Daylight – Harvesting Controls.
3. Indoor occupancy/vacancy sensors.
4. Lighting contractors.

B. Related Sections include the following:

1. Division 26 Section "Wiring Devices" for snap switches.

1.3 DEFINITIONS

A. LED: Light-emitting diode.

B. PC: Personal Computer

C. PIR: Passive infrared.

D. USB: Universal Serial Bus

1.4 SUBMITTALS

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

B. Coverage Plans: Show locations and coverage patterns for all occupancy sensors.

C. Shop Drawings: Show installation details for occupancy and light-level sensors.

1. Interconnection diagrams showing field-installed wiring.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For each type of product to include in emergency, operation, and maintenance manuals.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

1.6 COORDINATION

A. Coordinate layout and installation of ceiling-mounted devices with other construction that penetrates ceilings or is supported by them, including light fixtures, HVAC equipment, smoke detectors, fire-suppression system, and partition assemblies.

PART 2 PRODUCTS

2.1 TIME SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wattstopper TS-400 Digital Time Switch or comparable product by one of the following:

1. Cooper Industries, Inc.
2. Intermatic, Inc.
3. Leviton Manufacturing Co., Inc.
4. Pass & Seymour.

B. Digital Time Switches: Wall switch style, electroluminescent back-lit LCD display shows timer countdown, time-out and adjustments.

2.2 OUTDOOR PHOTOELECTRIC SWITCHES

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

1. Area Lighting Research, Inc.; Tyco Electronics.
2. Grasslin Controls Corporation; a GE Industrial Systems Company.
3. Intermatic, Inc.
4. Novitas, Inc.
5. Paragon Electric Co.; Invensys Climate Controls.
6. Square D; Schneider Electric.
7. TORK.
8. Touch-Plate, Inc.
9. Watt Stopper (The).

B. Description: Solid state, with SPST dry contacts rated for 1800-VA tungsten or 1000-VA inductive, to operate connected relay, contactor coils, or microprocessor input; complying with UL 773A.

1. Light-Level Monitoring Range: 1.5 to 10 fc (16.14 to 108 lx), with an adjustment for turn-on and turn-off levels within that range**,** and a directional lens in front of photocell to prevent fixed light sources from causing turn-off.
2. Time Delay: 15-second minimum, to prevent false operation.
3. Surge Protection: Metal-oxide varistor, complying with IEEE C62.41.1, IEEE C62.41.2, and IEEE 62.45 for Category A1 locations.
4. Mounting: Twist lock complying with IEEE C136.10, with base-and-stem mounting or stem-and-swivel mounting accessories as required to direct sensor to the north sky exposure.

2.3 DAYLIGHT-HARVESTING DIMMING CONTROLS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wattstopper LMLS-400 or comparable product by one of the following:

1. Sensor Switch nLight.
2. Hubbell NX.

B. System Description: Sensing daylight and electrical lighting levels, the system adjusts the indoor electrical lighting levels. As daylight increases, the lights are dimmed.

1. Lighting control set point is based on two lighting conditions:

a. When no daylight is present (target level).

b. When significant daylight is present.

2. System programming is performed via a networked PC with appropriate software, and also locally with a setup tool or USB interface and PC.

a. Initial setup tool: a hand held digital configuration tool. Sensor adjustments may also be made using configuration pushbuttons on the sensors.

b. USB interface and PC software: capability to program, read, store, modify and document device and system configuration.

C. Ceiling-Mounted Dimming Controls: Solid-state, digital light-level sensor unit, with separate power pack/controller unit, to detect changes in lighting levels that are perceived by the eye in order to automatically dim a lighting zone.

D. Electrical Components, Devices, and Accessories:

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).

3. Sensor Output: Digitally communicates with room controller to dim loads based on lighting conditions. Sensor is powered from the power pack/controller.

4. Light-Level Sensor Set-Point Adjustment Range: 10 to 200 fc (108 to 2152 lux).

2.4 INDOOR OCCUPANCY/VACANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wattstopper Digital Lighting Management LMDC-100, LMDX-100, LMPX-100, LMPC-100, LMDC-100 or comparable product by one of the following:

1. Sensor Switch nLight.

2. Hubbell NX.

B. General Requirements for Sensors: Wall- or ceiling-mounted, solid-state digital indoor occupancy/vacancy sensors with a separate power pack/controller.

1. Systems programming is performed via a networked PC with appropriate software, and also locally with a setup tool or USB interface and PC.

a. Initial setup tool: a hand held digital configuration tool. Sensor adjustments may also be made using configuration pushbuttons on the sensors.

b. USB interface and PC software: capability to program, read, store, modify and document device and system configuration.

2. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

3. Operation: Unless otherwise indicated, manual-on when coverage area is occupied, and automatic-off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes in 1-minute increments. Default setting: 20 minutes.

4. Sensor Output: Digitally communicates with room controller to turn loads on and off based on occupancy. Sensor is powered from the power pack/controller.

5. Mounting:

a. Sensor: Suitable for mounting in any position

b. Time-Delay and Sensitivity Adjustments: Recessed and concealed behind removable cover

6. Indicator: Digital display, to show when motion is detected during testing and normal operation of sensor.

C. PIR Type: Ceiling mounted; detect occupants in coverage area by their heat and movement.

1. Detector Sensitivity: Detect occurrences of 6-inch- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm).

2. Detection Coverage (Room): Detect occupancy anywhere in a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 10 foot (3m) high ceiling.

3. Detection Coverage (Small Room): Detect occupancy anywhere within a circular area of 450 sq. ft. (41.8 sq. m) when mounted on a 10 foot (3m) high ceiling.

4. Detection Coverage (Extended Height Lens): Detect occupancy anywhere within a circular area of 1,000 sq. ft. (93 sq. m) when mounted on a 40 foot (12.2m) high ceiling.

5. Detection Coverage (Corner Mount, Ceiling or Wall): Detect occupancy anywhere within an area of 2,000 sq. ft. (186 sq. m) when mounted on a 10 foot (3m) high ceiling or wall.

D. Ultrasonic/Microphonic Type: Ceiling mounted; detect occupants in coverage area through pattern changes of reflected ultrasonic energy.

1. Detector Sensitivity: Detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

2. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 10 foot (3m) high ceiling.

3. Detection Coverage (Corridor): Detect occupancy anywhere within 59 feet (18m) when mounted on a 10 foot (3m) high ceiling in a corridor not wider than 12 feet (3 m).

E. Dual-Technology Type: Ceiling mounted; detect occupants in coverage area using PIR and ultrasonic detection methods. The particular technology or combination of technologies that control on-off functions is 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- (150-mm-) minimum movement of any portion of a human body that presents a target of not less than 36 sq. in. (232 sq. cm), and detect a person of average size and weight moving not less than 12 inches (305 mm) in either a horizontal or a vertical manner at an approximate speed of 12 inches/s (305 mm/s).

3. Detection Coverage (Standard Room): Detect occupancy anywhere within a circular area of 1000 sq. ft. (93 sq. m) when mounted on a 96-inch- (2440-mm-) high ceiling.

4. Detection Coverage (Corner Mount, Ceiling or Wall): Detect occupancy anywhere within an area of 2,000 sq. ft. (186 sq. m) when mounted on a 10 foot (3m) high ceiling or wall.

2.5 SWITCHBOX-MOUNTED OCCUPANCY/VACANCY SENSORS

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wattstopper DSW-301, DSW-302, or comparable product by one of the following:

1. Sensor Switch.

2. Hubbell.

B. General Requirements for Sensors: Automatic-wall-switch occupancy sensor, suitable for mounting in a single gang switchbox. Wall mounted, solid-state, indoor occupancy/vacancy sensors.

1. Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Operating Ambient Conditions: Dry interior conditions, 32 to 120 deg F (0 to 49 deg C).
3. Sensor Output: Turns loads on and off based on occupancy. Sensor is line voltage.

C. Wall-Switch Sensor:

1. Standard Range: 180-degree field of view, field adjustable from 180 to 40 degrees; with a minimum coverage area of 900 sq. ft. (84 sq. m).
2. Sensing Technology: Dual technology - PIR and ultrasonic/microphonic.
3. Switch Type: 1-Button (1-load): manual “on”, automatic “off”. 2-Button (2-load): manual “on” for load-1, manual “on” for load-2, automatic “off” for both loads.
4. Operation: Unless otherwise indicated, manual-on when coverage area is occupied, and automatic-off when unoccupied; with a time delay for turning lights off, adjustable over a minimum range of 1 to 30 minutes in 1-minute increments. Default setting: 20 minutes.

2.6 DIGITAL WALL SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide Wattstopper LMSW-101, LMSW-102, LMSW-103, LMSW-104, LMSW-105, LMSW-108, LMDM-101 or comparable product by one of the following:

1. Sensor Switch nLight.
2. Hubbell NX.

B. Description Low voltage momentary pushbutton switches in 1, 2, 3, 4, 5 and 8 button configuration. Wall switches shall include the following features:

1. Two-way infrared (IR) transceiver for use with personal and configuration remote controls.
2. Removable buttons for field replacement with engraved buttons and/or alternate color buttons. Button replacement may be completed without removing the switch from the wall.
3. Configuration LED on each switch that blinks to indicate data transmission.
4. Load/Scene Status LED on each switch button with the following characteristics:
    a. Bi-level LED
    b. Dim locator level indicates power to switch
    c. Bright status level indicates that load or scene is active
    d. Dimming switches shall include seven bi-level LEDs to indicate load levels using 14 steps.
5. Programmable control functionality including:
    a. Button priority may be configured to any BACnet priority level, from 1-16, corresponding to networked operation allowing local actions to utilize life safety priority
    b. Scene patterns may be saved to any button other than dimming rockers. Once set, buttons may be digitally locked to prevent overwriting of the preset levels.

6. All digital parameter data programmed into an individual wall switch shall be retained in non-volatile FLASH memory within the wall switch itself. Memory shall have an expected life of no less than 10 years.

C. BACnet object information shall be available for the following objects:

1. Button state
2. Switch lock control
3. Switch lock status

D. Two RJ-45 ports for connection to DLM local network.

E. Multiple digital wall switches may be installed in a room by simply connecting them to the free topology DLM local network. No additional configuration shall be required to achieve multi-way switching.

F. Load and Scene button function may be reconfigured for individual buttons from Load to Scene, and vice versa.

1. Individual button function may be configured to Toggle, On only or Off only.
2. Individual scenes may be locked to prevent unauthorized change.
3. Fade Up and Fade Down times for individual scenes may be adjusted from 0 seconds to 18 hours.
4. Ramp rate may be adjusted for each dimmer switch.
5. Switch buttons may be bound to any load on any load controller or relay panel and are not load type dependent; each button may be bound to multiple loads.

2.7 CONFIGURATION TOOLS

A. Basis-of-Design Product: Subject to compliance with requirements, provide WattStopper LMCT-100, LMCI-100 and LMCS-100, or comparable products by one of the following:

1. Sensor Switch nLight.
2. Hubbell NX.

B. A configuration tool facilitates optional customization of DLM local networks, and is used to set up open loop daylighting sensors. A wireless configuration tool features infrared communications, while PC software connects to each local network via a USB interface. Features and functionality of the wireless configuration tool shall include:

1. Two-way infrared (IR) communication with DLM IR-enabled devices within a range of approximately 30 feet.
2. High visibility organic LED (OLED) display, pushbutton user interface and menu-driven operation.
3. Read, modify and send parameters for occupancy sensors, daylighting sensors, room controllers and buttons on digital wall switches.
4. Save up to nine occupancy sensor setting profiles, and apply profiles to selected sensors.
5. Temporarily adjust light level of any load(s) on the local network, and incorporate those levels in scene setting.
6. Adjust or fine-tune daylighting settings established during auto-commissioning, and input light level data to complete commissioning of open loop daylighting controls.

2.8 LIGHTING CONTACTORS

A. Basis of Design Product: Subject to compliance with requirements, provide ASCO; 917-6-20-7-47M or a comparable product by one of the following:

1. Square D; Schneider Electric.

B. Description: Electrically operated and mechanically held, combination type with nonfused disconnect, complying with NEMA ICS 2 and UL 508.

1. Current Rating for Switching: Listing or rating consistent with type of load served, including tungsten filament, inductive, and high-inrush ballast (ballast with 15 percent or less total harmonic distortion of normal load current).

2. Fault Current Withstand Rating: Equal to or exceeding the available fault current at the point of installation.

3. Enclosure: Comply with NEMA 250.

4. Provide with control and pilot devices as indicated on Drawings, matching the NEMA type specified for the enclosure.

C. BAS Interface: Provide hardware interface to enable the BAS to monitor and control lighting contactors.

1. Monitoring: On-off status.

2. Control: On-off operation.

2.9 CONDUCTORS AND CABLES

A. Power Wiring to Supply Side of Remote-Control Power Sources: Not smaller than No. 12 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

B. Classes 2 and 3 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 24 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

C. Class 1 Control Cable: Multiconductor cable with stranded-copper conductors not smaller than No. 18 AWG. Comply with requirements in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables."

PART 3 EXECUTION

3.1 SENSOR INSTALLATION

A. Install and aim sensors in locations to achieve not less than 90 percent coverage of areas indicated. Do not exceed coverage limits specified in manufacturer's written instructions.

3.2 CONTACTOR INSTALLATION

A. Mount electrically held lighting contactors with elastomeric isolator pads, to eliminate structure-borne vibration, unless contactors are installed in an enclosure with factory-installed vibration isolators.

3.3 WIRING INSTALLATION

A. Wiring Method: Comply with Division 26 Section "Low-Voltage Electrical Power Conductors and Cables." Minimum conduit size shall be 1/2 inch (13 mm).

B. Wiring within Enclosures: Comply with NECA 1. Separate power-limited and nonpower-limited conductors according to conductor manufacturer's written instructions.

C. Size conductors according to lighting control device manufacturer's written instructions, unless otherwise indicated.

D. Splices, Taps, and Terminations: Make connections only on numbered terminal strips in junction, pull, and outlet boxes; terminal cabinets; and equipment enclosures.

3.4 IDENTIFICATION

A. Identify components and power and control wiring according to Division 26 Section "Identification for Electrical Systems."

1. Identify controlled circuits in lighting contactors.

2. Identify circuits or luminaries controlled by photoelectric and occupancy sensors at each sensor.

B. Label time switches and contactors with a unique designation.

3.5 FIELD QUALITY CONTROL

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

1. After installing time switches and sensors, and after electrical circuitry has been energized, adjust and test for compliance with requirements.

2. Operational Test: Verify operation of each lighting control device, and adjust time delays.

B. Lighting control devices that fail tests and inspections are defective work.

3.6 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. Provide up to two (2) visits to Project during other-than-normal occupancy hours for this purpose.

3.7 DEMONSTRATION

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

END OF SECTION

SECTION 26 24 16

PANELBOARDS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Distribution panelboards.

2. Lighting and appliance branch-circuit panelboards.

B. Related sections include the following:

1. Division 26 Section “Surge Protection For Low-Voltage Electrical Power Circuits”

1.3 REFERENCES

A. The following references are useful in specifying panelboards. Other references may be needed for design purposes.

The Institute of Electrical and Electronics Engineers, Inc.

IEEE 344-2004: Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations (ANSI)

IEEE C62.41-1991 (Reaffirmed 1995): Recommended Practice on Surge Voltages in Low-Voltage AC Power Circuits

IEEE C62.41.2-2002: Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits

InterNational Electrical Testing Association

NETA Acceptance Testing Specification-2003: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

National Electrical Contractors Association

NECA 1-2000: Standard Practices for Good Workmanship in Electrical Contracting (ANSI)

NECA 407-2002: Recommended Practice for Installing and Maintaining Panelboards (ANSI)

National Electrical Manufacturers Association

NEMA 250-2003: Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA FU 1-2002: Low Voltage Cartridge Fuses

NEMA ICS 2-2000: Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts

NEMA KS 1-2001: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

NEMA PB 1-2000: Panelboards

NEMA PB 1.1-2002: General Instructions for Proper Installation, Operation, and Maintenance of Panelboards Rated 600 Volts or Less (ANSI)

NFPA

NFPA 70-2005: National Electrical Code

NFPA 70E-2004: Standard for Electrical Safety in the Workplace

Structural Engineering Institute/American Society of Civil Engineers

SEI/ASCE 7-2002: Minimum Design Loads for Buildings and Other Structures

Underwriters Laboratories Inc.

UL 67-1993: Panelboards (ANSI)

UL 489-2002 (Revised 2004): Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures (ANSI)

UL 1449-1996 (Revised 2005): Transient Voltage Surge Suppressors

UL 1699-1999 (Revised 2005): Arc-Fault Circuit-Interrupters

1.4 DEFINITIONS

A. SVR: Suppressed voltage rating.

B. SPD: Surge Protection Device.

1.5 SUBMITTALS

A. Product Data: For each type of panelboard, switching and overcurrent protective device, transient voltage suppression device, accessory, and component indicated. Include dimensions and manufacturers' technical data on features, performance, electrical characteristics, ratings, and finishes.

B. 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.

6. Include wiring diagrams for power, signal, and control wiring.

7. Include time-current coordination curves for each type and rating of overcurrent protective device included in panelboards. Submit on translucent log-log graft paper; include selectable ranges for each type of overcurrent protective device.

C. Panelboard Schedules: For installation in panelboards. Submit final versions after load balancing.

D. 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.

2. Time-current curves, including selectable ranges for each type of overcurrent protective device that allows adjustments.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain panelboards, overcurrent protective devices, components, and accessories 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 NEMA PB 1.

D. Comply with NFPA 70.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Remove loose packing and flammable materials from inside panelboards; install temporary electric heating (250 W per panelboard) to prevent condensation.

B. Handle and prepare panelboards for installation according to NECA 407 and NEMA PB 1.

1.8 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.

1.9 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace transient voltage suppression devices that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Five years from date of Substantial Completion.

1.10 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.

2. Circuit Breakers Including GFCI and Ground Fault Equipment Protection (GFEP) Types: Two spares for each panelboard.

PART 2 PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

2. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover. Skirt for kitchen surface-mounted panelboards: Same gauge and finish as panelboard front with flanges for attachment to panelboard, wall, ceiling, and floor.

3. Finishes:

a. Panels and Trim: Steel and galvanized steel, factory finished immediately after cleaning and pretreating with manufacturer's standard two-coat, baked-on finish consisting of prime coat and thermosetting topcoat.

b. Back Boxes: Galvanized steel.

4. Directory Card: Inside panelboard door, mounted in metal frame with transparent protective cover.

B. 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. Extra-Capacity Neutral Bus: Neutral bus rated 200 percent of phase bus and UL listed as suitable for nonlinear loads.

4. Solid neutral shall be equipped with a full capacity bonding strap for service entrance applications. Gutter mounted neutral will not be acceptable.

C. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Hard-drawn copper, 98 percent conductivity.

2. Main and Neutral Lugs: Compression type.

3. Ground Lugs and Bus-Configured Terminators: Compression type.

4. Feed-Through Lugs: Compression type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

5. Subfeed (Double) Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

6. Gutter-Tap Lugs: Compression type suitable for use with conductor material. Locate at same end of bus as incoming lugs or main device.

7. Extra-Capacity Neutral Lugs: Rated 200 percent of phase lugs mounted on extra-capacity neutral bus.

D. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

E. Multi-Section Panelboards: Consist of two or more equally-sized cabinets, doors and matching separate trims with identical interiors. Match ratings of each section main lugs and busses. Locate main breaker in one section with feed through lugs and sub-feed cables matching same ampere size as incoming feeder. Busses and lugs ampere capacity to match or exceed main breaker ampere rating. Divide loads as evenly as practical between sections and balanced across the phases.

F. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

G. Service Equipment Label: NRTL labeled for use as service equipment for panelboards with main service disconnect.

2.2 DISTRIBUTION PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Square D; a brand of Schneider Electric

2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.

3. Siemens Energy & Automation, Inc.

4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

1. For doors more than 36 inches (914 mm) high, provide two latches, keyed alike.

D. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes 125 A and Smaller: Bolt-on circuit breakers.

E. Branch Overcurrent Protective Devices for Circuit-Breaker Frame Sizes Larger Than 125 A: Bolt-on circuit breakers; plug-in circuit breakers where individual positive-locking device requires mechanical release for removal.

2.3 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Square D; a brand of Schneider Electric.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Branch Overcurrent Protective Devices: Bolt-on circuit breakers, replaceable without disturbing adjacent units.

D. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.4 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

A. Basis-of-Design Product: Subject to compliance with requirements, provide comparable product by one of the following:

1. Square D; a brand of Schneider Electric .
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. 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.
    a. Instantaneous trip.
    b. Long- and short-time pickup levels.
    c. Long- and short-time time adjustments.
    d. Ground-fault pickup level, time delay, and I^2t response.
2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
3. Ground-Fault Equipment Protection (GFEP) Circuit Breakers: Class B ground-fault protection (30-mA trip).
4. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:
    a. Standard frame sizes, trip ratings, and number of poles.
    b. Lugs: Compression style, suitable for number, size, trip ratings, and conductor materials.

c. Application Listing: Appropriate for application; Type SWD for switching fluorescent lighting loads; Type HID for feeding fluorescent and high-intensity discharge (HID) lighting circuits.

d. Handle Clamp: Loose attachment, for holding circuit-breaker handle in on position.

5. Main circuit breaker in service entrance panelboards shall have phase loss/failure relay that will trip main circuit breaker on loss of any phase.

2.5 ACCESSORY COMPONENTS AND FEATURES

A. Accessory Set: Include tools and miscellaneous items required for overcurrent protective device test, inspection, maintenance, and operation.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

A. Install panelboards and accessories according to NECA 407 and NEMA PB 1.1.

B. Mount top of trim 80 inches (2286 mm) above finished floor unless otherwise indicated.

C. 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.

D. Install overcurrent protective devices and controllers not already factory installed.

1. Set field-adjustable, circuit-breaker trip ranges.

E. Install filler plates in unused spaces.

F. Stub four 1-inch (27-GRC) empty conduits from panelboard into accessible ceiling space or space designated to be ceiling space in the future. Stub four 1-inch (27-GRC) empty conduits below slab not on grade.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties after completing load balancing.

H. Comply with NECA 1.

I. Branch circuit breakers (or switches) serving clocks, telephone and communications equipment, refrigerators, exit signs, fire alarm system controls, etc., shall be equipped with lock clips to prevent accidental operation.

3.3 IDENTIFICATION

A. Create a directory to indicate installed circuit loads after balancing panelboard loads; incorporate Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

1. Circuit Breakers serving the Fire Alarm System shall be identified in red lettering in the panelboard directory.

B. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.4 ADJUSTING

A. Adjust moving parts and operable component to function smoothly, and lubricate as recommended by manufacturer.

B. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

C. Load Balancing: After Substantial Completion, but not more than 60 days after Final Acceptance, measure load balancing and make circuit changes.

1. Measure as directed during period of normal system loading.

2. Perform load-balancing circuit changes outside normal occupancy/working schedule of the facility and at time directed. Avoid disrupting critical 24-hour services such as fax machines and on-line data processing, computing, transmitting, and receiving equipment.

3. After circuit changes, recheck loads during normal load period. Record all load readings before and after changes and submit test records.

4. Tolerance: Difference exceeding 20 percent between phase loads, within a panelboard, is not acceptable. Rebalance and recheck as necessary to meet this minimum requirement.

3.5 PROTECTION

A. Temporary Heating: Apply temporary heat to maintain temperature according to manufacturer's written instructions.

END OF SECTION

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SECTION 26 27 26

WIRING DEVICES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Wall-box motion sensors.
3. Snap switches.
4. Multi-Outlet Assemblies
5. Floor Boxes

B. Related Sections include the following:

1. Division 27 Section "Communications Horizontal Cabling" for workstation outlets.

1.3 REFERENCES

A. The following are useful in specifying wiring devices. Other references may be needed for design purposes.

The Institute for Electrical and Electronics Engineers, Inc.

IEEE C62.41.2-2002: Characterization of Surges in Low- Voltage (1000 V and less) AC Power Circuits

IEEE C62.45-2002: Surge Testing for Equipment Connected to Low- Voltage (1000 V and less) AC Power Circuits

National Electrical Contractors Association

NECA 1-1999: Good Workmanship in Electrical Contracting.

National Electrical Manufacturers Association

NEMA 250-03: Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA FB 11-00: Plugs, Receptacles, and Connectors of the Pin and Sleeve Type for Hazardous Locations

NEMA WD 1-99: General Color Requirements for Wiring Devices

NEMA WD 6-02: Wiring Devices - Dimensional Requirements

National Fire Protection Association

NFPA 70-02: National Electrical Code

NFPA 99-02: Health Care Facilities

Telecommunications Industry Association/Electronic Industries Alliance

TIA/EIA-568-B.1-01: Commercial Building Telecommunications Cabling Standard, Part 1: General Requirements (ANSI)

Underwriters Laboratories Inc.

UL 20-02: General-Use Snap Switches

UL 498-02: Attachment Plugs and Receptacles

UL 943-04: Ground- Fault Circuit-Interrupters

UL 1010-03: Receptacle- Plug Combinations for Use in Hazardous (Classified) Locations

UL 1436-98: Outlet Circuit Testers and Similar Indicating Devices

UL 1449-02: Transient Voltage Surge Suppressors

UL 1472-02: Solid-State Dimming Controls

UL 1863-00: Communications-Circuit Accessories

UL 1917-03: Solid-State Fan Speed Controls

1.4 DEFINITIONS

A. EMI: Electromagnetic interference.

B. GFCI: Ground-fault circuit interrupter.

C. Pigtail: Short lead used to connect a device to a branch-circuit conductor.

D. RFI: Radio-frequency interference.

E. SPD: Surge Protection Device.

F. UTP: Unshielded twisted pair.

1.5 SUBMITTALS

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

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

C. Samples: One for each type of device and wall plate specified, in each color specified.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For wiring devices to include in all manufacturers' packing label warnings and instruction manuals that include labeling conditions.

1.6 QUALITY ASSURANCE

A. Source Limitations: Obtain each type of wiring device and associated wall plate through one source from a single manufacturer. Insofar as they are available, obtain all wiring devices and associated wall plates from a single manufacturer and one source.

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 NFPA 70.

D. Products and installation shall comply with the applicable provisions of the ADA Standards.

1.7 COORDINATION

A. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1. Cord and Plug Sets: Match equipment requirements.

PART 2 PRODUCTS

2.1 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. Pass & Seymour/Legrand; Wiring Devices & Accessories (Pass & Seymour).

2.2 STRAIGHT BLADE RECEPTACLES

A. Convenience Receptacles: Tamper-resistant type, 125V, 20A. 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; TRBR20
   b. Hubbell; CR20TR
   c. Pass & Seymour; TR5262

2.3 GFCI RECEPTACLES

A. General Description: Tamper-resistant type, 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 the device is tripped.

B. Duplex GFCI Receptacles, 125V, 20A.

2. Products: Subject to compliance with requirements, provide one of the following:
   a. Cooper; TRVGF20
   b. Hubbell; GFTR20
   c. Pass & Seymour; 2095TR

2.4 SNAP 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; 2221 (single pole), 2222 (two pole), 2223 (three way), 2224 (four way).
   b. Hubbell; CS1221 (single pole), CS1222 (two pole), CS1223 (three way), CS1224 (four way).
   c. Pass & Seymour; 20AC1 (single pole), 20AC2 (two pole), 20AC3 (three way), 20AC4 (four way).

2.5 MULTI-OUTLET ASSEMBLIES

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

1. Hubbell Incorporated; Wiring Device-Kellems.
2. Wiremold Company (The).

B. Components of Assemblies: Products from a single manufacturer designed for use as a complete, matching assembly of raceways and receptacles.

C. Raceway Material: Metal, with manufacturer's standard finish.

2.6 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- (1-mm-) thick, satin-finished stainless steel.

3. Material for Unfinished Spaces: Galvanized steel.

4. Material for Damp Locations: Cast aluminum with spring-loaded lift cover, and listed and labeled for use in "wet locations."

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with type 3R weather-resistant**,** die-cast aluminum with lockable cover.

2.7 FLOOR BOXES

A. Available Products: Subject to compliance with requirements, products may be incorporated into the Work to include, but not limited to, the following:

1. Wiremold Company (The).

2. Hubbell, Incorporated.

2.8 FINISHES

A. Color: Wiring device catalog numbers in Section Text do not designate device color.

1. Wiring Devices Connected to Normal Power System: Ivory, unless otherwise indicated or required by NFPA 70 or device listing.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including the mounting heights listed in that standard, unless otherwise noted.

B. Provide a minimum of one (1) lighting switch in each space regardless of whether shown on the drawings.

C. Coordination with Other Trades:

1. Take steps to insure that devices and their boxes are protected. Do not place wall finish materials over device boxes and do not cut holes for boxes with routers 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 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.

D. 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.

E. 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 (152 mm) 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.

F. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles up, and on horizontally mounted receptacles to the right.

G. 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.

H. 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.

I. Arrangement of Devices: Unless otherwise indicated, mount flush, with long dimension vertical and with grounding terminal of receptacles on top. Group adjacent switches under single, multigang wall plates.

3.2 IDENTIFICATION

A. Comply with Division 26 Section "Identification for Electrical Systems."

1. Receptacles: Identify panelboard and circuit number from which served. Use hot, stamped or engraved machine printing with black-filled lettering on face of plate, and durable wire markers or tags inside outlet boxes.

3.3 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:

1. Line Voltage: Acceptable range is 105 to 132 V.
2. Percent Voltage Drop under 15-A Load: A value of 6 percent or higher is not acceptable.
3. Ground Impedance: Values of up to 2 ohms are acceptable.
4. GFCI Trip: Test for tripping values specified in UL 1436 and UL 943.
5. Using the test plug, verify that the device and its outlet box are securely mounted.
6. The tests shall be diagnostic, indicating damaged conductors, high resistance at the circuit breaker, poor connections, inadequate fault current path, defective devices, or similar problems. Correct circuit conditions, remove malfunctioning units and replace with new ones, and retest as specified above.

END OF SECTION

SECTION 26 28 13

FUSES

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Cartridge fuses rated 600-V ac and less for use in control circuits and enclosed controllers.

2. Spare-fuse cabinets.

1.3 REFERENCES

A. The following references are useful in specifying fuses. Other references may be needed for design purposes.

National Electrical Manufacturers Association

NEMA FU 1-2002: Low Voltage Cartridge Fuses

NFPA

NFPA 70-2005: National Electrical Code

Underwriters Laboratories Inc.

UL 248-11-2000 (Rev. 2005): Low-Voltage Fuses - Part 11: Plug Fuses (ANSI)

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material, dimensions, descriptions of individual components, and finishes for spare-fuse cabinets. Include the following for each fuse type indicated:

1. Ambient Temperature Adjustment Information: If ratings of fuses have been adjusted to accommodate ambient temperatures, provide list of fuses with adjusted ratings.

a. For each fuse having adjusted ratings, include location of fuse, original fuse rating, local ambient temperature, and adjusted fuse rating.

b. Provide manufacturer's technical data on which ambient temperature adjustment calculations are based.

2. Dimensions and manufacturer's technical data on features, performance, electrical characteristics, and ratings.

3. Current-limitation curves for fuses with current-limiting characteristics.

4. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

5. Coordination charts and tables and related data.

6. Fuse sizes for elevator feeders and elevator disconnect switches.

B. Operation and Maintenance Data: For fuses to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Ambient temperature adjustment information.

2. Current-limitation curves for fuses with current-limiting characteristics.

3. Time-current coordination curves (average melt) and current-limitation curves (instantaneous peak let-through current) for each type and rating of fuse.

4. Coordination charts and tables and related data.

1.5 QUALITY ASSURANCE

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

B. Comply with NEMA FU 1 for cartridge fuses.

C. Comply with NFPA 70.

D. Comply with UL 248-11 for plug fuses.

1.6 COORDINATION

A. Coordinate fuse ratings with utilization equipment nameplate limitations of maximum fuse size and with system short-circuit current levels.

1.7 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 two of each size and type.

PART 2 PRODUCTS

2.1 MANUFACTURERS

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

1. Cooper Bussmann, Inc.

2. Ferraz Shawmut, Inc.

3. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

2.3 SPARE-FUSE CABINET

A. Characteristics: Wall-mounted steel unit with full-length, recessed piano-hinged door and key-coded cam lock and pull.

1. Size: Adequate for storage of spare fuses specified with 15 percent spare capacity minimum.

2. Finish: Gray, baked enamel.

3. Identification: "SPARE FUSES" in 1-1/2-inch- (38-mm-) high letters on exterior of door.

4. Fuse Pullers: For each size of fuse, where applicable and available, from fuse manufacturer.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine fuses before installation. Reject fuses that are moisture damaged or physically damaged.

B. Examine holders to receive fuses for compliance with installation tolerances and other conditions affecting performance, such as rejection features.

C. Examine utilization equipment nameplates and installation instructions. Install fuses of sizes and with characteristics appropriate for each piece of equipment.

D. Evaluate ambient temperatures to determine if fuse rating adjustment factors must be applied to fuse ratings.

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

3.2 FUSE APPLICATIONS

A. Cartridge Fuses:

1. Motor Branch Circuits: Class RK1, time delay.

2. Other Branch Circuits: Class RK1, time delay.

3. Control Circuits: Class CC, fast acting.

3.3 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

B. Install spare-fuse cabinet(s).

3.4 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Division 26 Section "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block, socket, and holder.

END OF SECTION

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SECTION 26 28 16

ENCLOSED SWITCHES AND CIRCUIT BREAKERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Molded-case circuit breakers (MCCBs).
4. Molded-case switches.
5. Enclosures.

1.3 REFERENCES

A. The following references are useful in specifying enclosed switches and circuit breakers. Other references may be needed for design purposes.

American Society of Civil Engineers/Structural Engineering Institute

ASCE/SEI 7-2005: Minimum Design Loads for Buildings and Other Structures

ASME International

ASME A17.1-2004: Safety Code for Elevators and Escalators

InterNational Electrical Testing Association

NETA Acceptance Testing Specification-2003: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

National Electrical Contractors Association

NECA 1-2000: Standard Practices for Good Workmanship in Electrical Contracting (ANSI)

National Electrical Manufacturers Association

NEMA 250-2003: Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA AB 1-2002: Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures

NEMA AB 3-2001: Molded Case Circuit Breakers and Their Application

NEMA FU 1-2002: Low Voltage Cartridge Fuses

NEMA KS 1-2001: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

NFPA

NFPA 70-2005: National Electrical Code

NFPA 70E-2004: Standard for Electrical Safety in the Workplace

NFPA 72-2002: National Fire Alarm Code

Underwriters Laboratories Inc.

UL 50-1995 (Rev. 2003): Enclosures for Electrical Equipment (ANSI)

UL 98-2004: Enclosed and Dead-Front Switches (ANSI)

UL 489-2002 (Rev. 2004): Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures (ANSI)

UL 1053-1999: Ground-Fault Sensing and Relaying Equipment (ANSI)

1.4 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.5 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.

5. Include time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

B. Shop Drawings: For enclosed switches and circuit breakers. Include plans, elevations, sections, details, and attachments to other work.

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

C. Manufacturer's field service report.

D. 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.

2. Time-current coordination curves (average melt) for each type and rating of overcurrent protective device; include selectable ranges for each type of overcurrent protective device.

1.6 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.

1.7 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.

1.8 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.

2. Fuse Pullers: Two for each size and type.

PART 2 PRODUCTS

2.1 FUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Square D; a brand of Schneider Electric.

2. Siemens Energy & Automation, Inc.

3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper ground conductors.

2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.

3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.

4. Auxiliary Contact Kit: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.

5. Hookstick Handle: Allows use of a hookstick to operate the handle.

6. Lugs: Compression type, suitable for number, size, and conductor material.

2.2 NONFUSIBLE SWITCHES

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Square D; a brand of Schneider Electric.

2. Siemens Energy & Automation, Inc.

3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

B. Type HD, Heavy Duty, Single Throw, 600-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper 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: Two NO/NC (Form "C") auxiliary contact(s), arranged to activate before switch blades open.

4. Hookstick Handle: Allows use of a hookstick to operate the handle.

5. Lugs: Compression type, suitable for number, size, and conductor material.

2.3 MOLDED-CASE CIRCUIT BREAKERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Square D; a brand of Schneider Electric.

2. Siemens Energy & Automation, Inc.

3. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

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 250 A and larger.

D. Adjustable, Instantaneous-Trip Circuit Breakers: Magnetic trip element with front-mounted, field-adjustable trip setting.

E. Electronic Trip Circuit Breakers: Field-replaceable rating plug, rms sensing, with the following field-adjustable settings:

1. Instantaneous trip.

2. Long- and short-time pickup levels.

3. Long- and short-time time adjustments.

4. Ground-fault pickup level, time delay, and I^2t response.

F. Current-Limiting Circuit Breakers: Frame sizes 400 A and smaller, and let-through ratings less than NEMA FU 1, RK-5.

G. Integrally Fused Circuit Breakers: Thermal-magnetic trip element with integral limiter-style fuse listed for use with circuit breaker and trip activation on fuse opening or on opening of fuse compartment door.

H. Features and Accessories:

1. Standard frame sizes, trip ratings, and number of poles.

2. Lugs: Compression type, suitable for number, size, trip ratings, and conductor material.

3. Shunt Trip: Trip coil energized from separate circuit, with coil-clearing contact.

4. Auxiliary Contacts: Two SPDT switches with "a" and "b" contacts; "a" contacts mimic circuit-breaker contacts, "b" contacts operate in reverse of circuit-breaker contacts.

5. Accessory Control Power Voltage: Integrally mounted, self-powered 120-V ac.

2.4 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. Kitchen Areas: NEMA 250, Type 4X, stainless steel.
4. Other Wet or Damp, Indoor Locations: NEMA 250, Type 4.
5. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: NEMA 250, Type 12.

PART 3 EXECUTION

3.1 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.

3.2 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Comply with mounting and anchoring requirements specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

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

D. Install fuses in fusible devices.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each enclosure with engraved metal or laminated-plastic nameplate.

3.4 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 "Overcurrent Protective Device Coordination Study".

END OF SECTION

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SECTION 26 29 13

ENCLOSED CONTROLLERS

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section includes the following enclosed controllers rated 600 V and less:

1. Full-voltage magnetic.

1.3 REFERENCES

A. The following references are useful in specifying enclosed controllers. Other references may be needed for design purposes.

American Society of Civil Engineers/Structural Engineering Institute

ASCE/SEI 7-2005: Minimum Design Loads for Buildings and Other Structures

The Institute of Electrical and Electronics Engineers, Inc.

IEEE 344-2004: Recommended Practice for Seismic Qualification of Class 1E Equipment for Nuclear Power Generating Stations (BCI endorsed) (ANSI)

InterNational Electrical Testing Association

NETA Acceptance Testing Specification-2003: Acceptance Testing Specifications for Electrical Power Distribution Equipment and Systems

National Electrical Contractors Association

NECA 1-2000: Standard Practices for Good Workmanship in Electrical Contracting (ANSI)

National Electrical Manufacturers Association

NEMA AB 1-2002: Molded-Case Circuit Breakers, Molded Case Switches, and Circuit-Breaker Enclosures

NEMA AB 3-2001: Molded Case Circuit Breakers and Their Application

NEMA ICS 2-2000 (Reaffirmed 2005; Addendum/Errata to Part 2 - 2003; Part 9 - 2002): Industrial Control and Systems: Controllers, Contactors, and Overload Relays Rated 600 Volts

NEMA ICS 5-2000: Industrial Control and Systems: Control Circuit and Pilot Devices

NEMA ICS 6-1993 (Reaffirmed 2001): Industrial Control Systems: Enclosures

NEMA KS 1-2001: Enclosed and Miscellaneous Distribution Equipment Switches (600 Volts Maximum)

NEMA MG 1-2003 (Revision 1 - 2004): Motors and Generators

NFPA

NFPA 70-2005: National Electrical Code

NFPA 70E-2004: Standard for Electrical Safety in the Workplace

Underwriters Laboratories Inc.

UL 489-2002 (Rev. 2004): Molded-Case Circuit Breakers, Molded-Case Switches, and Circuit-Breaker Enclosures (ANSI)

UL 508-1999 (Rev. 2003): Standard for Industrial Control Equipment (ANSI)

1.4 DEFINITIONS

A. CPT: Control power transformer.

B. MCCB: Molded-case circuit breaker.

C. MCP: Motor circuit protector.

D. N.C.: Normally closed.

E. N.O.: Normally open.

F. OCPD: Overcurrent protective device.

G. SCR: Silicon-controlled rectifier.

1.5 SUBMITTALS

A. Product Data: For each type of enclosed controller. Include manufacturer's technical data on features, performance, electrical characteristics, ratings, and enclosure types and finishes.

B. Shop Drawings: For each enclosed controller. Include dimensioned plans, elevations, sections, details, and required clearances and service spaces around controller enclosures.

1. Show tabulations of the following:

a. Each installed unit's type and details.

b. Factory-installed devices.

c. Nameplate legends.

d. Short-circuit current rating of integrated unit.

e. Listed and labeled for integrated short-circuit current (withstand) rating of OCPDs in combination controllers by an NRTL acceptable to authorities having jurisdiction.

f. Features, characteristics, ratings, and factory settings of individual OCPDs in combination controllers.

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

C. Operation and Maintenance Data: For enclosed controllers to include in emergency, operation, and maintenance manuals. In addition to items specified in Division 01 Section "Operation and Maintenance Data," include the following:

1. Routine maintenance requirements for enclosed controllers and installed components.

2. Manufacturer's written instructions for testing and adjusting circuit breaker and MCP trip settings.

3. Manufacturer's written instructions for setting field-adjustable overload relays.

4. Manufacturer's written instructions for testing, adjusting, and reprogramming reduced-voltage solid-state controllers.

D. Load-Current and Overload-Relay Heater List: Compile after motors have been installed, and arrange to demonstrate that selection of heaters suits actual motor nameplate full-load currents.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store enclosed controllers indoors in clean, dry space with uniform temperature to prevent condensation. Protect enclosed controllers from exposure to dirt, fumes, water, corrosive substances, and physical damage.

1.7 COORDINATION

A. Coordinate installation of roof curbs, equipment supports, and roof penetrations.

1.8 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. Control Power Fuses: Equal to 10 percent of quantity installed for each size and type, but no fewer than two of each size and type.

2. Indicating Lights: Two of each type and color installed.

3. Auxiliary Contacts: Furnish one> spare(s) for each size and type of magnetic controller installed.

4. Power Contacts: Furnish three spares for each size and type of magnetic contactor installed.

PART 2 PRODUCTS

2.1 FULL-VOLTAGE CONTROLLERS

A. General Requirements for Full-Voltage Controllers: Comply with NEMA ICS 2, general purpose, Class A.

B. Motor-Starting Switches: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off or on.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

b. Rockwell Automation, Inc.; Allen-Bradley brand.

c. Siemens Energy & Automation, Inc.

d. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.

3. Surface mounting.

4. Red pilot light.

C. Fractional Horsepower Manual Controllers: "Quick-make, quick-break" toggle or push-button action; marked to show whether unit is off, on, or tripped.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.

b. Rockwell Automation, Inc.; Allen-Bradley brand.

c. Siemens Energy & Automation, Inc.

d. Square D; a brand of Schneider Electric.

2. Configuration: Nonreversing.

3. Overload Relays: Inverse-time-current characteristics; NEMA ICS 2, Class 10 tripping characteristics; heaters matched to nameplate full-load current of actual protected motor; external reset push button**;** bimetallic type.

4. Surface mounting.

5. Red pilot light.

D. Magnetic Controllers: Full voltage, across the line, electrically held.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   b. Rockwell Automation, Inc.; Allen-Bradley brand.
   c. Siemens Energy & Automation, Inc.
   d. Square D; a brand of Schneider Electric.
2. Configuration: Nonreversing.
3. Contactor Coils: Pressure-encapsulated type.
   a. Operating Voltage: Depending on contactor NEMA size and line-voltage rating, manufacturer's standard matching control power or line voltage.
4. Power Contacts: Totally enclosed, double-break, 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 of sufficient capacity to operate integral devices and remotely located pilot, indicating, and control devices.
   a. CPT Spare Capacity: 50 VA.
6. Melting Alloy Overload Relays:
   a. Inverse-time-current characteristic.
   b. Class 10 tripping characteristic.
   c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
7. Bimetallic Overload Relays:
   a. Inverse-time-current characteristic.
   b. Class 10 tripping characteristic.
   c. Heaters in each phase matched to nameplate full-load current of actual protected motor and with appropriate adjustment for duty cycle.
   d. Ambient compensated.
   e. Automatic resetting.
8. N.C. or N.O., isolated overload alarm contact.
9. External overload reset push button.

E. Combination Magnetic Controller: Factory-assembled combination of magnetic controller, OCPD, and disconnecting means.

1. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
   a. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
   b. Rockwell Automation, Inc.; Allen-Bradley brand.
   c. Siemens Energy & Automation, Inc.

d. Square D; a brand of Schneider Electric.

2. MCCB Disconnecting Means:

a. UL 489, NEMA AB 1, and NEMA AB 3, with interrupting capacity to comply with available fault currents; thermal-magnetic MCCB, with inverse time-current element for low-level overloads and instantaneous magnetic trip element for short circuits.

b. Front-mounted, adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.

c. Lockable Handle: Accepts three padlocks and interlocks with cover in closed position.

d. Auxiliary contacts "a" and "b" arranged to activate with MCCB handle.

e. N.C. or N.O. alarm contact that operates only when MCCB has tripped.

2.2 ENCLOSURES

A. Enclosed Controllers: NEMA ICS 6, 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.

2.3 ACCESSORIES

A. General Requirements for Control Circuit and Pilot Devices: NEMA ICS 5; factory installed in controller enclosure cover unless otherwise indicated.

1. Push Buttons, Pilot Lights, and Selector Switches: Heavy-duty, oiltight type.

a. Push Buttons: Shielded types; as indicated.

b. Pilot Lights: LED types; colors as indicated**;** push to test.

c. Selector Switches: Rotary type.

B. N.C. or N.O. auxiliary contact(s).

C. Breather and drain assemblies, to maintain interior pressure and release condensation in Type 4 or Type 4X enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

D. Spare control wiring terminal blocks, quantity as indicated; unwired.

PART 3 EXECUTION

3.1 EXAMINATION

A. Examine areas and surfaces to receive enclosed controllers, with Installer present, for compliance with requirements and other conditions affecting performance of the Work.

B. Examine enclosed controllers before installation. Reject enclosed controllers that are wet, moisture damaged, or mold damaged.

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

3.2 INSTALLATION

A. Wall-Mounted Controllers: Install enclosed controllers on walls with tops at uniform height unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not at walls, provide freestanding racks complying with Division 26 Section "Hangers and Supports for Electrical Systems."

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

C. Install fuses in control circuits if not factory installed. Comply with requirements in Division 26 Section "Fuses."

D. Install heaters in thermal overload relays. Select heaters based on actual nameplate full-load amperes after motors have been installed.

E. Comply with NECA 1.

3.3 IDENTIFICATION

A. Identify enclosed controllers, components, and control wiring. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.

2. Label each enclosure with engraved nameplate.

3. Label each enclosure-mounted control and pilot device.

3.4 CONTROL WIRING INSTALLATION

A. Install wiring between enclosed controllers and remote devices and facility's central control system.

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

C. Connect selector switches and other automatic-control selection devices where applicable.

1. Connect selector switches to bypass only those manual- and automatic-control devices that have no safety functions when switch is in manual-control position.

2. Connect selector switches with enclosed-controller 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.

3.5 ADJUSTING

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

B. Adjust overload-relay heaters or settings if power factor correction capacitors are connected to the load side of the overload relays.

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 ampere ratings and attempt to start motors several times, allowing for motor cooldown 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 Owner before increasing settings.

D. Set field-adjustable circuit-breaker trip ranges as specified in Division 26 Section "Overcurrent Protective Device Coordination Study."

3.6 PROTECTION

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

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

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SECTION 26 32 13

ENGINE GENERATORS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes packaged engine-generator sets for emergency standby power supply with the following features:

1. Generator engine: Gas Engine
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.

B. Related Sections include the following:

1. Division 26 Section "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.3 REFERENCES

A. The following publications are useful in specifying packaged engine generators. Other references may be needed for design purposes.

American Association of State Highway and Transportation Officials

AASHTO M 251-97 (Revised 2001): Plain and Laminated Elastomeric Bridge Bearings

American Society of Civil Engineers

ASCE 7-02: Minimum Design Loads for Buildings and Other Structures

ASME International

ASME B15.1-00: Safety Standard for Mechanical Power Transmission Apparatus

The Institute of Electrical and Electronics Engineers, Inc.

IEEE 115-1995 (Revised 2002): IEEE Guide: Test Procedures for Synchronous Machines

InterNational Electrical Testing Association

NETA Acceptance Testing Specification-2003: Acceptance Testing Specifications for Electric Power Distribution Equipment and Systems

National Electrical Manufacturers Association

NEMA 250-97: Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA AB 1-02: Molded Case Circuit Breakers and Molded Case Switches

NEMA ICS 6-93 (Revised 2001): Industrial Control and Systems: Enclosures

NEMA MG 1-98 (Revised 2002): Motors and Generators (Including Rev. 1)

National Fire Protection Agency

NFPA 1: Fire Code

NFPA 30-00: Flammable and Combustible Liquids Code

NFPA 37-02: Installation and Use of Stationary Combustion Engines and Gas Turbines

NFPA 70-02: National Electrical Code

NFPA 99-02: Health Care Facilities

NFPA 110-02: Emergency and Standby Power Systems

NFPA 704: Standard System for the Identification of the Hazards of Materials for Emergency Response

Underwriters Laboratories Inc.

UL 142-02: Steel Aboveground Tanks for Flammable and Combustible Liquids

UL 489-02: Molded Case Circuit Breakers, Molded Case Switches, and Circuit Breaker Enclosures

UL 891-98: Dead-Front Switchboards

UL 1236-02: Battery Chargers for Charging Engine Starter Batteries

UL 2085: Protected Aboveground Tanks for Flammable and Combustible Liquids

UL 2200-98: Stationary Engine Generator Assemblies

Code of Maryland Regulations

COMAR 26.11.02: Permits, Approvals, and Registration

1.4 DEFINITIONS

A. Operational Bandwidth: The total variation from the lowest to highest value of a parameter over the range of conditions indicated, expressed as a percentage of the nominal value of the parameter.

1.5 SUBMITTALS

A. Product Data: For each type of packaged engine generator indicated. Include rated capacities, operating characteristics, and furnished specialties and accessories. In addition, include the following:

1. Thermal damage curve for generator.
2. Time-current characteristic curves for generator protective device.

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. Dimensioned outline plan and elevation drawings of engine-generator set and other components specified.
2. Design Calculations: Signed and sealed by a qualified professional engineer. Calculate requirements for selecting vibration isolators and seismic restraints and for designing vibration isolation bases.
3. Vibration Isolation Base Details: Signed and sealed by a qualified professional engineer. Detail fabrication, including anchorages and attachments to structure and to supported equipment. Include base weights.
4. Wiring Diagrams: Power, signal, and control wiring.

C. Qualification Data: For installer and manufacturer.

D. Source quality-control test reports.

1. Certified summary of prototype-unit test report.
2. Certified Test Reports: For components and accessories that are equivalent, but not identical, to those tested on prototype unit.
3. Certified Summary of Performance Tests: Certify compliance with specified requirement to meet performance criteria for sensitive loads.
4. Report of factory test on units to be shipped for this Project, showing evidence of compliance with specified requirements.
5. Report of sound generation.
6. Report of exhaust emissions showing compliance with applicable regulations.
7. Certified Torsional Vibration Compatibility: Comply with NFPA 110.

E. Field quality-control test reports.

F. Operation and Maintenance Data: For packaged engine generators 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. List of tools and replacement items recommended to be stored at Project for ready access. Include part and drawing numbers, current unit prices, and source of supply.

G. Warranty: Special warranty specified in this Section.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

1. Maintenance Proximity: Not more than four hours' normal travel time from Installer's place of business to Project site.
2. Engineering Responsibility: Preparation of data for vibration isolators and seismic restraints of engine skid mounts, including Shop Drawings, based on testing and engineering analysis of manufacturer's standard units in assemblies similar to those indicated for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles (321 km) of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Source Limitations: Obtain packaged generator sets and auxiliary components through one source from a single manufacturer.

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. Comply with ASME B15.1.

F. Comply with NFPA 37.

G. Comply with NFPA 70.

H. Comply with NFPA 110 requirements for Level 1, Class 60 emergency power supply system.

I. Comply with UL 2200.

J. Engine Exhaust Emissions: Comply with applicable state and local government requirements.

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. Comply with NFPA 110 and Montgomery County Noise Control Ordinance, Chapter 31B of the County Code.

1.7 COORDINATION

A. Coordinate size and location of concrete bases for package engine generator. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 03.

1.8 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of packaged engine generators and associated auxiliary components that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two (2) years from date of Substantial Completion.

1.9 MAINTENANCE SERVICE

A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include quarterly exercising to check for proper starting, load transfer, and running under load. Include routine preventive maintenance as recommended by manufacturer and adjusting as required for proper operation. Provide parts and supplies same as those used in the manufacture and installation of original equipment.

1.10 EXTRA MATERIALS

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

1. Fuses: One for every 10 of each type and rating, but no less than one of each.
2. Indicator Lamps: Two for every six of each type used, but no fewer than two of each.
3. Filters: One set each of lubricating oil, fuel, and combustion-air filters.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:
1. Kohler Co.; Generator Division.
2. Onan/Cummins Power Generation; Industrial Business Group.
3. Generac.

2.2 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. Capacities and Characteristics:

1. Power Output Ratings: Nominal ratings as indicated, with capacity as required to operate as a unit as evidenced by records of prototype testing.
2. Output Connections: Three-phase, four-wire.
3. Nameplates: For each major system component to identify manufacturer's name and address, and model and serial number of component.
4. A self-contained paralleled generator solution is acceptable if the performance requirements and dimensional requirements of the single generator are met. All required accessories, modifications and connections shall be provided for a complete and functional system.

D. 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.

2.3 GASOUS ENGINE

A. Fuel: Natural gas.

B. Rated Engine Speed: 1800 rpm.

C. 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.

D. 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.
3. Industrial grade fuel filter with oil/water separator.

E. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

F. Governor: Adjustable isochronous, with speed sensing.

G. 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. Size of Radiator: Adequate to contain expansion of total system coolant from cold start to 110 percent load condition.
3. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.
4. Coolant Hose: Flexible assembly with inside surface of nonporous rubber and outer covering of aging-, ultraviolet-, and abrasion-resistant fabric.

    a. Rating: 50-psig (345-kPa) maximum working pressure with coolant at 180 deg F (82 deg C), and noncollapsible under vacuum.
    b. End Fittings: Flanges or steel pipe nipples with clamps to suit piping and equipment connections.

H. 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 25 feet (8 m) from exhaust discharge after installation is complete shall be 75 dBA or less.

I. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

J. 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 three times without recharging.
5. Battery Cable: Size as recommended by engine manufacturer for cable length. Include required interconnecting conductors and connection accessories.
6. Battery Compartment: Factory fabricated of metal with acid-resistant finish and thermal insulation. Thermostatically controlled heater shall be arranged to maintain battery above 10 deg C regardless of external ambient temperature within range specified in Part 1 "Project Conditions" Article. Include accessories required to support and fasten batteries in place.
7. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.
8. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236 and include the following features:

    a. Operation: Equalizing-charging rate of 10 A shall be initiated automatically after battery has lost charge until an adjustable equalizing voltage is achieved at battery terminals. Unit shall then be automatically switched to a lower float-charging mode and shall continue to operate in that mode until battery is discharged again.
    b. Automatic Temperature Compensation: Adjust float and equalize voltages for variations in ambient temperature from minus 40 deg C to plus 60 deg C to prevent overcharging at high temperatures and undercharging at low temperatures.

c. Automatic Voltage Regulation: Maintain constant output voltage regardless of input voltage variations up to plus or minus 10 percent.
d. Ammeter and Voltmeter: Flush mounted in door. Meters shall indicate charging rates.
e. Safety Functions: Sense abnormally low battery voltage and close contacts providing low battery voltage indication on control and monitoring panel. Sense high battery voltage and loss of ac input or dc output of battery charger. Either condition shall close contacts that provide a battery-charger malfunction indication at system control and monitoring panel.
f. Enclosure and Mounting: NEMA 250, Type 1, wall-mounted cabinet.

2.4 GASEOUS FUEL SYSTEM

A. Gas Train: Comply with NFPA 37.

B. Engine Fuel System:

1. Natural-Gas, Vapor-Withdrawal System:

a. Carburetor.
b. Secondary Gas Regulators: One for each fuel type, with atmospheric vents piped to building exterior.
c. Fuel-Shutoff Solenoid Valves: NRTL-listed, normally closed, safety shutoff valves; one for each fuel source.
d. Fuel Filters: One for each fuel type.
e. Manual Fuel Shutoff Valves: One for each fuel type.
f. Flexible Fuel Connectors: Minimum one for each fuel connection.
g. Fuel change gas pressure switch.

2.5 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. Operation of a remote emergency-stop switch also shuts down generator set.

B. 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.

C. 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.

D. 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.

E. Connection to Data Link: A separate terminal block, factory wired to Form C dry contacts, for each alarm and status indication is reserved for connections for data-link transmission of indications to remote data terminals.

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.
6. Fuel tank derangement alarm.
7. Fuel tank high-level shutdown of fuel supply alarm.
8. Generator overload.

G. Remote Alarm Annunciator: 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.

H. Remote Emergency-Stop Switch: Flush; wall mounted, unless otherwise indicated; and labeled. Push button shall be protected from accidental operation.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breaker: Molded-case, thermal-magnetic type; 100 percent rated; 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. Generator Protector: Microprocessor-based unit shall continuously monitor current level in each phase of generator output, integrate generator heating effect over time, and predict when thermal damage of alternator will occur. When signaled by generator protector or other generator-set protective devices, a shunt-trip device in the generator disconnect switch shall open the switch to disconnect the generator from load circuits. Protector shall perform the following functions:

1. Initiates a generator overload alarm when generator has operated at an overload equivalent to 110 percent of full-rated load for 60 seconds. Indication for this alarm is integrated with other generator-set malfunction alarms.
2. Under single or three-phase fault conditions, regulates generator to 300 percent of rated full-load current for up to 10 seconds.
3. As overcurrent heating effect on the generator approaches the thermal damage point of the unit, protector switches the excitation system off, opens the generator disconnect device, and shuts down the generator set.
4. Senses clearing of a fault by other overcurrent devices and controls recovery of rated voltage to avoid overshoot.

2.7 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 or Class F.

D. Stator-Winding Leads: Brought out to terminal box to permit future reconnection for other voltages if required.

E. 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.

F. Enclosure: Dripproof.

G. 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.

H. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

I. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

J. Subtransient Reactance: 12 percent, maximum.

2.8 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

2.9 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.

B. Project-Specific Equipment Tests: Before shipment, factory test engine-generator set and other system components and accessories manufactured specifically for this Project. Perform tests at rated load and power factor. Include the following tests:

1. Test components and accessories furnished with installed unit that are not identical to those on tested prototype to demonstrate compatibility and reliability.
2. Full load run.
3. Maximum power.
4. Voltage regulation.
5. Transient and steady-state governing.
6. Single-step load pickup.
7. Safety shutdown.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas, equipment bases, and conditions, with Installer present, for compliance with requirements for installation and other conditions affecting packaged engine-generator performance.

B. Examine roughing-in of piping systems and electrical connections. Verify actual locations of connections before packaged engine-generator installation.

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

3.2 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 packaged engine generator with restrained spring isolators having a minimum deflection of 1 inch (25 mm) on 4-inch- (100-mm-) high concrete base. Secure sets to anchor bolts installed in concrete bases. Concrete base construction is specified in Division 26 Section "Vibration and Seismic Controls for Electrical Systems."

D. 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."

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

3.3 CONNECTIONS

A. Piping installation requirements are specified in Division 23 Sections. Drawings indicate general arrangement of piping and specialties.

B. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

C. Connect engine exhaust pipe to engine with flexible connector.

D. Connect fuel piping to engines with a gate valve and union and flexible connector.
   1. Natural-gas piping, valves, and specialties for gas distribution are specified in Division 23 Section "Facility Natural-Gas Piping."

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

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

3.4 IDENTIFICATION

A. Identify system components according to Division 23 Section "Identification for HVAC Piping and Equipment" and Division 26 Section "Identification for Electrical Systems." Comply with NFPA 704.

3.5 FIELD QUALITY CONTROL

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

B. Tests and Inspections:

   1. 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. Exhaust Emissions Test: Comply with applicable government test criteria.
7. 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.
8. 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.
9. Noise Level Tests: Measure A-weighted level of noise emanating from generator-set installation, including engine exhaust and cooling-air intake and discharge, at four locations on the property line, and compare measured levels with required values.

C. Coordinate tests with tests for transfer switches and run them concurrently.

D. Test instruments shall have been calibrated within the last 12 months, traceable to standards of NIST, and adequate for making positive observation of test results. Make calibration records available for examination on request.

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

F. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

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

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

I. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

J. 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.

K. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each power wiring termination and each

L. bus connection. Remove all access panels so terminations and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan 11 months after date of Substantial Completion.
2. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.
3. Record of Infrared Scanning: Prepare a certified report that identifies terminations and connections checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.6 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."

END OF SECTION

SECTION 26 43 13

SURGE PROTECTION FOR LOW-VOLTAGE ELECTRICAL POWER CIRCUITS

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 field-mounted SPDs for low-voltage (120 to 600 V) power distribution and control equipment.

1.3 DEFINITIONS

A. Inominal: Nominal discharge current.

B. MCOV: Maximum continuous operating voltage.

C. Mode(s), also Modes of Protection: The pair of electrical connections where the VPR applies.

D. MOV: Metal-oxide varistor; an electronic component with a significant non-ohmic current-voltage characteristic.

E. OCPD: Overcurrent protective device.

F. SCCR: Short-circuit current rating.

G. SPD: Surge protective device.

H. VPR: Voltage protection rating.

1.4 ACTION SUBMITTALS

A. Product Data: For each type of product.

1. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

2. Copy of UL Category Code VZCA certification, as a minimum, listing the tested values for VPRs, Inominal ratings, MCOVs, type designations, OCPD requirements, model numbers, system voltages, and modes of protection.

B. Verifictaion that all SPD are UL tested and labeled with 20kA (In) nominal discharge rating for compliance to UL96A Lightning Protection Master Label and NFPA 780.

C. UL 1449 stipulation for fused SPD – The manufacturer’s authorized representative is required to submit the following:

1. Certify that the SPD is UL 1449 listed (UL Card) with UL Card.

2. Indicate the type of internal or external fusing that is incorporated in the SPD and what impact the fusing has on the performance of the device with respect to surge capacity and clamping levels.

D. Manufacturer must provide independent testing on repetitive capability and maximum surge current rating of service entrance suppressor units. This shall be performed at a nationally recognized lab not affiliated with the manufacturer.

1. Single pulse surge current capacity: single pulse surge current tested in a mode at rated surge currents. Single pulse surge current capacities of 200,000 A or less per mode are established by single pulse testing in a mode.

2. Single pulse surge current capacity test: an initial UL 1449 defined as 1.2 x 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 500A and 3kA short circuit current waveform is applied to benchmark the unit's suppression voltage.

3. A single pulse surge of maximum rated surge current (for units rated over 200,000A per mode, components or sub-assemblies are tested) magnitude with an approximated 8 x 20µs waveform is then applied. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival. Survival is achieved if the suppression voltage measured from the two UL1449 surges does not vary by more than 10%.

E. Minimum Repetitive Surge Current Capacity.

1. Service entrance suppressor units should be tested repetitively to verify repetitive capacity.

2. Minimum Repetitive Surge Current Capacity Test:

a. An initial UL 1449 surge defined as 1.2 x 50µs, 6000V open circuit voltage waveform and an 8 x 20µs, 500A and 3kA short circuit current waveform is applied to benchmark the unit's suppression voltage.

b. A repetitive number of ANSI/IEEE C62.41.2-2002 (Category C3) surges defined as a 1.2 x 50µs 10kV or 20kV open circuit voltage waveform and an 8 x 20µs 10,000A short circuit current waveform are then applied at one minute intervals.

c. To complete the test, another UL 1449 surge shall be applied to verify the unit's survival.

3. Survival is achieved if the suppression voltage measured from the two UL 1449 surges does not vary by more than 10%.

4. Proof of such testing shall be the test log generated by the surge generator.

F. Short Circuit Fuse Testing:

1. Each design configuration shall be short circuit tested in accordance with the type of fusing utilized in the suppression path.

2. Short Circuit Fuse Test:

a. Testing shall include application of a sustained overvoltage that causes the unit to enter a bolted fault condition.

b. This bolted fault condition shall occur with the full rated AIC current of the fuse available.

3. The fuse shall fail in a safe manner with no physical or structural damage to the unit and any failure shall be self-contained within the unit.

G. Surge Current fuse Testing:

1. Each design configuration shall be surge tested with fusing in series to verify that a transient of maximum surge current capacity magnitude is fully suppressed without fuse failure, operation or degradation.

H. Service Entrance SPD must be subjected to a series of waveforms as described in IEEE C62.41.2-2002. Clamping voltage measurements were taken throughout the tests to evaluate any deviations in performance as a result of the surges. Injected surges included the 1.2/50µs, 8/20µs waveforms at levels of 6kV/500A for bench marking, and high current 10/1000µs surges at 1.5, 3.1, 3.6 and 6.2 kA levels.

1.5 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Sample Warranty: For manufacturer's special warranty.

1.6 CLOSEOUT SUBMITTALS

A. Maintenance Data: For SPDs to include in maintenance manuals.

1.7 WARRANTY

A. Manufacturer's Warranty: Manufacturer agrees to replace or replace SPDs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Ten years from date of Substantial Completion.

PART 2 PRODUCTS

2.1 GENERAL SPD REQUIREMENTS

A. SPD with Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Comply with NFPA 70.

C. Comply with UL 1449, Third Edition.

D. MCOV of the SPD shall be the nominal system voltage.

E. Each protection device shall have a capacitive filtering system connected in each Line to Neutral (L-N)(wye) mode or Line to Line (L-L)(delta) mode to provide EMI/RFI noise attenuation.

F. Protection modes: The SPD shall provide Line to Neutral (L-N)(wye), Line to Ground (L-G)(wye or delta), Line to Line (L-L)(delta) ,and Neutral to Ground (N-G)(wye) protection.

G. SPD shall be a multi-stage parallel protector. SPDs minimum surge current capacity shall be 400kA per phase (L-N plus L-G) and 200kA per mode (L-N, L-G, L-L and N-G).

H. Coordinate location of field-mounted suppressors to allow adequate clearances for maintenance.

I. Service Conditions: Rate surge protective devices for continuous operation under the following conditions, unless otherwise indicated:

1. Maximum Continuous Operating Voltage (MCOV): Should be tested to 115% per UL 1449 3rd.

2. Operating Temperature: 0 to 50 deg F.

3. Humidity: 0 to 95 percent, noncondensing.

4. Altitude: Less than 12,000 feet above sea level.

J. Every component of every mode shall be protected by internal thermal protection. SPDs relying on external or supplementary installed safety overcurrent protection do not meet the intent of this specification.

K. All primary transient paths shall utilize copper wire, aluminum bus bar and lugs of equivalent capacity to provide equal impedance interconnection between phases. No plug-in module or components shall be used in surge carrying paths.

2.2 SERVICE ENTRANCE SUPPRESSOR

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

1. Advanced Protection Technologies Inc. (APT).

2. LEA International; Protection Technology Group–PV400.

3. Surge Suppression Inc.

4. Liebert SI-040-ANCE
5. Current Technology SL2-200-L2
6. Total Protection Solutions

B. SPDs: Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1449, Type 2.

1. SPDs with the following features and accessories:
   a. Integral disconnect switch.
   b. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
   c. Indicator light display for protection status.
   d. Surge counter.

C. Comply with UL 1283.

D. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 400 kA and 200kA per mode.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V.
2. Line to Ground: 1200 V for 480Y/277 V.
3. Line to Line: 2000 V for 480Y/277 V.

F. SCCR: Equal or exceed 100 kA.

G. Inominal Rating: 20 kA.

2.3 DISTRIBUTION PANEL SUPPRESSORS

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

1. Advanced Protection Technologies Inc. (APT).
2. LEA International; Protection Technology Group LS 200P.
3. PowerLogics, Inc.
4. Liebert – LM100-ANCE
5. Current Technology – CGP100
6. Total Protection Solutions

B. SPDs: Comply with UL 1449, Type 2.

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Surge counter.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 200 kA and 100kA per mode.

D. Comply with UL 1283.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 480Y/277 V and 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
2. Line to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
3. Neutral to Ground: 1200 V for 480Y/277 V, 700 V for 208Y/120 V.
4. Line to Line: 2000 V for 480Y/277 V, 1200 V for 208Y/120 V

F. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

G. SCCR: Equal or exceed 100 kA.

H. Inominal Rating: 20 Ka.

2.4 PANEL SUPPRESSORS

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

1. Advanced Protection Technologies Inc. (APT).
2. LEA International; Protection Technology Group SP100.
3. PowerLogics, Inc.
4. Liebert – ACV-III-RKE
5. Current Technology – CGP60
6. Total Protection Solutions

B. SPDs: Comply with UL 1449, Type 2.

1. Include LED indicator lights for power and protection status.
2. Internal thermal protection that disconnects the SPD before damaging internal suppressor components.
3. Indicator light display for protection status.
4. Surge counter.

C. Peak Surge Current Rating: The minimum single-pulse surge current withstand rating per phase shall not be less than 100 kA and 50kA per mode.

D. Comply with UL 1283.

E. Protection modes and UL 1449 VPR for grounded wye circuits with 208Y/120 V, three-phase, four-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V for 208Y/120 V.
2. Line to Ground: 700 V for 208Y/120 V.
3. Neutral to Ground: 700 V for 208Y/120 V.

4. Line to Line: 1200 V for 208Y/120 V

F. Protection modes and UL 1449 VPR for 240/120-V, single-phase, three-wire circuits shall not exceed the following:

1. Line to Neutral: 700 V.
2. Line to Ground: 700 V.
3. Neutral to Ground: 700 V.
4. Line to Line: 1200 V.

G. SCCR: Equal or exceed 100 kA.

H. Nominal Rating: 10 Ka.

2.5 ENCLOSURES

A. Indoor Enclosures: NEMA 250, Type 1.

B. Outdoor Enclosures: NEMA 250, Type 4X.

PART 3 EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1.

B. Install an OCPD or disconnect as required to comply with the UL listing of the SPD.

C. Install SPDs with conductors between suppressor and points of attachment as short and straight as possible, and adjust circuit-breaker positions to achieve shortest and straightest leads. Do not splice and extend SPD leads unless specifically permitted by manufacturer. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

D. Use crimped connectors and splices only. Wire nuts are unacceptable.

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

3.2 FIELD QUALITY CONTROL

A. Perform the following tests and inspections with the assistance of a factory-authorized service representative.

1. Compare equipment nameplate data for compliance with Drawings and Specifications.
2. Before energizing electrical circuitry, verify that the unit voltage and conneting equipment voltage is the same.
3. Inspect anchorage, alignment, grounding, and clearances.
4. Verify that electrical wiring installation complies with manufacturer's written installation requirements.

B. An SPD will be considered defective if it does not pass tests and inspections.

C. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Complete startup checks according to manufacturer's written instructions.

B. Do not perform insulation-resistance tests of the distribution wiring equipment with SPDs installed. Disconnect SPDs before conducting insulation-resistance tests, and reconnect them immediately after the testing is over.

C. Energize SPDs after power system has been energized, stabilized, and tested.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to operate and maintain SPDs.

END OF SECTION

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SECTION 26 51 00

INTERIOR LIGHTING

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and drivers/ballasts.
2. Emergency lighting units.
3. Exit signs.
4. Lighting fixture supports.

B. Related Sections:

1. Division 26 Section "Lighting Control Devices" for automatic control of lighting, including time switches, photoelectric relays, occupancy sensors, and multipole lighting relays and contactors.
2. Division 26 Section "Wiring Devices" for manual wall-box dimmers.

1.3 REFERENCES

A. The following references are useful in specifying interior lighting. Other references may be needed for design purposes.

American National Standards Institute

ANSI C82.1-2004: For Lamp Ballast - Line Frequency Fluorescent Lamp Ballast

ANSI C82.11-2002: High-Frequency Fluorescent Lamp Ballasts

ASTM International

ASTM A 580/A 580M-06: Specification for Stainless Steel Wire

ASTM A 641/A 641M-03: Specification for Zinc-Coated (Galvanized) Carbon Steel Wire

Code of Federal Regulations

29 CFR - Labor, Chapter XVII - Occupational Safety and Health Administration, Department of Labor, Part 1910 - "Occupational Safety and Health Standards," Subpart A - "General," Section 1910.7 - "Definition and Requirements for a Nationally Recognized Testing Laboratory." 2006.

47 CFR - Telecommunication, Chapter I - Federal Communications Commission, Part 18 - "Industrial, Scientific, and Medical Equipment," Subpart C - "Technical Standards." 2005.

The Institute of Electrical and Electronics Engineers, Inc.

IEEE C62.41.1-2002: Guide on the Surge Environment in Low-Voltage (1000 V and Less) AC Power Circuits (ANSI)

IEEE C62.41.2-2002: Recommended Practice on Characterization of Surges in Low-Voltage (1000 V and Less) AC Power Circuits (ANSI)

Military Specification and Standards (U.S. Department of Defense)

MIL-STD-461E-1999: Requirements for the Control of Electromagnetic Interference Characteristics of Subsystems and Equipment

National Electrical Manufacturers Association

NEMA 250-2003: Enclosures for Electrical Equipment (1000 Volts Maximum)

NEMA LE 4-2006: Recessed Luminaires, Ceiling Compatibility

NEMA LE 5-2001: Procedure for Determining Luminaire Efficacy Ratings for Fluorescent Luminaire

NFPA

NFPA 70-2005: National Electrical Code

NFPA 101-2006: Life Safety Code

Underwriters Laboratories Inc.

UL 924-2006: Emergency Lighting and Power Equipment

UL 935-2001: Fluorescent Lamp Ballasts

UL 1598-2004 (Rev. 2006): Luminaires

1.4 DEFINITIONS

A. BF: Ballast factor.

B. CCT: Correlated color temperature.

C. CRI: Color-rendering index.

D. LER: Luminaire efficacy rating.

E. Lumen: Measured output of lamp and luminaire, or both.

F. Luminaire: Complete lighting fixture, including driver/ballast housing if provided.

G. LED: Light-Emitting Diode.

1.5 SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, finishes, and the following:

1. Physical description of lighting fixture including dimensions.

2. Emergency lighting units including battery and charger.

3. Driver/Ballast, including BF.

4. Energy-efficiency data.

5. Life, output (lumens, CCT, and CRI), and energy-efficiency data for lamps.

6. Photometric data and adjustment factors based on laboratory tests, complying with IESNA Lighting Measurements Testing & Calculation Guides, of each lighting fixture type. The adjustment factors shall be for lamps, drivers/ballasts, and accessories identical to those indicated for the lighting fixture as applied in this Project.

a. Manufacturer Certified Data: Photometric data shall be certified by a manufacturer's laboratory with a current accreditation under the National Voluntary Laboratory Accreditation Program for Energy Efficient Lighting Products.

B. Shop Drawings: For nonstandard or custom lighting fixtures. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

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

C. Samples: For each lighting fixture where indicated in Lighting Fixture Schedule. Each Sample shall include the following:

1. Lamps and drivers/ballasts, installed.

2. Cords and plugs.

D. LEED Submittals: Product Data for Innovation in Design Credit 1: For low-mercury lamping, manufacturer's MSDS for each type of lamp installed showing mercury content of the lamps in milligrams.

E. Installation instructions.

F. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

1. Lighting fixtures.

2. Suspended ceiling components.

3. Ceiling-mounted projectors.

4. Other items in finished ceiling including the following:

a. Air outlets and inlets.

b. Speakers.

c. Sprinklers.

d. Smoke and fire detectors.

e. Occupancy sensors.

f. Access panels.

G. Product Certificates: For each type of driver/ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

H. Field quality-control reports.

I. Operation and Maintenance Data: For lighting equipment and fixtures to include in emergency, operation, and maintenance manuals.

1. Provide a list of all lamp types used on Project; use ANSI and manufacturers' codes.

J. Warranty: Sample of special warranty.

1.6 QUALITY ASSURANCE

A. Luminaire Photometric Data Testing Laboratory Qualifications: Provided by manufacturers' laboratories that are accredited under the National Volunteer Laboratory Accreditation Program for Energy Efficient Lighting Products.

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. FM Global Compliance: Lighting fixtures for hazardous locations shall be listed and labeled for indicated class and division of hazard by FM Global.

E. NECA/IESNA Compliance: Comply with NECA/IESNA 500-2006 Standard, INSTALLING INDOOR COMMERCIAL LIGHTING SYSTEMS (ANSI).

F. NFPA 101 Compliance: Comply with visibility and luminance requirements for exit signs.

G. Installer: All Installers shall have not less than five (5) years experience in the installation of lighting fixtures of the type and quality shown.

H. UL Compliance: Comply with UL Standards, including UL 486A and B, pertaining to interior lighting fixtures. Provide interior lighting fixtures and components which are UL-listed and labeled.

I. CBM Labels: Provide fluorescent lamp ballasts which comply with Certified Ballasts Manufacturer's Association Standards and carry the CBM label.

1.7 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.

1.8 WARRANTY

A. Special Warranty for Emergency Lighting Batteries: Manufacturer's standard form in which manufacturer of battery-powered emergency lighting unit agrees to repair or replace components of rechargeable batteries that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Emergency Lighting Unit Batteries: 10 years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining nine years.

2. Warranty Period for Emergency Fluorescent Ballast and Self-Powered Exit Sign Batteries: Seven years from date of Substantial Completion. Full warranty shall apply for first year, and prorated warranty for the remaining six years.

B. Special Warranty for Drivers/Ballasts: Manufacturer's standard form in which driver/ballast manufacturer agrees to repair or replace drivers/ballasts that fail in materials or workmanship within specified warranty period.

1. Warranty Period for Electronic Drivers/Ballasts: Five years from date of Substantial Completion.

C. Special Warranty for T5 and T8 Fluorescent Lamps: Manufacturer's standard form, made out to Owner and signed by lamp manufacturer agreeing to replace lamps that fail in materials or workmanship, F.O.B. the nearest shipping point to Project Site, within specified warranty period indicated below:

1. Warranty Period: Two years from date of Substantial Completion.

1.9 EXTRA MATERIALS

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

1. Lamps: 10 for every 100 of each type and rating installed. Furnish at least one of each type.

2. Plastic Diffusers and Lenses: One for every 100 of each type and rating installed. Furnish at least one of each type.

3. Fluorescent-fixture-mounted, emergency battery pack: One for every 20emergency lighting unit.

4. Drivers/Ballasts: Five (5) for every 100 of each type and rating installed. Furnish at least two (2) of each type.

5. Globes and Guards: One for every 20 of each type and rating installed. Furnish at least one of each type.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, available products that may be incorporated into the Work include product(s) indicated on Drawings and Specifications.

2.2 GENERAL REQUIREMENTS FOR LIGHTING FIXTURES AND COMPONENTS

A. Recessed Fixtures: Comply with NEMA LE 4 for ceiling compatibility for recessed fixtures.

B. Fluorescent Fixtures: Comply with UL 1598. Where LER is specified, test according to NEMA LE 5 and NEMA LE 5A as applicable.

C. LED Fixtures: comply with UL 8750. Test according to IESNA LM-79-2008 and IESNA LM-80-2008, in addition to ANSI C78.377-2008.

D. Metal Parts: Free of burrs and sharp corners and edges.

E. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

F. 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.

G. Diffusers and Globes:

1. Acrylic Lighting Diffusers: 100 percent virgin acrylic plastic. High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

a. Lens Thickness: At least 0.125 inch (3.175 mm) minimum unless otherwise indicated.

b. UV stabilized.

2. Glass: Annealed crystal glass unless otherwise indicated.

H. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and drivers/ballasts. Labels shall be located where they will be readily visible to service personnel, but not seen from normal viewing angles when lamps are in place.

1. Label shall include the following lamp and driver/ballast characteristics:

a. "USE ONLY" and include specific lamp type.

b. Lamp diameter code (T-4, T-5, T-8, etc.), tube configuration (twin, quad, triple, etc.), base type, and nominal wattage for fluorescent luminaires.

c. Lamp type, wattage, bulb type and coating.

d. Start type (programmed start, instant start, etc.) for fluorescent luminaires.

e. CCT and CRI for all luminaires.

2.3 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. Lamps for AC Operation: LEDs, 50,000 hours minimum rated lamp life.

2. Self-Powered Exit Signs (Battery Type): Integral automatic charger in a self-contained power pack.

a. Battery: Sealed, maintenance-free, nickel-cadmium type.

b. Charger: Fully automatic, solid-state type with sealed transfer relay.

c. Operation: Relay automatically energizes lamp from battery when circuit voltage drops to 80 percent of nominal voltage or below. When normal voltage is restored, relay disconnects lamps from battery, and battery is automatically recharged and floated on charger.

d. Test Push Button: Push-to-test type, in unit housing, simulates loss of normal power and demonstrates unit operability.

e. LED Indicator Light: Indicates normal power on. Normal glow indicates trickle charge; bright glow indicates charging at end of discharge cycle.

f. Remote Test: Switch in hand-held remote device aimed in direction of tested unit initiates coded infrared signal. Signal reception by factory-installed infrared receiver in tested unit triggers simulation of loss of its normal power supply, providing visual confirmation of either proper or failed emergency response.

g. Integral Self-Test: Factory-installed electronic device automatically initiates code-required test of unit emergency operation at required intervals. Test failure is annunciated by an integral audible alarm and a flashing red LED.

3. Master/Remote Sign Configurations:

a. Master Unit: Comply with requirements above for self-powered exit signs, and provide additional capacity in battery for power connection to remote unit.

b. Remote Unit: Comply with requirements above for self-powered exit signs, except omit power supply, battery, and test features. Arrange to receive full power requirements from master unit. Connect for testing concurrently with master unit as a unified system.

2.4 LED LUMINAIRES

A. An LED luminaire consists of LED light engine and driver, heat-sink, fixture housing, and optic assembly where applicable.

1. Temperature: Minimum starting temperature of -20 deg C (-4 deg F), maximum operating temperature of 70 deg C (158 deg F).

2. Lamp and Lumen Maintenance: Plus 50,000 hours rated life at greater than 70% lumen maintenance.

3. CRI and CCT: 3500 deg K CRI and greater than 80 CRI.

4. Dimming capability: 0-10 volt analog dimming.

5. Photometric Data and Test Reports: Comply with IESNA LM-79-08, IESNA LM-80-08, and ANSI C78.377-08.

6. Radio Frequency Interference: Comply with CAP 106B Telecommunications (Control of Interference) Regulations.

7. Luminaires and components thereof shall comply with UL 8750 Standard of Safety.

8. Five-year Warranty on Luminaire including LED light engine and driver.

9. Power Factor: 90 percent minimum.

10. Total Harmonic Distortion Rating: Less than 10 percent.

11. RoHS compliant.

12. Sound Rating: Class A.

13. Overload, short circuit, and thermal protection.

14. Transient Voltage Protection: Rated to withstand 2.5kV of transient line surge.

15. LED electronic drivers shall be manufactured by Advance, Universal, Osram, Eldoled, Lutron, or approved equal.

16. LED luminaires shall be listed with the Design Lights Consortium or Energy Star Qualified Products lists.

2.5 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Division 26 Section "Hangers and Supports for Electrical Systems" for channel- and angle-iron supports and nonmetallic channel and angle supports.

B. Single-Stem Hangers: 1/2-inch (13-mm) steel tubing with swivel ball fittings and ceiling canopy. Finish same as fixture.

C. Twin-Stem Hangers: Two, 1/2-inch (13-mm) steel tubes with single canopy designed to mount a single fixture. Finish same as fixture.

D. Wires: ASTM A 641/A 641M, Class 3, soft temper, zinc-coated steel, 12 gage (2.68 mm).

E. Wires for Humid Spaces: ASTM A 580/A 580M, Composition 302 or 304, annealed stainless steel, 12 gage (2.68 mm).

F. Rod Hangers: 3/16-inch (5-mm) minimum diameter, cadmium-plated, threaded steel rod.

G. Hook Hangers: Integrated assembly matched to fixture and line voltage and equipped with threaded attachment, cord, and locking-type plug.

PART 3 EXECUTION

3.1 INSTALLATION

A. Lighting fixtures:

1. Set level, plumb, and square with ceilings and walls unless otherwise indicated.

2. Install lamps in each luminaire.

B. Temporary Lighting: If it is necessary, and approved by Architect, to use permanent luminaires for temporary lighting, install and energize the minimum number of luminaires necessary. When construction is sufficiently complete, remove the temporary luminaires, disassemble, clean thoroughly, install new lamps, and reinstall.

C. Remote Mounting of Drivers/Ballasts: Distance between the driver/ballast and fixture shall not exceed that recommended by driver/ballast manufacturer. Verify, with driver/ballast manufacturers, maximum distance between driver/ballast and luminaire.

D. Lay-in Ceiling Lighting Fixtures Supports:

1. Install ceiling support system rods or wires**,** independent of the ceiling suspension devices**,** for each fixture. Locate not more than 6 inches (150 mm) from lighting fixture corners.

2. 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.

3. Fixtures of Sizes Less Than Ceiling Grid: Install as indicated on reflected ceiling plans or center in acoustical panel, and support fixtures independently with at least two 3/4-inch (20-mm) metal channels spanning and secured to ceiling tees.

4. Install at least one independent support rod or wire from structure to a tab on lighting fixture. Wire or rod shall have breaking strength of the weight of fixture at a safety factor of 3.

E. Suspended Lighting Fixture Support:

1. Pendants and Rods: Where longer than 48 inches (1200 mm), brace to limit swinging.
2. Stem-Mounted, Single-Unit Fixtures: Suspend with twin-stem hangers.
3. Continuous Rows: Use tubing or stem for wiring at one point and tubing or rod for suspension for each unit length of fixture chassis, including one at each end.
4. Do not use grid as support for pendant luminaires. Connect support wires or rods to building structure.

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

3.2 IDENTIFICATION

A. Install labels with panel and circuit numbers on concealed junction and outlet boxes. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Test for Emergency Lighting: Interrupt power supply to demonstrate proper operation. Verify transfer from normal power to battery and retransfer to normal.

B. Prepare a written report of tests, inspections, observations, and verifications indicating and interpreting results. If adjustments are made to lighting system, retest to demonstrate compliance with standards.

3.4 STARTUP SERVICE

A. Burn-in all lamps that require specific aging period to operate properly, prior to occupancy by Owner. Burn-in fluorescent lamps intended to be dimmed, for at least 100 hours at full voltage.

3.5 ADJUSTING

A. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting aimable luminaires to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose. Some of this work may be required after dark.

1. Adjust aimable luminaires in the presence of Architect.

END OF SECTION

SECTION 27 05 00

COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1. GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Communications equipment coordination and installation.
2. Sleeves for pathways and cables.
3. Sleeve seals.
4. Grout.
5. Common communications installation requirements.

1.3 DEFINITIONS

A. EPDM: Ethylene-propylene-diene terpolymer rubber.

B. NBR: Acrylonitrile-butadiene rubber.

1.4 SUBMITTALS

A. Product Data: For sleeve seals.

1.5 COORDINATION

A. Coordinate arrangement, mounting, and support of communications equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
3. To allow right of way for piping and conduit installed at required slope.
4. So connecting pathways, cables, wireways, cable trays, and busways will be clear of obstructions and of the working and access space of other equipment.

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

C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed. Access doors and panels are specified in Division 08 Section "Access Doors and Frames."

D. Coordinate sleeve selection and application with selection and application of firestopping specified in Division 07 Section "Penetration Firestopping”.

PART 2. PRODUCTS

2.1 SLEEVES FOR PATHWAYS AND CABLES

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

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

C. Sleeves for Rectangular Openings: Galvanized sheet steel.

1. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and no side more than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches (1270 mm) and 1 or more sides equal to, or more than, 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and pathway or cable.

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

a. Advance Products & Systems, Inc.

b. Calpico, Inc.

c. Metraflex Co.

d. Pipeline Seal and Insulator, Inc.

2. Sealing Elements: EPDM interlocking links shaped to fit surface of cable or conduit. Include type and number required for material and size of pathway or cable.

3. Pressure Plates: Carbon steel. 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.

2.3 GROUT

A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107, factory-packaged, nonmetallic aggregate grout, noncorrosive, nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

PART 3. EXECUTION

3.1 COMMON REQUIREMENTS FOR COMMUNICATIONS 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: Install to facilitate service, maintenance, and repair or replacement of components of both communications 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.

3.2 SLEEVE INSTALLATION FOR COMMUNICATIONS PENETRATIONS

A. Communications penetrations occur when pathways, cables, wireways, or cable trays 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 2 inches (50 mm) above finished floor level.

G. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and pathway or cable, 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. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and pathway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Division 07 Section "Joint Sealants."

J. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pathway and cable penetrations. Install sleeves and seal pathway and cable penetration sleeves with firestop materials. Comply with requirements in Division 07 Section "Penetration Firestopping."

K. Roof-Penetration Sleeves: Seal penetration of individual pathways and cables 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 (25-mm) 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 (25-mm) annular clear space between pathway or cable and sleeve for installing mechanical sleeve seals.

3.3 SLEEVE-SEAL INSTALLATION

A. Install to seal exterior wall penetrations.

B. Use type and number of sealing elements recommended by manufacturer for pathway or cable material and size. Position pathway or cable in center of sleeve. Assemble mechanical sleeve seals and install in annular space between pathway or cable and sleeve. Tighten bolts against pressure plates that cause sealing elements to expand and make watertight seal.

3.4 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for communications installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Division 07 Section "Penetration Firestopping."

END OF SECTION

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SECTION 27 11 00

COMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1. GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Telecommunications mounting elements.
2. Backboards.
3. Grounding.

B. Related Sections:

1. Division 27 Section "Data, Voice & Video" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

C. LAN: Local area network.

D. RCDD: Registered Communications Distribution Designer.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for equipment racks and cabinets. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

B. Shop Drawings: For communications equipment room fittings. Include plans, elevations, sections, details, and attachments to other work.

1. Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Equipment Racks and Cabinets: Include workspace requirements and access for cable connections.
3. Grounding: Indicate location of grounding bus bar and its mounting detail showing standoff insulators and wall mounting brackets.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

1.5 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings shall be under the direct supervision of RCDD.
2. Installation Supervision: Installation shall be under the direct supervision of Registered Technician, who shall be present at all times when Work of this Section is performed at Project site.
3. Field Inspector: Currently registered by BICSI as Commercial Installer, Level 2 to perform the on-site inspection.

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. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

D. Grounding: Comply with ANSI-J-STD-607-A.

1.6 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install equipment frames and cable trays until spaces are enclosed and weathertight, wet work in spaces is complete and dry, and work above ceilings is complete.

1.7 COORDINATION

A. Coordinate layout and installation of communications equipment with Owner's telecommunications and LAN equipment and service suppliers. Coordinate service entrance arrangement with local exchange carrier.

1. Meet jointly with telecommunications and LAN equipment suppliers, local exchange carrier representatives, and Owner to exchange information and agree on details of equipment arrangements and installation interfaces.

2. Record agreements reached in meetings and distribute them to other participants.

3. Adjust arrangements and locations of distribution frames, cross-connects, and patch panels in equipment rooms to accommodate and optimize arrangement and space requirements of telephone switch and LAN equipment.

4. Adjust arrangements and locations of equipment with distribution frames, cross-connects, and patch panels of cabling systems of other communications, electronic safety and security, and related systems that share space in the equipment room.

B. Coordinate location of power raceways and receptacles with locations of communications equipment requiring electrical power to operate.

PART 2. PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled. Cable support brackets shall be designed to prevent degradation of cable performance and pinch points that could damage cable. Cable tie slots fasten cable ties to brackets.

1. Comply with NFPA 70 and UL 2043 for fire-resistant and low-smoke-producing characteristics.

2. Support brackets with cable tie slots for fastening cable ties to brackets.

3. Lacing bars, spools, J-hooks, and D-rings.

4. Straps and other devices.

C. Cable Trays:

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

a. Cable Management Solutions, Inc.

b. Cablofil Inc.

c. Cooper B-Line, Inc.

d. Cope - Tyco/Allied Tube & Conduit.

e. GS Metals Corp.

2. Cable Tray Materials: Metal, suitable for indoors and protected against corrosion by electroplated zinc galvanizing, complying with ASTM B 633, Type 1, not less than 0.000472 inch (0.012 mm) thick.

a. Ladder Cable Trays: Nominally 12 inches wide, and a rung spacing of 12 inches (305 mm).

D. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Outlet boxes shall be no smaller than 4 inches (100 mm) wide, 4 inches (100 mm) high, and 2-1/2 inches (64 mm) deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches (19 by 1220 by 2440 mm). Comply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

2.3 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Telecommunications Main Bus Bar:

1. Connectors: Mechanical type, cast silicon bronze, solderless compression-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2. Ground Bus Bar: Copper, minimum 1/4 inch thick by 4 inches wide (6 mm thick by 100 mm wide) with 9/32-inch (7.14-mm) holes spaced 1-1/8 inches (28 mm) apart.

3. Stand-Off Insulators: Comply with UL 891 for use in switchboards, 600 V. Lexan or PVC, impulse tested at 5000 V.

C. Comply with ANSI-J-STD-607-A.

2.4 LABELING

A. Comply with TIA/EIA-606-A and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

PART 3. EXECUTION

3.1 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping." Comply with TIA/EIA-569-A, Annex A, "Firestopping."

B. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.2 GROUNDING

A. Install grounding according to BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. Comply with ANSI-J-STD-607-A.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall allowing at least 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar with a minimum No. 4 AWG grounding electrode conductor from grounding bus bar to suitable electrical building ground.

D. Bond metallic equipment to the grounding bus bar, using not smaller than No. 6 AWG equipment grounding conductor.

1. Bond the shield of shielded cable to the grounding bus bar in communications rooms and spaces.

3.3 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements in Division 26 Section "Identification for Electrical Systems." For fire-resistant plywood, do not paint over manufacturer's label.

B. See Division 27 Section "Data, Voice & Video" for additional identification requirements. See Evaluations for discussion of TIA/EIA standard as it applies to this Section. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 3 level of administration including optional identification requirements of this standard.

C. Labels shall be preprinted or computer-printed type.

END OF SECTION

SECTION 27 15 00

COMMUNICATIONS COPPER HORIZONTAL CABLING

PART 1. GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Category 6 twisted pair cable.
2. Twisted pair cable hardware, including plugs and jacks.
3. Cabling identification products.
4. Grounding provisions for twisted pair cable.
5. Source quality control requirements for twisted pair cable.

1.3 DEFINITIONS

A. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

B. EMI: Electromagnetic interference.

C. FTP: Shielded twisted pair.

D. F/FTP: Overall foil screened cable with foil screened twisted pair.

E. F/UTP: Overall foil screened cable with unscreened twisted pair.

F. IDC: Insulation displacement connector.

G. LAN: Local area network.

H. Jack: Also commonly called an "outlet," it is the fixed, female connector.

I. Plug: Also commonly called a "connector," it is the removable, male telecommunications connector.

J. RCDD: Registered Communications Distribution Designer.

K. Screen: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

L. Shield: A metallic layer, either a foil or braid, placed around a pair or group of conductors.

M. S/FTP: Overall braid screened cable with foil screened twisted pair.

N. S/UTP: Overall braid screened cable with unscreened twisted pairs.

O. UTP: Unscreened (unshielded) twisted pair.

1.4 COPPER HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable cabling system shall provide interconnections between Distributor A, Distributor B, or Distributor C, and the equipment outlet, otherwise known as "Cabling Subsystem 1," in the telecommunications cabling system structure. Cabling system consists of horizontal cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for horizontal-to-horizontal cross-connection.

1. TIA-568-C.1 requires that a minimum of two equipment outlets be installed for each work area.

2. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications equipment outlet.

3. Bridged taps and splices shall not be installed in the horizontal cabling.

B. A work area is approximately 100 sq. ft. (9.3 sq. m), and includes the components that extend from the equipment outlets to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet (90 m). This maximum allowable length does not include an allowance for the length of 16 feet (4.9 m) to the workstation equipment or in the horizontal cross-connect.

1.5 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: Reviewed and stamped by RCDD.

1. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.

2. Cabling administration Drawings and printouts.

3. Wiring diagrams and installation details of telecommunications equipment, to show location and layout of telecommunications equipment, including the following:

a. Telecommunications rooms plans and elevations.

b. Telecommunications pathways.

c. Telecommunications system access points.

d. Telecommunications grounding system.

e. Telecommunications conductor drop locations.

f. Typical telecommunications details.

g. Mechanical, electrical, and plumbing systems.

C. Twisted pair cable testing plan.

1.6 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer, installation supervisor, and field inspector.

B. Product Certificates: For each type of product.

C. Source quality-control reports.

D. Field quality-control reports.

1.7 CLOSEOUT SUBMITTALS

A. Maintenance Data: For splices and connectors to include in maintenance manuals.

1.8 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. Connecting Blocks: One of each type.

2. Faceplates: One of each type.

3. Jacks: Ten of each type.

4. Plugs: Ten of each type.

1.9 QUALITY ASSURANCE

A. Installer Qualifications: Cabling Installer must have personnel certified by BICSI on staff.

1. Layout Responsibility: Preparation of Shop Drawings, cabling administration Drawings, and field testing program development by an RCDD.

2. Installation Supervision: Installation shall be under the direct supervision of Technician, who shall be present at all times when Work of this Section is performed at Project site.

B. Testing Agency Qualifications: Testing agency must have personnel certified by BICSI on staff.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of twisted pair cable for open and short circuits.

1.11 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

PART 2. PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA-568-C.1, when tested according to test procedures of this standard.

B. Telecommunications Pathways and Spaces: Comply with TIA-569-D.

C. Grounding: Comply with TIA-607-B.

2.2 GENERAL CABLE CHARACTERISTICS

A. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with the applicable standard and NFPA 70 for the following types:

1. Communications, Plenum Rated: Type CMP complying with UL 1685.

B. Surface-Burning Characteristics: Comply with ASTM E84; testing by a qualified testing agency. Identify products with appropriate markings of applicable testing agency.

1. Flame-Spread Index: 25 or less.

2. Smoke-Developed Index: 50 or less.

C. RoHS compliant.

2.3 CATEGORY 6 TWISTED PAIR CABLE

A. Description: Four-pair, balanced-twisted pair cable, with internal spline, certified to meet transmission characteristics of Category 6 cable at frequencies up to 250MHz.

B. Standard: Comply with NEMA WC 66/ICEA S-116-732 and TIA-568-C.2 for Category 6 cables.

C. Conductors: 100-ohm, 23 AWG solid copper.

D. Shielding/Screening: Unshielded twisted pairs (UTP).

E. Cable Rating: Plenum.

F. Jacket: Blue thermoplastic.

2.4 TWISTED PAIR CABLE HARDWARE

A. Description: Hardware designed to connect, splice, and terminate twisted pair copper communications cable.

B. General Requirements for Twisted Pair Cable Hardware:

1. Comply with the performance requirements of Category 6.
2. Comply with TIA-568-C.2, IDC type, with modules designed for punch-down caps or tools.
3. Cables shall be terminated with connecting hardware of same category or higher.

C. Source Limitations: Obtain twisted pair cable hardware from same manufacturer as twisted pair cable, from single source.

D. Connecting Blocks:

1. 110-style IDC for Category 6.

E. Jacks and Jack Assemblies:

1. Female; eight position; modular; fixed telecommunications connector designed for termination of a single four-pair, 100-ohm, unshielded or shielded twisted pair cable.
2. Designed to snap-in to a patch panel or faceplate.
3. Standard: Comply with TIA-568-C.2.

F. Faceplate:

1. Plastic Faceplate: High-impact plastic. Coordinate color with Section 262726 "Wiring Devices."
2. For use with snap-in jacks accommodating any combination of twisted pair, optical fiber, and coaxial work area cords.
    a. Flush mounting jacks, positioning the cord at a 45-degree angle.

G. Legend:

1. Machine printed, in the field, using adhesive-tape label.
2. Snap-in, clear-label covers and machine-printed paper inserts.

2.5 IDENTIFICATION PRODUCTS

A. Comply with TIA-606-B and UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

2.6 GROUNDING

A. Comply with requirements in Section 26 "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with TIA-607-B.

2.7 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA-568-C.1.

C. Factory test twisted pair cables according to TIA-568-C.2.

D. Cable will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

PART 3. EXECUTION

3.1 WIRING METHODS

A. Wiring Method: Install cables in raceways and cable trays, except within consoles, cabinets, desks, and counters and except in accessible ceiling spaces where unenclosed wiring method may be used. Conceal raceway and cables, except in unfinished spaces.

1. Install plenum cable in environmental air spaces, including plenum ceilings.

3.2 INSTALLATION OF PATHWAYS

A. Comply with Section 27 "Communications Equipment Room Fittings."

B. Comply with Section 27 "Common Work Results for Communications."

C. Drawings indicate general arrangement of pathways and fittings.

3.3 INSTALLATION OF TWISTED-PAIR HORIZONTAL CABLES

A. Comply with NECA 1 and NECA/BICSI 568.

B. General Requirements for Cabling:

1. Comply with TIA-568-C.0, TIA-568-C.1, and TIA-568-C.2.

2. Comply with BICSI's "Information Transport Systems Installation Methods Manual (ITSIMM), Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section.

3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Do not untwist twisted pair cables more than 1/2 inch (12 mm) from the point of termination to maintain cable geometry.

5. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.

6. MUTOA shall not be used as a cross-connect point.

7. Consolidation points may be used only for making a direct connection to equipment outlets:

a. Do not use consolidation point as a cross-connect point, as a patch connection, or for direct connection to workstation equipment.

b. Locate consolidation points for twisted-pair cables at least 49 feet (15 m) from communications equipment room.

8. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches (760 mm) and not more than 6 inches (150 mm) from cabinets, boxes, fittings, outlets, racks, frames, and terminals.

9. Install lacing bars to restrain cables, prevent straining connections, and prevent bending cables to smaller radii than minimums recommended by manufacturer.

10. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI Information Transport Systems Installation Methods Manual , Ch. 5, "Copper Structured Cabling Systems," "Cable Termination Practices" Section. Use lacing bars and distribution spools.

11. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation, and replace it with new cable.

12. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.

13. In the communications equipment room, install a 10-foot- (3-m-) long service loop on each end of cable.

14. Pulling Cable: Comply with BICSI Information Transport Systems Installation Methods Manual, Ch. 5, "Copper Structured Cabling Systems," "Pulling and Installing Cable" Section. Monitor cable pull tensions.

C. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.

2. Suspend twisted pair cabling, not in a wireway or pathway, a minimum of 8 inches (200 mm) above ceilings by cable supports not more than [60 inches (1524 mm)] apart.

3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

D. Group connecting hardware for cables into separate logical fields.

E. Separation from EMI Sources:

1. Comply with recommendations from BICSI's "Telecommunications Distribution Methods Manual" and TIA-569-D for separating unshielded copper communication cable from potential EMI sources, including electrical power lines and equipment.

2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches (127 mm).

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches (300 mm).

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches (600 mm).

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches (64 mm).

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches (150 mm).

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches (300 mm).

4. Separation between communications cables in grounded metallic raceways, power lines, and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

a. Electrical Equipment Rating Less Than 2 kVA: No requirement.

b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches (76 mm).

c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches (150 mm).

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches (1200 mm).

6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches (127 mm).

3.4 FIRESTOPPING

A. Comply with requirements in Section 07 " Firestopping."

B. Comply with TIA-569-D, Annex A, "Firestopping."

3.5 GROUNDING

A. Install grounding according to the "Grounding, Bonding, and Electrical Protection" chapter in BICSI's "Telecommunications Distribution Methods Manual."

B. Comply with TIA-607-B and NECA/BICSI-607.

C. Locate grounding bus bar to minimize the length of bonding conductors. Fasten to wall, allowing at least a 2-inch (50-mm) clearance behind the grounding bus bar. Connect grounding bus bar to suitable electrical building ground, using a minimum No. 4 AWG grounding electrode conductor.

D. Bond metallic equipment to the grounding bus bar, using not smaller than a No. 6 AWG equipment grounding conductor.

3.6 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA-606-B.

1. Administration Class: Class 1.

2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Cable Schedule: Install in a prominent location in each equipment room and wiring closet. List incoming and outgoing cables and their designations, origins, and destinations. Protect with rigid frame and clear plastic cover. Furnish an electronic copy of final comprehensive schedules for Project.

C. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

D. Cable and Wire Identification:

1. Label each cable within 4 inches (100 mm) of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.

2. Each wire connected to building-mounted devices is not required to be numbered at the device if wire color is consistent with associated wire connected and numbered within panel or cabinet.

3. Exposed Cables and Cables in Cable Trays and Wire Troughs: Label each cable at intervals not exceeding 15 feet (4.5 m).

4. Label each terminal strip, and screw terminal in each cabinet, rack, or panel.

a. Individually number wiring conductors connected to terminal strips, and identify each cable or wiring group, extended from a panel or cabinet to a building-mounted device, with the name and number of a particular device.

b. Label each unit and field within distribution racks and frames.

5. Identification within Connector Fields in Equipment Rooms and Wiring Closets: Label each connector and each discrete unit of cable-terminating and -connecting hardware. Where similar jacks and plugs are used for both voice and data communication cabling, use a different color for jacks and plugs of each service.

E. Labels shall be preprinted or computer-printed type, with a printing area and font color that contrast with cable jacket color but still comply with TIA-606-B requirements for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.7 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

C. Tests and Inspections:

1. Visually inspect jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA-568-C.1.

2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.

3. Test twisted pair cabling for DC loop resistance, shorts, opens, intermittent faults, and polarity between conductors. Test operation of shorting bars in connection blocks. Test cables after termination but not cross-connection.

a. Test instruments shall meet or exceed applicable requirements in TIA-568-C.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

D. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similarly to Table 10.1 in BICSI's "Telecommunications Distribution Methods Manual," or shall be transferred from the instrument to the computer, saved as text files, printed, and submitted.

E. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

F. End-to-end cabling will be considered defective if it does not pass tests and inspections.

G. Prepare test and inspection reports.

END OF SECTION

SECTION 28 31 11

FIRE-ALARM SYSTEM

PART 1 GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. Section Includes:

1. Fire Alarm control unit.
2. Manual fire alarm boxes
3. System smoke detectors.
4. Heat detectors.
5. Notification appliances.
6. Remote annunciator.
7. Addressable interface device.
8. Digital alarm communicator transmitter.

1.3 REFERENCES

A. The following references are useful in specifying digital, addressable fire-alarm systems. Other references may be needed for design purposes.

American National Standards Institute

ANSI S1.4-1983 (Reaffirmed 2001) with Amendment S1.4A-1985: Sound Level Meters

ANSI S3.41-1990 (Reaffirmed 2001): Audible Emergency Evacuation Signal

Code of Federal Regulations

47 CFR - Telecommunication, Chapter I - Federal Communications Commission, Part 90 - "Private Land Mobile Radio Services." 2004.

The Institute of Electrical and Electronics Engineers, Inc.

IEEE 1100-1999: Recommended Practice for Powering and Grounding Sensitive Electronic Equipment (the Emerald Book)

National Electrical Manufacturers Association

NEMA 250-2003: Enclosures for Electrical Equipment (1000 Volts Maximum)

National Fire Protection Agency

NFPA 25-2015: Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems

NFPA 70-2015: National Electrical Code

NFPA 72-2015: National Fire alarm Code

NFPA 90A-2015: Installation of Air-Conditioning and Ventilating Systems

NFPA 101-2015: Life Safety Code

NFPA 1221-2015: Installation, Maintenance, and Use of Public Fire Service Communication Systems

Structural Engineering Institute/American Society of Civil Engineers

SEI/ASCE 7-2002: Minimum Design Loads for Buildings and Other Structure

Underwriters Laboratories Inc.

UL 38-1999 (Revised 2005): Manual Signaling Boxes for Fire alarm systems

UL 217-1997 (Revised 2004): Single and Multiple Station Smoke Alarms

UL 268-1996 (Revised 2003): Smoke Detectors for Fire alarm Signaling

UL 268A-1998 (Revised 2003): Smoke Detectors for Duct Application

UL 464-2003: Audible Signal Appliances

UL 521-1999 (Revised 2004): Heat Detectors for Fire Protective Signaling Systems

UL 632-2000: Electrically-Actuated Transmitters

UL 864-2003: Control Units and Accessories for Fire alarm systems

UL 1480-2003 (Revised 2005): Speakers for Fire alarm, Emergency, and Commercial and Professional Use

UL 1711-1999: Amplifiers for Fire Protective Signaling Systems

UL 1971-2002 (Revised 2004): Signaling Devices for the Hearing Impaired

1.4 DEFINITIONS

A. LED: Light-emitting diode.

B. NICET: National Institute for Certification in Engineering Technologies.

1.5 SYSTEM DESCRIPTION

A. Noncoded addressable system, with automatic sensitivity control of certain smoke detectors and multiplexed signal transmission, dedicated to fire-alarm service only.

1.6 SUBMITTALS

A. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.

2. Shop Drawings shall be prepared by persons with the following qualifications:

a. Trained and certified by manufacturer in fire system design.

b. NICET-certified fire-alarm technician, Level IV minimum.

c. Licensed or certified by authorities having jurisdiction.

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

C. Shop Drawings: For fire alarm system. Include plans, elevations, sections, details, and attachments to other work.

1. Comply with recommendations in the "Documentation" Section of the "Fundamentals of Fire alarm systems" Chapter in NFPA 72.

2. Include voltage drop calculations for notification appliance circuits.

3. Include battery-size calculations.

4. Include performance parameters and installation details for each device, verifying that each device is listed for complete range of air velocity, temperature, and humidity possible when system is operating. Submit information indicating manual fire alarm box

and cover operate correctly when exposed to the temperature and humidity where installed. Provide auxiliary heating where recommended by the manufacturer.

5. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale and coordinating installation of duct smoke detectors and access to them. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators. Locate detectors according to manufacturer's written recommendations.

6. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.

7. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits.

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

1. Drawings showing the location of each smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of the detector.

2. Design Calculations: Calculate requirements for selecting the spacing and sensitivity of detection, complying with NFPA 72.

E. Qualification Data: For qualified Installer.

F. Field quality-control reports.

G. 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. Record copy of site-specific software.

4. Provide "Maintenance, Inspection and Testing Records" according to NFPA 72 article of the same name and include the following:

a. Frequency of testing of installed components.

b. Frequency of inspection of installed components.

c. Requirements and recommendations related to results of maintenance.

d. Manufacturer's user training manuals.

5. Manufacturer's required maintenance related to system warranty requirements.

6. Abbreviated operating instructions for mounting at fire-alarm control unit.

7. Copy of NFPA 25.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV 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 an NRTL.

1.8 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning with Substantial Completion, provide software support for two years.

C. Upgrade Service: Update software to latest version at Project completion. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system. Upgrade shall include new or revised licenses for use of software.

1. Provide 30 days' notice to Owner to allow scheduling and access to system and to allow Owner to upgrade computer equipment if necessary.

1.9 CONDUIT AND WIRE

A. Conduit shall be in accordance with the National Electrical Code (NEC), local and state requirements.

B. Wiring shall be installed in conduit or raceway. Conduit fill shall not exceed 40 percent of interior cross sectional area where three or more cables are contained within a single conduit.

C. Cable must be separated from any open conductors of Power, or Class 1 circuits, and shall not be paled in any conduit, junction box or raceway containing these conductors, as per NEC Article 760-29.

D. Wiring for 24 volt control, alarm notification, emergency communication and similar power-limited auxiliary functions may be run in the same conduit as initiating and signaling line circuits. All circuits shall be provided with transient suppression devices and the system shall be designed to permit simultaneous operation of all circuits without interference or loss of signals.

E. Conduit shall not enter the Fire Alarm Control Panel, or any other remotely mounted Control Panel equipment or backboxes, except where conduit entry is specified by the manufacturer.

F. Conduit shall be 3/4-inch (19.1 mm) minimum.

G. Wire: All system wiring shall be new.

1. Wiring shall be copper, in accordance with local, state and national codes (e.g., NEC Article 760) and as recommended by the manufacturer of the fire alarm system. Number and size of conductors shall be as recommended by the fire alarm system manufacturer, but not less than 18 AWG (1.02 mm) for Initiating Device Circuits and Signaling Line Circuits, and 14 AWG (1.63 mm) for Notification Appliance Circuits).

2. All wire and cable shall be listed and/or approved by a recognized testing agency for use with a protective signaling system.

3. Wiring used for the multiplex communication loop shall be twisted and shielded and installed in conduit unless specifically excepted by the fire alarm equipment manufacturer. The system shall permit use of IDC and NAC wiring in the same conduit with the communication loop.

4. All field wiring shall be completely supervised.

H. Terminal Boxes, Junction Boxes, Cabinets, outlets, and pull boxes shall be painted red on the exterior.

I. All boxes and cabinets shall be UL listed for their use and purpose.

1.10 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. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than 1 unit.
3. Smoke Detectors, Fire Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than 1 unit of each type.
4. Detector Bases: Quantity equal to 2 percent of amount of each type installed, but no fewer than 1 unit of each type.
5. Keys and Tools: One extra set for access to locked and tamperproofed components.
6. Audible and Visual Notification Appliances: One of each type installed.
7. Fuses: Two of each type installed in the system.

PART 2 PRODUCTS

2.1 MANUFACTURERS

A. Basis-of-Design Product: Subject to compliance with requirements, provide product by one of the following:

1. Fire Lite Alarms; a Honeywell company.
2. NOTIFIER; a Honeywell company.
3. Siemens Building Technologies, Inc.; Fire Safety Division.

2.2 SYSTEMS OPERATIONAL DESCRIPTION

A. Fire-alarm signal initiation shall be by one or more of the following devices and systems:

1. Manual stations.
2. Heat detectors.
3. Smoke detectors.
4. Duct smoke detectors.
5. Verified automatic alarm operation of smoke detectors.
6. Fire standpipe system
7. Automatic sprinkler system water flow.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm at fire-alarm control unit.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Activate alarm communication system.
5. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
6. Close smoke dampers in air ducts of designated air-conditioning duct systems.

7. Recall elevators to primary or alternate recall floors.
8. Activate emergency power shunt trip.
9. Activate emergency lighting control.
10. Record events in the system memory.
11. Indicate device in alarm on the graphic annunciator.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:
1. Valve supervisory switch.
2. Elevator shunt trip supervision.

D. System trouble signal initiation shall be by one or more of the following devices and actions:
1. Open circuits, shorts, and grounds in designated circuits.
2. Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
3. Loss of primary power at fire-alarm control unit.
4. Ground or a single break in fire-alarm control unit internal circuits.
5. Abnormal ac voltage at fire-alarm control unit.
6. Break in standby battery circuitry.
7. Failure of battery charging.
8. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Trouble and Supervisory Signal Actions: Initiate notification appliance and annunciate at fire-alarm control unit.

2.3 FIRE-ALARM CONTROL UNIT

A. General Requirements for Fire-alarm Control Unit:
1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864 and listed and labeled by an NRTL.
a. System software and programs shall be held in flash electrically erasable programmable read-only memory (EEPROM), retaining the information through failure of primary and secondary power supplies.
b. Include a real-time clock for time annotation of events on the event recorder.
2. Addressable initiation devices that communicate device identity and status.
a. Smoke sensors shall additionally communicate sensitivity setting and allow for adjustment of sensitivity at fire-alarm control unit.
b. Temperature sensors shall additionally test for and communicate the sensitivity range of the device.
3. Addressable control circuits for operation of mechanical equipment.

B. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.
1. Annunciator and Display: Liquid-crystal type, 3 line(s) of 40 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.

3. Building Floor Plans graphic etched in faceplate indicating building name, address, “YOU ARE HERE”, system zones, boundaries, stairways, fire department connection, sprinkler valves, and flow detector locations.

C. Circuits:

1. Initiating Device, Notification Appliance, and Signaling Line Circuits: NFPA 72, Class A.

a. Install no more than 50 addressable devices on each signaling line circuit.

D. Smoke-Alarm Verification:

1. Initiate audible and visible indication of an "alarm-verification" signal at fire-alarm control unit.

2. Activate an NRTL-listed and -approved "alarm-verification" sequence at fire-alarm control unit and detector.

3. Sound general alarm if the alarm is verified.

4. Cancel fire-alarm control unit indication and system reset if the alarm is not verified.

E. Elevator Recall:

1. Elevator recall shall be initiated only by one of the following alarm-initiating devices:

a. Elevator lobby detectors except the lobby detector on the designated floor.

b. Smoke detector in elevator machine room

c. Smoke detectors in elevator hoistway.

2. Elevator controller shall be programmed to move the car to the alternate recall floor if lobby detectors located on the designated floor is activated.

3. Water-flow alarm connected to sprinkler in an elevator shaft and elevator machine room shall shut down elevators associated with the location without time delay.

a. Water-flow switch associated with the sprinkler in the elevator pit may have a delay to allow elevators to move to the designated floor.

F. Remote Smoke-Detector Sensitivity Adjustment: Controls shall select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory.

G. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

H. Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as a special module that is part of fire-alarm control unit.

1. Indicated number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of the central-control microphone. Amplifiers shall comply with UL 1711 and be listed by an NRTL.

a. Allow the application of and evacuation signal to indicated number of zones and, at same time, allow voice paging to the other zones selectively or in any combination.

b. Programmable tone and message sequence selection.

c. Standard digitally recorded messages for "Evacuation" and "All Clear."

d. Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification appliance circuits of fire-alarm control unit.

2. Status Annunciator: Indicate the status of various voice/alarm speaker zones.

3. Preamplifiers, amplifiers, and tone generators shall automatically transfer to backup units, on primary equipment failure.

I. 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, supervisory 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.

J. Secondary Power: 24-V dc supply system with batteries, automatic battery charger, and automatic transfer switch.

1. Batteries: Sealed, valve-regulated, recombinant lead acid.

K. 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.

2.4 MANUAL FIRE-ALARM BOXES

A. General Requirements for Manual Fire-alarm Boxes: Comply with UL 38. Boxes shall be finished in red with molded, raised-letter operating instructions in contrasting color; shall show visible indication of operation; and shall be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate an alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.

2. Station Reset: Key- or wrench-operated switch.

3. Indoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation. Unit must meet ADA requirements with cover in place.

4. Outdoor Protective Shield: Factory-fabricated clear plastic enclosure hinged at the top to permit lifting for access to initiate an alarm. Lifting the cover actuates an integral battery-powered audible horn intended to discourage false-alarm operation. Unit must meet ADA requirements with cover in place. Submit information indicating manual fire-alarm box and cover operate correctly when exposed to the temperature and humidity where installed. Provide auxiliary heating where recommended by the manufacturer.

2.5 SYSTEM SMOKE DETECTORS

A. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.

2. Detectors shall be two-wire type.

3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.

5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.

6. Integral Visual-Indicating Light: LED type indicating detector has operated and power-on status.

7. Remote Control: Unless otherwise indicated, detectors shall be analog-addressable type, individually monitored at fire-alarm control unit for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by fire-alarm control unit.

   a. Rate-of-rise temperature characteristic shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.

   b. Fixed-temperature sensing shall be independent of rate-of-rise sensing and shall be settable at fire-alarm control unit to operate at 135 or 155 deg F (57 or 68 deg C).

   c. Provide minimum 5 levels of detection sensitivity for each sensor.

B. Photoelectric Smoke Detectors:

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.

2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

   a. Primary status.

   b. Device type.

   c. Present average value.

   d. Present sensitivity selected.

   e. Sensor range (normal, dirty, etc.).

2.6 HEAT DETECTORS

A. General Requirements for Heat Detectors: Comply with UL 521.

B. Heat Detector, Combination Type: Actuated by either a fixed temperature of 135 deg F (57 deg C) or a rate of rise that exceeds 15 deg F (8 deg C) per minute unless otherwise indicated.

1. Mounting: Twist-lock base interchangeable with smoke-detector bases.

2. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.

2.7 NOTIFICATION APPLIANCES

A. General Requirements for Notification Appliances: Connected to notification appliance signal circuits, zoned, equipped for mounting 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. Provide Notification Appliance Circuit panels as recommended by the fire alarm system manufacturer or installer. Submit proposed locations on riser and plans submitted for review.

B. Visible Notification Appliances: Xenon strobe lights comply with UL 1971, with clear or nominal white polycarbonate lens mounted on an aluminum faceplate. The word "FIRE" is engraved in minimum 1-inch- (25-mm-) high letters on the lens.

1. Rated Light Output:

a. 15/30/75/110 cd, selectable in the field.

2. Mounting: Wall mounted unless otherwise indicated.

3. For units with guards to prevent physical damage, light output ratings shall be determined with guards in place.

4. Flashing shall be in a temporal pattern, synchronized with other units.

5. Strobe Leads: Factory connected to screw terminals.

6. Mounting Faceplate: Factory finished, white.

C. Horns: Electric-vibrating-polarized type, 24-V dc; with provision for housing the operating mechanism behind a grille. Comply with UL 464. Horns shall produce a sound-pressure level of 90 dBA, measured 10 feet (3 m) from the horn, using the coded signal prescribed in UL 464 test protocol.

2.8 REMOTE ANNUNCIATOR AND GRAPHIC DISPLAY

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

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

B. Display Type and Functional Performance: 80 character alphanumeric display with LED indicating lights shall match those of fire-alarm control unit. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

C. Key-Operated Switches shall include:

1. Alarm Silence.

2. Trouble Silence.

3. Test.

2.9 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 wired applications with normally open contacts. Provide for all sprinkler flow and tamper switches, and as required.

C. Integral Relay: Capable of providing a direct signal to elevator controller to initiate elevator recall, to disconnect shunt trip for power shutdown, etc.:

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.
3. Mute sound system(s).
4. Unlock security doors.
5. Initiate egress lighting through Networked Lighting Control System

2.10 DEVICE GUARDS

A. Description: Welded wire mesh of size and shape for the manual station, smoke detector, gong, or other device requiring protection.

1. Factory fabricated and furnished by manufacturer of device.
2. Finish: Paint of color to match the protected device.

PART 3 EXECUTION

3.1 EQUIPMENT INSTALLATION

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

B. 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 (9 m).
4. Spacing of detectors for irregular areas, for irregular ceiling construction, and for high ceiling areas shall be determined according to Appendix in NFPA 72.
5. HVAC: Locate detectors not closer than 3 feet (1 m) from air-supply diffuser or return-air opening.
6. Lighting Fixtures: Locate detectors not closer than 12 inches (300 mm) from any part of a lighting fixture.

C. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct.

D. Remote Status and Alarm Indicators: Install near each smoke detector and each sprinkler water-flow switch and valve-tamper switch that is not readily visible from normal viewing position.

E. Audible Alarm-Indicating Devices: Install flush in wall not less than 6 inches (150 mm) below the ceiling.

F. Visible Alarm-Indicating Devices: Install integral with each alarm speaker.

G. Device Location-Indicating Lights: Locate in public space near the device they monitor.

H. Fire-alarm Control Unit: Flush-mounted, with tops of cabinets not more than 72 inches (1830 mm) above the finished floor.

3.2 CONNECTIONS

A. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 3 feet (1 m) 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 designated air-conditioning duct systems.
2. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
3. Supervisory connections at valve supervisory switches.

3.3 IDENTIFICATION

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

B. Install framed instructions in a location visible from fire-alarm control unit.

3.4 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

3.5 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by Architect and 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. Test audible appliances for the public operating mode according to manufacturer's written instructions. Perform the test using a portable sound-level meter complying with Type 2 requirements in ANSI S1.4.
4. Test audible appliances for the private operating mode according to manufacturer's written instructions.
5. Test visible appliances for the public operating mode according to manufacturer's written instructions.

6. Factory-authorized service representative shall prepare the "Fire-alarm system Record of Completion" in the "Documentation" Section of the "Fundamentals of Fire-alarm systems" Chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" Section of the "Inspection, Testing and Maintenance" Chapter in NFPA 72.

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. Prepare test and inspection reports.

G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.6 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

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SECTION 31 10 00
CLEARING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract including General and Supplementary Conditions, and Division 1, Specification Sections apply to work in this section.

1.2 DESCRIPTION OF WORK

A. This section specifies materials and work required to clear the project site.

1.3 RELATED WORK

A. Refer to Section 31 20 00 "Earthmoving"

1.4 STANDARDS

A. Maryland Standards and Specifications for Soil Erosion and Sediment Control, current edition.

1.5 PROJECT CONDITIONS

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Existing Utilities: The locations of all existing utilities are approximate. These locations have been determined from field survey, public utility records and Owner records.
   1. The Contractor shall be responsible for contacting "Miss Utility" and all Owner's or controlling agencies of existing utilities within the construction area for verification of locations, prior to beginning of work.
   2. The Contractor shall be responsible for coordination of utility relocation or removal by others with all phases of construction activities.

1.6 SUBMITTALS

A. Submit written notification to public utility companies, at least one week prior to planned work, for disconnection of active utilities.

1.7 DEFINITIONS

A. Topsoil: A friable loam surface soil, free of subsoil, clay, lumps, weeds, roots, debris and stones exceeding one inch in any dimension.

1.8 CONSTRUCTION SURVEYS

A. Provide survey equipment and qualified personnel for construction surveys. Provide stakes and/or flag trees to designate the limits of clearing operations.

PART 2 - PRODUCTS
NOT USED

PART 3 - EXECUTION

3.1 PROTECTION AND RESTORATION

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Protect existing tree's to be saved per the Final Forest Conservation Plan.

3.2 CLEARING

A. Clear the project site, removing trees and vegetation, within "Clearing and Grading Limits" indicated.

3.3 GRUBBING

A. Completely remove stumps, roots and debris, within "Clearing and Grading Limits" indicated, to minimum 12-inch depth below existing ground surface. Employ manual methods for grubbing around trees indicated "To Remain".

3.4 TOPSOIL STRIPPING

A. Strip topsoil, within "Clearing and Grading Limits" indicated. Remove heavy vegetation growth before stripping. Strip topsoil to all depths encountered. Strip topsoil to prevent intermingling with tree roots underlying subsoil.
   1. Do not strip topsoil within the drip line of existing trees indicated "To Remain" or located beyond the indicated "Clearing and Grading Limits".

B. Stockpile topsoil, at locations approved by the County Inspector, until required for landscape development. Shape and grade stockpiles to prevent surface water ponding. Temporarily stabilize stockpiles as specified on the Montgomery County Approved Sediment Control Drawings.

3.5 WASTE MANAGEMENT

A. Transport combustible and non-combustible waste materials from the project site to legal offsite disposal areas. Document legal offsite waste disposal areas. Burning of waste materials is prohibited.

B. Recycle/compost/salvage site clearing debris in accordance with Division 1 "Construction Waste Management" requirements.

END OF SECTION

SECTION 31 10 05
DEMOLITION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. The General Conditions, Supplementary Conditions and Division 1, General Requirements, are a part of this section.

1.2 RELATED WORK

A. Refer to Section 31 20 00 "Earthmoving", and Division 26 "Electrical", and Section 01 74 19 “Construction Waste Management and Disposal.”

1.3 DESCRIPTION OF WORK

A. This section specifies demolition of existing site improvements and underground utilities.

1.4 CODES

A. For existing utilities refer to Section 31 20 00 "Earthmoving".

1.5 PROJECT CONDITIONS

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Existing Utilities: The locations of all existing utilities are approximate. These locations have been determined from field survey and public utility records.

1. The Contractor shall be responsible for contacting "Miss Utility" and all Owner's or controlling agencies of existing utilities within the construction area for verification of locations, prior to beginning of work.

2. The Contractor shall be responsible for coordination of utility relocation or removal by others with all phases of construction activities.

3. The Contractor shall be responsible for the removal/abandonment of any site related hazardous materials.

C. Existing Subsurface Conditions: Verify existing pavement materials and respective thicknesses prior to construction. Obtain written authorization from the owner before conducting test hole explorations of existing pavements within the project site.

D. Traffic: Obtain written authorization from the local jurisdiction or adjacent property owners prior to obstructing vehicular traffic and parking areas. Obtain written authorization from local jurisdiction prior to obstructing public rights-of-way and easements.

E. Pre-bid Inspection Conditions: Conditions, existing during prebid inspections, will not be altered or modified.

F. All work must be contained within the prescribed limits of disturbance shown on the contract documents.

1.6 SUBMITTALS

A. Submit written notifications to public utility companies for disconnection of active utilities.

1.7 DEFINITIONS

A. Demolition: Complete removal and disposal of existing structures and facilities specified or indicated.

B. Salvage: Complete removal, by methods, which prevent damage or destruction of any items indicated to be relocated (or salvaged) and subsequent relocation and reinstallation in an area designated by Owner.

PART 2 - PRODUCTS: (Not Used)

PART 3 – EXECUTION

3.1 PROTECTION AND RESTORATION

A. Refer to Section 31 10 00 "Clearing" and Section 31 20 00 "Earthmoving”.

B. Existing Facilities: Protect existing facilities and structures designated to remain, temporarily or permanently, from damage during demolition or construction activities. Repair items damaged during demolition or construction activities to their original condition or replace with new. Do not overload structural elements or pavements to remain. Provide new supports and reinforcement for existing construction weakened by demolition and/or removal work. Repairs, reinforcement or structural replacement shall be approved by the Architect or the Owner's Representative.

C. Existing Utility Services: The locations of underground utility services are approximate and are taken from Owner's record information and record information provided by utility companies. Protect existing utility services designated to remain temporarily or permanently, or to be relocated or removed by others. Contractor shall sequence demolition and construction activities to minimize utility service interruptions to existing facilities to remain. Where removal of existing utility services is required for other site construction, provide temporary covering of exposed areas, and temporary service or connections for utilities until permanent utility service replacements are completed.

1. Contractor shall coordinate with affected utility companies to determine extent of relocation work to be done by others.

2. Contractor shall coordinate utility relocation or removal by others with all phases of construction activity.

3.2 EXISTING SITE IMPROVEMENTS DEMOLITION

A. Existing Pavements: Demolish existing pavements, regardless of pavement thickness, at no increase to contract sum. Neatly saw cut existing pavements to straight, smooth and sharp edges perpendicular to pavement surface.

B. Existing Curbing: Remove existing concrete curbing to nearest expansion joint beyond demolition limits indicated at no increase to contract sum.

C. Existing Entrances and Aprons: Demolish existing entrances and aprons indicated.

D. Miscellaneous: Demolish existing fencing indicated, including posts, footings and related appurtenances. Demolish additional miscellaneous existing site improvements indicated, specified and required to construct project.

3.3 EXISTING OVERHEAD UTILITY DEMOLITION

A. Existing electrical facilities will be removed by Potomac Electric and Power Company. Contractor shall contact PEPCO to schedule and arrange for payment for removals.

B. Existing telephone facilities will be removed by Verizon. Contractor shall contact Verizon to schedule and arrange for payment for removals.

C. Existing cable television facilities will be removed by Comcast Cable Company. Contractor shall contact Comcast to schedule and arrange for payment for removals.

3.4 EXISTING UNDERGROUND UTILITY DEMOLITION

A. Excavate and expose existing underground utilities and related structures designated for, or as required to implement, removals. For excavation operations refer to Section 33 10 00 "Utility Standards". Remove existing utility structure castings. Backfill excavations, upon completion of utility demolition operations. For backfill operations refer to Section 33 10 00 "Utility Standards".

3.5 MAINTENANCE

A. Refer to Section 31 20 00 "Earthmoving".

3.6 WASTE MANAGEMENT

A. Transport demolition waste materials from the project site to legal offsite waste disposal areas. Document legal offsite waste disposal areas.

B. Recycle waste demolition materials in accordance with Construction Waste Management and Disposal requirements.

END OF SECTION

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SECTION 31 20 00
EARTHMOVING

PART 1 - GENERAL

1.1 RELATED DRAWINGS

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

1.2 DESCRIPTION OF WORK

A. This section specifies materials, equipment and work required to perform earthwork and grading operations for site development.

1.3 TESTING AND INSPECTIONS

A. The Owner shall be responsible for providing a Maryland Registered Professional Soils Engineer for required testing and inspections.

B. Services of the Soils Engineer will not necessarily be on a full-time basis, but will include the number of visits and tests required to observe the performance of all earthwork under this Section. If in the opinion of the Soils Engineer, any work performed under this Section does not meet the technical or design requirements stipulated for the work, the Contractor shall make all necessary readjustments to his approval.

C. All earthwork procedures shall be performed in the presence of the Soils Engineer. Give adequate (24 hours) notice when Soils Engineer’s services are required.

1.4 RELATED WORK

A. Refer to Section 31 10 00 "Clearing", Section 31 10 05 "Demolition"

1.5 CODES

A. Contractor shall comply with the applicable requirements of the governing agencies having jurisdiction.

1.6 DEFINITIONS

A. Excavation: Removal of earth materials to subgrade elevations indicated or specified.

B. Over-Excavation: Removal of earth materials, beyond subgrade elevations indicated or specified, without written authorization from the Architect.

C. Unsuitable Earth: Soft or unstable earth materials beyond limits of excavation indicated (e.g. muck, soft clays, organic soils, peat, etc.) If soils on-site are encountered that do not comply with this Specification, the contractor shall remove said soils from the site and replace them with soils that meet the requirements of the specifications.

D. Fill: Placement of earth materials over existing ground surfaces to subgrade elevations indicated or specified.

E. Backfill: Placement of earth materials in excavations to subgrade elevations indicated or specified.

F. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that cannot be removed by rock excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch-wide, maximum, short-tip-radius rock bucket; rated at not less than 138-hp flywheel power with bucket-curling force of not less than 28,700 lbf and stick-crowd force of not less than 18,400 lbf with extra-long reach boom; measured according to SAE J-1179.

G. Soils Engineer: Shall be a Professional Engineer, currently registered in the State of Maryland, or shall be an authorized representative of such an engineer.

1.7 SUBMITTALS

A. Density Test Results: The Contractor shall submit copies of the results of the specified density testing to the Owner's Representative for review and approval.

B. Submit location of product manufacture and of extraction/recovery of primary raw materials.

C. Submit recycled-content data, designating percentages of post-consumer and pre-consumer recycled material.

1.8 PROJECT CONDITIONS

A. Refer to Section 12.4.1 of the General Conditions.

B. Use of Explosives: Use of explosive is prohibited. Do not bring explosives onto site or use in work.

C. Existing Utilities: The locations of all existing utilities are approximate. These locations have been determined from field survey, public utility records and Owner records.

1. The Contractor shall be responsible for contacting "Miss Utility" and all Owner's or controlling agencies of existing utilities within the construction area for verification of locations, prior to beginning of work.

2. The Contractor shall be responsible for coordination of utility relocation or removal by others with all phases of construction activities.

1.9 CONSTRUCTION SURVEYS

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined vertical and horizontal stakes required to perform earthwork operations to subgrade elevations indicated or specified.

1.10 EARTHWORK BALANCE

A. Perform all earthwork operations regardless of actual quantities encountered.

1. Excess materials shall be legally disposed of off project property.

2. Off-site borrow shall be provided at no increase to the Contract sum.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide products manufactured and of primary raw materials extracted/recovered within a 500-mile radius of the project site.

B. Fill Materials: Soils used as fill materials shall have Unified Soils Classification (ASTM D 2487) of ML, SM, SC or more granular, but shall exclude highly plastic clays or silts (MH-CH). Soil material for fill shall be free of organic matter or debris, waste materials, frozen materials, vegetable matter and rock or stones exceeding three inches in any dimension. No more than 15 percent of rocks or lumps shall be larger than 2½ inches in any dimension. Materials shall be non-frost susceptible soils, and shall have a liquid limit of less than 40 and a plasticity index of less than 15.

1. Fill materials shall have a maximum dry density of at least 100 pcf, as determined by ASTM D 698.

2. Fill material used within the top 12 inches of fill shall be free of rocks or stones exceeding two inches in any dimension.

3. RC-6 recycled concrete may be used as fill and subbase material, except under building slab or within the public right-of-way or within stormwater management facilities, as performance requirements permit.

C. Backfill Material: As indicated for fill material.

D. Borrow Material: Off-site borrow, if required, shall be as specified for Fill Materials. Obtain and transport borrow material at no increase to the Contract sum.

PART 3 - EXECUTION

3.1 PROTECTION AND RESTORATION:

A. General: Provide protection to prevent settlement, movement, undermining of or erosion to existing site improvements, existing utilities, existing buildings, new site improvements, new buildings and new utilities.

B. Do not permit heavy equipment to pass over any utility until a minimum of two feet of compacted fill or backfill is placed over the top of utility. This may exceed the amount of cover required per final grades. When final grades established are less than two feet of cover over a utility, no equipment shall be permitted to pass over the utility.

C. Restore damage, at no increase to Contract sum, resulting from the lack of protection or improper installation of protective measures or careless execution of construction activities. Restoration work to be approved by the Soils Engineer and Owner's representative.

D. Provide protection for site benchmarks, survey control points, and existing site features and structures to remain.

3.2 EXISTING UTILITIES

A. Notify all public utility companies, 48 hours prior to the start of earthwork operations. Verify and mark horizontal utility locations prior to the start of earthwork operation. Manually excavate and expose utilities as earthwork operations approach marked locations.

B. Immediately notify the Owner’s Representative or the Architect in the event horizontal or vertical utility locations differ from locations indicated. Provide horizontal and vertical details of utility locations as directed by the Owner’s Representative or the Architect. Conflicts with construction to be determined by the Owner’s Representative or the

Architect. Payment for correction of unforeseen conflicts with construction shall be by change order.

C. Coordinate public utility relocation work required for public utilities conflicting with construction. The Owner's Representative or the Architect will provide directions and details required to relocate utilities conflicting with construction.

D. Do not disconnect or interrupt existing utilities serving existing facilities to remain without notification and authorization of the Architect or the Owner's Representatives.

3.3 DEWATERING

A. Perform earthwork and grading operations to prevent surface or subsurface water from flowing into excavations, surface or subsurface water from flooding project site or adjacent property and water accumulations detrimental to stability of subgrades. Provide, install, operate and maintain all required pumps, sumps, discharge lines and related equipment. Mitigation of groundwater during construction is the obligation of the Contractor.

3.4 EXCAVATION

A. Excavate materials encountered to subgrade elevations indicated or specified by the Soils Engineer.

B. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Owner's Representative. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents.

C. Subgrade Preparation: Upon completion of excavation activities, exposed subgrade shall be proofrolled utilizing a heavily loaded dump truck or other pneumatic-tired vehicle of similar size and weight, in the presence of the Soils Engineer. Proofrolling shall not be performed during or following wet weather conditions. Any unsuitable materials discovered during proofrolling operations shall be removed and replaced as specified below. Upon completion of proofrolling activities and approval of the subgrade by the Soils Engineer, exposed subgrade shall be further prepared as follows:

1. Unpaved Areas: Scarify subgrade to six-inch depth prior to topsoil placement.

2. Paved Areas: Scarify subgrade to twelve-inch depth and compact to 100 percent maximum dry density. Density test methods: ASTM D 698. Remove unsuitable earth, exhibiting excessive weaving during compaction operations, as specified.

3.5 OVER-EXCAVATION

A. Correct over-excavated areas as directed by the Soils Engineer. Remove unsuitable earth encountered as a direct result of over-excavation. Excavate and dispose of all unsuitable earth. Correct excavated area as directed.

3.6 UNSUITABLE EARTH

A. Immediately notify the Soils Engineer in the event unsuitable earth is encountered during earthwork or subsequent construction operations. Stop all work within immediate area of unsuitable earth. Do not remove unsuitable earth until direction is received from the Soils Engineer. Excavate and dispose of all unsuitable earth. Backfill excavated area as specified and directed by the Soils Engineer. Removal of and backfill for unsuitable soils shall be at the Contractors expense.

3.7 EXCAVATED MATERIAL STORAGE

A. Stockpile select excavated materials required for fill and/or backfill operations. Stockpile locations to be approved by the Owner's Representative or the Architect. Shape and grade stockpiles to prevent ponding of surface water. Temporarily stabilize stockpiles as required. Dispose of excess excavation materials as specified.

1. Excess excavated material shall be legally disposed of by removal from the project site.

2. The Contractor is responsible for stockpiling and protecting suitable soils that are to be re-used on-site. The Owner will not pay for import of suitable material that was removed from the site by the Contractor.

3.8 EARTH FILL

A. Existing Ground Surface Preparation: Remove vegetation and topsoil as specified in Section 31 10 00 "Clearing". Proofroll exposed subgrade utilizing a 20 ton loaded dump truck or other pneumatic-tired vehicle of similar size and weight, in the presence of the Soils Engineer. Proofrolling shall not be performed during or following wet weather conditions.

B. Existing Subgrade Preparation: Remove unsuitable earth, upon completion of clearing and proofrolling operations, as specified. Continuously bench existing slopes exceeding four feet horizontal to one foot vertical. Bench sufficiently to accommodate earthmoving and compaction equipment. Select material, removed as a result of benching operations, may be used for fill and/or backfill as specified.

1. Unpaved Areas: Scarify existing subgrade to six-inch depth and compact to 92 percent maximum dry density. Density test method: ASTM D 698.

2. Paved Areas: Scarify existing subgrade to twelve-inch depth and compact to 95 percent maximum dry density, and to 100% in the top 24". Density test method: ASTM D 698. Remove unsuitable earth, exhibiting excessive weaving during compaction operations, as specified.

C. Fill Placement: Do not place fill material on frozen or muddy subgrades.

1. Unpaved Areas: Place fill material in loose lifts not exceeding eight-inches.

2. Paved Areas: Place fill material in loose lifts not exceeding eight-inches.

D. Fill Compaction and Moisture Control: Obtain compaction with approved compaction equipment. Provide compaction equipment of proper size and in proper mechanical operating condition. All fill material shall be moisture conditioned to within two percent of optimum moisture content.

1. Unpaved Areas: Compact each lift to 92 percent maximum dry density. Density test method: ASTM D 698.

2. Paved Areas: Compact each lift to 95 percent maximum dry density, and to 100% in the top 24". Density test method: ASTM D 698.

E. Control moisture during placement and compaction operations. Remove and replace or scarify and aerate excessively moist material until required moisture content is obtained.

Moisten excessively dry material by applying measured amounts of water uniformly to fill material until required moisture content is obtained.

1. Contractor may utilize lime to dry out excessively wet soil at no increase to the contract sum.

3.9 EARTH BACKFILL

A. General: Backfill excavations as promptly as work permits, but not until completion of inspection, testing and approval by the Soils Engineer.

B. Placement and Compaction: Do not place backfill on frozen or muddy subgrades.

1. Unpaved Areas: Place backfill material in loose lifts not exceeding eight inches. Compact each lift to 92 percent maximum dry density. Density test method: ASTM D 698.

2. Paved Areas: Place backfill material in loose lifts not exceeding eight inches. Compact each lift to 95 percent maximum dry density, and to 100% in the top 24”. Density test method: ASTM D 698.

3. All material to be moisture conditioned to within two percent of optimum moisture content.

3.10 GRADING

A. General: Grade unpaved and paved areas to smooth and uniform surfaces and to prevent ponding of surface water.

1. Unpaved Areas: Areas to receive topsoil shall be graded to allow for installation of 6 inches of topsoil. Grade slopes exceeding four feet horizontal to one foot vertical, to smooth and uniformly rounded surfaces.

2. Paved Areas: Grade paved area subgrades to the lines, elevations and sections indicated or specified.

3.11 MAINTENANCE

A. Maintain all paved access roads in a clean and dust free condition during earthwork or subsequent construction operations. Clean trucks and equipment, removing mud and debris, prior to entering project site access roads and public right-of-way.

B. Maintain completed areas of project site free of trash and debris. Scarify, regrade and recompact subgrades damaged or disturbed by adverse weather, soil erosion, settlement and subsequent construction operations.

3.12 TESTING

A. The following tests will be conducted.

1. Laboratory Density Tests:

a. Test method: As specified.

b. Test interval: One test per each 15,000 s.f., or fraction thereof, of each lift of fill or backfill compacted by other than hand-operated machines, and 1 per each 5,000 s.f., etc, for areas done by hand-operated machines.

2. In-place Field Density Tests:

a. Test method: ASTM D 1556-82 or D 2167.

b. Density required: As specified.

c. Test Interval: One test per 2,000 s.f., or fraction thereof, of compacted subgrade, or of each lift of fill or backfill compacted by other than hand-operated machines, and 1 per 1000 s.f., etc, for each lift of fill or backfill compacted by hand-operated machines.

B. Correct work not conforming to specified densities as directed by the Soils Engineer, at no increase to the Contract Sum.

3.13 WASTE MANAGEMENT

A. Recycle or salvage waste earthwork materials in accordance with Division 1 “Construction Waste Management” requirements.

END OF SECTION

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SECTION 31 20 05
BUILDING EARTHWORK

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1, specification sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

A. This section specifies materials, equipment and work required to perform building earthwork operations.

1.3 TESTING AND INSPECTIONS

A. Refer to Section 31 20 00 "Earthmoving".

B. All earthwork procedures shall be performed in the presence of the Soils Engineer. Give adequate (24 hours) notice when Soils Engineer’s services are required. The Soils Engineer's duties will include, but not be limited to the following:

1. Observation, testing, and approval of subgrade for footings before placement of concrete.

2. Observation and approval of floor subgrade and fill placement before placement of under floor granular base.

3. Testing of proposed import fill material and verification of correlation of the import material to laboratory test samples. All test results shall be forwarded to the seeding and sodding contractor.

4. Verification of removal of sediment from sediment control basins and testing of subgrade in basins prior to fill placement.

1.4 RELATED WORK

A. Refer to Section 31 10 00 "Clearing", Section 31 20 00 "Earthmoving".

1.5 CODES

A. Refer to Section 31 20 00 "Earthmoving".

1.6 STANDARDS

A. Refer to Section 31 20 00 "Earthmoving".

1.7 SUBMITTALS

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Product Samples: Submit samples of the borrow material and structural fill material to the Soils Engineer. Sample size to be fifty pounds. Number of samples to be determined by the Soils Engineer.

C. Product data for Credit MR 4: For products having recycled content, documentation indicating percentages by weight of pre-consumer and post-consumer recycled content. Include statement indicating cost of each product with recycled content.

D. Product data for Credit MR 5: For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

1.8 DEFINITIONS

A. Refer to Section 31 20 00 "Earthmoving".

1.9 PROJECT CONDITIONS

A. Refer to Section 31 20 00 "Earthmoving".

B. All work must be contained within the prescribed limits of disturbance shown on the contract documents.

1.10 CONSTRUCTION SURVEYS

A. General: Retain the services of a Maryland Registered Land Surveyor or Registered Professional Engineer to provide horizontal and vertical alignment stakes required to perform building earthwork operations to subgrade elevations indicated or specified, and horizontal and vertical alignment stakes required to construct footings and foundations.

B. Earthwork Balance Conditions: Refer to Section 31 20 00 "Earthmoving".

PART 2 - PRODUCTS

2.1 MATERIALS:

A. General: Provide products manufactured and of primary raw materials extracted/recovered within a 500-mile radius of the Project Site.

2.2 Fill Material: ASTM D 2487, Unified Soils Classification ML or more granular. Liquid limit not to exceed forty (40). Plasticity Index not to exceed fifteen (15). Maximum particle size to be 2-1/2 inches. Free of debris, organic materials, waste materials and frozen materials. Obtain and transport fill materials from project site or borrow areas at no increase to contract sum.

2.3 Samples: Submit fill material samples for testing and approval to the Soils Engineer. Do not place fill until written approval is obtained. Sample approval will not relieve the contractor of the responsibility to have material placed conform to approved samples.

2.4 Porous Fill: ASTM C 33 Coarse Aggregate, size number 467 (1-1/2 inch to No. 4), blast furnace slag prohibited.

A. Size to be AASHTO M 43, size 57.

2.5 Backfill Material: Refer to Section 31 20 00 "Earthmoving".

PART 3 - EXECUTION

3.1 PROTECTION AND RESTORATION:

A. Refer to Section 31 20 00 "Earthmoving" and as noted. Provide support systems (e.g. sheeting, shoring, sheet piling, cribbing, etc.) at no increase to contract sum. Protect footing, foundation and slab subgrades, with insulating materials, to prevent frost penetration. Restore subgrades damaged from the lack of protection. Restoration work as directed by the Soils Engineer.

3.2 DEWATERING

A. Refer to Section 31 20 00 "Earthmoving" and as noted. Perform building earthwork operations to prevent water accumulations detrimental to stability of footing and foundation subgrades.

3.3 EXCAVATION

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Foundation Excavation: Excavate to footing and foundation elevations indicated or specified. Extend excavations horizontally beyond footings and foundations to permit formwork placement and removal, support system placement and removal, building utility installations, waterproofing and inspection. Do not place concrete until completion of inspections, testing and approval by the Soils Engineer. Trim and shape excavations by manual methods, prior to concrete placement.

C. Slab Excavation: Excavate to slab subgrade elevations indicated or specified. Excavate slab subgrades to smooth and even surfaces, free of voids and depressions. Prepare exposed subgrades as specified for paved areas, Section 31 20 00 "Earthmoving". Do not place concrete or porous fill until completion of inspection, testing and approval by the Soils Engineer. Inspection, testing and approval of subgrade shall be performed immediately prior to placement of porous fill and concrete.

D. Classified Excavation: Excavate to subgrade elevations. Material to be excavated will be classified as earth and rock. Do not excavate rock until it has been classified and cross sectioned by Owner’s Representative. The Contract Sum will be adjusted for rock excavation according to unit prices included in the Contract Documents.

E. Below Slab Utility Excavation: Refer to Section 33 10 00 "Utility Standards" and as noted.

1. Trench width below and 12 inches above top of utility not to exceed 12-inch clearance on each side of utility.

3.4 OVER-EXCAVATION

A. Refer to Section 31 20 00 "Earthmoving" except as noted. Correct over-excavated areas as directed by the Soils Engineer or Owner's Representative.

3.5 UNSUITABLE EARTH

A. Refer to Section 31 20 00 "Earthmoving"

3.6 EXCAVATED MATERIAL STORAGE

A. Refer to Section 31 20 00 "Earthmoving".

3.7 FILL

A. Refer to Section 31 20 00 "Earthmoving", except as noted.

B. Earth Fill: Prepare exposed subgrades as specified for paved areas, Section 31 20 00 "Earthmoving". Place fill material in loose lifts not exceeding eight inches and at moisture content within plus or minus two percentage points of optimum moisture content, and compact to 95 percent maximum dry density. Top 18 inches below foundations and slabs shall be compacted to 98 percent maximum dry density. Density test method: ASTM D 698.

1. Compacted fill material shall extend at least ten feet beyond building lines for lateral support.

2. Do not place concrete or porous fill until completion of inspection, testing and approval by the Soils Engineer. Inspection, testing and approval of subgrade shall be performed immediately prior to placement of porous fill and concrete.

C. Porous Fill: Upon approval of prepared subgrade, place porous fill in uniform lifts and compact to 70 percent relative density.

3.8 BACKFILL

A. Refer to Section 31 20 00 "Earthmoving". Place and compact backfill as specified for fill, except as noted.

B. Backfill excavations as promptly as work permits, but not until completion of formwork removal, foundation drainage system installation, building utility installations, waterproofing, termite treatment, trash and debris removal, support system removal, temporary and/or permanent wall bracing installation, and inspection and approval by the Soils Engineer.

C. Exercise care in the placement of backfill material adjacent to structure. Place backfill evenly and in a manner to prevent wedging action against the structure. Place backfill uniformly around the structure in lifts of equal elevation. Correct damage from improper backfilling operations, as directed by the Soils Engineer or Owner's Representative, at no increase to the Contract Sum.

D. Backfill placement operations to be tested and approved by the Soils Engineer.

3.9 TESTING

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Foundation Subgrade Testing: For each stratum of soil, on which foundations will be placed, conduct one test to verify required design bearing capacities. Conduct a minimum of one test beneath each wall. Subsequent verification and approval of each foundation subgrade may be based on a visual comparison of each subgrade with related tested strata. Additional testing shall be conducted as required by the Soils Engineer.

3.10 MAINTENANCE

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Tests, inspections, and approvals specified will be conducted in accordance with applicable Division One Sections regarding "Testing Services".

3.11 WASTE MANAGEMENT

A. Recycle or salvage waste earthwork materials in accordance with Division 1 “Construction Waste Management” requirements.

END OF SECTION

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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 the General and Supplementary Conditions and Division 1, specification sections, apply to work of this section.

1.2 RELATED WORK

A. Refer to Section 31 20 00 "Earthmoving".

1.3 DESCRIPTION OF WORK

A. This section specifies application of Termite Control soil treatment prior to placement of concrete floor slabs, foundation walls or grade beams.

1.4 QUALITY ASSURANCE

A. Applicator's Qualifications: Applicators shall be registered or licensed where required by State or County jurisdictions.

1.5 WARRANTY

A. On final acceptance, furnish the Owner's Representative with a written guarantee, executed by the Applicator and the Contractor, stating application was made in accordance with this specification, and certifying that the applied soil termiticide treatment will prevent infestation of subterranean termites.

B. Guarantee effectiveness of treatment for not less than five years.

C. Guarantee to correct damage caused by termite infestations in treated areas, within the five-year guarantee period. If subterranean termite activity is discovered during the guarantee period, the Contractor will re-treat the soil and repair or replace damage caused by the termite infestation.

1.6 STANDARDS

A. United States Department of Agriculture Federal Insecticide, Fungicide and Rodenticide Act.

B. The formulation of all soil poisons, insecticides, fungicides, etc. shall be registered under the Act and shall be registered with the appropriate agency of the State of Maryland.

1.7 SUBMITTALS

A. Submit manufacturer's written mixing and application instructions.

B. Submit typewritten detailed description of termite treatment program to, and obtain approval from, the local jurisdiction prior to implementation.

C. Submit evidence of compliance with Federal and State regulations.

1.8 PROJECT CONDITIONS

A. Protect occupied portions of existing structures to remain from fumes and vapors from application of the termite treatment.

PART 2 - PRODUCTS

2.1 Soil Treatment Solutions:

A. General: Use an emulsible, concentrated termiticide that dilutes with water, specially formulated to prevent termite infestation. Fuel oil will not be permitted as a dilutent. Use only soil treatment solutions that are not harmful to plants.

B. Provide a solution consisting one of the following chemical elements:
1. Premise, Bayer.

2. Permathrin:
a. Dragnet.

3. Cypermethrine:
a. Prevail FT, FMC Corp.
b. Dermon, ICI Americas, Inc.

4. Fenvalerate:

a. Gold Coast Tribute, Du Pont

5. Isofenphose:
a. Pryfon, Mobay Corp.

6. Or approved equal

C. Mixes: Dilute with water to concentration level recommended by the manufacturer. Follow manufacturer's written mixing instructions.

PART 3 - EXECUTION

3.1 INSPECTION

A. Verify that soil is in friable condition with moisture content low enough to permit absorption of toxicant solution. Remove any foreign matter which could decrease effectiveness of treatment.

B. Do not apply soil treatment until excavating, filling and grading operations are complete, except as otherwise required.

C. Do not apply soil treatment to frozen or excessively wet soils or during inclement weather.

3.2 APPLICATION

A. Apply soil treatment to areas beneath concrete floor slabs on grade or fill, suspended slab structures, at hollow masonry foundations and grade beams and along interior and exterior sides of foundation walls and grade beams.

B. Apply soil treatment at expansion joints, control joints and all areas where slabs will be penetrated.

C. Do not apply soil treatment solution until excavating

3.3 RATE OF APPLICATION

A. Surface Preparation: Remove foreign matter which could decrease effectiveness of treatment on areas to be treated. Loosen, rake and level soil to be treated, except previously compacted areas under slabs and foundations. Toxicants may be applied before placement of compacted fill under slabs, if recommended by toxicant manufacturer.

B. Application Rates: Apply soil treatment solution as follows:

C. Under slab-on-grade structures, treat soil before concrete slabs are placed, using the following rates of application:

1. Apply 4 gallons of chemical solution per 10 linear feet to soil in critical area under slab, including entire inside perimeter inside of foundation walls, along both sides of interior partition walls, around plumbing pipes and electric conduit penetrating slab, and around interior column footers.

2. Apply one gallon of chemical solution per 10 square feet as an overall treatment under slab and attached slab areas where fill is soil or unwashed gravel. Apply one and one half gallons of chemical solution per 10 square feet to areas where fill is washed gravel or other coarse absorbent material.

3. Apply 4 gallons of chemical solution per 10 linear feet of trench, for each foot of depth from grade to footing, along outside edge of building. Dig a trench six inches to eight inches along outside of foundation to a depth of not less than 12 inches. Punch holes to top of footing at not more than 12 inches on center and apply chemical solution. Mix chemical solution with the soil as it is being replaced in trench.

D. Under crawl-space and basement structures, treat soil along exterior and interior walls of foundations with shallow footings as specified above for exterior of slab-on-grade structures.

E. At hollow masonry foundations or grade beams, treat voids at rate of 2 gallons per 10 linear feet, poured directly into the hollow spaces.

F. At expansion joints, control joints, and areas where slabs will be penetrated, apply at a rate of 4 gallons per 10 linear feet of penetration.

G. Post signs in areas of application to warn workers that soil termiticide treatment has been applied. Remove signs when areas are covered by other construction.

H. Re-apply soil treatment solution to areas disturbed by subsequent excavation, landscape grading, or other construction activities following application.

END OF SECTION

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SECTION 31 50 00
EXCAVATION SUPPORT AND PROTECTION

PART 1 – GENERAL

1.1 SUMMARY

A. Work of this section includes sheeting and shoring and bracing.

1.2 RELATED SECTIONS

A. Section 31 10 00: Clearing

B. Section 31 20 00: Earthmoving

1.3 SYSTEM DESCRIPTION DESIGN REQUIREMENTS

A. Shoring systems shall be designed to safely and adequately prevent collapse of adjacent materials and permit construction of Work to arrangement shown on Contract Documents.

B. Secure approvals, including those of local governmental agencies having jurisdiction.

C. Analyze site conditions. Make supplemental investigations as needed for proper design of shoring.

1.4 QUALITY ASSURANCE SUBMITTALS FOR DESIGN DATA

A. Prepare and submit design drawings and calculations showing analysis of work to be performed, including horizontal support for shoring.

B. Drawings shall include methods, equipment and work procedures.

1. Include plans, elevations, sections, and details.
2. Show arrangement, locations, and details of soldier piles, piling, lagging, tiebacks, bracing, and other components of excavation support and protection system according to engineering design.

3. Indicate type and location of waterproofing.

4. Include a written plan for excavation support and protection, including sequence of construction of support and protection coordinated with progress of excavation.

C. Contractor is responsible for obtaining all permits or approvals from authorities having jurisdiction for the installation of the shoring. Documentation of these permits/approvals shall be provided to the owner prior to starting work.

1.5 QUALITY ASSURANCE

A. Qualifications

1. Bracing and shoring drawings shall be prepared by a registered professional engineer, licensed to practice in the State of Maryland. Drawings and calculations shall bear seal of Professional Engineer registered in the State of Maryland.

2. Personnel performing installation shall be trained or qualified in techniques and procedures of shoring installation with a minimum of three (3) years successful experience in such installation.

3. Installation shall be performed under supervision of a Professional Engineer registered in the State of Maryland, experienced in this type of work.

B. Regulatory Requirements: Conform to requirements of Occupational Safety and Health Administration (OSHA) as well as measures accepted as standards of industry.

C. Certifications: Upon completion of shoring, submit a letter signed and sealed by design engineer stating that, to best of his or her knowledge, systems were constructed in compliance with design drawings and calculations.

PART 2 – PRODUCTS

2.1 MATERIALS

A. Materials shall be selected and furnished to perform in compliance with design criteria.

B. Structural Steel Shapes and Plates: ASTM A 36 or ASTM A 572. Steel shall be of American manufacturer, new and free from defects in strength, durability, appearance and function.

1. Recycled Content: Provide steel with minimum 90 percent total recycled content, including at least 60 percent post-consumer recycled content.

2. Regional Materials: Provide steel manufactured and of primary raw materials extracted or recovered within 500-mile radius of Project Site.

C. Forest Certification: To the extent necessary to meet required LEED threshold, provide wood products made from forests certified by an FSC-accredited certification body. All non-FSC wood in assemblies with FSC-certified wood shall meet the FSC Controlled Wood (CW) criteria.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Site Verification of Conditions: Prior to commencing work of this Section, check and verify governing dimensions and elevations, including field measurements of existing or adjoining work on which this work is dependent to assure proper fit and clearances between new and existing structures.

3.2 PREPARATION

A. Protection

1. Protect and support water, sewer, gas, and other pipes and electrical conduits encountered and immediately notify persons, companies or governmental agencies, granting them ample opportunity to take such additional precautions as they may deem necessary.

2. Cut and cap street connections encountered in excavating along curb lines in compliance with local jurisdiction requirements. Mark locations of capped utilities

so they may be subsequently located and reconnected as needed.

3. Damage to adjacent properties, streets, sidewalks and utilities caused by work under this Section shall be repaired, restored to original condition, or replaced at no additional expense to Owner.

B. Coordination

1. Prepare a photographic or video survey of existing crack conditions in adjacent facilities and other conditions of structures prior to commencing work.

2. Maintain free flow of pedestrian and vehicular traffic to and from adjacent properties at levels existing prior to start of work and as described in Section 02000 “Clearing”.

3. Interior bracing shall be arranged to offer no interference with formwork for new construction.

4. Provide sufficient quantity of materials on hand at all times for protection of Work and for use in event of emergency.

5. Setting of formwork, reinforcing and placement of concrete shall be in compliance with requirements described in other related Sections of this Project Manual.

6. Provide pumps and other equipment as necessary to dewater excavations for shoring operations.

C. Sheeting

1. Provide sheeting of proper lengths and section needed, and anchor or brace to resist earth and hydrostatic pressures and superimposed loads from adjacent structures and/or construction equipment.

2. Install sheeting plumb and true, to lines and locations as indicated on design submittal drawings. Sheeting shall be used to form concrete walls and shall be located and driven to ensure that no part of sheeting is within outline of permanent construction.

3. Sheeting retaining earth on which support and stability of existing structures is dependent shall be left in place at completion of Work.

D. Shoring

1. Locate shoring at distances away from new construction sufficient to allow working room and observation of construction.

2. Shoring shall be set clear of permanent footings, walls and other structural features.

3. Shoring shall be installed to retain earth under surcharges, including such loads as weight of construction materials and equipment, vibration, snow, rainwater, water absorption by soils, and temporary construction.

4. Extend shoring as high as necessary to allow for construction of foundation walls and for berming to divert water run-off. Depth of shoring shall be as deep as necessary to brace excavation to ultimate depth.

5. Shoring supporting formwork may not be left in place upon written approval by the Owner's Representative.

3.3 RESTORATION

A. Remove temporary protective installations upon completion of shoring operations.

1. Contractor's option: Remove excavation support and protection systems to a minimum depth of 36 inches below overlying construction and abandon remainder. This will need approval from the permit authority. Denial from the permit authority will require the complete removal at no additional cost to the contract.

2. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "EarthMoving."

3. Repair or replace, as approved by Architect, adjacent work damaged or displaced by removing excavation support and protection systems.

B. Repair damage to structures caused by shoring operations and restore surfaces to original or better condition.

3.4 CLEANING

A. Remove debris and excess earth resulting from shoring operations as it accumulates. Do not store debris on site or permit debris to be scattered over site.

3.5 FIELD QUALITY CONTROL

A. Owner will engage an independent inspection agency to perform field quality control inspections.

END OF SECTION

SECTION 32 12 16
HOT-MIXED ASPHALT PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the contract, including General and Supplementary Conditions and Division 1, Specification Sections, apply to work in this section.

1.2 DESCRIPTION OF WORK

A. This section specifies materials and work required to construct new asphalt pavement, asphalt curbing, asphalt walks and overlay existing asphalt pavement.

1.3 RELATED WORK

A. Refer to Section 31 10 00 "Clearing", Section 31 10 05 "Demolition", Section 31 20 00 "Earthmoving", Section 32 13 13 "Cement Concrete Paving".

1.4 STANDARDS

A. Maryland Department of Transportation State Highway Administration, current "Standard Specifications for Construction and Materials".

B. Montgomery County Department of Transportation current "Design Standards".

1.5 SUBMITTALS

A. Products:

1. Submit asphalt plant mix formula, for each course specified. Mix formula to include percentage of aggregate passing each sieve size, percentage of bituminous material added to aggregate and mix temperature. Mix should be MDOT-SHA approved.

2. Submit certificates, signed by producer or manufacturer and contractor, stating that base course material and asphalt comply with this specification.

3. Submit results of testing specified for review by the Architect, Owner's Representative and required jurisdictional inspectors.

4. Submit location of product manufacture and of extraction/recovery of primary raw materials.

5. Submit recycled-content data, designating percentages of post-consumer and pre-consumer recycled materials.

1.6 PRODUCT DELIVERY AND STORAGE

A. Asphalt mixtures: Delivery temperature not to exceed 25° F below plant mix temperature.

1.7 PROJECT CONDITIONS

A. Existing Asphalt Pavements: Verify existing pavement conditions (e.g. deteriorated surface, joints, etc.) during prebid inspection.

B. Traffic: Maintain vehicular traffic during pavement construction operations.

C. Limitations: Do not proceed with pavement construction until underground utility construction is complete. Do not proceed with asphalt placement operations until adjacent or adjoining Portland cement concrete curb construction is complete. Do not place bituminous materials when ambient air temperature is below 40° or air temperature has been below 35° F for 12 or more consecutive hours. Do not place materials from 15 November to 01 March without written authorization from the Architect.

D. Construction Surveys: Retain the services of a Maryland Registered Land Surveyor or Professional Engineer to provide combined horizontal and vertical alignment stakes for road base construction

1. Paved area base alignment stake horizontal interval: 50 foot maximum stations at centerline and both edges to finished base elevations.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide products manufactured and of raw materials extracted/recovered within a 500-mile radius of the Project Site.

B. Subbase Course: SHA Graded Aggregate Subbase: Section 901.01.

C. Asphalt Base (Binder) Course: SHA Hot Mix Asphalt: Sections 901.01, 904.01 and 904.06.

D. Tack Coat: SHA cut-back asphalt: Section 904.04, M 81 or M 82.

E. Overlay Binder Coat: Asphalt cement: AASHTO M 20, penetration grade 80-100.

F. Overlay Protective Membrane: "Petromat" protective membrane manufactured by Phillips Fiber Corporation, a subsidiary of Phillips Petroleum Company, Greenville, South Carolina, or approved equal.

G. Overlay Protective Membrane Strips: "PavePrep" fiber reinforced mastic strips, manufactured by The PavePrep Corporation, Westfield, New Jersey.

H. Asphalt Surface Course: SHA Hot Mix Asphalt: Section 901.01, 904.01 and 904.06.

I. Asphalt Surface Course for Athletic Courts and Paved Play Areas: SHA Hot Mix Asphalt: Sections 901.01, 904.01 and 904.06.

J. Joint Sealant: SHA Section 911.01.

PART 3 - EXECUTION

3.1 PROTECTION AND RESTORATION

A. Asphalt Pavement: Protect improvements and facilities during tack coat and overlay binder coat applications to prevent overspray damage. Protect completed surface from damage. Do not permit heavy equipment or rollers on completed surface. Do not permit vehicular traffic on surface for 24 hours after completion. Restore damaged pavement as directed by the Owner’s Representative or the Architect, at no increase to contract sum.

3.2 SUBGRADE PREPARATION

A. Paved Areas: Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Verify subgrade compaction and elevations and correct discrepancies before proceeding with base construction. Verify utility casting elevations and reset or adjust to meet flush with finished pavement surface. Do not place the base material/subbase material on frozen or muddy subgrade.

3.3 SUBBASE COURSE

A. Place subbase course material on prepared subgrade in one uniform layer to depth required to produce compacted thickness indicated. Shape material, to sections and elevations indicated with blade grader and compact with pneumatic tired rollers to 100 percent maximum dry density. Control moisture content of the base course material to within 2 percent of optimum during compaction operations. Compaction Standard: ASTM D 698. Proof roll subbase course with 8 ton tandem steel wheel roller and correct irregularities.

3.4 ASPHALT BASE COURSE

A. Subbase Course Surface Preparation: Apply tack coat material to previously placed asphalt base course, existing pavement, curbing, utility castings and any structure abutting or projecting into paved area.

B. Base Course Placement: Place asphalt in layers not exceeding four inches in compacted depth to total depth required to produce compacted thickness indicated. Place material with mechanical self-powered pavers capable of maintaining required line and grade. Place material by approved manual methods in areas inaccessible to self-powered pavers. The temperature of the material shall be not less than 225° F at the time of placement.

C. Base Course Compaction: Compaction operations shall begin immediately following placement of the base course material, and shall consist of breakdown, intermediate and finish rolling. Material shall be compacted to in-place density of 92 to 97 percent of theoretical maximum density. In-place compaction shall be completed before the material cools below 185° F. Use self-powered tandem steel wheel rollers. Use power driven trench rollers in areas inaccessible to self-powered equipment. Begin rolling longitudinally at low side or edge and proceed toward high side or crown. Overlap successive roller trips one half-roller width. Do not terminate alternate roller trips at the same location. Continue finish rolling until 92 percent to 97 percent theoretical maximum density is obtained and all roller marks are eliminated. Density test method: AASHTO T 230.

3.5 ASPHALT SURFACE COURSE AND OVERLAY

A. General: Provide overlay protective membrane treatment where indicated. Provide overlay protective membrane strips over all long, running cracks or pavement joints except in areas where overlay protective membrane is already indicated.

B. Asphalt Base Course Surface Preparation: Remove loose material from surface before applying tack coat. Apply tack coat material uniformly to surface at a rate of 0.10 gallon per square yard. Allow tack coat to cure as long as required to properly set but not less than 12 hours.

C. Existing Asphalt Pavement Preparation: Clean and dry pavement, with compressed air, removing debris, dust, foreign materials and moisture.

1. Obtain pavement preparation approval, from the Architect prior to overlay binder coat application. Apply overlay binder coat material uniformly to prepared asphalt

surface. Apply at a rate of 0.25 gallon per square yard. For long running cracks or joints in existing pavement surface where overlay protective membrane strips will be used, apply overlay binder coat material to a width of approximately two feet so as to span existing cracks or joints. Adjust application rate, based on existing pavement relative porosity, at no increase to contract sum. Apply overlay binder coat material at 300° F minimum to 350° F maximum.

2. Lay down overlay protective membrane, on cured overlay binder coat, in accordance with manufacturer's installation instructions and as noted. Transverse joint overlap to be 12 inches, "shingled" in the direction of paving to prevent edge pick-up by the pavers. Longitudinal joint overlap to be six inches. Cut and piece membrane to fit irregular shaped areas (e.g. access road intersections, curb returns, etc.). Obtain pavement preparation approval from the Owner's Representative or the Architect prior to tack coat application.

3. Lay down overlay protective membrane strips on cured overlay binder coat, in accordance with manufacturer's installation instructions and as noted. Unroll overlay protective membrane strips, aligned with pavement joints, and seat in tacky overlay binder coat material by brooming, so as to span existing pavement joints. Blot excess overlay binder coat materials on the edges of the membrane strips with sand blanket. Cut and piece membrane to fit irregular shaped areas (e.g. access road intersections, curb returns, etc.). Obtain pavement preparation approval from the Owner's Representative or the Architect prior to tack coat application.

4. Apply tack coat material uniformly to prepared asphalt surface. Apply at rate of minimum of 0.05 gallon per square yard and a maximum of 0.15 gallon per square yard. Tack coat to cure as long as required to properly set, but not less than 12 hours.

5. Prepare existing asphalt pavement, as indicated and specified, at no increase to contract sum.

D. Surface Course and Overlay Placement: Place asphalt, in one uniform layer, to depth required to produce the compacted thickness indicated. Place with mechanical self-powered pavers capable of maintaining required line and grade. Place and spread asphalt by approved manual methods in areas inaccessible to self-powered pavers. The temperature of the material shall be not less than 225° F at the time of placement.

E. Surface Course and Overlay Compaction: Compaction operations shall begin immediately following placement of the surface course material, and shall consist of joint, breakdown, intermediate and finish rolling. In-place compaction shall be completed before the material cools below 185° F (85° C). Use power driven trench rollers in areas inaccessible to self-powered rollers. Begin rolling longitudinally at low side or edge and proceed toward high side or crown. Overlap successive roller trips, one-half roller width. Do not terminate alternate trips at same point. Continue finish rolling until 92 percent to 97 percent theoretical maximum density is obtained and all roller marks are eliminated. Density test method: AASHTO T 230.

3.6 JOINT SEALING

A. Completely seal and fill joints along existing and new pavement and curbing interface with joint sealant.

3.7 TESTING

A. General: Correct work not conforming to specified tolerances as directed by the Owner's Representative or the Architect, at no increase to the contract sum.

B. Thickness Tests: Conduct subbase, base and surface course thickness tests and provide test area restoration upon completion. Tolerance not less than 1/2 inch from compacted thickness indicated. Test locations are random and to be determined by the Owner's Representative or the Architect. Regardless of paved area size, at least one test shall be performed for each newly paved area. Provide testing by Ground Penetrating Radar (coring asphalt will not be accepted). Although the owner will provide a Maryland Registered Professional Soils Engineer for required testing and inspections, they will not perform Ground Penetrating Radar. The contractor must hire an independent Maryland Registered Professional Engineer to perform the Ground Penetrating Radar and must provide test resulted to the Owner / Architect. Any deficiencies found by the Ground Penetrating Radar will need to be replaced at the contractors expense.

C. Smoothness Tests: Conduct surface course smoothness tests. Tolerance not to exceed 1/8 inch between any two surface contacts on 10-foot straightedge. Test locations are random and to be determined by the Owner's Representative or the Architect. Regardless of paved area size, at least one test shall be performed for each newly paved area.

D. Laboratory Density Tests: Conduct subgrade, subbase and base course laboratory density tests. Density testing shall be performed by individuals certified to perform asphalt testing. Test method: ASTM D 1557. Test interval to be determined by the Owner's Representative or the Architect, but no less than one test for each newly paved area and/or one test per 1000 feet of roadway shall be performed.

1. Provide test area restoration.

E. Field Density Tests: Conduct subgrade, subbase and base course in-place field density tests. Density testing shall be performed by individuals certified to perform asphalt testing. Test method: ASTM D 1556 or D 2167. Test locations are random and to be determined by the Owner's Representative or the Architect, but no less than one test for each newly paved area and/or one test per 1000 feet of roadway shall be performed.

1. Provide test area restoration.

F. Owner may engage an independent testing and inspection agency to perform field quality control test and inspections.

3.8 CLEANING

A. Clean improvements and facilities damaged by tack coat overspray as directed by the Owner's Representative or the Architect.

3.9 WASTE MANAGEMENT

A. Recycle waste materials in accordance with Division 1 "Construction Waste Management" requirements.

- END OF SECTION 32 12 16 -

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SECTION 32 13 13
CEMENT CONCRETE PAVING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS:

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

1.2 DESCRIPTION OF WORK:

A. This section specifies materials and work required to construct Portland cement concrete walks, curbing, and heavy-duty concrete paving.

1.3 RELATED WORK

A. Refer to Section 31 20 00 "Earthmoving”.

1.4 STANDARDS

A. Maryland Department of Transportation State Highway Administration's current "Standard Specifications for Construction and Materials".

B. Montgomery County, Department of Transportation's current "Design Standards".

1.5 SUBMITTALS

A. The contractor shall provide a sample of eight linear feet of typical concrete walk, with a control joint, for approval by the Owner’s Representative. No additional concrete walk may be constructed until the sample is inspected and approved.

B. Product data for Credit MR 5: For products having regional material content, documentation indicating location of manufacture and location of extraction, recovery or harvest of primary raw materials. Include statement indicating cost of each product with regional material content.

C. Submit cut sheets for construction of curb in the public right-of-way to and obtain approval from the governing jurisdiction and the Architect prior to curb construction.

D. The contractor shall provide a sample of eight linear feet of typical concrete curb-and-gutter, with a control joint, for approval by the Owner’s Representative. No additional concrete curbing may be constructed until the sample is inspected and approved.

E. Submit recycled-content data, designating percentages of post-consumer and pre-consumer recycled material.

F. Submit documentation indicating Solar Reflectance Index (SRI) value.

1.6 PROJECT CONDITIONS

A. Traffic: Maintain pedestrian traffic during walk construction operations.
B. Limitations

1. Underground Utilities: Do not proceed with concrete construction until underground utility construction is complete.

2. Curbing: Do not proceed with concrete walk construction until adjacent or adjoining curb construction is complete.

3. Environmental: Refer to Section 33 10 00 "Utility Standards".

1.7 CONSTRUCTION SURVEYS

A. Retain the services of a Maryland Registered Land Surveyor or Professional Engineer to provide combined horizontal and vertical alignment stakes for curb construction within public right of way. Horizontal stake interval 25 feet maximum.

B. Provide combined horizontal and vertical alignment stakes for project site curb construction. Horizontal stake interval 25 feet maximum.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General: Provide aggregate manufactured and extracted/recovered within a 500-mile radius of the Project Site.

B. Gravel Base: Maryland DOT-SHA Graded Aggregate Base.

C. Sidewalk Concrete: Class "A" Portland cement concrete, Section 33 10 00 "Utility Standards".
Heavy-Duty Concrete: SHA Mix No. 6, Table 902 A. 28-Day compressive strength 4500 P.S.I.

1. Fly-ash or slag is not allowed.

2. Solar Reflectance Index (SRI): Concrete mix design, including cement and aggregate materials, shall achieve a minimum SRI of 29.

D. Joint Materials: Expansion and Isolation Joints: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.

E. Forms: Steel or wood for straight or tangent walks.

F. Curing Materials: Liquid Membrane in accordance with MDOT-SHA Standards and Specifications for Construction and Materials section 902.07.03.

G. Miscellaneous Products

1. Form Release Compound: Non-staining, zero-VOC, 100% biodegradable made from plant-based oils and approved by the Architect.

2. Cement Mortar: Section 33 10 00 "Utility Standards".

H. Joint Caps: All Construction, Expansion and Isolation Joints shall be topped with Vinylex Removable Cap Strip (Vinylex Corporation, www.vinylexwaterstop.com), or approved equal, and sealed with a polyurethane sealant.

1. Joints between curbing and concrete walks shall not require sealant.

2. Remove joint cap prior to caulking joint.

I. Colored Concrete Admixture

1. Acceptable Manufacturer

a. Basis-of-Design for colored concrete: L.M. Scofield Company; www.scofield.com.

2. Materials

a. Colored Admixture for Integrally Colored Concrete: CHROMIX P Admixture and CHROMIX ML; L.M. Scofield Company.

i. Admixture shall be a colored, water-reducing, admixture containing no calcium chloride with coloring agents that are lime proof and ultra-violet resistant.

ii. Colored admixture shall conform to the requirements of ACI 303.1, ASTM C979, ASTM C494 and ASHTO M194.

3. Colors and Texture

a. Concrete Color:
i. Cement: Color shall be gray.

ii. Sand: Color shall be locally available natural sand.

iii. Aggregate: Concrete producer's standard aggregate complying with specifications.

iv. Colored Admixture: 0288 Autumn Beige.

b. Curing Compound: Color to match integrally colored concrete.

c. Textures: Sponge and Medium/Heavy Sandblasted, locations selected by Architect.

PART 3 - EXECUTION

3.1 PROTECTION AND RESTORATION

A. Concrete: Protect completed concrete from damage. Restore damaged concrete as directed by the Owner's Representative or the Architect.

3.2 SUBGRADE PREPARATION

A. Paved Areas: Section 31 20 00 "Earthmoving" and as noted. Verify subgrade elevations and compaction and correct discrepancies before proceeding with construction. Verify utility casting elevations and reset or adjust to meet flush with finished concrete surface. Remove loose material from subgrade prior to gravel base placement.

3.3 GRAVEL BASE PLACEMENT

A. Place and compact gravel base on prepared subgrade to depth indicated. Remove debris from surface of gravel base prior to placement of concrete. Do not place gravel base material on frozen or muddy subgrade.

3.4 FORMS

A. Clean and coat forms with form release compound, prior to use. Install forms to lines, grades and elevations indicated or as specified. Brace forms to prevent movement during concrete placement.

3.5 EXPANSION JOINTS

A. Install expansion joints at maximum 25-foot intervals or as indicated. Install expansion joints, adjacent to curbing, opposite curbing joints and as indicated. Place expansion joints perpendicular to concrete surface and with top edge 1/4 inch below concrete surface.

3.6 ISOLATION JOINTS

A. Install isolation joints where concrete abuts buildings, existing walk sections, utility structures and concrete curb. Place isolation joints with top edge 1/4 inch below concrete surface.

3.7 CONTRACTION JOINTS (SCORE LINES)

A. Provide contraction joints at five-foot intervals or as indicated. Form contraction joints with 3/4 inch jointing tool.

3.8 CONCRETE PLACEMENT

A. Sample Approval: No concrete walks may be constructed until the sample section has been inspected and approved by the Owner’s Representative.

B. General: Place concrete in forms in one uniform layer. Consolidate concrete by tamping, spading or vibrating to prevent honeycombing. Place and consolidate concrete carefully to prevent dislocation of joint materials.

3.9 FINISHING

A. General: Draw a fine hair broom across concrete surface. Where longitudinal grade exceeds five percent, use a coarse texture finish by drawing a stiff bristle broom across concrete surface. Do not add water to finish. Do not wet broom to finish. After screeding and bull floating allow surface water to recede into concrete prior to any other work on the concrete surface.

B. Handicapped Ramps: Handicapped ramps shall have a detectable warning surface. Surface shall be yellow and *anchored* into the concrete ramp. Stamped concrete is not acceptable.

C. Curbs: Strike off top surfaces of curbing to top of forms and to smooth and uniform texture. Strip curb face forms when concrete takes initial set. Trowel curb face to smooth and uniform texture. Finish top surfaces and curb face to fine texture by drawing a soft bristle brush longitudinally along curb. Finish edges of curbing with edging tool having a radius as indicated. Maintain forms, except curb face forms, in place 12 hours after concrete placement. Correct defects (e.g. holes, honeycomb areas, broken edges, etc.) upon removal of remaining forms, with cement mortar. Finish contraction joints with 1/4-inch

radius edging tool. Finish curbing joints to clean and true edges. Maintain curbing surfaces moist during finishing operations.

3.10 CURING

A. Apply curing compound in accordance with Manufacturers recommendations.

3.11 TESTING

A. General: Correct work not conforming to tolerances as directed by the Owner's Representative or the Architect, at no increase to the contract sum.

B. Walk Horizontal Alignment Test: Tolerance not to exceed 1/2 inch between any two contacts on 10-foot straightedge, except along horizontal curves. Test locations random and determined by the Owner's Representative or the Architect. Test observation by the Owner's Representative or the Architect.

C. Walk Surface Smoothness Test: Tolerance not to exceed 3/8 inch between any two surface contacts on 10-foot straightedge. Test locations random and determined by the Owner's Representative or the Architect. Test observation by the Owner's Representative or the Architect.

D. Owner will engage an independent testing and inspection agency to perform field quality control tests and inspections of concrete mixes delivered to the project site, including testing for temperature, slump and air content, and fabricating and testing concrete cylinder samples.

3.12 WASTE MANAGEMENT

A. Recycle waste materials in accordance with Construction Waste Management requirements.

END OF SECTION

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SECTION 32 14 00
UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Brick pavers set in bituminous and mortar setting beds.
2. Stone pavers set in bituminous and mortar setting beds; including step treads and seat wall caps.
3. Aluminum edge restraints.
4. Cast-in-place concrete edge restraints.

1.2 SUBMITTALS

A. Product Data: For the following:

1. Pavers.
2. Bituminous setting materials.
3. Mortar and grout materials.
4. Edge restraints.

1.3 INFORMATIONAL SUBMITTALS

A. Adhesion and Compatibility Test Reports: From latex-additive manufacturer for mortar and grout containing latex additives.

B. Material Certificates: For unit pavers. Include statements of material properties indicating compliance with requirements, including compliance with standards. Provide for each type and size of unit.

C. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for unit pavers, indicating compliance with requirements.

1. For solid interlocking paving units, include test data for freezing and thawing according to ASTM C 67.

1.4 QUALITY ASSURANCE

A. Mockups: Build mockups to verify selections made under Sample submittals, to demonstrate aesthetic effects, and to set quality standards for materials and execution.

1. Subject to compliance with requirements, approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.

1.5 PRECONSTRUCTION TESTING

A. Preconstruction Adhesion and Compatibility Testing: Submit to latex-additive manufacturer, for testing as indicated below, Samples of flooring materials that will contact or affect mortar and grout that contain latex additives.

1. Use manufacturer's standard test methods to determine whether mortar and grout materials will obtain optimal adhesion with, and will be nonstaining to, installed brick and other materials constituting brick flooring installation.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Store pavers on elevated platforms in a dry location. If units are not stored in an enclosed location, cover tops and sides of stacks with waterproof sheeting, securely tied.

B. Store cementitious materials on elevated platforms, under cover, and in a dry location. Do not use cementitious materials that have become damp.

C. Store aggregates where grading and other required characteristics can be maintained and contamination avoided.

D. Store liquids in tightly closed containers protected from freezing.

E. Store asphalt cement and other bituminous materials in tightly closed containers.

1.7 FIELD CONDITIONS

A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

B. Weather Limitations for Bituminous Setting Bed:

1. Install bituminous setting bed only when ambient temperature is above 40 deg F and when base is dry.

2. Apply asphalt adhesive only when ambient temperature is above 50 deg F and when temperature has not been below 35 deg F for 12 hours immediately before application. Do not apply when setting bed is wet or contains excess moisture.

C. Weather Limitations for Mortar:

1. Cold-Weather Requirements: Comply with cold-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6.

2. Hot-Weather Requirements: Comply with hot-weather construction requirements contained in TMS 602/ACI 530.1/ASCE 6. Provide artificial shade and windbreaks and use cooled materials as required. Do not apply mortar to substrates with temperatures of 100 deg F and higher.

a. When ambient temperature exceeds 100 deg F, or when wind velocity exceeds 8 mph and ambient temperature exceeds 90 deg F, set pavers within 1 minute of spreading setting-bed mortar.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Source Limitations: Obtain each type of unit paver, joint material, and setting material from single source with resources to provide materials and products of consistent quality in appearance and physical properties.

2.2 BRICK PAVERS

A. Brick Pavers: Light-traffic paving brick; ASTM C 902, Class SX, Type I or Type II, Application PS. Provide brick without frogs or cores in surfaces exposed to view in the completed Work.

1. Selection: To be color and size approximating existing chimney brick, after cleaning; must meet above performance. Provide samples for Owner selection and approval

B. Efflorescence: Brick shall be rated "not effloresced" when tested according to ASTM C 67.

2.3 STONE PAVERS

A. Paver Selection: Pennsylvania Bluestone with a thermal finish on all exposed edges; thickness as indicated.

1. Wall Caps: 3-inch thick Select Pennsylvania Bluestone with a thermal finish on all exposed edges.

2. Step Treads: 2-inch thick Select Pennsylvania Bluestone with a thermal finish on all exposed edges.

2.4 CURBS AND EDGE RESTRAINTS

A. Aluminum Edge Restraints: Manufacturer's standard straight, 1/8-inch- thick by 4-inch high extruded-aluminum edging with loops pressed from face to receive stakes at 12 inches o.c. and aluminum stakes 12 inches long for each loop.

2.5 ACCESSORIES

A. Cork Joint Filler: Preformed strips complying with ASTM D 1752, Type II.

B. Compressible Foam Filler: Preformed strips complying with ASTM D 1056, Grade 2A1.

C. Stone Cap Flashing:

1. Stainless Steel: ASTM A 240/A 240M, Type 304, 0.016 inch thick.

2. Fabricate through-wall metal flashing embedded in masonry from stainless steel with ribs at 3-inch intervals along length of flashing to provide an integral mortar bond.

a. Subject to compliance with requirements, available products that may be incorporated into the Work include:

1) Cheney Flashing Company; Cheney 3-Way Flashing (Sawtooth).

2) Keystone Flashing Company, Inc.; Keystone 3-Way Interlocking Thruwall Flashing.

3) Sandell Manufacturing Co., Inc.; Mechanically Keyed Flashing.

3. Fabricate through-wall flashing with drip edge unless otherwise indicated. Fabricate by extending flashing 1/2 inch out from wall, with outer edge bent down 30 degrees and hemmed.

4. Fabricate metal drip edges and sealant stops for ribbed metal flashing from plain metal flashing of same metal as ribbed flashing and extending at least 3 inches into wall with hemmed inner edge to receive ribbed flashing and form a hooked seam. Form hem on upper surface of metal so that completed seam will shed water.

5. Metal Expansion-Joint Strips: Fabricate from stainless steel to shapes indicated.

2.6 BITUMINOUS SETTING-BED MATERIALS

A. Primer for Base: ASTM D 2028/D 2028M, cutback asphalt, grade as recommended by unit paver manufacturer.

B. Fine Aggregate for Setting Bed: ASTM D 1073, No. 2 or No. 3.

C. Asphalt Cement: ASTM D 3381/D 3381M, Viscosity Grade AC-10 or Grade AC-20.

D. Neoprene-Modified Asphalt Adhesive: Paving manufacturer's standard adhesive consisting of oxidized asphalt combined with 2 percent neoprene and 10 percent long-fibered mineral fibers containing no asbestos.

E. Sand for Joints: Fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve.

1. Provide sand of color needed to produce required joint color.

2.7 MORTAR SETTING-BED MATERIALS

A. Portland Cement: ASTM C 150/C 150M, Type I or Type II.

B. Sand: ASTM C 144.

C. Latex Additive: Manufacturer's standard acrylic resin or styrene-butadiene-rubber water emulsion, serving as replacement for part or all of gaging water, of type specifically recommended by latex-additive manufacturer for use with field-mixed portland cement and aggregate mortar bed, and not containing a retarder.

D. Thin-Set Mortar for Bond Coat: Latex-portland cement mortar complying with ANSI A118.4.

1. Provide prepackaged, dry-mortar mix combined with acrylic resin or styrene-butadiene-rubber liquid-latex additive at Project site.

E. Water: Potable.

2.8 BITUMINOUS SETTING-BED MIX

A. Mix bituminous setting-bed materials at an asphalt plant in approximate proportion, by weight, of 7 percent asphalt cement to 93 percent fine aggregate unless otherwise indicated. Heat mixture to 300 deg F.

2.9 MORTAR MIXES

A. General: Comply with referenced standards and with manufacturers' written instructions for mix proportions, mixing equipment, mixer speeds, mixing containers, mixing times, and other procedures needed to produce setting-bed and joint materials of uniform quality and with optimal performance characteristics. Discard mortars and grout if they have reached their initial set before being used.

B. Mortar-Bed Bond Coat: Mix neat cement and latex additive to a creamy consistency.

C. Latex-Modified, Portland Cement Setting-Bed Mortar: Proportion and mix portland cement, sand, and latex additive for setting bed to comply with written instructions of latex-additive manufacturer and as necessary to produce stiff mixture with a moist surface when bed is ready to receive pavers.

D. Latex-Modified, Portland Cement Bond Coat: Proportion and mix portland cement, aggregate, and liquid latex for bond coat to comply with written instructions of liquid-latex manufacturer.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine surfaces indicated to receive unit paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance.

B. Where unit paving is to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations, including areas where waterproofing system is turned up or flashed against vertical surfaces.

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

3.2 PREPARATION

A. Remove substances from concrete substrates that could impair mortar bond, including curing and sealing compounds, form oil, and laitance.

B. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.

C. Proof-roll prepared subgrade to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

3.3 INSTALLATION, GENERAL

A. Do not use unit pavers with chips, cracks, voids, discolorations, or other defects that might be visible or cause staining in finished work.

B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.

C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.

1. For concrete pavers, a block splitter may be used.

D. Handle protective-coated brick pavers to prevent coated surfaces from contacting backs or edges of other units. If, despite these precautions, coating does contact bonding surfaces of brick, remove coating from bonding surfaces before setting brick.

E. Joint Pattern: Running bond unless indicated otherwise; stagger joints a minimum of 6 inches.

F. Tolerances: Do not exceed 1/16-inch unit-to-unit offset from flush (lippage) nor 1/8 inch in 24 inches and 1/4 inch in 10 feet from level, or indicated slope, for finished surface of paving.

G. Expansion and Control Joints: Provide for sealant-filled joints at locations and of widths indicated. Provide compressible foam filler as backing for sealant-filled joints unless otherwise indicated; where unfilled joints are indicated, provide temporary filler until paver installation is complete. Install joint filler before setting pavers. Sealant materials and installation are specified in Section 079200 "Joint Sealants."

H. Provide edge restraints as indicated. Install edge restraints before placing unit pavers.

1. Install edge restraints to comply with manufacturer's written instructions. Install stakes at intervals required to hold edge restraints in place during and after unit paver installation.

2. For metal edge restraints with top edge exposed, drive stakes at least 1 inch below top edge.

3. Where pavers embedded in concrete are indicated as edge restraints for pavers set in aggregate setting bed, install pavers embedded in concrete and allow concrete to cure before placing aggregate setting bed and remainder of pavers. Hold top of concrete below aggregate setting bed.

3.4 BITUMINOUS SETTING-BED APPLICATIONS

A. Apply primer to concrete slab or binder course immediately before placing setting bed.

B. Prepare for setting-bed placement by locating 3/4-inch- deep control bars approximately 11 feet apart and parallel to one another, to serve as guides for striking board. Adjust bars to subgrades required for accurate setting of paving units to finished grades indicated.

C. Place bituminous setting bed where indicated, in panels, by spreading bituminous material between control bars. Spread mix at a minimum temperature of 250 deg F. Strike setting bed smooth, firm, even, and not less than 3/4 inch thick. Add fresh bituminous material to low, porous spots after each pass of striking board. After each panel is completed, advance first control bar to next position in readiness for striking adjacent panels. Carefully fill depressions that remain after removing depth-control bars.

1. Roll setting bed with power roller to a nominal depth of 3/4 inch. Adjust thickness as necessary to allow accurate setting of unit pavers to finished grades indicated. Complete rolling before mix temperature cools to 185 deg F.

D. Apply neoprene-modified asphalt adhesive to cold setting bed by squeegeeing or troweling to a uniform thickness of 1/16 inch. Proceed with setting of paving units only after adhesive is tacky and surface is dry to touch.

E. Place pavers carefully by hand in straight courses, maintaining accurate alignment and uniform top surface. Protect newly laid pavers with plywood panels on which workers can stand. Advance protective panels as work progresses, but maintain protection in areas subject to continued movement of materials and equipment to avoid creating depressions or disrupting alignment of pavers. If additional leveling of paving is required, and before treating joints, roll paving with power roller after sufficient heat has built up in the surface from several days of hot weather.

F. Joint Treatment: Place unit pavers with hand-tight joints. Fill joints by sweeping sand over paved surface until joints are filled. Remove excess sand after joints are filled.

3.5 MORTAR SETTING-BED APPLICATIONS

A. Saturate concrete subbase with clean water several hours before placing setting bed. Remove surface water about one hour before placing setting bed.

B. Apply mortar-bed bond coat over surface of concrete subbase about 15 minutes before placing mortar bed. Do not exceed 1/16-inch thickness for bond coat. Limit area of bond coat to avoid its drying out before placing setting bed.

C. Apply mortar bed over bond coat; spread and screed mortar bed to uniform thickness at subgrade elevations required for accurate setting of pavers to finished grades indicated.

D. Mix and place only that amount of mortar bed that can be covered with pavers before initial set. Before placing pavers, cut back, bevel edge, and remove and discard setting-bed material that has reached initial set.

E. Wet brick pavers before laying if the initial rate of absorption exceeds 30 g/30 sq. in. per minute when tested according to ASTM C 67. Allow units to absorb water so they are damp but not wet at time of laying.

F. Place pavers before initial set of cement occurs. Immediately before placing pavers on mortar bed, apply uniform 1/16-inch thick bond coat to mortar bed or to back of each paver with a flat trowel.

G. Tamp or beat pavers with a wooden block or rubber mallet to obtain full contact with setting bed and to bring finished surfaces within indicated tolerances. Set each paver in a single operation before initial set of mortar; do not return to areas already set or disturb pavers for purposes of realigning finished surfaces or adjusting joints.

3.6 REPAIRING, POINTING, AND CLEANING

A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

B. Pointing: During tooling of joints, enlarge voids or holes and completely fill with grout. Point joints at sealant joints to provide a neat, uniform appearance, properly prepared for sealant application.

C. Cleaning: Remove excess grout from exposed paver surfaces; wash and scrub clean.

1. Remove temporary protective coating as recommended by coating manufacturer and as acceptable to paver and grout manufacturers.

2. Do not allow protective coating to enter floor drains. Trap, collect, and remove coating material.

END OF SECTION

SECTION 321600
CONCRETE WALKS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. This section specifies materials and work required to construct portland cement concrete walks.

1.3 RELATED WORK

A. Refer to Section 312000 "Earthwork and Grading", Section 331000 "Utility Standards" and Section 321610 "Concrete Curbing" (Section 033000 "Concrete Work").

1.4 STANDARDS

A. Maryland Department of Transportation State Highway Administration's (MSHA) current "Standard Specifications for Construction and Materials".

B. Montgomery County, Department of Transportation's current "Design Standards".

1.5 SUBMITTALS

A. Products: Submit certificate signed by concrete producer and contractor stating Portland cement concrete complies with this specification.

B. Refer to Section 331000 "Utility Standards".
1. Submit recycled content certificates for materials in accordance with LEED requirements.

2. Submit certificates for the locations of manufacturers of the materials in accordance with LEED requirements.

3. Submit certificates stating that in-place surface concrete materials achieve a minimum Solar Reflectance Index value of at least 80 when freshly installed and will achieve a minimum Solar Reflectance Index of at least 35 when weathered.

1.6 PROJECT CONDITIONS

C. Traffic: Maintain pedestrian traffic during walk construction operations.

D. Limitations:
1. Underground Utilities: Do not proceed with concrete construction until underground utility construction is complete.

2. Curbing: Do not proceed with concrete walk construction until adjacent or adjoining curb construction is complete.

3. Environmental: Refer to Section 331000 "Utility Standards".

E. LEED Compliance: Refer to Section 331000 “Utility Standards”, and as noted.

1. Materials and products shall be coordinated with the LEED requirements for this project.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Gravel Base: MSHA graded aggregate subbase: GAB per Section 901.01.

B. Concrete: Class "A" portland cement concrete, Section 331000 "Utility Standards"
1. 310000 "Utility Standards". Provide light-colored aggregates and additives to assure that the finished concrete meets the minimum Solar Reflectance Index requirements.

2. Provide the maximum allowable amount of recycled material content in coordination with LEED requirements for the project.

C. Stair Hand Rails: Size as indicated, of hot-dip-galvanized steel, and powder coated black.

D. Stair Hardware: As indicated, of galvanized steel, and powder coated black.

E. Concrete Reinforcement: Refer to Section 331000"Utility Standards".

F. Joint Materials: Expansion and Isolation Joints: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.

G. Roofing Felt Joint Material: Roofing felt paper to be used in joints shall be composed of roofing felt saturated and coated on both sides with an asphaltic material. It shall not weigh less than 39.8 lbs./100 square feet and shall not crack when bent over a ½” radius at room temperature.

H. Joint Caps: All Construction, Expansion and Isolation Joints shall be topped with Vinylex Removable Cap Strip (Vinylex Corporation, 1-800-624-4435), or approved equal, and sealed with a polyurethane sealant. Remove joint cap prior to caulking joint.

I. Joint Sealants: Low modulus, self-leveling pourable polyurethane sealant.
1. Compatibility - Provide joint sealants, joint fillers, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

2. Colors - Provide color of exposed joint sealants to match colors of concrete.
3. Cold Applied Joint Sealants shall be one part, polyurethane-base sealant for concrete, pourable, chemically curing elastomeric formulation complying with the following requirements relative to formulation and with ASTM C 920 for Type S, Grade NS, Class 25, and uses indicated.

J. Joint Sealant Backing
1. General - Provide sealant backings of material and type that are nonstaining; are compatible with joint substrates, sealants, primers and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.

2. Backer Rods for cold Applied Sealants: Preformed, compressible, resilient, nonstaining, nonwaxing, nonextruding strips of flexible, plastic foam of either material indicated below and of size, shape, and density to control sealant depth and otherwise contribute to producing optimum sealant performance.
a. Provide 7/8-inch backer rods for ½-inch joints.

b. Closed cell polyethylene foam, nonabsorbent to liquid water and gas, and nonoutgassing in unruptured state.

c. Proprietary, reticulated, closed-cell polymeric foam, nonoutgassing, with a density of 2.5 pcf and tensile strength of 35 psi per ASTM D 1623, and with water absorption less than 0.02 gram/cubic centimeter per ASTM C 1083.

3. Bond Breaker Type: Polyethylene tape or other plastic tape as recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint filler materials or joint surfaces at back of joint where such adhesions would result in sealant failure. Provide self-adhesive tape where applicable.

K. Forms: Steel or wood for straight or tangent walks.

L. Curing Materials:
1. Burlap Mats: AASHTO M182, Class 1.

2. Liquid Membrane: ASMT C 309. Field control testing of the white pigmented curing compounds is on the basis of weight per gallon. The samples shall not deviate more than +/- 0.3 lb/gal from the original source sample.

M. Miscellaneous Products
1. Form Release Compound: Nonstaining, zero-VOC, 100 percent biodegradable made from plant-based oils and approved by the Architect.

2. Cement Mortar: Section 331000 "Utility Standards".

PART 3 - EXECUTION

3.1 PROTECTION AND RESTORATION

A. Concrete: Protect completed concrete from damage. Restore damaged concrete as directed by the Architect.

3.2 SUBGRADE PREPARATION

A. Paved Areas: Section 31 20 00 "Earthmoving" and as noted. Verify subgrade elevations and compaction and correct discrepancies before proceeding with construction. Verify utility casting elevations and reset or adjust to meet flush with finished concrete surface.

Remove loose material from subgrade prior to (gravel base) concrete placement. Moisten subgrade to provide uniform dampened condition prior to concrete placement. Do not place (gravel base) concrete on frozen or muddy subgrade.

3.3 GRAVEL BASE PLACEMENT

A. Place and compact gravel base on prepared subgrade to depth indicated. Remove debris from surface of gravel base prior to placement of concrete. Do not place gravel base material on frozen or muddy subgrade.

3.4 FORMS

A. Clean and coat forms with form release compound, prior to use. Install forms to lines, grades and elevations indicated or as specified. Brace forms to prevent movement during concrete placement.

3.5 EXPANSION JOINTS

A. Install expansion joints at maximum 25 foot intervals or as indicated. Install expansion joints, adjacent to curbing, opposite curbing joints and as indicated. Place expansion joints perpendicular to concrete surface and with top edge 1/4 inch below concrete surface.

3.6 ISOLATION JOINTS

A. Install isolation joints where concrete abuts buildings, existing walk sections, utility structures and concrete curb. Place isolation joints with top edge 1/4 inch below concrete surface.

3.7 JOINT FILLERS

A. Extend joint fillers full width and depth of joint.

B. Furnish joint fillers in one-piece lengths. Where more than one length is required, lace or clip joint-filler sections together.

C. Protect top edge of joint filler during concrete placement with metal, plastic, or other temporary performed cap. Remove protective cap after concrete has been placed on both sides of joint.

3.8 CONTRACTION JOINTS (SCORE LINES)

A. Provide contraction joints at five foot intervals or as indicated. Form contraction joints with 3/4 inch jointing tool.

3.9 CONCRETE PLACEMENT

A. General: Place concrete in forms in one uniform layer. Consolidate concrete by tamping, spading or vibrating to prevent honeycombing. Place and consolidate concrete carefully to prevent dislocation of joint materials.

B. Reinforced Concrete: Place and consolidate concrete in one uniform layer. Cut reinforcement to required shapes and set in plastic concrete to depth indicated. Do not extend reinforcement across expansion, isolation or contraction joints.

C. Concrete shall be installed at temperatures 50° F and greater. If ambient air temperature is below this, blankets and heaters shall be used to maintain a 50° F temperature.

3.10 CONCRETE STAIRS

A. Concrete stairs shall be constructed to the dimensions indicated and as detailed on the Drawings. Install nosing and handrails as detailed.

B. Subgrade shall be compacted to 95 percent maximum density at optimum moisture content.

C. Provide expansion joints where concrete stairs join concrete walks at top and bottom.

D. Provide a lightly brushed finish.

E. All exposed steel hardware and fittings shall be hot-dip-galvanized and powder coated black.

F. Protect completed concrete from damage. Remove and replace damaged or defective work.

3.11 FINISHING

A. General: Draw a fine hair broom across concrete surface. Where longitudinal grade exceeds five percent, use a coarse texture finish by drawing a stiff bristle broom across concrete surface.

B. Accessible Ramps: Accessible ramps shall have detectable warning surfaces.

3.12 CURING

A. Mat Method: Moisten mats thoroughly with water before placing on exposed concrete surfaces and overlap six inches. Cover mats with polyethylene sheeting and maintain mats in continuously moist condition for seven calendar days. Repair or replace damaged mats.

B. Liquid Membrane: Apply in accordance with manufacturers recommendations.

3.13 INSTALLATION OF SEALANTS

A. All expansion and isolation joints shall be sealed.

B. Clean out joints before installing joint sealants to comply with recommendations of manufacturer.

C. Comply with joint manufacturer printed installation instructions and recommendations of ASTM C 962 for use of joint sealants.

D. Immediately after sealant application and prior to time skinning or curing begins, tool sealants to a smooth, uniform bead to eliminate air pockets and to ensure contact and adhesion of sealant with sides of joint. Remove excess sealant or sealant smears from surfaces adjacent

to joint. Do not use tooling agents that discolor sealants or adjacent surfaces or are not approved by the sealant manufacturer. Protect joint sealants during and after curing period from contact with contaminating substances or from damage resulting from construction operations or other causes so they are without deterioration at final acceptance. If, despite such protection, damage, deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately so that installation is with repaired area are indistinguishable from original work.

3.14 TESTING

A. General: Correct work not conforming to tolerances as directed by the Architect or Owner's Representative at no increase to the contract sum.

B. Walk Horizontal Alignment Test: Tolerance not to exceed 1/2 inch between any two contacts on 10-foot straightedge, except along horizontal curves. Test locations random and determined by the Architect or Owner's Representative. Test observation by the Architect or Owner's Representative.

C. Walk Surface Smoothness Test: Tolerance not to exceed 3/8 inch between any two surface contacts on 10-foot straightedge. Test locations random and determined by the Architect or Owner's Representative. Test observation by the Architect or Owner's Representative.

D. Owner will engage an independent testing and inspection agency to perform field quality control tests and inspections of concrete mixes delivered to the project site, including testing for temperature, slump and air content, and fabricating and testing concrete cylinder samples.

3.15 WASTE MANAGEMENT:

A. Recycle waste materials in accordance with Division 1 “Construction Waste Management” requirements.

END OF SECTION

SECTION 321610
CONCRETE CURBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. This section specifies materials and work required to construct portland cement concrete curbing.

1.3 RELATED WORK

A. Refer to Section 310000 "Earthwork and Grading", Section 331000 "Utility Standards" and Section 321600 "Concrete Walks" (and Section 033000 "Concrete Work").

1.4 STANDARDS

A. Maryland Department of Transportation State Highway Administration's (MSHA) current "Standard Specifications for Construction and Materials".

B. Montgomery County, Department of Transportation's current "Design Standards".

1.5 SUBMITTALS

A. Submit cut sheets for construction of curb in the public right-of-way to and obtain approval from the governing jurisdiction and the Architect prior to curb construction.

B. Refer to Section 331000 "Utility Standards".

1. Submit recycled content certificates for materials in accordance with LEED requirements.

2. Submit certificates for the locations of manufacturers of the materials in accordance with LEED requirements.
3. Submit certificates stating that in-place surface concrete materials achieve a minimum Solar Reflectance Index value of at least 80 when freshly installed, and will achieve a minimum Solar Reflectance Index of at least 35 when weathered.

1.6 PROJECT CONDITIONS

A. LEED Compliance: Refer to Section 331000 “Utility Standards”, and as noted.

1. Materials and products shall be coordinated with the LEED requirements for this project.

B. Traffic: Maintain vehicular and pedestrian traffic during curb construction operations.

C. Limitations

1. Environmental: Refer to Section 331000 "Utility Standards".
2. Underground Utilities: Refer to Section 321600 "Concrete Walks".

1.7 CONSTRUCTION SURVEYS

A. Retain the services of a registered land surveyor or professional engineer to provide combined horizontal and vertical alignment stakes for curb construction within public right of way. Horizontal stake interval 25 feet maximum.

B. Provide combined horizontal and vertical alignment stakes for project site curb construction. Horizontal stake interval 25 feet maximum.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Concrete: Class 'A' portland cement concrete, Section 331000 "Utility Standards"

1. Maximum 50% GGBF slag replacement for Portland cement, per MDOT-SHA Specification 902.06.05.

B. Joint Materials: Refer to Section 321600 "Concrete Walks", and as noted. Expansion and isolation joints: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.

C. Forms: For straight or tangent curbing use steel or wood. For curved curbing use flexible spring steel or laminated wood.

D. Curing Material: Refer to Section 321600 "Concrete Walks".

PART 3 - EXECUTION

3.1 PROTECTION AND RESTORATION

A. Refer to Section 321600 "Concrete Walks".

3.2 SUBGRADE PREPARATION:

A. Refer to Section 321600 "Concrete Walks".

3.3 FORMS

A. Refer to Section 321600 "Concrete Walks", and as noted.

B. Form curbing to standards indicated and specified.

3.4 EXPANSION JOINTS

A. Refer to Section 321600 "Concrete Walks" and as noted.

B. Install expansion joints at maximum 30 foot intervals or as indicated. Place expansion joints perpendicular to surface and curbing face. Place combination curb and gutter expansion joints, with top edge 1/2 inch below gutter surface.

3.5 ISOLATION JOINTS

A. Refer to Section 321600 "Concrete Walks".

3.6 CONTRACTION JOINTS

A. Refer to Section 321600 "Concrete Walks" and as noted.

B. Provide contraction joints, perpendicular to surface and face of curbing, at 10 foot intervals. Place contraction joints at all points where curved and tangent sections of curbing meet. Place contraction joints with removable form spreader places. Contractors option: Score or saw joints to 1-1/4 inch depth.

3.7 CONCRETE PLACEMENT

A. Refer to Section 321600 "Concrete Walks".

3.8 FINISHING

A. Strike off top surfaces of curbing to top of forms and to smooth and uniform texture. Strip curb face forms when concrete takes initial set. Trowel curb face to smooth and uniform texture. Finish top surfaces and curb face to fine texture by drawing a soft bristle brush longitudinally along curb. Finish edges of curbing with edging tool having a radius as indicated. Maintain forms, except curb face forms, in place 12 hours after concrete placement. Correct defects (e.g. holes, honeycomb areas, broken edges, etc.) upon removal of remaining forms, with cement mortar. Finish contraction joints with 1/4 inch radius edging tool. Finish curbing joints to clean and true edges. Maintain curbing surfaces moist during finishing operations.

i. Curing: Refer to Section 321600 "Concrete Walks".

END OF SECTION

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SECTION 32 31 13
CHAIN LINK FENCES AND GATES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and General Provisions of the Contract, including the General Conditions and other Division 1 Specification Sections, apply to the work of this Section.

1.2 SUMMARY

B. This Section includes the following:

1. Materials and Work Required to Construct Chain Link Fence and Gates and Related Accessories.

C. Related Sections:

1. Section 31 20 00: Earthmoving
2. Section 32 13 13: Cement Concrete Paving
3. Section 32 12 16: Hot-Mixed Asphalt Paving

1.3 CODES

A. Existing Underground Utilities: Refer to Section 31 20 00 "Earthmoving".

1.4 STANDARDS

A. Installation shall be per chain link manufacturer’s standards (CLFMI).

1.5 SUBMITTALS

A. Submit manufacturer's descriptive literature, specifications and installation instructions for chain link fence and gates.

1. Include location of product manufacture.

B. LEED Submittals: Product data for steel components indicating percentages of pre-consumer and post-consumer recycled content.

C. Submit samples of vinyl-coated fabric 12 by 24 inches.

D. Warranty

1. Submit typewritten vinyl coated fence warranty signed by manufacturer and contractor.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Deliver chain link fencing to the project site in original unopened containers bearing manufacturer's label.

1.7 QUALITY ASSURANCE

A. Provide complete fencing (of each type) produced by a single manufacturer.

1.8 PROJECT CONDITIONS

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Limitations: Do not proceed with fencing installation until underground utility, bituminous concrete pavement and concrete curb and gutter construction is complete.

1.9 WARRANTY

A. Warrant vinyl coated fencing for 10 years against peeling, cracking and corrosion.

1.10 CONSTRUCTION SURVEYS

A. Retain the services of a registered land surveyor or professional engineer to provide horizontal alignment stakes for fencing located adjacent to site property lines. Horizontal stake interval 50 feet maximum, and at all angle points along property line.

B. Provide horizontal alignment stakes for project site fencing. Horizontal stake interval 50 feet maximum and at all corner points.

PART 2 – PRODUCTS

2.1 CHAIN LINK FENCING

A. Acceptable Manufacturers, giving preference to products manufactured within a 500-mile radius of the Project Site:

1. Anchor Fencing

2. Sonco Fence

3. Long Fence

4. P&H Tube Division/Southwestern Pipe

5. Allied Tube and Conduit Corp.

6. Other pre-bid approved manufacturer(s) meeting the requirements of this Specification Section will be considered in accordance with Specification Section 01630: Substitutions and Product Options.

B. General: Posts, rails, braces and bracing assemblies shall be high tensile steel pipe, cold-rolled and electric resistance welded from steel conforming to ASTM A 569, and hot-dip galvanized to ASTM A 525 G-90 zinc weight both inside and outside the pipe.

C. Finish: The outsides shall receive a conversion coating and fusion bonded polyester powder coating equivalent to "Lifecoat LCX" by P & H Tube. Coating color shall be black.
1. All fencing except Multipurpose Court shall have bottom tension wire.

2. All fencing shall have continuous top rail.

D. Fabric: 9-gauge (0.148-inch) core size, finished steel wires, galvanized in accordance with ASTM A 641-71a. Finish shall be thermally bonded PVC over galvanized steel, Class 2B, in accordance with ASTM F 668. Coating color shall be black. Fabric shall have 2-inch diamond mesh pattern with top and bottom selvages knuckled.

E. Multipurpose Court Fencing: Mesh size shall be 1-3/4 inches. All court fencing shall have top rail and bottom rail.

F. Posts, Rails and Braces:

1. Terminal Posts (Corner Posts): Up to 6 feet: 2.375 inch O.D.; over 6 feet: 2.875 inch O.D.

2. Line Posts: Up to 6 feet: 1.90 inch O.D.; over 6 feet: 2.375 inch O.D.

3. Gate Posts (Hinge Posts): Leaf widths up to 6 feet: 2.875 inch O.D.; leaf widths 6 feet to 13 feet: 4.00 inch O.D.

4. Top Rail and Bottom Rail: Manufacturer's longest lengths, with expansion couplings (approximately 6 inches long) for each joint. Provide means of attaching top rail securely to each corner, end, and pull post.

5. Terminal and Gate Post Bracing Assemblies: Manufacturer's standard adjustable brace at end posts and at both sides of corner and pull posts, with horizontal brace located at mid-height of fabric. Use same material as top rail for braces. Brace line posts with 0.375-inch diameter rod and adjustable tightener.

6. Stretcher Bars: One-piece lengths equal to full height of fabric, with minimum cross section of 3/16" x 3/4". Provide one stretcher bar at each end post and two for each corner and pull post, except where fabric is integrally woven into post.

G. Gates

1. Gate framing shall be 2-inch square aluminum tube with fabric installed inside the frame with "J" bolts.

2. Hinges shall be manufacturer's standards.

3. Latches shall be butterfly type.

4. Height shall match adjacent fencing fabric, leaf swings 180 degrees.

H. Bottom Tension Wire: 7-gauge, O.D. = 0.177-inch core size, with PVC coating.

I. Post Tops (Caps): Weathertight closure caps, dome type, at each post, with openings to permit passage of top rails.

J. Hardware and Accessories: Galvanized per ASTM A 152 with manufacturer's standard polyvinyl chloride (PVC) plastic resin finish over galvanizing, not less than 10 mils (0.010") thick.

K. Electrical Grounds: Provide at least one (1) electrical ground for each 1,000 ft. of fence, located near the center of the run. Provide additional grounds directly under the point where power lines pass over the fence. Vertically drive or drill in the grounding rod until the top of the rod is approximately 6 in. below the top of the ground. Connect a No. 6 solid copper conductor to the rod and to the fence by a UL-listed method so that each element of the fence is grounded.

2.2 CHAIN LINK FENCING HEIGHTS

A. Heights shall be as indicated or as specified:

2.3 PADLOCKS

A. Padlocks manufactured by Master Lock Company, Milwaukee, Wisconsin. Provide one "Steel Secret Service" lock and furnish Owner with two keys for each gate.

2.4 CONCRETE

A. Class "B" Portland cement concrete, Specification Section 33 10 00: Utility Standards.

PART 3 - EXECUTION

3.1 PROTECTION AND RESTORATION

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Existing Utilities: Verify utility locations prior to fencing excavation operation. Adjust horizontal fencing alignment to avoid utilities at no increase to contract sum.

3.2 GRADING

A. Grade fence lines to smooth and uniform surfaces, free of depressions and high spots exceeding four inches in ten feet.

3.3 CHAIN LINK FENCING

A. General: Install in accordance with manufacturer's installation instructions and as noted. Install corner posts at horizontal alignment changes exceeding 30 degrees. Install line posts at intervals not exceeding ten feet. Install gateposts on both sides of gate opening.

B. Post Installation

1. Excavate post footings to minimum 18-inch diameters and 39 inch depths or as otherwise indicated.

2. Place and consolidate concrete in footing excavations. Install posts in concrete plumb to 1/4 inch in 10 feet. Provide bracing to prevent movement. Embed line post in concrete to 18 inches, terminal and gate posts to 24 inches. Slope exposed concrete footing surface one inch with outside edge flush with ground surface. Trowel exposed concrete footing surface to smooth finish. Contractor shall allow concrete footings to cure a minimum of 14 calendar days before removing bracing or performing subsequent fencing operations.

C. Terminal and Gate Post Bracing Assemblies, Truss Rods and Tighteners and Tension Wire and Post Tops: Install in accordance with manufacturer's installation instructions and as specified.

D. Fabric: Each span shall be attached independently at pull and corner posts. Ends of fabric rolls and other section to be spliced shall be joined by weaving a single strand of the fabric wire into ends of the fabric to create a continuous pattern of mesh. Fabric shall be stretched taut and securely fastened to each post and rail. Fastenings at ends, gates, corners, and pull posts shall be with stretcher bars and metal bands.

3.4 MAINTENANCE

A. Refer to Section 31 20 00 "Earthmoving".

END OF SECTION

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SECTION 32 90 00
TREE CONSERVATION

PART 1 - GENERAL

1.1 DESCRIPTION

A. This section specifies labor, materials, and equipment and services necessary for and reasonably incidental to preservation, protection and care of trees as shown on the Drawings, specified or directed.

1.2 QUALITY ASSURANCE

A. Methods for tree preservation and protection shall conform to details shown on the Drawings and any pertinent nationally recognized standards.

B. The Contractor shall during pre-construction activities, construction activities and post-construction activities employ an ISA (International Society of Arboriculture) certified arborist with a minimum of two years experience in tree preservation. The Contractor shall submit documentation that arborist has the above qualifications.

C. The arborist shall be on-site at any time work is being performed in the vicinity of trees to supervise implementation of procedures for tree protection, to monitor tree health during construction operations and the installation of pipes, curbs, sidewalks, etc and to supervise any repair of damages after construction.

D. All work must be contained within the prescribed limits of disturbance shown on the contract documents.

1.3 SUBMITTALS

A. Provide written report by a certified arborist identifying root evaluations of the trees, which are in potential conflict with construction to determine the critical root zones.

B. Provide written report by a certified arborist indicating the best methods of construction, which will minimize the impact on the critical root zone. Obtain specifications from the arborist for individual tree protection and maintenance as required for the identified to be saved on the Drawings.

PART 2 - PRODUCTS

2.1 TREE PROTECTION DEVICE

A. Fencing shall be tenax alpi or approved equal. It shall be blaze orange plastic mesh at least forty-eight (48) inches in height, with grid openings not greater than three (3) inches in width.

2.2 SOIL AMENDMENTS

A. Suitable organic matter shall be peat moss, composted manure, deactivated sewage sludge or similar material as approved by the arborist or engineer.

B. Special soil mixture is composed of one part suitable organic matter and 6 parts backfill. Backfill material shall be loose, fine, friable, even textured loam. The mixture shall not contain any rock fragments larger than four (4) inches in any direction, nor construction debris of any sort.

PART 3 - EXECUTION

3.1 PRECONSTRUCTION ACTIVITIES

A. The limits of disturbance shall be located and flagged by the Contractor in the field prior to any stress reduction or construction activities. Limits of Disturbance shall be placed outside of critical root zones of trees to be preserved wherever possible.

B. As shown on the plans, trees which are to be preserved shall have their roots pruned. Root pruning trenches shall be located within one foot of limits of disturbance. Roots shall be cleanly cut to a depth of at least 24 inches using a vibratory plow (cable laying machine), tooth-chain trencher or other acceptable equipment. Fill trench as soon as possible with soil mixture herein described and pack to eliminate air pockets.

C. Fertilize trees in construction area at the rate of 3 pounds of nitrogen per 1,000 square feet of root zone disturbed. Apply fertilizer to entire critical root zone out to root pruning trench. Fertilizer should be at least 50 percent (50%) slow release nitrogen and contain other essential elements and micronutrients.

D. Water critical root zone immediately after applying fertilizer to saturate the top 6 inches of soil.

E. Mulch 2-4 inches deep comprised of weed-free straw, woodchips, shredded bark or leaves shall be applied in the critical root zone adjacent to the pruning trench. Mulching shall not extend farther than 20 feet from the pruning trench.

F. Trees which are dead or dying or are in poor condition prior to the start of construction shall be flagged and recorded on the plan.

G. Blaze Orange Plastic Mesh Fence

1. All tree Preservation Areas shall be surrounded by blaze orange plastic mesh fences.

2. Boundaries of fencing shall be staked, flagged and approved prior to installation.

3. All fencing shall be installed prior to construction activities.

4. Fences shall be firmly anchored at a spacing no greater than eight (8) feet and constructed in a manner which precludes sagging.

5. All fencing shall be maintained in a good condition and promptly repaired or restored as the situation warrants.

3.2 CONSTRUCTION PHASE

A. Any on-site decisions regarding conditions or activities which may be injurious to the health of certain specimen trees in the vicinity of the construction area shall be made in consultation with the specified arborist.

B. Excavated and backfill material shall not be placed or side cast within the critical root zones of trees to be preserved.

C. Construction equipment shall not be driven into or through protected trees, nor shall swinging cranes or backhoes be allowed in their canopies.

D. There shall be no stacking or storing supplies within the critical root zones of trees to be preserved.
E. Trees to be removed shall be taken out without damaging protected trees.
F. There shall be no burning in or close to protected trees.
G. Changing site grades which will cause drainage to flow into, or to collect near protected trees shall be prohibited. All grading shall take place outside the critical root zone of the trees to be protected.
H. All equipment shall be kept outside the blaze orange fencing.
I. In the event of drought, the protected trees shall be monitored for signs of stress and watered as needed or as directed by the arborist.
J. The certified arborist shall also monitor trees to be preserved for any other conditions or activities not mentioned above which may be injurious to their health.

3.3 POST-CONSTRUCTION ACTIVITIES

A. Repair & Care of Tree Damages
1. The ends of any additional roots damaged or cut during the construction phase of the project which have not already been pruned and dressed at the outset of the project shall be cut off smoothly. Then peat moss or other suitable organic matter shall be added to the backfill material at a ratio of 1 part organic matter to 6 parts backfill. Fill and pack around roots to avoid air spaces. Restore grades to preconstruction elevations.

2. Damaged limbs and dead limbs shall be removed if a safety hazard or if injurious to the health of the tree. Tree crown reduction procedures may be employed to promote the health of a tree and shall be performed by a certified arborist.

3. If a tree is wounded during construction, under direction of the arborist, wounds should be cleaned, torn bark cut, and if possible, the wounds dressed in a shape like a vertical ellipse, to facilitate rapid healing. Pruning knife shall be sharp and clean.

4. Unless directed otherwise by the arborist, any compacted soil within the critical root zone of the trees to be preserved shall be mechanically aerated to a depth of eight (8) inches. Aeration holes should be spaced one foot on center and should be positioned to avoid severing major roots.

5. The arborist shall inspect and review the trees within one-year after completion of construction and determine if the trees can be safely fertilized. The arborist shall make the initial fertilizer application and provide written instructions and information to the owner on successive fertilizer applications. After completion of construction the arborist shall perform Class II pruning on all trees to remove any damaged, dead, interfering and objectionable limbs ½ inch in diameter and larger. The arborist shall selectively thin the trees to properly shape the canopy, reduce wind resistance and the possibility of storm damage.

3.4 REMOVAL OF TEMPORARY STRUCTURES

A. Remove blaze orange fencing.

B. Re-seed or sod disturbed areas in accordance with the Contract Documents.

END OF SECTION 32 90 00

SECTION 32 93 05
LAWNS AND GRASSES

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

1.2 SUMMARY

A. This Section includes the following:
1. Fine grading and preparing lawn areas.

2. Furnishing and applying new topsoil.

3. Furnishing and applying soil amendments.

4. Furnishing and applying fertilizers.

5. Seeding new lawns.

6. Sodding new lawns.

7. Reconditioning existing lawn areas.

8. Replanting unsatisfactory or damaged lawns.

B. Related Sections: The following Sections contain requirements that relate to this Section:
1. Section 31 10 00 "Clearing" for protection of existing trees and planting, topsoil stripping and stockpiling, and site clearing.

2. Section 31 20 00 "Earthmoving" for excavation, filling, rough grading, and subsurface aggregate drainage and drainage backfill.

1.3 SUBMITTALS

A. General: Submit each item in this Article according to the Conditions of the Contract and Division Specification Sections.

B. Product data for the following:
1. Aluminum sulfate.

2. Fertilizers.

C. Submit location of product manufacture and of extraction/recovery of primary raw materials.

D. Certification of grass seed from seed vendor for each grass-seed mixture stating the botanical and common name and percentage by weight of each species and variety, and percentage of purity, germination, and weed seed. Include the year of production and date of packaging.
1. Certification of each seed mixture for sod, identifying sod source, including name and telephone number of suppliers.

E. Certification by product manufacturer that the following products supplied comply with requirements
   1. Limestone.
   2. Fertilizers.

F. Qualification data for firms and persons specified in the "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and address of architects and owners, and other information specified.

G. Material test reports from qualified independent testing agency indicating and interpreting test results relative to compliance of the following materials with requirements indicated.
   1. Analysis of existing surface soil.
   2. Analysis of imported topsoil.

H. Planting schedule indicating anticipated dates and locations for each type of planting.

I. Maintenance instructions recommending procedures to be established by Owner for maintenance of landscaping during an entire year. Submit before expiration of required maintenance periods.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Engage an experienced Installer who has completed landscaping work similar in material, design, and extent to that indicated for this Project and with a record of successful grass establishment.
   1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on the Project site during times that grass planting is in progress.

B. Testing Agency Qualifications: To qualify for acceptance, an independent testing agency must demonstrate to Architect's satisfaction, based on evaluation of agency-submitted criteria conforming to ASTM E 699, that it has the experience and capability to satisfactorily conduct the testing indicated without delaying the Work.

C. Topsoil Analysis: Furnish a soil analysis made by a qualified independent soil-testing agency stating percentages of organic matter, inorganic matter (silt, clay, and sand), deleterious material, pH, and mineral and plant-nutrient content of topsoil.
   1. Report suitability of topsoil for lawn growth. State recommended quantities of nitrogen, phosphorus, and potash nutrients and any limestone, aluminum sulfate, or other soil amendments to be added to produce a satisfactory topsoil.

D. Preinstallation Conference: Conduct conference at Project site to comply with requirements of Section 01 31 00 "Project Management and Coordination."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Seed: Deliver seed in original sealed, labeled, and undamaged containers.

B. Sod: Harvest, deliver, store, and handle sod according to the requirements of the American Sod Producers Association's (ASPA) "Specifications for Turfgrass Sod Materials and Transplanting/Installing."

1.6 COORDINATION AND SCHEDULING

A. Planting Season: Sow lawn seed and install sod during normal planting seasons for type of lawn work required. Correlate planting with specified maintenance periods to provide required maintenance from date of Substantial Completion.

B. Weather Limitations: Proceed with planting only when existing and forecast weather conditions are suitable for work.

1.7 MAINTENANCE

A. Begin maintenance of lawns immediately after each area is planted and continue until acceptable lawn is established, but for not less than the following periods:
   1. Seeded Lawns: 60 days after date of Substantial Completion.
      a. When full maintenance period has not elapsed before end of planting season, or if lawn is not fully established at that time, continue maintenance during next planting season.
   2. Sodded Lawns: 30 days after date of Substantial Completion.

B. Maintain and establish lawns by watering, fertilizing, weeding, mowing, trimming, replanting, and other operations. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth lawn.
   1. Replant bare areas with same materials specified for lawns.
   2. Add new mulch in areas where mulch has been disturbed by wind or maintenance operations sufficiently to nullify its purpose. Anchor as required to prevent displacement.

C. Watering: Provide and maintain temporary piping, hoses, and lawn-watering equipment to convey water from sources and to keep lawns uniformly moist to a depth of 4 inches.
   1. Lay out temporary lawn-watering system and arrange watering schedule to prevent wilting, puddling, erosion, and displacement of seed or mulch. Lay out temporary watering system to avoid walking over muddy or newly seeded, plugged, or sprigged areas.
   2. Water lawn at the minimum rate of 1 inch per week.

D. Mow lawns as soon as there is enough top growth to cut with mower set at specified height for principal species planted. Repeat mowing as required to maintain specified height without cutting more than 40 percent of the grass height. Remove no more than 40 percent of grass-leaf growth in initial or subsequent mowings. Do not delay mowing until grass blades bend over and become matted. Do not mow when grass is wet. Schedule initial and subsequent mowings to maintain following grass height
   1. Mow grass from 2 to 3 inches high.

E. Postfertilization: Apply fertilizer to lawn after first mowing and when grass is dry.
   1. Use fertilizer that will provide actual nitrogen of at least 1 lb per 1000 sq. ft. of lawn area.

PART 2 - PRODUCTS

2.1 GENERAL

A. Provide products manufactured and harvested within 500 miles of project site.

2.2 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with the Association of Official Seed Analysts' "Rules for Testing Seeds" for purity and germination tolerances. Seed mixes or blends are common in the northern and transition zones. Single-grass-species seed is common in the South.
   1. Seed Mixture: Provide seed of grass species and varieties, proportions by weight, and minimum percentages of purity, germination, and maximum percentage of weed seed as indicated on Schedules at the end of this Section. Seed mixtures vary by region and year depending on availability and current state or local recommendations.

2.3 SOD

A. Sod: Certified turfgrass sod complying with ASPA specifications for machine-cut thickness, size, strength, moisture content, and mowed height, and free of weeds and undesirable native grasses. Provide viable sod of uniform density, color, and texture of the following turfgrass species, strongly rooted, and capable of vigorous growth and development when planted.

2.4 TOPSOIL

A. Topsoil: ASTM D 5268, pH range of 5.5 to 7, 4 percent organic material minimum, free of stones 1 inch or larger in any dimension, and other extraneous materials harmful to plant growth.
   1. On-Site Topsoil Source: Reuse surface soil stockpiled on the site. Verify suitability of surface soil to produce topsoil meeting requirements and amend when necessary. Supplement with imported topsoil when quantities are insufficient. Clean topsoil of roots, plants, sods, stones, clay lumps, and other extraneous materials harmful to plant growth.

   2. Off-Site Topsoil Source: Import topsoil from off-site sources. Obtain topsoil from naturally well-drained sites where topsoil occurs at least 4 inches deep; do not obtain from bogs or marshes. Contractor’s option: Amend existing surface soil to produce topsoil. Supplement with imported topsoil when required.

2.5 SOIL AMENDMENTS

A. Lime: ASTM C 602, Class T, agricultural limestone containing a minimum 80 percent calcium carbonate equivalent, with a minimum 99 percent passing a No. 8 sieve and a minimum 75 percent passing a No. 60 sieve.
   1. Provide lime in the form of dolomitic limestone.

B. Aluminum Sulfate: Commercial grade, unadulterated.

C. Sand: Clean, washed, natural or manufactured sand, free of toxic materials.

D. Perlite: Horticultural perlite, soil amendment grade.

E. Peat Humus: Finely divided or granular texture, with a pH range of 6 to 7.5, composed of partially decomposed moss peat (other than sphagnum), peat humus, or reed-sedge peat.

F. Retain above or below when humus is required or add requirements for other preferred humus materials.

G. Sawdust or Ground-Bark Humus: Decomposed, nitrogen-treated, of uniform texture, free of chips, stones, sticks, soil, or toxic materials.
1. When site treated, mix with at least 0.15 lb of ammonium nitrate or 0.25 lb of ammonium sulfate per cu. ft. of loose sawdust or ground bark.

H. Manure: Well-rotted, unleached stable or cattle manure containing not more than 25 percent by volume of straw, sawdust, or other bedding materials; free of toxic substances, stones, sticks, soil, weed seed, and material harmful to plant growth.

I. Herbicides: EPA registered and approved, of type recommended by manufacturer.

J. Water: Potable.

2.6 FERTILIZER

A. Bonemeal: Commercial, raw, finely ground; minimum of 4 percent nitrogen and 20 percent phosphoric acid.

B. Superphosphate is an inorganic, neutral source of phosphorus, useful in alkaline calcareous soils of arid areas.

C. Superphosphate: Commercial, phosphate mixture, soluble; minimum of 20 percent available phosphoric acid.

D. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea-form, phosphorous, and potassium in the following composition:
1. Composition: 1 lb per 1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

2. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

E. Slow-Release Fertilizer: Granular fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
1. Slow-release fertilizer composition in subparagraphs below are examples only. Revise to suit Project. When used as a soil amendment, revise fertilizer mix to remedy deficiencies found in soil tests.

2. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

3. Composition: Nitrogen, phosphorous, and potassium in amounts recommended in soil reports from a qualified soil-testing agency.

2.7 MULCHES

A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.

B. Peat mulch may be required if seeded lawns are subjected to hot, dry weather or drying winds within 30 days of planting. Delete if not required.

C. Peat Mulch: Provide peat moss in natural, shredded, or granulated form, of fine texture, with a pH range of 4 to 6 and a water-absorbing capacity of 1100 to 2000 percent.

D. Fiber mulch and tackifiers below are used primarily to protect seeded or hydroseeded lawn areas from wind erosion.

E. Fiber Mulch: Biodegradable dyed-wood cellulose-fiber mulch, nontoxic, free of plant growth- or germination-inhibitors, with maximum moisture content of 15 percent and a pH range of 4.5 to 6.5.

F. Asphalt Emulsion Tackifier: Asphalt emulsion, ASTM D 977, Grade SS-1, nontoxic and free of lant growth- or germination-inhibitors.

G. Nonasphaltic Tackifier: Colloidal tackifier recommended by fiber-mulch manufacturer for slurry application, nontoxic and free of plant growth- or germination-inhibitors.

2.8 EROSION-CONTROL MATERIALS

A. Blankets: Biodegradable wood excelsior, straw, or coconut-fiber mat enclosed in a photodegradable plastic mesh. Include manufacturer's recommended steel wire staples, 6 inches long.

B. Fiber Mesh: Biodegradable twisted jute or spun-coir mesh, 0.92 lb per sq. yd. minimum, with 50 to 65 percent open area. Include manufacturer's recommended biodegradable staples, 6 inches long.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine areas to receive lawns and grass for compliance with requirements and for conditions affecting performance of work of this Section. Do not proceed with installation until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities, trees, shrubs, and plantings from damage caused by planting operations.
1. Protect adjacent and adjoining areas from hydroseed overspraying.

B. Provide erosion-control measures to prevent erosion or displacement of soils and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways.

3.3 PLANTING SOIL PREPARATION

A. Limit subgrade preparation to areas that will be planted in the immediate future.

B. Loosen subgrade to a minimum depth of 4 inches. Remove stones larger than 1-1/2 inches in any dimension and sticks, roots, rubbish, and other extraneous matter.

C. Mix soil amendments and fertilizers with topsoil at rates indicated. Delay mixing fertilizer if planting does not follow placing of planting soil within a few days. Either mix soil before

spreading or apply soil amendments on surface of spread topsoil and mix thoroughly into top 4 inches of topsoil before planting.

1. Mix lime with dry soil prior to mixing fertilizer.

D. Spread planting soil mixture to depth required to meet thickness, grades, and elevations shown, after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen.

1. Place approximately 1/2 the thickness of planting soil mixture required. Work into top of loosened subgrade to create a transition layer and then place remainder of planting soil mixture.

2. Allow for sod thickness in areas to be sodded.

E. Preparation of Unchanged Grades: Where lawns are to be planted in areas unaltered or undisturbed by excavating, grading, or surface soil stripping operations, prepare soil as follows:

1. Remove and dispose of existing grass, vegetation, and turf. Do not turn over into soil being prepared for lawns.

2. Till surface soil to a depth of at least 6 inches (150 mm). Apply required soil amendments and initial fertilizers and mix thoroughly into top 4 inches of soil. Trim high areas and fill in depressions. Till soil to a homogenous mixture of fine texture.

3. Clean surface soil of roots, plants, sod, stones, clay lumps, and other extraneous materials harmful to plant growth.

4. Remove waste material, including grass, vegetation, and turf, and legally dispose of it off the Owner's property.

F. Grade lawn and grass areas to a smooth, even surface with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit fine grading to areas that can be planted in the immediate future. Remove trash, debris, stones larger than 1-1/2 inches in any dimension, and other objects that may interfere with planting or maintenance operations.

G. Moisten prepared lawn areas before planting when soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

H. Restore prepared areas if eroded or otherwise disturbed after fine grading and before planting.

3.4 SEEDING NEW LAWNS

A. Sow seed with a spreader or a seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph. Evenly distribute seed by sowing equal quantities in 2 directions at right angles to each other.

1. Do not use wet seed or seed that is moldy or otherwise damaged in transit or storage.

B. Sow seed at the rates shown on drawings.

C. Rake seed lightly into top 1/8 inch of topsoil, roll lightly, and water with fine spray.

D. Retain applicable protection paragraphs below. Correlate erosion-control materials with slope ratios and revise as necessary to suit Project.

E. Protect seeded slopes exceeding 1:4 against erosion with erosion-control blankets installed and stapled according to manufacturer's recommendations.

F. Protect seeded slopes exceeding 1:6 against erosion with jute or coir-fiber erosion-control mesh installed and stapled according to manufacturer's recommendations.

G. Protect seeded areas with slopes less than 1:6 against erosion by spreading straw mulch after completion of seeding operations. Spread uniformly at a minimum rate of 2 tons per acre to form a continuous blanket 1-1/2 inches loose depth over seeded areas. Spread by hand, blower, or other suitable equipment.
   1. Anchor straw mulch by spraying with asphalt-emulsion tackifier at the rate of 10 to 13 gal. per 1000 sq. ft. Take precautions to prevent damage or staining of structures or other plantings adjacent to mulched areas. Immediately clean damaged or stained areas.

3.5 HYDROSEEDING NEW LAWNS

A. Hydroseeding: Mix specified seed, fertilizer, and fiber mulch in water, using equipment specifically designed for hydroseed application. Continue mixing until uniformly blended into homogenous slurry suitable for hydraulic application.
   1. Mix slurry with nonasphaltic tackifier.

   2. Apply slurry uniformly to all areas to be seeded in a 1-step process. Apply mulch at the minimum rate of 1500 lb per acre dry weight but not less than the rate required to obtain specified seed-sowing rate.

3.6 SODDING NEW LAWNS

A. Lay sod within 24 hours of stripping. Do not lay sod if dormant or if ground is frozen.

B. Lay sod to form a solid mass with tightly fitted joints. Butt ends and sides of sod; do not stretch or overlap. Stagger sod strips or pads to offset joints in adjacent courses. Avoid damage to subgrade or sod during installation. Tamp and roll lightly to ensure contact with subgrade, eliminate air pockets, and form a smooth surface. Work sifted soil or fine sand into minor cracks between pieces of sod; remove excess to avoid smothering sod and adjacent grass.
   1. Lay sod across angle of slopes exceeding 1:3.

   2. Delete subparagraph below when not required. Steel staple anchors are commonly used. Add to subparagraph below when acceptable.

   3. Anchor sod on slopes exceeding 1:6 with wood pegs spaced as recommended by sod manufacturer but not less than 2 anchors per sod strip to prevent slippage.

C. Saturate sod with fine water spray within 2 hours of planting. During first week, water daily or more frequently as necessary to maintain moist soil to a minimum depth of 1-1/2 inches below the sod.

3.7 RECONDITIONING LAWNS

A. Recondition existing lawn areas damaged by Contractor's operations, including storage of materials or equipment and movement of vehicles. Also recondition lawn areas where settlement or washouts occur or where minor regrading is required.
   1. Recondition other existing lawn areas.

B. Remove sod and vegetation from diseased or unsatisfactory lawn areas; do not bury into soil. Remove topsoil containing foreign materials resulting from Contractor's operations, including oil drippings, fuel spills, stone, gravel, and other construction materials, and replace with new topsoil.

C. Where substantial lawn remains, mow, dethatch, core aerate, and rake. Remove weeds before seeding. Where weeds are extensive, apply selective herbicides as required. Do not use pre-emergence herbicides.

D. Remove waste and foreign materials, including weeds, soil cores, grass, vegetation, and turf, and legally dispose of it off the Owner's property.

E. Till stripped, bare, and compacted areas thoroughly to a depth of 6 inches.

F. Apply required soil amendments and initial fertilizers and mix thoroughly into top 4 inches of soil. Provide new planting soil as required to fill low spots and meet new finish grades.

G. Apply seed and protect with straw mulch as required for new lawns.

H. Apply sod as required for new lawns.

I. Water newly planted areas and keep moist until new grass is established.

3.8 SATISFACTORY LAWN

A. Seeded lawns will be satisfactory provided requirements, including maintenance, have been met and a healthy, uniform, close stand of grass is established, free of weeds, bare spots exceeding 5 by 5 inches, and surface irregularities.

B. Sodded lawns will be satisfactory provided requirements, including maintenance, have been met and healthy, well-rooted, even-colored, viable lawn is established, free of weeds, open joints, bare areas, and surface irregularities.

C. Replant lawns that do not meet requirements and continue maintenance until lawns are satisfactory.

3.9 CLEANUP AND PROTECTION

A. Promptly remove soil and debris created by lawn work from paved areas. Clean wheels of vehicles before leaving site to avoid tracking soil onto surface of roads, walks, or other paved areas.

B. Erect barricades and warning signs as required to protect newly planted areas from traffic. Maintain barricades throughout maintenance period until lawn is established.

3.10 PLANTING SOIL AMENDMENTS SCHEDULE

A. Lawns: Provide soil amendments as required to ensure that the requirements as noted herein are met. The contractor shall test and adjust soil as required.

3.11 SEED MIXTURES SCHEDULE

A. Provide certified grass-seed blends or mixes, proportioned by weight, as follows:

Name	By Weight	Min. Pct. Germ.	Min. Pct. Pure Sd.	Max. Pct. Weed Sd.
Tall Fescue	80%	85%	95%	0.50
Provide mixture of at least 3 separate types “Rebel”, “Galelle”, “Falon”, “Fine Lawn”, or “Jaguar”				
Kentucky Bluegrass	10%	85%	95%	0.50
Perennial Rye	10%	85%	95%	0.50

END OF SECTION

SECTION 32 95 00
TREES, SHRUBS, AND GROUNDCOVERS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. Description of work: Work of this section includes, but is not limited to, the following

1. Trees, shrubs, and groundcovers.

2. Backfill mixtures.

3. Mulching and planting accessories.

4. Warranty and maintenance.

1.2 RELATED WORK

A. Coordinate with the earthwork and appropriate site specifications for proper scheduling for the performance of the work specified herein

1. Section 31 20 00: Earthmoving

2. Section 32 93 05: Lawns and Grasses

1.3 QUALITY ASSURANCE

A. Installer shall have not less than 5 years documented successful experience in installation of work similar to work of this Project and be a member of one of the following organizations:

1. Landscape Contractors Association.

2. American Nursery and Landscape Association.

3. Maryland Nurserymen’s Association.

1.4 SUBMITTALS

A. Product Data:

1. Submit manufacturer’s data and source data for materials including soils.

2. Submit location of product manufacture and harvest of primary raw materials.

B. Schedules

1. Submit schedule listing plants to be provided.

C. Samples

1. Submit to the Landscape Architect for review, one-pound (1lb.) samples packaged in plastic bags of mulch, topsoil, and soil mixes for all planting areas.

2. Provide samples typical of material used in Project with same color texture, and organic composition.

D. Test Reports

1. Submit soil analysis of both soil mixes and topsoil, stating pH, nutrient levels (N.P.K), % organic matter, and mechanical analysis prepared by qualified soil testing lab along with samples. Test and Reports shall be paid for by the Contractor.

E. Qualification Data

1. Submit installer qualifications verifying years of experience; include list of completed projects having similar scope of work identified by name, location, date, reference names and phone numbers.

F. Warranty and Maintenance

1. Submit written warranty and maintenance agreement for materials as specified.

1.5 WARRANTY AND MAINTENANCE AGREEMENT

A. All plants shall be guaranteed to remain alive and healthy for two (2) full years after initial acceptance.

B. Inspection and Initial Acceptance

1. Initial acceptance shall be defined as approval, by the Landscape Architect, of the complete landscape installation immediately after planting.

2. Contractor shall notify Landscape Architect, in writing, of project completion and request an inspection within two weeks.

3. If the plant material and workmanship are satisfactory, the Landscape Architect will give written notice to that effect. This will constitute the Certificate of Acceptance, and the warranty period will begin from that date.

4. Care of the plant material shall begin immediately after each plant item is satisfactorily installed and shall continue through the entire life of the contract. During this time, the Contractor shall do all work which is necessary to establish and keep the plants alive and healthy.

1.6 FINAL INSPECTION

A. The Contractor will conduct a final Inspection with the Landscape Architect at the end of the two-year period. It will be the Contractors responsibility to notify the Landscape Architect within two weeks of the anticipated meeting.

B. Any material that is 25% dead or more shall be considered dead and must be replaced at no charge. A tree shall be considered dead when the main leader has died back$_4$ or there is 25% of the crown dead.

C. Deciduous material will be guaranteed to break dormancy if planted in dormant season.

1.7 REPLACEMENTS AND CONDITIONS

A. Replacements will be made during the next appropriate planting period.

B. The Contractor shall be responsible for a one-time replacement.

C. Replacements will be of the same size and species as the original with no additional soil amendments to be used.

D. The Contractor will not be responsible for plant material that has been damaged due to vandalism, fire, relocation or other activities beyond the contractor's control.

E. Plant losses due to abnormal weather conditions such as floods, excessive wind, or severe freezing will not be the responsibility of the contractor.

PART 2 - PRODUCTS

2.1 TREES, SHRUBS AND GROUNDCOVERS

A. General: Provide products grown and harvested within 500 miles of project site.

B. Topsoil: New topsoil shall be good friable, natural loam topsoil, containing no subsoil material, free of sticks, stones, roots, weeds, debris or other extraneous matter, and shall be obtained from an area that has never been stripped and shall have an acidity range of pH 5.0 to pH 7.0.

C. Soil Mix: Soil mix shall be 50% topsoil, 25% sand and 25% leaf mulch organic matter.

D. Fertilizer: Fertilizer for planting areas and tree pits shall be approximately 5-10-5, and organically derived.

E. Mulch: Mulch for groundcover areas shall be dark brown, shredded hardwood bark, or approved equal.

F. Stakes (if needed): Stakes shall be 2" x 2" x 8' wood timbers.

G. Guy Wires and Turnbuckles (if needed); Guy wire shall be No. 14 gage galvanized steel wire: turnbuckles shall be galvanized, 1/2' dia. bolt size with closed eyes to receive guy wires.

H. Rubber Hose (if needed): Rubber hose shall be ¾" black corded hose.

I. Plant Material

1. Plant List The Contractor shall be responsible for furnishing and installing all plant material shown on the drawings. The plant list is provided for convenience only. The plant quantities indicated on the plans take precedence over plant lists. Contractor shall verify all quantities to his own satisfaction prior to bidding. Any discrepancies shall be reported to the Landscape Architect immediately.

2. Nomenclature: The names of plants required under this contract conform to those given in Hortus III, 1979 Edition.

3. The Contractor shall have investigated the sources of supply and satisfied himself that he can supply all of the plants specified on the plant list in the size, variety and quality noted prior to submitting his bid. Failure to take this precaution will not relieve

the successful bidder from his responsibility for furnishing and Installing all the plant material in strict accordance with the contract requirements and without additional expense to the owner. Substitutions will not be permitted. If proof is submitted that any plant specified is not obtainable, a proposal will be considered for use of nearest equivalent size or variety with an equitable adjustment of contract price. Such proof shall be substantiated and submitted in writing to the Landscape Architect.

4. All plants shall comply with the recommendations and requirements of ANSI Z60.1-1996 “American Standard for Nursery Stock”.

5. Rejection: Any materials and/or work may be rejected if in the opinion of the Landscape Architect such does not meet the requirements of the specifications. All rejected materials shall be removed from the site by the Contractor within 45 hours.

6. Size: All trees end shrubs shall be measured when their branches are in their normal position. Height and spread dimensions specified refer to the main body of the plant and not from branch or root tip to tip. The determining measurement for trees shall be caliper, which shall be taken six (6”) inches above the ground for trees up to four (4”) inches in caliper and twelve (12”) inches above the ground for larger sizes. All plants shall conform to the measurements specified in the plant lists except that plants larger than specified may be used if approved by the Landscape Architect Use of such plants shall not increase the contract price. If larger plants are approved, the size of the root ball shall be increased in proportion to the size of the plant.

7. All “matched” species shall be from the same nursery source and nursery lot location.

PART 3 - EXECUTION

3.1 EXAMINATION OF SITES

A. The Contractor shall examine the site and all conditions thereon, and take into consideration all such conditions that may affect his work. Start of work indicates acceptance of conditions and full responsibility for work of this section.

3.2 PERSONNEL

A. The work shall be performed by personnel familiar with the planting procedures under the supervision of qualified foremen.

3.3 PLANT INSPECTION

A. All plants shall be subject to inspection by the Landscape Architect for species, size, color, and quality. If so desired, a sample for each plant variety (tree, shrub, groundcover) shall be planted as specified. Once approved, these samples shall be tagged by the Contractor and used as standards of comparison for the remainder of the Work. Plant inspection shall be arranged by the Contractor at least one week prior to planting.

B. Photographs of any material that is coming from suppliers outside the immediate project area may be submitted as typical samples for pre-approval.

3.4 PROTECTION AND REPAIR

A. All portions of the property, which have been disturbed or damaged due to, or incidental to, work performed under this contract shall be repaired and restored to its original condition to the satisfaction of the Landscape Architect.

B. The Contractor shall fully and satisfactorily maintain and protect all work until completion and acceptance of all work or portions thereof and shall repair or replace, at his expense, any work damaged during that period, to the satisfaction of the Landscape Architect.

3.5 CLEANUP

A. At all times during the progress of the work, the contractor shall maintain the site in an orderly condition. Streets and pavements shall be kept clean. Materials and equipment for planting work shall be limited to the quantity required for the work. All rejected materials shall be immediately removed from the site.

3.6 TIMING

A. Planting work shall not be started until final grades have been established and approved by the Landscape Architect.

B. Under no conditions shall any work be done if weather or soil conditions are not satisfactory.

C. The season for planting trees, shrubs and groundcover shall be March 15 to June 1 and September 15 to November 15, unless otherwise approved by the Landscape Architect. Any out of season planting will be fully guaranteed by the Contractor.

3.7 DIGGING AND HANDLING PLANT MATERIAL

A. No plants shall be dug or delivered to the site until the required inspections have been made and the plants approved.

B. Balled and burlapped (B&B) plants shell be dug with firm, natural balls of earth, of diameter and sufficient depth to include the fibrous and feeding roots. No plants will be accepted if the ball is cracked or broken before or during planting operations.

C. Roots or balls of all plants shall be adequately protected at all times from sun and/or drying winds. Balled and burlapped plants that cannot be planted immediately upon delivery or collection from the site shall be set on the ground and protected with soil, wet peat or other acceptable material. Plants collected on site and planted immediately after digging need not be burlapped.

D. No plant shall be bound with wire or rope at any time so as to damage the bark or break branches.

E. Plants shall be pruned only as directed by the Landscape Architect.

3.8 PLANTING BEDS

A. Tree locations shall be staked by the Contractor and approved by the Landscape Architect before planting; all planting areas shall be excavated to depths and dimensions indicated; all subsoil shall be removed from the site.

B. The sides and bottom of all planting beds shall be scarified.

C. Planting beds shall be backfilled with specified soil mix and hand compacted.

D. Fertilizer shall be mixed thoroughly into the full depth of all planting areas.

3.9 PLANTING

A. Setting Plants

1. Unless otherwise specified, all plants shall be planted in pits, centered and set on undisturbed soil to such depth that 1/8 of the rootball is above grade. Plants shall be planted upright and faced to give the best appearance or relationship to adjacent structures.

2. No burlap shall be pulled out from under balls. Platforms, wire and surplus binding from top and sides of the ball shall be removed. All broken or frayed roots shall be cut off cleanly.

3. When trees are delivered in wire baskets, the wire baskets shall be cut down the side of each mesh and peeled away from the rootball and removed in entirety.

4. Topsoil shall be placed and compacted carefully to avoid injury to roots and to fill all voids. When the hole is nearly filled, water shall be added as necessary and allowed to soak in. The hole shall be filled to finished grade and a shallow saucer shall be formed around each plant by placing a ridge of soil around the edge of each pit. After the ground settles, additional soil shall be filled into the pit to reach the level of the finished grade.

5. After all backfill has been placed, water thoroughly on the interior of the tree saucer until it is filled, even if it is raining.

B. Plant Locations: Plants shall be located as shown on the contract drawings, from dimensions if shown, and by scaling if not dimensioned. All locations are to be approved by the Landscape Architect before any excavation is started.

C. Obstructions: All utilities shall be located in the field before any digging is begun. Any disruption or damage to utility lines shall be the responsibility of the Contractor.

D. Pruning: Only dead and broken branches shall be removed from trees unless otherwise directed by the Landscape Architect. Plant material shall be pruned in accordance with standard horticultural practice to preserve the natural character of the plant. Only clean sharp tools shall be used.

E. Mulching: All ground plant areas shall be mulched with a 2-inch layer of shredded hardwood bark within the entire area of the planting bed. Mulch shall be placed within 48 hours of planting.

F. Clean-Up: No debris shall be left on-site. Excavated materials shall be removed or disposed of per Landscape Architect’s instructions.

3.10 MAINTENANCE OF PLANT MATERIALS

A. DESCRIPTION

1. Maintenance shall begin immediately after each plant is installed. The landscape contractor shall provide all materials, labor and equipment to complete all landscape maintenance work for the two-year warranty period.

B. STANDARDS

1. All landscape maintenance services shall be performed by trained personnel using current, acceptable horticultural practices.

2. All work shall be performed in a manner, which maintains the original intent of the landscape design.

3. All chemical applications shall be performed in accordance with current county, state and federal laws, utilizing EPA-approved materials and methods of application. These applications shall be performed under the supervision of a Licensed Certified applicator.

C. WORKMANSHIP

1. During landscape maintenance operations, all areas shall be kept neat and clean. Precautions shall be taken to avoid damage to existing structures. All work shall be preformed in a safe manner to the operators, the occupants and pedestrians.

2. Upon completion of maintenance operations, all debris and waste materials shall be cleaned up and removed from the site, unless provisions have been granted by the owner to utilize on-site trash receptacles.

3. Any damage to the site caused by the Landscape Contractor shall be repaired by the Landscape Contractor without charge to the owner.

D. TREES, SHRUBS & GROUNDCOVERS

1. Pruning: All ornamental trees, shrubs and groundcover shall be pruned when appropriate to remove dead or damaged branches, develop the natural form of the plant and create the effect intended by the Landscape Architect.

2. Weeding: All beds shall be weeded on a continuous basis throughout the growing season to maintain a neat appearance at all times.

3. Insect and Disease Control: The Landscape Contractor shall be responsible for monitoring the site conditions on each visit to determine if any insect or disease problems exist. Immediate measures shall be taken to eliminate any disease or infestation problems.

4. Trash Removal: The Landscape Contractor shall remove trash from all groundcover beds with each visit.

5. Winter Clean Up: Project shall receive a general clean up once during each of the winter months (January, February, March) to include: Removing all trash and unwanted debris, turning mulch where necessary, and inspection of grounds.

6. Watering: The Landscape Contractor shall be responsible for watering all plant material as necessary throughout the growing season.

7. Fertilizing: A slow release fertilizer of 5-10-5 shall be applied to all plant material at the end of the 1 yr. maintenance period.

8. Miscellaneous

   a. Mulch areas of all planting beds and tree pits shall be maintained at a 2" level.

   b. Plants shall be reset to proper grade or upright position as necessary. Stakes and guys shall also be adjusted as necessary.

   c. The Contractor shall prepare maintenance guidelines for use by the Owner.

   d. All stakes and guys shall be removed by the Contractor at the end of two-year.

   e. Cut back tops of perennials. Dead tops of all perennials shall be cut back in February and the tops removed. Care shall be taken not to damage plants.

3.11 ACCEPTANCE

A. Final acceptance of the work by the Owner will be contingent on Contractor's compliance, with warranty and replacement requirements and Landscape Architect's approval. The Landscape Architect will notify the Owner within one week of final inspection.

END OF SECTION

SECTION 33 10 00
UTILITY STANDARDS

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. This section specifies materials, work and standards for site and utility construction materials and work.

1.3 RELATED WORK

A. Refer to Section 31 20 00 "Earthmoving"; Section 33 41 00 "Storm Drainage", Division 22 "Plumbing" and Division 26 "Electrical".

B. Refer to Section 321313 “Concrete Paving” for concrete curing and formwork.

1.4 STANDARDS

A. Washington Suburban Sanitary Commission's (WSSC) current "General Conditions and Standard Specifications".

B. Maryland Department of Transportation State Highway Administration current “Standard Specifications for Construction and Materials”, Measurement and Payment Clauses do not apply.

C. American Concrete Institute (ACI).

1.5 SUBMITTALS

A. Products:

1. Submit typewritten list of selected products, when options are specified, within 10 calendar days after contract execution. Submit detailed shop drawings of utility modifications required by selection of options.

2. Submit manufacturer's descriptive literature of structure castings.

3. Submit Portland cement concrete mix design formula for each class specified.

4. Submit certificates, signed by manufacturer or producer and contractor, stating the following comply with this specification:

a. Portland cement.

b. Fine aggregates.
c. Coarse aggregates.

d. Portland cement concrete.

e. Concrete masonry units.

f. Brick.

g. Foundation materials.

h. Bedding materials.

5. Submit shop drawings, of the following, indicating concrete reinforcement locations, size and placement:

a. Cast in place reinforced concrete structures.

b. Pre-cast reinforced concrete structures.

6. Submit location of product manufacture and of extraction/recovery of primary raw materials.

7. Submit recycled-content data, designating percentages of post-consumer and post-industrial recycled material.

8. Submit certification of FSC-certified sustainably harvested wood formwork materials, if applicable.

B. Compaction Equipment: Submit compaction equipment data prior to start of controlled fill earthwork operations.

C. Testing: Submit test reports of testing specified.

D. “As-Built” Plans: Submit “as-built” plans for water, sanitary sewer, storm drainage, and stormwater management systems. Submit to the Owner’s Representative and to controlling utility agencies as required. Plans shall be in AutoCAD Format and have an associated paper copy sealed by a Maryland Registered Professional Engineer.

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Delivery: Schedule delivery operations to avoid unnecessary re-handling.

B. Storage

1. General: Store in accordance with manufacturer's recommendations and as noted.

2. Portland cement: Store on platforms above ground and protect from adverse environmental conditions.

3. Aggregates: Store to prevent foreign material contamination.

4. Utility Joint Materials and Lubricants: Store in cool and dry location free of oil, grease, excessive heat and direct sunrays.

C. Handling

1. General: Comply with manufacturer's recommendations and as noted.

2. Aggregates: Handle to prevent segregation.

3. Pre-cast Concrete Structures: Handle to prevent damage. Utilize lifting holes provided by structure manufacturer.

1.7 DEFINITIONS

A. Refer to Section 31 20 00 "Earthmoving".

1.8 PROJECT CONDITIONS

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Traffic: Maintain pedestrian and vehicular traffic during utility construction operations.

C. Limitations

1. Environmental: Do not place Portland cement products or erect masonry when ambient air temperature is below 40 degrees Fahrenheit or air temperature has been below 35 degrees Fahrenheit for twelve or more consecutive hours or between 15 November and 01 March without written authorization from the Owner’s Representative or the Architect.

D. Certifications, Inspections and As-Built Documents

1. The Contractor shall provide inspection, certification and "as-built" plans of the on-site water, sanitary sewer service and storm sewer work by a registered professional Engineer. Contractor shall notify the Architect within 15 calendar days of signing the contract who the Maryland Registered P.E. will be and who will certify the as-built water and sewer plan. Show any changes and include ties for the location of valves, bends, manholes, fire hydrants, and laterals accompanied by the qualifying air test date and certification of compliance.

2. All stormwater management system work must be inspected by Montgomery County in accordance with agency permit requirements. Record of as-built conditions will be required by the contractor.

1.9 TESTING AND INSPECTIONS FOR BACKFILL

A. Refer to Section 31 20 00 “Earthmoving”.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Provide products manufactured and of primary raw materials extracted/recovered within a 500-mile radius of the project site.

B. Portland Cement Concrete: SHA Section 902, Portland Cement Concrete and Related Products.

1. Water: Clean and free of oil, acid and injurious amounts of vegetable matter, alkalis and salts. River, stream or lake water is prohibited.

2. Forms: Wood, steel or as specified. Form materials to produce smooth surfaces, free of irregularities. Nonrented wood formwork shall be made of FSC-certified sustainably harvested wood materials.

C. Mixes

1. Class "A" Concrete: SHA Mix No. 6, Table 902 A. 28-Day compressive strength 4500 P.S.I. Fly-ash or slag is not allowed.

2. Class "B" Concrete: SHA Mix No. 3, Table 902 A. 28-Day compressive strength 3500 P.S.I. Fly-ash or slag is not allowed.

D. Concrete Reinforcements

1. Steel bars: ASTM A 615, Grade 60, deformed, designation as indicated or specified. Minimum 99% recycled-content, of which minimum 60% shall be post-consumer and the remainder may be post-industrial material.

2. Steel Wire Mesh: ASTM A 185 welded wire mesh, roll type, size as indicated or specified.

E. Brick

1. Type A: ASTM C 55 Concrete Building Brick, type I, grade N, standard manufacture size.

2. Type B: ASTM C 32 Clay or Shale Brick, grade SS or as specified, solid, 2-1/4 by 3-3/4 by 8 inches.

F. Cement Mortar: SHA Section 902.05, Masonry Cement.

1. Water: As specified for Portland cement concrete.

G. Cast-in-Place Reinforced Concrete Structures

1. Structure Bases: Class "B" Portland Cement Concrete.

2. Structure Walls and Top Slabs: Class "A" Portland Cement Concrete.

3. Concrete Reinforcement, Structural Steel, Structure Castings and Appurtenances: As indicated and specified.

H. Pre-Cast Reinforced Concrete Structures (unless otherwise noted on plan)

1. Square and Rectangular Structures: ASTM C 858.

2. Structural Design Loading: ASTM C 858, live load designation A-16.

3. Circular Structures: ASTM C 478.

4. Structure Joints: ASTM C 443.

I. Foundation Materials

1. Type I: ASTM C 33 Coarse Aggregate, size No. 8 (3/8 inch to No. 8).

2. Type II: SHA Coarse Aggregate Size No. 57 stone (1 1/2 inch to No. 8).

3. Type III: Earth material free of debris, waste materials, frozen materials, vegetable matter, clay, rocks or stones exceeding 1 inch in any dimension. Obtain Type III material from on-site excavations or off-site borrow areas approved by the Soils Engineer.

J. Bedding Materials

1. Type A: ASTM C 33 Fine Aggregate.

2. Type B: ASTM C 33 Coarse Aggregate, size No. 6 (1 inch to No. 4).

a. Contractor’s Option: SHA Coarse Aggregate Size No. 57 stone (1 1/2 to # 8.)

b. Recycled concrete RC-6 may, at Contractor’s discretion, be used for bedding in approved locations.

3. Type C: Earth material free of debris, waste materials, frozen materials, vegetable matter, clay and rocks or stones exceeding one inch in any direction.

K. Bedding Material Schedule

1. Storm drainage system: Type B, or as per manufacturers recommendations.

2. Water Distribution System: W.S.S.C. Standards

3. Sanitary Sewer System: W.S.S.C. Standards

4. All other utilities: Type C.

L. Backfill Materials: As specified for Fill or Backfill, Section 31 20 00 "Earthmoving", and as noted.

1. Utility Trenches:

a. Phase I: Earth material free of debris, waste materials, frozen materials, vegetable matter and rock or stones exceeding one inch in any dimension.

b. Phase II: Earth material free of debris, waste material, frozen material, vegetable matter and rock or stones exceeding two inches in any dimension.

2. Utility Structures: Earth material free of debris, waste material, frozen material, vegetable matter and rock or stones exceeding two inches in any dimension. Obtain backfill material from the following: Excavated material approved by the Soils Engineer or the Owner's Representative.

PART 3 - EXECUTION

3.1 PROTECTION AND RESTORATION

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. General: Provide support systems (e.g. sheeting, shoring, sheet piling, cribbing, etc.) at no increase to contract sum. Cut off timber when using timber support systems above top of utility to prevent utility displacement. Exercise care when using trench shields or boxes during shield movement to prevent utility displacement.

3.2 EXISTING UTILITIES

A. Refer to Section 31 20 00 "Earthmoving", and as noted. Contractor shall notify "Miss Utility" at least 48 hours prior to start of construction.

B. Provide test pits at all existing utility crossings prior to any system construction. Verify utility inverts for review by Architect or the Owner's Representative to determine potential conflicts prior to start of system construction.

3.3 DEWATERING

A. Refer to Section 31 20 00 "Earthmoving".

3.4 EXCAVATION

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Trench Excavation: Open cut method or as specified. Excavate materials encountered to subgrade elevations indicated or specified.

1. Trench width below top of utility not to exceed the following clearances on each side of utility.

2.

Utility Exterior Width, Diameter or Span	Clearance
1 thru 30 in.	16 in.
31 and higher	24 in.

3. Excavate utility trenches to the following depths

a. Circular storm drainage pipe: Six inches below bottom of pipe.

b. Water distribution pipe: W.S.S.C. Standards

c. Sanitary sewer pipe: W.S.S.C. Standards

d. All other utilities: Bottom of utility.

C. Structure Excavation:

1. Utility structure excavation to produce 12-inch clearance between exterior structure

walls and excavation walls or support systems.

2. Extend excavation to the following

a. Cast in place reinforced concrete structures: Six inches beyond structure base.

b. Pre-cast reinforced concrete structures: Six inches below bottom of pre-cast structure base.

c. Pre-cast reinforced concrete structure with cast in place concrete base: Bottom of structure base.

d. Masonry structures: Bottom of structure base.

3.5 OVER-EXCAVATION

A. Refer to Section 31 20 00 "Earthmoving", except as noted.

B. Utility Trenches

1. Correct over-excavation of water distribution, storm drainage, and gravity flow sanitary sewer systems by backfilling over-excavated trenches with Type II foundation (Type B bedding) material and compacting.

2. Correct over-excavation of all other utilities by backfilling over-excavated trenches with Type III foundation (Type C bedding) material and compacting.

3. Place material in loose lifts not exceeding eight inches. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698.

C. Structures: Correct utility structure over-excavation by backfilling over-excavation with Type II foundation (Type B bedding) material and compacting.

1. Place material in loose lifts not exceeding eight inches. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698.

3.6 UNSUITABLE EARTH

A. Refer to Section 31 20 00 "Earthmoving", except as noted.

B. Restore unsuitable earth excavation as specified for over-excavation.

3.7 EXCAVATED MATERIAL STORAGE

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Stockpile select excavated materials required for backfill operations.

3.8 PORTLAND CEMENT CONCRETE CONSTRUCTION

A. Mixing

1. Ready-Mixed Concrete: ASTM C 94.

2. Project Site Batch Mixing: ACI 301, Chapter 7.

B. Formwork: ACI 301, Chapter 4.

C. Reinforcement: ACI 301, Chapter 5.

D. Joints and Embedded Items: ACI 301, Chapter 6.

E. Placement: ACI 301, Chapter 8.

F. Surface Defects: ACI 301, Chapter 9.

G. Finishes: ACI 301. Non-Exposed: Section 10.2.1. Exposed: Section 10.2.2.

H. Curing and Protection: ACI 301, Chapter 12.

I. Cold Weather Concreting: ACI 306R.

J. Hot Weather Concreting: ACI 305R.

3.9 STRUCTURES

A. Cast in Place Reinforced Concrete Structures: Construct cast in place concrete structures as indicated and specified.

B. Pre-cast Reinforced Concrete Structures

1. Pre-cast structure base: Place Type I foundation material, on excavation subgrade, to bottom of structure base and compact to 98 percent of maximum dry density by ASTM D 698. Install pre-cast structure base, on compacted foundation material, level to 1/8 inch in 5 feet. Clean and lubricate structure joints, immediately prior to installation, in accordance with manufacturer's recommendation. Install pre-cast reinforced structure sections, on structure base, plumb to 1/4 inch in 10 feet. Position structure sections on previously installed section and push joints tightly together. Position concrete top slabs on structure as indicated. Plug lifting holes with cement mortar. Install frames and covers to finished grade with bricks and cement mortar.

3.10 BEDDING

A. Storm drainage pipe: Place bedding material, on excavated trench subgrade to bottom of pipe and compact. Upon completion of pipe installation, place and compact bedding material to springline of pipe.

B. All Other Utilities: Bedding not required. Install utilities on excavated trench subgrade as indicated or specified.

3.11 BACKFILL

A. Backfill utility trenches in two consecutive phases as follows

1. Phase I - Backfill to 12-inch depth above top of utility. Place backfill material in loose lifts not exceeding six inches. Compact each lift to 98 percent maximum dry

density. Density test method: ASTM D 698.

2. Phase II - Unpaved Areas: Place backfill material to grade in loose lifts not exceeding 24 inches. Compact each lift to 92 percent maximum dry density. Density test method: ASTM D 698.

3. Phase II - Paved Areas: Place backfill material to grade in loose lifts not exceeding eight inches. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698.

B. Backfill utility structures as follows: Place backfill material carefully and in loose lifts not exceeding 12 inches (paved areas - 8 inches) in depth. Compact each lift to 95 percent maximum dry density. Density test method: ASTM D 698. Do not backfill masonry structures until cement mortar parge attains initial set.

3.12 EXCAVATED MATERIAL DISPOSAL

A. Refer to Section 31 20 00 "Earthmoving".

3.13 WASTE MANAGEMENT

A. Recycle waste materials in accordance with Division 1 “Construction Waste Management” requirements.

END OF SECTION

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SECTION 33 10 05
WATER DISTRIBUTION SYSTEM

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. This section specifies materials and work required to construct water distribution system.

1.3 RELATED WORK

A. Refer to Section 33 10 00 "Utility Standards".

1.4 STANDARDS

A. Washington Suburban Sanitary Commission's (WSSC) current "General Conditions and Standard Specifications" and "Standard Details".

B. Washington Suburban Sanitary Commission's current "Regulations Governing the Installation of Plumbing and Sewer Cleaning in the Washington Suburban Sanitary District".

C. American Water Works Association (AWWA).

1.5 SUBMITTALS

A. Refer to Section 33 10 00 "Utility Standards" and as noted.

B. Products: Submit product manufacturer's specifications and installation instructions and certificates of compliance signed by manufacturer and contractor stating that products comply with this specification to the Architect. Certificates of compliance must be notarized, signed by an officer of the Manufacturer, and shall include W.S.S.C. Contract Number or On-site number, job location, Contractor’s name, types, classes and strengths of pipe and fittings, and the Manufacturer’s name.

C. The contractor shall be responsible for preparing and submitting as-builts as required by WSSC. Copies shall be submitted to the Architect. As-builts shall be provided in AutoCAD format along with a paper copy that is sealed by a Maryland Licensed Registered Professional Engineer.

D. Service Connection Permit: Contractor shall submit to Architect all items required by WSSC to obtain a Service Connection Permit, including but not limited to: All required WSSC Bonds, Letter indicating Utility Contractor, and Certificate of Insurance. The Architect will obtain the Service Connection Permit once all these items are received. Any fees necessary to obtain the Service Connection Permit are the responsibility of the Contractor

1.6 PRODUCT DELIVERY, STORAGE AND HANDLING

A. Refer to Section 33 10 00 "Utility Standards", and as noted.

1.7 PROJECT CONDITIONS

A. Refer to Section 33 10 00 "Utility Standards", and as noted.

B. Jurisdiction Standards: Site is located within WSSC jurisdiction.

C. All on-site construction and materials shall be in accordance with the latest edition of the W.S.S.C. General Conditions and Standard Specifications, Design Manual, Standard Details and Plumbing and Gasfitters Regulations.

1.8 CONSTRUCTION SURVEYS

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 50 feet and at all appurtenances (e.g. fittings, valves, etc.). Provide construction cut sheet preparation as required.

1.9 TESTING AND INSPECTIONS FOR BACKFILL

A. Refer to Section 31 20 00 ”Earthmoving”.

PART 2 - PRODUCTS

2.1 MATERIALS

A. All materials shall be W.S.S.C. Standards and shall meet all W.S.S.C. requirements indicated.

B. Valve Boxes: Cast iron two-piece valve boxes, screw type box, bell base section, 5-1/4 inch shaft, round drop cover with "W" marking.

C. Due to the corrosive nature of the on-site soils, all ferrous metal pipes, fittings, and connections shall be provided with a pipe coating per American Water Works Association (AWWA) subsections C203 and C204.

2.3 CONCRETE PADS: Class 'A' portland cement.

2.4 CONCRETE ANCHORS: W.S.S.C. Standards indicated and specified. Class 'A' portland cement concrete, Section 33 10 00 "Utility Standards".

2.5 STRAPS AND RODS

A. Clamps, Straps and Washers: Steel, ASTM A 506.

B. Rods: Steel, ASTM A 575.

C. Rod Couplings: Malleable-Iron, ASTM A 197

D. Bolts: Steel, ASTM A 307

E. Cast-Iron Washers: Gray-iron, ASTM A 126

2.6 MISCELLANEOUS PRODUCTS

A. Underground Identification Tape: Manufactured by Allen Systems, Houston, Texas.

1. Type: “Markline”.

2. Color: Precaution Blue.

3. Legend: Caution water line buried below.

4. Tape Width: Three inches.

B. Disinfection Products: W.S.S.C. standards indicated and specified. For continuous feed disinfection method, use Calcium Hypochlorite: AWWA B 300, granular form.

1. Contractor's Option: AWWA B 301 Liquid Chlorine.

2. Contractor's Option: AWWA B 303 Sodium Chloride.

3. Water: Potable.

PART 3 - EXECUTION

3.1 PROTECTION AND RESTORATION

A. Refer to Section 33 10 00 "Utility Standards".

3.2 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH

A. Refer to Section 33 10 00 "Utility Standards".

3.3 PIPE

A. General

Install in accordance with pipe manufacturer's installation instructions, W.S.S.C. standards and requirements and as noted.

1. Inspect each pipe laying length, pipe joint materials and fittings for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Place fittings at changes in horizontal and vertical alignment as indicated. Construct concrete anchors at each fitting as indicated. Place concrete to permit access to joints for inspection and maintenance. Apply liberal coat of coal tar pitch to exposed steel and hardware. Field cut pipe only where required to complete closures or to install fittings, valves or fire protection equipment. Cut pipe to smooth square end with equipment designed for cutting pipe.

B. Ductile Iron Pipe

1. Install pipe in accordance with AWWA C 600 and as noted.

2. Install with bell ends facing in direction of laying operations. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed upgrade. Place identifying mark on pipe not provided with spigot depth mark. Clean interior and exterior surfaces of bell and spigot removing oil, grit, excess coating and foreign matter. Lubricate pipe ends and gasket in accordance with pipe manufacturer's instruction.

3. Ductile Iron Push-On Pipe: Position each laying length in previously installed pipe and push or pull joint tightly together with mechanical device designed for pipe jointing. Grind or file spigot end of field cut pipe to resemble manufactured spigot

end. Place spigot identifying depth mark as specified. Pipe joint deflection not to exceed the limits specified in Table 2, AWWA C 655.

3.4 BURIED VALVES

A. Install valves in accordance with valve manufacturer's installation instructions, and W.S.S.C. requirements.

3.6 BACKFILL

Refer to Section 33 10 00 "Utility Standards" and as noted.

A. Valve Box Installation: Install valve box for each buried gate valve during backfill operations. Install boxes to prevent shock or stress transmission to valves or pipe and center over valve operating nut plumb to 1/4 inch in five feet. Adjust box cover flush to finished grade.

B. Underground Identification Tape: Install tape during backfill operations. Tape shall be centered
over pipe, located 24 inches below finished grade.

3.7 SYSTEM TESTING

A. General: Provide materials, equipment (e.g. pumps, gauges, etc.) and labor required to test system. Do not conduct tests until concrete anchors cure and set seven calendar days. Provide a minimum of 48 hours notification of planned testing. Test observation by the W.S.S.C. personnel. Test system in accordance with AWWA C 600 and as noted.

B. Hydrostatic Pressure Tests: Conduct hydrostatic pressure tests, upon completion of Phase I backfill operations. Fill systems or valved section of system with water. Expel air from pipe. Slowly apply test pressure. Test pressure to be per approved plan. Test duration to be two hours. Test pressure shall not vary for the duration of the test. Examine all system joints. Correct defective products or improper system installation as directed by W.S.S.C. personnel.

A. Hydrostatic Leakage Tests: Conduct hydrostatic leakage tests upon completion of Phase II backfill operations. Test procedure as specified for hydrostatic pressure tests, except as noted. Test duration 24 hours. Allowable leakage for ductile iron pipe is not to exceed the limits specified in Table 3, AWWA C 600. Correct system installation exceeding allowable leakage specified as directed by W.S.S.C. personnel.

3.8 SYSTEM DISINFECTION

A. Disinfect system in accordance with AWWA C 651, W.S.S.C. standards specified, and as noted. Provide materials, equipment (e.g. pumps, etc.) and labor required to disinfect system.

B. Disinfection Method: Continuous feed.

1. Preliminary and final flushing velocity to be 2.5 fps. Solution concentration as specified. Maintain 50 MG/L available chlorine during 24-hour disinfection period. Bacteriologic test interval every six hours. Flushing and drainage locations where directed by the Owner's Representative.

3.10 DISINFECTION TESTING

A. Conduct chlorine residual tests upon completion of final flushing operations. Repeat disinfection operation until satisfactory chlorine residual quality tests are obtained.

3.11 WATER BACTERIOLOGIC QUALITY TESTING

A. Retain the services of an independent testing laboratory to conduct water bacteriologic quality testing.

END OF SECTION

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SECTION 33 30 00
SANITARY SEWERAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

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

1.2 DESCRIPTION OF WORK

A. This section specifies materials and work required to construct gravity flow sanitary sewer system.

1.3 RELATED WORK

A. Refer to Section 31 20 00 "Earthmoving", Section 33 10 00 "Utility Standards", Section 33 41 00 "Storm Drainage", and Division 26 "Plumbing".

1.4 STANDARDS

A. Refer to Section 33 10 00 "Utility Standards", and as noted.

B. Washington Suburban Sanitary Commission's (WSSC) current "General Conditions and Standard Specifications" and "Standard Details".

C. Washington Suburban Sanitary Commission's current "Regulations Governing the Installation of Plumbing and Sewer Cleaning in the Washington Suburban Sanitary District".

1.5 SUBMITTALS

A. Refer to Section 33 10 00 "Utility Standards" and as noted.

B. Products: Submit product manufacturer's specifications and installation instructions and certificates of compliance signed by manufacturer and contractor stating that products comply with this specification to the Architect. Certificates of compliance must be notarized, signed by an officer of the Manufacturer, and shall include W.S.S.C. Contract Number or On-site number, job location, Contractor’s name, types, classes and strengths of pipe and fittings, and the Manufacturer’s name.

C. Options: Submit typewritten list of selected products when options are specified within 10 calendar days after contract execution. Submit detailed shop drawings of system modifications required by selection of options.

D. Submit shop drawings of precast structures indicating concrete reinforcement location, size and placement.

E. Submit As-built drawings to the Architect. As-builts shall be provided in AutoCAD format along with a paper copy that is sealed by a Maryland Licensed Land Surveyor.

F. Service Connection Permit: Contractor shall submit to Architect all items required by WSSC to obtain a Service Connection Permit including but not limited to: All required WSSC Bonds, Letter indicating Utility Contractor, and Certificate of Insurance. The Architect will obtain the Service Connection Permit once all these items are received.

1.6 PRODUCT, DELIVERY, STORAGE AND HANDLING

A. Refer to Section 33 10 00 "Utility Standards".

1.7 PROJECT CONDITIONS

A. Refer to Section 33 10 00 "Utility Standards" and as noted.

B. All on-site construction and materials shall be in accordance with the latest edition of the W.S.S.C. General Conditions and Standard Specifications, Design Manual, Standard Details and Plumbing and Gasfitters Regulations.

C. Existing Sanitary Sewer System: Provide, install, operate and maintain pumps and related equipment required to divert sewage (bypass pumping) during system construction. Extend pump discharge lines to existing sanitary sewer structures. Surface flow is prohibited.

D. Traffic: Maintain vehicular and pedestrian traffic during system construction.

1.8 CONSTRUCTION SURVEYS

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 25 feet maximum and at all structures. Provide construction cut sheet preparation as required.

1.9 TESTING AND INSPECTIONS FOR BACKFILL

A. Refer to Section 31 20 00 “Earthmoving”

PART 2 - PRODUCTS

2.1 MATERIALS:

A. All materials shall be W.S.S.C. Standards and shall meet all W.S.S.C. requirements indicated.

B. Polyvinyl Chloride (PVC) Pipe: W.S.S.C. Standards indicated. ASTM D 3034, SDR 35 PVC gravity sewer pipe, size as indicated, standard manufacture laying length.

1. Pipe Joints: ASTM D 3212 bell and spigot type, with flexible elastomeric gasket seals. Gaskets shall meet the requirements of ASTM F 477.

2. Fittings shall be as indicated and required.

C. Cleanouts: W.S.S.C. standards indicated.

1. Cleanouts For Use in Paved Walk Areas: Refer to Section 33 41 00 "Storm Drainage", and as noted.

a. Expansion Joint: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.

2. Furnish the Owner with one cleanout wrench for each site.

D. Structures: W.S.S.C. standards specified and indicated.

E. Foundation and Bedding Materials: Refer to Section 33 10 00 "Utility Standards".

F. Concrete: Refer to Section 33 10 00 "Utility Standards".

G. Miscellaneous Products:

1. Underground identification type manufactured by Allen Systems, Houston, Texas. "Detectatape" type, three inches wide, marked "Caution Sewer Line Buried Below", "Safety Green" color.

PART 3 - EXECUTION

3.1 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH:

A. Refer to Section 33 10 00 "Utility Standards".

3.2 EXISTING SYSTEM CONNECTION

A. Notify WSSC no less than 48 hours prior to the start of system construction.

B. Excavate and expose existing pipe at connection location indicated. Adjust connection location, as required, in the event of conflicts with existing pipe joints. Neatly cut existing pipe and prepare cut end as required for connection with new pipe. Make connections with existing pipe using fittings designed for the purpose, in accordance with manufacturer's installation instructions.

3.3 PIPE:

A. General: Install in accordance with manufacturer's installation instructions and as noted. Inspect each pipe laying length and pipe joint materials for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Begin with installation at lowest system elevation and proceed up-grade. Field cut pipe only where required to complete structure-to-structure closures, install fittings or as specified. Cut pipe to smooth square end with equipment designed for cutting pipe.

B. Polyvinyl Chloride (PVC) Pipe: Install pipe in accordance with ASTM D 2321, manufacturer's installation instructions, and as noted.

1. Install with pipe spigot end pointing in flow direction. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed up-grade. Clean bell and spigot interior and exterior surfaces, removing oil, grit and foreign matter. Lubricate pipe ends and gasket in accordance with manufacturer's instructions. Position each laying length of previously installed pipe and manually push joint tightly together.

2. Field Pipe Cutting: Shape spigot end of cut pipe to resemble manufactured spigot end, with a pipe-beveling tool designed for PVC pipe. Copy the full insertion mark provided on the manufactured spigot end onto the prepared field cut end.

3.4 EXISTING PIPE/STRUCTURE CONSTRUCTION

A. Excavate and expose existing pipe at structure location indicated. Adjust structure location as directed by the Architect or Owner's Representative in the event existing pipe joint interferes with structure walls, or as required to obtain required invert, at no increase to contract sum. Manually excavate below existing pipe prior to structure base placement. Place concrete structure base and construct structure as specified. Neatly cut and remove upper half of existing pipe and construct invert flow channel.

3.5 STRUCTURES

A. Refer to Section 33 10 00 "Utility Standards" and as noted.

B. Pipe Connections: Install pipe opening sleeves in accordance with manufacturer's installation instructions. Neatly cut pipes flush with interior structure walls except as otherwise indicated or specified.

C. Structure Joints: Apply liberal coat of joint coating material to each structure section joint in accordance with manufacturer's application instructions.

D. Invert Flow Channels: Construct invert flow channels smooth and semicircular in shape. Shape channels with horizontal circular curve radii as large as structure will permit. Neatly form channels in structure base with bricks and cement mortar.

3.6 CLEANOUTS

A. Refer to Section 33 41 00 "Storm Drainage", and as noted.

B. Install cleanouts in accordance with manufacturer's installation instructions and as indicated.

1. Construct concrete pads of Class "A" concrete as indicated.

2. Cleanouts in paved walk shall be installed without a concrete pad. Top shall be cast into and set flush with finished walk surface.

3.7 BACKFILL:

A. Refer to Section 33 10 00 "Utility Standards", and as noted.

B. Sanitary Sewer mains must be inspected by W.S.S.C. prior to completion of backfill operations. Contractor shall provide a minimum of 48 hours notice to W.S.S.C. before completion of backfill operations.

C. Underground Identification Tape: Install tape during backfill operations. Tape shall be centered over pipe, located 12 inches above top of pipe.

3.8 SYSTEM TESTING:

A. Provide equipment, materials and labor required to test system. Conduct low pressure air tests in accordance with local jurisdiction approving agency standards. Provide a minimum of 48 hours notification of planned testing. Test observation by W.S.S.C. personnel.

B. Repair or replace defective products and system construction, which fails tests as directed by local jurisdiction approving agency. Provide additional corrective work and retesting until system is approved and accepted. Provide corrective work and retesting at no increase to contract sum.

3.9 SYSTEM INSPECTION

A. Provide additional corrective work, determined necessary by television inspection, as specified for system testing.

- END OF SECTION 33 30 00 -

SECTION 33 41 00
STORM DRAINAGE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract including the General and Supplementary Conditions and Division 1, Specifications Section, apply to work in this section.

1.2 DESCRIPTION OF WORK

A. This section specifies materials and work required to construct storm drainage system.

1.3 RELATED WORK

A. Refer to Section 31 10 00 "Clearing", Section 31 20 00 "Earthmoving", Section 33 10 00 "Utility Standards"; Section 32 13 13 "Cement Concrete Paving" and Division 22 "Plumbing".

1.4 STANDARDS

A. Washington Suburban Sanitary Commission (WSSC) current "General Conditions and Standard Specifications" and "Standard Details".

B. Montgomery County Department of Transportation current "Design Standards".

C. Maryland Department of Transportation State Highway Administration current "Standard Specifications for Construction and Materials".

D. Maryland Standards and Specifications for Soil Erosion and Sediment Control, current edition.

E. American Concrete Pipe Association (ACPA).

1.5 SUBMITTALS

A. Products:

1. Submit certificate signed by manufacturer and contractor stating that pipe and pipe joint materials comply with this specification.

2. Submit shop drawings of pre-cast reinforced structures and cast in place reinforced concrete structures indicating location, size and placement of concrete reinforcement.

1.6 PROJECT CONDITIONS

A. Refer to Section 31 20 00 "Earthmoving" and as noted.

B. Existing Storm Drainage System: Provide, install, operate and maintain pumps and related equipment required to divert storm water during system construction.

C. Traffic: Maintain pedestrian and vehicular traffic during system construction.

D. As-Built Documents:

1. Refer to Section 33 10 00 “Utility Standards

1.7 CONSTRUCTION SURVEYS

A. Provide survey equipment and qualified personnel for construction surveys. Provide combined horizontal and vertical alignment stakes for system construction. Horizontal stake interval to be 25 feet maximum and at all structures. Provide construction cut sheet preparation as required.

1.8 TESTING AND INSPECTIONS FOR BACKFILL

A. Refer to Section 31 20 00 “Earthmoving”.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Polyvinyl Chloride (PVC) Pipe: ASTM D 2466, Schedule 40 PVC gravity sewer pipe, size as indicated, standard manufacture laying length.

1. Pipe Joints: ASTM D 3212, bell and spigot type, with flexible elastomeric gasket seals. Gaskets shall meet the requirements of ASTM F 477.

2. Fittings shall be as indicated and required.

B. Concrete Pipe: ASTM C 76, Class IV, standard manufacture laying length.

1. Pipe Joints: Rubber gaskets, ASTM C 443 with vegetable oil soap joint lubricant.

2. Mortar Joints: Modified tongue and groove pipe with cement mortar.

C. Corrugated Steel Pipe: ASTM A 819 and AASHTO M 274 Aluminized Steel Type 2 pipe, corrugations and thickness as specified on plans.

1. Pipe Joints: Shall be watertight joints, made with bands gaskets as specified on plans.

D. High Density Polyethylene Pipe: ADS Type N-12, or approved equal.

1. Pipe Joints: All joints must meet a modified ASTM 3212 at 3.5-psi held for 10 minutes as certified by an independent testing laboratory.

2. Pipe Joints: Plastic Cement Welding Solvents shall have a VOC content not to exceed 250 g/l.

E. Structures: Standards specified and as indicated.

F. Structure Castings: MDOT-SHA or Montgomery County Standards.

1. Grates for storm drain inlets with grate tops shall be waffle shaped for wheel chair and bicycle safety. Slots shall not exceed ADA Guidelines.

G. Filter Fabric: "Mirafi 140N" manufactured by Mirafi Incorporated, Charlotte, North Carolina. Contractor's Option: "Typar", type 3341 manufactured by Remay Incorporated, Nashville, Tennessee, or approved equal.

1. Quality: Free of defects of flaws, which affect strength or filtering properties.

H. Cleanouts

1. Cleanout Ferrules and Plugs: Josam Series No. 58540 with cast iron body and bronze countersunk flanged plug. Size matching pipe size indicated. Contractor shall provide Owner with two "T" handles for recessed plugs.

2. Cleanouts For Use in Paved Walk Areas: Josam Series No. 58360 adjustable floor cleanout with cast iron body and bronze plug and top. Size matching pipe size indicated. Contractor shall provide Owner with one cleanout wrench.

a. Expansion Joint: ASTM D 994, bituminous preformed joint filler, 1/2 inch thick.

3. Fittings: Shall be as specified for PVC pipe (for pipe materials indicated).

I. Sand: ASTM C33 Fine Aggregate.

J. Concrete: Refer to Section 33 10 00 "Utility Standards".

K. Reinforcing Steel and Hardware: Refer to Section 33 10 00 "Utility Standards", and as noted:

1. Size and type of steel and hardware shall be as indicated.

2. Exposed reinforcing steel shall be hot dip galvanized, ASTM A 767, Coating Class I.

3. Hardware shall be hot dip galvanized, ASTM A 153.

L. Miscellaneous Products

1. Underground identification tape manufactured by Allen Systems, Houston, Texas. Tape shall be three inches wide, "Detectatape" type, "Safety Green" color, and marked "Caution Sewer Line Buried Below".

PART 3 - EXECUTION

3.1 DEWATERING, EXCAVATION, OVER-EXCAVATION AND UNSUITABLE EARTH:

A. Refer to Section 33 10 00 "Utility Standards".

3.2 CONNECTIONS TO EXISTING SYSTEM

A. For structure construction over existing pipe, excavate and expose existing pipe at structure location indicated. Adjust structure location as directed by the Owner's Representative in the event existing pipe joint interferes with structure walls, at no increase to Contract Sum. Manually excavate below existing pipe prior to structure base placement. Place concrete base and construct structure as specified. Neatly cut and remove upper half of existing pipe and construct invert flow channel.

B. For pipe connections to existing structures, excavate and expose existing structure. Cut and remove portion of existing structure wall required for pipe connection. Install pipe, through

existing structure wall, flush with interior wall surface. Remove portion of existing invert flow channel required for connection and reconstruct as specified. Fill joint between pipe and existing structure wall with cement mortar.

3.3 PIPE

A. General: Install in accordance with manufacturer's installation instructions and as noted. Inspect each pipe laying length and pipe joint materials for defects. Remove defective products from project site. Install pipe to horizontal and vertical alignment indicated. Begin installation at lowest system elevation and proceed up-grade. Field cut pipe only where required to complete structure-to-structure closures, install fittings or as specified. Cut pipe to smooth square end.

B. Concrete Pipe: Install with tongue end of pipe pointing in direction of flow. Clean and thoroughly wet joints immediately prior to joining pipe. Apply thick liberal coat of mastic to groove and tongue. Position each laying length in previously installed pipe and pull joint tightly together with mechanical device designed for pipe jointing.

1. Clean interior of each joint removing excess cement mortar and finish flush with surface. Fill exterior upper half of pipe joint with cement mortar.

C. Polyvinyl Chloride (PVC) Pipe: Install pipe in accordance with ASTM D 2321, manufacturer's installation instructions, and as noted.

1. Install with pipe spigot end pointing in flow direction. Begin installation of pipe, with vertical gradient exceeding 10 percent, at lowest elevation and proceed up-grade. Clean bell and spigot interior and exterior surfaces, removing oil, grit and foreign matter. Lubricate pipe ends and gasket in accordance with manufacturer's instructions. Position each laying length of previously installed pipe and manually push joint tightly together.

2. Field Pipe Cutting: Shape spigot end of cut pipe to resemble manufactured spigot end, with a pipe-beveling tool designed for PVC pipe. Copy the full insertion mark provided on the manufactured spigot end onto the prepared field cut end.

D. High Density Polyethylene Pipe: Install and Bed in accordance with manufacturer’s recommendations.

3.4 CLEANOUTS

A. Refer to Section 33 10 00 "Utility Standards" and as noted.

B. Install cleanouts and construct concrete pads of Class "A" concrete as indicated.

C. Cleanout in paved walk area shall be installed without a concrete pad. Top shall be cast into and set flush with finished walk surface.

3.5 STRUCTURES

A. Refer to Section 33 10 00 "Utility Standards" and as noted. Neatly cut pipes flush with interior structure walls. Construct invert flow channels smooth and semicircular in shape. Shape channels with horizontal circular curves, with radii as large as structure will permit or as indicated. Neatly form channels in structure base with bricks and cement mortar. Provide steps in structures exceeding 3.0 feet in depth. Vertical step spacing per standards specified.

3.6 BACKFILL

A. Refer to Section 33 10 00 "Utility Standards", and as noted.

B. Polyvinyl Chloride (PVC) Pipe: Conduct backfill operations when pipe temperature is below 60 degrees Fahrenheit or during early morning hours to prevent excessive contraction.

C. Underground Identification Tape: Install during backfill operations. Center tape horizontally over pipe, 12 inches above top of pipe.

3.7 WASTE MANAGEMENT

A. Recycle waste piping materials in accordance with Division 1 “Construction Waste Management” requirements.

- END OF SECTION 33 41 00 -

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