PROJECT MANUAL
VOLUME 2: DIVISIONS 21 - 33

THE COTTAGE AT THORNAPPLE

Hastings, Michigan
Project No. 2011-11-021

Issue:	Issued for Bids 21 February 2012
Owner:	Barry County, dba Thornapple Manor Hastings, Michigan
Architect:	Eckert Wordell, LLC Kalamazoo, Michigan

SECTION 21 1313 – FIRE SUPPRESSION SPRINKLER SYSTEMS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

B. The requirements of the following Division 23 Sections apply to this Section:

1. Basic Mechanical Requirements.

2. Basic Mechanical Materials and Methods.

3. Supports and Anchors.

1.2 SUMMARY

A. This Section specifies automatic sprinkler systems for buildings and structures. Materials and equipment specified in this Section include:

1. Pipe, fittings, valves, sprinklers, and specialties.

B. Products furnished but not installed include sprinkler cabinets with spare sprinklers. Furnish to Owner's maintenance personnel.

C. Related Sections: The following Sections contain requirements that relate to this Section:

1. Division 7 Section "Fire Stopping," for materials and methods for sealing pipe penetrations through basement walls and fire/smoke barriers.

2. Division 10 Section "Fire Extinguishers," Cabinets, and Accessories" for fire extinguishers and extinguisher cabinets.

3. Division 23 Section "Mechanical Identification," for labeling and identification of fire protection piping system and components.

4. Division 28 Section "Fire Alarm System," for wiring of fire protection system supervisory switches and water flow indicators.

1.3 DEFINITIONS

A. Pipe sizes used in this Specification are Nominal Pipe Sizes (NPS).

B. Working Plans as used in this Section means those documents (including drawings and calculations) prepared pursuant to the requirements contained in NFPA 13 for obtaining approval of the authority having jurisdiction.

C. Other definitions for fire protection systems are listed in NFPA Standards 13, 14, 20, 24, and 101.

1.4 SYSTEM DESCRIPTION

A. Fire protection system shall include the following and as indicated on drawings:

B. “Wet-Pipe” System: Fire protection system employs automatic sprinklers attached to piping system containing water and connected to water supply so that water discharges immediately from sprinklers opened by fire.

1.5 SYSTEM DESIGN

A. Wet Pipe Systems:

1. Ordinary Hazard Group 1: Provide a density of 0.15 gpm over the hydraulically most remote 1,500 square feet of operating area for all mechanical rooms, storage rooms, cooking areas, etc. except as otherwise specified. Sprinkler spacing shall be limited to a maximum of 130 square feet per sprinkler.
2. Light Hazard: Provide a density of 0.10 gpm over the hydraulically most remote 1,500 square feet of operating area for all mechanical rooms, storage rooms, cooking areas, etc. except as otherwise specified. Sprinkler spacing shall be limited to a maximum of 130 square feet per sprinkler.

1.6 SUBMITTALS

A. Layout and Contractor Responsibility:

B. The Contractor shall provide a complete fire protection system based on the construction documents and this specification. All design shall be in accordance with the requirements of NFPA Pamphlets 13, 14, 20, 24 and 101. The Contractors layout shall be compatible with and coordinated with all building systems, and particularly with the ceiling lighting layout, ceiling access panel layout, and the ceiling HVAC duct layout.

C. Product Data for each type sprinkler, valve, piping specialty, fire department connection and fire protection specialty.

D. Shop Drawings prepared in accordance with NFPA 13 identified as “Working Plans,” including hydraulic calculations where applicable, and which have been approved by the authority having jurisdiction.

E. Sprinklers shall be referred to on drawings, submittals, and other documentation, by the sprinkler identification or model number as specifically published in the appropriate agency listing or approval. Trade names or other abbreviated designations shall not be allowed.

F. Test Reports and Certificates including “Contractor’s Material & Test Certificate for Aboveground Piping” and “Contractor’s Material & Test Certificate for Underground Piping” as described in NFPA 13.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: Installation and alterations of fire protection piping, equipment, specialties, and accessories, and repair and servicing of equipment shall be performed only by a qualified installer. The term “qualified” means experienced in such work (“experienced” shall mean having a minimum of 5 previous projects similar in size and scope to this project), familiar with all precautions required, and has complied with all the requirements of the authority having jurisdiction. Upon request, submit evidence of such qualifications to the Engineer. Refer to Division1 Section “Definitions and Standards”, for definitions for “Installers.”

B. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

1. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

C. Qualifications for Welding Processes and Operators: Comply with the requirements of AWS D10.9, Specifications for Qualifications of Welding Procedures and Welders for Piping and Tubing, Level AR-3.

D. Regulatory Requirements: Comply with the requirements of the following codes:

1. NFPA 13 – Standard for the Installation of Sprinkler Systems; 1994 Edition.

2. NFPA 14 – Standard for the Installation of Standpipe and Hose Systems; 1993 Edition.

3. NFPA 1961 – Standard for Fire Hose; 1992 edition.

4. NFPA 1963 – Screw Threads and Gaskets for Fire Hose Connections; 1993 Edition.

5. UL and FM Compliance: Fire protection system materials and components shall be Underwriter's Laboratories listed and labeled, and Factory Mutual approved for the application anticipated.

E. Provide listing/approval stamp, label or other marking on equipment made to specified standards.

1.8 SEQUENCING AND SCHEDULING

A. Schedule rough-in installations with installations of other building components.

1.9 EXTRA MATERIALS

A. Valve Wrenches: Furnish to Owner, 2 valve wrenches for each type of sprinkler installed.

B. Sprinklers and Cabinets: Furnish extra sprinklers of each style included in the project. Furnish each style with its own sprinkler cabinet and special wrenches as specified in this Section. Quantity of sprinklers shall be in accordance with NFPA 13, Section 2-2.7.3.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. Ball Valves – 2" and Smaller:

a. Victaulic Series 728.

2. Butterfly Valves – 2" and Smaller:

a. Milwaukee Valve Co.

3. Butterfly Valves – 2 ½" and Larger:

    a. Victaulic, Series 705W (grooved end valves).
    b. Jenkins
    c. NIBCO

4. Gate Valves:

    a. Victaulic, Series 771 / 772 (grooved end valves)
    b. Jenkins
    c. Milwaukee Valve Co.

5. Wafer Check/Swing Check Valves:

    a. Victaulic Series 717 (grooved end valves).
    b. Jenkins
    c. Milwaukee Valve Co.

6. Grooved Mechanical Couplings and Fittings:

    a. Victaulic
    b. Gustin-Bacon

7. Water Flow Pressure Switches:

    a. System Sensor, Inc.
    b. Victaulic Company of America
    c. Viking Corp.

8. Reduced Pressure Principle Detector Backflow Preventors:

    a. Ames Company, Inc.
    b. Cla-Val
    c. Febco
    d. Watts Regulator Co.

9. Fire Department Connection:

    a. Croker Standard
    b. Elkhart Brass
    c. Guardian Fire Equipment, Inc.
    d. Potter Roemer, Inc.

10. Sprinklers:

    a. Victaulic Company.
    b. Central Sprinkler Corp.
    c. Globe Fire Equipment CO.
    d. Reliable Automatic Sprinkler Co., Inc.
    e. Star Sprinkler Co., Inc
    f. Viking Corp.

11. Fire Pumps:

    a. Peerless
    b. Aurora

c. A-C

12. Dry Pipe Valve:

    a. Victaulic Company; NXT-Series.
    b. Viking

2.2 PIPE AND FITTING MATERIALS

A. General: Refer to “Pipe Applications” for identification of systems where the below specified pipe and fitting materials are used.

B. Steel Pipe: ASTM A 53 Schedule 40, or ASTM A135 Schedule 10, black steel pipe.

C. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.

D. Steel Fittings, 2” and Smaller: Precision, cold drawn, steel with elastomer O-ring seals, suitable for installation with Schedule 5 pipe. UL listed and FM approved for fire protection services to 175 psi CWP. Victaulic Pressfit.

E. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125 and 250, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

F. Grooved Mechanical Fittings: ASTM A 536, Grade 65-45-12 ductile iron, short-pattern with flow equal to standard pattern, Victaulic FireLock.

    a. Where short pattern is not available, standard pattern ductile iron, wrought steel ASTM A234, Grade WPB, or ASTM A53, Type F or Types E or S, Grade B factory-fabricated steel fittings with grooves or shoulders designed to accept grooved end couplings may be used. Victaulic Company.

G. Grooved mechanical Couplings: Consist of ductile iron housing, a synthetic rubber gasket of a central cavity pressure-responsive design; with nuts and bolts to secure roll-grooved pipe and fittings. Grooved mechanical couplings including gaskets used on dry-pipe shall be listed for dry-pipe service.

    a. Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with NFPA-13. Couplings shall be fully installed at visual pad-to-pad offset contact. (Tongue and recess type couplings, or any coupling that requires exact gapping of bolt pads on each side of the coupling at specified torque ratings, are not allowed.)
        i. 1-1/4” through 4”: Installation-Ready, for direct stab installation without field disassembly. Victaulic Style 009-EZ.
        ii. Victaulic FireLock™ Style 005 or Zero-Flex Style 07.

    b. Flexible Type: For use in locations where vibration attenuation and stress relief are required, and for seismic applications. Victaulic Style 75 or 77.

    c. Flange Adapter: Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components. Victaulic Style 744 and 741.

d. Gaskets:

Fire Protection Service	Temp.Range	Gasket Recommendation
Dry Systems	Ambient	FlushSeal®, Grade EPDM, Type A
Freezer Applications	-40°F to 0°F	FlushSeal®, Grade L, Silicone
Water/Wet Systems	Ambient	Grade EPDM, Type A

H. Cast-Iron Threaded Flanges: ANSI B16.1, Class 250; raised ground face. Bolt holes spot faced.

I. Gasket Materials: Thickness, material, and type suitable for fluid or gas to be handled, and design temperatures and pressures.

2.3 GENERAL DUTY VALVES

A. Ball Valves – 2 Inch and Smaller: Handwheel operated open and close with integral supervisory tamper switches. Body and housing of cast bronze conforming to ASTM 584, with chrome plated brass ball and 316 stainless steel stem, carbon-filled TFE seat, with weatherproof gear box. Valve shall be UL listed and FM approved for 300 psi working pressure. Supervisory tamper switch shall have two (2) SPDT prewired switches rated for 10 amps at 125 VAC and 0.5 amps at 125 VDC. Valve shall have threaded or grooved ends, and be as manufactured by Victaulic Company, Series 728.

B. Butterfly Valves – 2 Inch and Smaller: Slow open and close with integral supervisory tamper switch. Body and housing of cast bronze conforming to ASTM 584 and Type 304 stainless steel disc with Viton disc seal. Valve shall be UL listed and FM approved for 175 psi working pressure. Supervisory tamper switch shall have two (2) SPDT prewired switches rated for 10 amps at 115 VAC and 0.5 amps at 28 VDC. Valve shall have threaded or grooved ends, and be as manufactured by the Milwaukee Valve Co., or equal.

C. Butterfly Valves – 2 ½ Inch and Larger:

a. Slow open and close with integral supervisory tamper switch. Body and housing of ductile iron conforming to ASTM A536 and elastomer coated ductile iron disc. Valve shall be UL listed and FM approved for 300 psi working pressure. Supervisory tamper switch shall have two (2) SPDT prewired switches rated for 10 amps at 125 VAC and 0.5 amps at 125 VDC. Valve shall have grooved ends, and be as manufactured by Victaulic Company, Series 705W.

b. MSS SP-67; lug type rated at 175 psi; cast-iron body conforming to ASTM A 126, Class B. Provide valves with field replaceable EPDM O-ring stem seals.

D. Gate Valves – 2 Inch and Smaller: Body and bonnet of cast bronze, 175 pound cold water working pressure, non-shock, threaded ends, solid wedge, outside screw and yoke, rising stem, screw-in bonnet, and malleable iron handwheel. Valves shall be capable of being repacked under pressure, with valve wide open.

E. Gate Valves – 2 ½ Inch and Larger: Iron body; bronze mounted, 175 pound cold water working pressure, non-shock. Valves shall have solid taper wedge; outside screw and yoke, rising stem; flanged bonnet, with body and bonnet conforming to ASTM A 536 Grade 65-45-12 or ASTM A 126 Class B; replaceable bronze wedge facing rings; flanged or grooved ends; and a packing assembly consisting of a cast iron gland flange, brass gland, packing, bonnet,

and bronze bonnet bushing. Valves shall be capable of being repacked under pressure, with valve wide open. Victaulic Company, Series 771.

F. Wafer Check Valves: Mss Sp-71; Class 175, cast iron body and bolted cap conforming to ASTM A 126, Class B; Horizontal swing, with bronze disc ring, and flanged or grooved ends. Valve shall be capable of being refitted while the valve remains in the line.

G. Spring-Actuated Check Valves: UL listed and FM approved to 250 psi CWP, one-piece grooved end ductile iron body, with stainless steel spring and shaft for vertical or horizontal installation. Victaulic Series 717.

2.4 SPECIALTY VALVES

A. Reduced Pressure Principle Detector Backflow Preventors: 175 psig working pressure, flanged inlet and outlet, bronze or stainless steel internal assemblies, with removable seats. Provide trim set for bypass meter assembly.

2.5 AUTOMATIC SPRINKLERS

A. Sprinklers: Glass bulb type, style as indicated or required by the application. Unless otherwise indicated, provide sprinklers with nominal ½ inch discharge orifice, for “Ordinary” temperature range.

B. Sprinkler body shall be integrally cast with hex-shaped wrench boss to reduce the risk of damage during installation.

1. Wrenches shall be provided by the sprinkler manufacturer that directly engage the hex-shaped wrench boss integrally cast in the sprinkler body. Victaulic FireLock Series.

C. Sprinkler Finishes: Provide the following finishes:

1. Upright, Pendent, and Sidewall Styles: White polyester in finish spaces, exposed to view; rough bronze finish for heads in unfinished spaces and not exposed to view. Victaulic Model V27.

2. Concealed Style: Rough brass, with painted white cover plate. Refer to drawings for applicable areas. Victaulic Model V38 / V39.

3. Recessed Style: White polyester, with painted white escutcheon plate. Victaulic Model V27.

D. Sprinkler Cabinet and Wrench: Finished steel cabinet, suitable for wall mounting, with hinged cover and space for 6 spare sprinkler heads plus sprinkler head wrench. Provide a separate cabinet for each style sprinkler head on the project. Victaulic ‘SA’ Series cabinet.

2.6 FIRE DEPARTMENT CONNECTIONS

A. Wall Type Siamese Connections: Polished cast brass, flush wall type, with wall escutcheon and two-way connections. Connection sizes shall be 4 inch outlet and two 2 –1/2 inch female inlets, having NH standard threads, for the connection size indicated, as specified in NFPA 1963. Each inlet shall have a clapper valve, and plug and chain. Unit shall have wall escutcheon of cast brass, finish to match connections, with words “AUTO SPKR & STANDPIPE – FIRE DEPT. CONNECTION” in raised letters.

B. At the low-point near each fire department connection, install a 90-degree elbow with drain connection to allow for system drainage to prevent freezing. Elbow shall be Victaulic #10-DR.

2.7 EQUIPMENT BASES

A. Construct concrete equipment pads of dimensions indicated.

B. Concrete: Portland cement mix, 4,000 psi.

1. Cement: ASTM C 150, Type I.

2. Fine Aggregate: ASTM C 33, Sand.

3. Course Aggregate: ASTM C 33, crushed gravel.

C. Reinforcement: Steel conforming to the following:

1. Fabric: ASTM A 185, welded wire fabric, plain.

2. Reinforcement Bars: ASTM A 615, Grade 60, deformed.

2.8 ALARM DEVICES

A. General: Types and sizes shall mate and match piping and equipment connections.

B. Alarm Pressure Switch: General service switch rated to 175 psi; 2-SPDT circuit switches to provide isolated alarm and auxiliary contact; 15 amp 125 Volts AC and 2 amp 24 Volts DC; factory set to transfer contracts at 4 – 8 psi on pressure rise.

C. Water Flow Switch: Vane type waterflow detector, rated to 250 psig; designed for horizontal or vertical installation; have 2-SPDT circuit switches to provide isolated alarm and auxiliary contacts, 7 ampere 125 volts AC and 0.25 ampere 24 Volts DC; complete with factory-set, field-adjustable retard element to prevent false signals, and tamper-proof cover which sends a signal when cover is removed.

D. Supervisory Switches: SPST, normally closed contacts, designed to signal valve in other than full open position.

PART 3 – EXECUTION

3.1 PIPE APPLICATIONS

A. Provide pipe and fittings as indicated below, selection is Installer’s option.

B. Install Schedule 40 steel pipe with threaded joints and fittings for 2 inch and smaller.

a. Schedule 5 pipe with Pressfit couplings and fittings at the Contractor’s option.

C. Install Schedule 40 steel pipe with roll-grooved or cut-grooved ends and grooved mechanical couplings.

D. Install Schedule 10 steel pipe with roll-grooved ends and grooved mechanical couplings.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. So far as practical, install piping as indicated.

1. Deviations from approved “Working Plans” for sprinkler piping, require written approval of the authority having jurisdiction. Written approval shall be on file with the Architect prior to deviating for the approved “Working Plans.”

B. Coordinate installation with other mechanical installations and building components.

C. Install sprinkler piping to provide for system drainage in accordance with NFPA 13.

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

E. Install unions in pipes 2 inch and smaller, adjacent to each valve. Unions are not required on flanged devices or in piping installations using grooved mechanical couplings.

F. Install flanges or flange adaptors on flanged valves, apparatus, and equipment having 2-1/2 inch and larger flanged connections.

G. Hangers and Supports: Comply with the requirements of NFPA 13 and NFPA 14. Hanger and support spacing and locations for piping joined with grooved mechanical couplings shall be in accordance with the grooved mechanical coupling manufacturer’s written instructions, for rigid systems. Provide protection from damage where subject to earthquake in accordance with NFPA 13.

H. Provide pipe penetrations in walls and floors as specified in Division 23 Section “Basic Mechanical Materials and Methods”, and Division 7 Section “Firestopping.”

I. Install test connections sized and located in accordance with NFPA 13 complete with shutoff valve. Test connections may also serve as drain pipes.

J. Install pressure gage on the riser or feed main at or near each test connection. Provide gage with a connection not less than ¼ inch and having a soft metal seated globe valve, arranged for draining pipe between gage and valve. Install gages to permit removal, and where they will not be subject to freezing.

3.3 PIPE JOINT CONSTRUCTION

A. Welded Joints: AES D10.9, Level AR-3.

B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads.

4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.

5. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

D. Mechanical Grooved Joints: Cut or roll grooves on pipe ends dimensionally compatible with the couplings. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)

E. End Treatment: After cutting pipe lengths, remove burrs and fins from pipe ends.

3.4 VALVE INSTALLATION

A. General: Install fire protection valves, fittings, and specialties in accordance with the manufacturer's written instructions, NFPA 13 and 14, and the authority having jurisdiction.

B. Butterfly Valves: Wafer and lug styles require flanges both upstream and downstream for proper shutoff and retention. Install grooved end valves in accordance with manufacturer's instructions.

C. Gate Valves: Install supervised-open gate valves so located to control all sources of water supply except fire department connections. Where there is more than one control valve, provide permanently marked identification signs indicating the portion of the system controlled by each valve. Refer to Division 23 Section "Mechanical Identification" for valve tags and signs.

D. Reduced Pressure Principle Detector Assembly: Install improper direction of flow in location to detect system leakage and unauthorized use of water, and to prevent backflow into public water mains. Install bypass meter, with gate valves on each side of the meter to permit meter removal, and check valve downstream from the meter.

3.5 SPRINKLER INSTALLATIONS

A. Use proper tools to prevent damage during installations.

B. Locate sprinkler heads in exact center (in two directions) of ceiling tiles.

C. Allowances shall be made to increase the number of sprinkler heads to maintain symmetric and aesthetic appearance as determined by the Architect.

D. Sprinkler bulb protector shall be removed by hand after installation. Do not use tools or any other device(s) to remove the protector that could damage the bulb in any way.

E. Do not install sprinklers that have been dropped, damaged, or show a visible loss of fluid. Never install sprinklers with cracked bulbs.

3.6 FIRE DEPARTMENT CONNECTION INSTALLATIONS

A. Install automatic drip valve near the fire department connection.

B. Install mechanical sleeve seal at pipe penetration in outside walls.

3.7 FIELD QUALITY CONTROL

A. Flush, test and inspect sprinkler piping systems in accordance with NFPA 13.

B. Replace piping system components which do not pass the test procedures specified, and retest repaired portion of the system.

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SECTION 220500 - BASIC PLUMBING REQUIREMENTS

PART 1 – GENERAL

SUMMARY

A. This section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1.

1. Related Documents
2. General Mechanical Provisions
3. Codes, ordinances, permits, fees, or assessments
4. Submittals
5. Record Documents
6. Maintenance Manuals
7. Delivery, storage and handling
8. Protection
9. Completion of work
10. Temporary Services
11. Rough-ins
12. Cutting and Patching
13. Substitutions

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 22. Each Division 22 Section applies where applicable to all other Division 22 Sections.

1.02 GENERAL MECHANICAL PROVISIONS

A. The work in this Division shall consists of furnishing all labor, materials, accessories, equipment, transportation, supervision, start-up services, instructions, permits and incidentals, and related items necessary to complete installation and successfully test, start-up and operate, in a practical and efficient manner, all mechanical work and systems indicated on the drawings and described in each Section of this Division. The work shall also include any items which, while not specifically included in these specifications or drawings, are reasonable and properly inferable therefrom or are accepted trade practice or necessary for the proper completion of this System.

B. The General Requirements of these specifications govern all portions of this heating, ventilating and plumbing system and will apply in full force to this contract.

C. Submission of a Bid Proposal is considered evidence that a contractor has visited the site, examined the drawings and specifications of all Trades and has fully informed himself as to project and site conditions and is proficient, experienced and knowledgeable of all state, local and federal standards, codes, ordinances, permits and regulations which affect every subcontractor trade’s completion, cost and time required and that all costs are included in his Bid Proposal.

D. The Contractor shall be responsible for all Subcontractors and suppliers, and shall include in his Bid Proposal and properly apportion, all materials, labor and equipment to the Subtrades.

E. All labor, materials and equipment shall be guaranteed by the Contractor and/or warranted by the manufacturer for one calendar year after date of final acceptance, except where specific, longer periods are specified. Make all necessary alterations, repairs, adjustments and replacements during guarantee period as directed by Engineer to comply with drawings and specifications. Such work shall be at no cost to the Owner.

F. Provide the service of factory-trained personnel for such periods of time as required to instruct the Owner's personnel on operation and maintenance of installed equipment.

G. This Contractor shall have in charge of the work at all times during construction a thoroughly competent Field Superintendent with experience in the work to be installed under this contract.

H. Where a conflict exists between the drawings and specifications it shall be immediately brought to the engineer's attention. If such a conflict is not resolved before work commences, contractor shall provide the most work of greatest value.

I. All products shall be installed per the manufacturers written instructions. Where a conflict exists between the contract documents and the manufacturer's instructions, the engineer shall be notified immediately to resolve the conflict.

1.03 CODES, ORDINANCES, PERMITS, FEES OR ASSESSMENTS

A. All work and materials shall be installed in accordance with the standards as described by local and state codes or ordinances including the rules of the National Plumbing Code, National Board of Fire Underwriters, American Standards Association, and with the prevailing rule and regulations pertaining to adequate protection and guarding of any moving parts or otherwise hazardous locations.

B. Should the drawings or specifications call for sizes and grades different than required by the governing code, this Contractor shall furnish and install the larger size of the higher grade.

C. In addition, this Contractor shall give all notices, file all drawings, obtain all necessary approvals, obtain all permits, pay for all fees, deposits and expenses required for installation of all work under this contract, as stated therein and in the General Requirements. In such instances where permits are not required, the contractor shall engage a third party, preferably the local official, to inspect the work.

D. In addition to all applicable federal, state and local codes, the standards and codes listed below shall apply to all mechanical work. Where standards or codes are mentioned in these specifications, the latest edition or revision shall be followed; hence, the specified numbers may be suspended by new numbers.

1. American National Standard Institute (ANSI)
2. American Society for Testing Materials (ASTM)
3. American Society of Mechanical Engineers (ASME)
4. American Water Works Association (AWWA)
5. Air Moving and Condition Association, Inc (AMCA)
6. Air Diffusion Council (ADC)
7. American Society Heating, Ventilating and Refrigerating and Air Conditioning Engineers (ASHRAE)
8. National Electrical Manufacturer's Association (NEMA)
9. American Refrigeration Institute (ARI)
10. ANSI Code of Pressure Piping and Unfired Pressure Vessels

11. Cast Iron Soil Pipe Institute
12. Underwriter's Laboratories (U.L.)
13. National Fire Protection Association (NFPA)
14. American Gas Association (AGA)
15. Occupational Safety and Health Administration (OSHA)
16. Sheet Metal and Air Conditioning National Association (SMACNA)

1.04 SUBMITTALS

A. General

1. Follow the procedures specified in Division 1 Section, Submittals.

1.05 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1 Section, Project Closeout. In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 22 Section, Mechanical Identification. Indicate actual inverts and horizontal locations of underground piping.
2. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
3. Contract Modifications, actual equipment and materials installed.

1.06 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section, Project Closeout. In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Deliver products adequately packaged and protected to prevent damage during shipment, storage, and handling.

C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

D. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

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

F. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

G. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.08 PROTECTION

A. All work, fixtures, equipment and materials shall be protected at all times. Contractor shall make good all damages caused, whether directly or indirectly, by his workmen. Work shall be properly protected to prevent obstruction or damage. All duct and pipe openings shall be closed with caps and plugs during installation. All fixtures and equipment shall be tightly covered and protected against dirt, water, chemical and mechanical injury. At completion, all Work shall be thoroughly cleaned and delivered in a perfect, unblemished condition.

1.09 COMPLETION OF WORK

A. Systems Verifications: The Installer shall start-up, adjust and operate every phase of the plumbing for verification that each system is complete and operational. Each shall be operated separately or in conjunction one with the other, for a sufficient period of time to demonstrate to the entire satisfaction of the Owner's Representative the ability of the equipment to meet capacity and performance requirements while maintaining design conditions as shown on the Construction Documents.

B. Provide the services of Contractor's personnel with experience on this project in electrical, mechanical and temperature control systems to operate the systems in the presences of Owner's representative for system verification.

1.10 TEMPORARY SERVICES

A. Where used for temporary services, Installer shall be responsible for proper operation, safety and protection of their systems and equipment, and maintenance and lubrication as required.

B. If used for temporary services, all warranties on equipment shall still start after the date of final acceptance.

1.11 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with requirements of the actual equipment to be connected.

B. Refer to equipment specifications in other divisions for rough-in requirements.

1.12 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with Division 1 Section, Cutting and Patching. In addition to the requirements specified in Division 1, the following requirements apply:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting and patching of mechanical equipment and materials required to:

1. Uncover work to provide installation of ill-time work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Cut, channel, chase and drill floors, wells, partitions, ceilings and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
7. Upon written instructions from the Architect, uncover and restore work to provide for Architect/Engineer observation of concealed work.

C. Cut, remove and legally dispose of selected mechanical equipment, components and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new work.

D. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.

E. Protect and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

F. Patch existing finished surfaces and building components using new materials matching existing materials and utilizing experienced installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

1. Refer to Division 1 Section, Definitions and Standards, for definition of "experienced installer".

G. Holes and openings shall be neatly cut and minimum size to allow the Work to be installed. Patching is to match adjacent surfaces in materials and finish. All patching is to be done in a neat and workmanlike manner.

H. The odor and fumes or dust from flame cutting or power blade cutting must be controlled to assure it will not enter the occupied spaces of the facility. Cutting or other odor causing operations must be controlled or scheduled for non-occupied time.

1.13 SUBSTITUTIONS

A. This Contractor shall be considered liable for all added costs both to himself and others (including those costs as incurred by the Engineer, for redesigning or redrawing) resultant from the substitution of products not the basis of the design.

B. This Contractor shall be responsible for the verification of adequate space (considering dimensions, required clearances, weights, and roughing-in requirements) for the installation of items or systems not the basis of the design. He shall be responsible for advising all other trades. He shall submit revised drawing layouts for the approval of the Engineer and shall not proceed without his approval.

END OF SECTION 220500

SECTION 220505 – BASIC PLUMBING MATERIALS AND METHODS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 22 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Field-fabricated metal equipment supports.
3. Installation requirements common to equipment specification Sections.
4. Fire Stop Systems.
5. Touch-up painting and finishing.

B. Pipe and pipe fitting materials are specified in piping system Sections.

1.2 DEFINITIONS

A. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

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

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

E. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts, also roof top locations.

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

1.3 QUALITY ASSURANCE

A. Qualify welding processes and operators for piping according to ASME “Boiler and Pressure Vessel Code,” Section IX, “Welding and Brazing Qualifications.”

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

B. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are

specified, the equipment must meet the design requirements and commissioning requirements.

1.4 SEQUENCING AND SCHEDULING

A. Coordinate with all other trades.

B. Coordinate all work with owner's schedule.

C. Coordinate connection of electrical services.

D. Coordinate connection of temperature control services.

1.5 FIRE STOP SYSTEMS

A. Mechanical Contractor shall furnish and install all fire stop systems required at all piping penetrations through rated walls and floors.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.

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

2.2 JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 15 for special joining materials not listed below.

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

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

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

b. AWWA C110, rubber, flat face, 1/8 inch thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.

D. Plastic Pipe Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, except where other type or material is indicated.

E. Solder Filler Metal: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10 percent lead content.

2. Alloy E: Tin (approximately 95 percent) and copper (approximately 5 percent) having 0.10 maximum lead content.
3. Alloy HA: Tin-antimony-silver-copper-zinc, having 0.10 percent maximum lead content.
4. Alloy HB: Tin-antimony-silver-copper-nickel, having 0.10 percent maximum lead content.

F. Brazing Filler Metals: AWS A5.8.

1. BcuP Series: Copper-phosphorus alloys.
2. Bag1: Silver alloy.

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

H. Solvent Cements: Manufacturer's standard solvents complying with the following:

1. Poly (Vinyl Chloride) (PVC): ASTM D 2564.
2. Acrylonitrile-Butadiene-Sytrene (ABS): ASTM D 2235.
3. Chlorinated Poly (Vinyl Chloride) (CPVC): ASTM F 493.

I. Plastic Pipe Seals: ASTM F 477, elastomeric gasket.

J. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon steel bolts and nuts.

2.3 PIPING SPECIALTIES

A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type where required to conceal protruding fittings and sleeves.

1. Inside Diameter: Closely fit around pipe, tube, and insulation.
2. Outside Diameter: Completely cover opening.
3. Cast Brass: One-piece, with set-screw.

    a. Finish: Rough brass.
    b. Finish: Polished chrome plate.

4. Cast Brass: Split casting, with concealed hinge and set-screw.

    a. Finish: Rough brass.
    b. Finish: Polished chrome plate.

5. Stamped Steel: One-piece, with set-screw and chrome-plated finish.
6. Stamped Steel: One-piece, with spring clips and chrome-plated finish.
7. Stamped Steel: Split plate, with concealed hinge, set-screw, and chrome-plated finish.
8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
9. Cast-Iron Floor Plate: One-piece casting.

B. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

1. Dielectric Couplings: Galvanized-steel coupling, having inert and non-corrosive, thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 ° F temperature.
2. Dielectric Nipples: Electroplated steel nipple, having inert and non-corrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig working pressure at 225 ° F temperature.

C. Dielectric Unions: Assembly having isolation characteristics used to join dissimilar metals to prevent galvanic action and stop corrosion.

1. Description: Ground joint, copper unions, ASME B16.18, cast-copper-alloy body, hexagonal stock, with ball-and socket-joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends; and suitable system fluid, pressure and temperature.

a. Threaded Ends: Threads conforming to ASME B1.20.1.

D. Mechanical Sleeve Seals: Modular, watertight mechanical type. Components include interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connecting bolts and pressure plates cause rubber sealing elements to expand when tightened.

E. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:

1. Steel Sheet-Metal: 24-gage or heavier galvanized sheet metal, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Cast-Iron: Cast or fabricated wall pipe equivalent to ductile-iron pressure pipe, having plain ends and integral water stop, except where other features are specified.

2.4 FIRE STOP SYSTEMS

A. Elastomeric Fire-stop Sealant

1. Metal Pipe
2. Where pipe movement or vibration is expected
3. Construction joints

B. Intumescent Fire-stop Sealant

1. Plastic pipe – closed or vented piping systems
2. Single and bundled cables
3. Insulated metal pipes

C. High Performance Fire-stop Sealant

1. Metal pipe – static conditions and sleeved openings

D. Trowelable Fire-stop Compound

1. Large openings

a. Cable trays
b. Electrical busway
c. Multiple metal pipes

E. Fire Barrier Collar

1. Plastic pipe – 3”, 4”, 5” and 6”

F. Approved Supplies

1. Must be approved by State Fire Marshals Office

a. Hilti, Fire-stop Systems
b. Fire Protection Systems, Incorporated

PART 3 – EXECUTION

3.1 PLUMBING INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

1. Coordinate 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 plumbing 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 or dimensioned, install systems, materials, and equipment to provide the maximum headroom possible.
7. Coordinate connection of plumbing 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. 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 Architect/Engineer.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install 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. Extend grease fittings to an accessible location.
11. Coordinate requirements for access panel and doors where mechanical items requiring access 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. Coordinate the cutting and patching of building components to accommodate the installation of equipment and materials.
14. Coordinate the installation of materials and equipment above ceilings with suspension system, light fixtures, and other installations.

15. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.
16. Should any structural difficulties prevent the installation of the piping, ductwork, fixtures or equipment at the points shown on the drawings, necessary deviations therefrom as determined by the Architect/Engineer will be permitted, and shall be made without additional costs.
17. Drawings are diagrammatic with no attempt made to show every ell, tee, transition, fitting, etc. All ducts and pipes shall be run in spaces indicated as job conditions warrant, arranged for most convenient access for servicing with due consideration given to swing joints and to other Installers work. Provide all necessary offsets, rises and drops in piping and ductwork as required by building conditions at no additional cost to Owner. Provide connections to equipment with matching connection devices and transitions as required to make connections.
18. It is understood and agreed by the Installer that work herein described shall be complete in every detail, even though every item involved is not particularly mentioned. Installer shall be held to provide all labor and materials necessary for the work intended and described for a complete and operational system. Such materials shall include piping, valves, traps, gauges, controls, etc. This also includes equipment required by State and local codes.
19. Install piping free of sags or bends, with ample space between to permit proper insulation applications, and install at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
20. Installer shall bear as a part of his contract, any additional costs incurred in his work, other Installers' work and any additional costs incurred in architectural or engineering redesign as a result of installation of other than scheduled equipment.
21. Ceilings and ceiling suspension systems required to be removed to facilitate the installation of work. Work above those ceilings shall be removed, stored, protected, and reinstalled. This work is the responsibility of the Mechanical Installer who must employ the appropriate Trade Installers (Acoustical Ceiling for ceiling components and Electrical for lighting fixtures) to do the work.

3.2 PIPING SYSTEMS-COMMON REQUIREMENTS

A. General Locations and Arrangements: Drawings (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, except where deviations to layout are approved on coordination drawings.

B. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 22 specify piping installation requirements unique to the piping system.

1. Install piping at indicated slope.
2. Install components having pressure rating equal to or greater than system operating pressure.
3. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
4. Install piping free of sags and bends.
5. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.
6. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow ceiling panel removal.

7. Install piping to allow application of insulation plus 1-inch clearance around insulation.
8. Locate group of pipes parallel to each other, spaced to permit valve servicing.
9. Install fittings for changes in direction and branch connections.
10. Install couplings according to manufacturer's printed instructions.

3.3 ESCUTCHEONS

A. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:

1. Chrome-Plated Piping: Cast-brass, one-piece, with set-screw, and polished chrome-plated finish. Use split-casting escutcheons, where required, for existing piping.
2. Uninsulated Piping Wall Escutcheons: Cast-brass or stamped-steel, with set-screw.
3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
4. Insulated Piping: Cast-brass or stamped-steel, with concealed hinge, spring clips, and chrome-plated finish.
5. Piping in Utility Areas: Cast-brass or stamped-steel, with set-screw or spring clips.

3.4 PIPE PENETRATIONS

A. Sleeves are not required for core drilled holes.

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

2. Build sleeves into new walls and slabs as work progresses.
3. Install large enough sleeves to provide ¼-inch annular clear space between sleeve and pipe insulation. Use the following sleeve materials:

    a. Steel Pipe Sleeves: For pipes smaller than 6 inches.
    b. Steel Sheet-Metal Sleeves: For pipes 6 inches and larger that penetrate gypsum-board partitions.
    c. Cast-Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Flashing is specified in Division 7 Section "Flashing and Sheet Metal."

4. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants specified in Division 7 Section "Joint Sealants."

C. Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.

1. Install steel pipe for sleeves smaller than 6 inches.
2. Install cast-iron wall pipes for sleeves 6 inches and larger.
3. Assemble and install mechanical seals according to manufacturer's printed instructions.

D. Below Grade, Exterior Wall, Pipe Penetrations: Install cast-iron wall pipes for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.

E. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping sealant material. Firestopping materials are specified in Division 7 Section “Firestopping.”

3.5 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings as follows and as specifically required in individual piping system Sections.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Construct joints according to AWS “Soldering Manual,” Chapter 22 “The Soldering of Pipe and Tube.”
4. Brazed Joints: Construct joints according to AWS “Brazing Manual” in the “Pipe and Tube” chapter.
5. 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 inside diameter. Join pipe fittings and valves as follows:

    a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
    b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
    c. Align threads at point of assembly.
    d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
    e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

6. Welded Joints: Construct joints according to AWS D10.12 “Recommended Practices and Procedures for Welding Low Carbon Steel Pipe” using qualified processes and welding operators according to the “Quality Assurance” Article.
7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
8. Plastic Pipe and Fitting Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following standards:

    a. Comply with ASTM F 402 for safe handling of solvent-cement and primers.
    b. Poly(Vinyl Chloride) (PVC) Pressure Aplication: ASTM D 2672.
    c. Poly(Vinyl Chloride) (PVC) Non-Pressure Application: ASTM D 2855.

3.6 PIPING CONNECTIONS

A. Except as otherwise indicated, make piping connections as specified below.

1. Install unions in piping 2 inches and smaller adjacent to each valve and at final connection to each piece of equipment having a 2-inch or smaller threaded pipe connection.
2. Install flanges in piping 2-1/2 inches and larger adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
3. Dry Piping Systems (Gas, Compressed Air, and Vacuum): Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems (Water): Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.7 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

A. Install equipment to provide the maximum possible headroom where 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 the Architect.

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

D. Install equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

E. Install equipment giving right-of-way to piping systems installed at a required slope.

F. All sprinklers, grilles, registers and diffusers shall be located in the center (in two directions) of the ceiling tile, except linear diffusers which shall be installed along one side. Any mechanical equipment installed which does not fit into the ceiling tile pattern will have to be relocated at no extra cost to the Owner.

3.8 PAINTING AND FINISHING

A. Refer to Division 9 Section “Painting” for field painting requirements.

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

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGE

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

B. Field Welding: Comply with AWS D1.1 “Structural Welding Code – Steel.”

3.10 ROOF PENETRATIONS

A. Provide roof penetrations as follows:

1. New roofs with or without warranty. Roof penetrations and curbs provided by Mechanical Installer with flashing provided by new Roof Installer.
2. Existing roofs with warranty. Roof penetrations and curbs provided by Mechanical

Installer with flashing provided by roof manufacturer's approved Installer with work done in such a manner to maintain existing warranty.

3. Existing roof without warranty. Roof penetrations and curbs provided by Mechanical Installer with flashing provided by Contractor.

END OF SECTION 220505

SECTION 220513 – MOTORS FOR PLUMBING EQUIPMENT

PART 1 – GENERAL

1.1 QUALITY ASSURANCE

A. Comply with NFPA 70, “National Electrical Code.”

B. NRTL Listing: Provide NRTL Listed motors.

1. Term “Listed”: As defined in “National Electrical Code,” Article 100.

PART 2 – PRODUCTS

2.1 MOTORS, GENERAL

A. General: Requirements below apply to motors covered by this Section except as otherwise indicated.

B. Motors ½ HP and smaller: Single phase.

C. Motors Larger Than ½ HP: Poly-phase.

D. Frequency Rating: 60 Hz.

E. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):

1. 120 V Circuit: 115 V – motor rating.
2. 208V Circuit: 200V – motor rating.
3. 240 V Circuit: 230 V – motor rating.
4. 480 V Circuit: 460V – motor rating.

F. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100 percent of rated capacity.

1. All motors 10 horsepower and above shall be approved for inverter duty control whether or not served by a variable frequency drive.
2. All motors 10 horsepower and above shall be “premium” with an efficiency of 93 percent or higher.

G. Temperature Rise: Based on 40 deg C ambient except as otherwise indicated.

H. Enclosure: Open drip proof, or as indicated.

I. Provide motors which will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.

2.2 POLYPHASE MOTORS

A. General: Squirrel-cage induction-type conforming to the following requirements except as otherwise indicated.

B. NEMA Design Letter Designation: “B.”

C. Insulation System: Class “F” or better.

D. Multi-Speed Motors: separate winding for each speed.

E. Energy Efficient Motors: Meeting EPACT efficiencies with nominal efficiency equal to or greater than that stated in NEMA MG 1, table 12-6C for that type of rating of motor.

F. Variable Speed Motors for Use with Solid-State Drives: Inverter duty, energy efficient, squirrel-cage induction, design B units with ratings, characteristics, and features coordinated with and approved by drive manufacturer. Provide with thermostats. Meet NEMA MG 1 part 31 and motors to be suitable for 10:1 speed range.

G. Internal Thermal Overload Protection for Motors: For Motors so indicated, protection automatically opens control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to the temperature rating of the motor insulation.

H. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading of the application.

I. Motors for Reduced Inrush Starting: Coordinate with indicated reduced inrush controller type and with characteristics of driven equipment load. Provide required wiring leads in motor terminal box to suit control method.

2.3 SINGLE-PHASE MOTORS

A. General: Conform to the following requirements except as otherwise indicated.

B. Energy Efficient Motors: One of the following types as selected to suit the starting torque and other requirements of the specific motor application.

1. Permanent Split Capacitor.
2. Split-Phase Start, Capacitor-RUN.
3. Capacitor-Start, Capacitor-Run.

C. Shaded-Pole Motors: Use only for motors smaller than 1/20 hp.

D. Internal Thermal Overload Protection for Motors: For motors so indicated, protection automatically opens the power supply circuit to the motor, or a control circuit arranged for external connection. Protection operates when winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation. Provide device that automatically resets when motor temperature returns to normal range except as otherwise indicated.

E. Bearings, belt connected motors and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single phase motors.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General: The following requirements apply to field-installed motors.

B. Install motors in accordance with manufacturer's published instructions and the following:

1. Direct Connected Motors: Mount securely in accurate alignment.
2. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

3.2 COMMISSIONING

A. Check operating motors, both factory and field-installed, for unusual conditions during normal operation. Coordinate with the commissioning of the equipment for which the motor is a part.

B. Report unusual conditions.

C. Correct deficiencies of field-installed units.

END OF SECTION 220513

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SECTION 220519 – METERS AND GAGES

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submittals: Submit manufacturer's product data for each type of meter and gage. Include certificates of accuracies, scale range and ratings and maintenance data for each type.

1.2 QUALITY ASSURANCE

A. Comply with ASME and ISA.

PART 2 – PRODUCTS

2.1 AVAILABLE MANUFACTURERS

A. Ashcroft.
B. Trerice.
C. Marsh Instrument Company.
D. Weiss Instruments.
E. Weksler.

2.2 PRESSURE GAGES

A. Description: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection, with the following features:

B. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.

C. Connector: Brass, ¼-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:

1. Vacuum: 30 inches Hg to 15 psi.
2. All fluids: 2 times operating pressure.

2.3 PRESSURE GAGE ACCESSORIES

A. Snubber: ¼-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

B. Cocks: ¼" ball valve, two piece, lever handle, 150 WSP, 600 WOG.

2.4 PRESSURE TEMPERATURE TAPPINGS

A. Nickel-plated brass body, with ½-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and body of length to extend beyond insulation. Pressure rating shall be 500 psig. Test plugs shall have the following additional features:

1. Core Material: Conform to the following for fluid and temperature range:

a. Air, Water, Oil and Gas, 20 to 200 degree F: Neoprene.
b. Air and Water, minus 30 degree to 275 degree F: EPDM.

2.5 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1 percent through out entire range of thermometer.

B. Scale range: -30°F to 300°F with permanently etched scale.

C. Plastic 9” long.

D. Red or blue reading liquid.

E. Adjustable connector with 180°F in the vertical plane and 360°F in the horizontal plane.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Piping installation requirements are specified in other sections of Division 22. The drawings indicate the general arrangement or piping, fittings, and specialties. The following are specific connection requirements:

B. Install meters and gages piping adjacent to machine to allow servicing and maintaining of machine.

C. Adjust thermometers and gages to proper angle to allow reading by observer standing on the floor.

D. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

E. Install pressure gages in piping tee with ball valve, located gage on pipe at most readable position.

F. Install gages where indicated.

G. Install Pressure Temperature Tapping test plugs in piping tee where indicated, located on pipe at most readable position. Secure cap.

H. Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer’s touch-up paint.

END OF SECTION 220519

SECTION 220523 – VALVES

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes general duty valves common plumbing piping systems.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Special purpose valves are specified in Division 22 piping system Sections.
2. Valve tags and charts are specified in Division 22 Section “Identification for Plumbing Piping and Equipment.”

1.2 SUBMITTALS

A. Submittals: Submit manufacturer’s technical data instructions on adjusting, servicing, disassembling and repairing; in accordance with requirements of Division 1 include list indicating valve and its application.

1.3 QUALITY ASSURANCE

A. Single-Source Responsibility: Comply with the requirements specified in Division 1 Section “Materials and Equipment,” under “Source Limitations” Paragraph.

B. Comply with ASME

C. Comply with MSS.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. Ball Valves:

a. Apollo/Conbraco
b. Watts
c. JamesBury

2. Butterfly Valves:

a. Crane
b. Bray
c. Apollo/Conbraco
d. Mueller

3. Swing Check Valves:

a. Crane
b. Watts

c. Stockham

4. Lift Check Valves:

a. Crane
b. Watts
c. Stockham

5. Valves for Grooved Piping Systems

a. Grooved End Butterfly Valves:

1. Anvil International Gruvlok Series 7700
2. Victaulic Style 300

b. Grooved End Ball Valves

1. Anvil International Gruvlok Series 7500
2. Victaulic Style 721

c. Grooved End Non Slam Check Valves

1. Anvil International Gruvlok Series 7800
2. Victaulic Style 716

d. Grooved end Circuit Balancing Valves

1. Anvil International Gruvlok
2. Victaulic

2.2 BASIC, COMMON FEATURES

A. Pressure and Temperature Ratings: As indicated in the “Application Schedule” of Part 3 of this Section and as required to suit system pressures and temperatures.

B. Sizes: Same size as upstream pipe, unless otherwise indicated.

C. Operators: Use specified operators, except provide the following special operator features:

1. Lever Handles: For quarter-turn valves 4 inches and smaller.
2. Gear-Drive Operators: For quarter-turn valves 6 inches and larger.

D. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

E. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

F. Threads: ASME B1.20.1.

G. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

H. Solder Joint: ASME B16.18.

1. Caution: Where soldered end connections are used, use solder having a melting point below 840 ° F for check valves; below 421 ° F for ball valves.

I. Grooved Ends: ASME / AWWA C606 for steel piping systems, and copper-tube dimensions for copper-tubing systems.

2.3 BALL VALVES

A. Ball Valves, 2 Inches and Smaller: MSS Sp-110, Class 150, 600-psi CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; chrome-plated brass ball, standard port for ½-inch valves and smaller and conventional port for ¾-inch valves and larger; blowout proof; bronze or brass stem; Teflon seats and seals; threaded or soldered end connections:

1. Operator: Vinyl-covered steel lever handle, or where indicated, lever operators with lock.
2. Stem Extension: For valves installed in insulated piping.
3. Memory Stop: For operator handles, where indicated.

B. Ball Valves 2½ Inches and Larger: Meets the intent of MSS SP-110, 800 psi CWP, ASTM A 536 ductile iron body, standard port chrome-plated carbon steel ball and stem, TFE seats, fluoroelastomer seals, grooved ends.

2.4 CHECK VALVES

A. Swing Check Valves, 2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections.

B. Swing Check Valves, 2½ Inches and Larger: MSS SP-71, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged end connections.

C. Lift Check Valves: Class 125, ASTM B 62 bronze body and cap (main components), horizontal or vertical pattern, lift-type, bronze disc or Buna N rubber disc with stainless-steel holder threaded or soldered end connections.

2.5 BUTTERFLY VALVES

A. Butterfly Valves, 2½ Inches through 12 Inches, Meets the intent of MSS SP-67, 300 psi CWP, ASTM A 536 ductile iron body, electroless nickel-plated ductile iron disc, blowout proof 416 stainless steel stem, disc shall be offset from stem centerline to provide full 360 degree seating, EPDM seat and seal material, TFE lined fiberglass bearings, lever handle or gear operator with memory stop feature, grooved ends. Valve shall be suitable for bi-directional, bubble tight shutoff and dead-end service.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

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

C. Operate valves from fully closed positions. Examine guides and seats made accessible by such operation.

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

E. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

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

3.2 INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 22 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

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

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

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

F. Install valves in a position to allow full stem movement.

G. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.
2. Lift Check Valve: With stem upright and plumb.

3.3 SOLDERED CONNECTION

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Remove the cap and disc holder of swing check valves having composition discs.

E. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.

F. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder stars cooling, remove excess amounts around the joint with a cloth or brush.

3.4 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assembly joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.5 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.6 VALVE END SECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2 Inches and Smaller: Solder ends, except provide threaded ends for heating hot water.
2. Steel Pipe Sizes, 2 Inches and Smaller: Threaded end.
3. Steel Pipe Sizes, 2½ Inches and Larger: Flanged and Grooved.

3.7 APPLICATION SCHEDULE

A. General Application: Use ball valves for shutoff duty; ball valves for throttling duty. Use ball valves with memory stop for balancing valves. Refer to piping system Specification Sections for specific valve applications and arrangements.

B. Domestic Water Systems: Use the following valve types:

1. Ball Valves: Class 150, 600-psi CWP, with stem extension.
2. Bronze Swing Check: Class 125, with rubber seat.
3. Check Valves: Class 125, swing type.

3.8 ADJUSTING

A. After piping systems have been tested and put into service, but before final adjusting and balancing, adjust or replace leaking packings. Replace valves if leak persists.

END OF SECTION 220523

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SECTION 220529 – SUPPORTS AND ANCHORS

PART 1 – GENERAL

1.1 QUALITY ASSURANCE

A. Comply with applicable plumbing and mechanical codes.

B. Comply with NFPA.

C. Comply with UL and FM.

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

A. Description: Hangers and support components shall be factory fabricated of materials, design and manufacturer complying with MSS SP-58. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

2.2 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

PART 3 – EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers, supports, and or miscellaneous steel, clamps and attachments to support piping properly from building structure; comply with MSS SP-69 and SP-89. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69 or as specified in other Division 22 sections for individual piping systems. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above fore individual pipe hangers.

B. Install building attachments within concrete, or to structural steel. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.

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

D. Field-Fabricated, Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS D-1.1.

E. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between expansion loops, expansion bends and similar units.

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

G. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

H. Insulated Piping: Comply with the following installation requirements.

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
3. Shields: Install protective shields MSS Type 40 on cold water piping that has vapor barrier. Shield shall span an arc of 180 degrees and shall have dimensions in inches not less than the following:

NPS	LENGTH	THICKNESS
¼ through 3	12	0.048
4	12	0.060
6	18	0.060

I. Vibrating Equipment: The first three hangers on piping from any piece of vibrating equipment shall incorporate a vibration isolator.

3.2 EQUIPMENT SUPPORTS

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

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

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

3.4 ADJUSTMENT

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

3.5 PAINTING

A. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

B. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

C. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 220529

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SECTION 220553 –IDENTIFICATION FOR PLUMBING PIPING AND EQUIPMENT

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submit product data for identification materials and devices in accordance with Conditions of Contract and Division 1 Specifications Section.

B. Valve Schedules: Submit valve schedules for each piping system. Reproduce on standard-size bond paper. Tabulate valve number, piping systems, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification. Mark valves intended for emergency shutoff and similar special uses. Furnish extra copies (in addition to mounted copies) for Maintenance Manuals as specified in Division 1 Section “Project Closeout”. One Valve Schedule (framed and mounted under glass) shall be mounted on the wall in the Boiler Room and the Chiller Room.

1.2 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color filed, colors, viewing angles of identification devices.

1.3 SEQUENCING AND SCHEDULING

A. Coordinate installation of identifying devices after completion of covering and painting where devices are applied to surfaces. Install identifying devices prior to installation of acoustical ceilings and similar concealment.

PART 2 – PRODUCTS

2.1 IDENTIFYING DEVICES AND LABELS

A. General: Products specified are manufacturer’s standard products of categories and types required for each application as referenced in other Division 22 Sections. Where more than single type is specified for listed application, selection is Installer’s option, but provide single selection for each product category.

B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped, permanently fastened to equipment.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances and similar essential data.
2. Location: An accessible and visible location.

C. Stencils: Standard stencils, prepared with letter sizes conforming to recommendations of ASME A13.1. Minimum letter height is 1-1/4 inches for ducts and ¾ inch for access door signs and similar operational instructions.

1. Material: Fiberboard or brass.
2. Stencil Paint: Exterior, oil-based alkyd gloss black enamel, except as otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, oil-based alkyd enamel in colors according to ASME A13.1, except as otherwise indicated.

D. Snap-On Plastic Pipe Markers: Manufacturer's standard pre-painted, semi-rigid snap-on, color-coded pipe markers conforming to ASME A13.1.

1. Pipes Smaller than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.
2. Pipes 6 Inches and Larger: Strip-type pipe markers, at least 3 times the letter height and of length required for label, with mounting bands.

E. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated.

1. Fabricate in sizes required for message.
2. Engraved with engraver's standard letter style, of sizes and with working to match equipment identification.
3. Punch for mechanical fastening.
4. Thickness: 1/8-inch, except as otherwise indicated.
5. Fasteners: Self-tapping stainless-steel screws.

F. Lettering: Use piping system terms as indicated and abbreviate only as necessary for each application length.

1. Arrows: Either integrally with piping system service lettering (to accommodate both directions), or as separate unit, on each pipe marker to indicate direction of flow.

G. Valve Tags: Stamped or engraved with ¼-inch letters for piping system abbreviation and ½-inch sequenced numbers. Provide a 5/32-inch hole for fastener.

1. Material: 19-gage polished brass.
2. Size: 1-1/2-inch diameter, except as otherwise indicated.

H. Valve tag fasteners: Brass wire-link chain, beaded chain, or S-hooks.

I. Valve Schedule Frames: Glazed display frame, with screws for removable mounting on walls for each page of valve schedule.

1. Frame: Rigid plastic.
2. Glazing: ASTM C 1036, 2.5 mm, single thickness, sheet glass.

a. Type: Type I, flat transparent.
b. Class: Class 1, clear.
c. Quality: Glazing B, for general applications.

J. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.

PART 3 – EXECUTION

3.1 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Stenciled Markers: Complying with ASME 13.1.
2. Plastic markers, with application systems. Install on pipe insulation.

    a. Fasten markers on pipes smaller than 6 inches by the following method:

        i. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

    b. Fasten markers on pipes 6 inches and larger the following method:

        i. Strapped to pipe (or insulation) with manufacturer's standard bands.

2. Locate pipe markers as follows wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

    a. Near each valve and control device.
    b. Near each branch connection, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where flow is not obvious.
    c. Near penetrations through walls, floors, ceilings, or enter non-accessible enclosures.
    d. At access doors, manholes, and similar access points that permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.
    f. Spaced at a maximum of 50-foot intervals along each run. Reduce intervals to 25 feet in congested areas of piping and equipment.

B. Valve Tags: Install valve tag on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shut-off valves, conveniences and lawn-watering hose bibs, and similar roughing-in connections of end-use fixtures and units. Install by using logical, sequential and unique order. Install mounted valve schedule in each major equipment room. List tagged valves in valve schedule.

    1. Water Heaters.
    2. Pumps.

C. Equipment: Install equipment markers on or near each major item of mechanical equipment. Provide signs for following general categories of equipment:

    1. Water Heater.
    2. Pumps.

3.2 ADJUSTING AND CLEANING

A. Relocate mechanical identification materials and devices which have become visually blocked by work of this Division or other Divisions.

B. Clean face of identification devices, and glass frames of valve charts.

END OF SECTION 220553

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SECTION 220700 – PLUMBING INSULATION

PART 1 – GENERAL

1.1 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, r-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.2 QUALITY ASSURANCE

A. All mechanical insulation work shall be performed by a recognized insulation subcontractor with successful installation experience on projects with mechanical insulations similar to that required for this project.

B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. Armstrong World Industries, Inc.
2. Halstead.
3. NOMACO IMCOA.
4. Knauf Fiber Glass Corp.
5. Johns Manville.
6. Owens-Corning.

2.2 PIPING INSULATION MATERIALS

A. General: Refer to system descriptions below for identification of systems where the below specified insulation materials are used.

B. Fiberglass Piping Insulation: Rigid one piece pipe insulation made form glass fibers bonded with thermosetting resin, with foil reinforced kraft paper vapor retarder jacket. ASTM C-547, Class 1.

C. Flexible Unicellular Piping Insulation: Expanded closed-cell structure flexible elastomeric thermal insulation, ASTM C-534 Type 1.

D. Flexible Polyolefin Piping Insulation: Closed-cell flexible thermal insulation.

E. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

F. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

PART 3 – EXECUTION

3.1 INSTALLATION OF PIPING INSULATION

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

F. Cover all valves, fittings and similar items in each piping system unless otherwise indicated, with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints with 3" wide vapor barrier tape or band.

I. Provide protective covering on all exterior piping insulation.

3.2 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

C. Any damages that occur due to condensation from improper insulation covering piping, valves, tanks, hangers, ducts and equipment, the cost to repair such damages will be charged to the Insulation Installer.

3.3 PLUMBING SYSTEM APPLICATIONS

A. Insulation Omitted: Omit insulation on chrome-plated exposed piping, air chambers, unions, strainers, check valves, balance cocks, flow regulators, drain lines from water coolers, fire protection piping, and pre-insulated equipment.

B. Cold Piping: Insulate the following cold plumbing piping systems with Fiberglass insulation, ½" thick, (1" diameter and under) or 1" thick (over 1" diameter) :

1. Potable cold water piping.
2. Interior above-ground storm water piping, vertical up to roof drains and overflow roof drains, including drain body, sump receiver pans, and all horizontal runs.

C. Hot Piping: Insulate the following hot plumbing piping systems with Fiberglass insulation, ½" thick, (1" diameter and under) or 1" thick (over 1" diameter) :

1. Potable hot water piping.
2. Potable hot water return piping.

END OF SECTION 220700

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SECTION 22 0800 – COMMISSIONING OF PLUMBING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. DID and BoD documents are included by reference for information purposes only.

1.2 SUMMARY

A. Section includes requirements that apply to the commissioning process

1.3 DEFINITIONS

A. DID: Design Intent Document. A document that details the functional requirements of a project and the expectations of how it will be used and operated. The include Project goals, measurable performance criteria, cost considerations, benchmarks, success criteria, and supporting information.

B. BoD: Basis of Design. A document that records concepts, calculations, decisions, and product selections used to meet the DID and to satisfy applicable regulatory requirements, standards, and guidelines. The document includes both narrative descriptions and lists of individual items that support the design process.

C. CxA: Commissioning Authority.

D. Commissioning Plan: A document that outlines the organization, schedule, allocation of resources and documentation requirements of the commissioning process.

1.4 GENERAL PROVISIONS

A. Attention is directed to the Contract, General Conditions, and all sections within Division 1 – General Requirements that are hereby made part of this Section of the Commissioning Specifications.

B. Examine all Sections of the Specifications for requirements that affect work under this Section.

C. This Section of the Contract is set aside to incorporate current Commissioning contract requirements and to be the document by which this Section of the Contract will be built into the Final Commissioning Report.

D. The Final Commissioning Report may also be that document by which LEED™, Additional Commissioning Point Criteria compliance is met and complies with the Re-commissioning Manual.

E. Commissioning: Commissioning is a systematic process of ensuring that all building systems perform interactively according to the design intent and the Owner's operational needs. This is achieved by beginning in the design phase and documenting design intent and continuing through construction, acceptance and the warranty period with actual verification of

performance. The commissioning process encompasses and coordinates the traditionally separate functions of system documentation, equipment start-up, control system calibration, testing and balancing, performance testing and training.

F. Commissioning Objective: To have the Contractor complete a comprehensive system readiness process followed by system demonstration to the Commissioning Team with the Commissioning Firm providing the documentation/verification of the building systems that they perform in accordance with the requirements of the contract documents. In addition, the commissioning process may be compliance with the prerequisite (and additional commissioning credit) compliance with LEED™ certification.

1.5 SUBMITTALS

A. Commissioning Plan

B. Commissioning Report

C. Certificates of Readiness

D. Certificates of Completion

1.6 COMMISSIONING PROCESS (CONSTRUCTION PHASE UP THRU WARRANTY PHASE OF PROJECT)

A. The Owner shall champion the commissioning process with the Commissioning Firm to commission the building systems to the quality standards and procedures specified herein.

B. The General Contractor (or Construction Manager) shall work closely with the Commissioning Firm in establishing and maintaining the schedule of commissioning events for the commissioning of systems and activities noted below.

C. Commissioning of the selected systems shall consist of demonstration and documentation of system readiness prior to demonstration using the PFPT checklists. The PFPT shall be developed and provided to the Contractors by the Commissioning Firm and shall be used in concert with the suggested manufacturer start-up checklists as part of contract start-up.

D. Commissioning of the selected systems shall consist of demonstration of the interactive system operation through the use of finalized Functional Performance Test (FPT) narratives. The FPT narratives shall be completed with input during the Construction Phase from the Contractor and used to verify operation per design intent through all modes and conditions. Facility staff shall participate and receive on-the-job training during the Functional Performance Testing.

E. Prior to Project Closeout, the Commissioning Firm shall work with the Contractor to compile the Re-Commissioning Management Manual.

F. In the Post-Construction Phase, the Commissioning Firm shall facilitate a 10-month Warranty/Project Closeout meeting.

1.7 SYSTEMS TO BE COMMISSIONED (LIST SYSTEMS TO BE COMMISSIONED)

A. Systems to be commissioned shall be listed below. Systems include all interconnected components and are not limited to the equipment listed within this specification.
   1. Plumbing Systems
   2. Fire Alarm Systems

3. Medical Gas Systems

1.8 COMMISSIONING ACTIVITIES

A. Construction Phase:
1. Draft Pre-functional Performance Test Checklists for insert into the Commissioning Report.
2. Draft Functional Performance Test narratives for insert into the Commissioning Report.
3. Facilitate a Commissioning Team Kick-off Meeting with handouts referencing Commissioning Task Schedule to provide a Commissioning Education Platform to the Commissioning Team.
4. Participate in regularly scheduled commissioning field coordination meetings facilitated by the Commissioning Firm at 4-6 week intervals (1-2 week intervals the last three months prior to completion) with the Contractor, Subcontractor, installing trade subcontractors, ATC subcontractor and TAB subcontractor. The purpose of the meetings will be to review the status of commissioning activities, schedule future activities, and resolve commissioning process issues.
5. Respond to comments on submittals that have been reviewed for commissionability.
6. Respond to comments on mechanical and electrical coordination drawings that have been reviewed for commissionability.
7. Observe and document Pre-Functional Performance Tests for systems being commissioned.
8. Observe and document Functional Performance Tests for systems being commissioned.
9. Participate in System Education/Training

B. Post-Construction Phase:
1. Facilitate in a Warranty/Project Closeout meeting at month 10.
2. Perform seasonal/deferred functional performance testing.
3. Complete Final Commissioning Report document.

PART 2 - PRODUCT

2.1 COMMISSIONING DOCUMENTATION

A. The Trade Contractors shall provide the following documentation for inclusion in the commissioning report:
1. Startup Reports
2. Completed Pre-Functional Test Checklists (blank checklists are provided by the CxA).
3. Certificate of Readiness certifying that installation, prestart checks, and startup procedures have been completed (blank certificates are provided by the CxA).
4. Certificate of Completion certifying that systems, subsystems, equipment, and associated controls are ready for testing (blank certificates are provided by the CxA).
5. Test and Inspection Reports and Certificates

B. The CxA shall provide the following documentation for inclusion in the commissioning report:
1. A commissioning plan that outlines the process for delivery and review of submittals, system manuals, process and schedule for completing pre-functional checklists, startup reports, and functional testing.
2. Identification of installed systems, assemblies, equipment, and components including design changes that occurred during the construction phase.
3. Certificates of Readiness.
4. Certificates of Completion
5. Test and Inspection Reports and Certificates.

6. Corrective Action Log
7. Verification of Testing, Adjusting, and Balancing Reports.

2.2 COMMISSIONING TEAM

A. The Commissioning Team shall consist of representatives from the following parties involved in the design and construction of this facility:
   1. Owner's Project Manager
   2. Owner's Facility Manager
   3. Commissioning Firm
   4. Design Team Professionals (*associated with system to be commissioned*)
   5. General Contractor (or *Construction Manager)*
   6. Testing Adjusting & Balancing (TAB) Contractor
   7. Installation Contractors (associated with system to be commissioned)
   8. Equipment Manufacturers (*associated with system to be commissioned*)

2.3 COMMISSIONING RESPONSIBILITY MATRIX

Work Description	TAB	Mech Contr	Elec Contr	Temp Cntrl Contr	GC	CxA	Architect Engineer	Owner's Rep.
Develop Cx Plan				S	S	P	S	S
Coordinate Cx Activities				S	S	P		
Prepare Construction Checklist Packages / Prefunctional Checklists						P		
Complete Construction Checklist Packages / Prefunctional Checklists	S	S	S	S	P			
Start-up and Debug	S	S	S	S	P	S		S
Prepare FPT's				S		P	S	
Preform FPT's		S	S	P		S		
Prepare Final Cx Report						P		
Review Cx Report							P	S
TAB Work	P	S	S	S				
Verify TAB Report Validity	S					P	S	
Owner Training		S	S	S	P			
Prepare Operating Manual		S	S	S	P	S	S	

P = Primary Responsibility
S = Support Role

2.4 PRE-FUNCTIONAL PERFORMANCE TESTS NARRATIVES

1. The Pre-Functional Performance Test Checklists will be included in the Commissioning Plan. The Commissioning Plan will be distributed at the "Kickoff" Commissioning Mtg.
2. Using the enhanced Pre-Functional Performance Test Checklists, the Contractor and/or installation Subcontractor shall complete the Pre-Functional Test and submit the completed sign forms and other appropriate start-up sheets, but limited to the equipment manufacturer's start-up sheets. Subcontractor shall submit the completed forms, initialed by the technician in-charge and attach other appropriate start-up sheets including but not limited to equipment manufacturer's start-up sheets. TAB contractor's field reports, etc., prior to the start of the Owner demonstration of the Functional Performance Tests.

2.5 FUNCTIONAL PERFORMANCE TEST NARRATIVES

1. The Contractor shall review and comment on the test actions specified in the Draft Functional Performance Test Narratives located in the Commissioning Plan and return documents to the Commissioning Firm prior to system commissioning.
2. The Commissioning Firm shall revise the Functional Performance Test Narratives during the Construction Phase to incorporate any changes required to comply with the approved submittals and any contract document changes. The revised Functional Performance Test Narratives shall be issued as Final and Approved for Executed Documents.
3. The Contractor shall use the Functional Performance Test format to test the systems prior to demonstrating the Functional Performance Test to the Owner, Facility Manager and Commissioning Firm. The Contractor shall submit a completed and signed Final Functional Performance Test form as evidence that the Contractor and/or the installation Subcontractor have tested the systems.
4. The Contractor shall use the Final Functional Performance Test Narrative format to commission the building systems demonstrating the Functional Performance to the Owner. During the Owner demonstration all deficiencies that can be corrected within 10 minutes, may be completed. Any corrective measures that will require more than a 10-minute corrective measure, will be documented by then Commissioning Firm on a Corrective Action Log for re-testing at a later, scheduled date.
5. The Contractor shall respond to the CxA's Corrective Action Log depicting non-compliant system demonstration items to be corrected within (2) business days after receipt of Corrective Action Log. CxA shall distribute log via email to Contractor within (2) business days after demonstration of systems to Owner to ensure their ability to comply. Upon CxA's receipt of executed Corrective Action Log from Contractor, re-testing of system will be scheduled upon notifying Owner of such intent.
    a. The Contractor will be backcharged for CxA re-testing for manufacturer defects and/or the system requires more than one re-test.
    b. The Contractor shall, with the Owner's approval, back charge the system installation Subcontractor for any additional costs incurred by the Owner for re-testing including, but not limited to, additional consultant fees. Contractor shall reimburse the Owner.

PART 3 - EXECUTION

3.1 COMMISSIONING GOALS

A. The goal is to test/demonstrate the building systems to verify and document that they perform in accordance with the requirements of the contract documents and the BoD.
    1. A comprehensive, reusable Commissioning, Re-Commissioning, and Retro-Commissioning Plan
    2. Documented benefits from the Commissioning process

3. A Commissioning Specification/Plan that defines the trade contractors' responsibilities as part of the commissioning process.
4. Pre-Functional Performance Tests narratives to document the startup of equipment and systems and for future operation and maintenance information.
5. Functional Performance Tests narratives to document the system performance, verification process and for future Re-Commissioning, and Retro-Commissioning Plan(s), as well as a lesson plan for system training in the future.
6. A Re-Commissioning Management Manual for sustainable facility management.

3.2 COMMISSIONING TEAM MEMBER RESPONSIBILITIES

A. Owner Project Manager
1. Champion the commissioning process
2. Provide the Design Intent Document to the CxA and the Design Professionals.
3. Review and comment on any revisions to the Basis of Design Document.
4. Provide the Basis of Design Document, prepared by the Design Professional and approved by the Owner, to the CxA, and each contractor for use in developing the Commissioning Plan, systems manual, and operation and maintenance training plan.
5. Attend commissioning specific coordination meetings
6. Participate in Pre-Functional Performance Testing
7. Participate in Functional Performance Testing
8. Facilitate the Commissioning process.
9. Participate in system education/training.

B. Owner Facility Manager
1. Periodically visit the construction site to become familiar with the project equipment/system installation.
2. Attend all commissioning coordination meetings.
3. Review equipment, system and control submittals for compliance with Design Intent Document.
4. Work with other commissioning team members to review CMMS preventive maintenance work order system.
5. Work with other commissioning team members with system education/training.
6. Witness and, to the greatest extent possible, participate in the following commissioning activities:
    a. Initial equipment startup
    b. Testing, adjusting and balancing
    c. Component tests
    d. Pre-functional Performance Tests
    e. Functional Performance Test
7. Work with the Commissioning Team with interface of automatic control systems with existing building automation system.
8. Work with other Commissioning Team Members to complete equipment, panel and valve bar code/labeling and tagging.
9. Work with Commissioning Firm to develop the Re-Commissioning Management Manual.

C. Commissioning Firm
1. Organize and lead the commissioning team.
2. Coordinate and direct the commissioning activities.
3. Provide a commissioning plan.
4. Convene commissioning team meetings.
5. Coordinate commissioning activities onto the project schedule with General Contractor.
6. Receive and review construction documentation (Requests for Information, Bulletins, Change Orders etc.) for impact on commissioning process.
7. Maintain Pending Issues and Deferred Seasonal Test Log.

8. Review equipment, system and control submittals for compliance with Basis of Design Document.
9. Provide an outline to the Trades Contractors what materials are required in the O&M documentation and assist in the assignment of someone who will organize the collection of this process.
10. Work with other commissioning team members to review O&M Manuals.
11. Work with other commissioning team members to establish CMMS preventive maintenance work order system.
12. Work with other commissioning team members with system education/training and provide written verification that training was conducted for all commissioning features and systems. Training program needs to address all training/education aspects as per LEED certification compliance.
13. Work with other commissioning team members to complete equipment, panel and valve bar code labeling/and tagging.
14. Each component, equipment or system shall be commissioned per LEED Certification Compliance.
15. Installation observation according to the Basis of Design Document and the verification that no other systems compromise operation.
16. Startup and checkout of equipment shall be completed by the contractor and documented per the manufacturer's instructions and contract documents.
17. The Commissioning Firm shall apply a sampling method of start-up observation for systems to be commissioned. Ensure that all points are reading and reporting as expected and visually verify operation.
18. Witness and observe to the greatest extent possible, participate in the following commissioning activities:
    a. Initial equipment startup
    b. Testing and balancing
    c. Component tests
    d. Pre-functional Performance Tests
19. Work with building automation system contractor to create and maintain system trending data
20. Facilitate Functional Performance Tests by testing each Sequence of Operation for each system.
21. Maintain Corrective Action Logs
22. Maintain Commissioning Pending Issues Log.
23. Compile test data, inspection reports, and certificates; Include them in the commissioning report.

D. Design Professionals
1. Fulfill construction administration per their contract with the Architect or Owner.

E. General Contractor
1. Champion and support the commissioning process.
2. Attend commissioning coordination meetings.
3. Manage the master scheduling process with regard to timing and duration of the commissioning activities.
4. Manage the master prefunctional test checklists, master shop drawing log, data retrieval log, O&M Manuals and training schedule log.
5. Immediately following the acceptance of each submittal and no later than 60-days from submittal acceptance, the Contractor's equipment supplier shall complete the Data Retrieval form included within Division 1 as an integral part of the submission process. Included with this form shall be also be the operation and maintenance requirements noted within the Division 1 Specification. In addition, the Contractor shall submit the equipment website where the O&M data can be located.
6. Contractor shall provide a separate area within the Construction Trailer for the assembly of the O&M Manuals. An all-inclusive Table of Contents shall be displayed for the

subcontractors to highlight open items and scheduled due dates of O&M insertions. The O&M Manuals will be built on a construction progress basis and will be reflective of each equipment/system that has been accepted and installed thus being in a completed state prior to demonstration of equipment/systems to Owner. Contractor shall assign a Project Coordinator to monitor this process thru to completion.

7. Coordinate the completion and delivery of shop drawings, data retrieval log and O&M Manuals prior to system demonstration to allow Facility staff to reference during system education/training provided by the Contractor and observed by the Commissioning Firm.
8. Ensure that Contractor correct deficiencies and make necessary adjustments to O&M Manuals and as-built drawings for applicable issues in any testing.
9. General Contractor/Construction Manager shall provide Commissioning Firm with normal cut sheets and submittals of equipment/systems to be commissioned.
10. Coordinate equipment, panel and valve tagging process.
11. Contractor shall coordinate the individual databases (rooms, equipment, valves, panels and components) with the Owner's CMMS operator prior to production of labels. Each database shall be in Microsoft Excel for ease of downloading into the CMMS by the Owner.
12. Contractor shall follow Label Installation Procedures as so noted in Division 1.
13. Coordinate and schedule all equipment and system education/training.
14. Coordinate and schedule all testing compliance and maintain test log for equipment distribution and systems.
15. Coordinate and schedule Pre-Functional Performance Test and notify Commissioning Firm at least one (1) week prior to scheduled date.
16. Coordinate and schedule the contractor's initial Functional Performance Tests.
17. Coordinate and schedule Functional Performance Test demonstrations to the Owner and the Commissioning Firm at least two (2) weeks prior to scheduled date. Notify Commissioning Firm of any changes of scheduled testing giving Commissioning Firm at least 48-hour notice of change.
18. Coordinate and schedule deferred/seasonal tests in the appropriate season. All heating sequences to be tested in the winter and all cooling sequences in the summer.
19. Coordinate and schedule retest activities.
20. Ensure that commissioning activities are being scheduled into the Master Project Schedule and labeled as "Start-up" (PFPT) and "Demonstration of Systems" (FPT) and such schedule is distributed to Commissioning Team.

F. Installation Contractors
1. Trade Contractors required to participate in the commissioning process are as follows:
   a. HVAC
   b. Sheet Metal
   c. Building Automation
   d. Electrical
   e. Plumbing
   f. Equipment Manufacturers required to participate in the commissioning process that provides self-contained building automation equipment.
2. Attend commissioning coordinating meetings
3. Cooperate with the CxA for resolution of issues recorded in the issues log.
4. Complete the Pre-Functional Test and submit the completed sign forms and other appropriate start-up sheets.
   a. Complete the Pre-Functional Tests as work is completed and provide copies to the CxA or CM on a regularly scheduled basis.
5. Submit completed data retrieval forms for the equipment specified on the preventive maintenance list.
6. Develop and deliver O&M manuals immediately after equipment submittal is approved (typical all equipment)
7. Refine and implement Pre-Functional Performance test procedures and, where applicable, have equipment manufacturer participation.
8. Develop and implement equipment education/training.

9. Prior to the system demonstrations with the commissioning team, perform systems Functional Performance Tests and submit documented results to the Commissioning Firm.
10. Demonstrate systems working with the commissioning team implementing Functional Performance Tests.
11. Demonstrate systems working with the commissioning team implementing deferred/seasonal test Functional Performance Tests.
12. Correct all contractor-related deficiencies identified during Functional Performance Tests and retest the corrected functions with the commissioning team.

G. Equipment Manufacturers
1. Equipment Manufacturers of commissioned equipment are required to participate in the commissioning process. Participation shall include demonstration of furnished equipment operation and packaged control system functions.
2. Prior to the systems demonstrations with the commissioning team, perform system Functional Performance Tests in conjunction with the Installation Trade Contractor.
3. Demonstrate systems working with the commissioning team implementing Functional Performance Tests in conjunction with the Installation Subcontractor.
4. Demonstrate systems working with the commissioning team implementing deferred/seasons test Functional Performance Tests in conjunction with the Installation Subcontractor.
5. Correct all equipment deficiencies identified during Functional Performance Tests and retest the corrected functions with the commissioning team.

H. Testing, Adjusting, Balancing (TAB) Contractor Agency
1. Attend all commissioning coordination meetings.
2. Submit TAB industry standard requirement including but not limited to schematic flow diagrams of each system to be commissioned with points where TAB readings will be taken, TAB strategy, and field notes.
3. Review and comment on field coordination drawings during the mechanical-electrical field drawing coordination meetings relative to testing, adjusting and balancing.
4. Participate in Pre-Functional Performance Tests.
5. Complete testing, adjusting and balancing of systems.
6. Participate in Functional Performance Tests.
7. Provide system performance verification data for commissioned systems.

3.3 RE-COMMISSIONING MANAGEMENT MANUAL

A. The Contractor shall be responsible for coordination and development of the Re-Commissioning Manual beginning immediately following the acceptance of equipment and component submittals.

B. The Re-Commissioning Manual shall include:
1. Design Team, Construction Team, Commissioning Firm and Contracting Officer Representatives.
2. Brief Description of each system commissioned.
3. Record documents of ATC Sequence of Operation.
4. Building Automation logic flow diagram (P&ID)
5. Building Occupancy Schedules
6. Trending Checklist with control logic to each trending program.
7. Equipment start-up, shutdown and restarting instructions.
8. Equipment manufacturer's re-calibration instructions for sensors, transmitters and actuators and frequency of tasking.
9. Listing of all systems commissioned adjustable setpoints and reset schedule with description of set point purpose and recommended adjustable range.

10. Automatic control manufacturer's recommended re-commissioning interval and continuous commissioning recommendations, as well as recommendation to reassess setpoints and schedule based on current system use.
11. Recommended energy monitoring and benchmarking of energy metering (all utilities) using the building automation for energy reporting.
12. List of diagnostic tools for those systems commissioned that will be useful for facility management in maintaining efficient operation of the equipment and systems.

3.4 PRE-FUNCTIONAL PERFORMANCE TESTS

A. Test Checklists will be included with the Commissioning Plan

3.5 FUNCTIONAL PERFORMANCE TEST NARRATIVES

A. Functional Performance Test Narratives will be included with the Commissioning Plan and will be in a "draft" format and will be finalized upon final approved sequence of operations and comments from the disciplines involved in demonstrating the systems to the Owner.

3.6 WARRANTY PERIOD

A. The goals of the commissioning tasks during the Warranty Period include the following:
   1. Identify and correct any outstanding deficiencies.
   2. Perform seasonal and other deferred functional performance testing.
   3. Review facility operation at 10-month mark into the 12-month warranty period.
   4. Complete Final Commissioning Report document

B. Team Member Responsibilities
   1. Owner Project Manager
      a. Maintain records of problems or concerns associated with the systems during normal operation.
      b. Distribute Post Construction Evaluation information to other commissioning team members for review and comment.
      c. Coordinate and facilitate the meeting with the commissioning team at the 10-month mark to discuss operational problems and concerns.
      d. Oversee the revision of the Owner Design and Construction Standards based on the results of the 10-month warranty meeting.

C. Owner Facility Manager
   1. Maintain problems/complaints from occupants and Owner personnel regarding new building systems.
   2. Participate in seasonal/deferred functional performance tests.
   3. Maintain "as-commissioned" proper operation of the building systems.
   4. Participate in 10-month Warranty meeting present the problems, issues, and concerns.
   5. Identify warranty versus operational issues and concerns.

D. Commissioning Firm
   1. Maintain Commissioning Corrective Action Log until all issues are resolved.
   2. Facilitate seasonal/deferred functional performance tests
   3. Complete Final Commissioning Report document.
   4. Have in place a contractor a "near warranty end" or "post occupancy review". Within this contract, an excerpt from the Commissioning Plan is to highlight the 5 Additional Commissioning Tasks per LEED prerequisite for Additional Commissioning of which three are as follows:
      a. Conduct a focused review of the design prior to construction document phase.

b. Conduct a focused review of the design when close to completion
c. Conduct a selective review of contractor submittals of commissioned equipment.

5. Complete Final Commissioning Report document.
6. Participate in 10-month Warranty meeting present the problems, issues, and concerns.
7. Make suggestions for improvements and for recording these changes in the O&M manuals.

E. Design Professionals
1. Be available to consult on the results of the seasonal/deferred functional performance test results.
2. Meet with the commissioning team at the 10-month mark to discuss operational problems and concerns.

F. General Contractor (or Construction Manager)
1. Coordinate scheduling of seasonal/deferred functional performance tests.
2. Participate in 10-month Warranty meeting present the problems, issues, and concerns.
3. Address outstanding warranty issues and tasks identified as being under the original construction contract.

G. Installation Contractors
1. Be present for and conduct seasonal/deferred functional performance tests.
2. Address outstanding warranty issues and tasks identified as being under the original construction contract.
3. Be available to meet with the commissioning team at the 10-month mark to discuss operational problems, issues, and concerns.
4. Address outstanding warranty issues and tasks identified as being under the original construction contract.

H. Equipment Manufacturers
1. Be present for and conduct seasonal/deferred functional performance tests.
2. Address outstanding warranty issues and tasks identified as being under the original construction contract.
3. Be available to meet with the commissioning team at the 10-month mark to discuss operational problems, issues and concerns.
4. Address outstanding warranty issues and tasks identified as being under the original construction contract.

I. Independent Test Agency
1. Conduct seasonal/deferred TAB associated with functional performance tests.

END OF SECTION 220800

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SECTION 221116 – WATER DISTRIBUTION PIPING

PART 1 – GENERAL

1.1 SUMMARY

A. This section specifies the Water Distribution Piping System, including potable cold water, hot water, hot water return piping, fittings, and specialties within the building.

1.2 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the provisions of the following:

1. Michigan Plumbing Code.
2. Michigan and/or local Department of Health.

1.3 SUBMITTALS

A. Product data for all piping and fittings.

PART 2 – PRODUCTS

2.1 PIPE, TUBE AND FITTINGS

A. General: Refer to Article “Pipe Application” of this section for identification of systems where the below materials are used.

B. Copper Tube: ASTM B 88, Type L Water Tube, drawn temper.

C. Wrought Copper Solder-Joint Fittings: ANSI B16.22, streamlined pattern.

D. Unions: Ground joint, copper unions, ASME B16.18, cast-copper-alloy body, hexagonal stock, with ball-and-socket joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends; and suitable system fluid, pressure and temperature.

E. Dielectric Fittings: Refer to Section 15050.

F. Steel Pipe: ASTM A 53, Type S, Grade A, Schedule 40, seamless, galvanized, plain ends.

1. Steel Pipe Nipples: ASTM A 733, made of ASTM A 53 or ASTM A 106, Schedule 40, seamless, galvanized, carbon-steel pipe.

G. Cast-Iron Threaded Flanges: ASME B16.1, galvanized, Class 125.

H. Cast-Iron Flanged Fittings: ASME B16.1, galvanized, Class 125.

I. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, galvanized, standard pattern for threaded joints. Threads shall conform to ANSI B1.20.1.

J. Malleable Threaded Fittings: ANSI B16.3, Class 125, galvanized, for threaded joints. Threads shall conform to ANSI B1.20.1.

2.2 JOINING MATERIALS

A. Solder Filler Metal: ASTM B 32, No-lead.

B. Gasket Material: Thickness, material, and type suitable for fluid to be handled and design temperatures and pressures.

2.3 GENERAL DUTY VALVES

A. Potable Water: Check, butterfly, and ball valves are specified in Division 22 Section “Valves.” Special duty valves are specified below by their generic name; refer to Article “Valve Application” for specific uses and applications for each valve specified.

2.4 WATER METERS

A. Displacement-Type Water Meters:
   1. Description:
      i. Standard: AWWA C700.
      ii. Pressure Rating: 150-psig working pressure.
      iii. Body Design: Nutating disc; totalization meter.
      iv. Registration: In gallons or cubic feet as required by utility.
      v. Case: Bronze.
      vi. End Connections: Threaded.

B. Compound-Type Water Meters:
   1. Description:
      i. Standard: AWWA C702.
      ii. Pressure Rating: 150-psig working pressure.
      iii. Body Design: With integral mainline and bypass meters; totalization meter
      iv. Registration: In gallons or cubic feet as required by utility company
      v. Case: Bronze
      vi. Pipe Connections: Flanged

C. Remote Registration System: Modified with signal transmitting assembly, low-voltage connecting wiring, and remote register assembly as required by utility company.

PART 3 – EXECUTION

3.1 PIPE APPLICATIONS

A. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes 2 inches and smaller, above ground, within building.

B. Install Type L, drawn copper tube with wrought copper fittings and solder joints for pipe sizes 2 and ½ inches and larger, above ground, within building.

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems. Location and arrangement of piping layout take into consideration pipe sizing and frictional loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and branch connections.

C. Install piping at right angles or parallel to building walls. Diagonal runs are not permitted unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install piping tight to slabs, beams, joists, columns, walls and other permanent elements of the building. Provide space to permit insulation applications, with 1-inch clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Locate groups of pipes parallel to each other, spaced to permit applying full insulation and servicing valves.

H. Install drains at low points in mains, risers, and branch lines consisting of a tee fitting, ¾-inch ball valve, and short ¾-inch threaded nipple cap.

I. Provide pipe penetrations in walls and floors as specified in Division 22 Section “Basic Mechanical Materials and Methods”.

J. Install piping with 1/32-inch-per-foot (1/4 percent) downward slope towards drain point.

K. Provide dielectric waterway fittings or ground-joint cast brass unions to connect piping of dissimilar metals.

3.3 HANGERS AND SUPPORTS

A. General: Hanger, support, and anchor devices conforming to MSS SP-69 are specified in Division 22 Section “Supports and Anchors.” Conform to the table below for maximum spacing of supports.

B. Pipe Attachments: Install the following:

1. Adjustable steel clevis hangers, MSS Type 1, for individual horizontal runs.
2. Pipe roll, complete MSS Type 44 for multiple horizontal runs, 20 feet or longer, supported on a trapeze.
3. Spring hangers to support vertical runs.

C. Install hangers for horizontal potable water piping with the following maximum spacing and minimum rod sizes:

Nom. Pipe Size-In.	Steel Pipe Max. Span – Ft.	Copper Tube Max. Span – Ft.	Min. Rod Dia. – In.
Up to ¾	--	5	3/8
1	--	6	3/8
1¼	--	7	3/8
1½	--	8	3/8
2	--	8	3/8
2½	11	9	½

3	12	10	½
4	14	12	½

1. Support vertical runs at each floor.

3.4 TUBE AND FITTING JOINT CONSTRUCTION

A. Soldered Joint Construction: Comply with the procedures contained in the AWS “Soldering Manual.”

1. CAUTION: Remove stems, seats, and packing of valves and accessible internal parts of piping specialties before soldering and brazing.
2. Fill the tubing and fittings during soldering and brazing with an inert gas (nitrogen or carbon dioxide) to prevent formation of scale.
3. Heat joints to proper and uniform temperature.

B. Threaded Joint Construction: Conform to ASME B1.20.1, tapered pipe threads for field-cut threads. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
2. Align threads at point of assembly.
3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.
5. Damaged Threads: Do not use pipe with corroded or damaged threads. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Flanged Joints: Align flange surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubrications on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.5 SERVICE ENTRANCE

A. Extend water distribution piping to connect to water service piping, of size and in location indicated for service entrance to building.

B. Install sleeve and mechanical sleeve seal at penetrations through foundation wall for watertight installation.

3.6 VALVE APPLICATIONS

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

1. Refer to Division 22, Section 220523 for specific uses and applications for each valve specified.
2. Shut-off duty: Use ball valves.
3. Throttling duty: Use ball valves.

3.7 INSTALLATION OF VALVES

A. Install sectional valves on each branch and riser, close to main, where branch or riser serves 2 or more plumbing fixtures or equipment connections, and elsewhere as indicated. For sectional valves 2 inches and smaller, use ball valves; for sectional valves 2-1/2 inches and larger, use butterfly valves.

B. Install shutoff valves on inlet of each plumbing equipment item, on each supply to each plumbing fixture, and elsewhere as indicated. For shutoff valves 2 inches and smaller, use ball valves; for shutoff valves 2-1/2 inches and larger, use butterfly valves.

3.8 EQUIPMENT CONNECTIONS

A. Piping Runouts to Fixtures: Provide hot and cold water piping runouts to fixtures of sizes indicated, but in no case smaller than required by plumbing code.

B. Mechanical Equipment Connections: Connect hot and cold water piping system to mechanical equipment as indicated. Provide shutoff valve and union for each connection; provide drain valve on drain connection.

3.9 FIELD QUALITY CONTROL

A. Test and Inspections: Test and inspect water distribution piping as specified in the local plumbing code.

3.10 ADJUSTING AND CLEANING

A. Clean and Disinfect water distribution piping as specified in the local plumbing code, and provide test report from a state approved testing agency. If no procedure is specified, provide the following. The system shall first be flushed out and drained and then filled with a solution mixture of 60 ppm of chlorine in the water. It shall be held in the system for a 24 hour period. The system shall then be drained and flushed. After flushing, the chlorine residue shall not be in excess of 0.5 to AWWA spec. Repeated chlorination shall be necessary until accepted.

B. Prepare reports for all purging and disinfecting activities.

END OF SECTION 221116

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SECTION 221119 – PLUMBING SPECIALTIES

PART 1 – GENERAL

1.1 SYSTEM PERFORMANCE REQUIREMENTS

A. Provide components and installation capable of producing piping systems with the following minimum working pressure ratings, except where otherwise indicated:

1. Water Distribution Systems, Below Ground: 150 psig.
2. Water Distribution Systems, Above Ground: 125 psig.

1.2 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Submit product data including rated capacities of selected models and weights (shipping, installation and operation). Indicate materials, finishes, dimensions, required clearances, and methods of assembly of components; and piping and wiring connections for the following plumbing specialty products:

1. Calibrated Balancing Valves
2. Water Hammer Arresters
3. Hose Bibs and Wall Hydrants
4. Backflow Preventers
5. Strainers
6. Thermostatic water-mixing valves and water-tempering valves
7. Trap Seal Protection Device
8. Water Pressure Regulators
9. Washing Machine Outlet Box

C. Maintenance data for inclusion in Operating and Maintenance manuals as specified in Division 1 Section, Project Closeout, for the following:

1. Backflow preventers
2. Water pressure regulators
3. Thermostatic water-mixing valves and water-tempering valves

1.3 QUALITY ASSURANCE

A. Comply with ASME B31.9, Building Services Piping, for materials, products and installation.

B. Comply with NFPA 70, National Electrical Code.

C. Provide equipment that is listed and labeled.

D. The drawings indicate capacities, sizes and dimensional requirements of system components. Components having equal performance characteristics that deviate from the indicated size and dimensions may be considered, provided deviations do not change the design concept or intended performance. The burden of proof for equality of products is on the Contractor. Refer to Division 1 Section, Product Substitutions.

1.4 EXTRA MATERIALS

A. Deliver extra materials to Owner. Furnish extra materials matching products installed as described below. Package them with protective covering for storage and identify with label clearly describing contents.

B. Operating Keys (Handles): Furnish one extra key for each key-operated hose bib and hydrant installed.

PART 2 – PRODUCTS

2.1 SPECIAL DUTY VALVES

A. Calibrated Balancing Valves: Provide as indicated, calibrated balance valves equipped with valves on readout ports to facilitate connecting of differential pressure meter to balance valves. Readout valves shall have ¼" NPT connection for meters. Provide calibrated nameplate to indicated degree of closure of orifice. Construct balancing valve with internal seals to prevent leakage around rotating element. Valves to have memory stop feature to allow valve to be closed and then reopened to set point without disturbing balancing position. Provide balance valves with performed polyurethane insulation suitable for use on domestic hot water systems, and to protect balance valves during equipment. Bell & Gossett "Circuit Setter" or equal.

2.2 PIPING SPECIALTIES

A. Water Hammer Arrestors: Provide stainless steel construction, bellows type precharged water hammer arrestors, suitable for operation in temperature range -100 to 300ºF and maximum 250 psi working pressure. Install on both hot and cold water lines, sized and located as indicated on the plans or shall be sized and located in accordance with Plumbing and Drainage Institute Standard PDI-WH 201.

1. Wade Shokstop series or equal with all stainless steel construction, temperature range of –100 ° F to +300 ° F and a maximum working pressure of 250 PSIG.

a. W-5 ¾" Size PDI Fixture Unit Rated Capacity	1 to 11
b. W-101" Size PDI Fixture Unit Rated Capacity	12 to 32
c. W-20 1" Size PDI Fixture Unit Rated Capacity	33 to 60
d. W-50 1" Size PDI Fixture Unit Rated Capacity	61 to 113
e. W-75 1" Size PDI Fixture Unit Rated Capacity	114 to 154

B. Hose Connections: Hose connections shall have garden hose thread outlets conforming to ASME B1.20.7.

C. Hose Bibbs: Bronze body, renewable composition disc, tee handle, ¾-inch NPT inlet, ¾-inch hose outlet.

D. Recessed Nonfreeze Wall Hydrants: Cast-bronze box, with tee handle key, vacuum breaker, hinged locking cover, ¾-inch inlet, and hose outlet. Provide bronze casing of suitable length to have valve body inside building, not within exterior wall. "Woodford" Model B67, "Conbraco" or equal.

E. Vacuum Breakers: Hose connection vacuum breakers shall conform to ASSE Standard 1011, with finish to match hose connection.

F. Backflow Preventers: Reduced-pressure-principle assembly consisting of shutoff valves on inlet and outlet and strainer on inlet. Assemblies shall include test cocks, air gap drain fitting and pressure-differential relief valve located between 2 positive seating check valves and comply with

requirements of ASSE Standard 1013. Pressure drop through assembly shall not exceed 12 psig. “Watts” No. 909 Series, “Febco”, “Conbraco/Apollo”, “Wilkins” or equal.

G. Strainers: For 2” and smaller provide ASTM B-62 bronze “Y” strainer with ANSI B1.201 threaded end connections. 20 mesh stainless steel screen, rated to 300 WOG, cap plug and silicone-rubber O-ring cap seal. For 2 ½” and larger, provide ASTM A-126 cast-iron “Y” strainer with ANSI B16.1 125 pound flanged ends, gasketed cover with plug for screen removal, rated for 125 WSP and 175 WOG, 1/16” perforated stainless steel screen up to 4” sizes and 1/8” perforations on larger sizes.

H. Water Pressure Regulators: Self-contained, adjustable, bronze body. Watts, Cash Acme, Fisher.

I. Trap Seal Protection Device: Provide SureSeal Manufacturing, Inline Floor Drain Trap Sealer. ASSE 1072 Standard, ASB Plastic body with neoprene rubber diaphragm and sealing gasket.

J. Thermostatic Mixing valves:

1. Manufacturers:
    a. Lawler Manufacturing Company, Inc.
    b. Leonard Valve Company
    c. Mark Controls Corp.; Powers Process Controls.
    d. Conbraco Industries Inc.

2. Thermostatic mixing valve for individual lavs or sinks: Lawler Series 310 conforming to ASSE Standard 1070 with high limit set at 110ºF with checkstops on inlets.
3. General: ASSE 1017, manually adjustable, thermostatic water mixing valve with bronze body. Including check stop and union on hot- and cold-water-supply inlets, adjustable temperature setting, and thermometer.

    a. Type: Liquid filled thermal motor operation and pressure rating 125 psig minimum. Valve shall be bronze body with stainless steel sliding piston and liner, union and stop and check inlets with removable stainless steel strainers.

K. Air Admittance Valve: Provide IPS Corporation Studor Redi-Vent or equal.

L. Washing Machine Outlet Box:

a. White powder coated cold rolled steel outlet box with (2) ½” sweat connection valves and 2” PVC drain. IPS Corporation Guy Grey Outlet Box Model T200TPPVC (Center drain) or T200TPPVCHA (with water hammer arrester valves) or equivalent.

PART 3 – EXECUTION

3.1 PIPING SPECIALTY INSTALLATION

A. Install backflow preventers of type, and capacity indicated, at each water supply connection to mechanical equipment and systems, and to other equipment and systems as indicated. Comply with plumbing code and authority have jurisdiction. Locate in same room as equipment being connected. Install air-gap fittings on units having atmospheric vent connection and pipe relief outlet drain to nearest floor drain. Do not install bypass around backflow preventer.

B. Install pressure-regulating valves with inlet and outlet shutoff valves and balance cock bypass. Install pressure gage on valve outlet and install valved bypass.

C. Install strainers on supply side of each control valve, pressure-regulating valve solenoid valve, and where indicated.

D. Install key operated hose bibs with integral or field-installed vacuum breaker.

E. Install key operated non-freeze wall hydrants with integral vacuum breaker.

F. Install drain valves on each plumbing equipment item, located to drain equipment completely for service or repair. Install drain valves at the base of each riser, at low points of horizontal runs, and elsewhere as required to drain distribution piping system completely. For drain valves 2 inches and smaller, use ball valves; for drain valves 2-1/2 inches and larger, use butterfly valves.

G. Install swing check valves on discharge side of each pump and elsewhere as indicated.

H. Install calibrated balancing valves in each hot water recirculating loop. Install with readout valves in vertical upright position. Maintain minimum length of straight unrestricted piping equivalent to 3 pipe diameters upstream of valve.

I. Install thermostatic mixing valves to comply with the installation requirements of required codes and standards with respect to Barrier-Free plumbing fixtures.

J. Install trap seal devices where indicated.

K. Install water hammer arrestors on hot and cold water supply piping to toilet rooms, at all equipment utilizing solenoid valves and at all locations in accordance with PDI-WH-201.

3.2 CONNECTIONS

A. Supply Runouts to Fixtures: Install hot – and cold-water supply piping runouts to fixtures of sizes indicated, but not smaller than required by plumbing code.

3.3 COMMISSIONING

A. Preparation: Perform the following checks before start-up.

1. Systems tests are complete.
2. Damaged and defective specialties and accessories have been replaced or repaired.
3. There is clear space for servicing of specialties.

B. Before operating systems, perform these steps:

1. Close drain valves.
2. Open valves to full open position.
3. Remove and clean strainers.

C. Starting Procedures: Follow manufacturer’s written procedures. If no procedures are prescribed by manufacturer, proceed as follows:

3.4 ADJUSTING

A. Adjust operation and correct deficiencies discovered during commissioning.

END OF SECTION 221119

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SECTION 22 1123 – DOMESTIC WATER PUMPS

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submittals: Submit manufacturer's technical data, installation and start-up instructions, piping and wiring diagrams, and maintenance data; in accordance with requirements of Division 1.

1.2 QUALITY ASSURANCE

A. Comply with UL Standard 778.

B. Comply with NEMA:

PART 2 – PRODUCTS

2.1 DOMESTIC WATER PUMPS

A. Available Manufacturers: Subject to compliance with requirements, provide products by:

1. Bell & Gossett, ITT.
2. Armstrong.
3. Grundfos.

B. Pumps, General: Pumps and circulators shall be factory assembled and factory tested.

1. Preparation for shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles with wooden flange covers or with screwed-in plugs.

2. Motors: Refer to division 22 " Motors for Plumbing Equipment".

3. Apply factory finish paint to assembled, tested units prior to shipping.

C. Inline Booster Pumps: Horizontal inline, centrifugal, separately coupled, single-stage, all-bronze, radially split case design, with mechanical seals, and rated for 125 psig working pressure and 225 deg F continuous water temperature.

1. Casings: Bronze, with threaded companion flanges for piping connections smaller than 2-1/2 inches, and threaded gage tappings at inlet and outlet connections.

2. Impeller: Statically and dynamically balanced, closed, overhung single suction, fabricated from Rolled Temper brass conforming to ASTM B 36, and keyed to shaft.

3. Pump Shaft and Sleeve: Steel shaft with oil-lubricated copper sleeve.

4. Mechanical Seals: Carbon steel rotating ring, stainless-steel spring, ceramic seat, and flexible bellows and gasket.

5. Pump Bearings: Oil-lubricated, bronze journal and thrust bearings.

6. Motor Bearings: Oil-lubricated sleeve bearings.

7. Shaft Couplings: Flexible; capable of absorbing torsional vibration and shaft misalignment.

8. Motors: Resiliently mounted to the pump casing.

2.2 CONTROLS

A. Timers: Electric time clock for control of hot-water circulation pump.

1. Type: Programmable, seven-day clock with manual override on-off switch.

2. Enclosure: Suitable for wall mounting.

3. Operation of Pump: On or off.

4. Transformer: Provide if required.

5. Power Requirements: [24 V, ac] [120 V, ac] <Insert other>.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install pumps in locations for easy access and maintenance.

B. Support pumps and piping separately so that the weight of the piping system does not rest on the pump. Support inline pumps from floor using structural steel membranes of sufficient size to support the weight of the pump. Maximum mounting height above floor shall be 5’-0”.

C. Install valves that are same size as the piping connecting the pump.

D. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.

E. Install a nonslam check valve and balancing valve on the discharge side of inline pumps. Install a shut-off valve and strainer on the suction side of the pumps. Install pressure/temperature tappings on the suction and discharge of each inline pump.

F. Electrical wiring and connections are specified in Division 26 sections.

END OF SECTION 22 1123

SECTION 22 1316 – DRAINAGE AND VENT SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes building sanitary drainage and vent piping; condensate drainage piping, and storm drainage piping systems within the building and to a point five feet outside the building.

1.2 SUBMITTALS

A. Product data for the following products:

1. Drainage piping specialties.

a. Cleanouts
b. Vent caps, vent terminals and roof flashing

2. Floor drains.
3. Floor Sinks.
4. Roof drains.
5. Grease Trap
6. Trench Drain

1.3 QUALITY ASSURANCE

A. Regulatory Requirements: comply with the provisions of the following:

1. Michigan Plumbing Code.
2. Michigan and/or local Department of Health Codes.

1.4 SYSTEM PERFORMANCE

A. Provide components and installation capable of producing piping systems with the following minimum working pressure ratings, except where otherwise indicated:

1. Soil, Waste and Vent Systems: 10-foot head of water.
2. Storm Drainage Systems: 10-foot head of water.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer uniformity shall be as specified in Section 220500: Basic Plumbing Requirements.

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

1. Floor drains, cleanouts:

a. Josam
b. Jay R. Smith
c. Wade
d. Zurn

2.2 PIPE AND FITTINGS

A. General: Refer to “PIPE APPLICATIONS” for identification of systems where the below specified pipe and fitting materials are used.

B. Above Ground Drainage and Vent Pipe and Fittings:

1. Hubless Cast-Iron Soil Pipe: CISPI Standard 301, cast-iron soil pipe and fittings, with neoprene gaskets and stainless steel bands conforming to CISPI Standard 310.

C. Underground Building Drain Pipe and Fittings:

1. Hubless Cast-Iron Soil Pipe: CISPI Standard 301, cast-iron soil pipe and fittings, with neoprene gaskets and stainless steel bands conforming to CISPI Standard 310.
2. PVC Type DWV Pipe and Fittings: ASTM D2665 pipe and fittings, with solvent cemented joints.

a. Solvent: ASTM D2564.

2.3 DRAINAGE PIPING SPECIALTIES

A. Cleanouts, General: Cleanouts shall be sized and located as indicated on drawings.

B. Floor Cleanouts: “Wade” W-6000 Series or equal with cast iron spigot or ty-seal outlet ferrule, taper threaded bronze CO plug and round scoriated nickel bronze top.

C. Wall Cleanouts: “Wade” W-8470-R Series Cleanout or equal with taper brass CO plug and round smooth stainless steel access cover with securing screw.

D. Cleanout Plugs: Cast-bronze or brass, threads complying with ANSI B2.1, countersunk head.

E. Flashing Flanges: Cast-iron watertight stack or wall sleeve with membrane flashing ring. Provide under deck clamp and sleeve length as required.

2.4 FLOOR DRAINS

A. General: Drain type designations and sizes are indicated on Drawings and schedule below.

B. Floor drains: “Wade” cast iron floor drains or equal with coated cast iron body having integral double drainage flange with weep holes and no-hub spigot or ty-seal bottom outlet. Provide flashing clamp device where located in membrane floor or when flashing is required for lead pans. Provide drain with trap primer connection.

FD-1: “Wade” W-1100-STD7-1 with 7” round N.B. top.

2.5 FLOOR SINKS

A. Floor sinks: “Wade” cast iron floor sink or equal with cast iron body nickel bronze top, and no-hub spigot or ty-seal bottom outlet. Provide aluminum dome strainer and seepage flange.

FS-1: “Wade” W-9140-1 with 12x12 top and 8” sump.

2.6 GREASE TRAP

A. Grease trap shall be Wade model W-5125-XT with 25 GPM flow rate and 50 lb. Capacity or equal by Zurn, MIFAB or J.R. Smith.

PART 3 – EXECUTION

3.1 PREPARATION OF FOUNDATION FOR UNDERGROUND BUILDING DRAINS

A. Grade Trench Bottoms to provide a smooth, firm, and stable foundation, free from rock, throughout the length of pipe.

B. Remove Unstable, Soft, and Unsuitable materials at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated invert elevation.

C. Shape bottom of trench to fit bottom of pipe for 90-degrees (bottom ¼ of the circumference). Fill unevenness with tamped sand backfill. At each pipe joint dig bell holes to relieve the bell of the pipe of all loads, and to ensure continuous bearing of the pipe barrel on the foundation.

3.2 PIPE APPLICATIONS – ABOVE GROUND, WITHIN BUILDING

A. Drainage and Vent:

1. Install hubless cast-iron soil pipe and fittings.

2. Install PVC Type DWV plastic pipe and fittings or hubless cast-iron soil pipe and fittings with gasketed joints.

B. Condensate Drain Piping:

1. Type L copper with sweat fittings, or PVC type DWV pipe and fittings.

3.3 PIPE APPLICATIONS – BELOW GROUND, WITHIN BUILDING

A. Drainage and Vent:

1. Install PVC Type DWV plastic pipe and fittings or hubless cast-iron soil pipe and fittings with gasketed joints.

3.4 PIPE AND TUBE JOINT CONSTRUCTION

A. Cast-Iron Soil Pipe: Make hubless joints in accordance with the recommendations in the CISPI Cast Iron Soil Pipe and Fittings Handbook, Chapter IV.

B. All cast iron soil pipe and fittings shall be marked with the collective trademark of the Cast Iron Soil Pipe Institute (CISPI) and be listed by NSF International.

C. PVC DWV Pipe: Joining and installation of PVC drainage pipe and fittings shall conform to ASTM D 2855 and ASTM F 402.

3.5 INSTALLATION, GENERAL

A. General Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of the piping systems

B. Use fittings for all changes in direction and all branch connections.

C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

E. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

F. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Allow sufficient space above removable ceiling panels to allow for panel removal.

G. Provide pipe penetrations in walls and floors as specified in Division 22 Section “Basic Plumbing Materials and Methods.”

H. Make changes in direction for drainage and vent piping using appropriate 45 degree wyes, half-wyes, or long sweep quarter, sixth, eighth, or sixteenth bends. Sanitary tees or short quarter bends may be used on vertical stacks of drainage lines where the change in direction of flow is from horizontal to vertical, except use long-turn tees, where two crosses may be used on vent lines. No change in direction of flow is greater than 90 degrees shall be made. Where different sizes of drainage pipes and fittings are connected, use proper size, standard increasers and reducers. Reduction of the size of drainage piping in the direction of flow is prohibited.

I. Install underground building drains to conform with the plumbing code, and in accordance with the Cast Iron Soil Pipe Institute Engineering Manual. Lay underground building drains beginning at low point of systems, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install required gaskets in accordance with manufacturer’ s recommendations for use of lubricants, cements, and other special installation requirements. Maintain swab or drag in line and pull past each joint as it is completed.

    1. Below slab sanitary drains shall be minimum 3” unless otherwise indicated with reducer down to above slab pipe size located at floor line.

J. Install building drain pitched down at minimum slope of ¼ inch per foot (2 percent) for piping 2 ½ inch and smaller, 1/8 inch per foot (1 percent) for piping 3 inch to 6 inch, and 1/16 inch per foot, (1/2 percent) for piping 8 inch and larger.

K. Install sleeve and mechanical sleeve seal through foundation wall for watertight installation.

L. Install expansion joints on vertical risers, stacks and conductors.

3.6 HANGERS AND SUPPORTS

A. General: Hanger, supports and anchors devices are specified in Division 22 Section "Supports and Anchors". Conform to the table below for maximum spacing and supports:

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for horizontal runs.
2. Two or four bolt riser clamps for vertical runs.

C. Install hangers at the following intervals:

Pipe Material	Max Horiz. Spacing In Feet	Max Vert. Spacing In Feet
Cast-Iron Pipe	5	15
PVC Pipe	4	4
Copper Pipe	5	10

D. Support vertical runs at each floor.

3.7 CLEANOUT INSTALLATION

A. Install cleanouts in above-ground piping and building drain piping as indicated, and where not indicated, according to the following:

1. Size same as drainage piping up to 4" size. Use 4" size for larger drainage piping except where larger size cleanout is indicated.
2. Locate at each change in direction of piping greater than 45 degrees.
3. Locate at not more than 75 feet apart, unless otherwise noted.
4. Locate at base of each vertical soil or waste stack.
5. Install cleanout deck plates (covers), of types indicated, with top flush with finished floor, for floor cleanouts for piping below floors.
6. Install cleanout wall access covers, of types indicated, with frame and cover flush with finished wall, for cleanouts located in concealed piping.
7. Install flashing flange and clamping device with each stack and cleanout passing through floors having waterproof membrane.

3.8 FLOOR DRAIN INSTALLATION

A. Install drains in accordance with manufacturer's written instructions and in locations indicated.

B. Install drains at low points of surface areas to be drained, or as indicated. Set tops of drains flush with finished floor.

C. Trap all drains connected to the sanitary sewer.

D. Install drain flashing collar or flange so that no leakage occurs between drain and adjoining flooring. Maintain integrity of waterproof membranes, where penetrated.

E. Provide lead pans for all floor drains mounted in floors that do not have membranes and that are not slab on grade. Securely fasten lead pans to clamping device.

F. Position drains for easy access and maintenance.

G. Refer to Plumbing Specialties, Section 221119 for Trap seal devices for floor drain traps.

3.9 FLASHING INSTALLATION

A. Provide flashing manufactured in a single piece except where large pans, sumps or other drainage shapes are required.

B. Install 4-psf lead flashing or 16-oz.-per. sq. ft. copper, except when another weight or material is specified.

C. Solder joints of copper sheets where required.

D. Install sheet flashing on pipes, sleeves and specialties passing through or embedded in floors and roofs with membrane waterproofing.

1. Pipe Flashing: Sleeve type, matching pipe size, with minimum sleeve length of 10” and skirt or flange extending at least 8” around pipe.
2. Sleeve Flashing: Flat sheet, with skirt or flange extending at least 8” around sleeve.
3. Embedded Specialty Flashing: Flat sheet, with skirt or flange extending at least 8” around specialty.

E. Set flashing on floors and roofs in solid coating of bituminous cement.

F. Secure flashing into sleeve and specialty clamping ring or device.

G. Extend flashing up vent pipe passing through roofs and turn down into pipe or secure flashing into cast-iron sleeve having caulking recess.

3.10 CONNECTIONS

A. Piping Runouts to Fixtures: Provide drainage and vent piping runouts to plumbing fixtures and drains, with approved trap, of sizes indicated; but in no case smaller than required by the plumbing code.

B. Locate piping runouts as close as possible to bottom of floor slab supporting fixtures or drains.

3.11 FIELD QUALITY CONTROL

A. Inspections:

1. Do not enclose, cover, or put into operation drainage and vent piping system until it has been inspected and approved by the authority having jurisdiction.
2. During the progress of the installation, notify the plumbing official having jurisdiction, at least 24 hours prior to the time such inspection must be made. Perform tests specified below in the presence of the plumbing official.

a. Rough-In Inspection: Arrange for inspection of the piping system before concealed or closed-in after system is roughed-in, and prior to setting fixtures.

b. Final Inspection: Arrange for a final inspection by the plumbing official to observe the tests specified below and to insure compliance with the requirements of the plumbing code.

3. Re-inspections: Whenever the piping system fails to pass the test or inspection, make the required corrections, and arrange for re-inspection by the plumbing official.
4. Reports: Prepare inspection reports, signed by the plumbing official.

B. Piping System Test: Test drainage and vent system in accordance with the procedures of the authority having jurisdiction.

C. Repair all leaks and defects using new materials and retest system or portion thereof until satisfactory results are obtained.

1. Prepare reports for all tests and required corrective action.

3.12 ADJUSTING AND CLEANING

A. Clean interior of piping system. Remove dirt and debris as work progresses.

B. Clean drain strainers, domes, and traps. Remove dirt and debris.

3.13 PROTECTION

A. Protect drains during construction period, to avoid clogging with dirt and debris, and to prevent damage from traffic and construction work.

B. Place plugs in ends of uncompleted piping at end of day or whenever work stops.

END OF SECTION 22 1316

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SECTION 223400 – WATER HEATERS

PART 1 – GENERAL

1.1 CODES AND STANDARDS

A. Comply with NFPA 54.

B. AGA Certified and Labeled.

C. Equipment to be ASME Stamped.

D. Comply with ASHRAE 90A.

E. Unit to be UL-listed and labeled.

1.2 SUBMITTALS

A. Submittals: Submit manufacturer's technical data, installation and start-up instructions, piping and wiring diagrams, and maintenance data; in accordance with requirements of Division 1.

1.3 WARRANTY

A. Special Project Warranty: Submit a written warranty, executed by manufacturer, agreeing to repair or replace water heater units that fail in materials or workmanship within the specified warranty period. Failures include, but are not limited to, tanks, coils, heat exchangers, and burners. This warranty shall be in addition to, and not a limitation of, other rights the Owner may have against the Contractor under the Contract Documents.

1. Warranty Period: 5 years from Date of Substantial Completion.

PART 2 – PRODUCTS

2.1 GAS FIRED STAINLESS STEEL HEAT EXCHANGER WATER HEATERS

A. Description: Commercial, gas-fired, ASME Labeled, 150-psig rated, with integral controls, all bronze circulating pump, storage tank, direct vent, gas burner, gas train including gas regulator.

B. Water Heater Insulation: Manufacturer's standard insulation.

C. Water Heater Jacket: Steel, with baked-on enamel finish.

D. Water Storage Tank: Steel, glass lined with insulated jacket.

E. Intermittent electronic ignition.

F. Controls: Adjustable aquastat, manual reset high limit control and low water cut off.

G. Safety Controls: Automatic gas shutoff device to shut off entire gas supply in event of excessive temperature.

H. Water Heater Pressure Relief Valve: ASME rated and labeled.

I. Minimum Recover Rate: As scheduled.

J. Fuel Gas Input: As scheduled.

K. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

1. Lochinvar.

2. A.O. Smith.

3. Raypak

PART 3 – EXECUTION

3.1 WATER HEATER INSTALLATION

A. General: Install water heaters on concrete bases. Set and connect units in accordance with manufacturer's written installation instructions. Install units plumb and level, firmly anchored in locations indicated, and maintain manufacturer's recommended clearances. Install thermometer on water heater outlet piping.

3.2 CONNECTIONS

A. Special piping installation requirements are:

1. Connect hot and cold water piping to units with shutoff valves and unions. Extend relief valve discharge to floor.

2. Connect gas supply piping to burner and drip leg, tee, gas cock, and union; minimum size same as inlet connection. Arrange piping to allow unit servicing.

B. Electrical Connections: Power wiring and disconnect switches are specified in Division 26.

3.3 FIELD QUALITY CONTROL

A. Start-Up: Start-up, test, and adjust gas-fired water heaters in accordance with manufacturer's start-up instructions, and utility company's requirements. Check and calibrate controls, adjust burner for maximum 140 ° water discharge temperature.

END OF SECTION 223400

SECTION 224000 – PLUMBING FIXTURES

PART 1 – GENERAL

1.1 CODES AND STANDARDS

A. Comply with ASHRAE Standard 18

B. Comply with ARI Standard 1010

C. Comply with UL Standard 399:

D. Comply with Michigan “Barrier Free Design Code.”

E. Comply with Michigan Plumbing Code.

F. Comply with Michigan and/or local Department of Health requirements.

G. ANSI Z358.1 “Emergency Eyewash and Shower Equipment”

1.2 SUBMITTALS

A. Product Data: Submit Product Data and installation instructions for each fixture, faucet, specialties, accessories, and trim specified; clearly indicate rated capacities of selected models of water coolers.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Manufacturer uniformity shall be as specified in Section 22: Basic Plumbing Requirements.

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

1. Lavatories, Water Closets, Service Sinks:
    a. American Standard.
    b. Crane.
    c. Kohler.
    d. Fiat Products.
    e. TOTO.
    f. Florestone.
    g. Zurn.

2. Stainless Steel Sinks:
    a. Elkay.
    b. Just.
    c. Kohler.

3. Faucets:
    a. Chicago Faucet.

4. Flush Valves:
    a. Sloan.
    b. Zurn.

5. Water Closet Seats:
    a. Bemis.
    b. Beneke.
    c. Olsonite.

6. Water Coolers:
    a. Elkay.
    b. Oasis.
    c. Halsey-Taylor.

7. Shower Head and Valves:
    a. Bradley.
    b. Chicago Faucet.
    c. Powers Process Contro.
    d. Symmons.

8. Fixture Supports
    a. Josam.
    b. Wade.
    c. Zurn.
    d. Jay R. Smith.

9. Emergency Fixtures
    a. Bradley Corporation.
    b. Encon Safety Products.
    c. Guardian Equipment Co.
    d. Haws Corporation.
    e. Speakman Company

2.2 FIXTURES

A. Provide plumbing fixtures and appurtenances as scheduled below:

WC-1
Water Closets (Floor Mounted): Barrier free, vitreous china, siphon jet, elongated closet bowl with 1-1\2" top spud; with self draining jets and large passageway. Kohler "Highcrest" 16-1/2" H" low-consumption Model K-4302 or equal. Provide seat and flush valve. Flush valve to be quiet, exposed, diaphragm operated water closet flush valve, chrome plated, metal oscillation non-hold-open low force/ADA compliant handle, 1" I.P.S. screw driver operated combination angle check and stop valve with protective cap, adjustable tailpiece, escutcheons, seat bumper, vacuum breaker flush connection and spud coupling for 1-1/2" top spud flanges. Sloan Royal Model 111 or Zurn Model Z-6000-WS1 or equal. Water Closet color shall be white.

LAV-1
Lavatories (Undermount, barrier free): 18" x 12" vitreous china with overflow Kohler model "Ladena" K-2214. Faucet shall be Chicago faucet model 894-317 with 4" wrist blades, gooseneck spout and aerator. Chrome plated fixed drain strainer with chrome plated 1-1/4" tailpiece and trap. Complete with supplies and stops. Lavatory shall be white in color.

LAV-2
Lavatories (wall hung, barrier free): 20" x 18" vitreous china lavatory with faucet ledge, overflow, 4" center set for faucets, concealed arm supports. Kohler "Chesapeake" model K-1729 . Faucet shall be Chicago faucet model 894-317 with 4" wrist blades, gooseneck spout and aerator. Chrome plated fixed drain strainer with chrome plated 1-1/4" tailpiece and trap. Complete with supplies and stops and wall carrier. Lavatory shall be white in color.

SK-1
Stainless Steel Sink (Double compartment, Undermount): 31 ¾" x 18 ¼" x 8" 304 stainless steel polished satin finish, sound deadened 18 gage double compartment sink, Elkay model EGUH3118 with two LK-99 stainless steel crumb cup strainer with rubber seat stopper and 1 ½" chrome plated brass tailpieces. Faucet shall be Chicago model 1100-GN2AE3-317, 8" center set with goose neck spout and 4"wrist blade handles and aerator.

SK-2
Stainless Steel Sink (Single compartment, Undermount): 18 ½ " x 14" x 5" 304 stainless steel polished satin finish, sound deadened 18 gage single compartment sink, Elkay model ELUHAD1116 with grid strainer and 1 ½" chrome plated brass tailpiece. Faucet shall be Chicago model 1100-GN2AE3-317, 8" center set with goose neck spout and 4"wrist blade handles and aerator.

SK-3
Stainless Steel Sink (Single compartment, Undermount): 17½ " x 17 ½" x 7 7/8" 304 stainless steel polished satin finish, sound deadened 18 gage single compartment sink, Elkay model ELU1116 with grid strainer and 1 ½" chrome plated brass tailpiece.

SK-4
Stainless Steel Sink (Single compartment, Undermount): 17½ " x 17 ½" x 7 7/8" 304 stainless steel polished satin finish, sound deadened 18 gage single compartment sink, Elkay model ELU1116 with one LK-99 stainless steel crumb cup strainer with rubber seat stopper and 1 ½" chrome plated brass tailpiece. Faucet shall be Chicago model 1100-GN2AE3-317, 8" center set with goose neck spout and 4"wrist blade handles and aerator.

SK-5
Stainless Steel Sink (Single compartment, Undermount): 15½ " x 19 ½" x 7 7/8" 304 stainless steel polished satin finish, sound deadened 18 gage single compartment sink, Elkay model ELU1418 with one with grid strainer and 1 ½" chrome plated brass tailpiece. Faucet shall be Chicago model 1100-GN2AE3-317, 8" center set with goose neck spout and 4"wrist blade handles and aerator.

SK-6
Shampoo Sink: based Belvedere USA Corporation model 2800 Beta Bowl, White, bracket for wall / counter mounting. Provide complete with vacuum breaker, faucet, hose and spray, drain neckrest and mounting brackets. Provide hair interceptor by Zurn or equal.

SH-3
Barrier Free Shower Assembly: Thermostatic mixing shower valve with single lever blade handle. Valve shall open to cold water first then through warm (mix) to hot. Valve shall have all operating parts separately replaceable from outside or wall through valve cover plate, stainless steel seats, stainless steel wearing surfaces on the inner valve, adjustable safety limit stop, check stop, shower arm, flange and 2.6 gpm hand held shower head with slide bar, hose and vacuum breaker. All exposed surfaces shall be chrome-plated. Powers "Hydroguard" Thermostatic Mixing Valve Model e420 with Model 141-163 hand shower or equal and European metal hose and 23" slide bar.

CSS-1
Clinical Service Sink shall be vitreous china, siphon jet action, flush rim, 4" outlet, 1 ½" brass top spud, white in color, and stainless steel rim guards Kohler "Tyrrell" K-6676. Base shall be Stern-Williams Model 1028 Clinic Sink Base A terrazzo pedestal. Provide complete with Sloan Model BPW-1040 slimline bedpan washer flush valve with foot pedal operation. Provide with Chicago faucet bedpan washer model 778-S777 with vacuum breaker 892-GCP and wall valve 770-PL.

MB-1
Mop Basin: One piece molded in stone 10” high 24” x 24” basin with 1” shoulders and tiling flanges as required. Furnish with factory installed stainless steel 3” drain body with removable stainless steel strainer. Mustee model 63M Durastone or equal. Faucet shall be Chicago Faucet model 897-CP, chrome plated cast brass combination service sink fitting with vacuum breaker, ¾” threaded hose spout, wall brace, pail hook, adjustable flanged female supply arms and integral stops.

LT-1
Mop Basin: Size 20” x 24” floor standing plastic service sink with angular steel legs and molded in washboard. Mustee Model 19F. Faucet shall be Chicago Faucet Model 527-CP, chrome plated cast brass combination service sink fitting with vacuum breaker, ¾” threaded hose spout, wall brace. Provide with tailpiece and trap.

EEW-1
Emergency Eye Wash Unit. Speakman SE-582 Eye Wash Unit, wall mounted, stainless steel bowl, with chrome plated brass sprayhead with twin eye wash heads and protective sprayhead covers, chrome plated ½” IPS stay-open ball valve eye wash valve, chrome plated tailpiece. Provide with Lawler model 911E or equivalent thermostatic mixing valve.

EEW-2
Emergency Eye Wash Unit. Speakman SE-570 or equivalent. Swing activated Eye Wash Unit with chrome plated brass sprayhead with twin eye wash heads and protective sprayhead covers, chrome plated ½” IPS stay-open ball valve eye wash valve. Provide with Speakman model SE-370 thermostatic mixing valve. Provide with Speakman SGN1 Emergency eyewash sign.

EWC-1
Electric Water Coolers (Barrier-Free): Wall mounted, one-level, self-contained electric water cooler with fully sealed hermetic refrigeration system. Capacity 8 GPH of 50 ° F drinking water, 80° F inlet and 90° F ambient. Hand operated from mounted, self-closing push bar control. Provide flow regulator from 20 to 100 psi, mounting hangers, stainless steel top and cabinet. Refrigeration unit located below basin, 1/5 HP, 115/1/60 compressor, 1-1/4” P-trap and supply with stop. Elkay Model EZS8.

2.3 FIXTURE SUPPORTS

A. General: All Fixture support carriers to conform to ANSI A112.6.1M (American National Standards Institute).

B. Water Cooler Support Carriers: Wade W-400-AM11-M36 or equal foot supported carrier with tubular steel uprights, top support plate, and lower bearing plate with studs. Carrier shall be securely bolted to floor construction.

C. Lavatory Support Carriers: “Wade” Model W-520-M36 Series or equal concealed arm, foot supported carrier with rectangular steel uprights. Carrier shall be securely bolted to floor construction.

2.4 FITTINGS, TRIM AND ACCESSORIES

A. Toilet Seats: Elongated, solid white plastic with molded-in bumpers, closed back/open front, less cover, and having brass check hinge. Olsonite No. 95 or equal.

B. Supplies and Stops for Lavatories and Sinks: Polished chrome-plated, loose-keyed angle stop having ½" inlet and 3/8" O.D. x 12" long chrome-plated brass tubing outlet, and wall flange and escutcheon.

C. Traps: Brass, chrome plated adjustable "P" trap with cleanout and waste to wall with escutcheon.

D. Thermostatic mixing valve for individual lavs or sinks: Lawler Series 310 conforming to ASSE Standard 1070 with high limit set at 110ºF with checkstops on inlets.

E. Barrier-Free Lavatory Trap Shield: Provide one piece assembly constructed of high impact stain resistant molded plastic, white in color, complete with wall anchors. True-bro Lav Shield or equal.

F. Barrier-Free Lavatory Trap Wrap: Provide ADA-conforming, wheelchair accessible lavatory P-trap and angle valve assembly protective pipe cover. Cover shall be secured with snap-clip flush reusable fasteners, angle stop shall have lock-lid locking access covers. True-bro Lav Guard or equal.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install plumbing fixtures level and plumb, in accordance with fixture manufacturer's written instructions, rough-in drawings, and pertinent codes and regulations, the original design, and the referenced standards.

B. Comply with the installation requirements of required codes and standards with respect to Barrier-Free plumbing fixtures. Coordinate with grab bar installations.

C. Install counter top mounted sinks as far forward as possible within counter top.

D. Fasten plumbing fixtures securely to supports or building structure. Secure supplies behind or within wall construction to provide rigid installation.

E. Set mop basins in a leveling bed of cement ground.

F. Install a stop valve in an accessible location in the water connection to each fixture.

G. Install escutcheons at each wall, floor, and ceiling penetration in exposed finished locations and within cabinets and millwork.

H. Seal fixtures to walls and floors using silicone sealant. Match sealant color to fixture color.

I. Install flush valves for water closets in off-set type Barrier-Free stalls with handles on wide side of stall.

J. Shower controls for individual barrier-free showers shall be located on same wall as showerhead support bar.

3.2 FIELD QUALITY CONTROL

A. Test fixtures to demonstrate proper operation upon completion of installation and after units are water pressurized. Replace malfunctioning units, then retest.

B. Inspect each installed unit for damage. Replace damaged fixtures.

3.3 ADJUSTING AND CLEANING

A. Adjust water pressure at faucets and flush valves to provide proper flow and stream.

B. Replace washers of leaking or dripping faucets and stops.

C. Clean fixtures, trim, and strainers using manufacturer's recommended cleaning methods and materials.

D. Provide protective covering for installed fixtures trim.

E. Do not allow use of fixtures for temporary facilities unless expressly approved in writing by the Owner.

3.4 ROUGH-IN SCHEDULE

A. Line sizes indicated below are run-out sizes, reduce size as required at connection to fixture. Main lines shall be installed as indicated on drawings.

Fixture	Hot Water	Cold Water	Waste	Min Vent
Lavatory	½"	½"	1-1/2"	1-1/4"
Mop Basins	¾"	¾"	3"	1-1/2"
Water Cooler	-	½"	1-1/4"	1-1/4"
Sink	½"	½"	2"	1-1/2"
Water Closet tank	-	½"	4"	2"
Water Closet w/FV	-	1-1/4"	4"	2"
Showers	½"	½"	2", 3", 4"	-
Non Freeze Wall Hydrant	-	¾"	-	-
Hose Bibb	-	¾"	-	-

3.5 MOUNTING HEIGHTS SCHEDULE

A. Mount plumbing fixtures as scheduled below.

Fixture	Mounting Height
Lavatory	31" floor to rim
Sink	36" floor to rim
Barrier-Free Lavatories & Sinks	Max. 34" floor to rim counter surface
Barrier-Free Water Closet	17" floor to top of seat
Water Cooler	39" min. floor to orifice
Barrier-Free Water Cooler	Max. 36" floor to orifice Min. 27" floor to bottom edge of front apron
Shower Head	72" floor to head
Barrier-Free Shower controls	Min. 38" above floor Max. 48" above floor
Barrier-Free Flush Valves	W.C - 44" max. handle to floor
Barrier-Free Shower Spray Unit	Bottom max. 48" above floor
Slide Bar	Top min. 72" above floor

END OF SECTION 224000

SECTION 23 0500 - BASIC MECHANICAL REQUIREMENTS

PART 1 – GENERAL

SUMMARY

A. This section includes general administrative and procedural requirements for mechanical installations. The following administrative and procedural requirements are included in this Section to expand the requirements specified in Division 1.

1. Related Documents
2. General Mechanical Provisions
3. Codes, ordinances, permits, fees, or assessments
4. Submittals
5. Record Documents
6. Maintenance Manuals
7. Delivery, storage and handling
8. Protection
9. Completion of work
10. Temporary Services
11. Rough-ins
12. Cutting and Patching
13. Substitutions

1.01 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this and the other sections of Division 23. Each Division 23 Section applies where applicable to all other Division 23 Sections.

1.02 GENERAL MECHANICAL PROVISIONS

A. The work in this Division consists of furnishing all labor and materials, accessories, equipment, transportation, supervision, start-up services, instructions, permits and incidentals, and related items necessary to complete installation and successfully test, start-up and operate, in a practical and efficient manner, all mechanical work and systems indicated on the drawings and described in each Section of this Division. The work shall also include any items which, while not specifically included in these specifications or drawings, are reasonable and properly inferable therefrom or are accepted trade practice or necessary for the proper completion of this System.

B. The General Requirements of these specifications govern all portions of this heating, ventilating and plumbing system and will apply in full force to this contract.

C. Submission of a Bid Proposal is considered evidence that a contractor has visited the site, examined the drawings and specifications of all Trades and has fully informed himself as to project and site conditions and is proficient, experienced and knowledgeable of all state, local and federal standards, codes, ordinances, permits and regulations which affect every subcontractor trade's completion, cost and time required and that all costs are included in his Bid Proposal.

D. The Contractor shall be responsible for all Subcontractors and suppliers, and shall include in his Bid Proposal and properly apportion, all materials, labor and equipment to the Subtrades.

E. All labor, materials and equipment shall be guaranteed by the Contractor and/or warranted by the manufacturer for one calendar year after date of final acceptance, except where specific, longer periods are specified. Make all necessary alterations, repairs, adjustments and replacements during guarantee period as directed by Engineer to comply with drawings and specifications. Such work shall be at no cost to the Owner.

F. Provide the service of factory-trained personnel for such periods of time as required to instruct the Owner's personnel on operation and maintenance of installed equipment.

G. This Contractor shall have in charge of the work at all times during construction a thoroughly competent Field Superintendent with experience in the work to be installed under this contract.

H. Where a conflict exists between the drawings and specifications it shall be immediately brought to the engineer's attention. If such a conflict is not resolved before work commences, contractor shall provide the most work of greatest value.

I. All products shall be installed per the manufacturers written instructions. Where a conflict exists between the contract documents and the manufacturers instructions, the engineer shall be notified immediately to resolve the conflict.

1.03 CODES, ORDINANCES, PERMITS, FEES OR ASSESSMENTS

A. All work and materials shall be installed in accordance with the standards as described by local and state codes or ordinances including the rules of the National Plumbing Code, National Board of Fire Underwriters, American Standards Association, and with the prevailing rule and regulations pertaining to adequate protection and guarding of any moving parts or otherwise hazardous locations.

B. Should the drawings or specifications call for sizes and grades different than required by the governing code, this Contractor shall furnish and install the larger size of the higher grade.

C. In addition, this Contractor shall give all notices, file all drawings, obtain all necessary approvals, obtain all permits, pay for all fees, deposits and expenses required for installation of all work under this contract, as stated therein and in the General Requirements. In such instances where permits are not required, the contractor shall engage a third party, preferably the local official, to inspect the work.

D. In addition to all applicable federal, state and local codes, the standards and codes listed below shall apply to all mechanical work. Where standards or codes are mentioned in these specifications, the latest edition or revision shall be followed; hence, the specified numbers may be suspended by new numbers.

1. American National Standard Institute (ANSI)
2. American Society for Testing Materials (ASTM)
3. American Society of Mechanical Engineers (ASME)
4. American Water Works Association (AWWA)
5. Air Moving and Condition Association, Inc (AMCA)
6. Air Diffusion Council (ADC)
7. American Society Heating, Ventilating and Refrigerating and Air Conditioning Engineers (ASHRAE)
8. National Electrical Manufacturer's Association (NEMA)
9. American Refrigeration Institute (ARI)
10. ANSI Code of Pressure Piping and Unfired Pressure Vessels

11. Cast Iron Soil Pipe Institute
12. Underwriter's Laboratories (U.L.)
13. National Fire Protection Association (NFPA)
14. American Gas Association (AGA)
15. Occupational Safety and Health Administration (OSHA)
16. Sheet Metal and Air Conditioning National Association (SMACNA)

1.04 SUBMITTALS

A. General

1. Follow the procedures specified in Division 1 Section, Submittals.

1.05 RECORD DOCUMENTS

A. Prepare record documents in accordance with the requirements in Division 1 Section, Project Closeout. In addition to the requirements specified in Division 1, indicate the following installed conditions:

1. Ductwork mains and branches, size and location, for both exterior and interior; locations of dampers and other control devices; filters, boxes, and terminal units requiring periodic maintenance or repair.
2. Mains and branches of piping systems, with valves and control devices located and numbered, concealed unions located, and with items requiring maintenance located (i.e., traps, strainers, expansion compensators, tanks, etc.). Valve location diagrams, complete with valve tag chart. Refer to Division 23 Section, Mechanical Identification. Indicate actual inverts and horizontal locations of underground piping.
3. Approved substitutions, Contract Modifications, and actual equipment and materials installed.
4. Contract Modifications, actual equipment and materials installed.

1.06 MAINTENANCE MANUALS

A. Prepare maintenance manuals in accordance with Division 1 Section, Project Closeout. In addition to the requirements specified in Division 1, include the following information for equipment items:

1. Description of function, normal operating characteristics and limitations, performance curves, engineering data and tests, and complete nomenclature and commercial numbers of replacement parts.
2. Manufacturer's printed operating procedures to include start-up, break-in, and routine and normal operating instructions; regulation, control, stopping, shutdown, and emergency instructions; and summer and winter operating instructions.
3. Maintenance procedures for routine preventative maintenance and troubleshooting; disassembly, repair, and reassembly; aligning and adjusting instructions.
4. Servicing instructions and lubrication charts and schedules.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Deliver products to the project properly identified with names, model numbers, types, grades, compliance labels, and other information needed for identification.

B. Deliver products adequately packaged and protected to prevent damage during shipment, storage, and handling.

C. Store equipment and materials at the site, unless off-site storage is authorized in writing. Protect stored equipment and materials from damage.

D. Coordinate deliveries of mechanical materials and equipment to minimize construction site congestion. Limit each shipment of materials and equipment to the items and quantities needed for the smooth and efficient flow of installations.

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

F. Protect stored pipes and tubes from moisture and dirt. Elevate above grade. When stored inside, do not exceed structural capacity of the floor.

G. Protect flanges, fittings, and piping specialties from moisture and dirt.

1.08 PROTECTION

A. All work, fixtures, equipment and materials shall be protected at all times. Contractor shall make good all damages caused, whether directly or indirectly, by his workmen. Work shall be properly protected to prevent obstruction or damage. All duct and pipe openings shall be closed with caps and plugs during installation. All fixtures and equipment shall be tightly covered and protected against dirt, water, chemical and mechanical injury. At completion, all Work shall be thoroughly cleaned and delivered in a perfect, unblemished condition.

1.09 COMPLETION OF WORK

A. Systems Verifications: The Installer shall start-up, adjust and operate every phase of air conditioning, heating and ventilating equipment for verification that each system is complete and operational. Each shall be operated separately or in conjunction one with the other, for a sufficient period of time to demonstrate to the entire satisfaction of the Owner's Representative the ability of the equipment to meet capacity and performance requirements while maintaining design conditions as shown on the Construction Documents. Air and Hydronic Systems balancing shall have been completed prior to any performance tests.

B. Provide the services of Contractor's personnel with experience on this project in electrical, mechanical and temperature control systems to operate the systems in the presences of Owner's representative for system verification.

1.10 TEMPORARY SERVICES

A. Where used for temporary services, Installer shall be responsible for proper operation, safety and protection of their systems and equipment, and maintenance and lubrication as required.

B. If used for temporary services, all warranties on equipment shall still start after the date of final acceptance.

1.11 ROUGH-IN

A. Verify final locations for rough-ins with field measurements and with requirements of the actual equipment to be connected.

B. Refer to equipment specifications in other division for rough-in requirements.

1.12 CUTTING AND PATCHING

A. Perform cutting and patching in accordance with Division 1 Section, Cutting and Patching. In addition to the requirements specified in Division 1, the following requirements apply:

1. Protection of Installed Work: During cutting and patching operations, protect adjacent installations.

B. Perform cutting, fitting and patching of mechanical equipment and materials required to:

1. Uncover work to provide installation of ill-time work.
2. Remove and replace defective work.
3. Remove and replace work not conforming to requirements of the Contract Documents.
4. Remove samples of installed work as specified for testing.
5. Install equipment and materials in existing structures.
6. Cut, channel, chase and drill floors, wells, partitions, ceilings and other surfaces necessary for mechanical installations. Perform cutting by skilled mechanics of the trades involved.
7. Upon written instructions from the Architect, uncover and restore work to provide for Architect/Engineer observation of concealed work.

C. Cut, remove and legally dispose of selected mechanical equipment, components and materials as indicated, including but not limited to removal of mechanical piping, heating units, plumbing fixtures and trim, and other mechanical items made obsolete by the new work.

D. Protect the structure, furnishings, finishes and adjacent materials not indicated or scheduled to be removed.

E. Protect and maintain temporary partitions or dust barriers adequate to prevent the spread of dust and dirt to adjacent areas.

F. Patch existing finished surfaces and building components using new materials matching existing materials and utilizing experienced installers. Installers' qualifications refer to the materials and methods required for the surface and building components being patched.

1. Refer to Division 1 Section, Definitions and Standards, for definition of "experienced installer".

G. Holes and openings shall be neatly cut and minimum size to allow the Work to be installed. Patching is to match adjacent surfaces in materials and finish. All patching is to be done in a neat and workmanlike manner.

H. The odor and fumes or dust from flame cutting or power blade cutting must be controlled to assure it will not enter the occupied spaces of the facility. Cutting or other odor causing operations must be controlled or scheduled for non-occupied time.

1.13 SUBSTITUTIONS

A. This Contractor shall be considered liable for all added costs both to himself and others (including those costs as incurred by the Engineer, for redesigning or redrawing) resultant from the substitution of products not the basis of the design.

B. This Contractor shall be responsible for the verification of adequate space (considering dimensions, required clearances, weights, and roughing-in requirements) for the installation of items or systems not the basis of the design. He shall be responsible for advising all other trades. He shall submit revised drawing layouts for the approval of the Engineer and shall not proceed without his approval.

END OF SECTION 23 0500

SECTION 23 0505 – BASIC MECHANICAL MATERIALS AND METHODS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes the following basic mechanical materials and methods to complement other Division 23 Sections.

1. Piping materials and installation instructions common to most piping systems.
2. Field-fabricated metal equipment supports.
3. Installation requirements common to equipment specification Sections.
4. Fire Stop Systems.
5. Touch-up painting and finishing.

B. Pipe and pipe fitting materials are specified in piping system Sections.

1.2 DEFINITIONS

A. Pipe, pipe fittings, and piping include tube, tube fittings, and tubing.

B. Finished Spaces: Spaces other than mechanical and electrical equipment rooms, furred spaces, pipe and duct shafts, unheated spaces immediately below the roof, spaces above ceilings, unexcavated spaces, crawl spaces, and tunnels.

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

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

E. Concealed Interior Installations: Concealed from view and protected from physical contact by building occupants. Examples include above ceilings and in duct shafts, also roof top locations.

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

1.3 QUALITY ASSURANCE

A. Qualify welding processes and operators for piping according to ASME “Boiler and Pressure Vessel Code,” Section IX, “Welding and Brazing Qualifications.”

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

B. Equipment Selection: Equipment of greater or larger power, dimensions, capacities, and ratings may be furnished provided such proposed equipment is approved in writing and connecting mechanical and electrical services, circuit breakers, conduit, motors, bases, and equipment spaces are increased. No additional costs will be approved for these increases, if larger equipment is approved. If minimum energy ratings or efficiencies of the equipment are

specified, the equipment must meet the design requirements and commissioning requirements.

1.4 SEQUENCING AND SCHEDULING

A. Coordinate with all other trades.

B. Coordinate all work with owner's schedule.

C. Coordinate connection of electrical services.

D. Coordinate connection of temperature control services.

1.5 FIRE STOP SYSTEMS

A. Mechanical Contractor shall furnish and install all fire stop systems required at all piping penetrations through rated walls and floors.

PART 2 - PRODUCTS

2.1 PIPE AND PIPE FITTINGS

A. Refer to individual piping system specification Sections for pipe and fitting materials and joining methods.

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

2.2 JOINING MATERIALS

A. Refer to individual piping system specification Sections in Division 15 for special joining materials not listed below.

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

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

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

b. AWWA C110, rubber, flat face, 1/8 inch thick, except where other thickness is indicated; and full-face or ring type, except where type is indicated.

C. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, except where other material is indicated.

D. Plastic Pipe Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer, except where other type or material is indicated.

E. Solder Filler Metal: ASTM B 32.

1. Alloy Sn95 or Alloy Sn94: Tin (approximately 95 percent) and silver (approximately 5 percent), having 0.10 percent lead content.
2. Alloy E: Tin (approximately 95 percent) and copper (approximately 5 percent) having 0.10 maximum lead content.
3. Alloy HA: Tin-antimony-silver-copper-zinc, having 0.10 percent maximum lead content.
4. Alloy HB: Tin-antimony-silver-copper-nickel, having 0.10 percent maximum lead content.

F. Brazing Filler Metals: AWS A5.8.

1. BcuP Series: Copper-phosphorus alloys.
2. Bag1: Silver alloy.

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

H. Solvent Cements: Manufacturer's standard solvents complying with the following:

1. Poly (Vinyl Chloride) (PVC): ASTM D 2564.
2. Acrylonitrile-Butadiene-Sytrene (ABS): ASTM D 2235.
3. Chlorinated Poly (Vinyl Chloride) (CPVC): ASTM F 493.

I. Plastic Pipe Seals: ASTM F 477, elastomeric gasket.

J. Flanged, Ductile-Iron Pipe Gasket, Bolts, and Nuts: AWWA C110, rubber gasket, carbon steel bolts and nuts.

2.3 PIPING SPECIALTIES

A. Escutcheons: Manufactured wall, ceiling, and floor plates; deep-pattern type where required to conceal protruding fittings and sleeves.

1. Inside Diameter: Closely fit around pipe, tube, and insulation.
2. Outside Diameter: Completely cover opening.
3. Cast Brass: One-piece, with set-screw.

a. Finish: Rough brass.
b. Finish: Polished chrome plate.

4. Cast Brass: Split casting, with concealed hinge and set-screw.

a. Finish: Rough brass.
b. Finish: Polished chrome plate.

5. Stamped Steel: One-piece, with set-screw and chrome-plated finish.
6. Stamped Steel: One-piece, with spring clips and chrome-plated finish.
7. Stamped Steel: Split plate, with concealed hinge, set-screw, and chrome-plated finish.
8. Stamped Steel: Split plate, with concealed hinge, spring clips, and chrome-plated finish.
9. Cast-Iron Floor Plate: One-piece casting.

B. Dielectric Fittings: Assembly or fitting having insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion.

1. Dielectric Couplings: Galvanized-steel coupling, having inert and non-corrosive, thermoplastic lining, with threaded ends and 300-psig minimum working pressure at 225 ° F temperature.
2. Dielectric Nipples: Electroplated steel nipple, having inert and non-corrosive thermoplastic lining, with combination of plain, threaded, or grooved end types and 300-psig working pressure at 225 ° F temperature.

C. Dielectric Unions: Assembly having isolation characteristics used to join dissimilar metals to prevent galvanic action and stop corrosion.

1. Description: Ground joint, copper unions, ASME B16.18, cast-copper-alloy body, hexagonal stock, with ball-and socket-joint, metal-to-metal seating surfaces, and solder-joint, threaded, or solder-joint and threaded ends; and suitable system fluid, pressure and temperature.

a. Threaded Ends: Threads conforming to ASME B1.20.1.

D. Mechanical Sleeve Seals: Modular, watertight mechanical type. Components include interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve. Connecting bolts and pressure plates cause rubber sealing elements to expand when tightened.

E. Sleeves: The following materials are for wall, floor, slab, and roof penetrations:

1. Steel Sheet-Metal: 24-gage or heavier galvanized sheet metal, round tube closed with welded longitudinal joint.
2. Steel Pipe: ASTM A 53, Type E, Grade A, Schedule 40, galvanized, plain ends.
3. Cast-Iron: Cast or fabricated wall pipe equivalent to ductile-iron pressure pipe, having plain ends and integral water stop, except where other features are specified.

2.4 FIRE STOP SYSTEMS

A. Elastomeric Fire-stop Sealant

1. Metal Pipe
2. Where pipe movement or vibration is expected
3. Construction joints

B. Intumescent Fire-stop Sealant

1. Plastic pipe – closed or vented piping systems
2. Single and bundled cables
3. Insulated metal pipes

C. High Performance Fire-stop Sealant

1. Metal pipe – static conditions and sleeved openings

D. Trowelable Fire-stop Compound

1. Large openings

a. Cable trays
b. Electrical busway
c. Multiple metal pipes

E. Fire Barrier Collar

1. Plastic pipe – 3", 4", 5" and 6"

F. Approved Supplies

1. Must be approved by State Fire Marshals Office

a. Hilti, Fire-stop Systems
b. Fire Protection Systems, Incorporated

PART 3 – EXECUTION

3.1 MECHANICAL INSTALLATIONS

A. General: Sequence, coordinate, and integrate the various elements of mechanical systems, materials, and equipment. Comply with the following requirements:

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 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. 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 Architect/Engineer.
9. Install systems, materials, and equipment level and plumb, parallel and perpendicular to other building systems and components, where installed exposed in finished spaces.
10. Install mechanical 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. Extend grease fittings to an accessible location.
11. Coordinate requirements for access panel and doors where mechanical items requiring access 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. Coordinate the cutting and patching of building components to accommodate the installation of mechanical equipment and materials.
14. Coordinate the installation of mechanical materials and equipment above ceilings with suspension system, light fixtures, and other installations.
15. Coordinate installation of identifying devices after completing covering and painting where devices are applied to surfaces. Install identifying devices prior to installing acoustical ceilings and similar concealment.
16. Should any structural difficulties prevent the installation of the piping, ductwork, fixtures or equipment at the points shown on the drawings, necessary deviations therefrom as determined by the Architect/Engineer will be permitted, and shall be made without additional costs.
17. Mechanical drawings are diagrammatic with no attempt made to show every ell, tee, transition, fitting, etc. All ducts and pipes shall be run in spaces indicated as job conditions warrant, arranged for most convenient access for servicing with due consideration given to swing joints and to other Installers work. Provide all necessary offsets, rises and drops in piping and ductwork as required by building conditions at no additional cost to Owner. Provide connections to equipment with matching connection devices and transitions as required to make connections.
18. It is understood and agreed by the Installer that work herein described shall be complete in every detail, even though every item involved is not particularly mentioned. Installer shall be held to provide all labor and materials necessary for the work intended and described for a complete and operational system. Such materials shall include piping, valves, traps, gauges, controls, etc. This also includes equipment required by State and local codes.
19. Install piping and ductwork free of sags or bends, with ample space between to permit proper insulation applications, and install at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated on the Drawings.
20. Installer shall bear as a part of his contract, any additional costs incurred in his work, other Installers' work and any additional costs incurred in architectural or engineering redesign as a result of installation of other than scheduled equipment.
21. Ceilings and ceiling suspension systems required to be removed to facilitate the installation of mechanical. Work above those ceilings shall be removed, stored, protected, and reinstalled. This work is the responsibility of the Mechanical Installer who must employ the appropriate Trade Installers (Acoustical Ceiling for ceiling components and Electrical for lighting fixtures) to do the work.

3.2 PIPING SYSTEMS-COMMON REQUIREMENTS

A. General Locations and Arrangements: Drawings (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, except where deviations to layout are approved on coordination drawings.

B. General: Install piping as described below, except where system Sections specify otherwise. Individual piping system specification Sections in Division 23 specify piping installation requirements unique to the piping system.

1. Install piping at indicated slope.
2. Install components having pressure rating equal to or greater than system operating pressure.
3. Install piping in concealed interior and exterior locations, except in equipment rooms and service areas.
4. Install piping free of sags and bends.

5. Install exposed interior and exterior piping at right angles or parallel to building walls. Diagonal runs are prohibited, except where indicated.
6. Install piping tight to slabs, beams, joists, columns, walls, and other building elements. Allow sufficient space above removable ceiling panels to allow ceiling panel removal.
7. Install piping to allow application of insulation plus 1-inch clearance around insulation.
8. Locate group of pipes parallel to each other, spaced to permit valve servicing.
9. Install fittings for changes in direction and branch connections.
10. Install couplings according to manufacturer's printed instructions.

3.3 ESCUTCHEONS

A. Install pipe escutcheons for pipe penetrations of concrete and masonry walls, wall board partitions, and suspended ceilings according to the following:

1. Chrome-Plated Piping: Cast-brass, one-piece, with set-screw, and polished chrome-plated finish. Use split-casting escutcheons, where required, for existing piping.
2. Uninsulated Piping Wall Escutcheons: Cast-brass or stamped-steel, with set-screw.
3. Uninsulated Piping Floor Plates in Utility Areas: Cast-iron floor plates.
4. Insulated Piping: Cast-brass or stamped-steel, with concealed hinge, spring clips, and chrome-plated finish.
5. Piping in Utility Areas: Cast-brass or stamped-steel, with set-screw or spring clips.

3.4 PIPE PENETRATIONS

A. Sleeves are not required for core drilled holes.

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

2. Build sleeves into new walls and slabs as work progresses.
3. Install large enough sleeves to provide ¼-inch annular clear space between sleeve and pipe insulation. Use the following sleeve materials:

    a. Steel Pipe Sleeves: For pipes smaller than 6 inches.
    b. Steel Sheet-Metal Sleeves: For pipes 6 inches and larger that penetrate gypsum-board partitions.
    c. Cast-Iron Sleeve Fittings: For floors having membrane waterproofing. Secure flashing between clamping flanges. Install section of cast-iron soil pipe to extend sleeve to 2 inches above finished floor level. Flashing is specified in Division 7 Section "Flashing and Sheet Metal."

4. Except for below-grade wall penetrations, seal annular space between sleeve and pipe or pipe insulation, using elastomeric joint sealants specified in Division 7 Section "Joint Sealants."

C. Above Grade, Exterior Wall, Pipe Penetrations: Seal penetrations using sleeves and mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.

1. Install steel pipe for sleeves smaller than 6 inches.
2. Install cast-iron wall pipes for sleeves 6 inches and larger.
3. Assemble and install mechanical seals according to manufacturer's printed instructions.

D. Below Grade, Exterior Wall, Pipe Penetrations: Install cast-iron wall pipes for sleeves. Seal pipe penetrations using mechanical sleeve seals. Size sleeve for 1-inch annular clear space between pipe and sleeve for installation of mechanical seals.

E. Fire Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestopping sealant material. Firestopping materials are specified in Division 7 Section "Firestopping."

3.5 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings as follows and as specifically required in individual piping system Sections.

1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
3. Soldered Joints: Construct joints according to AWS "Soldering Manual," Chapter 22 "The Soldering of Pipe and Tube."
4. Brazed Joints: Construct joints according to AWS "Brazing Manual" in the "Pipe and Tube" chapter.
5. 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 inside diameter. Join pipe fittings and valves as follows:

    a. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.
    b. Apply appropriate tape or thread compound to external pipe threads (except where dry seal threading is specified).
    c. Align threads at point of assembly.
    d. Tighten joint with wrench. Apply wrench to valve end into which pipe is being threaded.
    e. Damaged Threads: Do not use pipe or pipe fittings having threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

6. Welded Joints: Construct joints according to AWS D10.12 "Recommended Practices and Procedures for Welding Low Carbon Steel Pipe" using qualified processes and welding operators according to the "Quality Assurance" Article.
7. Flanged Joints: Align flange surfaces parallel. Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.
8. Plastic Pipe and Fitting Solvent-Cement Joints: Clean and dry joining surfaces by wiping with clean cloth or paper towels. Join pipe and fittings according to the following standards:

    a. Comply with ASTM F 402 for safe handling of solvent-cement and primers.

b. Poly(Vinyl Chloride) (PVC) Pressure Aplication: ASTM D 2672.
c. Poly(Vinyl Chloride) (PVC) Non-Pressure Application: ASTM D 2855.

3.6 PIPING CONNECTIONS

A. Except as otherwise indicated, make piping connections as specified below.

1. Install unions in piping 2 inches and smaller adjacent to each valve and at final connection to each piece of equipment having a 2-inch or smaller threaded pipe connection.
2. Install flanges in piping 2-1/2 inches and larger adjacent to flanged valves and at final connection to each piece of equipment having flanged pipe connection.
3. Dry Piping Systems (Gas, Compressed Air, and Vacuum): Install dielectric unions and flanges to connect piping materials of dissimilar metals.
4. Wet Piping Systems (Water): Install dielectric coupling and nipple fittings to connect piping materials of dissimilar metals.

3.7 EQUIPMENT INSTALLATION – COMMON REQUIREMENTS

A. Install equipment to provide the maximum possible headroom where 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 the Architect.

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

D. Install mechanical equipment to facilitate servicing, maintenance, and repair or replacement of equipment components. Connect equipment for ease of disconnecting, with minimum of interference with other installations. Extend grease fittings to an accessible location.

E. Install equipment giving right-of-way to piping systems installed at a required slope.

F. All sprinklers, grilles, registers and diffusers shall be located in the center (in two directions) of the ceiling tile, except linear diffusers which shall be installed along one side. Any mechanical equipment installed which does not fit into the ceiling tile pattern will have to be relocated at no extra cost to the Owner.

3.8 PAINTING AND FINISHING

A. Refer to Division 9 Section “Painting” for field painting requirements.

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

3.9 ERECTION OF METAL SUPPORTS AND ANCHORAGE

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

B. Field Welding: Comply with AWS D1.1 “Structural Welding Code – Steel.”

3.10 MECHANICAL ROOF PENETRATIONS

A. Provide mechanical roof penetrations as follows:

1. New roofs with or without warranty. Roof penetrations and curbs provided by Mechanical Installer with flashing provided by new Roof Installer.
2. Existing roofs with warranty. Roof penetrations and curbs provided by Mechanical Installer with flashing provided by roof manufacturer's approved Installer with work done in such a manner to maintain existing warranty.
3. Existing roof without warranty. Roof penetrations and curbs provided by Mechanical Installer with flashing provided by Contractor.

3.11 FAN SHEAVES

A. Provide all fan sheave changes as required during testing and balancing to attain proper total CFM Quantities. Provide new v-belts, if required, to maintain fan motor sheave at approximate mid-point of its adjustable range.

END OF SECTION 23 0505

SECTION 23 0513 – MOTORS FOR HVAC EQUIPMENT

PART 1 – GENERAL

1.1 QUALITY ASSURANCE

A. Comply with NFPA 70, “National Electrical Code.”

B. NRTL Listing: Provide NRTL Listed motors.

1. Term “Listed”: As defined in “National Electrical Code,” Article 100.

PART 2 – PRODUCTS

2.1 MOTORS, GENERAL

A. General: Requirements below apply to motors covered by this Section except as otherwise indicated.

B. Motors ½ HP and Smaller: Single-phase.

C. Motors Larger Than ½ HP: Polyphase.

D. Frequency Rating: 60 Hz.

E. Voltage Rating: Determined by voltage of circuit to which motor is connected for the following motor voltage ratings (utilization voltages):

1. 120 V Circuit: 115 V – motor rating.
2. 208V Circuit: 200V – motor rating.
3. 240 V Circuit: 230 V – motor rating.
4. 480 V Circuit: 460V – motor rating.

F. Capacity: Sufficient to start and operate connected loads at designated speeds in indicated environment, and with indicated operating sequence, without exceeding nameplate ratings. Provide motors rated for continuous duty at 100 percent of rated capacity.

1. All motors 10 horsepower and above shall be approved for inverter duty control whether or not served by a variable frequency drive.
2. All motors 10 horsepower and above shall be “premium” with an efficiency of 93 percent or higher.

G. Temperature Rise: Based on 40 deg C ambient except as otherwise indicated.

H. Enclosure: Open drip proof, or as indicated.

I. Provide motors which will not operate in service factor range when supply voltage is within 10 percent of motor voltage rating.

2.2 POLYPHASE MOTORS

A. General: Squirrel-cage induction-type conforming to the following requirements except as otherwise indicated.

B. NEMA Design Letter Designation: “B.”

C. Insulation System: Class “F” or better.

D. Multi-Speed Motors: separate winding for each speed.

E. Energy Efficient Motors: Meeting EPACT efficiencies with nominal efficiency equal to or greater than that stated in NEMA MG 1, table 12-6C for that type of rating of motor.

F. Variable Speed Motors for Use with Solid-State Drives: Inverter duty, energy efficient, squirrel-cage induction, design B units with ratings, characteristics, and features coordinated with and approved by drive manufacturer. Provide with thermostats. Meet NEMA MG 1 part 31 and motors to be suitable for 10:1 speed range.

G. Internal Thermal Overload Protection for Motors: For Motors so indicated, protection automatically opens control circuit arranged for external connection. Protection operates when winding temperature exceeds safe value calibrated to the temperature rating of the motor insulation.

H. Bearings: Double-shielded, prelubricated ball bearings suitable for radial and thrust loading of the application.

I. Motors for Reduced Inrush Starting: Coordinate with indicated reduced inrush controller type and with characteristics of driven equipment load. Provide required wiring leads in motor terminal box to suit control method.

2.3 SINGLE-PHASE MOTORS

A. General: Conform to the following requirements except as otherwise indicated.

B. Energy Efficient Motors: One of the following types as selected to suit the starting torque and other requirements of the specific motor application.

1. Permanent Split Capacitor.
2. Split-Phase Start, Capacitor-RUN.
3. Capacitor-Start, Capacitor-Run.

C. Shaded-Pole Motors: Use only for motors smaller than 1/20 hp.

D. Internal Thermal Overload Protection for Motors: For motors so indicated, protection automatically opens the power supply circuit to the motor, or a control circuit arranged for external connection. Protection operates when winding temperature exceeds a safe value calibrated to the temperature rating of the motor insulation. Provide device that automatically resets when motor temperature returns to normal range except as otherwise indicated.

E. Bearings, belt connected motors and other motors with high radial forces on motor shaft shall be ball bearing type. Sealed, prelubricated sleeve bearings may be used for other single phase motors.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General: The following requirements apply to field-installed motors.

B. Install motors in accordance with manufacturer's published instructions and the following:

1. Direct Connected Motors: Mount securely in accurate alignment.
2. Belt Drive Motors: Use adjustable motor mounting bases. Align pulleys and install belts. Use belts identified by the manufacturer and tension belts in accordance with manufacturer recommendations.

3.2 COMMISSIONING

A. Check operating motors, both factory and field-installed, for unusual conditions during normal operation. Coordinate with the commissioning of the equipment for which the motor is a part.

B. Report unusual conditions.

C. Correct deficiencies of field-installed units.

END OF SECTION 23 0513

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SECTION 23 0514 – VFD'S FOR HVAC EQUIPMENT

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submittals: Submit manufacturer's technical data, installation and start-up instructions, piping and wiring diagrams, and maintenance data; in accordance with requirements of Division 1.

1.2 QUALITY ASSURANCE

A. Comply with applicable local electrical code requirements of the authority having jurisdiction and NEC.

B. Comply with NFPA 70E.

C. Provide controllers and components which are UL-listed and labeled.

D. Comply with applicable requirements of NEMA.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Variable frequency drives shall be as manufactured by

A. Magnetek
B. Square "D" Co.
C. Yaskawa

2.2 MANUFACTURED UNITS

A. General: Provide variable frequency drive units for variable speed operation of associated mechanical equipment motors using a pulse width modulation (PWM) variable frequency inverter and hardware as required to provide the required operations.

B. Unit Design: Provide VFD's suitable for variable torque loads. Efficiency shall be 97 percent or better at full speed and full load, fundamental power factor shall not be less than 0.98 at all speeds and loads. Power circuit shall consist of an AC to DC power converter, a DC power filter and a DC to AC power inverter. The inverter shall be a transistor type inverter.

C. Serviceability: Provide VFD's which utilize the following design features:

1. Modular construction.
2. Plug connected printed circuit board.
3. Access to all components from the front of the inverter enclosure.

D. Performance Requirements: Comply with the following:

1. Efficiency: Not less than 95% at maximum output voltage, current and frequency and, 85% efficient at 60% speed.
2. Suitable for operation of the specified equipment.
3. Capable of 110% current for a minimum of one minute.
4. Separately adjustable linear acceleration and deceleration from 2.5 seconds to one minute.

5. Current limit protection adjustable from 50% to 110%
6. Frequency accuracy within +2 Hertz ub 24 hours following conditions:
    a. Ambient temperature 0 to 40° C.
    b. Altitude to 3300 feet.
    c. Humidity to 95%, non-condensing
7. Speed regulation within 3%.

E. Compatibility: The VFD shall not require modifications or readjustments to accept replacement NEMA design B motor of equal or lower horsepower within maximum design current of the VFD.

F. Enclosure: Wall mounted, NEMA 12 type with provisions for locking with the following features:

1. Main circuit breaker disconnect.
2. Door interlocked between input over-current device with lockable handle.
3. Output motor contactor to provide mechanical disconnect from motor.
4. Fuseless electronic power circuit protection.
5. Input power: AC line voltage variation (+10%, -10%)/3 PH/60 Hz.
6. Electrically isolated low voltage logic and control circuits.
7. Grounded signal circuit common.
8. Power ride through feature on inverter to accommodate up to five cycle line loss for fans, and one cycle line loss for pumps.
9. Instantaneous over current trip
10. Integral input reactor(s) with 3% minimum impedance.
11. Form C, dry contacts to indicate when the VFD is in the run and fault modes.
12. Operator interface, including digital display, keypad and application specific connections; regardless of horsepower rating. Keypad shall permit local control (start/stop, forward/reverse, and speed adjust), setting (including uploading and downloading) all control and monitor parameters, and display and menu review.
13. Diagnostic fault detection integral to each inverter, provide English language indication of the following:
    a. External fault
    b. Processor line fault
    c. Low AC line
    d. High AC line
    e. Current Overload
    f. High bus voltage
    g. Current trip
    h. Inverter output fault
14. Line side sensing single phase protection

G. Safety Shutdown: Provide VFD's which are protected to safely shutdown without fault of components or fuses under any failure of equipment or electrical service.

H. Electronic Output Overload Protection: Provide VFD with electronic output overload protection. The drive shall not be phase sequence sensitive.

I. Contactor Bypass: Provide to allow motor to be safely transferred from VFD output power to the A-C line, or from the A-C line to the VFD, while the motor is at zero speed. Motor protection is to be provided in both the VFD mode and the "BYPASS" mode by a motor overload relay. The same "START/STOP" command shall operate the motor in both VFD

and “BYPASS” modes. The bypass circuit shall include a second disconnect or fast-acting SCR fuses installed in the VFD. All equipment for bypass option shall mount within the controller enclosure and be mechanically isolated from the VFD.

J. Provide snubber transistor bracing to aid start-up when fan motor is freewheeling.

K. Provide adjustable auto restart with a minimum 5 restarts spaced 20 seconds apart.

L. Serial Communications:

1. Provide RS-485 port to communicate with PLC’s, DCS’s and DDC system, and including the following capabilities:
    a. Run-stop control
    b. Speed set adjustment
    c. PID control (Set Point) adjustments
    d. Current limit and accel/decel time adjustments.
2. Provide capability to permit remote DDC control system to monitor feedback of 15 parameters including, but not limited to:
    a. Output speed/frequency
    b. Current (in amperes)
    c. Percent torque
    d. Power (in kilowatts)
    e. Kilowatt hours and operating hours (resettable)
    f. Digital inputs and diagnostic warning and fault information.

M. Operating Modes: Configure VFD’s as follows:

1. Keypad or Selector Switch in MANUAL Mode: Operation of 1-100% between the minimum and maximum speeds as set in the inverter.
2. Keypad or Selector Switch in AUTO Mode: Operation will be from the input signal as specified with output speed being proportional to the input signal. Provide a 4-20 m.a. signal follower with VFD capable of following a transducer signal furnished by temperature controls contractor, incorporating the following features:
    a. Accept and condition transducer output signal to produce speed reference signal for inverter.
    b. Differential input circuit which allows signal to be grounded at its source, and of either positive or negative polarity.
    c. Minimum speed adjustment.

N. Auxiliary Devices: Provide separate terminal strip to accept inputs for low-temperature limit, duct smoke detector, and external start command. All external interlocks and start/stop contacts shall remain fully functional whether the drive is in Hand, Auto, or Bypass.

O. Remote Monitoring (in lieu of Serial Communications capabilities specified above): Equip with remote monitoring interface capabilities, including the following:

1. “Run” indication by contact closure.
2. Isolated 0-10 VDC analog signals proportional to output voltage, output current, and output frequency to provide status indication to DDC system.
3. Two programmable output relays.
4. Alarm failure and bypass to DDC system.

P. The following operator devices shall be door mounted on those VFD products which do not offer keypad access to these control functions:

1. Speed indicator calibrated 0-100%
2. Manual/Automatic selector switch.
3. Manual speed potentiometer for operation in the manual/normal mode.
4. Normal/Bypass Selector Switch.
5. Start/Stop push buttons
6. Load indicator calibrated 0-150%.

Q. Configure VFD for automatic restart after a line loss or drive fault with ample protection to prevent restart until fan has coasted to below 6 hertz speed.

R. Provide with disconnect and line reactors.

S. Provide with 22 KAIC UL coordinated rating.

2.3 SOURCE QUALITY CONTROL

A. Testing: Prior to shipment, completely adjust, operationally test and burn-in maximum rated enclosure temperature while running a loaded motor.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Turn drive over to electrical contractor for installation and power wiring.

B. Touch-up scratched or marred enclosure surfaces to match original finishes.

C. Coordinate installation and controls wiring with Temperature Controls Contractor.

3.2 FIELD QUALITY CONTROL

A. Provide factory-authorized service representative to check, test, program parameters to tune and control the drive for the specific motor application, and start-up VFD's in accordance with manufacturer's written start-up instructions.

B. Test and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

C. Coordinate with Temperature Control Contractor to meet requirements of the sequence of operations.

D. Adjust ramping speed to avoid nuisance tripping.

3.3 DEMONSTRATION

A. Provide manufacturer's service representative to train/instruct Owner's personnel.

B. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and troubleshooting procedures plus procedures for obtaining repair parts and technical assistance.

C. Schedule training with Owner, provide at least 7-day prior notice.

END OF SECTION 23 0514

SECTION 23 0519 – METERS AND GAGES

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submittals: Submit manufacturer's product data for each type of meter and gage. Include certificates of accuracies, scale range and ratings and maintenance data for each type.

1.2 QUALITY ASSURANCE

A. Comply with ASME and ISA.

PART 2 – PRODUCTS

2.1 AVAILABLE MANUFACTURERS

A. Ashcroft.
B. Trerice.
C. Marsh Instrument Company.
D. Weiss Instruments.
E. Weksler.

2.2 PRESSURE GAGES

A. Description: General use, ASME B40.1, Grade A, phosphor bronze bourdon-tube type, bottom connection, with the following features:

B. Case: Drawn steel or brass, glass lens, 4-1/2-inches diameter.

C. Connector: Brass, ¼-inch NPS.

D. Scale: White coated aluminum, with permanently etched markings.

E. Accuracy: Plus or minus 1 percent of range span.

F. Range: Conform to the following:

1. Vacuum: 30 inches Hg to 15 psi.
2. All fluids: 2 times operating pressure.

2.3 PRESSURE GAGE ACCESSORIES

A. Snubber: ¼-inch NPS brass bushing with corrosion-resistant porous metal disc. Disc material shall be suitable for fluid served and rated pressure.

B. Cocks: ¼" ball valve, two piece, lever handle, 150 WSP, 600 WOG.

2.4 PRESSURE TEMPERATURE TAPPINGS

A. Nickel-plated brass body, with ½-inch NPS fitting and 2 self-sealing valve-type core inserts, suitable for inserting a 1/8-inch O.D. probe assembly from a dial-type thermometer or pressure gage. Test plug shall have gasketed and threaded cap with retention chain and

body of length to extend beyond insulation. Pressure rating shall be 500 psig. Test plugs shall have the following additional features:

1. Core Material: Conform to the following for fluid and temperature range:

    a. Air, Water, Oil and Gas, 20 to 200 degree F: Neoprene.
    b. Air and Water, minus 30 degree to 275 degree F: EPDM.

2.5 THERMOMETERS, GENERAL

A. Accuracy: Plus or minus 1 percent through out entire range of thermometer.

B. Scale range: -30°F to 300°F with permanently etched scale.

C. Plastic 9” long.

D. Red or blue reading liquid.

E. Adjustable connector with 180 degrees in the vertical plane and 360 degrees in the horizontal plane.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Piping installation requirements are specified in other sections of Division 23. The drawings indicate the general arrangement or piping, fittings, and specialties. The following are specific connection requirements:

B. Install meters and gages piping adjacent to machine to allow servicing and maintaining of machine.

C. Adjust thermometers and gages to proper angle to allow reading by observer standing on the floor.

D. Thermometer Wells: Install in piping tee where thermometers are indicated, in vertical position. Fill well with oil or graphite and secure cap.

E. Install pressure gages in piping tee with ball valve, located gage on pipe at most readable position.

F. Install pressure gages where indicated.

G. Install Pressure Temperature Tapping test plugs in piping tee where indicated, located on pipe at most readable position. Secure cap.

H. Clean windows of meters and gages and factory-finished surfaces. Replace cracked and broken windows, and repair scratched and marred surfaces with manufacturer’s touch-up paint.

END OF SECTION 23 0519

SECTION 23 0523 – VALVES

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes general duty valves common to the following mechanical piping systems.

1. Hydronic water systems.
2. Natural gas systems.

B. Related Sections: The following Sections contain requirements that relate to this Section:

1. Special purpose valves are specified in Division 23 piping system Sections.
2. Valve tags and charts are specified in Division 23 Section “Mechanical Identification.”

1.2 SUBMITTALS

A. Submittals: Submit manufacturer’s technical data instructions on adjusting, servicing, disassembling and repairing; in accordance with requirements of Division 1 include list indicating valve and its application.

B. Grooved joint valves shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.

1.3 QUALITY ASSURANCE

A. Single-Source Responsibility: Comply with the requirements specified in Division 1 Section “Materials and Equipment,” under “Source Limitations” Paragraph.

B. Comply with ASME

C. Comply with MSS.

D. All grooved joint valves shall be of a single manufacturer and the products of the same manufacturer as the adjoining couplings.

E. All castings used for valve bodies shall be date stamped for quality assurance and traceability.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. Ball Valves:

a. Apollo/Conbraco
b. Watts
c. JamesBury

2. Butterfly Valves:

    a. Crane
    b. Bray
    c. Apollo/Conbraco
    d. Mueller

3. Swing Check Valves:

    a. Crane
    b. Watts
    c. Stockham

4. Lift Check Valves:

    a. Crane
    b. Watts
    c. Stockham

5. Valves for Grooved Piping Systems

    a. Grooved End Butterfly Valves:

        1. Anvil International Gruvlok Series 7700
        2. Victaulic MasterSeal™/AGS-Vic300 and Series 608.

    b. Grooved End Ball Valves

        1. Anvil International Gruvlok Series 7500
        2. Victaulic Style 721 and 726

    c. Grooved End Non Slam Check Valves

        1. Anvil International Gruvlok Series 7800
        2. Victaulic Style 716 and 779

    d. Grooved end Circuit Balancing Valves

        1. Anvil International Gruvlok
        2. Victaulic Series 787 and 789

2.2 BASIC, COMMON FEATURES

A. Pressure and Temperature Ratings: As indicated in the “Application Schedule” of Part 3 of this Section and as required to suit system pressures and temperatures.

B. Sizes: Same size as upstream pipe, unless otherwise indicated.

C. Operators: Use specified operators, except provide the following special operator features:

1. Lever Handles: For quarter-turn valves 4 inches and smaller.
2. Gear-Drive Operators: For quarter-turn valves 6 inches and larger.

D. Extended Stems: Where insulation is indicated or specified, provide extended stems arranged to receive insulation.

E. Bypass and Drain Connections: Comply with MSS SP-45 bypass and drain connections.

F. Threads: ASME B1.20.1.

G. Grooved Ends: ASME / AWWA C606 for steel piping systems, and copper-tube dimensions for copper-tubing systems.

H. Flanges: ASME B16.1 for cast iron, ASME B16.5 for steel, and ASME B16.24 for bronze valves.

I. Solder Joint: ASME B16.18.

1. Caution: Where soldered end connections are used, use solder having a melting point below 840 ° F for check valves; below 421 ° F for ball valves.

2.3 BALL VALVES

A. Ball Valves, 2 Inches and Smaller: MSS Sp-110, Class 150, 600-psi CWP, ASTM B 584 bronze body and bonnet, 2-piece construction; chrome-plated brass ball, standard port for ½-inch valves and smaller and conventional port for ¾-inch valves and larger; blowout proof; bronze or brass stem; Teflon seats and seals; threaded or soldered end connections:

1. Operator: Vinyl-covered steel lever handle, or where indicated, lever operators with lock.
2. Stem Extension: For valves installed in insulated piping.
3. Memory Stop: For operator handles, where indicated.

B. Ball Valves 2½ Inches and Larger: Meets the intent of MSS SP-110, 800 psi CWP, ASTM A 536 ductile iron body, standard port chrome-plated carbon steel ball and stem, TFE seats, fluoroelastomer seals, grooved ends.

2.4 CHECK VALVES

A. Swing Check Valves, 2 Inches and Smaller: MSS SP-80; Class 125, 200-psi CWP, or Class 150, 300-psi CWP; horizontal swing, y-pattern, ASTM B 62 cast-bronze body and cap, rotating bronze disc with rubber seat or composition seat, threaded or soldered end connections.

B. Swing Check Valves, 2-1/2 Inches and Larger: MSS SP-71, Class 125, 200-psi CWP, ASTM A 126 cast-iron body and bolted cap, horizontal-swing bronze disc, flanged or grooved end end connections. Victaulic Series 317, for installation on steel pipe with Style 307 transition couplings.

C. Lift Check Valves:

a. Class 125, ASTM B 62 bronze body and cap (main components), horizontal or vertical pattern, lift-type, bronze disc or Buna N rubber disc with stainless-steel holder threaded or soldered end connections.

b. 200 psi CWP, ASTM B584 cast bronze body, horizontal or vertical pattern, lift type, TFE disc, with stainless-steel spring and shaft, and push-to-connect ends. Victaulic PL-510.

D. Grooved End Spring-Actuated Check Valves:

2.5 BUTTERFLY VALVES

A. Butterfly Valves, 2 Inches through 12 Inches, MSS SP-67, 300 psi CWP, ASTM A 536 ductile iron body, electroless nickel-plated ductile iron, aluminum-bronze, or stainless steel disc, blowout proof 416 stainless steel stem, disc shall be offset from stem centerline to provide full 360 degree circumferential seating, EPDM pressure-responsive seat and EPDM seal material, TFE lined fiberglass bearings, lever handle or gear operator with memory stop feature, grooved ends. Valve shall be suitable for bi-directional, bubble tight shutoff and dead-end service.

B. Butterfly Valves for Grooved Joint Copper-Tubing Systems: Meets the intent of MSS SP-67, ASTM B584 bronze body, elastomer coated ductile iron disc with integrally cast stem, lever handle or gear operator with memory stop feature, copper-tube dimensioned grooved ends. (Flaring the adjoining tube or fittings to accommodate alternate sized valves and couplings is not permitted.) Valve shall be suitable for bi-directional, bubble tight shutoff and dead-end service.

2.6 GAS VALVES

A. Gas Valves 2 Inch and Smaller: ASME B16.33, 150 psi WOG, bronze body, bronze tapered plug type, straightaway pattern, square head with lever actuator, threaded ends.

B. Gas Valves 2-1/2 Inch and Larger: MSS SP-78; 175 psi WOG, lubricated plug type, semi-steel body, wrench operated, flanged ends.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine piping system for compliance with requirements for installation tolerances and other conditions affecting performance of valves. Do not proceed with installation until unsatisfactory conditions have been corrected.

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

C. Operate valves from fully closed positions. Examine guides and seats made accessible by such operation.

D. Examine grooved ends on valve for form and cleanliness. Grooved ends shall be clean and free from indentations or projections in the area from valve end to and including the groove.

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

F. Examine mating flange faces for conditions that might cause leakage. Check bolting for proper size, length, and material. Check gasket material for proper size, material composition suitable for service, and freedom from defects and damage.

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

3.2 INSTALLATION

A. Install valves as indicated, according to manufacturer's written instructions.

B. Piping installation requirements are specified in other Division 15 Sections. Drawings indicate the general arrangement of piping, fittings, and specialties.

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

D. Unions and flanges are not required in installations using grooved mechanical joint couplings.

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

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

G. Install valves in a position to allow full stem movement.

H. Installation of Check Valves: Install for proper direction of flow as follows:

1. Swing Check Valves: Horizontal position with hinge pin level.
2. Lift Check Valve: With stem upright and plumb.

3.3 SOLDERED CONNECTION

A. Cut tube square and to exact lengths.

B. Clean end of tube to depth of valve socket with steel wool, sand cloth, or a steel wire brush to a bright finish. Clean valve socket.

C. Apply proper soldering flux in an even coat to inside of valve socket and outside of tube.

D. Remove the cap and disc holder of swing check valves having composition discs.

E. Insert tube into valve socket, making sure the end rests against the shoulder inside valve. Rotate tube or valve slightly to ensure even distribution of the flux.

F. Apply heat evenly to outside of valve around joint until solder melts on contact. Feed solder until it completely fills the joint around tube. Avoid hot spots or overheating valve. Once the solder stars cooling, remove excess amounts around the joint with a cloth or brush.

3.4 THREADED CONNECTIONS

A. Note the internal length of threads in valve ends and proximity of valve internal seat or wall to determine how far pipe should be threaded into valve.

B. Align threads at point of assembly.

C. Apply appropriate tape or thread compound to the external pipe threads, except where dry seal threading is specified.

D. Assembly joint, wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

3.5 FLANGED CONNECTIONS

A. Align flange surfaces parallel.

B. Assemble joints sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly with a torque wrench.

3.6 VALVE END SECTION

A. Select valves with the following ends or types of pipe/tube connections:

1. Copper Tube Size, 2 Inches and Smaller:
    i. Threaded ends.
2. Steel Pipe Sizes, 2 Inches and Smaller: Threaded end.
3. Steel Pipe Sizes, 2-1/2 Inches and Larger: Grooved end or flanged.

3.7 APPLICATION SCHEDULE

A. General Application: Use ball valves for shutoff duty; ball valves for throttling duty. Use ball valves with memory stop for balancing valves. Refer to piping system Specification Sections for specific valve applications and arrangements.

3.8 ADJUSTING

A. After piping systems have been tested and put into service, but before final adjusting and balancing, adjust or replace leaking packings. Replace valves if leak persists.

END OF SECTION 23 0523

SECTION 23 0529 – SUPPORTS AND ANCHORS

PART 1 – GENERAL

1.1 QUALITY ASSURANCE

A. Comply with applicable plumbing and mechanical codes.

B. Comply with NFPA.

C. Comply with UL and FM.

PART 2 – PRODUCTS

2.1 MANUFACTURED UNITS

A. Description: Hangers and support components shall be factory fabricated of materials, design and manufacturer complying with MSS SP-58. Components shall have galvanized coatings where installed for piping and equipment that will not have field-applied finish. Pipe attachments shall have nonmetallic coating for electrolytic protection where attachments are in direct contact with copper tubing.

2.2 MISCELLANEOUS MATERIALS

A. Steel Plates, Shapes, and Bars: ASTM A 36.

B. Cement Grout: Portland cement (ASTM C 150, Type I or Type III) and clean uniformly graded, natural sand (ASTM C 404, Size No. 2). Mix ratio shall be 1.0 part cement to 3.0 parts sand, by volume, with minimum amount of water required for placement and hydration.

PART 3 – EXECUTION

3.1 INSTALLATION OF HANGERS AND SUPPORTS

A. Install hangers, supports, and or miscellaneous steel, clamps and attachments to support piping properly from building structure; comply with MSS SP-69 and SP-89. Arrange for grouping of parallel runs of horizontal piping supported together on field-fabricated, heavy-duty trapeze hangers where possible. Install supports with maximum spacings complying with MSS SP-69 or as specified in other Division 23 sections for individual piping systems. Where piping of various sizes is supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe as specified above fore individual pipe hangers.

B. Install building attachments within concrete, or to structural steel. Install additional attachments at concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.

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

D. Field-Fabricated, Heavy-Duty Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS D-1.1.

E. Support fire protection systems piping independently from other piping systems. Each trade shall provide their own hangers; sharing is not acceptable.

F. Install hangers and supports to allow controlled movement of piping systems, to permit freedom of movement between expansion loops, expansion bends and similar units.

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

H. Pipe Slopes: Install hangers and supports to provide indicated pipe slopes, so that maximum pipe deflections allowed by ASME B31.9 Building Services Piping Code is not exceeded.

I. Insulated Piping: Comply with the following installation requirements.

1. Clamps: Attach clamps, including spacers (if any), to piping with clamps projecting through insulation; do not exceed pipe stresses allowed by ASME B31.9.
2. Saddles: Install protection saddles MSS Type 39 where insulation without vapor barrier is indicated. Fill interior voids with segments of insulation that match adjoining pipe insulation.
3. Shields: Install protective shields MSS Type 40 on cold water piping that has vapor barrier. Shield shall span an arc of 180 degrees and shall have dimensions in inches not less than the following:

NPS	LENGTH	THICKNESS
¼ through 3	12	0.048
4	12	0.060
6	18	0.060

J. Vibrating Equipment: The first three hangers on piping from any piece of vibrating equipment shall incorporate a vibration isolator.

3.2 EQUIPMENT SUPPORTS

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

B. Grouting: Place grout under support for piping and equipment.

3.3 METAL FABRICATIONS

A. Cut, drill, and fit miscellaneous metal fabrications for pipe anchors and equipment supports. Install and align fabricated anchors in indicated locations.

B. Field Welding: Comply with AWS D1.1 for procedures of manual shielded metal-arc welding, appearance and quality of welds made, methods used in correcting welding work, and the following:

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

3.4 ADJUSTMENT

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

3.5 PAINTING

A. Touch-Up Painting: Immediately after erection of anchors and supports, clean field welds and abraded areas of shop paint and paint exposed areas with same material as used for shop painting to comply with SSPC-PA-1 requirements for touch-up of field-painted surfaces.

B. Apply by brush or spray to provide a minimum dry film thickness of 2.0 mils.

C. For galvanized surfaces clean welds, bolted connections and abraded areas and apply galvanizing repair paint to comply with ASTM A 780.

END OF SECTION 23 0529

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SECTION 23 0533 – HEAT TRACING CABLES

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submit manufacturer's technical product data and installation instructions and wiring diagrams.

1.2 QUALITY ASSURANCE

A. Codes and Standards:

1. Comply with applicable local electrical code and NEC.

2. Comply with UL, IEEE and NEMA.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide electric heating cables of 1 of the following:

1. Easy-Heat WireKraft Div; Bristol Corporation.

2. Fostoria Industries, Inc.

3. Raychem Corporation/Tyco Thermal Controls

4. Smith-Gates Corporation

5. Wiegand Div; Emerson Electric Company

2.2 PIPE FREEZE PROTECTION HEATING CABLES

A. Provide self-regulating heat-tracing electric heating cable and components which are suitable for freeze protection of metal or plastic piping. Select heater consisting of 2-16 AWG tinned-copper bus wires parallel embedded in radiation cross-linked conductive polymer core that varies its power output to respond to temperature along its length, allowing the heater to be crossed over itself without overheating, to cut to length in the field, and to be used directly on plastic pipe. Cover heater with radiation cross-linked modified polyfin dielectric jacket. Provide heater with self-regulating factor of greater than 90 percent to conserve energy and to prevent overheating. Self-regulation factor is defined as the percentage reduction, without thermostatic control, of the heater output ranging from 40°F (4° C) pipe temperature operation to 150° F (65° C) pipe temperature operation.

2.3 ELECTRICAL HEATING CABLE ACCESSORIES

A. Provide heating system accessories as required, including thermostats and contactors.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Mechanical contractor is responsible for complete installation including hiring the electrical contractor for the power wiring. Comply with installation requirements of NECA and the manufacturer's installation instructions.

B. Install freeze protection heating cables on exterior cooling tower make-up water and exterior cooling tower supply and return piping, and overflow drainage piping.

C. All piping that is heat traced shall be insulated, if not already indicated in the insulation piping section.

D. Furnish and install pipe warning labels on piping systems insulation

3.2 ELECTRICAL CONNECTORS

A. All electrical work to be in accordance with Division 23.

3.3 FIELD QUALITY CONTROL

A. Test all heating cabling for electrical continuity.

B. Test heating cabling prior to and after insulation is installed.

END OF SECTION 23 0533

SECTION 23 0553 –IDENTIFICATION FOR HVAC PIPING AND EQUIPMENT

PART 1 – GENERAL

1.1 SUBMITTALS

A. Submit product data for identification materials and devices in accordance with Conditions of Contract and Division 1 Specifications Section.

B. Valve Schedules: Submit valve schedules for each piping system. Reproduce on standard-size bond paper. Tabulate valve number, piping systems, system abbreviation (as shown on tag), location of valve (room or space), and variations for identification. Mark valves intended for emergency shutoff and similar special uses. Furnish extra copies (in addition to mounted copies) for Maintenance Manuals as specified in Division 1 Section “Project Closeout”. One Valve Schedule (framed and mounted under glass) shall be mounted on the wall in the Boiler Room and the Chiller Room.

1.2 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color filed, colors, viewing angles of identification devices.

1.3 SEQUENCING AND SCHEDULING

A. Coordinate installation of identifying devices after completion of covering and painting where devices are applied to surfaces. Install identifying devices prior to installation of acoustical ceilings and similar concealment.

PART 2 – PRODUCTS

2.1 IDENTIFYING DEVICES AND LABELS

A. General: Products specified are manufacturer’s standard products of categories and types required for each application as referenced in other Division 23 Sections. Where more than single type is specified for listed application, selection is Installer’s option, but provide single selection for each product category.

B. Equipment Nameplates: Metal nameplate with operational data engraved or stamped, permanently fastened to equipment.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances and similar essential data.
2. Location: An accessible and visible location.

C. Stencils: Standard stencils, prepared with letter sizes conforming to recommendations of ASME A13.1. Minimum letter height is 1-1/4 inches for ducts and ¾ inch for access door signs and similar operational instructions.

1. Material: Fiberboard or brass.
2. Stencil Paint: Exterior, oil-based alkyd gloss black enamel, except as otherwise indicated. Paint may be in pressurized spray-can form.
3. Identification Paint: Exterior, oil-based alkyd enamel in colors according to ASME A13.1, except as otherwise indicated.

D. Snap-On Plastic Pipe Markers: Manufacturer's standard pre-painted, semi-rigid snap-on, color-coded pipe markers conforming to ASME A13.1.

1. Pipes Smaller than 6 Inches: Full-band pipe markers, extending 360 degrees around pipe at each location.
2. Pipes 6 Inches and Larger: Strip-type pipe markers, at least 3 times the letter height and of length required for label, with mounting bands.

E. Engraved Plastic-Laminate Signs: ASTM D 709, Type I, cellulose, paper-base, phenolic-resin-laminate engraving stock; Grade ES-2, black surface, black phenolic core, with white (letter color) melamine subcore, except when other colors are indicated.

1. Fabricate in sizes required for message.
2. Engraved with engraver's standard letter style, of sizes and with working to match equipment identification.
3. Punch for mechanical fastening.
4. Thickness: 1/8-inch, except as otherwise indicated.
5. Fasteners: Self-tapping stainless-steel screws.

F. Lettering: Use piping system terms as indicated and abbreviate only as necessary for each application length.

1. Arrows: Either integrally with piping system service lettering (to accommodate both directions), or as separate unit, on each pipe marker to indicate direction of flow.

G. Valve Tags: Stamped or engraved with ¼-inch letters for piping system abbreviation and ½-inch sequenced numbers. Provide a 5/32-inch hole for fastener.

1. Material: 19-gage polished brass.
2. Size: 1-1/2-inch diameter, except as otherwise indicated.

H. Valve tag fasteners: Brass wire-link chain, beaded chain, or S-hooks.

I. Valve Schedule Frames: Glazed display frame, with screws for removable mounting on walls for each page of valve schedule.

1. Frame: Rigid plastic.
2. Glazing: ASTM C 1036, 2.5 mm, single thickness, sheet glass.

a. Type: Type I, flat transparent.
b. Class: Class 1, clear.
c. Quality: Glazing B, for general applications.

J. Lettering and Graphics: Coordinate names, abbreviations, and other designations used in mechanical identification, with corresponding designations indicated. Use numbers, letters, and terms indicated for proper identification, operation, and maintenance of mechanical systems and equipment.

PART 3 – EXECUTION

3.1 LABELING AND IDENTIFYING

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Stenciled Markers: Complying with ASME 13.1.
2. Plastic markers, with application systems. Install on pipe insulation.

    a. Fasten markers on pipes smaller than 6 inches by the following method:

        i. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.

    b. Fasten markers on pipes 6 inches and larger the following method:

        i. Strapped to pipe (or insulation) with manufacturer's standard bands.

2. Locate pipe markers as follows wherever piping is exposed in finished spaces, machine rooms, accessible maintenance spaces (shafts, tunnels, plenums) and exterior non-concealed locations.

    a. Near each valve and control device.
    b. Near each branch connection, excluding short take-offs for fixtures and terminal units. Mark each pipe at branch, where flow is not obvious.
    c. Near penetrations through walls, floors, ceilings, or enter non-accessible enclosures.
    d. At access doors, manholes, and similar access points that permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.
    f. Spaced at a maximum of 50-foot intervals along each run. Reduce intervals to 25 feet in congested areas of piping and equipment.

B. Valve Tags: Install valve tag on valves and control devices in piping systems, except check valves, valves within factory-fabricated equipment units, shut-off valves, conveniences and lawn-watering hose bibs, and HVAC terminal devices and similar roughing-in connections of end-use fixtures and units. Install by using logical, sequential and unique order. Install mounted valve schedule in each major equipment room. List tagged valves in valve schedule.

    1. Air Handling Units, Air-cooled condensing units and zone-type units.
    2. Boilers and Heaters.
    3. Pumps.
    4. Fans.

C. Equipment: Install equipment markers on or near each major item of mechanical equipment. Provide signs for following general categories of equipment:

    1. Air Handling Units.
    2. Boilers.
    3. Pumps.
    4. Fans

3.2 ADJUSTING AND CLEANING

A. Relocate mechanical identification materials and devices which have become visually blocked by work of this Division or other Divisions.

B. Clean face of identification devices, and glass frames of valve charts.

END OF SECTION 23 0553

SECTION 23 0593 – TESTING, ADJUSTING, AND BALANCING

PART 1 – GENERAL

1.1 SUMMARY

A. This Section specifies the requirements and procedures for total mechanical systems testing, adjusting, and balancing. Requirements include measurement and establishment of the fluid quantities of the mechanical systems as required to meet design specifications, and recording and reporting the results.

B. Test, adjust, and balance the following mechanical systems:

1. Supply air systems.
2. Return air systems.
3. Exhaust air systems.
4. Relief air systems.
5. Outside air systems.
6. Hydronic systems
7. Verify temperature control system operation.

1.2 DEFINITIONS

A. Systems testing, adjusting, and balancing is the process of checking and adjusting all the building environmental systems to produce the design objectives. It includes the balance and adjustment of air and water systems, electrical measurement and verification of all equipment.

1.3 SUBMITTALS

A. Certified Reports: Submit 5 copies of testing, adjusting, and balancing reports bearing the signature of the Test and Balance Engineer. The reports shall be certified proof that the systems have been tested, adjusted, and balanced in accordance with the referenced standards; are an accurate representation of how the systems have been installed; are a true representation of how the systems are operating at the completion of the testing, adjusting, and balancing procedures; and are an accurate record of all final quantities measured, to establish normal operating values of the systems. Follow the procedures and format specified below:

1. Final report: Before submitting final balance reports, meet with the A/E firm representative to review marked up drawings and raw data gathered during the test and balance process. This meeting shall be repeated, if necessary, until the A/E firm representative is confident that the balance process has been completed and that the specifications have been met. Upon approval, prepare final reports, type written, and organized and formatted as specified below.
2. Report Format: Report forms shall be similar to those standard forms prepared by a referenced standard for each respective item and system to be tested, adjusted, and balanced. Bind report forms complete with schematic systems diagrams and other data in reinforced, vinyl, three-ring binders. Provide binding edge labels with the project identification and a title descriptive of the contents. Divide the contents of the binder into the below listed divider tabs:

    a. General Information and Summary.
    b. Air Systems.
    c. Temperature Control Systems.

d. Special Systems.

3. Report Contents: Provide the following minimum information, forms and data:

a. General Information and Summary: Inside cover sheet to identify testing, adjusting, and balancing agency, Contractor, Owner, Architect/Engineer, and Project. Include addresses, and contact names and telephone numbers. Also include a certification sheet containing the name, address, telephone number, and signature of the Test and Balance Engineer. Include in this division a listing of the instrumentations used for the procedures along with the proof of calibration.
b. The remainder of the report shall contain the appropriate forms containing as a minimum, the information indicated on the standard report forms prepared by the AABC or NEBB and as indicated below, for each respective item and system. Prepare a schematic diagram for each item of equipment and system to accompany each respective report form.
c. In addition to the minimum information required as described above, each piece of equipment mentioned below shall have the following information listed on the report with measurements taken when equipment is operating at full capacity.

Air Handling Units:

1. Air pressure drop across or static pressure at each component section.
2. Water pressure drop across each coil section.
3. RPM
4. S.P.
5. BHP
6. Voltage & AMP Readings
7. CFM

Fans:

1. RPM
2. S.P.
3. BHP
4. Voltage & AMP Readings
5. CFM

Pumps:

1. RPM
2. HEAD
3. BHP
4. Voltage & AMP Readings
5. GPM

Air terminal units:

1. CFM (maximum) and velocity pressure.
2. CFM (minimum) and velocity pressure.
3. GPM.

B. Calibration Reports: Submit proof that all required instrumentation has been calibrated to tolerances specified in the referenced standards, within a period of one year prior to stating the project. Calibration shall be certified.

1.4 QUALITY ASSURANCE

A. Test and Balance Contractor's Qualifications: The Testing, Adjusting and Balancing Contractor shall be a member of one of the following: AABC or NEBB. The Contractor shall assign one person to the project as the Test and Balance Engineer. This person shall operate as a project coordinator and technician throughout the entire job. The Test and Balance Engineer shall have a minimum of 5 years of air/water balance experience and shall have had experience on projects in testing and balancing requirements similar to those required for this project. The Contractor shall assign additional personnel to assist in the balancing process as necessary. These people shall have had a minimum of 3 years experience in balancing of air and water systems.

B. Codes and Standards

1. NEBB: "Procedural Standards for Testing, Adjusting, and Balancing of Environmental Systems."
2. AABC: "National Standards for Total System Balance."
3. ASHRAE: ASHRAE Handbook, 1984 Systems Volume, Chapter 37, Testing, Adjusting, and Balancing.

C. Pre-Balancing Review: Prior to beginning of the testing, adjusting and balancing procedures, review all drawings and mark up any changes, additions, or deletions that they would recommend for better and more accurate balance of the system. These marked up drawings would then be reviewed by the Test and Balance Engineer and a representative of the A/E firm. The objective of the conference is final coordination and verification of system operation.

D. Following is a list of acceptable balance contractors. Any contractor not listed must contact the Engineer and obtain approval at least 5 working days prior to the date of bidding. Any mechanical contractor using a non-approved balance contractor shall do so at his own resk and shall provide a balance contractor listed below or one approved in writing by the Engineer at no additional costs.

Approved Balance Contractors:

1. International Test and Balance, Inc., 380 Northwest Highway, Des Plaines, IL, 60016 Phone: (847) 759-1800
2. Mechanical Testing Services, 4275 Spartan Industrial #D, Grandville, MI, 49418 Phone (616) 224-7044
3. Quality Air Service Inc., 6701 Quality Way, P.O. Box 2947, Kalamazoo, MI, 49003 Phone (269) 327-3055
4. Hi Tech & Balance, 10270 Pierce Road, Freeland, MI, 48623 Phone (989) 695-5498
5. Great Lakes Balancing, 1595 Falcon Crest Dr. NE, Grand Rapids, MI 49525 (616) 949-8331
6. Synergy, 6250 Jupiter NE, Belmont, MI 49306 (231) 652-9730
7. Absolute Balancing Co., 10099 Fairlane Dr., South Lyon, MI 48178 (734) 449-0911

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 7.2.2 – "Air Balancing."

F. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6.7.2.3 – "System Balancing."

1.5 Project Conditions

A. Walk Down: The Testing, Adjusting and Balancing Contractor shall walk down the job as they deem necessary at the project's beginning and up to the time that the test and balance process begins to insure that the systems are installed as specified and that the system is balanceable

with all turning vanes, volume dampers, balance dampers, grilles, registers, etc. installed in their proper places.

B. Checklists: The Testing, Adjusting and Balancing Contractor shall submit checklists for each of the mechanical, electrical and temperature control contractors. These shall be reviewed by the A/E firm representative prior to distribution, and then completed and signed by the appropriate firm's representative. Start-up of systems and testing, adjusting and balancing shall not be done until these checklists are completed.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.1 PRELIMINARY PROCEDURES FOR AIR SYSTEM BALANCING

A. Before operating the system, perform these steps:

1. Obtain copies of approved shop drawings of all air handling equipment, outlets (supply, return, and exhaust) and temperature control diagrams.
2. Prepare report test sheets for both fans and outlets. Obtain manufacturer's outlet factors and recommended procedures for testing. Prepare a summation of required outlet volumes to permit a crosscheck with required fan volumes.
3. Determine best locations in main and branch ductwork for most accurate duct traverse.
4. Check fans for proper rotation.
5. Check motors for proper amp draw.
6. Prepare schematic diagrams of system "as-built" ductwork and piping layouts to facilitate reporting.

B. Before operating the system, verify these items:

1. All prefilters, secondary and final filters are installed per specifications and are clean.
2. Unit(s) are clean of any construction debris.
3. All sheaves and v-belts are installed and checked for proper alignment and tension.
4. Fan belt guards are properly installed.
5. Ductwork is properly installed and supported.
6. Duct system should be cleaned and purged.
7. All mixing, balance, fire and backdraft dampers are installed correctly, in proper locations and in proper position.
8. Terminal units are properly installed.
9. All diffusers, grilles, and dampers are installed per specifications.

3.2 MEASUREMENTS

A. Provide all required instrumentation to obtain proper measurements, calibrated to the tolerances specified in the referenced standards. Instruments shall be properly maintained and protected against damage.

B. Provide instruments meeting the specifications of the referenced standards.

C. Use only those instruments which have the maximum field measuring accuracy and are best suited to the function being measured.

D. Apply instrument as recommended by the manufacturer.

E. Use instruments with minimum scale and maximum subdivisions and with scale ranges proper for the value being measured.

F. When averaging values, take a sufficient quantity of readings which will result in a repeatability error of less than 5 percent. When measuring a single point, repeat readings until 2 consecutive identical values are obtained.

G. Take all readings with the eye at level of the indicated value to prevent parallax.

H. Use pulsation dampers where necessary to eliminate error involved in estimating average of rapidly fluctuation readings.

I. Take measurements in the system where best suited to the task.

3.3 PERFORMANCE TESTING, ADJUSTING, AND BALANCING

A. Provide all supervision, labor, materials, instrumentation and equipment necessary to effect complete and proper testing and balancing.

B. Adjust fans, dampers, sheaves, belts, balancing valves, etc., take test and balance readings and make adjustments. Complete all test and balance reports.

C. Perform testing and balancing procedures on each system identified, in accordance with the detailed procedures outlined in the referenced standards.

D. Cut insulation, ductwork, and piping for installation of test probes to the minimum extent necessary to allow adequate performance of procedures.

E. Patch insulation, ductwork, and housings, using materials identical to those removed.

F. Seal insulation to re-establish integrity of the vapor barrier.

G. Mark equipment settings, including damper control positions, valve indicators, fan speed control levers, and similar controls and devices, to show final settings. Mark with paint or other suitable, permanent identification materials.

H. Adjust all belted fan speeds as required to attain proper total CFM qualities. Fan installing contractor shall provide al required sheave changes and provide new v-belts, if required, to maintain fan motor at approximate mid-point of its adjustable range.

I. Retest, adjust, and balance systems subsequent to significant system modifications, and resubmit test results.

J. All test and adjustments performed will be guaranteed for a period of one (1) year, beginning at the time of final acceptance. During this time the Testing, Adjusting, and Balancing Contractor will work with the Owner for coordination of any work required of the Temperature Control Contractor, Mechanical Contractor, etc., which related to systems' operation.

K. The balancing contractor shall perform an inspection of the HVAC system during the opposite season from that in which the initial adjustments were made. The balancing agency shall make any necessary modifications to the initial adjustments to produce optimum system operation.

L. Provide all fan sheave changes as required during testing and balancing to attain proper total CFM Quantities. Provide new v-belts, if required, to maintain fan motor sheave at approximate mid-point of its adjustable range.

3.4 FINAL ACCEPTANCE

A. At the time of final inspection, the balancing contractor may be required to recheck, in the presence of the Owner's representative, specific and random selections of data recorded in the certified test-and-balance report.

B. Point and areas for recheck shall be selected by the Owner's representative.

C. Measurements and test procedures shall be same as the original test and balance.

D. Selections for recheck, specific plus random, shall not normally exceed 15 percent of the total number tabulated in the report, except where special air systems require a complete recheck for safety reasons.

E. If random tests demonstrate a measured flow deviation of 10% or more from that recorded in the certified test-and-balance report, the report shall automatically be rejected. In the event the report is rejected, all systems shall be readjusted and tested, new data recorded, a new certified test-and-balance report submitted, and a new inspection test made, all at no additional cost to the Owner.

END OF SECTION 23 0593

SECTION 23 0700 – MECHANICAL INSULATION

PART 1 – GENERAL

1.1 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions for each type of mechanical insulation. Submit schedule showing manufacturer's product number, r-value, thickness, and furnished accessories for each mechanical system requiring insulation.

1.2 QUALITY ASSURANCE

A. All mechanical insulation work shall be performed by a recognized insulation subcontractor with successful installation experience on projects with mechanical insulations similar to that required for this project.

B. Flame/Smoke Ratings: Provide composite mechanical insulation (insulation jackets, coverings, sealers, mastics and adhesives) with flame-spread index of 25 or less, and smoke developed index of 50 or less, as tested by ASTM E 84 (NFPA 255) method.

1. Exception: Outdoor mechanical insulation may have flame spread index of 75 and smoke developed index.

1.3 COMPLIANCE

A. All mechanical insulation work shall be per the currently adopted version of ANSI/ASHRAE 90.1 Energy Standard or jurisdiction required code.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. Armstrong World Industries, Inc.
2. Halstead.
3. NOMACO IMCOA.
4. Knauf Fiber Glass Corp.
5. Johns Manville Products Corp.
6. Owens-Corning.
7. MFM Building Products Corp.
8. 3M

2.2 PIPING INSULATION MATERIALS

A. General: Refer to system descriptions below for identification of systems where the below specified insulation materials are used.

B. Fiberglass Piping Insulation: Rigid one piece pipe insulation made form glass fibers bonded with thermosetting resin, with foil reinforced kraft paper vapor retarder jacket. ASTM C-547, Class 1.

C. Flexible Unicellular Piping Insulation: Expanded closed-cell structure flexible elastomeric thermal insulation, ASTM C-534 Type 1.

D. Flexible Polyolefin Piping Insulation: Closed-cell flexible thermal insulation.

E. Staples, Bands, Wires, and Cement: As recommended by insulation manufacturer for applications indicated.

F. Adhesives, Sealers, and Protective Finishes: As recommended by insulation manufacturer for applications indicated.

2.3 DUCTWORK INSULATION MATERIALS

A. General: Refer to system descriptions below for identification of systems where the below specified insulation materials are used.

B. Rigid Fiberglass Ductwork Insulation: Rigid insulation board made from glass fibers preformed into boards, bonded by a thermosetting resin, with factory applied foil reinforced kraft vapor retarder jacket, ASTM C-612, Class 1.

C. Flexible Fiberglass Ductwork Insulation: Insulation blanket made from resilient glass fibers bonded by thermosetting resin, with factory adhered foil reinforced kraft vapor retarder jacket ASTM C-553, Type 1.

D. Ductwork Insulation Accessories: Provide staples, bands, wires, tape, anchors, corner angles and similar accessories as recommended by insulation manufacturer for applications indicated

E. Ductwork Insulation Compounds: Provide cements, adhesives, coatings, sealers, protective finishes and similar compounds as recommended by insulation manufacturer for applications indicated.

2.4 FIRE RATED DUCT WRAP INSULATION

A. General: Refer to system descriptions below for identification of systems where the below specified insulation materials are used.

B. Materials: Fire resistive duct wrap insulation; 1.5" or 2” thick, 24" or 48" wide X 20 ft. or 25 ft. long rolls, fully encapsulated with a scrim-reinforced foil, marked with Manufacturer's logo and UL and Intertek markings.

C. Tapes: High performance filament tape, 3M No. 898 1" wide. Aluminum foil tape: 3" or 4” wide (for sealing cut blanket edges and seams)..

D. Banding material: Carbon steel banding: 1/2" wide X 0.015" thick. Stainless steel banding: 1/2" wide X 0.015" thick. Consult individual listings for approved banding type.

PART 3 – EXECUTION

3.1 INSTALLATION OF PIPING INSULATION

A. General: Install insulation products in accordance with manufacturer’s written instructions, and in accordance with recognized industry practices to ensure that insulation serves its intended purpose.

B. Install insulation on pipe systems subsequent to installation of heat tracing, painting, testing, and acceptance of tests.

C. Install insulation materials with smooth and even surfaces. Insulate each continuous run of piping with full-length units of insulation, with a single cut piece to complete run. Do not use cut pieces or scraps abutting each other.

D. Clean and dry surfaces prior to insulating. Butt insulation joints firmly together to ensure a complete and tight fit over surfaces to be covered.

E. Maintain integrity of vapor-barrier jackets on pipe insulation, and protect to prevent puncture or other damage.

F. Cover all valves, fittings and similar items in each piping system unless otherwise indicated, with equivalent thickness and composition of insulation as applied to adjoining pipe run. Install factory molded, precut or job fabricated units (at Installer's option) except where specific form or type is indicated.

G. Extend piping insulation without interruption through walls, floors and similar piping penetrations, except where otherwise indicated.

H. Butt pipe insulation against pipe hanger insulation inserts. For hot pipes, apply 3" wide vapor barrier tape or band over the butt joints. For cold piping apply wet coat of vapor barrier lap cement on butt joints with 3" wide vapor barrier tape or band.

I. Provide protective covering on all exterior piping insulation.

J. Exterior piping shall be sealed with white, pre-fabricated, self-adhering, water and weather resistant sheet-type protective membrane with UV-resistant embossed aluminum. MFM FlexClad-400.

3.2 INSTALLATION OF DUCTWORK INSULATION

A. General: Install insulation products in accordance with manufacturer's written instructions, and in accordance with recognized industry practices to ensure that insulation serves its indicated purpose.

B. Install insulation materials with smooth and even surfaces.

C. Clean and dry ductwork prior to insulating. Butt insulation joints firmly together to ensure complete and tight fit over surfaces to be covered.

D. Maintain integrity of vapor-barrier on ductwork insulation, and protect it to prevent puncture and other damage.

E. Extend ductwork insulation without interruption through walls, floors and similar ductwork penetrations, except where otherwise indicated.

F. Insulation located inside building shall be attached by adhesive applied in 6" wide strips on 12" centers; tape and seal all joints.

G. Where rectangular ducts are 24" in width or greater, duct insulation shall be additionally secured to the bottom of duct with mechanical fasteners, spaced on 18" centers to prevent sagging of insulation.

H. Exterior ductwork shall be insulated with two layers of flexible unicellular insulation, with joints staggered between layers. Provide aluminum wrap over insulation.

3.3 PROTECTION AND REPLACEMENT

A. Replace damaged insulation which cannot be repaired satisfactorily, including units with vapor barrier damage and moisture saturated units.

B. Protection: Insulation Installer shall advise Contractor of required protection for insulation work during remainder of construction period, to avoid damage and deterioration.

C. Any damages that occur due to condensation from improper insulation covering piping, valves, tanks, hangers, ducts and equipment, the cost to repair such damages will be charged to the Insulation Installer.

3.4 HVAC PIPING SYSTEM APPLICATIONS

A. Insulation Omitted: Omit insulation on hot piping within radiation enclosures or unit cabinets and on unions, flanges, strainers, flexible connections, and expansion joints; on cold piping within unit cabinets provided piping is located over drain pan.

B. Cold Piping: Insulate the following cold HVAC piping systems:

1. Chilled water cooling piping.
    a. 40°-60° Fluid temperature: Insulate hot water heating piping system systems with ½" thick Fiberglass insulation (Less than 1½" diameter) or 1" thick (equal to or greater than 1½" diameter).
    b. Less than 40° Fluid temperature: Insulate hot water heating piping system systems with ½" thick Fiberglass insulation (less than 1" diameter) or 1.0" thick (equal to or greater than 1" diameter).
2. Cooling coil cold condensate drain lines located above ceilings.

C. Hot Piping: Insulate the following hot HVAC piping systems:

1. Hot water heating piping.
    a. 141°-200° Fluid temperature: Insulate hot water heating piping system systems with 1" thick Fiberglass insulation (Less than 4" diameter) or 1½" thick (equal to or greater than 4" diameter).
    b. 105°-140° Fluid temperature: Insulate hot water heating piping system systems with ½" thick Fiberglass insulation (less than or equal to 1½" diameter) or 1.0" thick (greater than 1½" diameter).

3.5 DUCT SYSTEM APPLICATIONS

A. Insulation Omitted: Unless otherwise noted, do not insulate exhaust air ductwork below attic, return air ductwork or exposed supply air ductwork.
    1. Note: On VAV systems, even if exposed, all supply ductwork up to the inlet of the VAV box SHALL be insulated.

B. Ductwork: Insulate the following ductwork:

1. Supply air ductwork, located both indoor and outdoor.
2. Outdoor air intake ductwork between air entrance and room inlet, fan inlet or HVAC unit inlet.
3. Exhaust Duct in attic space.

C. Insulate each ductwork system specified above within building with the following type and thickness of insulation:

1. Flexible Fiberglass: 1-1/2” thick, ¾ lb. Per cu. Ft. density.
2. Rigid Fiberglass Ductboard: 1” thick ¾ lb. Density.

D. Special Condition: Ductwork exposed in mechanical rooms shall be insulated with 1” thick, 3 lb. per cubic foot density rigid insulation.

E. [Provide acoustical ductwork lagging as indicated. Based on Kinetics Model KNM-100ALQ Pipe/Duct Lagging Material or equal]

F. [Provide duct lining as indicated.]

3.6 EQUIPMENT APPLICATIONS

A. Hot Equipment: Insulate the following hot equipment:

1. Air Separators

B. Cold Equipment: Insulate the following cold equipment:

1. Air Separators

C. Insulate air separators with fiberglass, 3 lbs. per cu. Ft. density, 1-1/2” thick. Held in place with ½” x 0.20” galvanized steel bands or No. 16 galvanized annealed wire on 12” centers. Fill all joints and voids with insulating cement. Finish with two coats insulating cement approximately 1-1/4” thick reinforced with 1” hexagonal wire mesh and a glass fabric jacket applied between two coats of white lagging adhesive.

3.7 FIRE RATED DUCT WRAP APPLICATIONS (1 AND 2 HR. ENCLOSURES)

A. For kitchen exhaust grease ducts: Install fire resistive duct wrap insulation in direct contact with ductwork to Manufacturer's instructions and referenced standards, to applicable Intertek design numbers, including Listed penetration firestop system:

B. Apply fire resistive duct wrap insulation continuously to ductwork as indicated on Drawings. For kitchen exhaust grease ducts, regardless of fire rating, provide two layers of 1.5" thick Duct Wrap per layer with 4” overlaps or two layers of 2.0" thick per layer with 3” overlaps:

C. <u>For kitchen exhaust ductwork:</u> overlap perimeter and longitudinal joints 3" or 4” on both layers. If required, tape seams using minimum 3” wide aluminium foil adhesive tape.

END OF SECTION 23 0700

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SECTION 23 0900 – TEMPERATURE CONTROLS

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 control equipment for HVAC systems and components, including control components for terminal heating and cooling units not supplied with factory-wired controls.

1.3 DEFINITIONS

A. DDC: Direct –digital controls.

1.4 SYSTEM DESCRIPTION

A. Control system consists of sensors, indicators, actuators, final control elements, interface equipment, other apparatus, and accessories to control mechanical systems according to sequences of operation.
B. Open protocol system.

1.5 SUBMITTALS

A. Product Data: Include manufacturer's technical literature for each control device. Indicate dimensions, capacities, performance characteristics, electrical characteristics, finishes for materials, and installation and startup instructions for each type of product indicated.

1. Each control device labeled with setting or adjustable range of control.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

C. Maintenance Data: For systems to include in maintenance manuals specified in Division 1.

D. Project Record Documents: Record actual locations of control components, including control units, thermostats, and sensors. Revise Shop Drawings to reflect actual installation and operating sequences.

1.6 QUALITY ASSURANCE

A. Installer Qualifications: An experienced installer who is an authorized and certified installer of the automatic control system manufacturer for both installation and maintenance of units required for this Project.

B. Manufacturer Qualifications: A firm experienced in manufacturing automatic temperature-control systems similar to those indicated for this Project and with a record of successful in-service performance.

C. Comply with NFPA 70.

D. Comply with NFPA 90A.

1.7 DELIVERY, STORAGE, AND HANDLING

A. Factory-Mounted Components: Where control devices specified in this Section are indicated to be factory mounted on equipment, arrange for shipping of control devices to unit manufacturer.

B. Store equipment and materials inside and keep protected from weather.

1.8 COORDINATION

A. Coordinate location of thermostats, and other exposed control sensors with plans and room details before installation.

B. Coordinate equipment with Division 26.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements. Provide products by one of the following:

1. Control Systems and Components:
    a. Tridium

2.2 THERMOSTATS

A. Programmable, microcomputer-based room thermostat.

1. Automatic switching from heating to cooling.

2. Preferential rate control to minimize overshoot and deviation from set point.

3. Set up for four separate temperatures per day.

4. Instant override of set point for continuous or timed period from 1 hour to 31 days.

5. Short-cycle protection.

6. Programming based on every day of the week.

7. Selection features include deg F or deg C display, 12- or 24-hour clock, keyboard disable, remote sensor, 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 time.
    d. Programmed time.
    e. Duration of timed override.
    f. Day of week.

g. System mode indications include “heating”, “off”, “fan auto”, and “fan on”.

B. Line-Voltage, On-Off Thermostats: Bimetal-actuated, open contact or bellows-actuated, enclosed, snap-switch type, or equivalent solid-state type, with heat anticipator, integral manual on-off-auto selector switch.

1. Equip thermostats, which control electric heating loads directly, with off position on dial wired to break ungrounded conductors.

2. Dead Band: Maximum 2° F (1° C).

C. Room Thermostat accessories include the following:

1. Insulating Bases: for thermostats located on exterior walls.
2. Thermostat Guards: Locking, heavy-duty, transparent plastic; mounted on separate base.

D. Control Dampers

1. Provide all automatic control dampers shown on the Drawings and not specified to be integral with other equipment. Frames shall not be less than 13-gauge galvanized steel. Blades shall not be over 8 inches wide nor less than 16-gauge galvanized steel roll formed. Bearings shall be OILITE, ball-bearing or nylon with steel shafts. Side seals shall be stainless steel of the tight-seal spring type. Dampers and seals shall be suitable for temperature ranges of -40 to 150F.

E. Control Valves

1. Provide all automatic control valves shown on the Drawings and not furnished as an integral part of related sections. Provide normally open or normally closed automatic control vales as required. Provide globe, ball, or butterfly valves as indicated on the drawings.
2. Automatic control valves 2 1/2 " and smaller shall be screwed type, and valves 3" and larger shall be flanged. Valves shall be ANSI-rated to withstand the pressures and temperatures encountered. Valves shall have stainless-steel stems and spring loaded Teflon packaging with replaceable discs.

F. Control Panels

1. Provide each controlled system [air conditioning unit, heating and ventilating unit, heat exchanger, etc.] with an enclosed steel or aluminum local panel proximately located to contain controllers, thermometers, humidity indicators, relays and related equipment properly labeled. Provide laminated name tags for each internal and external panel device. Provide a laminated label on the panel face indicating the system name, number, and service.

G. Analog Damper and Valve Actuators

1. Electric or electronic actuators provided for automatic control of dampers and valves shall be sized to operate their appropriate loads with sufficient reserve power to provide smooth modulating action or two-position action and tight close-off. Control circuits shall be 24 volt or less. Provide line voltage to low voltage transformers as required.
2. Electric or electronic actuators shall be provided with suitable corrosion resistant linkages for valves or dampers. Except as specified herein, all actuators shall be sized

for the load and close off encountered in strict accordance with manufacturers recommendations. All actuators on outside air dampers, relief air dampers, and converter steam valves shall be spring return heavy duty type with oil immersed gear train. All actuators shall drive to their "normal" position anytime their associated AHU (etc.) is shut down. Actuators for valves above 2 inches shall be heavy duty type with oil immersed gear train.

H. Relays:

1. Relay Outputs shall be designed for the voltages and currents they control.

I. Safeties:

1. Safety Low Limits (Freezestats) shall be provided on all fan systems involving the intake of outside air. The element shall be a minimum of 20 feet in length and be activated from the sensing of a dangerous condition along an accumulative one foot section of the element. The element shall be positioned on the leaving side of the heating coil (or the entering side of the chilled water cooling coil) in such a manner to protect the coil from a freezing condition. Multiple devices shall be used if required to provide adequate protection. The Safety Low Limit shall be of the manual reset variety with an adjustable setpoint. The Safety Low Limit shall be wired to the starter circuit to prevent operation in both the “hand” and “auto” modes if a dangerous condition is sensed.
2. Duct mounted smoke detectors shall be provided as part of Division 26 and installed in the ductwork under the supervision of Section 230900. The power wiring and the fire alarm system wiring of the duct smoke detector shall be under Division 26. The wiring of the duct mounted smoke detectors to the air handling unit starters shall be under Section 230900. The duct smoke detectors shall be wired to the starter circuit to prevent operation in both the “hand” and “auto” modes if a dangerous condition is sensed.

J. Workstation(s) - Hardware

1. A personal computer (PC) based central, with minimum Pentium 4 processor, 2.8GHz minimum clock speed. PC shall be provided with a minimum of 1 GB of RAM, 1.44 MB diskette drives, minimum 80 GB EIDE hard drive suitable for peripherals and applications herein specified and 48X CD-R ROM. Operator Work Station (OWS) shall include all required serial parallel and network communication ports with associated cables, mouse, keyboard, and seventeen inch (17”) SVGA color monitor (1024 x 768) and an internal modem (57.6K baud minimum) connected to a PC COM port for remote access to the network.

2. Printers and associated cables shall be provided for each operator workstation recording alarms, and system reports. Printer shall be color, ink-jet type with b/w print minimum speed of 8ppm and color print minimum speed of 5ppm.

3. [Provide Owner with hand held device to allow owner to interface with temperature controls system.]

K. Workstation(s) - Software

1. Operator Workstation (OWS) software shall include as a minimum the Operating System, Data Base Manager, Communications Control, Operator Interface (OI), access to Trend and History Files, Report Generator, and Support Utilities.

2. Operator Interface Software. Provide operator workstation software to allow users to modify time of day schedules and setpoints at multiple sites. OWS shall also allow remote monitoring to retrieve energy usage, alarm data and trend point reports.

3. Provide software which will allow the user to modify and tailor the BMCS to the specific and unique requirements of the equipment installed, the programs implemented, and to staffing and operational practices. On-line modification of program parameters, and database shall be provided via menu selection and keyboard entry of data into formatted self-prompting templates.

4. Alarms. The OWS shall monitor and report all analog input points and specified digital points for off-normal conditions that are transmitted by the controllers. Each alarm shall have user-defined pre-delay and post delay times. Each alarm shall be assigned one of five levels of alarm priority.

5. Reports. The following standard pre-formatted reports shall be provided: Alarm history log, TOD bypass log, Runtime log, Trend log, and Energy history log.

L. BUILDING MANAGEMENT CONTROLLER - HARDWARE

1. Building Manager Control System (BMCS) shall be standalone controllers configured to perform the sequences specified, and with I/O selected for the application. Each BMCS controller shall be tested and listed under UL916 for Energy Management computing devices. Each BMCS controller shall be provided with a face mounted LED type annunciation to continually display its operational mode: power, normal, or in an alarm state.

2. AHU/Central Plant controllers (AHU/CP) shall be configurable to meet the specific application. All control sequences within or programmed into the AHU/CPs shall be stored in non-volatile memory, which is not dependent upon the presence of a battery, to be retained.

M. BUILDING MANAGEMENT CONTROLLER - SOFTWARE

1. Control Application Software shall be customized to meet the detailed requirements of the "Sequence of Operation". All BMCS control software shall be designed via an icon based and ‘fill-in-the-blanks” configuration tool.

N. SOFTWARE LICENSE AGREEMENT

1. Software licensing for the NAC (Network Access Control) or Supervisor shall give the Owner the capability to control their system and determine which contractors can bid and engineer their system.

2. It shall be possible to insure the Owner can prevent unauthorized partners from accessing the system for engineering changes.

3. Software licensing shall have the freedom to individually manage authorized parties and independent parties.

4. The software licensing shall have no restrictions on which brand of NAC, Supervisor or System Programming tools can interact with the system. Station NiCS (Network Interface Controller) Compatibility must = ALL and Tool NiCS Compatibility must = ALL.

5. The Owner shall accept the manufacturer's standard software and firmware licensing agreement as a condition of this contract. Such license shall grant use of all programs

and application software to Owner as defined by the manufacturer's license agreement, but shall protect manufacturer's rights to disclosure of trade secrets contained within such software

2.3 CONTROL CABLE

A. Electronic Cable for Control Wiring: As specified in Division 26.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install equipment level and plumb.

B. Verify location of thermostats, and other exposed control sensors with plans and room details before installation. Locate all 60 inches (1524 mm) above the floor.

C. Verify final location of thermostats and temperature sensors with Owner.

D. Install labels and nameplates to identify control components according to Division 23.

E. Install refrigerant instrument wells, valves, and other accessories according to Division 23.

F. Install electronic cables according to Division 26.

3.2 ELECTRICAL WIRING AND CONNECTION INSTALLATION

A. Install raceways, boxes, and cabinets according to Division 26.

B. Install building wire and cable according to Division 26.

C. Install signal and communication cable according to Division 26.

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 multi-conductor 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.

3.3 CONNECTIONS

A. Ground equipment

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

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

1. Operational Test: After electrical circuitry had been energized, start units to confirm proper unit operation. Remove malfunctioning units, replace with new units, and retest.
2. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment, and retest.
3. Calibration test controllers by disconnecting input sensors and stimulating operation with compatible signal generator.

B. Engage a factory-authorized service representative to perform startup service.

C. Replace damaged or malfunctioning controls and equipment.

1. Start, test, and adjust control systems.
2. Demonstrate compliance with requirements, including calibration and testing, and control sequences.
3. Adjust, calibrate, and fine tune circuits and equipment to achieve sequence of operation specified.

D. Verify DDC as follows:

1. Verify operation of control units.

3.5 DEMONSTRATION

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

1. Train Owner's maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Provide operator training on data display, alarm and status descriptors, requesting data, executing commands, calibrating and adjusting devices, resetting default values, and requesting logs. Include a minimum of 40 hours' dedicated instructor time on-site.
3. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout".
4. Schedule training with Owner, through Architect, with at least seven days' advance notice.

3.6 ON-SITE ASSISTANCE

A. Occupancy Adjustments: Within one year of date of Substantial Completion, provide up to three Project site visits, when requested by Owner, to adjust and calibrate components and to assist Owners personnel in making program changes and in adjusting sensors and controls to suit actual conditions.

END OF SECTION 23 0900

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SECTION 23 0993 – HVAC SEQUENCE OF OPERATIONS

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes sequence of operations for the following HVAC equipment:

1. Ceiling Radiation Panels
2. Cabinet Heaters
3. Unit Heaters
4. Exhaust Fans.
5. Boiler and Heating Hot Water Circulation Pumps.
6. Split-System Air Conditioning Units
7. Air Handling Units.
8. VAV Boxes with Reheat Coils
9. Chilled Water
10. Chilled Water Circulation Pumps.
11. Bypass Valve
12. Chillers

1.2 RELATED SECTIONS

A. Refer to Division 1 Section “Alternatives” for requirements that relate to this Section.

B. Operating equipment, devices, and system components required for control systems is specified in the Temperature Controls’ section of this specification.

C. The following is HVAC equipment not specified in this section but have factory furnished control components or have control requirements that will require the Temperature Control Installer to furnish, install or provide control components and provide interconnecting wiring. Provide components required by sequence of operations and as noted in these other sections listed below:

1. Boilers – refer to Section 235200.
2. Air Handling Unit – refer to Section 237313.
3. Terminal Units – refer to Section 233600.

1.3 DEFINITIONS

A. Sequence of operation is hereby defined as the manner and method by which controls function. Requirements for each type of control system operation are specified in this section.

PART 2 – PRODUCTS (NOT APPLICABLE)

PART 3 – EXECUTION

3.1 HOT WATER CEILING RADIATION PANEL CONTROLS

A. Provide room thermostat to maintain desired space temperature by opening/closing normally open two position hot water control valve.

3.2 HOT WATER WALL/FLOOR CABINET HEATER CONTROLS

A. Cabinet heaters shall be controlled by thermostat and valve

B. Factory provide thermostat, mounted in cabinet return air compartment, to cycle fan motor to maintain desired space temperature. Provide one of the following:

1. Factory furnished and field installed strap-on aquastat on unit return piping, within cabinet piping end pocket, to de-energize fan motor when fluid temperature falls below adjustable setting of aquastat.
2. Factory mounted and wired thermostat

3.3 HOT WATER UNIT HEATER CONTROLS

A. Unit heaters shall be controlled by thermostat and valve

B. Factory provided thermostat, mounted on unit near return air inlet, to cycle the unit fan motor to maintain the desired space temperature. Provide one of the following:

1. Factory furnished and field installed strap-on aquastat on unit return piping, to de-energize fan motor when fluid temperature falls below adjustable setting of aquastat.
2. Factory mounted and wired thermostat.

3.4 EXHAUST FAN CONTROLS

A. The following exhaust fans shall be controlled by Building Management System using occupied/unoccupied time sequencing to cycle fan motor:

1. EF-1, 2, 3, 4, 5, 6.

B. The following exhaust fans shall be tied into the kitchen exhaust hood:

1. EF-7, 8.

C. The following exhaust fan shall be tied into the 50lb dryer. When the dryer is running the exhaust fan shall turn off and when the dryer fan turns off the exhaust fan shall turn back on:

1. EF-9.

3.5 BOILER SYSTEM

A. The Boiler System shall be allowed to operate below 90 degrees (adj.) for systems with reheat coils outside air temperature. The Boiler Circulation Pump shall operate whenever its boiler operates.

B. The Heating Water Supply temperature shall be reset inversely by the outside air temperature. When the outside air temperature is +10 degrees, the Heating Water Supply temperature shall be 200 degrees (adj.). When the outside air temperature is +50 degrees (adj.), the Heating Water Supply temperature shall be 140 degrees (adj.).

C. PRIMARY PUMPS
The lead primary heating pump shall run continuously when the outside air temperature is below 60 degrees (adjustable) 90 degrees (adj.) for systems with reheat coils. The lag primary pump shall run if the lead pump fails. The pumps shall alternate the lead/lag roles on the first day of each month at 8:00am. Pump failure (no flow 10 seconds after the command is given or anytime

flow stops during operation) shall be annunciated on the BMCS. Flow is determined through the use of an adjustable current switch. The primary pumps shall run for a minimum of 20 minutes after the boiler system is disabled (i.e. outside air temperature above 60 degrees).

D. POINTS MONITORED / CONTROLLED
All points referred to in the sequence of operation are the **minimum** points required to be monitored / controlled by the BMCS and available to be displayed on the PC Graphics for the systems described. All fans and pumps controlled shall also be monitored for status through the use of a combination start/stop relay, current sensing switch.
The following points are the **minimum** points required to be monitored / controlled by the BMCS and available to be displayed on the PC Graphics for the Boiler System:

1. ANALOG HARDWARE INPUT POINTS
    a. Outside Air Temperature
    b. Heating Water System Supply Temperature
    c. Heating Water System Return Temperature
    d. Boiler Supply Temperature (Each Boiler)
    e. System Differential Pressure
    f. Primary-Secondary Bridge Station Supply/Return Temperature (Each Station)
    g. Sidestream Filter Pressure Drop (5PSI Clean, 20PSI Dirty)(Verify with Water Treatment Contractor)

2. ANALOG HARDWARE OUTPUT POINTS
    a. Boiler Firing Rate (0 – 20 mA Signal)
    b. [Primary Heating Pump VFD Speed Signal]

3. ANALOG SOFTWARE POINTS
    a. Heating Water Supply Temperature Setpoint
    b. Heating Water Temperature Differential Setpoint

4. BINARY HARDWARE INPUT POINTS
    a. Boiler Low Water Alarm
    b. Boiler Flame Fail Alarm
    c. Boiler Low/High Gas Pressure Alarm
    d. Primary Heating Pump Status
    e. [Primary Heating Pump VFD Failure]
    f. [Primary-Secondary Bridge Station Pump Status (Each Station)]

5. BINARY HARDWARE OUTPUT POINTS
    a. [Primary Heating Pump VFD Start/Stop]
    b. [Primary Heating Pump VFD Start/Stop]
    c. Boiler Enable
    d. [Primary-Secondary Bridge Station Pump Start/Stop (Each Station)]
    e. Sidestream Filter Pump Start/Stop

6. BINARY SOFTWARE POINTS
    a. Primary Heating Pump Run Failure
    b. Primary Heating Pump Run Failure

3.6 CHILLED WATER CIRCULATION PUMP CONTROLS

A. Chilled water system shall be enabled by the Building Automation System whenever the outside air temperature exceeds 55ºF (adjustable), and disabled when the outside air drops below 53ºF.

3.7 SPLIT-SYSTEM AIR CONDITIONING UNITS

A. Unit shall operate utilizing unit supplied microprocessor control panel and sequencing. Mount unit supplied room temperature sensor and connect back to unit.

3.8 AIR HANDLING UNITS (VARIABLE VOLUME, HEATING AND COOLING)

A. Provide direct digital control system. Refer to Section 230900. Provide control components including discharge air sensor and outside air temperature sensor.

B. The supply and return fans shall run continuously on occupied mode. The return fan shall be interlocked to run when the supply fan is running, and be off when the supply fan is off.

C. The minimum outside air flow rates are as scheduled on the drawings.

D. An adjustable mixed air temperature controller shall modulate the outdoor, relief, and return air dampers to maintain a mixed air temperature of 55° F. A minimum position controller shall limit the closing of the outdoor air damper to provide the indicated percentage of the total air flow with the return air damper open to provide the remaining percentage of the total air flow.

E. The Hot water coil pump for shall operate anytime the outdoor air temperature falls below 60° F.

F. Use of outside air for economizer cooling is allowed when the supply fan is on and outside air temperature is less than 72°F. When economizer cooling is enabled or the system comes out of warm-up, the dampers open slowly to prevent mixed air temperature from falling too low and to allow better mechanical operation of the various damper sections.

G. Upon a call for heating with the outdoor and relief air dampers at the minimum position and the return air damper at the corresponding position, an adjustable duct thermostat located in the supply air discharge duct shall position the hot water heating coil modulating valve to maintain supply air temperature of 55° to 60° F.

H. Upon a call for cooling with the outdoor and relief air dampers at 100% open position and the return air damper closed, the outdoor and relief air dampers shall close down to the minimum position and the return air damper shall open to the corresponding position and the discharge air sensor shall modulate the control to maintain the desired discharge temperature.

I. When the unit is de-energized, the outdoor air and relief air dampers shall close, the return air damper shall open, and the condensing unit shall be de-energized. Heating coil control valve shall be controlled by the minimum coil discharge temperature controller.

J. The following shall be supplied and installed by temperature control Installer:

1. Outside air damper operator.
2. Relief air damper operator.
3. Return air damper operator.
4. Duct mounted discharge stat.
5. Static pressure sensor.

K. The following shall be supplied by temperature control Installer and installed by others:

1. Heating coil control valve with valve operator.
2. Cooling coil control valve with valve operator.

L. A low-temperature protection thermostat shall de-energize the unit, close outside and relief air dampers, open return air damper, and position the heating coil modulating valve to full open to coil whenever the unit mixed air temperature drops below 40° F. Provide manual reset.

M. Duct mounted ionization smoke detector(s) provided by Division 26 shall de-energize the unit, close outside and relief air dampers, and open return air damper whenever products of combustion are sensed. The duct smoke detector shall be supplied with auxiliary contacts for status indication at the BMCS front end.

N. Static Pressure sensor shall modulate the fan VFD.

3.9 VAV BOXES WITH REHEAT

A. VAV boxes with hot water heating coils shall modulate between the scheduled minimum and maximum CFM to maintain a cooling set point. Upon call for heat, the box shall modulate to minimum airflow and the hot water control valve is to modulate as required to maintain temperature set point.

B. Kitchen VAV boxes with hot water heating coils shall modulate between the scheduled minimum and maximum CFM. VAV Box is to be tied into the kitchen hood exhaust fan. When the hood exhaust fan is running the vav box is to be at the maximum cfm and when the hood exhaust fan is off the fan is to return to the minimum cfm setting. Upon call for heat the hot water control valve is to modulate as required to maintain temperature set point.

C. Laundry room VAV box with hot water heating coils shall modulate between the scheduled minimum and maximum CFM. VAV Box is to be tied into the 75 lb capacity dryer exhaust fan. When the hood exhaust fan is running the vav box is to be at the maximum cfm and when the dryer exhaust fan is off the fan is to return to the minimum cfm setting. Upon call for heat the hot water control valve is to modulate as required to maintain temperature set point.

3.10 HUMIDIFIERS

A. Duct mounted humidifiers shall be controlled by return air duct mounted humidistat.

1. Field mounted and wired humidistat, mounted in duct as indicated on drawings, to cycle humidifier to maintain desired space humidity of up to 30% (adj.) for entire area served by AHU.

3.11 CHILLED WATER SUPPLY TEMPERATURE SETPOINT

A. Chilled water supply temperature setpoint shall be automatically reset from a minimum of 42° F (adjustable) at an outside air wet bulb temperature of 65° F (adjustable) and higher up to a maximum of 48° F (adjustable) at an outside air wet bulb temperature of 45° F (adjustable) and lower.

3.12 CHILLED WATER CIRCULATION PUMPS

A. Chilled water pumps are sequenced in lead-lag manner. Lead and lag pumps are automatically alternated on a weekly basis to equalize wear.

B. Lead chilled water pump is typically in operation at all times. Lead chilled water pump speed is modulated from a minimum speed of 20% (adjustable) up to a maximum of 100% as required to maintain the chilled water differential pressure at setpoint of 5 psig (adjustable).

C. When lead chilled water pump speed is more than 95% and differential pressure is more than 1 psig (adjustable) lower than setpoint for more than 5 minutes, lag pump is automatically started. Lead and lag pump speeds are modulated in unison from a minimum of 40% (adjustable) up to a maximum of 100% (adjustable) as required to maintain the chilled water differential pressure at setpoint. When lead and lag chilled water pump speed is less than 45% and chilled water differential pressure is more than 1 psig (adjustable) higher than setpoint for more than 5 minutes, lag pump is automatically stopped.

D. When only the lead pump is in operation and the pumps are to be alternated, the lag pump speed is gradually increased from a minimum speed of 20% up to the lead pump speed (increasing at a rate of 5% per minute). When the lag pump speed is equal to the lead pump speed, the lead pump speed is gradually decreased to 20% (decreasing at a rate of 5% per minute). When lead pump speed is 20%, lead pump is stopped. Lead and lag pump designations are then alternated.

E. When lead and lag pumps are both in operation and the pumps are to be alternated, lead and lag pump designations are simply alternated (both pumps are at the same speed).

3.13 BYPASS VALVE

A. Chilled water bypass valve is modulated as required to prevent the chilled water flow at any chiller enabled to operate from decreasing below its associated minimum flow setpoint (established by the water chiller manufacturer).

3.14 WATER CHILLERS

A. Chilled water system shall be enabled by the Building Automation System whenever the outside air temperature exceeds 55ºF (adjustable), and disabled when the outside air drops below 53ºF

END OF SECTION 23 0993

SECTION 23 1123 – NATURAL GAS SYSTEMS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes providing a new gas service to the building and distribution piping systems for natural gas within building and extending from the point of delivery to the connections with gas utilization devices. Piping materials and equipment specified in this section include:

1. Pipes, fittings, valves and specialties.

1.2 SYSTEM PERFORMANCE REQUIREMENTS

A. Minimum Working Pressure ratings: The minimum working pressure requirements for this system shall be 10 psig per local utility requirements.

1.3 SUBMITTALS

A. Product data for each gas piping specialty and valve. Include rated capacities of selected models, furnished specialties and accessories, and installation instructions.

B. Test reports as specified in below.

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with the requirements of the following codes:

2. NFPA 54 – National Fuel Gas Code, for gas piping materials and components, gas piping installations, and inspection, testing, and purging of gas piping systems.
3. State Fire Marshal, Local Gas Company and American Gas Association regulations.

PART 2 – PRODUCTS

2.1 PIPE AND FITTING MATERIALS

A. General: Refer to “PIPE APPLICATIONS” for identification of systems where the below specified pipe and fitting materials are used.

B. Steel Pipe: ASTM A 53, Type E, Electric-Resistance Welded or Type S, seamless, Grade B, Scheduled 40, black steel pipe.

C. Malleable-Iron Threaded Fittings: ANSI B16.3, Class 150, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

D. Steel Fittings: ASTM B16.9, wrought steel, butt-welded type; and ASME B16.11 forged steel.

E. Transition Fittings: Type, material and end connections to match piping being joined.

F. Steel Flanges: ASTM B16.5, including bolts, nuts, and gaskets.

G. Gasket Material: Thickness, material, and type suitable for gas to be handled, and for design temperatures and pressures.

2.2 JOINING MATERIALS

A. Joint Compound: suitable for the gas being handled.

2.3 PIPING SPECIALTIES

A. Unions: ANSI B16.39, Class 150 black malleable iron; female pattern, brass to iron seat; ground joint.

B. Dielectric Unions: ANSI B16.39, Class 250; malleable iron and cast bronze; with threaded end connections suitable for pipe to be joined; designed to isolate galvanic and stray current corrosion.

C. Protective Coating: When piping will be in contact with material or atmosphere exerting a corrosive action, pipe and fittings shall be factory-coated with polyethylene tape, having the following properties:

1. Overall thickness: 20 mils.
2. Synthetic adhesive.
3. Water vapor transmission rate; gallons per 100 square inch: 0.10 or less. Water absorption, percent: 0.02 or less.

D. Prime pipe and fittings with a compatible primer prior to application of tape.

2.4 GENERAL DUTY VALVES

A. Natural Gas Valves: Valves are specified in Division 230523 Section “Valves”.

PART 3 – EXECUTION

3.1 PIPE APPLICATIONS

A. For above grade and within building gas piping, install steel pipe with threaded joints and fittings for 2 inch and smaller, and with welded joints for 2-1/2 inch and larger.

B. For underground, outside building, install one of the following:

1. Steel pipe with welded joints and fittings. Piping to have asphault protective wrapping or coating.
2. Plastic pipe, tubing and fittings, conforming to ASTM D 2513.

3.2 PIPING INSTALLATIONS

A. General: Conform to the requirements of NFPA 54 – National Fuel Gas code and International Fuel Gas Code.

B. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Design locations and arrangements of piping take into consideration pipe sizing, flow direction, slope of pipe, expansion, and other design considerations. So far as practical, install piping as indicated.

C. Concealed Locations: Except as specified below, install concealed gas piping in an air-tight conduit constructed of Schedule 40, seamless black steel with welded joints. Vent conduit to the outside and terminate with a screened vent cap.

1. Above-Ceiling Locations: Gas piping may be installed in accessible above-ceiling spaces (subject to the approval of the authority having jurisdiction), whether or not such spaces are used as a plenum. Valves shall not be located in such spaces.
2. Piping In Partitions: Concealed piping shall not be located in solid partitions. Tubing shall not be run inside hollow walls or partitions unless protected against physical damage. This does not apply to tubing passing through walls or partitions.
3. Prohibited Locations: Do not install gas piping in or through a circulating air duct, clothes chute, chimney or gas vent, ventilating duct, dumb waiter or elevator shaft. This does not apply to accessible above-ceiling space specified above.

D. Provide pipe penetrations in walls and floors as specified in Division 23, Section “Basic Mechanical Materials and Methods”.

E. Drips and Sediment Traps: Install a drip leg at points where condensate may collect, at the outlet of the gas meter, and in a location readily accessible to permit cleaning and emptying. Do not install drips where condensate is likely to freeze.

1. Construct drips and sediment traps using a tee fitting with the bottom outlet capped. Use a minimum of 3 pipe diameters in length for the drip leg. Use same size pipe for drip leg as the connected pipe.

F. Use fittings for all changes in direction and all branch connections.

G. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

H. Install piping free of sags or bends and with ample space between piping to permit proper insulation applications.

I. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed to view.

J. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Allow sufficient space above removable ceiling panels to allow for panel removal.

K. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing valves.

L. Install gas piping at a uniform grade of ¼ inch in 15 feet, upward to risers, and from the risers to the meter, or service regulator when meter is not provided, or the equipment.

M. Make reductions in pipe sizes using eccentric reducer fittings installed with the level side down.

N. Connect branch outlet pipes from the top or sides of horizontal lines, not from the bottom.

O. Hanger, supports, and anchors are specified in Division 15 Section “Supports and Anchors”. Conform to the table below for maximum spacing of supports:

Steel Pipe Size (NPS)	Spacing in Feet	Min. Rod Size – Inch
½	5	3/8
¾ to 1-1/4	6	3/8
1-1/2 to 3	12	½
4	14	½

Vertical	Every Floor Level

P. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required on flanged devices.

Q. Install dielectric unions where piping of dissimilar metals are joined.

R. Install flanges on valves, apparatus, and equipment having 2 ½ inch and larger connections.

S. Install strainers on the supply side of each control valve, pressure reducing valve, pressure regulating valve, solenoid valve, and elsewhere as indicated.

T. Above grade and outside the building gas piping is to be painted black.

U. All underground piping shall have a metal detection underground warning tape installed above the pipe at a depth recommended by the manufacturer. The tape shall be capable of being identified by a metal detector, have a brightly colored background, and shall continuously identify the pipe with black letters.

3.3 PIPE JOINT CONSTRUCTION

A. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe, fittings, and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint. Refer to NFPA 54, for guide for number and length of threads for filed threading steel pipe.
2. Align threads at point of assembly.
3. Apply appropriate tape or thread compound to the external pipe threads.
4. Assemble joint to appropriate thread depth. When using a wrench on valves place the wrench on the valve end into which the pipe is being threaded.
5. Damaged Threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

B. Welded Joints: Comply with the retirement in ASME Boiler and Pressure Vessel Code, Section IX.

C. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly to appropriate torque specified by the bolt manufacturer.

3.4 VALVE APPLICATIONS

A. General: The Drawings and specification indicate locations and arrangements.

B. Shut-off duty: Use gas valves specified in Division 230523 Section “Valves”.

3.5 VALVE INSTALLATIONS

A. Install a gas cock upstream of each gas pressure regulator. Where two gas pressure regulators are installed in series in a single gas line, a manual valve is not required at the second regulator.

B. Install pressure relief or pressure limiting devices so they can be readily operated to determine if the valve is free; so they can be tested to determine the pressure at which they will operate; and examined for leakage when in the closed position.

C. Install vent line to outside of building from vent connection on gas pressure regulators.

D. Install all valves in accessible locations, protected from physical damage. Tag valves with a metal tag attached with a metal chain indicating the piping systems or area supplied.

3.6 TERMINAL EQUIPMENT CONNECTIONS

A. Install gas cock upstream and within 6 feet of gas appliance. Install a union or flanged connection downstream from the gas cock to permit removal of controls.

B. Sediment Traps: Install a tee fitting with the bottom outlet plugged or capped as close to the inlet of the gas appliance as practical. Drip leg shall be a minimum of 3 pipe diameters in length.

3.7 ELECTRICAL BONDING AND GROUNDING

A. Install above ground portions of gas piping systems, upstream from equipment shutoff valves electrically continuous and bonded to a grounding electrode in accordance with NFPA 70 – “National Electrical Code.”

B. Do not use gas piping as a grounding electrode.

3.8 UNDERGROUND PIPE IDENTIFICATION

A. Install pipe identification tape 12” above all underground pipe installations.

3.9 FIELD QUALITY CONTROL

A. Piping Tests: Inspect, test, and purge natural gas systems in accordance with NFPA 54, and local utility requirements.

END OF SECTION 23 1123

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SECTION 23 2113 – HYDRONIC PIPING

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

A. This Section includes piping systems for hot water heating and chilled water. Piping materials and equipment specified in this Section include:

1. Pipes, fittings, and specialties.

2. Special duty valves.

3. Hydronic specialties.

4. Glycol Water Systems.

1.3 SUBMITTALS

A. Product Data, including rated capacities of selected models, weights (Shipping, installed, and operating), furnished specialties and accessories, and installation instructions for each hydronic specialty and special duty valve specified.

1. Furnish flow and pressure drop curves for calibrated balancing valves and flow meters based on manufacturer's testing.

2. Grooved joint couplings and fittings shall be shown on drawings and product submittals, and shall be specifically identified with the applicable style or series designation.

1.4 QUALITY ASSURANCE

A. Comply with ASME B 31.9 "Building Services Piping" for materials, products, and installation. Safety valves and pressure vessels shall bear the appropriate ASME label.

B. Comply with ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.

C. Comply with ASME "Boiler and Pressure Vessel Code", Section XI, "Welding and Brazing Qualification"

D. Michigan Mechanical Code.

E. All grooved joint couplings, fittings, valves, and specialties shall be the products of a single manufacturer. Grooving tools shall be of the same manufacturer as the grooved components.

F. All castings used for coupling housings, fittings, valve bodies, etc., shall be date stamped for quality assurance and traceability.

PART 2 – PRODUCTS

2.1 PIPE AND TUBING MATERIALS

A. General: Refer to “Pipe Applications” for identification of systems where the below specified pipe and fitting materials are used.

B. Drawn Temper Copper Tubing: ASTM B 88, Type L.

C. Steel Pipe: ASTM A 53, Schedule 40, black steel pipe.

D. Grooved Steel Pipe: ASTM A53, schedule 40, black steel pipe.

2.2 FITTINGS

A. Cast-Iron Threaded Fittings: ANSI B16.4, Class 125, standard pattern, for threaded joints. Threads shall conform to ANSI B1.20.1.

B. Steel Fittings: ASTM A 234, seamless or welded, for welded joints.

C. Wrought-Copper Fittings: ANSI B16.22, streamlined pattern.

D. Grooved mechanical joint fittings and couplings as provided by Victaulic or Gruvlock.

1. Fittings shall be ASTM A536, Grade 65-45-12 ductile iron; ASTM A234, Grade WPB wrought steel; or factory-fabricated from ASTM A53 steel pipe; with factory-grooved ends.
2. Couplings shall consist of two ductile iron housing segments conforming to ASTM A536 Grade 65-45-12, ASTM D2000 pressure responsive elastomer gasket, and ASTM A449 zinc-electroplated steel bolts and nuts.
    a. Rigid Type: Housings shall be cast with offsetting angle-pattern bolt pads to provide rigidity and system support and hanging in accordance with ANSI B31.1 and B31.9.
        1. 2” through 8”: Installation-Ready, for direct stab installation without field disassembly, with grade EHP gasket rated to +250 deg F / 120 deg C.
    b. Flexible Type: For use in locations where vibration attenuation and stress relief are required. Three flexible couplings may be used in lieu of a flexible connector. The couplings shall be placed in close proximity to the source of the vibration.
3. Flange Adapter: Flat face, ductile iron housings with elastomer pressure responsive gasket, for direct connection to ANSI Class 125 or 150 flanged components.

E. Cast-Iron Threaded Flanges: ANSI B16.1, Class 125; raised ground face, bolt holes spot faced.

F. Cast Bronze Flanges: ANSI B16.24, Class 150; raised ground face, bolt holes spot faced.

G. Steel Flanges: ANSI B16.5, including bolts, nuts, and gaskets of the following material group, end connection and facing:

1. Material Group: 1.1.

2. End Connections: Butt Welding.

3. Facings: Raised Face.

H. Unions: ANSI B16.39 malleable-iron, Class 150, hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends. Threads shall conform to ANSI B1.20.1.

1. Unions are not required in installations using grooved mechanical joint couplings. (The couplings shall serve as unions and disconnect points.)

I. Dielectric Fittings: Refer to Section 15050.

J. Flexible Connectors: Stainless steel bellows with woven flexible bronze wire reinforcing protective jacket; minimum 150 psig working pressure, maximum 250 ° F operating temperature. Connectors shall have flanged or threaded end connections to match equipment connected; and shall be capable of ¾ inch misalignment.

2.3 JOINING MATERIALS

A. Solder Filler Metals: ASTM B 32, 95-5 Tin-Antimony.

B. Welding Materials: Comply, with Section II, Part C. ASME Boiler and Pressure Vessel Code for welding materials appropriate for the wall thickness and chemical analysis of the pipe being welded.

C. Grooved Joint Lubricants: Lubricate gaskets in accordance with the manufacturer's recommendations with lubricant supplied by the coupling manufacturer that is suitable for the gasket elastomer and system media.

D. Gasket Material: Thickness, material, type suitable for fluid to be handled, and design temperatures and pressures.

2.4 GENERAL DUTY VALVES

A. General duty valves (i.e. check, butterfly, and ball valves) are specified in Division 23 Section "Valves." Refer to Section 230523 for specific uses and applications for each valve specified. Special duty valves are specified below by their generic name.

2.5 SPECIAL DUTY VALVES

A. Balancing Valve: Provide general duty throttling valve, size as indicated, suitable for service indicated, as specified in Division 23, Section "Valves". Provide positive locking memory stop feature to valve operator, to allow valve to be closed and then reopened to set point without disturbing balancing position.

B. Calibrated Balancing Valves: Provide calibrated balance valves equipped with valves on readout ports to facilitate connecting of differential pressure meter to balance valves. Readout valves shall have ¼" NPT connection for meters. Provide calibrated nameplate to indicated degree of closure of orifice. Construct balancing valve with internal seals to prevent leakage around rotating element. Valves to have memory stop feature to allow valve to be closed and then reopened to set point without disturbing balancing position. Provide balance valves with performed polyurethane insulation suitable for use on heating and cooling systems, and to protect balance valves during shipment. Bell & Gossett "Circuit Setter", Victaulic / TA Hydronics Series 787 / 789 or engineer approved equal.

C. Pressure Reducing Valves: Diaphragm operated, cast-iron or brass body valve, with low inlet pressure check valve, inlet strainer removable without system shut-down, and non-corrosive valve seat and stem. Select valve size, capacity, and operating pressure to suit system. Valve

shall be factory-set at operating pressure and have the capability for field adjustment. Bell & Gossett or equal.

D. Safety Relief Valves: 125 psig working pressure and 250 ° F maximum operating temperature; designed, manufactured, tested, and labeled in accordance with the requirements of Section IV of the ASME Boiler and Pressure Vessel Code. Valve body shall be cast-iron, with all wetted internal working parts made of brass and rubber. Select valve to suit actual system pressure with Btu capacity. Bell & Gossett or equal.

2.6 HYDRONIC SPECIALTIES

A. Flow Meter: Differential-pressure wafer type or venturi type design for insertion into piping. Meter shall have brass shut-off valves with ¼" NPT connections and attached tag with flow conversion data. Meter shall be pressure rated for a minimum of 300 psig and 250 ° F. Bell & Gossett or equal.

B. Manual Air Vent: Bronze body and nonferrous internal parts; 150 psig working pressure, 225 ° F operating temperature; manually operated with screwdriver or thumbscrew; and having 1/8 inch discharge connection and ½ inch inlet connection. Bell & Gossett or equal.

C. Expansion Tanks: Size and number as indicated; construct of welded carbon steel for 125 psig working pressure, 375 ° F maximum operating temperature. Provide taps in bottom of tank for tank fitting. Tank with taps constructed shall be tested and labeled in accordance with ASME Pressure Vessel Code, Section VIII, Division 1. Bell & Gossett or equal. Furnish with the following fittings and accessories:

1. Air Control Tank Fitting: cast-iron body, copper-plated tube, brass vent tube plug, and stainless steel ball check (100 gallon unit only); sized for compression tank diameter. Design tank fittings for 125 psig working pressure and 250 ° F maximum operating temperature.

2. Tank Drain Fitting: brass body, nonferrous internal parts; 125 psig working pressure and 240 ° F maximum operating temperature. Fitting shall be designed to admit air to the compression tank and drain water, plus close off the system.

D. Air Separator: welded black steel; ASME constructed and labeled for minimum 125 psig water working pressure and 375 ° F operating temperature; perforated stainless steel air collector tube designed to direct released air into compression tank; tangential inlet and outlet connections; screwed connections up to and including 2" NPS; flanged connections for 2-1/2" NPS and above; threaded blowdown connection. Bell & Gossett or equal.

E. Pump Suction Diffusers: Bell & Gossett or Victaulic diffuser with ductile-iron or cast-iron body, with threaded connections for 2 inch and smaller, grooved inlet and flanged connections for 2-1/2 inch and larger; 300 psig working pressure, 230° F maximum operating temperature; and complete with the following features:

1. Stainless steel inlet vanes with length 2-1/2 times pump suction diameter or greater.

2. Cylinder strainer with 5/32 or 3/16 inch diameter openings with total free area equal to or greater than 5 times cross-sectional area of pump suction, designed to withstand pressure differential equal to pump shutoff head.

3. Disposable stainless steel fine mesh strainer to fit over cylinder strainer.

4. Permanent magnet, located in flow stream, removable for cleaning.

5. Adjustable foot support or base support boss, designed to carry weight of suction piping.

6. Blowdown tapping in bottom; gage tapping in side.

7. For open systems, provide with stainless steel straightening vanes and orifice cylinder.

F. Y-Pattern Strainers: 300 psig working pressure ductile-iron (ASTM A536, Grade 65-45-12) or cast-iron body (ASTM A 126, Class B), grooved or flanged ends for 2-1/2 inch and larger, threaded connections for 2 inch and smaller, bolted cover, perforated Type 304 stainless steel basket, and bottom drain connection. Victaulic Series 732/W732 or equal.

G. Hydronic Heating Bypass Filter: Filter housing construction to be 304 L stainless steel, rated for 150 psi and 450 ° F. Unit to be complete with Buna-N gasket, poly-coat finish, mounting legs, flanged connections, vent, drain and swing bolt lid. Filters to be high temperature polyester filter cartridge with high temp. Glass filled cores. Provide United, Shelco or equal. Contractor shall change filter at completion of system cleaning and maintain filters during temporary use of system. At project completion, Contractor shall change filters and provide owner with two cases of extra filters.

H. Glycol Solution/Water Make-up Unit: Packaged, automatic glycol solution make up unit model GMU as manufactured by Bell & Gossett or approved equal. The package shall consist of a base, polyethylene reservoir with removable lid and visible solution level scale in gallons, y-strainer, isolation valve, pump, open drip-proof motor, pump isolation, check and balance valve, expansion tank, discharge pressure gauge, motor contactor, pressure control and necessary interconnecting piping. Pump shall start based on falling pressure. Green light shall indicate power supplied to unit. System shall require a 115/1/60 single power connection and a ¾" NPT system piping connection. GMU shall provide (10 or 5) GPM and maintain a fill pressure of (30 or 60) PSI. Unit includes low level cutout, with red indicator light and a dry contact for alarm indication, to stop the pump during low level condition. Contractor shall furnish application specific pressure reducing valve between GMU and connection to the system piping.

2.7 GLYCOL WATER SYSTEMS

A. INHIBITED GLYCOL

1. Manufacturer: The Dow Chemical Company.
2. Product: Dowfrost HD (Propylene Glycol) for hot water glycol systems, chilled water glycol systems and heat pump glycol systems.
3. Glycol shall be pre-mixed to appropriate concentration from chemical manufacturer, or may be mixed with de-ionized water with concentrated chemical. Glycol shall NOT be mixed with city water.

PART 3 – EXECUTION

3.1 PIPE APPLICATIONS

A. For hot water and chilled water piping systems within the building, install Type L, drawn copper tubing with solder joint wrought copper fittings or steel pipe with cast iron threaded fittings for 2 inch and smaller. Install steel pipe with mechanical grooved joints or welded joints and fittings for 2-1/2 inch and larger.

3.2 PIPING INSTALLATION

A. Locations and Arrangements: Drawings (plans, schematics, and diagrams) indicate the general location and arrangement of piping systems. Locations and arrangements of piping take into consideration pipe sizing and friction loss, expansion, pump sizing, and other design considerations. So far as practical, install piping as indicated.

B. Use fittings for all changes in direction and all branch connections.

C. Install exposed piping at right angles or parallel to building walls. Diagonal runs are not permitted, unless expressly indicated.

D. Conceal all pipe installations in walls, pipe chases, utility spaces, above ceilings, below grade or floors, unless indicated to be exposed view.

E. Install piping tight to slabs, beams, joists, columns, walls, and other permanent elements of the building. Provide space to permit insulation applications, with 1" clearance outside the insulation. Allow sufficient space above removable ceiling panels to allow for panel removal.

F. Locate groups of pipes parallel to each other, spaced to permit applying insulation and servicing valves.

G. Install drains at low points and vents at high points in mains, risers, and branch lines consisting of a tee fitting, ¾" ball valve, and short ¾" threaded hose nipple and cap.

H. Provide pipe penetrations in walls and floors as specified in Division 23 Section "Basic Mechanical Materials and Methods."

I. Install piping at a uniform grade of 1 inch in 40 feet upward in the direction of flow.

J. Make reductions in pipe sizes using eccentric reducer fitting installed with the level side up.

K. Install branch connections to mains using Tee fittings in main with take-off out the bottom of the main.

L. Expansion Compensation for Risers and Terminals: Install connection between piping mains and risers with at least 5 pipe fittings including tee in main. Install connections between piping risers and terminal units with at least 4 pipe fittings including tee in riser.

M. Install unions in pipes 2 inch and smaller, adjacent to each valve, at final connections each piece of equipment, and elsewhere as indicated. Unions are not required to flanged devices or in installations with grooved mechanical joints.

N. Provide dielectric waterway fittings or ground-joint cast brass unions to connect piping where joining dissimilar metals.

O. Install flanges or grooved joint couplings on valves, apparatus, and equipment having 2-1/2 inch and larger connections.

P. Install strainers on the supply side of each control valve, flow control valve, pressure reducing valve, pressure regulating valve, solenoid valve, inline pump, and elsewhere as indicated. Install nipple and ball valve in blow down connection of strainers 2 inch and larger.

Q. Install temperature sensing wells, pressure sensors and control valves supplied by temperature controls. Install as indicated on drawings and as directed by temperature controls Installer.

3.3 HANGERS AND SUPPORTS

A. General: Hanger, supports, and anchors devices are specified in Division 15 Section “Supports and Anchors.” Conform to the table below for maximum spacing of supports:

B. Install the following pipe attachments:

1. Adjustable steel clevis hangers for individual horizontal runs.

2. Pipe roller complete – MSS Type 44 for multiple horizontal runs, supported on a trapeze.

3. Spring hangers to support vertical runs.

C. Install hangers with the following minimum rod sizes and maximum spacing schedule:

Nom. Pipe Size– In.	Max. Span – Ft. Copper	Steel	Min. Rod Dia. – In. Copper	Steel
Up to ¾”	5	6	3/8	3/8
1	6	7	3/8	3/8
1-1/4	7	8	3/8	3/8
1-1/2	8	9	3/8	3/8
2	8	10	3/8	3/8
2-1/2	-	11	-	½
3	-	12	-	½
4	-	14	-	5/8
6	-	17	-	¾

D. Support vertical runs at each floor.

3.4 PIPE JOINT CONSTRUCTION

A. Soldered Joints: Comply with the procedures contained in the AWS “Soldering Manual”.

B. Threaded Joints: Conform to ANSI B1.20.1, tapered pipe threads for field cut threads. Join pipe fittings and valves as follows:

1. Note the internal length of threads in fittings or valve ends, and proximity of internal seat or wall, to determine how far pipe should be threaded into joint.

2. Align threads at point of assembly.

3. Apply appropriate tape or thread compound to the external pipe threads (except where dry seal threading is specified).

4. Assemble joint wrench tight. Wrench on valve shall be on the valve end into which the pipe is being threaded.

a. Damaged threads: Do not use pipe with threads which are corroded or damaged. If a weld opens during cutting or threading operations, that portion of pipe shall not be used.

C. Welded Joints: Comply with the requirement in ASME Code B31.9-“Building Services Piping”.

D. Flanged Joints: Align flanges surfaces parallel. Assemble joints by sequencing bolt tightening to make initial contact of flanges and gaskets as flat and parallel as possible. Use suitable lubricants on bolt threads. Tighten bolts gradually and uniformly using torque wrench.

E. Mechanical Joints: Comply with ASTM and Manufacturer's recommendations.
   1. Grooved joints shall be installed in accordance with the manufacturer's latest published installation instructions.
   2. Grooved ends shall be clean and free from indentations, projections, and roll marks in the area from pipe end to groove.
   3. Gaskets shall be of an elastomer grade suitable for the intended service, and shall be molded and produced by the coupling manufacturer.
   4. The grooved coupling manufacturer's factory trained representative shall provide on-site training for contractor's field personnel in the use of grooving tools and installation of grooved joint products. The representative shall periodically visit the jobsite and review contractor is following best recommended practices in grooved product installation. (A distributor's representative is not considered qualified to conduct the training or jobsite visit(s).)

3.5 VALVE APPLICATIONS

A. General Duty Valve Applications: The Drawings indicate valve types to be used. Where specific valve types are not indicated the following requirements apply:

   5. Refer to Division 23, Section 230523 for specific uses and applications for each valve specified.

   6. Shut-off duty: use butterfly and ball valves.

   7. Throttling duty: use butterfly and ball valves.

   8. Install shut-off duty valves at each branch connection to supply mains, at supply connection to each piece of equipment, and elsewhere as indicated.

   9. Install throttling duty valves at each branch connection to return mains, at return connections to each piece of equipment, elsewhere as indicated.

B. Install calibrated balance valves on 2 inches and smaller piping where indicated with readout valves in vertical upright position. Maintain minimum length of straight unrestricted piping equivalent to 3 pipe diameters upstream of valve.

C. Install drain valves at low points in mains, risers, branch lines, and elsewhere as required for system drainage.

D. Install check valves on each pump discharge and elsewhere as required to control flow direction.

E. Install safety relief valves on hot water generators, and elsewhere as required by ASME Boiler and Pressure Vessel Code. Pipe discharge to floor without valves. Comply with ASME Boiler and Pressure Vessel Code Section VIII, Division 1 for installation requirements.

F. Install pressure reducing valves on hot water generators, and elsewhere as required to regulate system pressure.

3.6 HYDRONIC SPECIALTIES INSTALLATION

A. Install flow meters on 2-1/2 inches and larger piping where indicated with a minimum straight length of pipe upstream and downstream from element as prescribed by the manufacturer's installation instructions.

1. Install connections for attachment to portable flow meters in a readily accessible location.

B. Install balancing valves in conjunction with venturi or wafer type flow meters and elsewhere as indicated. Use balancing valve to adjust flow rate based on flow measurements taken from flow meter.

C. Install manual air vents at high points in the system, at heat transfer coils, and elsewhere as required for system air venting.

D. Install inline air separators as indicated. Run piping to expansion tank with ¼ inch per foot (2 percent) upward slope towards tank. Install drain valve on units 2 inch and larger.

E. Install pump suction diffusers on base mounted pump suction inlet, adjust foot support to carry weight of suction piping. Install nipple and ball valve in blowdown connection.

F. Install bypass pot feeders where indicated; in upright position with top of funnel not more than 48 inches above floor. Install feeder in bypass line, off main using valves on each side of feeder. Pipe drain, with valve, to nearest equipment drain.

G. Install expansion tanks above air separator. Install tank fitting in tank bottom and charge tank. Use manual vent for initial fill to establish proper water level in tank.

1. Support tank as detailed on the Drawings. In the absence of details provide support from the floor or structure above sufficient for the weight of the tank, piping connections, and fittings, plus weight of water assuming a full tank of water. Do not overload building components and structural members.

H. Install expansion loops or compensators where indicated and where required for adequate expansion of installed piping system.

3.7 FIELD QUALITY CONROL

A. Preparation for testing: Prepare hydronic piping in accordance with ASME B 31.9.

B. Testing: Refer to Section 230593

3.8 ADJUSTING AND CLEANING

A. Preoperational System Cleanout: All hydronic piping and related equipment (except as noted) shall be thoroughly flushed out with precleaning chemicals designed to remove pipe dope, oils, loose rust, mill scale and other extraneous materials. Precleaner chemical product shall be added in chemical manufacturer recommended dosages and circulated throughout the water system for at least 4 hours. The water system will then be drained, refilled and flushed thoroughly until no foreign matter is observed and the total alkalinity of the rinse water is equal to that of the make-up water.

B. Glycol Fluid Installation:

1. New or lightly corroded existing systems to be cleaned with a 1% to 2% solution of trisodium phosphate in water prior to the installation of industrially inhibited propylene glycol fluid.

2. Extensively corroded existing systems should be cleaned by an industrial cleaning company and all necessary replacements and repairs should be made.

3. After cleaning, the Contractor shall drain and refill the glycol water system piping and refill with a solution of propylene glycol water.

4. The Contractor shall introduce a suitable corrosion inhibitor to protect system and maintain the pH of the water between 7.5 and 8.5

5. Delivery and Storage: Deliver all chemicals in manufacturer's sealed shipping containers. Store in designated space and protect from deleterious exposure and hazardous spills.

C. Mark calibrated name plates of pump discharge valves after hydronic system balancing has been completed, to permanently indicate final balanced position.

3.9 COMMISSIONING

A. Fill system and perform initial chemical treatment.

B. Check expansion tanks to determine that they are not air bound and that the system is completely full of water.

C. Before operating the system perform these steps:

1. Open valves to full open position. Close coil bypass valves.

2. Remove and clean strainers.

3. Check pump for proper direction and correct improper wiring.

4. Set automatic fill valves for required system pressure.

5. Check air vents at high points of systems and determine if all are installed.

6. Set temperature controls so all coils are calling for full flow.

7. Check operation of automatic bypass valves.

8. Check and set operating temperatures of boilers.

9. Lubricate motors and bearings.

END OF SECTION 23 2113

SECTION 23 2114 – UNDERGROUND HYDRONIC PIPING

PART 1 – GENERAL

1.1 SUBMITTALS

A. Product Data: Manufacturer's information for all system components including carrier piping, insulation type and k-value, casing, and major components for each conduit piping system.

B. Shop Drawings: Fabrication details showing anchors, alignment guides, supports, and expansion loops.

C. Record Drawings: Dimensioned scale documents representing hydronic piping as installed including invert elevations, vaults and valves.

1.2 PROJECT CONDITIONS AND COORDINATION

A. Site Information: Review site survey, research public utility records, and verify existing utility locations. Verify that piping may be installed in compliance with the original design and referenced standards.

B. Coordinate underground systems with interior hydronic water piping and all utility work.

PART 2 – PRODUCTS

2.1 DUCTILE IRON PIPE AND PIPE FITTINGS

A. Ductile-Iron and Cast-Iron Fittings: AWWA C110, Ductile-iron or cast-iron, 250-psi pressure rating; or AWWA C153, Ductile-iron compact fittings, 350-psi pressure rating.

1. Lining: AWWA C104, cement mortar.

2. Gaskets: AWWA C111, rubber.

B. Ductile-Iron Pipe 4 Inches and Larger: AWWA C151, Class 50.

1. Lining: AWWA C104, cement mortar, sealcoated.

2. Gaskets: AWWA C111.

2.2 ANCHORAGES

A. Rods and Clamps:

1. Clamps, Straps, and Washers: ASTM A 506, steel.

2. Rods Couplings: ASTM A 197, malleable iron.

3. Rods: ASTMA A 575, steel.

4. Bolts: ASTM A 307, steel.

5. Cast-Iron Washers: ASTM A 126, gray iron.

B. Concrete Reaction Backing: Portland cement concrete mix, 3000 psi.

1. Cement: ASTM C 150, Type I.

2. Fine Aggregate: ASTM C 33, sand.

3. Course Aggregate: ASTM C 33, crushed gravel.

4. Water: Potable.

2.3 UNDERGROUND WARNING TAPE

A. Underground Plastic Pipe Markers: Bright colored continuously printed plastic ribbon tape, minimum 6-inch width/ 4-mil thickness, manufactured for direct burial service.

PART 3 – EXECUTION

3.1 PREPARATION OF BURIED PIPE FOUNDATION

A. Grade trench bottom to provide a smooth, firm, stable, and rock-free foundation throughout the length of the piping.

B. Removable unstable, soft and unsuitable material at the surface upon which pipes are to be laid and backfill with clean sand or pea gravel to indicated level.

C. Shape bottom of trench to fit bottom of piping. Fill unevenness with tamped sand backfill. Dig bell holes at each pipe joint to relieve the bells of all loads and to ensure continuous bearing of the pipe barrel on the foundation.

3.2 INSTALLATION OF PIPE AND FITTINGS

A. Chilled Water Applications: Install cement-mortar-lined, ductile-iron or cast-iron, mechanical joint fittings and rubber gaskets in accordance with AWWA C600.

B. Depth of Cover: Provide minimum cover over piping of 12 inches below average local frost depth or 48 inches below finished grade, whichever is greater.

C. Tunneling: Install pipe under streets or other obstructions that cannot be disturbed, by tunneling, jacking, or combination or both.

D. Piping Termination: Provide watertight sleeve seal at building entrance and terminated piping where indicated. Provide line-size gate valve, ¾-inch valved test tee, and pressure gage.

3.3 INSTALLATION OF ANCHORAGES

A. Provide anchorages for tees, plugs and caps, bends, crosses, valves, and branches.

B. Apply full coat of asphalt or other acceptable corrosion-retarding material to surfaces of installed ferrous anchorage devices.

3.4 INSTALLATION OF IDENTIFICATION

A. Install continuous plastic underground warning tape during back- filling of trench for underground water piping. Locate 6 to 8 inches below finished grade, directly over piping.

1. Use warning tape or detectable warning tape over ferrous piping.

2. Use detectable warning tape over nonferrous piping.

3.5 FIELD QUALITY CONTROL

A. Manufacture's Field Service: Arrange and pay for pre-insulated piping system certified representative to observe joint construction, pressure testing and backfilling.

B. Piping Tests: Comply with the following:

1. General: Conduct piping tests before joints are covered.

2. Preparation: Fill pipeline 24 hours prior to testing and apply test pressure to stabilize system. Use only potable water.

3. Hydrostatic Testing: test at not less that 1-1/2 times working pressure for 2 hours in accordance with the following procedure:

    a. Increase pressure in 50-psi increments and inspect each joint between increments.

    b. Hold at test pressure for one hour; decrease to 0 psi.

    c. Slowly increase again to test pressure and hold for one more hour. Maximum allowable leakage is 2 quarts per hour per 100 joints.

4. Remake leaking joints with new material and repeat test until leakage is within above limits

END OF SECTION 23 2114

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SECTION 23 2123 – HVAC PUMPS

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes pumps for hydronic piping systems.

B. Refer to Division 230514 “VFD’s for HVAC equipment”.

1.2 SUBMITTALS

A. Submit manufacturer’s technical data, installation and start-up instructions, piping and wiring diagrams, maintenance data and certified performance curves.

1.3 QUALITY ASSURANCE

A. Design, manufacture, and install HVAC pumps in accordance with “Hydraulic Institute Standards.”

B. Comply with NFPA 70.

C. Comply with UL Standard 778.

D. Comply with NEMA.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, provide products by:

1. Bell & Gossett, ITT.
2. Armstrong
3. Flo Fab

2.2 PUMPS, GENERAL

A. Factory-assembled and factory-tested. Fabricate casings to allow removal and replacement of impellers without necessity of disconnecting piping. Type, sizes, and capacities shall be as indicated.

1. Preparation for Shipping: After assembly and testing, clean flanges and exposed machined metal surfaces and treat with an anticorrosion compound. Protect flanges, pipe openings, and nozzles.

2. Motors: Refer to division 230513 “Motors for HVAC equipment”.

3. Apply factory finish paint to assembled, tested units prior to shipping.

4. Provide extensions on lubrication fittings to accommodate insulation.

2.3 INLINE CIRCULATORS

A. Circulators shall be horizontal inline, centrifugal, separately-coupled, single-stage, bronze-fitted, radially split case design, with mechanical seals, and rated for 175 psig working pressure and 225 ° F continuous water temperature.

1. Casings Construction: Cast iron, with threaded companion flanges for piping connections smaller than 2-1/2 inches, and threaded gage tappings at inlet and outlet connections.

2. Impeller Construction: Statically and dynamically balanced, closed, overhung, single-suction, fabricated from Rolled Temper brass conforming to ASTM B 36, and keyed to shaft.

3. Pump Shaft and Sleeve: Steel shaft, with copper sleeve. Provide flinger on motor shaft between motor and seals to prevent liquid that leaks past pump seals from entering the motor bearings.

4. Mechanical Seals: [Carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows and gasket.] Pump seals shall be capable of performing with fluids having pH up to 11.0 and dissolved solids up to 8000 ppm.

    a. Sintered Silicon Carbide (EPR/SIC/SIC) for all systems [not available on B&G series 60]
    b. Buna/Carbon/Ceramic seals for systems containing glycol.

5. Pump Shaft Bearings: Oil-lubricated, bronze journal and thrust bearings.

6. Pump Couplings: Flexible, capable of absorbing torsional vibration and shaft misalignment.

7. Motors: Resiliently mounted to the pump casing.

2.4 BASE-MOUNTED, SEPARATELY-COUPLED, END-SUCTION PUMPS

A. Pumps shall be base-mounted, centrifugal, separately-coupled, end-suction, single-stage, bronze-fitted, radially split case back pullout design, and rated for 175 psig working pressure and 225 ° F continuous water temperature.

1. Casings Construction: Cast-iron, with integral cast pedestal support, flanged piping connections, and threaded gage tappings at inlet and outlet flange connections.

2. Impeller Construction: Statically and dynamically balanced, closed, overhung, single-suction, fabricated from cast bronze conforming to ASTM B 584, keyed to shaft and secured by a locking capscrew.

3. Wear Rings: Replaceable, bronze.

4. Pump Shaft and Sleeve Bearings: Steel shaft, with bronze sleeve.

5. Seals: Mechanical seals consisting of carbon steel rotating ring, stainless steel spring, ceramic seat, and flexible bellows gasket. Pump seals for glycol systems shall be capable of performing with fluids having pH up to 12.5 and dissolved solids up to 25,000 ppm.

    a. Buna/Carbon/Ceramic seals for all systems other than glycol.
    b. Sintered silicon carbide (SiC) faced seals for systems containing glycol.

6. Pump Couplings: Flexible, capable of absorbing torsional vibration and shaft misalignment; complete with metal coupling guard.

7. Mounting Frame: Factory-welded frame and cross members, fabricated of steel channels and angles conforming to ASTM B 36, suitable for grouting. Fabricate for mounting pump casing, coupler guard, and motor. Grind welds smooth prior to application of factory finish. Motor mounting holes for field-installed motors shall be field-drilled.

8. Motor: Secured to mounting frame with adjustable alignment on mounting frame.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install pumps in locations and arranged to provide access for periodic maintenance, including removal of motors, impellers, couplings, and accessories.

B. Support pumps and piping separately so that the weight of the piping system does not rest on the pump.

C. Support inline pumps from floor using structural steel members of sufficient size to support the weight of the pump independent of the piping system.

D. Mounting Bases:

1. Set base - mounted pumps on concrete housekeeping pad for slab on grade installations.

E. Install suction and discharge pipe sizes equal to or greater than the diameter of the pump nozzles.

F. Install a nonslam check valve and throttling valve on the discharge side of pumps.

G. Install a shut-off valve and strainer on the suction side of inline pumps.

H. Install a pump suction diffuser and shut-off valve on the suction side of base-mounted, end-suction pumps. [Suction diffusers on cooling tower water systems shall have stainless steel inlet vanes].

I. Install flexible connectors on the suction and discharge side of each base-mounted pump.

J. Install pressure gages on the suction and discharge of each pump.

K. Electrical wiring and connections are specified in Division 260000 sections.

L. Control wiring and connections are specified in other Division 230000 sections.

END OF SECTION 23 2123

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SECTION 23 2500 – CHEMICAL WATER TREATMENT

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes automatic chemical treatment system

1. Provide a one (1) year supply of all chemicals for control of scale corrosion and microbiological growth.

2. Provide a comprehensive service program including technical assistance to contractor during installation, supervision of cleaning, operator training and regular on-site testing including written reports for one (1) year after startup.

1.2 QUALITY ASSURANCE

A. Supplier: Water treatment chemical and service supplier who has been active in field of industrial water treatment for not less than 5 years, and who has full-time service personnel located within trading area of job site.

B. Codes and Standards: Comply with UL, NEMA and NEC.

1. Chemical Standards: Provide only chemical products which are acceptable under state and local pollution control regulations.

1.3 SUBMITTALS

A. Submit manufacturer's technical data, installation and start-up instructions, piping and wiring diagrams, and maintenance data; in accordance with requirements of Division 1.

1.4 EXTENDED MAINTENANCE SERVICES

A. Agreement to Maintain: Prior to time of final acceptance, submit 4 copies of "Agreement for Continued Service and Maintenance" for water treatment system, for Owner's possible acceptance. Offer terms and conditions for furnishing chemicals and providing continued testing and servicing, and including replacement of materials and equipment, for 1-year period with option for renewal of Agreement by Owner.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide products of 1 of the following:

1. GE Betz.

2. H.V. Burton Company

3. Enerco Corporation

4. Nalco Chemical Co.

5. Mitco Inc.

B. Base Bid: Enerco Corporation 317 N. Bridge Street, Grand Ledge, MI 48837. 517-627-8444.

2.2 MATERIALS AND EQUIPMENT

A. General: Provide chemical cleaning for the water systems and chemical water treatment. Provide all necessary mechanical equipment, chemicals, injection and control equipment and service.

B. Pre-Cleaning: Thoroughly flush all piping with fresh water. Remove and clean all strainers and open drip legs or other non flow piping to remove debris. Determine loop capacity in gallons by carefully filling the loop from completely drained dry to full with air bled out. Loop capacity to be taken from water meter readings. Submit written report of loop capacity to water treatment subcontractor and owner. Refill system with fresh water along with alkaline detergent cleaner at the recommended use rates. Circulate 8 – 72 hours. Flush system and open, clean and inspect all strainers, drip legs and non-flow areas. Refill with fresh water, establish bleed, and allow system to makeup fresh water and bleed until water leaving the system is of same quality as makeup. Immediately introduce corrosion inhibitor to protect the clean system until normal start up.

C. Chemical Treatment: Provide chemical for each hydronic piping loop. System to include the following equipment with installation as shown on the drawings and as recommended by the manufacturer.

1. Provide one (1) Electric Contact Head Water Meter of bronze construction up to 110 degrees, Fahrenheit with pressure up to 150 psig. Meter is to be of oscillating piston design using a magnetic drive to couple the measuring piston to the electric contact head. The electric contact switch shall be normally open and capable of handling control voltages up to 240V. Contacts to be rated 10 amp minimum. The gallons per contact to be initially set for 50 gpc, but must be readily field changeable. Water meter size and gallons per contact to be determined by water treatment sub-contractor.

2. One (1) Shotfeeder for each loop. Shotfeeder to include feeder body, funnel and control valves all constructed of materials compatible with the system. Pressure rating of the feeder to be 125 psig minimum.

   Shotfeeder of 5 gallon capacity and larger, to have welded legs included.

3. Shotfeeder size selection guide.

Approximate Loop Size (Gal.)	Shotfeeder Size
100-1000 gal	4 qt
1000-2500 gal	6 qt
2500-4000 gal	8 qt
4000-6000 gal	10 qt
6000-8000 gal	5 gal

4. Provide pressure gauges on inlet and outlet of filter. Pressure range of gauges matched to system.

5. Provide one (1) circulation pump of close coupled design employing casing, impeller and diffuser of 304 stainless steel. 416 stainless steel shaft to be mechanically sealed with Buna/Ceramic seals.

   Pump to be driven by 1 ½ hp, 115/230, 1 phase motor.

   Pump deliver to be 30 gpm at 30 psig pressure drop up to 60 gpm at 10 psig pressure drop.

6. Provide testing equipment to include portable kit as required for monitoring system scale and corrosion inhibitor.

7. Provide a one (1) year supply of all chemicals for corrosion control.

8. Provide a comprehensive service program that includes technical assistance to contractor during installation, supervision of cleaning, operator training and regular on-site testing with written reports for one (1) year after start up.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install water treatment system and all appurtenances in accordance with manufacturer's written instructions.

B. Coordinate with other work as necessary.

3.2 FIELD QUALITY CONTROL

A. Provide supplier representative to verify system startup and operation.

END OF SECTION 23 2500

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SECTION 23 3113 – METAL DUCTWORK

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes rectangular and round metal ducts and plenums for heating, ventilating, and air conditioning systems in pressure classes from minus 3 inches to plus 10 inches water gage.

1.2 DEFINITIONS

A. Sealing Requirements Definitions: For the purpose of duct systems sealing requirements specified in this Section, the following definitions apply:

1. Seams: A seam is defined as joining of two longitudinally (in the direction of airflow) oriented edges of duct surface material occurring between two joints. All other duct surface connections made on the perimeter are deemed to be joints.
2. Joints: Joints include girth joints, branch and subbranch intersections, so-called duct collar tap-ins, fitting subsections, louver and air terminal connections to ducts, access door and access panel frames and jambs, duct, plenum, and casing abutments to building structures.

1.3 SYSTEM PERFORMANCE REQUIRMENTS

A. The duct system design, as indicated, has been used to select and size air moving and distribution equipment and other components of the air system. Changes or alterations to the layout or configuration of the duct system must be specifically approved in writing. Accompany requests for layout modifications with calculations showing that the proposed layout will provide the original design results without increasing the system total pressure.

1.4 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data including details of construction relative to materials, dimensions of individual components, profiles, and finishes for the following items:

1. Sealing Materials.

C. Record drawings including duct systems routing, fittings details, reinforcing, support, and installed accessories and devices, in accordance with Division 15 Section “Basic Mechanical Requirements” and Division 1.

D. Duct Leakage Reports: Submit duct leakage test reports. The reports shall be certified proof that the systems have been leak tested, in accordance with this specification section and the referenced standards and are an accurate representation of the system leakage.

1.5 QUALITY ASSURANCE

A. Comply with NFPA

B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2007, Section 5 – "System and Equipment" and Section 7 – "Construction and System Start-Up."

C. ASHRAE/IESNA Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2007, Section 6.4.4 – "HVAC System Construction and Insulation."

1.6 DUCTWORK – GENERAL NOTE

A. All duct sizes shown on the drawings are to establish total duct area required. If duct sizes need to be changed or ducts be rerouted to install the ducts through joists, above ceilings, below steel, etc., changes shall be done at no extra cost to the Owner. The Contractor shall check with the Architect/Engineer before changing any sizes.

1.7 PERFORMANCE REQUIREMENTS

A. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1-2007

PART 2 – PRODUCTS

2.1 SHEET METAL MATERIALS

A. Sheet Metal, General: Provide sheet metal in thickness indicated, packaged and marked as specified in ASTM A 700.

B. Galvanized Sheet Steel: Lock-forming quality, ASTM A 527, Coating Designation G 90. Provide mill phosphatized finish for exposed surfaces of ducts exposed to view.

C. Reinforcement Shapes and Plates: Unless otherwise indicated, provide galvanized steel reinforcing where installed on galvanized sheet metal ducts. For aluminum and stainless steel ducts provide reinforcing of compatible materials.

D. Tie Rods: Galvanized steel, ¼ inch minimum diameter for 36 inch length or less; 3/8 inch minimum for lengths longer than 36 inches.

E. At kitchen hood, provide minimum 16 gauge thickness steel construction, with welded joints, seams and penetrations, or else factory-built commercial kitchen grease ducts listed and labeled in accordance with UL 1978.

2.2 SEALING MATERIALS

A. Joint and Seam Sealants, General: The term sealant used here is not limited to materials of adhesive or mastic nature, but also includes combinations of tape sealants or open weave fabric strips and mastics. Joint sealants shall have fire and smoke hazard rating as tested by ASTM E-84, NFPA255, or UL 723 not to exceed: Flame spread 25; Smoke Develop 50. Exterior mastic sealant shall be certified to pass 500 hours QUV.

B. Tape Sealing System: Woven-fiber tape impregnated with a gypsum mineral compound and a modified acrylic/silicone activator to react exothermically with tape to form a hard, durable, airtight seal.

C. Joint and Seam Sealant: One-part, nonsag, solvent-release-curing, polymerized butyl sealant, formulated with a minimum of 60 percent solids.

D. Flanged Joint Mastics: One-part, acid-curing, elastomeric joint sealants, complying with ASTM C 920.

2.3 HANGERS AND SUPPORTS

A. Building Attachments: Concrete inserts, powder actuated fasteners, or structural steel fasteners appropriate for building materials.

B. Hangers: Galvanized sheet steel, or round, uncoated steel, threaded rod Sizes per SMACNA.

C. Duct Attachments: Sheet metal screws, blind rivets, or self-tapping metal screws.

D. Trapeze and Riser Supports: Steel shapes conforming to ASTM A 36.

2.4 FLEXIBLE DUCTS

A. Provide flexible ductwork of type and size as indicated and as specified below.

1. Low Pressure: Provide flexible ductwork meeting UL 181 Class I air duct, NFPA 90A and 90B requirements, rated for a minimum of 5000 FPM velocity and for a minimum of 10" w.g. pressure. Flexible duct shall have woven inner duct liner, providing an air seal, bonded to coated steel wire helix. Ducts shall have a minimum 1" thick, 1.5 lb density fiberglass insulation blanket and low permeability outer vapor barrier jacket. Fiberglass shall not be exposed to the air stream. Hart and Cooley NT25VM2 or equal.

2.5 RECTANGULAR DUCT FABRICATION

A. Fabricated rectangular ducts with galvanized sheet steel in accordance with SMACNA "HVAC Duct Construction Standards".

B. Crossbreaking or Cross Breading: As indicated in SMACNA "HVAC Duct Construction Standard," Figure 1-8.

C. Fabricate elbows, transitions, offsets, branch connections, and other duct construction in accordance with SMACNA "HVAC Metal Duct Construction Standard," 1985 Edition, Figures 2-1 through 2-10.

2.6 LOW PRESSURE ROUND DUCTWORK

A. Round Ducts: Fabricate round ducts with spiral lockseam construction, comply with SMACNA "HVAC Duct Construction Standards," Table 3-2 for galvanized steel gages.

B. 90-Degree Tees and Laterals and Conical Tees: Fabricate to conform to SMACNA "HVAC Duct Construction Standards," 1985 Edition, Figures 3-4 and 3-5 and with metal thickness specified for longitudinal seam straight duct.

C. Elbows: Fabricate in die-formed or mitered construction. Fabricate the bend radius of elbows 1.5 times the elbow diameter. Provide elbows meeting the following requirements:

1. Mitered Elbows fabricate as per SMACNA.
2. Round Elbows – 8 inches and Smaller: At installers option, in lieu of mitered elbows, provide die-formed elbows with welded construction.

D. Manufacturers: At installer's option, in lieu of shop-fabricated duct and fittings, and subject to compliance with requirements, provide factory-fabricated duct and fittings by one of the following or equal:

1. Semco Mfg., Inc.
2. United Sheet Metal Div., United McGill Corp.
3. Spiral Pipe of Texas.
4. LaPine Metal Products.
5. Eastern Sheet Metal, Inc.
6. Foremost.
7. Lindab.

2.7 CONSTRUCTION OF METAL DUCTWORK

A. Construction and Leakage: Provide ductwork constructed in accordance with SMACNA Duct Construction Standards but no less than the static pressure classification indicated below. Fabricate ductwork that will have less leakage than the percentage of system design air flow as indicated below. Test all ductwork for leakage, unless otherwise noted, in accordance with SMACNA "HVAC Air Duct Leakage Test Manual" and the following chart:

System	Duct. Const. Static Pressure Class.	SMACNA Seal Class.	% Leakage of System Design Air Flow	Testing Static Pressure
Supply Air Ductwork (Constant Volume)				
AHU to Diffusers	+ 3"	B	5%	+ 3"
Return Air Ductwork	- 3"	B	5%	+ 3"
Exhaust Air Ductwork	- 3"	B	5%	- 3"
Relief Air Ductwork	+ 1"	C	5%	*
Outside Air Ductwork	- 1"	C	5%	*
Transfer Air Ductwork	- ½"	C	5%	*
Supply Air Ductwork (Variable Air Volume)				
AHU to VAV Box	+ 6"	A	5%	+ 6"
VAV Box to Diffusers	+ 1"	C	5%	*

* No Testing Required

2.8 DUCT LEAKAGE TESTING

A. Provide duct leakage testing in accordance with SMACNA HVAC Air/Duct Leakage Test Manual.

B. Disassemble, reassemble, and seal segments of the systems as required to accommodate leakage testing, and as required for compliance with test requirements.

C. Remake leaking joints as required and apply sealants to achieve specified maximum allowable leakage.

D. Seal and leak test externally insulated ducts prior to insulation installation.

E. Provide Leakage Testing on ductwork located in inaccessible locations (underslab, in walls and chases, etc.) before final covering is performed.

2.9 SEAM AND JOINT SEALING

A. General: All duct work shall be suitably cleaned and prepared, and sealant applied in strict accordance with manufacturer's instructions. Seal duct seams and joints as follows:

1. Pressure Classifications Greater than 3 inches Water Gage: All transverse joints, longitudinal seams, and duct penetrations (SMACNA Seal Class A).
2. Pressure Classification 2 and 3 inches Water Gage: All transverse joints and longitudinal seams (SMACNA Seal Class B).
3. Pressure Classification Less than 2 inches Water Gage: Transverse joints only (SMACNA Seal Class C).

PART 3 – EXECUTION

3.1 DUCT INSTALLATION, GENERAL

A. Duct System Pressure Class: Construct and install each duct system for the specific duct pressure classification indicated.

B. Install ducts with the fewest possible joints.

C. Use fabricated fittings for all changes in directions, changes in size and shape, and connections.

D. Install couplings tight to duct wall surface with projections into duct at connections kept to a minimum.

E. Locate ducts, except as otherwise indicated, vertically and horizontally, parallel and perpendicular to building lines; avoid diagonal runs. Install duct systems in shortest route that does not obstruct usable space or block access for servicing building and its equipment.

F. Ducts located on roof shall be supported on manufactured supports, insulated, wrapped in aluminum weatherproof covering and anchored for wind resistance. Supports shall be manufactured of polypropylene, recycled rubber, polycarbonate or pliable polyethylene. Supports shall be a maximum of 10 foot intervals and within 2 feet of any change in directions.

1. Acceptable manufacturers:

a. Clearline Technologies "C-Port"
b. Miro Industries "Duct Supports."

G. Install ducts close to walls, overhead construction, columns, and other structural and permanent enclosure elements of building.

H. Provide clearance of 1 inch where furring is shown for enclosure or concealment of ducts, plus allowance for insulation thickness, if any.

I. Install insulated ducts with 1 inch clearance outside of insulation.

J. Conceal ducts from view in finished and occupied spaces by locating in mechanical shafts, hollow wall construction, or above suspended ceilings. Do not encase horizontal runs in solid partitions, except as specifically shown.

K. Coordinate layout with suspended ceiling and lighting layouts and similar finished work.

L. Electrical Equipment Spaces: Route ductwork to avoid passing through transformer vaults and electrical equipment spaces and enclosures.

M. Penetrations: Openings through floors and walls shall be minimum size to prevent excess space between structure and ductwork passing through openings. Where ducts pass through interior partitions and exterior walls, provide the following penetrations:

1. Where ducts penetrate interior partitions and are not exposed to view, seal space between opening and duct or duct insulation with fiberglass insulation.
2. Where ducts pass interior partitions and exterior walls, and are exposed to view, conceal space between construction opening and duct or duct insulation with sheet metal flanges of same gage as duct. Overlap opening on 4 sides by at least 1-1/2 inches. Seal space between opening and duct or duct insulation with fiberglass insulation.
3. Where ducts pass through fire-rated floors, walls, or partitions, provide fire dampers, in accordance with requirements.

N. Coordination: Coordinate duct installations with installation of accessories, dampers, coil frames, equipment, controls and other associated work of ductwork system. Install control dampers supplied by temperature Control Installer.

3.2 INSTALLATION OF FLEXIBLE DUCTS

A. General: Flexible ducts shall be used for alignment purposes only. Maximum offset 1” per foot length. No elbows using flexible ducts will be allowed. Ducts should not be compressed. The specifications herein, shall not supersede the application contingencies dictated by the flexible duct manufacturer if those are more stringent.

B. Installation: Flexible duct connections shall be made by applying duct sealer to inside of flexible duct and outside of hard duct collar. Adhesive shall be chemically compatible with materials in contact with it. The ends of ducts shall be trimmed squarely prior to installation. Collars and sleeves shall be inserted into flexible duct a minimum of 1” before fastening. Slide flex duct over collar and tape with three wraps of duct tape around joint and seal with stainless steel clamps over outside of tape.

1. High Pressure: Install at inlet connections of terminal units. Maximum developed length of flex duct shall be 3’-0”. Use metal ducts and fittings to reach within 3’-0” of terminal unit.
2. Low Pressure: Install where indicated on drawings and be a maximum of 5’-0” in length. Use metal duct and fittings to reach within 5’-0” of diffuser.

3.3 HANGING AND SUPPORTING

A. Install round and rectangular metal duct with support systems indicated in SMACNA “HVAC Duct Construction Standards,” Tables 4-1 through 4-3 and Figures 4-1 through 4-8.

B. Support horizontal ducts within 2 feet of each elbow and within 4 feet of each branch intersection.

C. Support vertical ducts at maximum interval of 16 feet and at each floor.

D. Upper attachments to structures shall have an allowable load not exceeding ¼ of the failure (proof test) load but are not limited to the specific methods indicated.

E. Supports: Support ducts rigidly with suitable ties, braces, hangers and anchors of type which will hold ducts true-to-shape and to prevent buckling. Support vertical ducts at every floor. Supports (hangers) shall be as per SMACNA.

3.4 CONNECTIONS

A. Equipment Connections: Connect metal ductwork to equipment as indicated, provide flexible connection for each ductwork connection to equipment mounted on vibration isolators, and/or equipment containing rotating machinery. Provide access doors as indicted. Refer to Section “Ductwork Accessories” for flexible connectors and access doors.

B. Branch Connections: Comply with SMACNA “HVAC Duct Construction Standards,” Figures 2-7 and 2-8.

C. Outlet and Inlet Connections: Comply with SMACNA “HVAC Duct Construction Standards.” Figures 2-16 through 2-18. Paint inside of ductwork with flat black paint to a point where bare metal or duct liner cannot be seen through grilles and registers.

D. Sealant: All duct work shall be suitably cleaned and prepared, and sealant applied in strict accordance with manufacturer’s instructions. Sealant shall be applied only after duct work has been installed. Manufacturers recommendations for cure time shall be followed before pressure testing is begun. Any additional paint or coatings must conform to manufacturers specifications.

3.5 ADJUSTING AND CLEANING

A. Clean ductwork internally, unit by unit as it is installed, of dust and debris. Clean external surfaces of foreign substances which might cause corrosive deterioration of metal or, where ductwork is to be painted, might interfere with painting or cause paint deterioration.

B. Temporary Closure: At ends of ducts which are not connected to equipment or air distribution devices at time of ductwork installation, provide temporary closure of polyethylene film or other covering which will prevent entrance of dust and debris until time connections are to be completed.

END OF SECTION 23 3113

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SECTION 23 3300 – DUCTWORK ACCESSORIES

PART 1 – GENERAL

1.1 QUALITY ASSURANCE

A. Comply with SMACNA.

B. Comply with ASHRAE.

C. Comply with NFPA 90A.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data for each type of ductwork accessory.

PART 2 – PRODUCTS

2.1 DAMPERS

A. General: Provide dampers of type and size indicated on drawings.

B. Volume Control Dampers: Provide dampers of single blade type or multiblade type construction. Use single blade for round dampers, minimum 20 gauge galvanized steel construction. Use single blade for square or rectangular dampers up to 11 inches in height. For larger than 11" in height use multi-leaf opposed blade dampers.

C. Backdraft Dampers: Provide counter balanced, parallel blade dampers with aluminum blades and frame. Provide non-ferrous pivot pins, nylon bearings and vinyl gaskets.

D. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

1. Air Balance.
2. Ruskin.
3. American Warming and Ventilating.
4. Greenheck.

2.2 REMOTE CABLE CONTROL FOR DAMPERS

A. General: Provide dampers of type and size indicated on drawings.

B. Balance dampers located in inaccessible spaces to be controlled with Bowden Remote Cable Assemblies, Model 270-275. Access to be concealed in the ceiling, inside plenums, or moved to a convenient area such as a nearby mechanical room or above a lay-in ceiling. A flexible casing and wire, model BCW, up to 50' long from a steel rack and pinion locking controller to a damper where the rotary motion of the rack and pinion controller is converted to a push-pull motion with a lever arm.

C. Round Damper model 5020CC or Rectangular Damper model 830ACC with opposed blades

D. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

A. Young Regulator Co.

2.3 STATIC FIRE DAMPERS

A. Locations and Selections: Fire dampers shall be installed in fire-rated walls and at each floor penetration where indicated. Fire dampers shall be selected to provide total duct free area. Exception: Units in air transfer openings shall have frame size that fits within opening indicated.

B. Types (Industry Designations): Provide Fire dampers that meet UL standard 555 Class III construction with a 1½ hour fire-resistant rating.

1. Type A – Curtain type blades stored within air stream, damper sleeve same width and height as air transfer opening.
2. Type B – Curtain type blades stored out of air stream within enclosure above duct, damper sleeve width same width as duct, blade guides are within air stream.
3. Type C – Curtain type blades stored and guides occur entirely out of air stream. Damper sleeves have duct collars on both sides of assembly.

C. Applications:

1. Type A shall be used in air transfer openings or ductwork only. Opening duct size indicated represents nominal outside frame dimensions of damper.
2. Type B shall be used in rectangular ducts where air velocities do not exceed 2500 fpm,based on CFM at duct opening divided by duct cross sectional area in square feet of duct at fire damper. Oversized Type A's will not be acceptable. Type C in this application is an acceptable Installer's option.
3. Type C shall be used in rectangular ducts where duct air velocity exceeds 2500 FPM, based on CRM at duct opening divided by duct cross sectional area in square feet of duct at fire damper and for all round and flat oval ducts.

D. Frame: Galvanized steel (in gauges required by manufacturer's UL listing).

E. Sleeve: Each damper shall be furnished complete with factory sleeve of length and gauge required for satisfactory installation.

F. Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer's UL listing.

G. Blades: Galvanized Curtain Style.

H. Closure Device: Fusible Link (replaceable).

2.4 DYNAMIC FIRE DAMPERS

A. Locations and Selections: Fire dampers shall be installed where indicated. Fire dampers shall be selected to provide total duct free area. Dynamic fire dampers only to be used with a smoke evacuation system and interconnected with the fan of the evacuation system.

B. Type: Provide Fire dampers that meet UL standard 555 Class III construction with a 1½ hour fire-resistant rating.

C. Differential Pressure: Dampers shall have a minimum UL 555 differential pressure rating of 4 in. wg.

D. Frame: Galvanized steel (in gauges required by manufacturer's UL listing).

E. Sleeve: Each damper shall be furnished complete with factory sleeve of length and gauge required for satisfactory installation.

F. Velocity: Dampers shall have a minimum UL 555 velocity rating of 2000 fpm.

G. Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer's UL listing.

H. Blades:

1. Galvanized Curtain Style.
2. Steel Vee-Blades with blades stops and jamb seals.

I. Closure Device: Fusible Link (replaceable).

2.5 SMOKE DAMPERS

A. Locations and Selections: Smoke dampers shall be installed where indicated. Smoke dampers shall be selected to provide total duct free area.

B. Type: Provide smoke dampers that meet UL standard 555S Class III construction.

C. Elevated Operational Temperature: Dampers shall have a UL 555S elevated temperature rating of 350º F.

D. Differential Pressure: Dampers shall have a minimum UL 555 differential pressure rating of 4 in. wg.

E. Frame: Galvanized steel (in gauges required by manufacturer's UL listing).

F. Sleeve: Each damper shall be furnished complete with factory sleeve of length and gauge required for satisfactory installation.

G. Velocity: Dampers shall have a minimum UL 555 velocity rating of 2000 fpm.

H. Retaining Angles: Damper shall be supplied with factory retaining angles sized to provide installation overlap in accordance with the manufacturer's UL listing.

I. Blades:

1. Steel Airfoil Blades.
2. Steel Vee-Blades with blades stops and jamb seals.

J. Linkage: Concealed in jamb.

K. Axles: Minimum ½" dia. Plated steel.

L. Bearings: Axle bearings shall be sintered bronze sleeve type rotating in polished extruded holes in damper frame.

M. Actuators: Electric, 120V AC, 2-position, fail close

2.6 MOTOR OPERATED FIRE/SMOKE DAMPERS

A. Locations and Selections: Combination fire/smoke dampers shall be installed where indicated. Combination fire/smoke dampers shall be selected to provide total duct free area.

B. Type: Provide combination fire/smoke dampers that meet UL standard 555S Class III construction with a 1½ hour fire-resistant rating.

C. Sleeve: Each combination fire/smoke damper shall be furnished complete with factory sleeve of length and gauge required for satisfactory installation, and with damper operator factory installed on exterior of sleeve and properly linked to damper operating shaft.

D. Operators: Fire damper shall operate using fusible link. Smoke operators shall be 120 VAC spring-return fail closed type that will close damper upon power interruption. Damper operators shall be UL listed as Fire Damper Operators, and shall bear appropriate UL Fire Damper Operator label. Damper shall close upon a 24 VDC signal from zone smoke detector and reopen upon manual reset of smoke detector.

2.7 TURNING VANES

A. Provide fabricated or manufactured turning vanes and vane runners as per SMACNA.

2.8 DUCT HARDWARE

A. Provide duct hardware, manufactured by one manufacturer for all items on project, for the following:

1. Test Holes: Provide in ductwork at fan inlet and outlet, and elsewhere as indicated, duct test holes, consisting of slot and cover, for instrument tests.
2. Quadrant Locks: Provide for each damper, quadrant lock device on one end of shaft; and end bearing plate on other end for damper lengths over 12”. Provide extended quadrant locks and end extended bearing plates for externally insulated ductwork.

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

1. Ventfabric.
2. Venlok.
3. Young Regulator.

2.9 DUCT ACCESS DOORS

A. General: Provide duct access doors constructed of same or greater gage as ductwork served. Provide insulated doors with 1” thick insulation and solid sheet metal liner for insulated ductwork. Provide flush frames for uninsulated ductwork, extended frames for externally insulated duct. Provide one side hinged, other side with one cam type latch for doors 16” high and smaller, 2 cam type latches for larger doors. Access doors shall be as large as possible to fit ductwork using manufacturer’s standard sizes.

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

1. Air Balance.
2. Duro Dyne.
3. Vent Products.
4. Ruskin.
5. Ventfabrics.

2.10 PRESSURE RELIEF DOORS

A. Pressure relief doors designed to open automatically to prevent exploding or imploding ductwork in the event dampers close while fan is still operating. Doors to open outward (positive) or inward (negative) at a specified pressure setting relieving or supply pressure within the duct to equalize the pressure.

B. Furnish and install, at locations shown on plans or in accordance with schedules, pressure relief doors that meet the following minimum specifications. Frames shall be Z-shape 12 gage galvanized steel. Door shall be 12 gage galvanized steel hinged on one side. Seal shall be around the door perimeter allowing no more than 7 CFM per sq. foot at 1.0 inch w.g. Leakage and relief volume information must be included in submittals. Door shall include stainless steel springs to close door upon pressure relief and system shutdown. All release mechanisms springs and parts shall be completely out of airstream. Pressure relief settings available from 2" to 10" increments of 1" w.g.. Pressure relief mechanism shall be fatory calibrated in an AMCA Registered Laboratory.

C. Based on Ruskin Model RPD18 (Positive) and NRD18 (Negative) Pressure Relief Doors

2.11FLEXIBLE CONNECTIONS

A. Provide flexible duct connections wherever ductwork connects to vibration isolated equipment. Construct flexible connections of neoprene-coated flameproof fabric crimped into duct flanges for attachment to duct and equipment. Make airtight joint. Provide adequate joint flexibility to allow for thermal, axial, transverse, and torsional movement, and also capable of absorbing vibrations of connected equipment.

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

1. American/Elgen.
2. Duro Dyne.
3. Flexaust.
4. Ventfabrics.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install ductwork accessories in accordance with manufacturer's installation instructions, with applicable portions of details of construction as shown in SMACNA standards, and in accordance with recognized industry practices to ensure that products serve intended function.

B. Install turning vanes in square or rectangular 90 ° elbows.

C. Provide access doors in ductwork for proper access to all instruments, duct mounted coils, dampers, controls, air monitor devices (upstream) and equipment, and for convenient inspection, maintenance and replacement of same.

D. Coordinate with other work, including ductwork, as necessary to interface installation of ductwork accessories properly with other work.

E. Operate installed ductwork accessories to demonstrate compliance with requirements. Test for air leakage while system is operating. Repair or replace faulty accessories, as required to obtain proper operation and leak proof performance.

F. Install [backdraft] [control] dampers at inlet of exhaust fans or exhaust ducts as close as possible to exhaust fan unless otherwise indicated

G. Install duct access doors on sides of ducts to allow for inspecting, adjusting, and maintaining accessories and equipment at the following locations:

1. At each change in direction and at maximum 50-foot (15-m) spacing.

2. Upstream [and downstream] from turning vanes.

END OF SECTION 23 3300

SECTION 23 3423 – POWER VENTILATORS

PART 1 – GENERAL

1.1 QUALITY ASSURANCE

A. Comply with AMCA.

B. Comply with UL.

1.2 SUBMITTALS

A. Product data for selected models, including specialties, accessories, certified fan performance curves, certified fan sound power ratings, motor ratings and electrical characteristics, maintenance data, materials gages and finishes.

PART 2 – PRODUCTS

2.1 VENTILATORS

A. General: Except as otherwise indicated, provide standard prefabricated ventilator units of type and size indicated, modified as necessary to comply with requirements, and as required for complete installation.

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

1. Cook
2. Greenheck
3. Penn
4. Acme

2.2 INLINE VENTILATORS (EXHAUST FANS)

A. General; Provide centrifugal inline fans of size and capacity as scheduled and as scheduled and as specified herein.

1. Type: Centrifugal fan, belt driven. Galvanized housing backward inclined aluminum wheel and access panels.
2. Bearing and drive components are to be isolated from the airstream.
3. Electrical: Provide factory-wired non-fusible type disconnect switch at motor in fan housing. Provide thermal overload protection in fan motor for single phase motors. Provide conduit chase within unit for electrical connection.
4. Dampers: Provide motor-actuated dampers.
5. Fan to be provided with vibration isolators.
6. Kitchen fans to be U.L. 762 listed and provided with drain, heat shield and access door for cleaning.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install ventilators level and plumb in accordance with manufacturer's installation instructions.

B. Install with flexible connections between inline exhaust fan and ductwork. Refer to Division 23 section "Ductwork Accessories".

C. Coordinate ventilator work with work of roofing, as necessary for proper interfacing.

D. Ensure that power ventilators are wired properly, with correct motor rotation, and positive electrical motor grounding.

E. Remove shipping bolts and temporary support within ventilators. Adjust dampers for free operation.

END OF SECTION 23 3423

SECTION 23 3600 – TERMINAL UNITS

PART 1 – GENERAL

1.1 DESCRIPTION OF WORK

A. Extent of terminal unit work is indicated by drawings and schedules, and by requirements of this section.

B. Types of terminal units required for project include the following:

1. Hot Water Cabinet Heaters.
2. Radiant Ceiling Panels.
3. Hot Water Unit Heaters.

1.2 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Firms regularly engaged in manufacture of terminal units, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Codes and Standards

1. I=B=R Compliance: Test and rate baseboard and finned tube radiation in accordance with I=B=R, provide published ratings bearing emblem of I=B=R.
2. ASHRAE Compliance: Test coils in accordance with ASHRAE Standard 33 "Methods of Testing Forced Circulation Air Cooling and Heating Coils".
3. ARI Compliance: Provide coil ratings in accordance with ARI Standard 410 "Forced-Circulation Air-Cooling and Air-Heating Coils".
4. UL Compliance: Provide electrical components for terminal units which have been listed and labeled by UL.

1.3 SUBMITTALS

A. Submit manufacturers' technical product data, installation and start-up instructions, piping and wiring diagrams, and maintenance data all in accordance with the requirements of division 1.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. Hot Water Cabinet Heaters:

a. Trane.
b. Sterling.
c. Vulcan.
d. McQuay.
e. American Air Filter.
f. Rittling.
g. Dunham-Bush.

2. Radiant Ceiling Panels:

    a. Aero Tech Manufacturing, Inc..
    b. Airtex.
    c. Sun-El Corporation

3. Hot Water Unit Heaters:

    a. Trane.
    b. Sterling.
    c. Vulcan.
    d. McQuay.
    e. American Air Filter.
    f. Rittling.
    g. Dunham-Bush.

2.2 HOT WATER CABINET HEATERS

A. General: Provide cabinet heaters having cabinet sizes and in locations as indicated, and of capacities, style, and having accessories as scheduled. Include in basic unit chassis, coil, fanboard, fan wheels, housings, motor, insulation, filters and speed control switch.

B. Chassis: Galvanized steel wrap-around structural frame with edges flanged.

C. Insulation: Faced, heavy density glass fiber.

D. Cabinet: Decorated cabinets with 16-ga removable front panel with insulation over entire coil section. Provide access door on coil connection side. Clean cabinet parts, bonderize, phosphatize, and coat with baked-on enamel primer. Provide ceiling hung units with safety chains.

E. Water Coils: Construct of 5/8” seamless copper tubes mechanically bonded to configurated aluminum fins. Design for 300 psi and leak test at 300 psi. Provide same end connections for supply and return.

F. Fans: Provide centrifugal, forward curved double width fan wheels constructed of non-corrosive, molded, fiberglass-reinforced thermo-plastic material. Construct fan scrolls of galvanized steel.

G. Motors: Provide shaded pole motors with integral thermal overload protection, and motor cords for plug-in to junction box in unit.

H. Filters: Provide 1” thick throwaway type filters in fiberboard frames.

2.3 HOT WATER CEILING RADIANT PANELS

A. General: Provide radiant ceiling module and linear panels of length, size and in locations as indicated, and of capacities, style and having accessories as scheduled.

B. Linear Radiant Panels: extruded aluminum fluted face plate with white finish, ½” I.D. copper tubes with integral heat saddle extending more than half way around tube with tube mechanically formed such that tube is in intimate contact with saddle. The use of adhesive or clips to attach the copper to the extrusion will not be acceptable.

2.4 HOT WATER UNIT HEATERS

A. General: Provide unit heaters in locations as indicated, and of capacities, style, and having accessories as scheduled.

B. Horizontal Discharger Unit Heaters: Construct casings of steel and finish with baked enamel. Fabricate casing to enclose coil, louvers, and fan blades. Provide louvers for 4-way air diffusion. Construct fans of aluminum, and factory-balance. Provide fan inlet orifice, smooth, and drawn into casing back panel.

C. Vertical Discharge Unit Heaters: Construct casings of steel, and finished with baked enamel. Design casing to enclose fan, motor, and coil, design fan orifice formed into discharge panel. Construct fans of aluminum and factory-balance. Design so motor and fan assembly is removable through fan outlet panel.

D. Coils: Construct of plate-type aluminum fins, mechanically bonded to copper tubes. Design coil for use in hot water applications.

E. Motors: Provide totally enclosed motors, with built-in overload protection, having electrical characteristics as scheduled.

PART 3 – EXECUTION

3.1 INSTALLATION OF HOT WATER CABINET HEATERS

A. Install cabinet heaters as indicated, and in accordance with manufacturer's installation instructions. Locate as indicated, coordinate with other trades to assure correct recess size for recessed units. Install piping as indicated. Protect units with protective covers during balance of construction.

3.2 INSTALLATION OF HOT WATER CEILING RADIATION PANELS

A. Install radiant ceiling panels as indicated, and in accordance with manufacturer's installation instructions. Manufacturer shall provide all special tools required for installation or modification of panels, and piping required to interconnect linear panel sections. Hangers shall be installed not over 3'-0" on center. Entire installation shall take into consideration the expansion of panels during operation. Provide 1" thick, ¾ pound density fiberglass insulation on the entire back of the panel. Cut insulation blanket to pass around the suspension wires and interconnecting piping. Make sure that the blanket abuts the adjacent blanket tightly. Manufacturer shall provide pigtail type expansion compensating connection at each point where panel piping ties into hot water heating piping system. If radiant ceiling panel is installed in an exposed location, provide a trim piece to hide insulation located on top of panel from view.

3.3 INSTALLATION OF HOT WATER UNIT HEATERS

A. Install unit heaters as indicated, and in accordance with manufacturer's installation instructions. Verify that nameplate data corresponds with unit designation. Hang units from building substrate, not from piping. Mount as high as possible to maintain greatest headroom possible unless otherwise indicated. Support units with rod-type hangers anchored to building substrate. Provide sway-brace where required. Install piping as indicated. Protect units with protective covers during balance of construction.

3.4 ADJUSTMENT AND CLEANING OF TERMINAL UNITS

A. General: After construction is completed, including painting, clean unit exposed surfaces, vacuum clean coils and inside of cabinets.

B. Retouch any marred or scratched surfaces of factory-finished cabinets, using finish materials furnished by manufacturer.

C. Install new filter units for terminals requiring same.

END OF SECTION 23 3600

SECTION 23 3616 – VAV BOXES

PART 1 – GENERAL

1.1 SUMMARY

A. Section includes variable and constant volume VAV boxes.

B. Related Sections: The following Sections contain requirements that relate to this section:

1. Division 23 Section “Basic Mechanical Materials and Methods”

2. Division 23 Section “Hydronic Piping”

3. Division 23 Section “Metal Ductwork”

4. Division 23 Section “Ductwork Accessories”

5. Division 23 Section ”Temperature Controls”

6. Division 23 Section “Sequence of Operation”

7. Division 23 Section “Testing, Adjusting and Balancing”

1.2 VAV BOX SYSTEM DESCRIPTION

A. General Requirements: Provide VAV boxes which are:

1. Pressure independent and able to reset to any airflow between 0 and maximum cataloged cfm; VAV Boxes using cfm limits are not acceptable.

2. Capable of morning warm-up operating control sequence incorporating maximum airflow in response to call for heat.

3. Factory furnished and mounted CFM reset controller and actuator. (Direct acting thermostat by Temperature Controls Contractor).

B. Design and Performance Requirements: Comply with the following:

1. Casing Leakage:Construct casings such that when subjected to 0.5-in w.g. pressure for low pressure units, and 3.0-in w.g. pressure for high pressure units, total leakage is less than 4 percent of scheduled air flow capacity with outlets sealed and inlets full open.

2. Air Valve Leakage: Construct air dampers such that when subjected to 6.0-in w.g. inlet pressure with damper closed, total leakage does not exceed 10 percent of specified air flow capacity.

3. Noise Levels: Not to exceed NC 35 in spaces served for all inlet velocities up to 2000 fpm.

1.3 SUBMITTALS

A. Product Data: Submit manufacturer’s technical product data, including performance data for each size and type of air terminal furnished; schedule showing drawing designation, room

location, number furnished, model number, size, and accessories furnished; and installation and start-up instructions.

B. Shop Drawings: Submit manufacturer's assembly-type shop drawings indicating dimensions, weight loadings, required clearances, and methods of assembly of components.

C. Wiring Diagrams: Submit ladder-type wiring diagrams for power and control components, clearly indicating required field connections.

D. Maintenance Data: Submit maintenance data and parts list for each type of air terminal including "trouble-shooting" maintenance guide. Include this data, product data, shop drawings, and maintenance data in maintenance manual; in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

A. Comply with ADC.

B. Comply with ARI.

1.5 DELIVERY, STORAGE AND HANDLING

A. Deliver, store and handle VAV Boxes according to manufacturer's recommendations.

B. Store VAV Boxes on elevated platforms in a dry location.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

A. Subject to compliance with requirements, provide VAV Boxes by one of the following:

1. Price
2. Titus
3. Trane
4. Tuttle and Bailey

2.2 VAV TERMINAL UNITS

A. General: Provide pressure independent factory-fabricated and tested variable volume and constant volume VAV Boxes as indicated, with performance characteristics as scheduled.

B. Casings: Fabricate of minimum 24 gage galvanized sheet metal. Comply with the following:

1. Supports: Provide hanger brackets for attachment of supports.
2. Double-Wall Casings: Provide minimum ½-inch thick insulation fill in space between outer wall and inner liners to provide acoustic performance, thermal insulation, and condensation protection. Seal all 90 corners and leading and trailing edges of solid inner liner from airstream using galvanized sheet metal.
3. Access: Provide removable panels for access to air dampers and other serviceable parts.

C. Sensors: Provide multipoint averaging pitot tube sensing element (single point sensing is not acceptable), located at inlet of assembly and designed to average the flow across inlet.

D. Air Dampers: Construct of non-corroding materials requiring no lubrication or periodic servicing. Provide with factory-mounted damper actuator. Coordinate with Temperature Control Contractor for DDC interface.

E. Identification: Label each unit indicating equipment Mark/Tag Number, cfm range, cfm factory-setting, and calibration curve.

F. Hot Water Heating Coils: Provide where indicated and as scheduled two-row heating coils constructed of copper tubes and aluminum fins with galvanized steel casing.

G. Control Disconnect: Provide non-fused switch capable of breaking both legs of control power to box DDC control module; for field mounting by temperature control Installer.

PART 3 – EXECUTION

3.1 INSTALLATION

A. Install units as indicated, and in accordance with manufacturer's installation instructions.

B. Install each unit level and accurately in position indicated in relation to other work; and maintain sufficient clearance for normal service and maintenance, but in no case less than that recommended by manufacturer.

C. Connect ductwork to VAV Boxes in accordance with Division 23 ductwork section.

D. Connect heating hot water piping to VAV Box in accordance with Division 23 Piping Sections. Install heating coil control valve furnished by Control Vendor.

E. Upon completion of installation and prior to initial operation, test and demonstrate that VAV Boxes, and duct connections to VAV Boxes, are leak-tight.

F. Repair or replace VAV Boxes and duct connections as required to eliminate leaks, and retest to demonstrate compliance.

G. Clean expose factory-finished surfaces. Repair any marred or scratched surfaces with manufacturers touch-up paint.

END OF SECTION 23 3616

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SECTION 23 3713 – AIR OUTLETS AND INLETS

PART 1 – GENERAL

1.1 QUALITY ASSURANCE

A. Comply with ADC.

B. Comply with ARI Standard 650.

C. Comply with AMCA Standard 500.

D. Comply with NFPA 90A, and 90B.

1.2 SUBMITTALS

A. Submittals: Submit manufacturer's technical product data, assembly-type shop drawings, and maintenance data.

PART 2 – PRODUCTS

2.1 GRILLES, REGISTERS, AND DIFFUSERS, GENERAL

A. General: Except as otherwise indicated, provide manufacturer's standard grilles, registers and diffusers where shown; of size, shape, capacity and type indicated; constructed of materials and components as indicated, and as required for complete installation.

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

1. Titus.
2. Price.
3. Krueger.
4. Tuttle and Bailey.
5. Anemostat.

2.2 CEILING AIR DIFFUSERS

A. Performance: Provide ceiling air diffusers that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

B. Ceiling Compatibility: Provide diffusers with border styles that are compatible with adjacent ceiling systems, and that are specifically manufactured to fit into ceiling module with accurate fit and adequate support. Refer to general construction drawings and specifications for types of ceiling systems which will contain each type of ceiling air diffuser.

C. Types: Provide ceiling diffusers of type, capacity, and with accessories and finishes as listed on diffuser schedule. The following requirements shall apply:

1. Diffuser faces:

a. Square: Square housing; core of square concentric louvers, stamped, not mitered; square or round duct connection.

b. Linear Slot: Linear slot diffusers shall have lengths, number of slots and widths as scheduled on drawings.

2. Diffuser Mountings:

a. Surface: Diffuser housing at ceiling surface with perimeter flange and gasket to seal against ceiling.
b. Lay-In: Diffuser housing sized to fit between ceiling exposed suspension tee bars and rest on top surface of tee bar.
c. End of Duct: Diffuser exposed, attached to the end of the duct.
d. Plenum: Slot Diffuser exposed, attached to bottom of plenum. Plenum shall have ¼-inch thick, 2-pound density internal insulation.

3. Diffuser Patterns:

a. 2 Way: Fixed louver face for 2 direction air flow, directions indicated on drawings.
b. 4 Way: Fixed louver face for 4 direction air flow, directions indicated on drawings.

4. Diffuser Dampers:

a. Opposed Blade: Adjustable opposed blade damper assembly, key operated from face of diffuser.

5. Diffuser Finishes:

a. White Enamel: Semi-gloss white enamel finish.

2.3 REGISTERS AND GRILLES

A. Performance: Provide registers and grilles that have, as minimum, temperature and velocity traverses, throw and drop, and noise criteria ratings for each size device as listed in manufacturer's current data.

B. Compatibility: Provide registers and grilles with border styles that are compatible with adjacent construction, and that are specifically manufactured to fit into construction with accurate fit and adequate support. Refer to general construction drawings and specifications for types of construction which will contain each type of register and grille.

C. Types: Provide registers and grilles of type, capacity, and with accessories and finishes listed on register and grille schedule. The following requirements shall apply:

1. Register and Grille Materials

a. Steel Construction: Manufacturer's standard stamped sheet steel frame and adjustable blades.
b. Aluminum Construction: Manufacturer's standard extruded aluminum frame and adjustable blades.

2. Register and Grille Dampers

a. Opposed Blade: Adjustable opposed blade damper assembly, key operated from face of register.

3. Register and Grille Finishes

a. White Enamel: Semi-gloss white enamel finish.

2.4 LOUVERS

A. Provide manufacturer's standard drainable blade type louvers where shown. Louvers shall be of the size, shape and capacity as indicated. Provide louvers that have maximum free area, and minimum pressure drop as listed in manufacturer's current data. Louvers shall be provided with frame and sill styles that are compatible with adjacent structure and that are specifically manufactured to fit into construction openings with an accurate fit and an adequate support, for weatherproof installation. Refer to general construction drawings and specifications for types of substrate which will contain each type of louver. Materials include Aluminum extrusions, ASTM B 221, Alloy 6063-T5

B. Minimum 0.081-inch thick material for the frame and blades with weld or stainless steel fasteners.

C. Screens: ½-inch square mesh, .051-inch diameter aluminum wire, mounted in removable extruded aluminum frames mounted on rear side of louver.

D. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

a. American Warming and Ventilating (AWV).
b. Greenheck.
c. Louvers and Dampers.
d. Ruskin.

2.5 ROOF HOODS

A. Bird Screening: Aluminum, ½-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire.

B. Provide manufacturer's standard exhaust ventilator for where shown. Ventilator shall be of the size, shape and capacity as indicated. Provide ventilators that have low hood heights, and minimum pressure drop

C. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

a. Cook.
b. Greenheck.

2.6 GOOSENECKS

A. Bird Screening: Aluminum, ½-inch- (12.7-mm-) square mesh, 0.063-inch (1.6-mm) wire.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General: Install outlets and inlets in accordance with manufacturer's written instructions and in accordance with recognized industry practices to insure that products serve intended functions.

B. Coordinate with other work, including ductwork and duct accessories, as necessary to interface installation of air outlets and inlets with other work.

C. Locate ceiling air diffusers, registers, and grilles, as indicated on general construction drawings. Unless otherwise indicated, locate units in center (in two directions) of acoustical ceiling modules.

END OF SECTION 23 3713

SECTION 23 5100 – BREECHINGS, CHIMNEYS, AND STACKS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification sections, apply to work of this section.

1.2 SUMMARY

A. This Section specifies double wall metal vents and accessories for gas-fired appliances.

B. Related Sections: The following sections relate to this section:

1. Section 235200 - Boilers.
2. Section 223400 – Water Heaters.

1.3 SUBMITTALS

A. Product Data: Submit product data including materials, dimensions, weights, and accessories.

B. Shop Drawings: Submit shop drawings including required clearances, assembly and installation instructions, and support of components.

C. Quality Control Submittals:

1. Certificates: Submit certificates of materials compliance with specified ASTM, UL, and ASHRAE requirements.

1.4 QUALITY ASSURANCE

A. Codes and Standards:

1. UL: Comply with applicable portions of UL safety standards; provide products which have been UL listed and labeled.

PART 2 – PRODUCTS

2.1 TYPE AL29-4C GAS VENTS

A. General: Provide Type AL29-4C gas vents for hydronic boilers and water heaters.
B. Description: Double wall gas vents, UL listed for category IV Type AL29-4C, consisting of an inner pipe of stainless steel, and outer pipe of aluminized sheet steel, with the following minimum thickness:

Size	Inner Pipe	Outer Pipe
Round, up to 6”	0.015”	0.018”
Round, 6 to 12	0.015”	0.018”
Round, 14 to 24	0.024”	0.024”

C. Accessories: UL-labeled tees, elbows, increasers, draft hood connectors, metal cap with bird barrier, adjustable roof flashing, storm collar, support assembly, thimbles, fire stop spacers, and fasteners, fabricated of similar materials and designs as vent pipe straight sections.

2.2 TYPE B GAS VENTS

A. General: Provide type B vents for the combustion air intakes for boilers and water heaters.

B. Description: Double-wall gas vents comply with NFPA 211, Type B. Inner pipe of sheet aluminum, outer pipe of a galvanized-steel sheet, each with the following minimum thickness.

1. Round, 6-inch and Smaller ID: 0.012-inch inner pipe, 0.0187-inch outer pipe.
2. Round, 7- to 18- inch ID: 0.014-inch inner pipe, 0.0187-inch outer pipe.
3. Round, 20- to 24-inch ID: 0.018-inch inner pipe, 0.0217-inch outer pipe.

C. Accessories: Tees, elbows, increasers, draft hood connectors, metal cap with bird barrier, adjustable roof flashing, storm collar, support assembly, thimbles, firestop spacers, and fasteners, fabricated of similar materials and designs as vent-pipe straight sections.

D. Available Manufacturers: Subject to compliance with requirements, provide products by one of the following or equal:

1. Selkirk Metalbestos.
2. Metal-Fab Inc.
3. Heat-Fab Inc.
4. Schebler Chimney Systems

PART 3 – EXECUTION

3.1 INSTALLATION OF DOUBLE WALL CONNECTORS, BREECHINGS, AND VENTS

A. Install gas vents in accordance with manufacturer's installation instructions and UL listing. Maintain minimum clearances from combustibles specified in UL listing.

B. Seal joints between sections of positive pressure vents in accordance with manufacturer's installation instructions, and using only sealants recommended by manufacturer.

C. Support vents at intervals recommended by the manufacturer to support weight of the vent and all accessories, without exceeding loading of appliances.

D. Use fittings for all changes in direction.

E. Provide suitable rain cap at the stack outlet. Provide necessary flanges and special fittings for installation.

3.2 ADJUSTING AND CLEANING

A. Clean breechings during installation, to remove dust and debris.

3.3 PROTECTION

A. Temporary Closure: At ends of breechings and chimneys which are not completed or connected to equipment, provide temporary closure which will prevent entrance of dust and debris until installations are completed.

END OF SECTION 23 5100

SECTION 23 5200 – BOILERS

Part 1 – General

1.1 WORK INCLUDED

A. Furnish all labor, materials, tools, and equipment; furnish and install complete and in place all the boiler-burner units and associated accessories as indicated on the drawings, specified herein, and as required for a complete and operable installation. Items required for this work are as follows:

1. Boiler Burner Units.

1.2 RELATED WORK

A. Section 23 5100 – For breechings, and stacks.

B. All related sections of this Division.

1.3 SUBMITTALS

A. Submittals: Submit manufacturer's technical data, installation and start-up instructions, piping and wiring diagrams, and maintenance data; in accordance with requirements of Division 1.

1.4 QUALITY ASSURANCE

A. System shall be in accordance with all codes and authorities having jurisdiction, including Owner's Insurance Company.

B. All components shall be furnished and assembled by one manufacturer.

C. Comply with ASME Boiler Code and all local and state codes.

Part 2 – Products

2.1 ACCEPTABLE MANUFACTURERS (COPPER FIN BOILERS)

A. Lochinvar

B. Patterson-Kelley

C. Thermal Solutions.

2.2 COPPER FIN BOILERS

A. The boilers shall be of the copper fin type. The unit shall be constructed in accordance with ASME requirements for low pressure heating boilers and all local and State codes and shall bear the ASME symbol, AGA seal of approval for gas fired units, and IBR rating. The entire unit shall be factory assembled, pre-wired and tested.

B. Each module shall be constructed of 16 gauge steel jacket material, and protected with a baked enamel or epoxy finish. The water containing section shall be of copper, fin-tube construction employing straight, solid 7/8" I.D. copper tubes having extruded integral fins. Tubes shall be set vertically and "rolled" securely into headers forming the top and bottom of the heat exchanger. The heat exchanger shall be circular in pattern and shall completely surround combustion

chamber for maximum efficiency. The entire heat exchanger shall carry a five (5) year limited warranty against failure caused by defective workmanship or material.

C. The boiler shall bear the ASME “H” stamp and shall be National Board listed for 160 PSI working pressure. Boiler shall be test certified at minimum 85% thermal efficiency.

D. Each module shall be arranged for natural gas fuel, fan assisted firing, and as follows:

1. The combustion chamber shall be of the sealed combustion type. The fan assisted burner shall be fired in a vertical plane within the combustion chamber. The burner will fire in a full 360 degree pattern.

2. Gas burner assembly shall include shutoff cock, gas pressure regulator, automatic safety and operating gas valves, and interrupted type pilot system with electric spark-to-pilot ignition.

3. Entire assembly shall meet Owner’s insurance company requirements. Provide additional controls devices, wiring and piping as required.

4. Standard operating controls and equipment shall include a spark ignition device, operating temperature limit and adjustable manual reset safety limit, and low pressure gas switch.

5. The entire control sequence shall be monitored with indicating lights.

E. Control panel shall contain the control transformer and other components. Panel factory assembled and wired.

F. Boiler shall have a UL approved microprocessor based integrated burner flame safeguard control.

G. Units shall be equipped with the following devices mounted on the boiler:

1. Water flow switch.

2. Air flow switch.

3. Pressure and temperature gauge.

4. ASME pressure relief valves with capacity not less than the boiler input. Pipe to floor drain.

H. Venting

1. Units shall utilize an approved stainless steel venting system and components for cold-start condensate. Exhaust venting shall be constructed of AL-29-4C.

2. Refer to Section 235100 – Breechings, Chimneys and Stacks.

PART 3 – EXECUTION

3.1 INSPECTION

A. Examine the areas and conditions under which work of this section will be performed. Correct conditions detrimental to the proper and timely completion of the work. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Advise all parties concerned as to the proper size and shape and location of all necessary housekeeping concrete bases, openings for piping, breechings, stacks, rough-in for electric and temperature control, etc.

B. Coordinate with affected contractors in regard to openings to be left in construction to allow for equipment to be set in place in a timely manner without interrupting construction schedule.

3.3 INSTALLATION

A. Units shall be installed level and plumb and grouted, if necessary. The units shall be installed to prevent vibration or other noise from being transmitted to the building and shall be free from rattles, squeaks, etc. that may cause a disturbance within the building.

B. Pipe all drain lines and relief valve discharges to nearest floor drain. Use Schedule 40 black steel with matching fittings. Pitch piping to drain.

C. Pipe all gas pressure regulator vents to outside of building.

D. Furnish and install isolating shutoff valves on all water and gas connections to each boiler module.

E. Arrange and support all piping so that it is totally supported by its hangers and is not creating any undue strain on the units.

F. Coordinate with electrical contractor to ensure provision of all necessary controls per State of Michigan/ASME CSD-1, including emergency shut down controls. Electrical shall provide a manually operated remote shutdown switch or circuit breaker located outside the boiler room door and marked for easy identification. The emergency shutdown switch or circuit breaker must disconnect all power to burner controls.

3.4 FIELD QUALITY CONTROL

A. Maintain units in clean condition at all times. Totally protect from the elements all equipment when in storage in the field prior to and after installation.

B. Do not use equipment for temporary service during construction until piping systems and associated equipment are properly flushed and cleaned.

C. Start and maintain water treatment systems as soon as flushing and cleaning is completed, and systems are initially filled with water.

D. At completion of work clean up all equipment, remove unneeded shipping labels, and touch up and repair all scratches, dents, etc.

E. Provide the services of a competent factory representative to supervise the on-the-job check, test, start-up and operator training. Start-up for the Contractor shall not be construed as start-up and training of the Owner's operating personnel. Provide copy of factory start up report to project engineer.

F. Materials of construction for the air intake and venting systems must comply with the boiler manufacturers AGA certification.

END OF SECTION 23 5200

SECTION 23 6423 – AIR COOLED SCROLL WATER CHILLERS

PART 1 – GENERAL

1.1 SCOPE

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this section.

B. Requirements of the following Division 23 Sections apply to this section:

1. “Basic Mechanical Requirements”.

2. “Basic Mechanical Materials and Methods”.

C. Provide Microprocessor controlled, multiple-scroll compressor, air-cooled, liquid chillers of the scheduled capacities as shown and indicated on the Drawings, including but not limited to:

1. Chiller package
2. Electrical power and control connections
3. Chilled water connections
4. Factory start-up
5. Charge of refrigerant and oil

1.2 QUALITY ASSURANCE

A. Products shall be Designed, Tested, Rated and Certified in accordance with, and installed in compliance with applicable sections of the following Standards and Codes:
1. ANSI/ASHRAE Standard 15 – Safety Code for Mechanical Refrigeration
2. ASHRAE 90.1 – Energy Efficiency compliance.
3. ANSI/NFPA Standard 70 – National Electrical Code (NEC).
4. ASME Boiler and Pressure Vessel Code, Section VIII, Division 1.
5. ARI Standard 550/590 – Positive Displacement Compressors and Air Cooled Rotary Screw Water-Chilling Packages.
6. Conform to Intertek Testing Services, formerly ETL, for construction of chillers and provide ETL/cETL Listing label.
7. Manufactured in facility registered to ISO 9002.
8. OSHA – Occupational Safety and Health Act

B. Factory Test: Chiller shall be pressure-tested, evacuated and fully charged with refrigerant and oil, and shall be factory operational run tested with water flowing through the vessel.

C. Chiller manufacturer shall have a factory trained and supported service organization that is within a 50 mile radius of the site.

D. Warranty: Manufacturer shall Warrant all equipment and material of its manufacture against defects in workmanship and material for a period of one year from date of initial start-up or eighteen (18) months from date of shipment, whichever occurs first.

E. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 – “Heating, Ventilating, and Air-Conditioning.”

1.3 MANUFACTURERS

A. Available Manufacturers: Subject to compliance with requirements, provide products by:
   a. York
   b. Trane
   c. McQuay

1.4 DELIVERY AND HANDLING

B. Unit shall be delivered to job site fully assembled and charged with refrigerant and oil by the Manufacturer.

C. Unit shall be stored and handled per Manufacturer's instructions.

D. Protect the chiller and its accessories from the weather and dirt exposure during shipment.

E. During shipment, provide protective covering over vulnerable components. Fit nozzles and open ends with plastic enclosures.

1.5 SUBMITTALS

A. Submit shop drawings indicating components, assembly, dimensions, weights and loadings, required clearances, and location and size of field connections. Indicate valves, strainers, vents, and thermostatic valves required for complete system.

B. Submit product data indicating rated capacities, weights, specialties and accessories, electrical requirements, and wiring diagrams.

1.6 OPERATION AND MAINTENANCE DATA

A. Include manufacturer's descriptive literature, start-up instructions, and maintenance procedures.

PART 2 – PRODUCTS

2.1 CHILLER MATERIALS AND COMPONENTS

A. General: Install and commission, as shown on the schedules and plans, factory assembled, charged, and tested air cooled scroll compressor chiller(s) as specified herein. Chiller shall be designed, selected, and constructed using a refrigerant with Flammability rating of "1", as defined by ANSI/ASHRAE STANDARD - 34 Number Designation and Safety Classification of Refrigerants. Chiller shall include, but is not limited to: a complete system with a single refrigerant circuit 35 tons (123kW) and below, and not less than two refrigerant circuits above 35 tons (123kW), scroll compressors, direct expansion type evaporator, air-cooled condenser, refrigerant, lubrication system, interconnecting wiring, safety and operating controls including capacity controller, control center, motor starting components, and special features as specified herein or required for safe, automatic operation.

B. Cabinet: External structural members shall be constructed of heavy gauge, galvanized steel coated with baked on powder paint which, when subject to ASTM B117, 1000 hour, 5% salt spray test, yields minimum ASTM 1654 rating of "6".

C. Wire Panels (full unit): Heavy gauge, welded wire-mesh, coated to resist corrosion, to protect condenser coils from incidental damage and restrict unauthorized access to internal components. Factory installed.

2.2 COMPRESSORS
Compressors: Shall be hermetic, scroll-type, including:

A. Compliant design for axial and radial sealing
B. Refrigerant flow through the compressor with 100% suction cooled motor.
C. Large suction side free volume and oil sump to provide liquid handling capability.
D. Compressor crankcase heaters to provide extra liquid migration protection.
E. Annular discharge check valve and reverse vent assembly to provide low-pressure drop, silent shutdown and reverse rotation protection.
F. Initial Oil charge.
G. Oil Level sightglass.
H. Vibration isolator mounts for compressors.
I. Brazed-type connections for fully hermetic refrigerant circuits.

2.3 REFRIGERANT CIRCUIT COMPONENTS

A. Each refrigerant circuit shall include: liquid line shutoff valve with charging port, low side pressure relief device, filter-drier, solenoid valve, sight glass with moisture indicator, thermostatic expansion valves, and flexible, closed-cell foam insulated suction line and suction pressure transducer.

2.4 HEAT EXCHANGERS

A. Evaporator:
   1. Direct expansion type with refrigerant inside high efficiency copper tubes, chilled liquid forced over the tubes by galvanized steel baffles.

   2. Constructed, tested, and stamped in accordance with applicable sections of ASME pressure vessel code for minimum 350 PSIG (24 bar)refrigerant side design working pressure and150 PSIG (10 bar) water side design working pressure.

   3. Shell covered with 3.4" (19mm), flexible, closed cell insulation, thermal conductivity of 0.26k ([BTU/HR-Ft2 -°F]/in.) maximum. Water nozzles with grooves for mechanical couplings, and insulated by Contractor after pipe installation.

   4. Provide vent and drain fittings, and thermostatically controlled heaters to protect to -20°F (29°C) ambient in off-cycle.

B. Air Cooled Condenser:

   1. Coils: Internally enhanced, seamless copper tubes, mechanically expanded into aluminum alloy fins with full height collars. Subcooling coil an integral part of condenser. Design working pressure shall be 450 PSIG (31 bar).

   2. Fans: Shall be dynamically and statically balanced, direct drive, corrosion resistant glass fiber reinforced composite blades molded into a low noise, full-airfoil cross section, providing vertical air discharge and low sound. Each fan in its own compartment to prevent crossflow during fan cycling. Guards of heavy gauge, PVC (polyvinylchloride) coated or galvanized steel.

   3. Fan Motors: High efficiency, direct drive, 6 pole, 3 phase, insulation class “F”, current protected, Totally Enclosed Air-Over (TEAO), rigid mounted, with double sealed, permanently lubricated, ball bearings.

2.5 POWER AND ELECTRICAL REQUIREMENTS

A. General: Automatic start, stop, operating, and protection sequences across the range of scheduled conditions and transients.

B. Microprocessor Enclosure: Rain and dust tight NEMA 3R/12 (IP55) powder painted steel cabinet and gasket sealed door.

C. Microprocessor Control Center:

1. Automatic control of compressor start/stop, anti-coincidence and anti-recycle timers, automatic pumpdown shutdown, condenser fans, evaporator pump, evaporator heater, unit alarm contacts, and chiller operation from 0°F to 125°F (-18°C to 52°C) ambient. Automatic reset to normal chiller operation after power failure.

2. Remote water temperature reset via a Pulse Width Modulated (PWM) input signal or up to two steps of demand (load) limiting.

3. Software stored in non-volatile memory, with programmed setpoints retained in lithium battery backed real time clock (RTC) memory for minimum 5 years.

4. Forty character liquid crystal display, descriptions in English (or Spanish, French, Italian, or German), numeric data in English (or Metric) units. Sealed keypad with sections for Setpoints, Display/Print, Entry, Unit Options & clock, and On/Off Switch.

5. Programmable Setpoints (within Manufacturer limits): display language; chilled liquid temperature setpoint and range, remote reset temperature range, set daily schedule/holiday for start/stop, manual override for servicing, low and high ambient cutouts, number of compressors, low liquid temperature cutout, low suction pressure cutout, high discharge pressure cutout, anti-recycle timer (compressor start cycle time), and anti-coincident timer (delay compressor starts).

6. Display Data: Return and leaving liquid temperatures, low leaving liquid temperature cutout setting, low ambient temperature cutout setting, outdoor air temperature, English or metric data, suction pressure cutout setting, each system suction pressure (optional on YCAL0014-0060 models), discharge pressure (optional), liquid temperature reset via a YORK ISN DDC or Building Automation System (by others) via PWM input as standard or a 4-20milliamp or 0-10 VDC input or contact closure with optional BAS interface, anti-recycle timer status for each compressor, anti-coincident system start timer condition, compressor run status, no cooling load condition, day, date and time, daily start/stop times, holiday status, automatic or manual system lead/lag control, lead system definition, compressor starts/operating hours (each), status of hot gas valves, evaporator heater and fan operation, run permissive status, number of compressors running, liquid solenoid valve status, load & unload timer status, water pump status.

7. System Safeties: Shall cause individual compressor systems to perform auto shut down; manual reset required after the third trip in 90 minutes. Includes: high discharge pressure, low suction pressure, high pressure switch, and motor protector. Compressor motor protector shall protect against damage due to high input current or thermal overload of windings.

8. Unit Safeties: Shall be automatic reset and cause compressors to shut down if low ambient, low leaving chilled liquid temperature, under voltage, and flow switch operation. Contractor shall provide flow switch and wiring per chiller manufacturer requirements.

9. Alarm Contacts: Low ambient, low leaving chilled liquid temperature, low voltage, low battery, and (per compressor circuit): high discharge pressure, and low suction pressure.

D. Manufacturer shall provide any controls not listed above, necessary for automatic chiller operation. Mechanical Contractor shall provide field control wiring necessary to interface sensors to the chiller control system.

2.6 POWER CONNECTION AND DISTRIBUTION

A. Power Panels:

1. NEMA 3R/12 (IP55) rain/dust tight, powder painted steel cabinets with hinged, latched, and gasket sealed outer doors. Provide main power connection(s), control power connections, compressor and fan motor start contactors, current overloads, and factory wiring.
2. Power supply shall enter unit at a single location, be 3 phase of scheduled voltage, and connect to individual terminal blocks per compressor. Separate disconnecting means and/or external branch circuit protection (by Contractor) required per applicable local or national codes.

B. Exposed compressor, control and fan motor power wiring shall be routed through liquid tight conduit.

2.7 ACCESSORIES AND OPTIONS

A. Microprocessor controlled, Factory installed Across the-Line type compressor motor starters as standard.

B. Power Supply Connections: Single Point or Multiple Point Disconnect: Single or Dual point Non-Fused Disconnect(s) and lockable external handle (in compliance with Article 440-14 of N.E.C.) can be supplied to isolate the unit power voltage for servicing. Separate external fusing must be supplied, by others, in the in coming power wiring, which must comply with the National Electric Code and/or local codes.

C. Flow Switch (Field-mounted):
Vapor proof SPDT, NEMA 4X switch, 150 PSIG, -20°F to 250°F.

D. Service Isolation valves: Service suction and discharge (ball type) isolation valves are added to unit per system. This option also includes a system high pressure relief valve in compliance with ASHRAE15. (Factory-mounted.)

E. Building Automation System (EMS) Reset Interface: Chiller to accept 4 to 20mA, 0 to 10 VDC, or discrete contact closure input to reset the leaving chilled liquid temperature.

PART 3 – EXECUTION

3.1 INSTALLATION

A. General: Rig and Install in full accordance with Manufacturer's requirements, Project drawings, and Contract documents.

B. Location: Locate chiller as indicated on drawings, including cleaning and service maintenance clearance per Manufacturer instructions. Adjust and level chiller on support structure. If equipment provided exceeds height of scheduled chiller, installing contractor is responsible for additional costs associated with extending the height of parapet or screening walls/enclosures.

C. Components: Installing Contractor shall provide and install all auxiliary devices and accessories for fully operational chiller.

D. Electrical: Coordinate electrical requirements and connections for all power feeds with Electrical Contractor (Division 26).

E. Controls: Coordinate all control requirements and connections with Controls Contractor.

F. Finish: Installing Contractor shall paint damaged and abraded factory finish with touch-up paint matching factory finish.

G. Align chiller package on steel or concrete foundations.

H. Install units in vibration isolation.

I. Verify power requirements and connect to electrical service.

J. Connect to chilled water piping. On inlet, provide thermometer well for temperature controller, thermometer well for temperature limit controller, flow switch, flexible pipe connector, and shut-off valve. On outlet, provide flexible pipe connector and shut-off valve.

3.2 MANUFACTURER'S FIELD SERVICES

A. Supply service of factory trained representative to supervise testing, start-up, and instruction on operation and maintenance to Owner.

END OF SECTION 23 6423

SECTION 23 7313 – CENTRAL-STATION AIR-HANDLING UNITS

PART 1 – GENERAL

1.1 RELATED DOCUMENTS

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

B. Requirements of the following Division 23 Sections apply to this section:

1. Section 230500 – “Basic Mechanical Requirements.”
2. Section 230505 – “Basic Mechanical Materials and Methods.”
3. Section 230513 – “Motors.”
4. Section 236200 – “Air-Cooled Condensing Units.”

1.2 SUMMARY

A. This section includes central-station air-handling units for indoor installations; complete with fan(s), heat transfer coil(s), air cleaning devices, and other elements configured in factory-fabricated modules; for factory or field assembly; as indicated on the drawings, as specified herein, and as required for the proper and complete performance of the Work.

1.3 SUBMITTALS

A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.

B. Product data for each central-station air-handling unit indicated, including the following:

1. Certified fan performance curves with system operating conditions indicated.
2. Certified fan sound power ratings.
3. Certified coil performance ratings with system operating conditions indicated.
4. Motor ratings and electrical characteristics plus motor and fan accessories.
5. Materials gages and finishes.
6. Filters with performance characteristics.
7. Dampers, including housings, linkages, and operators.

C. Shop drawings from manufacturer detailing dimensions, required clearances, components, and location and size of each field connection.

D. Wiring diagrams detailing wiring for power and controls and differentiating between manufacturer-installed wiring and field-installed wiring.

E. Maintenance data for central-station air-handling units for inclusion in Operating and Maintenance Manual specified in Division 1 and Division 23 Section “Basic Mechanical Requirements.”

1.4 QUALITY ASSURANCE

A. NFPA Compliance: Central-station air-handling units and components shall be designed, fabricated, and installed in compliance with NFPA Standard 90A “Standard for the Installation of Air Conditioning and Ventilating Systems.”

B. ARI Certification: Central-station air-handling units and their components shall be factory tested in accordance with the applicable portions of ARI 430 – Standard for Central-Station Air-

Handling Units and shall be listed and bear the label of the Air-Conditioning and Refrigeration Institute.

C. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2004, Section 5 – "Systems and Equipment" and Section 7 – "Construction and Startup."

D. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 – "Heating, Ventilating, and Air-Conditioning."

1.5 DELIVERY, STORAGE, AND HANDLING

A. Lift and support units with the manufacturer's designated lifting or supporting points.

B. Disassemble and reassemble units as required for movement into the final location following manufacturer's written instructions.

C. Deliver central-station air-handling units as a factory-assembled unit to the extent allowable by shipping limitations, with protective crating and covering.

1.6 SEQUENCING AND SCHEDULING

A. Coordinate the size and location of concrete equipment pads. Cast anchor bolt inserts into pad.

1.7 EXTRA MATERIALS

A. Furnish one additional complete set of filters for each central-station air-handling unit.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. McQuay.
2. Trane.
3. York.

2.2 MANUFACTURED UNITS

A. General Description: Provide factory assembled air-handling units comprised of dimensionally compatible casing modules which house all system components; including fans, motor and drive assembly, access sections, coils, plenums, filters, drain pans, and dampers.

2.3 CASING

A. General: Construct of structural steel framing with removable double-wall insulated panels; all galvanized steel materials.

B. Framing: Minimum 16 gage formed material with welded joints, capable of providing structural integrity independent of the removable wall panels, and fully insulated at all panel connection points. Construct medium and high pressure units with addition bracing and supports as required.

C. Panels: Minimum 18 gage exterior and 20 gage interior surfaces of galvanized solid sheet steel, with integral closed-cell foam seals at all framing element contact surfaces, and secured to frame with corrosion resistant fastening system configured to minimized thermal bridging to air side of unit. Provide perforated material for interior surfaces on all fan module casings unless indicated otherwise on the drawings.

D. Insulation: R-13 injected foam material complying with NFPA 90A, “Standard for the Installation of Air Conditioning and Ventilating Systems”; same thickness as panel, or as required for framing members; and secured between inner and outer panel surfaces or covered such that no insulation is exposed to airstream.

E. Access Doors: Insulated double wall construction; of same materials, thickness, and finishes as casing panels; and complete with hinges, latches, handles, and gaskets. Unless indicated otherwise, provide at all fan, filter, and access sections; same side for all doors on individual air-handling units; both sides for units greater than 6 feet overall width.

F. Drain Pans: Double wall, stainless steel construction; internally insulated to prevent condensation at exterior casing surfaces; sloped in two planes, cross broken and pitched toward either side of unit.

1. Coils: Provide at all cooling coil modules; configured to collect all condensate from cooling coils (including coil piping connections and return bends) when units are operating at maximum cataloged coil face velocity.
2. Fans: Provide at all draw-through fan modules; same size as module floor.
3. Drain Connections: Provide at both ends of the pan with NPS pipe connections exiting through side of unit base for proper trapping.
4. Stacked Coils: Provide intermediate drain pan or a drain trough to collect condensate from top coil, piped down to main pan.

G. Base Rails: Provide unit with base rail.

2.4 FAN SECTIONS

A. Testing Requirements:

1. General: Sound power level ratings shall comply with AMCA Standard 301 “Method for Calculating Fan Sound Ratings form Laboratory Test Data” and shall be the result of tests made in accordance with AMCA Standard 300 “Test Code for Sound Rating.” Fans shall be licensed to bear the AMCA Certified Sound Ratings Seal.
2. Unit’s fans performance ratings for flow rate, pressure, power, air density, speed of rotation and efficiency shall be factory tested and ratings established in accordance with AMCA Standard 210/ASHRAE Standard 51 – Laboratory Methods of Testing Fans for Rating.

B. Fan Section Construction: Fan section shall be equipped with a formed steel channel base for integral mounting of fan, motor, and casing panels. The fan scroll, wheel, shaft, bearings, and motor shall be mounted on a structural steel frame with frame mounted on base with spring vibration isolators. Spring vibration isolators shall be sized to eliminate fan vibration and noise. Provide flexible duct connecting between fan casing and fan scroll outlet.

C. Fans and Shafts: Statically and dynamically balanced and designed for continuous operation at the maximum rated fan speed and motor horsepower. Fan wheel shall be double-width, double-inlet type with forward-curved blades or backward-curved airfoil section blades as indicated. Forward-curved blade wheels shall be galvanized steel or bonderized steel painted with baked-enamel finish. Airfoil wheels shall be steel painted with zinc chromate primer and an enamel

coat. Fan shaft shall be solid steel, turned, ground, and polished. Fan wheels shall be keyed to the shaft.

D. Shaft Bearings: Grease-lubricated ball bearings selected for 200,000 hours' average life, with grease fittings extended to an accessible location outside the fan section.

E. Fan Drives: Designed for a 1.4 service factor and factory mounted with final alignment and belt adjustment made after installation.

1. Belt Drive: Motors and fan wheel pulleys shall be fixed pitch for units with vfd's. Provide smooth belts. Grooved or ribbed belts will not be accepted.
2. Belt Guards: Required for motors mounted on the outside of the fan cabinet; OSHA approved steel construction.
3. Motor Sizes: Minimum size as scheduled. Where not scheduled, provide motor large enough so that the driven load will not require the motor to operate in the service factor range. Comply with applicable provisions of Division 23 sections, "Motors" and "Variable Frequency Drives for Mechanical Equipment".
4. Starters, Electrical Devices, and Wiring: Electrical devices and connections are specified in Division 26.

2.5 COIL SECTIONS

A. Testing Requirements: Cooling and heating coils[, except sprayed surface coils,] shall be factory tested for rating in accordance with ARI 410 - Standard for Forced-Circulation Air-Cooling and Air-Heating Coils.

B. Coil Section Casings: Provide heat transfer coils mounted in insulated, galvanized steel casing modules as specified above; designed and constructed to facilitate coil removal for maintenance and replacement, and to assure full air flow through coils.

C. Connections: Provide factory installed piping connection points outside of unit casing and ready for field connections; with casing penetration points sealed against leakage for unit's rated pressure.

D. Water Coils: Drainable, rigidly supported across the full face of the coil, and pitched to allow drainage.

1. Fins: Aluminum or copper, constructed from flat plate with belled collars for tubes. Fins shall be bonded to tubes by mechanically expanding copper tubes.
2. Tubes: Seamless copper.
3. Coil Casing: Galvanized steel.
4. Headers: Steel or cast-iron, with connections for drain valve and air vent and threaded piping connections.

E. Chilled Water Coils: Chilled water coils shall be provided to meet the capacities as specified on the drawings and also the minimum number of coil rows shall be ***8 row coils***.

2.6 DAMPER SECTIONS

A. General: Leakage rate when tested in accordance with AMCA Standard 500 – Test Method for Louvers, Dampers and Shutters, shall not exceed 2 percent of air quantity calculated at 2,000 fpm face velocity through damper and 4.0 inches w.g. pressure differential.

1. Damper operators are specified in Division 23 temperature Control Section.

B. Combination Filter/Mixing Box: Reinforced, galvanized steel double wall cabinet; with hinged access doors on both sides, integral filter channels compatible with standard 2-inch thick filter module, and damper openings located and oriented as indicated on the Drawings. Provide parallel blade dampers constructed in accordance with the following:

1. Frame: Minimum 16 gage galvanized steel hat channel with compression type metal jamb seals.

2. Blades: 16 gage galvanized steel construction with vinyl or other flexible material edge seals.
3. Axles: Solid steel of non-cylindrical cross section, supported at each end with non-metallic bearings.

2.7 FILTER SECTION

A. General: Filters shall comply with NFPA Standard 90A “Standard for the Installation of Air Conditioning and Ventilating Systems.”

B. Construction: Common or individual insulated, galvanized steel double wall casings; with integral filter tracks arranged for flat or angular orientation compatible with individual unit filtration requirements as scheduled; and tight sealing access doors on both sides to facilitate filter replacement.

C. Filter Gages: Provide MAGNEHELIC type device for each filter bank including static pressure tips, tubing, gage connections, and mounting bracket.

D. Pre-Filters: Provide MERV 8.

E. Final Filters: MERV 13.

2.8 ELECTRICAL COMPONENTS

A. Service Lights: For provide marine type light fixture with 150 watt incandescent lamp in each fan section and access module, complete with switch/pilot light assembly, mounting box and conduit. Locate switch on exterior of unit adjacent to access door.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine areas and conditions, with Installer present, for compliance with requirements for installation tolerances, housekeeping pads, and other conditions affecting performance of central-station air-handling units.

B. Examine rough-in for hydronic, condensate drainage piping and electrical to verify actual locations of connections prior to installation.

C. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

A. Install central-station air-handling units level and plumb, in accordance with manufacturer’s written instructions.

1. Support floor-mounted units on concrete equipment bases. Secure units to anchor bolts installed in concrete equipment base.

B. Arrange installation of units to provide access space around air-handling units for service and maintenance.

C. Install air filter gage pressure tips upstream and downstream of filters to indicate air pressure drop through air filter. Mount filter gages on outside of filter housing or ductwork in accessible position. Adjust level for proper readings.

D. Do not operate fan system until filters (temporary or permanent) are in place. Replace temporary filters used during construction and testing, with new, clean filters.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 23 sections. The Drawings indicate the general arrangement of piping, valves, fittings, and specialties. The following are specific connection requirements:

1. Arrange piping installations adjacent to units to allow unit servicing and maintenance.
2. Connect condensate drain pans using copper tubing. Extend to the nearest equipment or floor drain. Construct deep trap at connection to drain pan and install cleanouts at changes in direction.

B. Duct installations and connections are specified in other Division 23 sections. Make final duct connections with flexible connections.

C. Electrical Connections: The following requirements apply:

1. Electrical power wiring is specified in Division 26.
2. Temperature control wiring and interlock wiring is specified in Division 23, Temperature Control Section.
3. Grounding: Connect unit components to ground in accordance with the National Electrical Code.

3.4 FIELD QUALITY CONTROL

A. Manufacturer’s Field Inspection: Arrange and pay for a factory-authorized service representative to perform the following:

1. Inspect the field assembly of components and installation of central-station air-handling units including piping, ductwork, and electrical connections.
2. Prepare a written report on findings and recommended corrective actions.

3.5 ADJUSTING AND CLEANING

A. Clean unit cabinet interiors to remove foreign material and construction dirt and dust. Vacuum clean fan wheel, fan cabinet, and coils entering air face.

3.6 DEMONSTRATION

A. Demonstration Services: Arrange and pay for a factory-authorized service representative to train Owner’s maintenance personnel on the following:

1. Procedures and schedules related to start-up and shut down, troubleshooting, servicing, preventative maintenance, and how to obtain replacement parts.

2. Familiarization with contents of Operating and Maintenance Manuals specified in Division 1 Section “Project Closeout” and Division 23 Section “Basic Mechanical Requirements.”

B. Schedule training with at least 7 days’ advance notice.

END OF SECTION 23 7313

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SECTION 23 8126 – SPLIT-SYSTEM AIR-CONDITIONING UNITS

PART 1 – GENERAL

1.1 SUMMARY

A. This Section includes split-system air-conditioning and heat pump units consisting of separate evaporator-fan and compressor-condenser components.

B. Split-system air-conditioning units consisting of separate wall mounted evaporator-fan and compressor-condenser components.

1.2 SUBMITTALS

A. Submittals: Submit manufacturer's technical product data, installation and start-up instructions, piping and wiring diagrams, and maintenance data; in accordance with requirements of Division .

1.3 QUALITY ASSURANCE

A. Capacity ratings for condensing units shall be in accordance with ARI Standard 360 "Standard for Commercial and Industrial Unitary Air-Conditioning Equipment".

B. Refrigeration system of condensing units shall be in accordance with ASHRAE 15 "Safety Code for Mechanical Refrigeration".

C. Condensing units shall meet or exceed the minimum COP/Efficiency levels as prescribed in ASHRAE 90A "Energy Conservation in New Building Design".

D. Condensing units shall be listed by UL and have UL label affixed.

E. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1-2204, Section 5 – "Systems and Equipment" and Section 7 – "Construction and Startup."

F. ASHRAE/IESNA 90.1-2004 Compliance: Applicable requirements in ASHRAE/IESNA 90.1-2004, Section 6 – "Heating, Ventilating, and Air-Conditioning."

1.4 COORDINATION

A. Coordinate size, location, and connection details with roof curbs, equipment supports, and roof penetrations.

1.5 WARRANTY

A. Special Project Warranty: Submit a written warranty, executed by manufacturer, agreeing to replace or repair, within warranty period, motors/compressors with inadequate or defective materials and workmanship, including leakage, breakage, improper assembly, or failure to perform as required; provided manufacturer's instructions for handling, installing, protecting, and maintaining units have been adhered to during warranty period. Replacement is limited to component replacement only, and does not include labor for removal or reinstallation. This warranty shall be in addition to, and not a limitation of, other rights the Owner may have against the Contractor under the Contract Documents.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. Enviromaster International Corporation (EMI).
2. Fujitsu General America, Inc.
3. Mitsubishi Electronics America, Inc; HVAC Division.
4. Sanyo HVAC.
5. Trane.

2.2 CEILING-MOUNTED, EVAPORATOR-FAN COMPONENTS

A. Cabinet: Enameled steel with removable panels on front and ends, and discharge drain pans with drain connection.

B. Refrigerant Coils: Copper-tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

C. Fan and Motor: Centrifugal fan, directly driven by multispeed, electric motor with integral overload protection; resiliently mounted.

D. Filters: Permanent, cleanable.

2.3 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. Casing: Steel, finished and baked enamel, 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.

B. Compressor: Hermetically sealed with crankcase heater and mounted on vibration isolation. Compressor motor shall have thermal- and current-sensitive overload devices, start capacitor, relay, and contractor.

1. Compressor Type: Scroll.
2. Two-speed compressor motor with manual-reset high-pressure switch and automatic-reset low-pressure switch.

C. Refrigerant Coil: Copper tube, with mechanically bonded aluminum fins, complying with ARI 210/240, and with liquid subcooler.

D. Heat Pump Components: Reversing valve and low-temperature air cut-off thermostat.

E. Fan: Aluminum-propeller type, directly connected to motor.

F. Motor: Permanently lubricated, with integral thermal-overload protection.

G. Low Ambient Kit: Permits operation down to 0° F.

2.4 ACCESSORIES

A. Thermostat: Low voltage with subbase to control compressor and evaporator fan.

B. Automatic-reset timer to prevent rapid cycling of compressor.

2.5 WALL MOUNTED, EVAPORATOR-FAN COMPONENTS

A. Provide wall mounted type air handler complete with factory assembled coil, condensate drain pan, fan motor, washable filter, air purifying filter and electronic controls to be used with a wired or wireless remote controller. Air handler assembly shall include at least 2 feet of insulated refrigerant piping (gas and liquid line), drain hose and interconnecting cables , so it can be properly connected to outdoor unit. Unit shall be shipped with the proper remote controller, operating batteries, and unit mounting plate. Unit shall be matched with a Trane outdoor unit, rated and tested in accordance with ARI standard. Unit shall be UL listed.

B. Casing: ABS (acrylonitrite-butadiene-styrene) molded casing shall have a thickness of no less than 1/8" and must not discolor with time. The front grille shall have an anti-static treatment and must be removable for washing. Casing shall be provided with knockouts on the right, left and bottom of the unit to facilitate piping and electrical connection on either side or bottom of unit. An electrical service cover shall be provided to permit easy access to the electrical terminal strip.

C. Discharge Airflow and Distribution System: Unit shall have auto swing, dual horizontal blades to optimize the aperture outlet for vertical airflow and air distribution. Blade shall close automatically when the air conditioner is turned off to minimize dust entering the unit. Five-step preset program on the remote controller shall be available to control the blade angle. Manually adjusted wide-angle louvers shall be provided to adjust the coverage and direction of airflow.

D. Controls: Units shall have the capability to be controlled remotely and must have a convenient On/Off switch on the wall mounted unit to be manually operated in the event the wireless remote controller is misplaced or the batteries are low in charge. A filter cleaning indicator light shall be included on all units, except the MCW512, to provide a reminder as to when the pre-filter needs cleaning.

E. Remote Controller: The unit shall have an infrared remote controller with easy reading digital display panel to start, stop and regulate the air conditioner from a distance. Wired remote shall be available as an option on MCW530 and MCW536 models.

The unit remote controller shall provide the following functions:

a. 5 Step Fan Speed.
b. Auto Fan Speed to allow the microprocessor to most efficiently control the actual room temperature to the set temperature.
c. 24-hour On/Off timer that allows settings to be programmed for On/Off scheduling.
d. Vertical auto-swing programming to ensure an even distribution of air.
e. Dry function program that automatically reduces the level of humidity while maintaining the preset indoor temperature.
f. Auto-restart after power failure
g. Self-diagnostic digital display for fast and easy maintenance.
h. Time display.
i. Temperature setting.

F. Filters: The unit shall have a pre-filter net impregnated with a mold prevention solution. In addition, this filter shall be capable of trapping dust up to 0.01 microns; MCW512-24 shall have an air-cleaning electrostatic filter on the front side and a deodorizing, charcoal-activated filter on the other.

G. Unit shall come with the following options

a. Field installed transformer kit.

b. Field installed orifice kit.
c. Field installed wireless controller.

H. Unit shall have condensate pump to pump condensate to nearest drain, as indicated on drawings.

2.6 AIR-COOLED, COMPRESSOR-CONDENSER COMPONENTS

A. General – Split system cooling: Unit shall be fully charged from the factory for matched indoor section and up to 15 feet of piping. Unit is designed to operate at outdoor ambient temperatures as high as 115 deg F. Cooling capacities matched with a wide selection of air handlers and furnace coils that are A.R.I certified. The unit shall be UL listed. Exterior must be designed for outdoor application.

B. Split System Cooling Unit Casing: Unit casing shall be constructed of heavy gauge, galvanized steel and painted with a weather-resistant powder paint. Corrosion and weatherproof CMBP-G30 Duratuff base.

C. Split System Cooling Compressor: Compressor features to include internal over temperature and pressure protector, total dipped hermetic motor, and thermostatically controlled sump heater. Unit also to include: roto-lock suction and discharge refrigeration connections, centrifugal oil pump, and low vibration and noise. Compressor to come with a 5-year limited warranty.

D. Split System Cooling Condenser Coil: Spine Fin coil to be continuously wrapped, corrosion resistant, all aluminum with minimum brazed joints. Coil to be 3/8" O.D. seamless aluminum glued to a continuous aluminum fin. Coils to be lab tested to withstand 2,000 pounds of pressure per square inch. The outdoor coil to provide low airflow resistance and efficient heat transfer. Coil to be protected on all four sides by louvered panels and have a 1year warranty.

E. Split System Cooling Refrigerant Controls: Refrigeration system controls to include condenser fan and compressor contactor. High and low pressure protection to be inherent to the compressor. Factory installed liquid line drier to be included

F. Split System Low Ambient Cooling: Unit shall have Low Ambient cooling to 0 deg F with Non-bleed TXV and Low Ambient Kit. Other accessories for low ambient operation to include Quick Start components and Compressor Crankcase Heat if not factory supplied. A liquid line solenoid valve to be installed in the refrigeration system.

G. Head Pressure Control Accessory: Provide a low voltage (24 Volts) electronic head pressure control that cycles the condenser fan motor based on liquid temperature.

2.7 ACCESSORIES

A. Refrigerant Line Kits: Soft-annealed copper suction and liquid lines factory cleaned, dried, pressurized, and sealed; factory-insulated suction line with flared fittings at both ends.

1. Minimum Insulation Thickness: ½ inch (13 mm) thick.

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 units on equipment rails and provide pipe portal curbs. Anchor units to rails.

D. Install tubing to allow access to unit.

3.2 DEMONSTRATION

A. Start-up Services: Provide the services of a factory-authorized service representative to verify refrigerant piping installation and to check, test and start-up condensing units, in accordance with manufacturer's written start-up instructions. Test controls and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

B. Operating and Maintenance Training: Provide services of manufacturer's service representative to instruct Owner's personnel in operation and maintenance of condensing units. Training shall include start-up and shut-down, servicing and preventative maintenance schedule and procedures, and trouble-shooting procedures plus procedures for obtaining repair parts and technical assistance. Review operating and maintenance data contained in the Operating and Maintenance Manuals specified in Division 1.

1. Schedule training with Owner, provide at least 7-day prior notice.

END OF SECTION 23 8126

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SECTION 23 8413 – HUMIDIFIERS

PART 1 – GENERAL

1.1 SUMMARY

A. This section includes the following types of humidifiers:

1. Electric Evaporative humidifiers for application on ducted HVAC systems.
2. Electrode steam humidifiers as indicated on drawings and as indicated on schedules.
3. Complete and operable humidification system which meets applicable building codes.
4. Equipment start-up and project inspection by qualified factory trained representative.

1.2 SUBMITTALS

A. Product Data: Submit manufacturer's technical product data and installation instructions. Include product description, model, dimensions, component sizes, rough-in requirements, service sizes, and finishes, rated capacities, operating weights, furnished specialties, and accessories.

B. Shop Drawings: Detail fabrication and installation of humidifiers. Include piping details, plans, elevations, sections, details of components, and dispersion tubes.

1. Wiring Diagrams: Power, signal, and control wiring. Differentiate between manufacturer-installed and field-installed wiring.
2. Coordination Drawings: Detail humidifiers and adjacent equipment. Show support locations, type of support, weight on each support, and required clearances.

C. Operation and Maintenance Data: For humidifiers to include in maintenance manuals specified in Division 1.

1.3 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with ARI 640, "Standard for Commercial and Industrial Humidifiers".

C. Products shall be supported with a warranty that ensures the product will be free from defects in materials and workmanship for a period of two years after shipment.

D. Commissioning of a system or systems specified in this section is part of the construction process. Documentation and testing of these systems, as well as training of the Owner's operation and maintenance personnel, is required in cooperation with the Commissioning Authority. Project Closeout is dependent on successful completion of all commissioning procedures, documentation, and issue closure. Refer to Project Closeout, Section 01700, for substantial completion details. Refer to Section 01810, Commissioning, for detailed commissioning requirements.

E. Products specified below are to be manufactured is an ISO 9001-2000 certified facility.

1.5 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. Supply one replacement cylinder with each humidifier.

1.6 COORDINATION

A. Coordinate location and installation of humidifiers in ducts and air-handling units. Revise locations and elevations to suit field conditions and to ensure proper humidifier operation.

B. Coordinate location and installation of humidifier in the space it serves with the electrical, mechanical, and plumbing contractors.

PART 2 – PRODUCTS

2.1 MANUFACTURERS

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

1. Electric Evaporative Humidifiers:

a. Armstrong International, Inc.
b. Dri-Steem Humidifier Co.
c. Nortec Industries, Inc.
d. Neptronic

2.2 ELECTRIC EVAPORATIVE HUMIDIFIERS

A. Fabrication requirements:
1. Enclosure shall be an 18-gauge steel frame with resin cover suitable for finished spaces. Enclosure frame shall constitute a drip pan, having a threaded connection for drain piping. A separate compartment shall house electrical devices and shall be secured to prevent accidental contact with electrical components. The front exterior of the cabinet shall contain the microprocessor controller's digital keypad.
2. Cleanable vaporized chamber shall be stainless steel with Heli-arc welded seams. The evaporating chamber shall be mounted on slide rails. Electrical, water supply and drain connections shall have unions and plugs to allow convenient removal of the evaporating chamber for cleaning.
3. The humidifier frame shall have prepunched keyhole-style mounting holes located on 16" centers for ease of wall mounting and leveling.
4. Steam outlet on top of tank shall be configured to connect to:
    a. A dispersion unit in a duct via hose or pipe. Stainless-steel, duct-mounting, single- or manifold-grid tube extending across entire width of duct; connected to heated-pan housing with flexible hose and equipped with mounting brackets for both ends of tube.

B. Immersion heater: Heater shall be Incoloy allow-sheathed resistance type designed for no more than 86 watts per square inch and shall be mounted on the vaporizing chamber's removable cover.

C. Over-temperature switch: A factory-mounted and –wired UL-listed limit control sensor with manual reset shall sense an over-temperature condition and de-energize heater circuit controls.

D. Water requirements: The humidifier shall be capable of generating steam from tap, softened or DI/RO water.

E. Drain: An electric drain valve shall be mounted on humidifier assembly to allow tank to drain automatically at the end of a humidification season.

F. Controls

1. Time-proportioning (TP) modulation control: The humidifier shall cycle the heater contactor to modulate steam output.
2. Vapor-logic3 microprocessor controller with the following features or functions:
    a. Interoperable with any LonTalk network. The system shall, through the use of Standard Network Variable Types (SNVTs), allow communication with a LonTalk building automation system.
    b. Makeup water switch control and low water safety shutdown.
    c. Fully modulating (0% to 100%) control of humidifier outputs.
    d. PID control capability.
    e. Self-diagnostic test at start-up.
    f. Integral fault relay for remote signaling of alarms.
    g. A keypad, capable of either unit or remote mounting with a 5’ cable, and able to operate within a temperature range of 32ºF to 122ºF.
    h. A keypad that provides text highlighting and allows personal password codes.
    i. A keypad capable of monitoring and/or controlling the following parameters:
        i. Relative humidity (RH) set point and actual conditions in the space (from humidity transmitter)
        ii. Relative humidity (RH) set point and actual conditions in the duct for variable air volume applications (from duct humidity transmitter)
        iii. Relative humidity (RH) high limit set point and actual conditions.
        iv. Total system demand in % of humidifier capacity.
        v. Total system output in lbs/hour.
        vi. Drain/flush frequency interval and duration.
        vii. End-of-season drain status
        viii. System alarms
        ix. Previous fault messages
        x. Operating temperature
    j. User-adjustable water skim duration.
    k. Water level control for softened or hard water:
        i. System shall provide for automatic refill, low water cutoff, field-adjustable skimmer bleed off functions and automatic drain-down of humidifier. System shall consist of:
        ii. A water level sensing unit comprised of three metallic probes screwed into a threaded probe head. Probe head shall incorporate probe isolation chamber to eliminate short-circuiting between probes caused by mineral coating of probe head. Probe head shall be mounted on the humidifier assembly.
        iii. A solenoid operated fill valve factory mounted on the humidifier assembly.
        iv. End-of-season drain.

G. Accessories: Include the following:

1. Dispersion tubes: Dispersion tubes shall be fabricated of stainless steel tubing with uniformly spaced tubelets for steam dispersion. Each tubelet shall be made of a thermal-resin material designed for high steam temperatures. Each tubelet shall extend through the wall and to the center of dispersion tube and incorporate properly sized calibration orifice.

2. Wall mounted humidistat.
3. Duct-mounted, high-limit humidistat
4. Airflow switch to prevent humidifier operation when there is no airflow. Shall be a sail-operated electric switch for field installation.

H. Control input accessory options:

1. Humidity transmitter, room: Humidity transmitter shall be a room-mounted device that measures from 0% to 100% of RH range and provides a linear output (10% RH to 90% RH) from 4mA to 20mA. Accuracy ±2% RH. Supply voltage 21 VDC. Operating temperature range: -4ºF to 140ºF.
2. VAV control package: The VAV control package shall be a modulating control system with two modulating electronic humidity transmitters (one space-mounted, the other duct-mounted downstream of the humidifier). Both shall transmit to the microprocessor controller to modulate humidifier output and maintain the highest desired space humidity possible, at all airflow volumes, without saturation of the airstream.
3. Wall mounted humidistat.
4. Duct-mounted, high-limit humidistat
5. Airflow switch to prevent humidifier operation when there is no airflow.

PART 3 – EXECUTION

3.1 EXAMINATION

A. Examine ducts, air-handling units, and conditions for compliance with requirements for installation tolerance and other conditions affecting performance.

B. Examine roughing-in for piping systems to verify actual locations of piping connections before humidifier installation.

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

3.2 HUMIDIFIER INSTALLATION

A. Install with required clearance for service and maintenance.

B. Seal humidifier dispersion-tube duct penetrations with flange.

C. Install dispersion tubes pitched to drain condensate back to housing.

D. Install drip leg upstream from steam trap, a minimum of 12 inches for proper operation of trap.

E. Install humidifiers and steam dispersion panels per manufacturers' instructions.

F. Seal humidifier dispersion-tube duct penetrations with flange.

G. Install with required clearance for service and maintenance.

H. Install humidifiers with required clearance for service and maintenance. Maintain path, downstream from humidifiers, clear of obstructions as required by ASHRAE 62.1-2004.

I. Install stainless – steel drain pan under each manifold mounted in duct.

1. Construct drain pans with connection for drain; insulated and complying with ASHRAE 62.1-2004.

3.3 CONNECTIONS

A. Piping installation requirements are specified in other Division 15 Sections. Drawings indicated general arrangement of piping, fittings, and specialties.

2. Install piping adjacent to machine to allow service and maintenance.
3. Install shutoff valve and strainer in humidifier supply line.
4. Install backflow prevention device in humidifier supply line.
5. Connect piping with a minimum of 1-inch air gap in fill line to prevent backflow into supply line.

B. Install electrical devices furnished by manufacturer but not specified to be factory mounted.

C. Ground equipment.

1. 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 UL486B.

3.4 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation, including piping and electrical connections. Report results in writing.

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 unit operation. Remove malfunctioning units, replace with new units, and retest.
3. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.

3.5 DEMONSTRATION

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

1. Train Owners maintenance personnel on procedures and schedules for starting and stopping, troubleshooting, servicing, and maintaining equipment and schedules.
2. Review data in maintenance manuals. Refer to Division 1 Section "Contract Closeout."
3. Review data in maintenance manuals. Refer to Division 1 Section "Operation and Maintenance Data."
4. Schedule training with Owner, through Architect, with at least seven days advance notice.

END OF SECTION 23 8413

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SECTION 26 0519 - LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.1 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.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

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.

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 CONDUCTORS AND CABLES

A. Copper Conductors: Comply with NEMA WC 70.

B. Conductor Insulation: Comply with NEMA WC 70 for Types THHN-THWN.

C. Multiconductor Cable: Comply with NEMA WC 70 for hospital grade 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. AFC Cable Systems, Inc.
2. Hubbell Power Systems, Inc.

3. O-Z/Gedney; EGS Electrical Group LLC.
4. 3M; Electrical Products Division.
5. Tyco Electronics Corp.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

PART 3 - EXECUTION

3.1 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper, stranded.

B. Branch Circuits: Copper, stranded.

3.2 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Service Entrance: Type THHN-THWN, single conductors in raceway.

B. Exposed Feeders: Type THHN-THWN, single conductors in raceway.

C. Feeders Concealed in Ceilings, Walls, Partitions, and Crawlspaces: Type THHN-THWN, single conductors in raceway.

D. Feeders Concealed in Concrete, 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.

F. Branch Circuits Concealed in Ceilings, Walls, and Partitions: Type THHN-THWN, single conductors in raceway or hospital grade Metal-clad cable, Type MC. MC not allowed above lay-in ceilings.

G. Branch Circuits Concealed in Concrete, 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.

3.3 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors, unless otherwise indicated.

B. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

C. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

D. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

E. Support cables according to Section 260529 "Hangers and Supports for Electrical Systems."

F. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

G. 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.

H. Make splices and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

I. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches (150 mm) of slack.

3.4 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.5 FIRESTOPPING

A. Apply firestopping to electrical penetrations of fire-rated floor and wall assemblies to restore original fire-resistance rating of assembly according to Section 078413 "Penetration Firestopping."

3.6 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in cables and conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner.

    a. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each splice 11 months after date of Substantial Completion.
    b. Instrument: Use an infrared scanning device designed to measure temperature or to detect significant deviations from normal values. Provide calibration record for device.

c. Record of Infrared Scanning: Prepare a certified report that identifies splices checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

C. Test Reports: Prepare a written report to record the following:

1. Test procedures used.
2. Test results that comply with requirements.
3. Test results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

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

END OF SECTION 26 0519

SECTION 26 0526 - GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes grounding and bonding systems and equipment.

1.2 ACTION SUBMITTALS

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

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

1. Burndy; Part of Hubbell Electrical Systems.
2. Dossert; AFL Telecommunications LLC.
3. ERICO International Corporation.
4. Fushi Copperweld Inc.
5. Galvan Industries, Inc.; Electrical Products Division, LLC.
6. Harger Lightning and Grounding.
7. ILSCO.
8. O-Z/Gedney; A Brand of the EGS Electrical Group.
9. Robbins Lightning, Inc.
10. Siemens Power Transmission & Distribution, Inc.

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. Stranded Conductors: ASTM B 8.
2. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch (6 mm) in diameter.
3. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

4. 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.

2.4 CONNECTORS

A. Listed and labeled by an NRTL 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.

C. Welded Connectors: Exothermic-welding kits of types recommended by kit manufacturer for materials being joined and installation conditions.

2.5 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel[, sectional type]; 3/4 inch by 10 feet (19 mm by 3 m).

PART 3 - EXECUTION

3.1 APPLICATIONS

A. Conductors: Copper, stranded.

B. Underground Grounding Conductors: Install barecopper conductor, No. 3/0 AWG minimum.

1. Bury at least 24 inches (600 mm) below grade.

C. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.
2. Underground Connections: Welded connectors.
3. Connections to Ground Rods: Welded 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 EQUIPMENT GROUNDING

A. Install insulated equipment grounding conductors with all feeders and branch circuits.

B. Install insulated equipment grounding conductors with the following items, in addition to those required by NFPA 70:

1. Feeders and branch circuits.
2. Lighting circuits.

3. Receptacle circuits.
4. Single-phase motor and appliance branch circuits.
5. Three-phase motor and appliance branch circuits.
6. Flexible raceway runs.
7. Metal-clad cable runs.

C. 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.

D. 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.

E. Poles Supporting Outdoor Lighting Fixtures: Install grounding electrode and a separate insulated equipment grounding conductor in addition to grounding conductor installed with branch-circuit conductors.

3.4 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches (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.
2. For grounding electrode system, install at least three rods spaced at least one-rod length from each other and located at least the same distance from other grounding electrodes, and connect to the service grounding electrode conductor.

C. Bonding Straps and Jumpers: Install in locations accessible for inspection and maintenance except where routed through short lengths of conduit.

1. Bonding to Structure: Bond straps directly to basic structure, taking care not to penetrate any adjacent parts.
2. Bonding to Equipment Mounted on Vibration Isolation Hangers and Supports: Install bonding so vibration is not transmitted to rigidly mounted equipment.
3. Use exothermic-welded connectors for outdoor locations; if a disconnect-type connection is required, use a bolted clamp.

D. Grounding and Bonding for Piping:

1. Metal Water Service Pipe: Install insulated copper grounding conductors, in conduit, from building's main service equipment, or grounding bus, to main metal water service entrances to building. Connect grounding conductors to main metal water service pipes; use a bolted clamp connector or bolt a lug-type connector to a pipe flange by 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.

3.5 FIELD QUALITY CONTROL

A. Perform tests and inspections. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

END OF SECTION 26 0526

SECTION 26 0529 - HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

1.2 ACTION SUBMITTALS

A. Product Data: For steel slotted support systems.

B. Shop Drawings: Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Equipment supports.

1.3 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.4 QUALITY ASSURANCE

A. Comply with NFPA 70.

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 products by one of the following:

a. Allied Tube & Conduit.
b. Cooper B-Line, Inc.; a division of Cooper Industries.
c. ERICO International Corporation.
d. GS Metals Corp.
e. Thomas & Betts Corporation.
f. Unistrut; Tyco International, Ltd.
g. Wesanco, Inc.

2. Metallic Coatings: Hot-dip galvanized after fabrication and applied according to MFMA-4.
3. 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. Mechanical-Expansion Anchors: Insert-wedge-type, [zinc-coated] [stainless] steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
   a. Manufacturers: Subject to compliance with requirements, provide products by one of 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.

2. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
3. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
4. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.
5. Toggle Bolts: All-steel springhead type.
6. 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.

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 slottedsupport 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.

D. Spring-steel clamps designed for supporting single conduits without bolts may be used for 1-1/2-inch (38-mm) and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.2 SUPPORT INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.

B. Raceway Support Methods: In addition to methods described in NECA 1, EMT, IMC, and RMC may be supported by openings through structure members, as permitted in NFPA 70.

C. 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).

D. 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. Instead of expansion anchors, powder-actuated driven threaded studs provided with lock washers and nuts may be used in existing standard-weight concrete 4 inches (100 mm) thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches (100 mm) thick.
6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
7. To Light Steel: Sheet metal screws.
8. 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.

E. 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 Section 055000 "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.

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.

END OF SECTION 26 0529

SECTION 26 0533 - RACEWAYS AND BOXES FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Metal conduits, tubing, and fittings.
2. Nonmetal conduits, tubing, and fittings.
3. Metal wireways and auxiliary gutters.
4. Boxes, enclosures, and cabinets.
5. Handholes and boxes for exterior underground cabling.

1.2 ACTION SUBMITTALS

A. Product Data: For surface raceways, wireways and fittings, floor boxes, hinged-cover enclosures, and cabinets.

B. Shop Drawings: For custom enclosures and cabinets. Include plans, elevations, sections, and attachment details.

1.3 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.

PART 2 - PRODUCTS

2.1 METAL CONDUITS, TUBING, AND FITTINGS

A. Listing and Labeling: Metal 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.

B. GRC: Comply with ANSI C80.1 and UL 6.

C. IMC: Comply with ANSI C80.6 and UL 1242.

D. EMT: Comply with ANSI C80.3 and UL 797.

E. FMC: Comply with UL 1; zinc-coated steel.

F. LFMC: Flexible steel conduit with PVC jacket and complying with UL 360.

G. Fittings for Metal Conduit: Comply with NEMA FB 1 and UL 514B.

1. Conduit Fittings for Hazardous (Classified) Locations: Comply with UL 886 and NFPA 70.
2. Fittings for EMT:

a. Material: Steel or die cast.
b. Type: Setscrew or 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.

H. Joint Compound for IMC or GRC: Approved, as defined in NFPA 70, by authorities having jurisdiction for use in conduit assemblies, and compounded for use to lubricate and protect threaded conduit joints from corrosion and to enhance their conductivity.

2.2 NONMETALLIC CONDUITS, TUBING, AND FITTINGS

A. 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.

B. ENT: Comply with NEMA TC 13 and UL 1653.

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 and adhesive primers shall have a VOC content of 510 and 550 g/L or less, respectively, when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

2.3 METAL WIREWAYS AND AUXILIARY GUTTERS

A. Description: Sheet metal, complying with UL 870 and NEMA 250, Type 1 unless otherwise indicated, and sized according to NFPA 70.

B. Fittings and Accessories: Include covers, couplings, offsets, elbows, expansion joints, adapters, hold-down straps, end caps, and other fittings to match and mate with wireways as required for complete system.

2.4 BOXES, ENCLOSURES, AND CABINETS

A. General Requirements for Boxes, Enclosures, and Cabinets: Boxes, enclosures, and cabinets installed in wet locations shall be listed for use in wet locations.

B. Sheet Metal Outlet and Device Boxes: Comply with NEMA OS 1 and UL 514A.

C. Cast-Metal Outlet and Device Boxes: Comply with NEMA FB 1, ferrous alloy, Type FD, with gasketed cover.

D. Metal Floor Boxes:

1. Material: Cast metal.
2. Type: Fully adjustable.
3. Shape: Rectangular.
4. Listing and Labeling: Metal floor boxes shall be 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. Paddle Fan Outlet Boxes: Nonadjustable, designed for attachment of paddle fan weighing 70 lb (32 kg).

1. Listing and labeling: Paddle fan outlet boxes shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

G. Small Sheet Metal Pull and Junction Boxes: NEMA OS 1.

H. Cast-Metal Access, Pull, and Junction Boxes: Comply with NEMA FB 1 and UL 1773, cast aluminum with gasketed cover.

I. Device Box Dimensions: 4 inches square by 2-1/8 inches deep (100 mm square by 60 mm deep) and 4 inches by 2-1/8 inches by 2-1/8 inches deep (100 mm by 60 mm by 60 mm deep) <Insert dimension>.

J. Gangable boxes are prohibited.

K. Hinged-Cover Enclosures: Comply with UL 50 and 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.
2. Interior Panels: Steel; all sides finished with manufacturer's standard enamel.

L. Cabinets:

1. NEMA 250, Type 1 galvanized-steel box with removable interior panel and removable front, finished inside and out with manufacturer's standard enamel.
2. Hinged door in front cover with flush latch and concealed hinge.
3. Key latch to match panelboards.
4. Metal barriers to separate wiring of different systems and voltage.
5. Accessory feet where required for freestanding equipment.

2.5 HANDHOLES AND BOXES FOR EXTERIOR UNDERGROUND WIRING

A. General Requirements for Handholes and Boxes:

1. Boxes and handholes for use in underground systems shall be designed and identified as defined in NFPA 70, for intended location and application.
2. Boxes installed in wet areas shall be listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

B. Polymer-Concrete Handholes and Boxes with Polymer-Concrete Cover: Molded of sand and aggregate, bound together with polymer resin, and reinforced with steel, fiberglass, or a combination of the two.

1. Standard: Comply with SCTE 77.
2. Configuration: Designed for flush burial with closed bottom unless otherwise indicated.
3. Cover: Weatherproof, secured by tamper-resistant locking devices and having structural load rating consistent with enclosure and handhole location.
4. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
5. Cover Legend: Molded lettering, "ELECTRIC.", “LIGHTING”, “T-COM” as required for service type.
6. Conduit Entrance Provisions: Conduit-terminating fittings shall mate with entering ducts for secure, fixed installation in enclosure wall.

PART 3 - EXECUTION

3.1 RACEWAY APPLICATION

A. Outdoors: Apply raceway products as specified below unless otherwise indicated:

1. Exposed Conduit: GRC or IMC.
2. Concealed Conduit, Aboveground: GRC or IMC.
3. Underground Conduit: RNC, Type EPC-40-PVC,.
4. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): LFNC.
5. Boxes and Enclosures, Aboveground: NEMA 250, Type 3R.

B. Indoors: Apply raceway products as specified below unless otherwise indicated.

1. Exposed, Not Subject to Physical Damage: EMT.
2. Exposed, Not Subject to Severe Physical Damage: EMT.
3. Exposed and Subject to Severe Physical Damage: GRC or IMC. Raceway locations include the following:
   a. Mechanical and electrical rooms.

4. Concealed in Ceilings and Interior Walls and Partitions: EMT.
5. Connection to Vibrating Equipment (Including Transformers and Hydraulic, Pneumatic, Electric Solenoid, or Motor-Driven Equipment): FMC, except use LFMC in damp or wet locations.
6. Damp or Wet Locations: GRC or IMC.
7. Boxes and Enclosures: NEMA 250, Type 1, except use NEMA 250, Type 4 stainless steel in kitchens and damp or wet locations.

C. Minimum Raceway Size: 1/2-inch (16-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. Comply with NEMA FB 2.10.
2. EMT: Use setscrew or compression, steel or cast-metal fittings. Comply with NEMA FB 2.10.
3. Flexible Conduit: Use only fittings listed for use with flexible conduit. Comply with NEMA FB 2.20.

3.2 INSTALLATION

A. Comply with NECA 1 and NECA 101 for installation requirements except where requirements on Drawings or in this article are stricter. Comply with NECA 102 for aluminum conduits. Comply with NFPA 70 limitations for types of raceways allowed in specific occupancies and number of floors.

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. Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems" for hangers and supports.

D. Arrange stub-ups so curved portions of bends are not visible above finished slab.

E. Install no more than the equivalent of three 90-degree bends in any conduit run except for control wiring conduits, for which fewer bends are allowed. Support within 12 inches (300 mm) of changes in direction.

F. Conceal conduit and EMT within finished walls, ceilings, and floors unless otherwise indicated. Install conduits parallel or perpendicular to building lines.

G. Support conduit within 12 inches (300 mm)of enclosures to which attached.

H. Raceways Embedded in Slabs:

1. Run conduit larger than 1-inch (27-mm) trade size, parallel or at right angles to main reinforcement. Where at right angles to reinforcement, place conduit close to slab support. Secure raceways to reinforcement at maximum 10-foot (3-m) intervals.
2. Arrange raceways to cross building expansion joints at right angles with expansion fittings.
3. Arrange raceways to keep a minimum of 2 inches (50 mm) of concrete cover in all directions.
4. Do not embed threadless fittings in concrete unless specifically approved by Architect for each specific location.
5. Change from ENT to GRC or IMC before rising above floor.

I. Stub-ups to Above Recessed Ceilings:

1. Use EMT, IMC, or RMC for raceways.
2. Use a conduit bushing or insulated fitting to terminate stub-ups not terminated in hubs or in an enclosure.

J. 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.

K. Raceway Terminations at Locations Subject to Moisture or Vibration: Use insulating bushings to protect conductors including conductors smaller than No. 4 AWG.

L. Terminate threaded conduits into threaded hubs or with locknuts on inside and outside of boxes or cabinets. Install bushings on conduits up to 1-1/4-inch (35-mm) trade size and insulated throat metal bushings on 1-1/2-inch (41-mm) trade size and larger conduits terminated with locknuts. Install insulated throat metal grounding bushings on service conduits.

M. 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. Cap underground raceways designated as spare above grade alongside raceways in use.

N. Install raceway sealing fittings at accessible locations according to NFPA 70 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.

O. Install devices to seal raceway interiors at accessible locations. Locate seals so no fittings or boxes are between the seal and the following changes of environments. Seal the interior of all raceways at the following points:

1. Where conduits pass from warm to cold locations, such as boundaries of refrigerated spaces.
2. Where an underground service raceway enters a building or structure.
3. Where otherwise required by NFPA 70.

P. Flexible Conduit Connections: Comply with NEMA RV 3. Use a maximum of 72 inches (1830 mm) of flexible conduit for recessed and semirecessed luminaires, equipment subject to vibration, noise transmission, or movement; 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.

Q. Mount boxes at heights indicated on Drawings. If mounting heights of boxes are not individually indicated, give priority to ADA requirements. Install boxes with height measured to center of box unless otherwise indicated.

R. Recessed Boxes in Masonry Walls: Saw-cut opening for box in center of cell of masonry block, and install box flush with surface of wall. Prepare block surfaces to provide a flat surface for a raintight connection between the box and cover plate or the supported equipment and box.

S. Horizontally separate boxes mounted on opposite sides of walls so they are not in the same vertical channel.

T. Locate boxes so that cover or plate will not span different building finishes.

U. Support boxes of three gangs or more from more than one side by spanning two framing members or mounting on brackets specifically designed for the purpose.

V. Fasten junction and pull boxes to or support from building structure. Do not support boxes by conduits.

W. Set metal floor boxes level and flush with finished floor surface.

3.3 INSTALLATION OF UNDERGROUND CONDUIT

A. Direct-Buried Conduit:

1. Excavate trench bottom to provide firm and uniform support for conduit. Prepare trench bottom as specified in Section 312000 "Earth Moving" for pipe less than 6 inches (150 mm) in nominal diameter.
2. Install backfill as specified in Section 312000 "Earth Moving."
3. After installing conduit, backfill and compact. Start at tie-in point, and work toward end of conduit run, leaving conduit at end of run free to move with expansion and contraction as temperature changes during this process. Firmly hand tamp backfill around conduit to provide maximum supporting strength. After placing controlled backfill to within 12 inches (300 mm) of finished grade, make final conduit connection at end of run and complete backfilling with normal compaction as specified in Section 312000 "Earth Moving."
4. Install manufactured duct elbows for stub-up at poles and equipment and at building entrances through floor unless otherwise indicated. Encase elbows for stub-up ducts throughout length of elbow.
5. Install manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through floor.

    a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3 inches (75 mm) of concrete for a minimum of 12 inches (300 mm) on each side of the coupling.
    b. For stub-ups at equipment mounted on outdoor concrete bases and where conduits penetrate building foundations, extend steel conduit horizontally a minimum of 60 inches (1500 mm) from edge of foundation or equipment base. Install insulated grounding bushings on terminations at equipment.

6. Underground Warning Tape: Comply with requirements in Section 260553 "Identification for Electrical Systems."

3.4 INSTALLATION OF UNDERGROUND HANDHOLES AND BOXES

A. Install handholes and boxes level and plumb and with orientation and depth coordinated with connecting conduits to minimize bends and deflections required for proper entrances.

B. Unless otherwise indicated, support units on a level bed of crushed stone or gravel, graded from 1/2-inch (12.5-mm) sieve to No. 4 (4.75-mm) sieve and compacted to same density as adjacent undisturbed earth.

C. Elevation: In paved areas, set so cover surface will be flush with finished grade. Set covers of other enclosures 1 inch (25 mm) above finished grade.

D. Field-cut openings for conduits according to enclosure manufacturer's written instructions. Cut wall of enclosure with a tool designed for material to be cut. Size holes for terminating fittings to be used, and seal around penetrations after fittings are installed.

3.5 SLEEVE AND SLEEVE-SEAL INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Install sleeves and sleeve seals at penetrations of exterior floor and wall assemblies. Comply with requirements in Section 260544 "Sleeves and Sleeve Seals for Electrical Raceways and Cabling."

3.6 FIRESTOPPING

A. Install firestopping at penetrations of fire-rated floor and wall assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

3.7 PROTECTION

A. Protect coatings, finishes, and cabinets from damage and deterioration.

1. Repair damage to galvanized finishes with zinc-rich paint recommended by manufacturer.

END OF SECTION 26 0533

SECTION 26 0544 - SLEEVES AND SLEEVE SEALS FOR ELECTRICAL RACEWAYS AND CABLING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Sleeves for raceway and cable penetration of non-fire-rated construction walls and floors.
2. Sleeve-seal systems.
3. Sleeve-seal fittings.
4. Grout.
5. Silicone sealants.

B. Related Requirements:

1. Section 078413 "Penetration Firestopping" for penetration firestopping installed in fire-resistance-rated walls, horizontal assemblies, and smoke barriers, with and without penetrating items.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

PART 2 - PRODUCTS

2.1 SLEEVES

A. Wall Sleeves:

1. Steel Pipe Sleeves: ASTM A 53/A 53M, Type E, Grade B, Schedule 40, zinc coated, plain ends.
2. Cast-Iron Pipe Sleeves: Cast or fabricated "wall pipe," equivalent to ductile-iron pressure pipe, with plain ends and integral waterstop unless otherwise indicated.

B. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies: Galvanized-steel sheet; 0.0239-inch (0.6-mm) minimum thickness; round tube closed with welded longitudinal joint, with tabs for screw-fastening the sleeve to the board.

C. Sleeves for Rectangular Openings:

1. Material: Galvanized sheet steel.
2. Minimum Metal Thickness:

a. For sleeve cross-section rectangle perimeter less than 50 inches (1270 mm) and with no side larger than 16 inches (400 mm), thickness shall be 0.052 inch (1.3 mm).

b. For sleeve cross-section rectangle perimeter 50 inches (1270 mm) or more and one or more sides larger than 16 inches (400 mm), thickness shall be 0.138 inch (3.5 mm).

2.2 SLEEVE-SEAL SYSTEMS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway or cable.

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

a. Advance Products & Systems, Inc.
b. CALPICO, Inc.
c. Metraflex Company (The).
d. Pipeline Seal and Insulator, Inc.
e. Proco Products, Inc.

2. Sealing Elements: EPDM rubber 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.
4. Connecting Bolts and Nuts: Carbon steel, with corrosion-resistant coating, of length required to secure pressure plates to sealing elements.

2.3 SLEEVE-SEAL FITTINGS

A. Description: Manufactured plastic, sleeve-type, waterstop assembly made for embedding in concrete slab or wall. Unit shall have plastic or rubber waterstop collar with center opening to match piping OD.

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

a. Presealed Systems.

2.4 GROUT

A. Description: Nonshrink; recommended for interior and exterior sealing openings in non-fire-rated walls or floors.

B. Standard: ASTM C 1107/C 1107M, Grade B, post-hardening and volume-adjusting, dry, hydraulic-cement grout.

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

D. Packaging: Premixed and factory packaged.

2.5 SILICONE SEALANTS

A. Silicone Sealants: Single-component, silicone-based, neutral-curing elastomeric sealants of grade indicated below.

1. Grade: Pourable (self-leveling) formulation for openings in floors and other horizontal surfaces that are not fire rated.
2. Sealant shall have VOC content of g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. Silicone Foams: Multicomponent, silicone-based liquid elastomers that, when mixed, expand and cure in place to produce a flexible, nonshrinking foam.

PART 3 - EXECUTION

3.1 SLEEVE INSTALLATION FOR NON-FIRE-RATED ELECTRICAL PENETRATIONS

A. Comply with NECA 1.

B. Comply with NEMA VE 2 for cable tray and cable penetrations.

C. Sleeves for Conduits Penetrating Above-Grade Non-Fire-Rated Concrete and Masonry-Unit Floors and Walls:

1. Interior Penetrations of Non-Fire-Rated Walls and Floors:

a. Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 079200 "Joint Sealants."
b. Seal space outside of sleeves with mortar or grout. Pack sealing material solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect material while curing.

2. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.
3. Size pipe sleeves to provide 1/4-inch (6.4-mm) annular clear space between sleeve and raceway or cable unless sleeve seal is to be installed.
4. Install sleeves for wall penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of walls. Cut sleeves to length for mounting flush with both surfaces of walls. Deburr after cutting.
5. Install sleeves for floor penetrations. Extend sleeves installed in floors 2 inches (50 mm) above finished floor level. Install sleeves during erection of floors.

D. Sleeves for Conduits Penetrating Non-Fire-Rated Gypsum Board Assemblies:

1. Use circular metal sleeves unless penetration arrangement requires rectangular sleeved opening.
2. Seal space outside of sleeves with approved joint compound for gypsum board assemblies.

E. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

F. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch (25-mm) annular clear space between pipe and sleeve for installing mechanical sleeve seals.

G. Underground, Exterior-Wall and Floor 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 sleeve-seal system.

3.2 SLEEVE-SEAL-SYSTEM INSTALLATION

A. Install sleeve-seal systems in sleeves in exterior concrete walls and slabs-on-grade at raceway entries into building.

B. Install 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.

3.3 SLEEVE-SEAL-FITTING INSTALLATION

A. Install sleeve-seal fittings in new walls and slabs as they are constructed.

B. Assemble fitting components of length to be flush with both surfaces of concrete slabs and walls. Position waterstop flange to be centered in concrete slab or wall.

C. Secure nailing flanges to concrete forms.

D. Using grout, seal the space around outside of sleeve-seal fittings.

END OF SECTION 26 0544

SECTION 26 0553 - IDENTIFICATION FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.1 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. Equipment identification labels.
6. Miscellaneous identification products.

1.2 ACTION SUBMITTALS

A. Product Data: For each electrical identification product indicated.

1.3 QUALITY ASSURANCE

A. Comply with ANSI A13.1.

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.

E. Adhesive-attached labeling materials, including label stocks, laminating adhesives, and inks used by label printers, shall comply with UL 969.

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. Self-Adhesive Vinyl Labels for Raceways Carrying Circuits at 600 V or Less: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.2 METAL-CLAD CABLE 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 and cable size.

B. Colors for Raceways Carrying Circuits at 600 V and Less:

1. Black letters on an orange field.
2. Legend: Indicate voltage and system or service type.

C. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.3 POWER AND CONTROL CABLE 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 and cable size.

B. Self-Adhesive Vinyl Labels: Preprinted, flexible label laminated with a clear, weather- and chemical-resistant coating and matching wraparound adhesive tape for securing ends of legend label.

2.4 CONDUCTOR IDENTIFICATION MATERIALS

A. Color-Coding Conductor Tape: Colored, self-adhesive vinyl tape not less than 3 mils (0.08 mm) thick by 1 to 2 inches (25 to 50 mm) wide.

2.5 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: Type ID:

1. Detectable three-layer laminate, consisting of a printed pigmented polyolefin film, 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: 5 mils (0.125 mm).

3. Foil Core Thickness: 0.35 mil (0.00889 mm).
4. Weight: 28 lb/1000 sq. ft. (13.7 kg/100 sq. m).
5. 3-Inch (75-mm) Tensile According to ASTM D 882: 70 lbf (311.3 N), and 4600 psi (31.7 MPa).

2.6 EQUIPMENT IDENTIFICATION LABELS

A. Self-Adhesive, Engraved, Laminated Acrylic or Melamine Label: Adhesive backed, with white letters on a black background. Minimum letter height shall be 3/8 inch (10 mm).

2.7 MISCELLANEOUS IDENTIFICATION PRODUCTS

A. 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. Location: Install identification materials and devices at locations for most convenient viewing without interference with operation and maintenance of equipment.

B. Apply identification devices to surfaces that require finish after completing finish work.

C. Self-Adhesive Identification Products: Clean surfaces before application, using materials and methods recommended by manufacturer of identification device.

D. Attach 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) and at 6 to 8 inches (150 to 200 mm) below finished grade. Use multiple tapes where width of multiple lines installed in a common trenchexceeds 16 inches (400 mm) overall.

3.2 IDENTIFICATION SCHEDULE

A. Accessible Raceways and Metal-Clad Cables, 600 V or Less, for Service, Feeder, and Branch Circuits More Than 30 A, and 120 V to ground: Install labels at 10-foot (3-m) maximum intervals.

B. Accessible Raceways and Cables within Buildings: Identify the covers of each junction and pull box of the following systems with self-adhesive vinyl labels with the wiring system legend and system voltage. System legends shall be as follows:

1. Power.

C. Power-Circuit Conductor Identification, 600 V or Less: For conductors in pull and junction boxes, 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 208/110-V Circuits:

1) Phase A: Black.
2) Phase B: Red.
3) Phase C: Blue.

c. 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. Install instructional sign including the color-code for grounded and ungrounded conductors using adhesive-film-type labels.

E. Conductors to Be Extended in the Future: Attach marker tape to conductors and list source.

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.
1. Install underground-line warning tape for both direct-buried cables and cables in raceway.

H. Emergency Operating Instruction Signs: Install instruction signs with white legend on a red background with minimum 3/8-inch- (10-mm-) high letters for emergency instructions at equipment used for power transfer or shutdown of boilers.

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. Unless provided with self-adhesive means of attachment, fasten labels with appropriate mechanical fasteners that do not change the NEMA or NRTL rating of the enclosure.

END OF SECTION 26 0553

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SECTION 26 1200 - MEDIUM-VOLTAGE TRANSFORMERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following types of transformers with medium-voltage primaries:
   1. Pad-mounted, liquid-filled transformers.

1.2 ACTION SUBMITTALS

A. Product Data: For each type and size of transformer indicated.

B. Shop Drawings: For each type and size of transformer indicated.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

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.

B. Comply with IEEE C2 and NFPA 70.

C. Comply with ANSI C57.12.28, IEEE C57.12.10, IEEE C57.12.70, and IEEE C57.12.80.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

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

   1. Acme Electric Corporation; Power Distribution Products Division.
   2. Cooper Industries; Cooper Power Systems Division.
   3. Cutler-Hammer.
   4. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
   5. GE Electrical Distribution & Control.
   6. Hammond Manufacturing; Transformer Group.
   7. Kuhlman Electric Corporation.
   8. Pauwels Transformers.
   9. Pioneer Transformers Ltd.
   10. Siemens Energy & Automation, Inc.
   11. Square D/Groupe Schneider NA.

12. Uptegraff, R. E. Mfg. Co.
13. Virginia Transformer Corp.

2.2 PAD-MOUNTED, LIQUID-FILLED TRANSFORMERS

A. Description: Comply with ANSI C57.12.13, IEEE C57.12.00, IEEE C57.12.22 for pad-mounted, 2-winding transformers. Stainless-steel tank base and cabinet.

B. Insulating Liquid: Less flammable, edible-seed-oil based, and listed by a NRTL acceptable to authority having jurisdiction as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.

C. Insulation Temperature Rise: 55 deg C when operated at rated kVA output in a 40 deg C ambient temperature.

D. Basic Impulse Level: 60 kV.

E. Full-Capacity Voltage Taps: Four, 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable, de-energized, tap changer; position indicator; and padlock hasp.

F. High-Voltage Switch: 200 A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 2-position, gang-operated, load-break switch, oil immersed in transformer tank with hook-stick operating handle in primary compartment.

G. Primary Fuses: 150-kV fuse assembly with fuses complying with IEEE C37.47. Rating of current-limiting fuses shall be 50-kA RMS at specified system voltage.

1. Current-limiting type in dry-fuse holder wells, mechanically interlocked with liquid-immersed switch in transformer tank to prevent disconnect under load.

H. Surge Arresters: Distribution class, one for each primary phase; complying with IEEE C62.11 and NEMA LA 1. Transformers shall have three arresters for radial-feed circuits.

I. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:

1. Bushing-Well Inserts: One for each high-voltage bushing well.
2. Surge Arresters: Dead-front, elbow-type, metal-oxide-varistor units.
3. Parking Stands: One for each high-voltage bushing well.
4. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.

J. Accessories:

1. Drain Valve: 1 inch (25 mm), with sampling device.
2. Dial-type thermometer.
3. Liquid-level gage.
4. Pressure-vacuum gage.
5. Pressure Relief Device: Self-sealing with an indicator.
6. Mounting provisions for low-voltage current transformers.
7. Busway terminal connection at low-voltage compartment.
8. Alarm contacts for gages and thermometer listed above.

2.3 IDENTIFICATION DEVICES

A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install and anchor transformers on concrete bases according to manufacturer's written instructions and per drawings.

1. Construct concrete bases of dimensions indicated, but not less than 6 inches (150 mm) larger in both directions than supported unit and 8 inches (200 mm) thick.
2. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Section 033000 "Cast-in-Place Concrete."
3. Anchor equipment with epoxy-embedded anchor bolts that extend through concrete base and anchor into structural concrete floor.

B. Maintain minimum clearances according to manufacturer's written instructions and NFPA 70.

3.2 IDENTIFICATION

A. Identify components and provide warning signs as specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform electrical test and visual and mechanical inspection stated in NETA ATS, Section 7.2. Certify compliance with test parameters.

B. Test and adjust controls and safeties.

3.4 FOLLOW-UP SERVICE

A. Voltage Monitoring and Adjusting: Perform the following voltage monitoring after Substantial Completion but not more than six months after Final Acceptance:

1. During a period of normal load cycles, perform seven days of continuous three-phase voltage recording at secondary terminals of each transformer. Voltage unbalance greater than 1 percent between phases, or deviation of any phase voltage from nominal value by more than plus or minus 5 percent during test period, is unacceptable.
2. Corrective Actions: If test results are unacceptable, perform the following corrective actions, as appropriate:

a. Adjust transformer taps.

3. Retests: After corrective actions have been performed, repeat monitoring until satisfactory results are obtained.

END OF SECTION 26 1200

SECTION 26 2416 - PANELBOARDS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes distribution panelboards and lighting and appliance branch-circuit panelboards.

1.2 ACTION SUBMITTALS

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

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. Include evidence of NRTL listing for series rating of installed devices.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 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 PB 1.

C. Comply with NFPA 70.

1.5 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: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR PANELBOARDS

A. Enclosures: Flush- and surface-mounted cabinets.

1. Rated for environmental conditions at installed location.

a. Indoor Dry and Clean Locations: NEMA 250, Type 1.

2. Front: Secured to box with concealed trim clamps. For surface-mounted fronts, match box dimensions; for flush-mounted fronts, overlap box.
3. Hinged Front Cover: Entire front trim hinged to box and with standard door within hinged trim cover.
4. Directory Card: Inside panelboard door, mounted in transparent card holder.

B. Incoming Mains Location: Top and bottom.

C. Phase, Neutral, and Ground Buses: Tin-plated aluminum.

D. Conductor Connectors: Suitable for use with conductor material and sizes.

1. Material: Tin-plated aluminum.
2. Main and Neutral Lugs: Mechanical type.
3. Ground Lugs and Bus Configured Terminators: Mechanical type.
4. Feed-Through Lugs: Mechanical type, suitable for use with conductor material. Locate at opposite end of bus from incoming lugs or main device.

E. Future Devices: Mounting brackets, bus connections, filler plates, and necessary appurtenances required for future installation of devices.

F. Panelboard Short-Circuit Current Rating: Rated for series-connected system with integral or remote upstream overcurrent protective devices and labeled by an NRTL. Include size and type of allowable upstream and branch devices, and listed and labeled for series-connected short-circuit rating by an NRTL.

G. Panelboard Short-Circuit Current Rating: Fully rated to interrupt symmetrical short-circuit current available at terminals.

2.2 PERFORMANCE REQUIREMENTS

A. Surge Suppression: Factory installed as an integral part of indicated panelboards, complying with UL 1449 SPD Type 1.

2.3 DISTRIBUTION PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.

4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, power and feeder distribution type.

C. Doors: Secured with vault-type latch with tumbler lock; keyed alike.

D. Mains: Circuit breaker or Lugs only.

E. Branch Overcurrent Protective Devices: For Circuit-Breaker Frame Sizes 125 A and Smaller: Plug-in circuit breakers.

F. 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.

2.4 LIGHTING AND APPLIANCE BRANCH-CIRCUIT PANELBOARDS

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Panelboards: NEMA PB 1, lighting and appliance branch-circuit type.

C. Mains: Circuit breaker or lugs only.

D. Branch Overcurrent Protective Devices: Plug-in circuit breakers, replaceable without disturbing adjacent units.

E. Doors: Concealed hinges; secured with flush latch with tumbler lock; keyed alike.

2.5 DISCONNECTING AND OVERCURRENT PROTECTIVE DEVICES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Molded-Case Circuit Breaker (MCCB): Comply with UL 489, with series-connected rating to meet available fault currents.

1. Thermal-Magnetic Circuit Breakers: Inverse time-current element for low-level overloads, and instantaneous magnetic trip element for short circuits. Adjustable magnetic trip setting for circuit-breaker frame sizes 250 A and larger.
2. GFCI Circuit Breakers: Single- and two-pole configurations with Class A ground-fault protection (6-mA trip).
3. Molded-Case Circuit-Breaker (MCCB) Features and Accessories:

a. Standard frame sizes, trip ratings, and number of poles.
b. Lugs: Mechanical style, suitable for number, size, trip ratings, and conductor materials.
c. 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. Ground-Fault Protection: Integrally mounted relay and trip unit with adjustable pickup and time-delay settings, push-to-test feature, and ground-fault indicator.
e. Handle Padlocking Device: Fixed attachment, for locking circuit-breaker handle in off position.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Receive, inspect, handle, store and install panelboards and accessories according to NECA 407.

B. Mount top of trim 90 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.

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 into raised floor space or below slab not on grade.

G. Arrange conductors in gutters into groups and bundle and wrap with wire ties.

H. Comply with NECA 1.

3.2 IDENTIFICATION

A. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs complying with Section 260553 "Identification for Electrical Systems."

B. Create a directory to indicate installed circuit loads and incorporating Owner's final room designations. Obtain approval before installing. Use a computer or typewriter to create directory; handwritten directories are not acceptable.

C. Panelboard Nameplates: Label each panelboard with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

D. Device Nameplates: Label each branch circuit device in distribution panelboards with a nameplate complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each panelboard bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Panelboards will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies panelboards included and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 2416

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SECTION 26 2726 - WIRING DEVICES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Receptacles, receptacles with integral GFCI, and associated device plates.
2. Weather-resistant receptacles.
3. Snap switches and wall-box dimmers.
4. Solid-state fan speed controls.
5. Wall-switch occupancy sensors.

1.2 ADMINISTRATIVE REQUIREMENTS

A. Coordination:

1. Receptacles for Owner-Furnished Equipment: Match plug configurations.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: List of legends and description of materials and process used for premarking wall plates.

1.4 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.5 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

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; Division of Cooper Industries, Inc. (Cooper).
2. Hubbell Incorporated; Wiring Device-Kellems (Hubbell).
3. Leviton Mfg. Company Inc. (Leviton).

4. Pass & Seymour/Legrand (Pass & Seymour).

B. Source Limitations: Obtain each type of wiring device and associated wall plate from single source from single manufacturer.

2.2 GENERAL WIRING-DEVICE REQUIREMENTS

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

B. Comply with NFPA 70.

C. Devices that are manufactured for use with modular plug-in connectors may be substituted under the following conditions:

1. Connectors shall comply with UL 2459 and shall be made with stranding building wire.
2. Devices shall comply with the requirements in this Section.

2.3 STRAIGHT-BLADE RECEPTACLES

A. Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498, and FS W-C-596.

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

a. Cooper; 5351 (single), CR5362 (duplex).
b. Hubbell; HBL5351 (single), HBL5352 (duplex).
c. Leviton; 5891 (single), 5352 (duplex).
d. Pass & Seymour; 5361 (single), 5362 (duplex).

B. Hospital-Grade, Duplex Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

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

a. Cooper; 8310 (single), 8300 (duplex).
b. Hubbell; HBL8310 (single), HBL8300 (duplex).
c. Leviton; 8310 (single), 8300 (duplex).
d. Pass & Seymour; 8301 (single), 8300H (duplex).

2. Description: Single-piece, rivetless, nickel-plated, all-brass grounding system. Nickel-plated, brass mounting strap.

2.4 GFCI RECEPTACLES

A. General Description:

1. Straight blade, non-feed-through type.
2. Comply with NEMA WD 1, NEMA WD 6, UL 498, UL 943 Class A, and FS W-C-596.
3. Include indicator light that shows when the GFCI has malfunctioned and no longer provides proper GFCI protection.

B. Duplex GFCI Convenience Receptacles, 125 V, 20 A:

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

a. Cooper; VGF20.
b. Hubbell; GFR5352L.
c. Pass & Seymour; 2095.
d. Leviton; 7590.

C. Hospital-Grade, Duplex GFCI Convenience Receptacles, 125 V, 20 A: Comply with NEMA WD 1, NEMA WD 6 Configuration 5-20R, UL 498 Supplement sd, and FS W-C-596.

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

a. Cooper; VGFH20.
b. Hubbell; HFR8300HL.
c. Leviton; 7899-HG.
d. Pass & Seymour; 2095HG.

2.5 TOGGLE SWITCHES

A. Comply with NEMA WD 1, UL 20, and FS W-S-896.

B. Switches, 120/277 V, 20 A:

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

1) Single Pole:

2) Cooper; AH1221.
3) Hubbell; HBL1221.
4) Leviton; 1221-2.
5) Pass & Seymour; CSB20AC1.

6) Three Way:

7) Cooper; AH1223.
8) Hubbell; HBL1223.
9) Leviton; 1223-2.
10) Pass & Seymour; CSB20AC3.

11) Four Way:

12) Cooper; AH1224.
13) Hubbell; HBL1224.
14) Leviton; 1224-2.
15) Pass & Seymour; CSB20AC4.

2.6 WALL-BOX DIMMERS

A. Dimmer Switches: Modular, full-wave, solid-state units with integral, quiet on-off switches, with audible frequency and EMI/RFI suppression filters.

B. Control: Continuously adjustable slider; with single-pole or three-way switching. Comply with UL 1472.

C. LED Lamp Dimmer Switches: Modular; compatible with dimmer ballasts; trim potentiometer to adjust low-end dimming; dimmer-ballast combination capable of consistent dimming with low end not greater than 20 percent of full brightness.

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

a. Ace; 34050, 3027596.
b. Cooper: 9536AD
c. Leviton; 6633-PL, 6684, 6631, IPI06-1LX.
d. Lutron: S-600PR-WH, DV-600PR-WH, TG-600PR-WH, AY600P, Q600P, GL600, CN-600PHW, DV-603PG, S-600, S-600P, LG-600P, D-600PH, TT-300NLH, TG-603PG, HW/LP-RPM-4A-120, HW/LP-RPM-4U-120, QSG-6D, SZ-6ND, HW/LP-RPM-4A-120, HW/LP-RPM- 4U-120, HxD-6ND, QSG-6D, PHPM-WBX w/DVF-103P, PHPM-PA w/QSG-6D
e. Legrand: DrRD4W

2.7 WALL PLATES

A. Single and combination types shall match corresponding wiring devices.

1. Plate-Securing Screws: Metal with head color to match plate finish.
2. Material for Finished Spaces: Smooth, high-impact thermoplastic.
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 and damp locations.

B. Wet-Location, Weatherproof Cover Plates: NEMA 250, complying with Type 3R, weather-resistant, die-cast aluminum with lockable cover.

2.8 FINISHES

A. Device Color:

1. Wiring Devices Connected to Normal and Emergency Power System: Almond unless otherwise indicated or required by NFPA 70 or device listing.

B. Wall Plate Color: For plastic covers, match device color. Devices on Emergency system to match device color and have the word “EMERGENCY” engraved in red on the device cover.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Comply with NECA 1, including mounting heights listed in that standard, unless otherwise indicated.

B. Coordination with Other Trades:

1. Protect installed devices and their boxes. 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 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.

C. Conductors:

1. Do not strip insulation from conductors until right before they are spliced or terminated on devices.
2. Strip insulation evenly around the conductor using tools designed for the purpose. Avoid scoring or nicking of solid wire or cutting strands from stranded wire.
3. The length of free conductors at outlets for devices shall meet provisions of NFPA 70, Article 300, without pigtails.
4. Existing Conductors:

    a. Cut back and pigtail, or replace all damaged conductors.
    b. Straighten conductors that remain and remove corrosion and foreign matter.
    c. Pigtailing existing conductors is permitted, provided the outlet box is large enough.

D. Device Installation:

1. Replace devices that have been in temporary use during construction and that 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, two-thirds to three-fourths of the way around terminal screw.
6. Use a torque screwdriver when a torque is recommended or required by 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.

E. Receptacle Orientation:

1. Install ground pin of vertically mounted receptacles down, and on horizontally mounted receptacles to the left.

F. 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.

G. 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.

H. 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.

I. Adjust locations of service poles to suit arrangement of partitions and furnishings.

3.2 GFCI RECEPTACLES

A. Install non-feed-through-type GFCI receptacles where protection of downstream receptacles is not required.

3.3 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. Test Instruments: Use instruments that comply with UL 1436.
2. Test Instrument for Convenience Receptacles: Digital wiring analyzer with digital readout or illuminated digital-display 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 unacceptable.
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. 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.

C. Wiring device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

END OF SECTION 26 2726

SECTION 26 2813 - FUSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes: Cartridge fuses rated 600-V ac and less for use in enclosed switches and enclosed controllers.

1.2 ACTION SUBMITTALS

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

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 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.

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. Edison Fuse, Inc.
3. Ferraz Shawmut, Inc.
4. Littelfuse, Inc.

2.2 CARTRIDGE FUSES

A. Characteristics: NEMA FU 1, nonrenewable cartridge fuses with voltage ratings consistent with circuit voltages.

PART 3 - EXECUTION

3.1 FUSE APPLICATIONS

A. Motor Branch Circuits: Class RK1, time delay.

B. Other Branch Circuits: Class RK1, time delay.

C. Control Circuits: Class CC, fast acting.

3.2 INSTALLATION

A. Install fuses in fusible devices. Arrange fuses so rating information is readable without removing fuse.

3.3 IDENTIFICATION

A. Install labels complying with requirements for identification specified in Section 260553 "Identification for Electrical Systems" and indicating fuse replacement information on inside door of each fused switch and adjacent to each fuse block and holder.

END OF SECTION 26 2813

SECTION 26 2816 - ENCLOSED SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fusible switches.
2. Nonfusible switches.
3. Enclosures.

1.2 DEFINITIONS

A. NC: Normally closed.

B. NO: Normally open.

C. SPDT: Single pole, double throw.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of enclosed switch, circuit breaker, accessory, and component indicated.

B. Shop Drawings: For enclosed switches. Include plans, elevations, sections, details, and attachments to other work.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 FUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, with clips or bolt pads to accommodate indicated fuses, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Class R Fuse Kit: Provides rejection of other fuse types when Class R fuses are specified.
4. Lugs: Suitable for number, size, and conductor material.
5. Service-Rated Switches: Labeled for use as service equipment.

2.2 NONFUSIBLE SWITCHES

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

1. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
2. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
3. Siemens Energy & Automation, Inc.
4. Square D; a brand of Schneider Electric.

B. Type HD, Heavy Duty, Single Throw, 240-V ac, 1200 A and Smaller: UL 98 and NEMA KS 1, horsepower rated, lockable handle with capability to accept three padlocks, and interlocked with cover in closed position.

C. Accessories:

1. Equipment Ground Kit: Internally mounted and labeled for copper and aluminum ground conductors.
2. Neutral Kit: Internally mounted; insulated, capable of being grounded and bonded; labeled for copper and aluminum neutral conductors.
3. Lugs: Suitable for number, size, and conductor material.

2.3 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,, 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 INSTALLATION

A. Install individual wall-mounted switches and circuit breakers with tops at uniform height unless otherwise indicated.

B. Install fuses in fusible devices.

C. Comply with NECA 1.

3.2 IDENTIFICATION

A. Comply with requirements in Section 260553 "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.

3.3 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each enclosed switch and circuit breaker, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
2. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.

D. Enclosed switches will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies enclosed switches and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

END OF SECTION 26 2816

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SECTION 26 2923 - VARIABLE-FREQUENCY MOTOR CONTROLLERS

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes separately enclosed, preassembled, combination VFCs, rated 600 V and less, for speed control of three-phase, squirrel-cage induction motors.

B. VFC units supplied by the Manufacturer, as part of a complete system package, are not bound by the requirements of this section.

1.2 DEFINITIONS

A. BAS: Building automation system.

B. CE: Conformite Europeene (European Compliance).

C. CPT: Control power transformer.

D. EMI: Electromagnetic interference.

E. OCPD: Overcurrent protective device.

F. PID: Control action, proportional plus integral plus derivative.

G. RFI: Radio-frequency interference.

H. VFC: Variable-frequency motor controller.

1.3 ACTION SUBMITTALS

A. Product Data: For each type and rating of VFC indicated.

B. Shop Drawings: For each VFC indicated.

1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
2. Include diagrams for power, signal, and control wiring.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace VFCs that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years 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. Cerus Industrial, Inc.
2. Danfoss Inc; Danfoss Drives Div.
3. Eaton Electrical Sector; Eaton Corporation; Cutler-Hammer Business Unit.
4. Rockwell Automation, Inc; Allen-Bradley Brand.
5. Schneider Electric USA, Inc.
6. Siemens Energy & Automation, Inc.
7. Yaskawa Electric America, Inc.

2.2 SYSTEM DESCRIPTION

A. General Requirements for VFCs:

1. VFCs and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
2. Comply with NEMA ICS 7, NEMA ICS 61800-2, and UL 508A.

B. Application: Constant torque and variable torque.

C. VFC Description: Variable-frequency motor controller, consisting of power converter that employs pulse-width-modulated inverter, factory built and tested in an enclosure, with integral disconnecting means and overcurrent and overload protection; listed and labeled by an NRTL as a complete unit; arranged to provide self-protection, protection, and variable-speed control of one or more three-phase induction motors by adjusting output voltage and frequency.

1. Units suitable for operation of NEMA MG 1 motors.
2. Listed and labeled for integrated short-circuit current (withstand) rating by an NRTL acceptable to authorities having jurisdiction.

D. Design and Rating: Match load type, such as fans, blowers, and pumps; and type of connection used between motor and load such as direct or through a power-transmission connection.

E. Output Rating: Three phase; 10 to 60 Hz, with voltage proportional to frequency throughout voltage range; maximum voltage equals input voltage.

F. Unit Operating Requirements:

1. Input AC Voltage Tolerance: Plus 10 and minus 10 percent of VFC input voltage rating.
2. Input AC Voltage Unbalance: Not exceeding [3] [5] percent.
3. Input Frequency Tolerance: Plus or minus 3 percent of VFC frequency rating.
4. Minimum Efficiency: 96 percent at 60 Hz, full load.
5. Minimum Displacement Primary-Side Power Factor: 96 percent under any load or speed condition.
6. Minimum Short-Circuit Current (Withstand) Rating: 22 kA.
7. Ambient Temperature Rating: Not less than 32 deg F (0 deg C) and not exceeding 104 deg F (40 deg C).
8. Humidity Rating: Less than 95 percent (noncondensing).
9. Altitude Rating: Not exceeding 3300 feet (1000 m).
10. Vibration Withstand: Comply with NEMA ICS 61800-2.
11. Overload Capability: 1.5 times the base load current for 60 seconds; minimum of 1.8 times the base load current for three seconds.
12. Starting Torque: Minimum 100 percent of rated torque from 3 to 60 Hz.
13. Speed Regulation: Plus or minus 5 percent.
14. Output Carrier Frequency: Selectable; 0.5 to 15 kHz.
15. Stop Modes: Programmable; includes fast, free-wheel, and dc injection braking.

G. Inverter Logic: Microprocessor based, 32 bit, isolated from all power circuits.

H. Isolated Control Interface: Allows VFCs to follow remote-control signal over a minimum 40:1 speed range.

1. Signal: Electrical.

I. Internal Adjustability Capabilities:

1. Minimum Speed: 5 to 25 percent of maximum rpm.
2. Maximum Speed: 80 to 100 percent of maximum rpm.
3. Acceleration: 0.1 to 999.9 seconds.
4. Deceleration: 0.1 to 999.9 seconds.
5. Current Limit: 30 to minimum of 150 percent of maximum rating.

J. Self-Protection and Reliability Features:

1. Surge Suppression: Factory installed as an integral part of the VFC, complying with UL 1449 SPD, Type 1 or Type 2.
2. Loss of Input Signal Protection: Selectable response strategy, including speed default to a percent of the most recent speed, a preset speed, or stop; with alarm.
3. Under- and overvoltage trips.
4. Inverter overcurrent trips.
5. VFC and Motor-Overload/Overtemperature Protection: Microprocessor-based thermal protection system for monitoring VFCs and motor thermal characteristics, and for providing VFC overtemperature and motor-overload alarm and trip; settings selectable via the keypad.
6. Critical frequency rejection, with three selectable, adjustable deadbands.
7. Instantaneous line-to-line and line-to-ground overcurrent trips.
8. Loss-of-phase protection.
9. Reverse-phase protection.
10. Short-circuit protection.
11. Motor-overtemperature fault.

K. Automatic Reset/Restart: Attempt three restarts after drive fault or on return of power after an interruption and before shutting down for manual reset or fault correction; adjustable delay time between restart attempts.

L. Power-Interruption Protection: To prevent motor from re-energizing after a power interruption until motor has stopped, unless "Bidirectional Autospeed Search" feature is available and engaged.

M. Torque Boost: Automatically varies starting and continuous torque to at least 1.5 times the minimum torque to ensure high-starting torque and increased torque at slow speeds.

N. Motor Temperature Compensation at Slow Speeds: Adjustable current fall-back based on output frequency for temperature protection of self-cooled, fan-ventilated motors at slow speeds.

O. Integral Input Disconnecting Means and OCPD: NEMA KS 1, nonfusible switch, with power fuse block and current-limiting fuses with pad-lockable, door-mounted handle mechanism.
   1. Disconnect Rating: Not less than 115 percent of NFPA 70 motor full-load current rating or VFC input current rating, whichever is larger.
   2. Auxiliary Contacts: NO or NC, arranged to activate before switch blades open.

2.3 CONTROLS AND INDICATION

A. Status Lights: Door-mounted LED indicators displaying the following conditions:

   1. Power on.
   2. Run.
   3. Overvoltage.
   4. Line fault.
   5. Overcurrent.
   6. External fault.

B. Panel-Mounted Operator Station: Manufacturer's standard front-accessible, sealed keypad and plain-English-language digital display; allows complete programming, program copying, operating, monitoring, and diagnostic capability.

   1. Keypad: In addition to required programming and control keys, include keys for HAND, OFF, and AUTO modes.
   2. Security Access: Provide electronic security access to controls through identification and password with at least one level of access: View only; view and operate; and view, operate, and service.

      a. Control Authority: Supports at least four conditions: Off, local manual control at VFC, local automatic control at VFC, and automatic control through a remote source.

C. Historical Logging Information and Displays:

   1. Real-time clock with current time and date.
   2. Running log of total power versus time.
   3. Total run time.
   4. Fault log, maintaining last four faults with time and date stamp for each.

D. Indicating Devices: Digital display mounted flush in VFC door and connected to display VFC parameters including, but not limited to:

1. Output frequency (Hz).
2. Motor speed (rpm).
3. Motor status (running, stop, fault).
4. Motor current (amperes).
5. Motor torque (percent).
6. Fault or alarming status (code).
7. PID feedback signal (percent).
8. DC-link voltage (V dc).
9. Set point frequency (Hz).
10. Motor output voltage (V ac).

E. Control Signal Interfaces:

1. Electric Input Signal Interface:
   a. A minimum of six multifunction programmable digital inputs.

2. Remote Signal Inputs: Capability to accept any of the following speed-setting input signals from the BAS or other control systems:

   a. 0- to 10-V dc.
   b. 4- to 20-mA dc.
   c. Potentiometer using up/down digital inputs.
   d. Fixed frequencies using digital inputs.

3. Output Signal Interface: A minimum of one programmable analog output signal(s) (4- to 20-mA dc), which can be configured for any of the following:

   a. Output frequency (Hz).
   b. Output current (load).
   c. DC-link voltage (V dc).
   d. Motor torque (percent).
   e. Motor speed (rpm).
   f. Set point frequency (Hz).

F. PID Control Interface: Provides closed-loop set point, differential feedback control in response to dual feedback signals. Allows for closed-loop control of fans and pumps for pressure, flow, or temperature regulation.

1. Number of Loops: Two.

2.4 BYPASS SYSTEMS

A. Bypass Mode: Manual operation only; requires local operator selection at VFC. Transfer between power converter and bypass contactor, and retransfer shall only be allowed with the motor at zero speed.

2.5 ENCLOSURES

A. VFC Enclosures: NEMA 250, to comply with environmental conditions at installed location.

1. Dry and Clean Indoor Locations: Type 1.
2. Indoor Locations Subject to Dust, Falling Dirt, and Dripping Noncorrosive Liquids: Type 12.

2.6 ACCESSORIES

A. General Requirements for Control-Circuit and Pilot Devices: NEMA ICS 5; factory installed in VFC enclosure cover unless otherwise indicated.

1. Push Buttons: Unguarded.
2. Pilot Lights: Push to test.
3. Selector Switches: Rotary type.

B. Reversible NC/NO bypass contactor auxiliary contact(s).

C. Control Relays: Auxiliary and adjustable solid-state time-delay relays.

D. Phase-Failure, Phase-Reversal, and Undervoltage and Overvoltage Relays: Solid-state sensing circuit with isolated output contacts for hard-wired connections. Provide adjustable undervoltage, overvoltage, and time-delay settings.

1. Current Transformers: Continuous current rating, basic impulse insulating level (BIL) rating, burden, and accuracy class suitable for connected circuitry. Comply with IEEE C57.13.

E. Breather and drain assemblies, to maintain interior pressure and release condensation in NEMA 250, Type 12 enclosures installed outdoors or in unconditioned interior spaces subject to humidity and temperature swings.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Wall-Mounting Controllers: Install with tops at uniform height and with disconnect operating handles not higher than 79 inches (2000 mm) above finished floor, unless otherwise indicated, and by bolting units to wall or mounting on lightweight structural-steel channels bolted to wall. For controllers not on walls, provide freestanding racks complying with Section 260529 "Hangers and Supports for Electrical Systems."

B. Install fuses in each fusible-switch VFC.

C. Install fuses in control circuits if not factory installed. Comply with requirements in Section 262813 "Fuses."

D. Install heaters in thermal-overload relays. Select heaters based on actual nameplate full-load amperes after motors are installed.

E. Install, connect, and fuse thermal-protector monitoring relays furnished with motor-driven equipment.

F. Comply with NECA 1.

3.2 CONTROL WIRING INSTALLATION

A. Install wiring between VFCs and remote devices and facility's central-control system. Comply with requirements in Section 260523 "Control-Voltage Electrical Power Cables."

B. Bundle, train, and support wiring in enclosures.

3.3 IDENTIFICATION

A. Identify VFCs, components, and control wiring. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

1. Identify field-installed conductors, interconnecting wiring, and components; provide warning signs.
2. Label each VFC with engraved nameplate.
3. Label each enclosure-mounted control and pilot device.

3.4 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Acceptance Testing Preparation:

1. Test insulation resistance for each VFC element, bus, component, connecting supply, feeder, and control circuit.
2. Test continuity of each circuit.

C. Tests and Inspections:

1. Inspect VFC, wiring, components, connections, and equipment installation. Test and adjust controllers, components, and equipment.
2. Test insulation resistance for each VFC element, component, connecting motor supply, feeder, and control circuits.
3. Test continuity of each circuit.
4. Verify that voltages at VFC locations are within 10 percent of motor nameplate rated voltages. If outside this range for any motor, notify Construction Manager before starting the motor(s).
5. Test each motor for proper phase rotation.
6. Perform tests according to the Inspection and Test Procedures for Adjustable Speed Drives stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
7. Correct malfunctioning units on-site, where possible, and retest to demonstrate compliance; otherwise, replace with new units and retest.
8. Test and adjust controls, remote monitoring, and safeties. Replace damaged and malfunctioning controls and equipment.

D. VFCs will be considered defective if they do not pass tests and inspections.

E. Prepare test and inspection reports, including a certified report that identifies the VFC and describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations made after remedial action.

3.5 ADJUSTING

A. Program microprocessors for required operational sequences, status indications, alarms, event recording, and display features. Clear events memory after final acceptance testing and prior to Substantial Completion.

B. Set field-adjustable switches, auxiliary relays, time-delay relays, timers, and overload-relay pickup and trip ranges.

C. Set the taps on reduced-voltage autotransformer controllers.

3.6 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, reprogram, and maintain VFCs.

END OF SECTION 26 2923

SECTION 26 3213 - ENGINE GENERATORS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes packaged engine-generator sets for [emergency] [standby] power supply with the following features:

1. Diesel engine.
2. Unit-mounted cooling system.
3. Unit-mounted control and monitoring.
4. Remote mounted monitoring panel
5. Outdoor enclosure.

B. See Section 263600 "Transfer Switches" for transfer switches including sensors and relays to initiate automatic-starting and -stopping signals for engine-generator sets.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of packaged engine generator and accessory indicated.

B. Shop Drawings: Detail equipment assemblies and indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.

1.3 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.4 QUALITY ASSURANCE

A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.

B. Manufacturer Qualifications: A qualified manufacturer. Maintain, within 200 miles (321 km) of Project site, a service center capable of providing training, parts, and emergency maintenance repairs.

C. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

D. Comply with ASME B15.1.

E. Comply with NFPA 37.

F. Comply with NFPA 70.

G. Comply with NFPA 99.

H. Comply with NFPA 110 requirements for Level 1 emergency power supply system.

I. Comply with UL 2200.

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.

1.5 PROJECT CONDITIONS

A. Environmental Conditions: Engine-generator system shall withstand the following environmental conditions without mechanical or electrical damage or degradation of performance capability:

1. Ambient Temperature: Minus 15 to plus 40 deg C.
2. Relative Humidity: 0 to 95 percent.
3. Altitude: Sea level to 1000 feet (300 m).

1.6 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 years 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. Caterpillar; Engine Div.
2. Generac Power Systems, Inc.
3. Kohler Co.; Generator Division.
4. Magnetek, Inc.
5. Onan/Cummins Power Generation; Industrial Business Group.
6. Spectrum Detroit Diesel.

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.
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.

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 ENGINE

A. Fuel: Fuel oil, Grade DF-2.

B. Rated Engine Speed: 1800 rpm.

C. Maximum Piston Speed for Four-Cycle Engines: 2250 fpm (11.4 m/s).

D. Lubrication System: The following items are mounted on engine or skid:

1. Filter and Strainer: Rated to remove 90 percent of particles 5 micrometers and smaller while passing full flow.
2. Thermostatic Control Valve: Control flow in system to maintain optimum oil temperature. Unit shall be capable of full flow and is designed to be fail-safe.
3. Crankcase Drain: Arranged for complete gravity drainage to an easily removable container with no disassembly and without use of pumps, siphons, special tools, or appliances.

E. Engine Fuel System:

1. Main Fuel Pump: Mounted on engine. Pump ensures adequate primary fuel flow under starting and load conditions.
2. Relief-Bypass Valve: Automatically regulates pressure in fuel line and returns excess fuel to source.
3. Dual Natural Gas with LP-Gas Backup (Vapor-Withdrawal) System:

    a. Carburetor.
    b. Secondary Gas Regulators: One for each fuel type.
    c. Fuel-Shutoff Solenoid Valves: One for each fuel source.
    d. Flexible Fuel Connectors: One for each fuel source.

F. Coolant Jacket Heater: Electric-immersion type, factory installed in coolant jacket system. Comply with NFPA 110 requirements for Level 1 equipment for heater capacity.

G. Governor: Adjustable isochronous, with speed sensing.

H. Cooling System: Closed loop, liquid cooled, with radiator factory mounted on engine-generator-set mounting frame and integral engine-driven coolant pump.

1. Coolant: Solution of 50 percent ethylene-glycol-based antifreeze and 50 percent water, with anticorrosion additives as recommended by engine manufacturer.
2. Temperature Control: Self-contained, thermostatic-control valve modulates coolant flow automatically to maintain optimum constant coolant temperature as recommended by engine manufacturer.

I. Muffler/Silencer: Critical type, sized as recommended by engine manufacturer and selected with exhaust piping system to not exceed engine manufacturer's engine backpressure requirements.

1. Minimum sound attenuation of 25 dB at 500 Hz.
2. Sound level measured at a distance of 10 feet (3 m) from exhaust discharge after installation is complete shall be 85 dBA or less.

J. Air-Intake Filter: Heavy-duty, engine-mounted air cleaner with replaceable dry-filter element and "blocked filter" indicator.

K. Starting System: 24-V electric, with negative ground.

1. Components: Sized so they will not be damaged during a full engine-cranking cycle with ambient temperature at maximum specified in Part 1 "Project Conditions" Article.
2. Cranking Motor: Heavy-duty unit that automatically engages and releases from engine flywheel without binding.
3. Cranking Cycle: As required by NFPA 110 for system level specified.
4. Battery: Adequate capacity within ambient temperature range specified in Part 1 "Project Conditions" Article to provide specified cranking cycle at least twice without recharging.
5. Battery-Charging Alternator: Factory mounted on engine with solid-state voltage regulation and 35-A minimum continuous rating.

    a. Battery Charger: Current-limiting, automatic-equalizing and float-charging type. Unit shall comply with UL 1236.

2.4 FUEL OIL STORAGE

A. Comply with NFPA 30.

B. Base-Mounted Fuel Oil Tank: Factory installed and piped, complying with UL 142 fuel oil tank. Features include the following:

1. Tank level indicator.
2. Capacity: Fuel for twenty-fourt (24) hours' continuous operation at 100 percent rated power output.
3. Vandal-resistant fill cap.
4. Containment Provisions: Comply with requirements of authorities having jurisdiction.

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.

B. Manual Starting System Sequence of Operation: Switching on-off switch on the generator control panel to the on position starts generator set. The off position of same switch initiates generator-set shutdown. When generator set is running, specified system or equipment failures or derangements automatically shut down generator set and initiate alarms.

C. Configuration: Operating and safety indications, protective devices, basic system controls, and engine gages shall be grouped in a common control and monitoring panel mounted on the generator set. Mounting method shall isolate the control panel from generator-set vibration.

D. Indicating and Protective Devices and Controls: As required by NFPA 110 for Level [1] [2] system, and the following:

1. AC voltmeter.
2. AC ammeter.
3. AC frequency meter.
4. DC voltmeter (alternator battery charging).
5. Engine-coolant temperature gage.
6. Engine lubricating-oil pressure gage.
7. Running-time meter.
8. Ammeter-voltmeter, phase-selector switch(es).
9. Generator-voltage adjusting rheostat.
10. Fuel tank derangement alarm.
11. Fuel tank high-level shutdown of fuel supply alarm.
12. Generator overload.

E. Supporting Items: Include sensors, transducers, terminals, relays, and other devices and include wiring required to support specified items. Locate sensors and other supporting items on engine or generator, unless otherwise indicated.

F. Common Remote Audible Alarm: Comply with NFPA 110 requirements for Level 1 systems. Include necessary contacts and terminals in control and monitoring panel.

1. Overcrank shutdown.
2. Coolant low-temperature alarm.
3. Control switch not in auto position.

4. Battery-charger malfunction alarm.
5. Battery low-voltage alarm.

G. Remote Alarm Annunciator: Comply with NFPA 99. An LED labeled with proper alarm conditions shall identify each alarm event and a common audible signal shall sound for each alarm condition. Silencing switch in face of panel shall silence signal without altering visual indication. Connect so that after an alarm is silenced, clearing of initiating condition will reactivate alarm until silencing switch is reset. Cabinet and faceplate are surface- or flush-mounting type to suit mounting conditions indicated.

2.6 GENERATOR OVERCURRENT AND FAULT PROTECTION

A. Generator Circuit Breakers: 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. Mounting: Adjacent to or integrated with control and monitoring panel.

B. Ground-Fault Indication: Comply with NFPA 70, "Emergency System" signals for ground-fault. Integrate ground-fault alarm indication with other generator-set alarm indications.

2.7 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. Instrument Transformers: Mounted within generator enclosure.

H. 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.

I. Strip Heater: Thermostatically controlled unit arranged to maintain stator windings above dew point.

J. Windings: Two-thirds pitch stator winding and fully linked amortisseur winding.

K. Subtransient Reactance: 12 percent, maximum.

2.8 OUTDOOR GENERATOR-SET ENCLOSURE

A. Description: Vandal-resistant, weatherproof steel housing, wind resistant up to 100 mph (160 km/h). Multiple panels shall be lockable and provide adequate access to components requiring maintenance. Panels shall be removable by one person without tools. Instruments and control shall be mounted within enclosure.

B. Engine Cooling Airflow through Enclosure: Maintain temperature rise of system components within required limits when unit operates at 110 percent of rated load for 2 hours with ambient temperature at top of range specified in system service conditions.

1. Louvers: Fixed-engine, cooling-air inlet and discharge. Storm-proof and drainable louvers prevent entry of rain and snow.
2. Automatic Dampers: At engine cooling-air inlet and discharge. Dampers shall be closed to reduce enclosure heat loss in cold weather when unit is not operating.

C. Interior Lights with Switch: Factory-wired, vaporproof-type fixtures within housing; arranged to illuminate controls and accessible interior. Arrange for external electrical connection.

1. AC lighting system and connection point for operation when remote source is available.
2. DC lighting system for operation when remote source and generator are both unavailable.

D. Convenience Outlets: Factory wired, GFCI. Arrange for external electrical connection.

2.9 VIBRATION ISOLATION DEVICES

A. Restrained Spring Isolators: Freestanding, steel, open-spring isolators with seismic restraint.

1. Housing: Steel with resilient vertical-limit stops to prevent spring extension due to wind loads or if weight is removed; factory-drilled baseplate bonded to 1/4-inch- (6-mm-) thick, elastomeric isolator pad attached to baseplate underside; and adjustable equipment mounting and leveling bolt that acts as blocking during installation.
2. Outside Spring Diameter: Not less than 80 percent of compressed height of the spring at rated load.
3. Minimum Additional Travel: 50 percent of 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.

2.10 FINISHES

A. Indoor and Outdoor Enclosures and Components: Manufacturer's standard finish over corrosion-resistant pretreatment and compatible primer.

PART 3 - EXECUTION

3.1 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 Section 260548 "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 Section 232116 "Hydronic Piping Specialties."Section 15179 "Hydronic Piping Specialties."

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 Section 232116 "Hydronic Piping Specialties."Section 15179 "Hydronic Piping Specialties."

E. Electrical Wiring: Install electrical devices furnished by equipment manufacturers but not specified to be factory mounted.

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

G. Connect fuel, cooling-system, and exhaust-system piping adjacent to packaged engine generator to allow service and maintenance.

H. Connect engine exhaust pipe to engine with flexible connector.

I. Connect fuel piping to engines with a gate valve and union and flexible connector.

J. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

K. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

L. Identify system components according to Section 230553 "Identification for HVAC Piping and Equipment" and Section 260553 "Identification for Electrical Systems."

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections and prepare test reports.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform tests recommended by manufacturer and each electrical test and visual and mechanical inspection 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-System Back-Pressure Test: Use a manometer with a scale exceeding 40-inch wg (120 kPa). Connect to exhaust line close to engine exhaust manifold. Verify that back pressure at full-rated load is within manufacturer's written allowable limits for the engine.
7. Exhaust Emissions Test: Comply with applicable government test criteria.
8. 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.
9. 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.
10. 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. Leak Test: After installation, charge system and test for leaks. Repair leaks and retest until no leaks exist.

E. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.

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

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

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

I. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation resistances, time delays, and other values and observations. Attach a label or tag to each tested component indicating satisfactory completion of tests.

3.3 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain packaged engine generators. Refer to Section 017900 "Demonstration and Training."

END OF SECTION 26 3213

SECTION 26 3600 - TRANSFER SWITCHES

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes automatic transfer switches rated 600 V and less.

1.2 ACTION SUBMITTALS

A. Product Data: Include rated capacities, weights, operating characteristics, furnished specialties, and accessories.

B. Shop Drawings: Dimensioned plans, elevations, sections, and details showing minimum clearances, conductor entry provisions, gutter space, installed features and devices, and material lists for each switch specified.

1.3 INFORMATIONAL SUBMITTALS

1. Dimensioned Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
2. Detailed description of equipment anchorage devices on which the certification is based.

B. Field quality-control reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

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

B. Comply with NEMA ICS 1.

C. Comply with NFPA 70.

D. Comply with NFPA 99.

E. Comply with NFPA 110.

F. Comply with UL 1008 unless requirements of these Specifications are stricter.

PART 2 - PRODUCTS

2.1 MANUFACTURED UNITS

A. Contactor Transfer Switches:

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

a. AC Data Systems, Inc.
b. Caterpillar; Engine Div.
c. Emerson; ASCO Power Technologies, LP.
d. Generac Power Systems, Inc.
e. GE Zenith Controls.
f. Kohler Power Systems; Generator Division.
g. Onan/Cummins Power Generation; Industrial Business Group.
h. Russelectric, Inc.
i. Spectrum Detroit Diesel.

2.2 GENERAL TRANSFER-SWITCH PRODUCT REQUIREMENTS

A. Indicated Current Ratings: Apply as defined in UL 1008 for continuous loading and total system transfer, including tungsten filament lamp loads not exceeding 30 percent of switch ampere rating, unless otherwise indicated.

B. Tested Fault-Current Closing and Withstand Ratings: Adequate for duty imposed by protective devices at installation locations in Project under the fault conditions indicated, based on testing according to UL 1008.

1. Where transfer switch includes internal fault-current protection, rating of switch and trip unit combination shall exceed indicated fault-current value at installation location.

C. Solid-State Controls: Repetitive accuracy of all settings shall be plus or minus 2 percent or better over an operating temperature range of minus 20 to plus 70 deg C.

D. Resistance to Damage by Voltage Transients: Components shall meet or exceed voltage-surge withstand capability requirements when tested according to IEEE C62.41. Components shall meet or exceed voltage-impulse withstand test of NEMA ICS 1.

E. Electrical Operation: Accomplish by a nonfused, momentarily energized solenoid or electric-motor-operated mechanism, mechanically and electrically interlocked in both directions.

F. Switch Characteristics: Designed for continuous-duty repetitive transfer of full-rated current between active power sources.

1. Limitation: Switches using molded-case switches or circuit breakers or insulated-case circuit-breaker components are not acceptable.
2. Switch Action: Double throw; mechanically held in both directions.
3. Contacts: Silver composition or silver alloy for load-current switching. Conventional automatic transfer-switch units, rated 225 A and higher, shall have separate arcing contacts.

G. Neutral Terminal: Solid and fully rated, unless otherwise indicated.

H. Oversize Neutral: Ampacity and switch rating of neutral path through units indicated for oversize neutral shall be double the nominal rating of circuit in which switch is installed.

I. Battery Charger: For generator starting batteries.

1. Float type rated 10 A.
2. Ammeter to display charging current.
3. Fused ac inputs and dc outputs.

J. Enclosures: General-purpose NEMA 250, Type 1, complying with NEMA ICS 6 and UL 508, unless otherwise indicated.

2.3 AUTOMATIC TRANSFER SWITCHES

A. Comply with Level 1 equipment according to NFPA 110.

B. Switching Arrangement: Double-throw type, incapable of pauses or intermediate position stops during normal functioning, unless otherwise indicated.

C. Signal-Before-Transfer Contacts: A set of normally open/normally closed dry contacts operates in advance of retransfer to normal source. Interval is adjustable from 1 to 30 seconds.

D. In-Phase Monitor: Factory-wired, internal relay controls transfer so it occurs only when the two sources are synchronized in phase.

E. Automatic Transfer-Switch Features:

1. Undervoltage Sensing for Each Phase of Normal Source: Sense low phase-to-ground voltage on each phase. Pickup voltage shall be adjustable from 85 to 100 percent of nominal, and dropout voltage is adjustable from 75 to 98 percent of pickup value. Factory set for pickup at 90 percent and dropout at 85 percent.
2. Adjustable Time Delay: For override of normal-source voltage sensing to delay transfer and engine start signals. Adjustable from zero to six seconds, and factory set for one second.
3. Voltage/Frequency Lockout Relay: Prevent premature transfer to generator. Pickup voltage shall be adjustable from 85 to 100 percent of nominal. Factory set for pickup at 90 percent. Pickup frequency shall be adjustable from 90 to 100 percent of nominal. Factory set for pickup at 95 percent.
4. Time Delay for Retransfer to Normal Source: Adjustable from 0 to 30 minutes, and factory set for 10 minutes to automatically defeat delay on loss of voltage or sustained undervoltage of emergency source, provided normal supply has been restored.
5. Test Switch: Simulate normal-source failure.
6. Switch-Position Pilot Lights: Indicate source to which load is connected.
7. Source-Available Indicating Lights: Supervise sources via transfer-switch normal- and emergency-source sensing circuits.

    a. Normal Power Supervision: Green light with nameplate engraved "Normal Source Available."
    b. Emergency Power Supervision: Red light with nameplate engraved "Emergency Source Available."

8. Unassigned Auxiliary Contacts: Two normally open, single-pole, double-throw contacts for each switch position, rated 10 A at 240-V ac.

9. Transfer Override Switch: Overrides automatic retransfer control so automatic transfer switch will remain connected to emergency power source regardless of condition of normal source. Pilot light indicates override status.
10. Engine Starting Contacts: One isolated and normally closed, and one isolated and normally open; rated 10 A at 32-V dc minimum.
11. Engine Shutdown Contacts: Instantaneous; shall initiate shutdown sequence at remote engine-generator controls after retransfer of load to normal source.
12. Engine Shutdown Contacts: Time delay adjustable from zero to five minutes, and factory set for five minutes. Contacts shall initiate shutdown at remote engine-generator controls after retransfer of load to normal source.
13. Engine-Generator Exerciser: Solid-state, programmable-time switch starts engine generator and transfers load to it from normal source for a preset time, then retransfers and shuts down engine after a preset cool-down period. Initiates exercise cycle at preset intervals adjustable from 7 to 30 days. Running periods are adjustable from 10 to 30 minutes. Factory settings are for 7-day exercise cycle, 20-minute running period, and 5-minute cool-down period. Exerciser features include the following:

    a. Exerciser Transfer Selector Switch: Permits selection of exercise with and without load transfer.
    b. Push-button programming control with digital display of settings.
    c. Integral battery operation of time switch when normal control power is not available.

2.4 SOURCE QUALITY CONTROL

A. Factory test and inspect components, assembled switches, and associated equipment. Ensure proper operation. Check transfer time and voltage, frequency, and time-delay settings for compliance with specified requirements. Perform dielectric strength test complying with NEMA ICS 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Identify components according to Section 260553 "Identification for Electrical Systems."

B. Set field-adjustable intervals and delays, relays, and engine exerciser clock.

3.2 CONNECTIONS

A. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."

B. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to test and inspect components, assemblies, and equipment installations, including connections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing equipment and after electrical circuitry has been energized, test for compliance with requirements.
2. Perform each visual and mechanical inspection and electrical test stated in NETA Acceptance Testing Specification. Certify compliance with test parameters.
3. Measure insulation resistance phase-to-phase and phase-to-ground with insulation-resistance tester. Use test voltages and procedure recommended by manufacturer. Comply with manufacturer's specified minimum resistance.

    a. Check for electrical continuity of circuits and for short circuits.
    b. Inspect for physical damage, proper installation and connection, and integrity of barriers, covers, and safety features.
    c. Verify that manual transfer warnings are properly placed.
    d. Perform manual transfer operation.

4. After energizing circuits, demonstrate interlocking sequence and operational function for each switch at least three times.

    a. Simulate power failures of normal source to automatic transfer switches and of emergency source with normal source available.
    b. Simulate loss of phase-to-ground voltage for each phase of normal source.
    c. Verify time-delay settings.
    d. Verify pickup and dropout voltages by data readout or inspection of control settings.
    e. Perform contact-resistance test across main contacts and correct values exceeding 500 microhms and values for 1 pole deviating by more than 50 percent from other poles.
    f. Verify proper sequence and correct timing of automatic engine starting, transfer time delay, retransfer time delay on restoration of normal power, and engine cool-down and shutdown.

5. Ground-Fault Tests: Coordinate with testing of ground-fault protective devices for power delivery from both sources.

    a. Verify grounding connections and locations and ratings of sensors.

C. Coordinate tests with tests of generator and run them concurrently.

D. Report results of tests and inspections in writing. Record adjustable relay settings and measured insulation and contact resistances and time delays. Attach a label or tag to each tested component indicating satisfactory completion of tests.

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

F. Prepare test and inspection reports.

G. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each switch. Remove all access panels so joints and connections are accessible to portable scanner.

1. Follow-up Infrared Scanning: Perform an additional follow-up infrared scan of each switch 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 switches checked and that describes scanning results. Include notation of deficiencies detected, remedial action taken, and observations after remedial action.

3.4 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain transfer switches and related equipment as specified below. Refer to Section 017900 "Demonstration and Training."

B. Coordinate this training with that for generator equipment.

END OF SECTION 26 3600

SECTION 26 4313 - TRANSIENT-VOLTAGE SUPPRESSION

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes field-mounted TVSS for low-voltage (120 to 600 V) power distribution and control equipment.

1.2 ACTION SUBMITTALS

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

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

B. Warranties: Sample of special warranties.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

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

B. Comply with IEEE C62.41.2 and test devices according to IEEE C62.45.

C. Comply with NEMA LS 1.

D. Comply with UL 1283 and UL 1449.

E. Comply with NFPA 70.

1.6 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of surge suppressors that fail in materials or workmanship within specified warranty period.

1. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SERVICE ENTRANCE PANELBOARD SUPPRESSORS

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

1. ABB USA.
2. AC Data Solutions.
3. Advanced Protection Technologies Inc. (APT).
4. Atlantic Scientific.
5. Current Technology Inc.; Danaher Power Solutions.
6. Danaher Power Solutions; United Power Products.
7. Eaton Electrical Inc.; Cutler-Hammer Business Unit.
8. General Electric Company; GE Consumer & Industrial - Electrical Distribution.
9. Intermatic, Inc.
10. LEA International.
11. Leviton Mfg. Company Inc.
12. Liebert Corporation; a division of Emerson Network Power.
13. Northern Technologies, Inc.; a division of Emerson Network Power.
14. Siemens Energy & Automation, Inc.
15. Square D; a brand of Schneider Electric.
16. Surge Suppression Incorporated.

B. Surge Protection Devices:

1. Non-modular.

2. Integral or remotely mounted to Panelboard
3. LED indicator lights for power and protection status.
4. Comply with UL 1449.
5. Fuses, rated at 200-kA interrupting capacity.
6. Fabrication using bolted compression lugs for internal wiring.
7. Integral disconnect switch.
8. Redundant suppression circuits.
9. Arrangement with copper bus bars and for bolted connections to phase buses, neutral bus, and ground bus.
10. Arrangement with wire connections to phase buses, neutral bus, and ground bus.
11. LED indicator lights for power and protection status.

C. Peak Single-Impulse Surge Current Rating: 320 kA per mode/640 kA per phase.

D. Minimum single impulse current ratings, using 8-by-20-mic.sec waveform described in IEEE C62.41.2

1. Line to Neutral: 70,000 A.
2. Line to Ground: 70,000 A.
3. Neutral to Ground: 50,000 A.

E. Protection modes and UL 1449 SVR for grounded wye circuits with 208Y/120 V, 3-phase, 4-wire circuits shall be as follows:

1. Line to Neutral: 400 V for 208Y/120 V.
2. Line to Ground: 400 V for 208Y/120 V.

3. Neutral to Ground: 400 V for 208Y/120 V.

2.2 ENCLOSURES

A. Indoor Enclosures: NEMA 250 Type 1.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Install remote TVSS devices at service entrance on load side, with ground lead bonded to service entrance ground.

B. Install TVSS devices for panelboards and auxiliary panels with conductors or buses between suppressor and points of attachment as short and straight as possible. Do not exceed manufacturer's recommended lead length. Do not bond neutral and ground.

1. Provide multiple, 60-A circuit breaker as a dedicated disconnecting means for TVSS unless otherwise indicated.

3.2 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

B. Tests and Inspections:

1. Perform each visual and mechanical inspection and electrical test stated in NETA ATS, "Surge Arresters, Low-Voltage Surge Protection Devices" Section. Certify compliance with test parameters.
2. After installing TVSS devices but before electrical circuitry has been energized, test for compliance with requirements.
3. Complete startup checks according to manufacturer's written instructions.

C. TVSS device will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.3 STARTUP SERVICE

A. Do not energize or connect service entrance equipment and panelboards to their sources until TVSS devices are installed and connected.

B. Do not perform insulation resistance tests of the distribution wiring equipment with the TVSS installed. Disconnect before conducting insulation resistance tests, and reconnect immediately after the testing is over.

3.4 DEMONSTRATION

A. Train Owner's maintenance personnel to maintain TVSS devices.

END OF SECTION 26 4313

SECTION 26 5100 - INTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Interior lighting fixtures, lamps, and ballasts.
2. Exit signs.
3. Lighting fixture supports.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of lighting fixture, arranged in order of fixture designation. Include data on features, accessories, and finishes.

B. Shop Drawings: Show details of nonstandard or custom lighting fixtures. Indicate dimensions, weights, methods of field assembly, components, features, and accessories. Product Certificates: For each type of ballast for bi-level and dimmer-controlled fixtures, from manufacturer.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control reports.

1.4 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 NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

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. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Steel unless otherwise indicated. Form and support to prevent warping and sagging.

E. 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.

F. 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.

2.3 BALLASTS FOR LINEAR FLUORESCENT LAMPS

A. General Requirements for Electronic Ballasts:

1. Comply with UL 935 and with ANSI C82.11.
2. Designed for type and quantity of lamps served.
3. Ballasts shall be designed for full light output unless another BF, dimmer, or bi-level control is indicated.
4. Sound Rating: Class A.
5. Total Harmonic Distortion Rating: Less than 10 percent.
6. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
7. Operating Frequency: 42 kHz or higher.
8. Lamp Current Crest Factor: 1.7 or less.
9. BF: 0.88 or higher.
10. Power Factor: 0.95 or higher.

B. Luminaires controlled by occupancy sensors shall have programmed-start ballasts.

C. Ballasts for Residential Applications: Fixtures designated as "Residential" may use low-power-factor electronic ballasts having a Class B sound rating and total harmonic distortion of approximately 30 percent.

2.4 BALLASTS FOR COMPACT FLUORESCENT LAMPS

A. Description: Electronic-programmed rapid-start type, complying with UL 935 and with ANSI C 82.11, designed for type and quantity of lamps indicated. Ballast shall be designed for full light output unless dimmer or bi-level control is indicated:

1. Lamp end-of-life detection and shutdown circuit.
2. Automatic lamp starting after lamp replacement.
3. Sound Rating: Class A.
4. Total Harmonic Distortion Rating: Less than 20 percent.

5. Transient Voltage Protection: IEEE C62.41.1 and IEEE C62.41.2, Category A or better.
6. Operating Frequency: 20 kHz or higher.
7. Lamp Current Crest Factor: 1.7 or less.
8. BF: 0.95 or higher unless otherwise indicated.
9. Power Factor: 0.95 or higher.
10. Interference: Comply with 47 CFR 18, Ch. 1, Subpart C, for limitations on electromagnetic and radio-frequency interference for nonconsumer equipment.

2.5 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.

2.6 FLUORESCENT LAMPS

A. T8 rapid-start lamps, rated 32 W maximum, nominal length of 48 inches (1220 mm), 2800 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life 20,000 hours unless otherwise indicated.

B. T8 rapid-start lamps, rated 17 W maximum, nominal length of 24 inches (610 mm), 1300 initial lumens (minimum), CRI 75 (minimum), color temperature 3500 K, and average rated life of 20,000 hours unless otherwise indicated.

C. Compact Fluorescent Lamps: 4-Pin, CRI 80 (minimum), color temperature 3500 K, average rated life of 10,000 hours at three hours operation per start unless otherwise indicated.

1. 13 W: T4, double or triple tube, rated 900 initial lumens (minimum).
2. 18 W: T4, double or triple tube, rated 1200 initial lumens (minimum).
3. 26 W: T4, double or triple tube, rated 1800 initial lumens (minimum).
4. 32 W: T4, triple tube, rated 2400 initial lumens (minimum).

2.7 LIGHTING FIXTURE SUPPORT COMPONENTS

A. Comply with Section 260529 "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.

PART 3 - EXECUTION

3.1 INSTALLATION

A. Lighting fixtures: Set level, plumb, and square with ceilings and walls. Install lamps in each fixture.

B. Comply with NFPA 70 for minimum fixture supports.

C. 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.

D. Adjust aimable lighting fixtures to provide required light intensities.

E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

END OF SECTION 26 5100

SECTION 26 5600 - EXTERIOR LIGHTING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Exterior luminaires with lamps and ballasts.
2. Poles and accessories.

1.2 ACTION SUBMITTALS

A. Product Data: For each luminaire, pole, and support component, arranged in order of lighting unit designation. Include data on features, accessories, and finishes.

B. Shop Drawings: Anchor-bolt templates keyed to specific poles and certified by manufacturer.

1.3 QUALITY ASSURANCE

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

B. Comply with IEEE C2, "National Electrical Safety Code."

C. Comply with NFPA 70.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

A. Products: Subject to compliance with requirements, provide product indicated on Drawings.

2.2 GENERAL REQUIREMENTS FOR LUMINAIRES

A. Luminaires shall comply with UL 1598 and be listed and labeled for installation in wet locations by an NRTL acceptable to authorities having jurisdiction.

1. LER Tests Incandescent Fixtures: Where LER is specified, test according to NEMA LE 5A.
2. LER Tests HID Fixtures: Where LER is specified, test according to NEMA LE 5B.

B. Lateral Light Distribution Patterns: Comply with IESNA RP-8 for parameters of lateral light distribution patterns indicated for luminaires.

C. Metal Parts: Free of burrs and sharp corners and edges.

D. Sheet Metal Components: Corrosion-resistant aluminum unless otherwise indicated. Form and support to prevent warping and sagging.

E. Housings: Rigidly formed, weather- and light-tight enclosures that will not warp, sag, or deform in use. Provide filter/breather for enclosed luminaires.

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. Doors shall be removable for cleaning or replacing lenses. Designed to disconnect ballast when door opens.

G. Exposed Hardware Material: Stainless steel.

H. Plastic Parts: High resistance to yellowing and other changes due to aging, exposure to heat, and UV radiation.

I. Reflecting surfaces shall have minimum reflectance as follows unless otherwise indicated:

1. White Surfaces: 85 percent.
2. Specular Surfaces: 83 percent.
3. Diffusing Specular Surfaces: 75 percent.

J. Lenses and Refractors Gaskets: Use heat- and aging-resistant resilient gaskets to seal and cushion lenses and refractors in luminaire doors.

K. Luminaire Finish: Manufacturer's standard paint applied to factory-assembled and -tested luminaire before shipping. Where indicated, match finish process and color of pole or support materials.

L. Factory-Applied Finish for Steel Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or SSPC-SP 8, "Pickling."
2. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

    a. Color: As selected from manufacturer's standard catalog of colors.
    b. Color: Match Architect's sample of manufacturer's standard color.
    c. Color: As selected by Architect from manufacturer's full range.

M. Factory-Applied Finish for Aluminum Luminaires: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.
2. Class I, Color Anodic Finish: AA-M32C22A42/A44 (Mechanical Finish: medium satin; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 611.

a. Color: Dark bronze.

N. Factory-Applied Labels: Comply with UL 1598. Include recommended lamps and 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 ballast characteristics:

a. "USES ONLY" and include specific lamp type.
b. Lamp tube configuration (twin, quad, triple), base type, and nominal wattage for compact fluorescent luminaires.
c. Lamp type, wattage, bulb type (ED17, BD56, etc.) and coating (clear or coated) for HID luminaires.
d. Start type (preheat, rapid start, instant start) compact fluorescent luminaires.
e. ANSI ballast type (M98, M57, etc.) for HID luminaires.
f. CCT and CRI for all luminaires.

2.3 FLUORESCENT BALLASTS AND LAMPS

A. Ballasts for Low-Temperature Environments:
1. Temperatures Minus 20 Deg F (Minus 29 Deg C) and Higher: Electromagnetic type designed for use with indicated lamp types.

B. Ballast Characteristics:

1. Power Factor: 90 percent, minimum.
2. Sound Rating: Class A.
3. Total Harmonic Distortion Rating: Less than 10 percent.
4. Electromagnetic Ballasts: Comply with ANSI C82.1, energy-saving, high power factor, Class P, automatic-reset thermal protection.
5. Case Temperature for Compact Lamp Ballasts: 65 deg C, maximum.
6. Transient-Voltage Protection: Comply with IEEE C62.41.1 and IEEE C62.41.2, Category A or better.

C. Low-Temperature Lamp Capability: Rated for reliable starting and operation with ballast provided at temperatures minus 20 deg F (minus 29 deg C) and higher.

2.4 BALLASTS FOR HID LAMPS

A. Comply with ANSI C82.4 and UL 1029 and capable of open-circuit operation without reduction of average lamp life. Include the following features unless otherwise indicated:

1. Ballast Circuit: Constant-wattage autotransformer or regulating high-power-factor type.
2. Minimum Starting Temperature: Minus 22 deg F (Minus 30 deg C).
3. Normal Ambient Operating Temperature: 104 deg F (40 deg C).
4. Ballast Fuses: One in each ungrounded power supply conductor. Voltage and current ratings as recommended by ballast manufacturer.

2.5 HID LAMPS

A. Metal-Halide Lamps: ANSI C78.43, with minimum CRI 65, and CCT color temperature 4000 K.

B. Pulse-Start, Metal-Halide Lamps: Minimum CRI 65, and CCT color temperature 4000 K.

2.6 GENERAL REQUIREMENTS FOR POLES AND SUPPORT COMPONENTS

A. Structural Characteristics: Comply with AASHTO LTS-4-M.

1. Wind-Load Strength of Poles: Adequate at indicated heights above grade without failure, permanent deflection, or whipping in steady winds of speed indicated in "Structural Analysis Criteria for Pole Selection" Article.
2. Strength Analysis: For each pole, multiply the actual equivalent projected area of luminaires and brackets by a factor of 1.1 to obtain the equivalent projected area to be used in pole selection strength analysis.

B. Luminaire Attachment Provisions: Comply with luminaire manufacturers' mounting requirements. Use stainless-steel fasteners and mounting bolts unless otherwise indicated.

C. Mountings, Fasteners, and Appurtenances: Corrosion-resistant items compatible with support components.

1. Materials: Shall not cause galvanic action at contact points.
2. Anchor Bolts, Leveling Nuts, Bolt Caps, and Washers: Hot-dip galvanized after fabrication unless otherwise indicated.
3. Anchor-Bolt Template: Plywood or steel.

D. Handhole: Oval-shaped, with minimum clear opening of 2-1/2 by 5 inches (65 by 130 mm), with cover secured by stainless-steel captive screws. Provide on all, except wood poles.

E. Concrete Pole Foundations: Cast in place, with anchor bolts to match pole-base flange. Concrete, reinforcement, and formwork are specified on drawings.

F. Breakaway Supports: Frangible breakaway supports, tested by an independent testing agency acceptable to authorities having jurisdiction, according to AASHTO LTS-4-M.

2.7 STEEL POLES

A. Poles: Comply with ASTM A 500, Grade B, carbon steel with a minimum yield of 46,000 psig (317 MPa); one-piece construction up to 40 feet (12 m) in height with access handhole in pole wall.

1. Shape: Square, tapered with hinged base.
2. Mounting Provisions: Butt flange for bolted mounting on foundation or breakaway support.

B. Steel Mast Arms: Single-arm type, continuously welded to pole attachment plate. Material and finish same as pole.

C. Brackets for Luminaires: Detachable, cantilever, without underbrace.

1. Adapter fitting welded to pole, allowing the bracket to be bolted to the pole mounted adapter, then bolted together with stainless-steel bolts.
2. Cross Section: Tapered oval, with straight tubular end section to accommodate luminaire.
3. Match pole material and finish.

D. Steps: Fixed steel, with nonslip treads, positioned for 15-inch (381-mm) vertical spacing, alternating on opposite sides of pole; first step at elevation 10 feet (3 m) above finished grade.

E. Grounding and Bonding Lugs: Welded 1/2-inch (13-mm) threaded lug, complying with requirements in Section 260526 "Grounding and Bonding for Electrical Systems," listed for attaching grounding and bonding conductors of type and size listed in that Section, and accessible through handhole.

F. Cable Support Grip: Wire-mesh type with rotating attachment eye, sized for diameter of cable and rated for a minimum load equal to weight of supported cable times a 5.0 safety factor.

G. Factory-Painted Finish: Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

1. Surface Preparation: Clean surfaces to comply with SSPC-SP 1, "Solvent Cleaning," to remove dirt, oil, grease, and other contaminants that could impair paint bond. Grind welds and polish surfaces to a smooth, even finish. Remove mill scale and rust, if present, from uncoated steel, complying with SSPC-SP 5/NACE No. 1, "White Metal Blast Cleaning," or with SSPC-SP 8, "Pickling."
2. Interior Surfaces of Pole: One coat of bituminous paint, or otherwise treat for equal corrosion protection.
3. Exterior Surfaces: Manufacturer's standard finish consisting of one or more coats of primer and two finish coats of high-gloss, high-build polyurethane enamel.

a. Color: Manufacturer’s Dark Bronze.

2.8 POLE ACCESSORIES

A. Base Covers: Manufacturers' standard metal units, arranged to cover pole's mounting bolts and nuts. Finish same as pole.

PART 3 - EXECUTION

3.1 LUMINAIRE INSTALLATION

A. Install lamps in each luminaire.

B. Fasten luminaire to indicated structural supports.

1. Use fastening methods and materials selected to resist seismic forces defined for the application and approved by manufacturer.

C. Adjust luminaires that require field adjustment or aiming.

3.2 POLE INSTALLATION

A. Alignment: Align pole foundations and poles for optimum directional alignment of luminaires and their mounting provisions on the pole.

B. Clearances: Maintain the following minimum horizontal distances of poles from surface and underground features unless otherwise indicated on Drawings:

1. Fire Hydrants and Storm Drainage Piping: 60 inches (1520 mm).
2. Water, Gas, Electric, Communication, and Sewer Lines: 10 feet (3 m).
3. Trees: 15 feet (5 m) from tree trunk.

C. Concrete Pole Foundations: Set anchor bolts according to anchor-bolt templates furnished by pole manufacturer. Concrete materials, installation, and finishing requirements are specified in Section 033000 "Cast-in-Place Concrete."

D. Raise and set poles using web fabric slings (not chain or cable).

3.3 BOLLARD LUMINAIRE INSTALLATION

A. Align units for optimum directional alignment of light distribution.

B. Install on concrete base with top 1 inches (25 mm) above finished grade or surface at bollard location. Cast conduit into base, and shape base to match shape of bollard base. Finish by troweling and rubbing smooth. Concrete materials, installation, and finishing are specified in Section 033000 "Cast-in-Place Concrete."

3.4 GROUNDING

A. Ground metal poles and support structures according to Section 260526 "Grounding and Bonding for Electrical Systems."

1. Install grounding electrode for each pole unless otherwise indicated.
2. Install grounding conductor pigtail in the base for connecting luminaire to grounding system.

END OF SECTION 26 5600

SECTION 27 0500 - 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. Sleeves for Rectangular Openings: Galvanized sheet steel.
   1. Minimum Metal Thickness:
      a. For sleeve cross-section rectangle perimeter less than 50 inches and no side more than 16 inches, thickness shall be 0.052 inch.
      b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

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: 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.

2.3 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 above finished floor level.

G. Size pipe sleeves to provide 1/4-inch 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."

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 27 0500

SECTION 27 0536 - CABLE TRAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Wire-basket cable trays.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product.

B. Shop Drawings: For each type of cable tray.

PART 2 - PRODUCTS

2.1 GENERAL REQUIREMENTS FOR CABLE TRAYS

A. Cable Trays and Accessories: Identified as defined in NFPA 70 and marked for intended location, application, and grounding.

B. Sizes and Configurations: See the Cable Tray Schedule on Drawings for specific requirements for types, materials, sizes, and configurations.

C. Structural Performance: See articles on individual cable tray types for specific values for uniform load distribution, concentrated load, and load and safety factor parameters.

2.2 WIRE-BASKET CABLE TRAYS

A. Description:

1. Configuration: Wires are formed into a standard 2-by-4-inch (50-by-100-mm) wire mesh pattern with intersecting wires welded together. Mesh sections must have at least one bottom longitudinal wire along entire length of section.
2. Materials: High-strength-steel longitudinal wires with no bends.
3. Safety Provisions: Wire ends along wire-basket sides (flanges) rounded during manufacturing to maintain integrity of cables and installer safety.
4. Sizes:

   a. Straight sections shall be furnished in standard 118-inch (3000-mm) lengths.
   b. Wire-Basket Depth: 2-inch (50-mm) usable loading depth by 6 inches (150 mm) and 12 inches (300 mm) wide.

5. Connector Assemblies: Bolt welded to plate shaped to fit around adjoining tray wires and mating plate. Mechanically joins adjacent tray wires to splice sections together or to create horizontal fittings.

6. Connector Assembly Capacity: Splices located within support span shall not diminish rated loading capacity of cable tray.
7. Hardware and Fasteners: Steel, zinc plated according to ASTM B 633.

2.3 CABLE TRAY ACCESSORIES

A. Fittings: Tees, crosses, risers, elbows, and other fittings as indicated, of same materials and finishes as cable tray.

B. Cable tray supports and connectors, including bonding jumpers, as recommended by cable tray manufacturer.

2.4 WARNING SIGNS

A. Lettering: 1-1/2-inch- (40-mm-) high, black letters on yellow background with legend "Warning! Not To Be Used as Walkway, Ladder, or Support for Ladders or Personnel."

B. Comply with requirements for fasteners in Section 260553 "Identification for Electrical Systems."

2.5 SOURCE QUALITY CONTROL

A. Testing: Test and inspect cable trays according to NEMA FG 1.

PART 3 - EXECUTION

3.1 CABLE TRAY INSTALLATION

A. Install cable trays according to NEMA FG 1.

B. Install cable trays as a complete system, including fasteners, hold-down clips, support systems, barrier strips, adjustable horizontal and vertical splice plates, elbows, reducers, tees, crosses, cable dropouts, adapters, covers, and bonding.

C. Fasten cable tray supports to building structure.

D. Design fasteners and supports to carry cable tray, the cables, and a concentrated load of 200 lb (90 kg). Comply with requirements in Section 260529 "Hangers and Supports for Electrical Systems."

E. Support wire-basket cable trays with center support hangers or wall brackets.

F. Support center support hangers for wire-basket trays with 3/8-inch- (10-mm-) diameter rods.

G. Make connections to equipment with flanged fittings fastened to cable trays and to equipment. Support cable trays independent of fittings. Do not carry weight of cable trays on equipment enclosure.

H. Install expansion connectors where cable trays cross building expansion joints and in cable tray runs that exceed dimensions recommended in NEMA FG 1. Space connectors and set gaps according to applicable standard.

I. Seal penetrations through fire and smoke barriers. Comply with requirements in Section 078413 "Penetration Firestopping."

J. Install capped metal sleeves for future cables through firestop-sealed cable tray penetrations of fire and smoke barriers.

K. Install warning signs in visible locations on or near cable trays after cable tray installation.

3.2 CABLE TRAY GROUNDING

A. Ground cable trays according to NFPA 70 unless additional grounding is specified. Comply with requirements in Section 260526 "Grounding and Bonding for Electrical Systems."

B. Cable trays with communications cable shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

C. Cable trays with control conductors shall be bonded together with splice plates listed for grounding purposes or with listed bonding jumpers.

D. Bond cable trays to power source for cables contained within with bonding conductors sized according to NFPA 70, Article 250.122, "Size of Equipment Grounding Conductors."

3.3 CABLE INSTALLATION

A. Install cables only when each cable tray run has been completed and inspected.

B. Fasten cables on horizontal runs with cable clamps or cable ties according to NEMA VE 2. Tighten clamps only enough to secure the cable, without indenting the cable jacket.

C. Fasten cables on vertical runs to cable trays every 18 inches (450 mm).

D. Fasten and support cables that pass from one cable tray to another or drop from cable trays to equipment enclosures. Fasten cables to the cable tray at the point of exit and support cables independent of the enclosure. The cable length between cable trays or between cable tray and enclosure shall be no more than 72 inches (1800 mm).

E. In existing construction, remove inactive or dead cables from cable trays.

3.4 CONNECTIONS

A. Connect raceways to cable trays according to requirements in NEMA VE 2 and NEMA FG 1.

3.5 FIELD QUALITY CONTROL

A. Perform the following tests and inspections:

1. After installing cable trays and after electrical circuitry has been energized, survey for compliance with requirements.
2. Visually inspect cable insulation for damage. Correct sharp corners, protuberances in cable trays, vibrations, and thermal expansion and contraction conditions, which may cause or have caused damage.

3. Verify that the number, size, and voltage of cables in cable trays do not exceed that permitted by NFPA 70. Verify that communications or data-processing circuits are separated from power circuits by barriers or are installed in separate cable trays.
4. Verify that there are no intruding items such as pipes, hangers, or other equipment in the cable tray.
5. Remove dust deposits, industrial process materials, trash of any description, and any blockage of tray ventilation.
6. Visually inspect each cable tray joint and each ground connection for mechanical continuity. Check bolted connections between sections for corrosion. Clean and retorque in suspect areas.
7. Check for missing, incorrect, or damaged bolts, bolt heads, or nuts. When found, replace with specified hardware.
8. Perform visual and mechanical checks for adequacy of cable tray grounding; verify that all takeoff raceways are bonded to cable trays. Test entire cable tray system for continuity. Maximum allowable resistance is 1 ohm.

B. Prepare test and inspection reports.

3.6 PROTECTION

A. Protect installed cable trays and cables.

END OF SECTION 27 0536

SECTION 27 1100 - COMMUNICATIONS 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. Telecommunications mounting elements.
2. Backboards.
3. Telecommunications equipment racks and cabinets.
4. Telecommunications service entrance pathways.
5. Grounding.

B. Related Sections:

1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Division 27 Section "Communications Horizontal Cabling" for voice and data cabling associated with system panels and devices.
3. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. LAN: Local area network.

C. RCDD: Registered Communications Distribution Designer.

D. Trough or Ventilated Cable Tray: A fabricated structure consisting of integral or separate longitudinal rails and a bottom having openings sufficient for the passage of air and using 75 percent or less of the plan area of the surface to support cables.

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 RCDD 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. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems.".

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inchesComply with requirements for plywood backing panels specified in Division 06 Section "Rough Carpentry."

2.3 EQUIPMENT FRAMES

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. AMP; a Tyco International Ltd. company.
2. Hubbell Premise Wiring.
3. Leviton Voice & Data Division.
4. Panduit Corp.

B. General Frame Requirements:

1. Distribution Frames: Freestanding and wall-mounting, modular-steel units designed for telecommunications terminal support and coordinated with dimensions of units to be supported.
2. Module Dimension: Width compatible with EIA 310 standard, 19-inch panel mounting.
3. Finish: Manufacturer's standard, baked-polyester powder coat.

C. Floor-Mounted Racks: Modular-type, aluminum construction.

1. Vertical and horizontal cable management channels, top and bottom cable troughs, grounding lug, and a power strip.
2. Baked-polyester powder coat finish.

D. Cable Management for Equipment Frames:

1. Metal, with integral wire retaining fingers.
2. Baked-polyester powder coat finish.
3. Vertical cable management panels shall have front and rear channels, with covers.
4. Provide horizontal crossover cable manager at the top of each relay rack, with a minimum height of two rack units each.

2.4 POWER STRIPS

A. Power Strips: Comply with UL 1363.

1. Rack mounting.
2. Six, 20-A, 120-V ac, NEMA WD 6, Configuration 5-20R receptacles.
3. LED indicator lights for power and protection status.
4. LED indicator lights for reverse polarity and open outlet ground.
5. Cord connected with 15-foot line cord.
6. Rocker-type on-off switch, illuminated when in on position.

2.5 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. See drawing sheets for Telecommunications grounding point.

2.6 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 ENTRANCE FACILITIES

A. Contact telecommunications service provider and arrange for installation of demarcation point, protected entrance terminals, and a housing when so directed by service provider.

3.2 INSTALLATION

A. Comply with NECA 1.

B. Comply with BICSI TDMM for layout and installation of communications equipment rooms.

C. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

D. Bundle, lace, and train conductors and cables to terminal points without exceeding manufacturer's limitations on bending radii. Install lacing bars and distribution spools.

3.3 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.4 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 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.

3.5 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."

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration including optional identification requirements of this standard.

D. Labels shall be preprinted or computer-printed type.

END OF SECTION 27 1100

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SECTION 27 1300 - COMMUNICATIONS BACKBONE 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. Pathways.
2. UTP cable.
3. 62.5/125-micrometer, optical fiber cabling.
4. Coaxial cable.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Cabling identification products.

B. Related Sections:

1. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

C. EMI: Electromagnetic interference.

D. IDC: Insulation displacement connector.

E. LAN: Local area network.

F. RCDD: Registered Communications Distribution Designer.

G. UTP: Unshielded twisted pair.

1.4 BACKBONE CABLING DESCRIPTION

A. Backbone cabling system shall provide interconnections between communications equipment rooms, main terminal space, and entrance facilities in the telecommunications cabling system structure. Cabling system consists of backbone cables, intermediate and main cross-connects, mechanical terminations, and patch cords or jumpers used for backbone-to-backbone cross-connection.

B. Backbone cabling cross-connects may be located in communications equipment rooms or at entrance facilities. Bridged taps and splitters shall not be used as part of backbone cabling.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Backbone cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

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

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.
2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics including the following:

a. Cross-connects.
b. Patch panels.
c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

a. Vertical and horizontal offsets and transitions.
b. Clearances for access above and to side of cable trays.
c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

D. Source quality-control reports.

E. Field quality-control reports.

F. Maintenance Data: For splices and connectors to include in maintenance manuals.

G. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: 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 Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 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.

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

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

F. Grounding: Comply with ANSI-J-STD-607-A.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test optical fiber cable to determine the continuity of the strand end to end. Use optical fiber flashlight or optical loss test set.
2. Test optical fiber cable while on reels. Use an optical time domain reflectometer to verify the cable length and locate cable defects, splices, and connector, including the loss value of each. Retain test data and include the record in maintenance data.
3. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining

ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

1.11 SOFTWARE SERVICE AGREEMENT

A. Technical Support: Beginning with Substantial Completion, provide software support for two years.

B. 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.

1.12 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. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled for support of Category 5 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

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

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Superior Essex Inc.

B. Description: 100-ohm, 100-pair UTP, formed into 25-pair binder groups covered with a gray thermoplastic jacket and overall metallic shield.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

    a. Communications, Riser Rated: Type CMR, complying with UL 1666.

2.4 UTP CABLE HARDWARE

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. Hubbell Premise Wiring.
2. Leviton Voice & Data Division.
3. Panduit Corp.
4. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated, plus spares and blank positions adequate to suit specified expansion criteria.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, 4-pair cables inlengths as retired; terminated with 8-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.5 OPTICAL FIBER CABLE

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

1. Berk-Tek; a Nexans company.
2. CommScope, Inc.
3. Corning Cable Systems.
4. Mohawk; a division of Belden CDT.
5. Superior Essex Inc.
6. 3M.
7. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: Multimode, 62.5/125-micrometer, 6-fiber, nonconductive, tight buffer, optical fiber cable.

1. Comply with ICEA S-83-596 for mechanical properties.
2. Comply with TIA/EIA-568-B.3 for performance specifications.
3. Comply with TIA/EIA-492AAAA-B for detailed specifications.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444, UL 1651, and NFPA 70 for the following types:

    a. General Purpose, Nonconductive: Type OFN or OFNG.
    b. Plenum Rated, Nonconductive: Type OFNP, complying with NFPA 262.
    c. Riser Rated, Nonconductive: Type OFNR, complying with UL 1666.
    d. General Purpose, Conductive: Type OFC or OFCG.
    e. Plenum Rated, Conductive: Type OFCP, complying with NFPA 262.
    f. Riser Rated, Conductive: Type OFCR, complying with UL 1666.

5. Conductive cable shall be aluminum armored type.
6. Maximum Attenuation: 3.50 dB/km at 850 nm; 1.5 dB/km at 1300 nm.
7. Minimum Modal Bandwidth: 160 MHz-km at 850 nm; 500 MHz-km at 1300 nm.

C. Jacket:

1. Jacket Color: Orange for 62.5/125-micrometer cable.
2. Cable cordage jacket, fiber, unit, and group color shall be according to TIA/EIA-598-B.
3. Imprinted with fiber count, fiber type, and aggregate length at regular intervals not to exceed 40 inches.

2.6 OPTICAL FIBER CABLE HARDWARE

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. Berk-Tek; a Nexans company.
2. Corning Cable Systems.
3. Dynacom Corporation.
4. Hubbell Premise Wiring.

B. Cross-Connects and Patch Panels: Modular panels housing multiple-numbered, duplex cable connectors.

1. Number of Connectors per Field: One for each fiber of cable or cables assigned to field, plus spares and blank positions adequate to suit specified expansion criteria.

C. Patch Cords: Factory-made, dual-fiber cables in 36-inch lengths.

D. Cable Connecting Hardware:

1. Comply with Optical Fiber Connector Intermateability Standards (FOCIS) specifications of TIA/EIA-604-2, TIA/EIA-604-3-A, and TIA/EIA-604-12. Comply with TIA/EIA-568-B.3.
2. Quick-connect, simplex and duplex, Type ST connectors. Insertion loss not more than 0.75 dB.
3. Type SFF connectors may be used in termination racks, panels, and equipment packages.

2.7 COAXIAL CABLE

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

1. Belden CDT Inc.; Electronics Division.
2. CommScope, Inc.

B. General Coaxial Cable Requirements: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-6/U: NFPA 70, Type CATV or CM.

1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
3. Jacketed with black PVC or PE.
4. Suitable for indoor installations.

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70, "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Cable: Type CATV.
2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
3. CATV Riser Rated: Type CATVR, complying with UL 1666.
4. CATV Limited Rating: Type CATVX.

2.8 COAXIAL CABLE HARDWARE

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. Aim Electronics; a brand of Emerson Electric Co.
2. Leviton Voice & Data Division.

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.9 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems." for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.10 IDENTIFICATION PRODUCTS

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.

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory test multimode optical fiber cables according to TIA/EIA-526-14-A and TIA/EIA-568-B.3.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 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, in attics, and in gypsum board

partitions 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.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables within enclosures. Connect to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.

4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
7. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Use lacing bars and distribution spools.
8. 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.
9. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
10. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
11. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Optical Fiber Cable Installation:

1. Comply with TIA/EIA-568-B.3.
2. Cable may be terminated on connecting hardware that is rack or cabinet mounted.

E. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway, a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

F. Group connecting hardware for cables into separate logical fields.

G. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 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 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.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 2.
2. Color-code cross-connect fields and apply colors to voice and data service backboards, connections, covers, and labels.

B. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

C. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration including optional identification requirements of this standard.

D. Comply with requirements in Division 27 Section "Communications Horizontal Cabling" for cable and asset management software.

E. 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.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire 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. 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 being extended from a panel or cabinet to a building-mounted device with name and number of particular device as shown.
    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.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA 606-A, for the following:

1. Cables use flexible vinyl or polyester that flexes as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber jacket materials for NRTL certification markings. Inspect cabling terminations in communications equipment rooms for compliance with color-coding for pin assignments, and inspect cabling connections for compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP copper 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/EIA-568-B.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.

4. Optical Fiber Cable Tests:

    a. Test instruments shall meet or exceed applicable requirements in TIA/EIA-568-B.1. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.
    b. Link End-to-End Attenuation Tests:

        1) Horizontal and multimode backbone link measurements: Test at 850 or 1300 nm in 1 direction according to TIA/EIA-526-14-A, Method B, One Reference Jumper.
        2) Attenuation test results for backbone links shall be less than 2.0 dB. Attenuation test results shall be less than that calculated according to equation in TIA/EIA-568-B.1.

C. Data for each measurement shall be documented. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. Remove and replace cabling where test results indicate that they do not comply with specified requirements.

E. End-to-end cabling will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

END OF SECTION 27 1300

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SECTION 27 1500 - COMMUNICATIONS 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. Pathways.
2. UTP cabling.
3. Coaxial cable.
4. Multiuser telecommunications outlet assemblies.
5. Cable connecting hardware, patch panels, and cross-connects.
6. Telecommunications outlet/connectors.
7. Cabling system identification products.
8. Cable management system.

B. Related Sections:

1. Division 27 Section "Communications Backbone Cabling" for voice and data cabling associated with system panels and devices.
2. Division 28 Section "Conductors and Cables for Electronic Safety and Security" for voice and data cabling associated with system panels and devices.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. Consolidation Point: A location for interconnection between horizontal cables extending from building pathways and horizontal cables extending into furniture pathways.

C. Cross-Connect: A facility enabling the termination of cable elements and their interconnection or cross-connection.

D. EMI: Electromagnetic interference.

E. IDC: Insulation displacement connector.

F. Ladder Cable Tray: A fabricated structure consisting of two longitudinal side rails connected by individual transverse members (rungs).

G. LAN: Local area network.

H. MUTOA: Multiuser telecommunications outlet assembly, a grouping in one location of several telecommunications outlet/connectors.

I. Outlet/Connectors: A connecting device in the work area on which horizontal cable or outlet cable terminates.

J. RCDD: Registered Communications Distribution Designer.

K. Trough or Ventilated Cable Tray: A fabricated structure consisting of longitudinal side rails and a bottom having openings for the passage of air.

L. UTP: Unshielded twisted pair.

1.4 HORIZONTAL CABLING DESCRIPTION

A. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.

1. TIA/EIA-568-B.1 requires that a minimum of two telecommunications outlet/connectors be installed for each work area.
2. Horizontal cabling shall contain no more that one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector.
3. Bridged taps and splices shall not be installed in the horizontal cabling.
4. Splitters shall not be installed as part of the optical fiber cabling.

B. A work area is approximately 100 sq. ft., and includes the components that extend from the telecommunications outlet/connectors to the station equipment.

C. The maximum allowable horizontal cable length is 295 feet. This maximum allowable length does not include an allowance for the length of 16 feet to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet in the horizontal cross-connect.

1.5 PERFORMANCE REQUIREMENTS

A. General Performance: Horizontal cabling system shall comply with transmission standards in TIA/EIA-568-B.1, when tested according to test procedures of this standard.

1.6 SUBMITTALS

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

1. For coaxial cable, include the following installation data for each type used:

a. Nominal OD.
b. Minimum bending radius.
c. Maximum pulling tension.

B. Shop Drawings:

1. System Labeling Schedules: Electronic copy of labeling schedules, in software and format selected by Owner.

2. System Labeling Schedules: Electronic copy of labeling schedules that are part of the cabling and asset identification system of the software.
3. Cabling administration drawings and printouts.
4. Wiring diagrams to show typical wiring schematics, including the following:

    a. Cross-connects.
    b. Patch panels.
    c. Patch cords.

5. Cross-connects and patch panels. Detail mounting assemblies, and show elevations and physical relationship between the installed components.
6. Cable tray layout, showing cable tray route to scale, with relationship between the tray and adjacent structural, electrical, and mechanical elements. Include the following:

    a. Vertical and horizontal offsets and transitions.
    b. Clearances for access above and to side of cable trays.
    c. Vertical elevation of cable trays above the floor or bottom of ceiling structure.
    d. Load calculations to show dead and live loads as not exceeding manufacturer's rating for tray and its support elements.

C. Samples: For workstation outlets, jacks, jack assemblies, in specified finish, one for each size and outlet configuration and faceplates for color selection and evaluation of technical features.

D. Qualification Data: For Installer, qualified layout technician, installation supervisor, and field inspector.

E. Source quality-control reports.

F. Field quality-control reports.

G. Maintenance Data: For splices and connectors to include in maintenance manuals.

H. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.7 QUALITY ASSURANCE

A. Installer Qualifications: 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 Level 2 Installer, who shall be present at all times when Work of this Section is performed at Project site.
3. Testing Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

C. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 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.

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

E. Telecommunications Pathways and Spaces: Comply with TIA/EIA-569-A.

F. Grounding: Comply with ANSI-J-STD-607-A.

1.8 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

1.9 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

1.10 COORDINATION

A. Coordinate layout and installation of telecommunications pathways and cabling with Owner's telecommunications and LAN equipment and service suppliers.

B. Coordinate telecommunications outlet/connector locations with location of power receptacles at each work area.

1.11 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. Patch-Panel Units: One of each type.
2. Connecting Blocks: One of each type.
3. Device Plates: Five of each type.
4. Multiuser Telecommunications Outlet Assemblies: Five of each type.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. General Requirements: Comply with TIA/EIA-569-A.

B. Cable Support: NRTL labeled for support of Category 6 cabling, designed to prevent degradation of cable performance and pinch points that could damage cable.

1. Support brackets with cable tie slots for fastening cable ties to brackets.
2. Lacing bars, spools, J-hooks, and D-rings.
3. Straps and other devices.

C. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements in Division 06 Section "Rough Carpentry" for plywood backing panels.

2.3 UTP CABLE

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

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Superior Essex Inc.

B. Description: 100-ohm, 4-pair UTP, formed into 25-pair, binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 6.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.4 UTP CABLE HARDWARE

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. Hubbell Premise Wiring.
2. Leviton Voice & Data Division.
3. Panduit Corp.
4. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. General Requirements for Cable Connecting Hardware: Comply with TIA/EIA-568-B.2, IDC type, with modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of same category or higher.

C. Connecting Blocks: 110-style IDC for Category 6. Provide blocks for the number of cables terminated on the block, plus 25 percent spare. Integral with connector bodies, including plugs and jacks where indicated.

D. Cross-Connect: Modular array of connecting blocks arranged to terminate building cables and permit interconnection between cables.

1. Number of Terminals per Field: One for each conductor in assigned cables.

E. Patch Panel: Modular panels housing multiple-numbered jack units with IDC-type connectors at each jack for permanent termination of pair groups of installed cables.

1. Number of Jacks per Field: One for each four-pair UTP cable indicated plus spares and blank positions adequate to suit specified expansion criteria.

F. Jacks and Jack Assemblies: Modular, color-coded, eight-position modular receptacle units with integral IDC-type terminals.

G. Patch Cords: Factory-made, four-pair cables in lengths as required; terminated with eight-position modular plug at each end.

1. Patch cords shall have bend-relief-compliant boots and color-coded icons to ensure Category 6 performance. Patch cords shall have latch guards to protect against snagging.
2. Patch cords shall have color-coded boots for circuit identification.

2.5 COAXIAL CABLE

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

1. Belden CDT Inc.; Electronics Division.
2. CommScope, Inc.

B. Cable Characteristics: Broadband type, recommended by cable manufacturer specifically for broadband data transmission applications. Coaxial cable and accessories shall have 75-ohm nominal impedance with a return loss of 20 dB maximum from 7 to 806 MHz.

C. RG-6/U: NFPA 70, Type CATV or CM.

1. No. 16 AWG, solid, copper-covered steel conductor; gas-injected, foam-PE insulation.
2. Double shielded with 100 percent aluminum-foil shield and 60 percent aluminum braid.
3. Jacketed with black PVC or PE.
4. Suitable for indoor installations.

D. NFPA and UL compliance, listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 1655 and with NFPA 70 "Radio and Television Equipment" and "Community Antenna Television and Radio Distribution" Articles. Types are as follows:

1. CATV Cable: Type CATV.

2. CATV Plenum Rated: Type CATVP, complying with NFPA 262.
3. CATV Riser Rated: Type CATVR, complying with UL 1666.
4. CATV Limited Rating: Type CATVX.

2.6 COAXIAL CABLE HARDWARE

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. Aim Electronics; a brand of Emerson Electric Co.
2. Leviton Voice & Data Division.

B. Coaxial-Cable Connectors: Type BNC, 75 ohms.

2.7 CONSOLIDATION POINTS

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. Dynacom Corporation.
2. Hubbell Premise Wiring.
3. Panduit Corp.

B. Description: Consolidation points shall comply with requirements for cable connecting hardware.

1. Number of Terminals per Field: One for each conductor in assigned cables.
2. Number of Connectors per Field:

    a. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.

3. Mounting: Recessed in wall.
4. NRTL listed as complying with UL 50 and UL 1863.
5. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.8 MULTIUSER TELECOMMUNICATIONS OUTLET ASSEMBLY (MUTOA)

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. Hubbell Premise Wiring.
2. Panduit Corp.

B. Description: MUTOAs shall meet the requirements for cable connecting hardware.

1. Number of Terminals per Field: One for each conductor in assigned cables.
2. Number of Connectors per Field:

    a. One for each four-pair UTP cable indicated.

b. One for each four-pair conductor group of indicated cables, plus 25 percent spare positions.

3. Mounting: Recessed in wall.
4. NRTL listed as complying with UL 50 and UL 1863.
5. Label shall include maximum length of work area cords, based on TIA/EIA-568-B.1.
6. When installed in plenums used for environmental air, NRTL listed as complying with UL 2043.

2.9 TELECOMMUNICATIONS OUTLET/CONNECTORS

A. Jacks: 100-ohm, balanced, twisted-pair connector; four-pair, eight-position modular. Comply with TIA/EIA-568-B.1.

B. Workstation Outlets: Minimum Four-port-connector assemblies mounted in single or multigang faceplate.

1. Plastic Faceplate: High-impact plastic. Coordinate color with Division 26 Section "Wiring Devices."
2. For use with snap-in jacks accommodating any combination of UTP, optical fiber, and coaxial work area cords.

a. Flush mounting jacks, positioning the cord at a 45-degree angle.

3. Legend: Machine printed, in the field, using adhesive-tape label.
4. Legend: Snap-in, clear-label covers and machine-printed paper inserts.

2.10 GROUNDING

A. Comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems" for grounding conductors and connectors.

B. Comply with ANSI-J-STD-607-A.

2.11 IDENTIFICATION PRODUCTS

A. Comply with TIA/EIA-606-A and UL 969 for labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

B. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.12 CABLE MANAGEMENT SYSTEM

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. iTRACS Corporation.
2. Telsoft Solutions.

B. Description: Computer-based cable management system, with integrated database and graphic capabilities.

C. Document physical characteristics by recording the network, TIA/EIA details, and connections between equipment and cable.

D. Information shall be presented in database view, schematic plans, or technical drawings.

1. Microsoft Visio Professional or AutoCAD drawing software shall be used as drawing and schematic plans software.

E. System shall interface with the following testing and recording devices:

1. Direct upload tests from circuit testing instrument into the personal computer.
2. Direct download circuit labeling into labeling printer.

2.13 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.2.

D. Factory-sweep test coaxial cables at frequencies from 5 MHz to 1 GHz. Sweep test shall test the frequency response, or attenuation over frequency, of a cable by generating a voltage whose frequency is varied through the specified frequency range and graphing the results.

E. Cable will be considered defective if it does not pass tests and inspections.

F. Prepare test and inspection reports.

PART 3 - EXECUTION

3.1 ENTRANCE FACILITIES

A. Coordinate backbone cabling with the protectors and demarcation point provided by communications service provider.

3.2 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, in attics, and in gypsum board partitions 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.
2. Comply with requirements for raceways and boxes specified in Division 26 Section "Raceway and Boxes for Electrical Systems."

B. Wiring Method: Conceal conductors and cables in accessible ceilings, walls, and floors where possible.

C. Wiring within Enclosures: Bundle, lace, and train cables to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

3.3 INSTALLATION OF PATHWAYS

A. Cable Trays: Comply with NEMA VE 2 and TIA/EIA-569-A-7.

B. Comply with requirements for demarcation point, pathways, cabinets, and racks specified in Division 27 Section "Communications Equipment Room Fittings." Drawings indicate general arrangement of pathways and fittings.

C. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

D. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems" for installation of conduits and wireways.

E. Install manufactured conduit sweeps and long-radius elbows whenever possible.

F. Pathway Installation in Communications Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed, or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

G. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.4 INSTALLATION OF CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. MUTOA shall not be used as a cross-connect point.
5. Consolidation points may be used only for making a direct connection to telecommunications outlet/connectors:

    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 UTP at least 49 feet from communications equipment room.

6. Terminate conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, cross-connects, and patch panels.
7. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
8. Install lacing bars to restrain cables, to prevent straining connections, and to prevent bending cables to smaller radii than minimums recommended by manufacturer.
9. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
10. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
11. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
12. In the communications equipment room, install a 10-foot- long service loop on each end of cable.
13. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Open-Cable Installation:

1. Install cabling with horizontal and vertical cable guides in telecommunications spaces with terminating hardware and interconnection equipment.
2. Suspend UTP cable not in a wireway or pathway a minimum of 8 inches above ceilings by cable supports not more than 60 inches apart.
3. Cable shall not be run through structural members or in contact with pipes, ducts, or other potentially damaging items.

E. Group connecting hardware for cables into separate logical fields.

F. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

    a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
    b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
    c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Communications Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Communications Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.5 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, Annex A, "Firestopping."

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.6 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 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.

3.7 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

1. Administration Class: 2.
2. Color-code cross-connect fields. Apply colors to voice and data service backboards, connections, covers, and labels.

B. Using cable management system software specified in Part 2, develop Cabling Administration Drawings for system identification, testing, and management. Use unique, alphanumeric designation for each cable and label cable, jacks, connectors, and terminals to which it connects with same designation. At completion, cable and asset management software shall reflect as-built conditions.

C. Comply with requirements in Division 09 Section "Interior Painting" for painting backboards. For fire-resistant plywood, do not paint over manufacturer's label.

D. Paint and label colors for equipment identification shall comply with TIA/EIA-606-A for Class 2 level of administration, including optional identification requirements of this standard.

E. Cable Schedule: Post in 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.

F. Cabling Administration Drawings: Show building floor plans with cabling administration-point labeling. Identify labeling convention and show labels for telecommunications closets, backbone pathways and cables, entrance pathways and cables, terminal hardware and positions, horizontal cables, work areas and workstation terminal positions, grounding buses and pathways, and equipment grounding conductors. Follow convention of TIA/EIA-606-A. Furnish electronic record of all drawings, in software and format selected by Owner.

G. Cable and Wire Identification:

1. Label each cable within 4 inches of each termination and tap, where it is accessible in a cabinet or junction or outlet box, and elsewhere as indicated.
2. Each wire connected to building-mounted devices is not required to be numbered at device if color of wire 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. 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 being extended from a panel or cabinet to a building-mounted device shall be identified with name and number of particular device as shown.
    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.
6. Uniquely identify and label work area cables extending from the MUTOA to the work area. These cables may not exceed the length stated on the MUTOA label.

H. Labels shall be preprinted or computer-printed type with printing area and font color that contrasts with cable jacket color but still complies with requirements in TIA/EIA-606-A.

1. Cables use flexible vinyl or polyester that flex as cables are bent.

3.8 FIELD QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable 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/EIA-568-B.1.
2. Visually confirm Category 6, marking of outlets, cover plates, outlet/connectors, and patch panels.
3. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
4. Test UTP backbone copper 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/EIA-568-B.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.

5. UTP Performance Tests:

    a. Test for each outlet and MUTOA. Perform the following tests according to TIA/EIA-568-B.1 and TIA/EIA-568-B.2:

        1) Wire map.
        2) Length (physical vs. electrical, and length requirements).
        3) Insertion loss.
        4) Near-end crosstalk (NEXT) loss.
        5) Power sum near-end crosstalk (PSNEXT) loss.
        6) Equal-level far-end crosstalk (ELFEXT).
        7) Power sum equal-level far-end crosstalk (PSELFEXT).
        8) Return loss.
        9) Propagation delay.
        10) Delay skew.

6. Coaxial Cable Tests: Conduct tests according to Division 27 Section "Master Antenna Television System."
7. Final Verification Tests: Perform verification tests for UTPsystems after the complete communications cabling and workstation outlet/connectors are installed.

    a. Voice Tests: These tests assume that dial tone service has been installed. Connect to the network interface device at the demarcation point. Go off-hook and listen and receive a dial tone. If a test number is available, make and receive a local, long distance, and digital subscription line telephone call.
    b. Data Tests: These tests assume the Information Technology Staff has a network installed and is available to assist with testing. Connect to the network interface device at the demarcation point. Log onto the network to ensure proper connection to the network.

C. Document data for each measurement. Data for submittals shall be printed in a summary report that is formatted similar to Table 10.1 in BICSI TDMM, or transferred from the instrument to the computer, saved as text files, and printed and submitted.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

3.9 DEMONSTRATION

A. Engage a factory-authorized service representative to train Owner's maintenance personnel in cable-plant management operations, including changing signal pathways for different workstations, rerouting signals in failed cables, and keeping records of cabling assignments and revisions when extending wiring to establish new workstation outlets. Include training in cabling administration software.

END OF SECTION 27 1500

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SECTION 28 0500 - COMMON WORK RESULTS FOR ELECTRONIC SAFETY AND SECURITY

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. Electronic safety and security equipment coordination and installation.
2. Grout.
3. Common electronic safety and security 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 electronic safety and security 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 electronic safety and security 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 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 and no side more than 16 inches, thickness shall be 0.052 inch.
b. For sleeve cross-section rectangle perimeter equal to, or more than, 50 inches and 1 or more sides equal to, or more than, 16 inches, thickness shall be 0.138 inch.

2.2 SLEEVE SEALS

A. Description: Modular sealing device, designed for field assembly, to fill annular space between sleeve and raceway 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 raceway or cable.
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.

2.3 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 ELECTRONIC SAFETY AND SECURITY 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 electronic safety and security 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 ELECTRONIC SAFETY AND SECURITY PENETRATIONS

A. Electronic safety and security penetrations occur when raceways, pathways, cables, wireways, or cable trays penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

C. 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.

D. Cut sleeves to length for mounting flush with both surfaces of walls.

E. Extend sleeves installed in floors 2 inches above finished floor level.

F. Size pipe sleeves to provide 1/4-inch annular clear space between sleeve and raceway or cable, unless indicated otherwise.

G. 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.

H. 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."

I. 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 "Penetration Firestopping."

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 electronic safety and security 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 28 0500

SECTION 28 0513 - CONDUCTORS AND CABLES FOR ELECTRONIC SAFETY AND SECURITY

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. UTP cabling.
2. RS-232 cabling.
3. RS-485 cabling.
4. Low-voltage control cabling.
5. Control-circuit conductors.
6. Fire alarm wire and cable.
7. Identification products.

1.3 DEFINITIONS

A. BICSI: Building Industry Consulting Service International.

B. EMI: Electromagnetic interference.

C. IDC: Insulation displacement connector.

D. Low Voltage: As defined in NFPA 70 for circuits and equipment operating at less than 50 V or for remote-control and signaling power-limited circuits.

E. RCDD: Registered Communications Distribution Designer.

F. UTP: Unshielded twisted pair.

1.4 SUBMITTALS

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

B. Qualification Data: For qualified layout technician, installation supervisor, and field inspector.

C. Source quality-control reports.

D. Field quality-control reports.

E. Maintenance Data: For wire and cable to include in maintenance manuals.

1.5 QUALITY ASSURANCE

A. Testing Agency Qualifications: An NRTL.

1. Testing Agency's Field Supervisor: Currently certified by BICSI as an RCDD to supervise on-site testing.

B. Surface-Burning Characteristics: As determined by testing identical products according to ASTM E 84 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. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Test cables upon receipt at Project site.

1. Test each pair of UTP cable for open and short circuits.

1.7 PROJECT CONDITIONS

A. Environmental Limitations: Do not deliver or install UTP, optical fiber, and coaxial cables and connecting materials until wet work in spaces is complete and dry, and temporary HVAC system is operating and maintaining ambient temperature and humidity conditions at occupancy levels during the remainder of the construction period.

PART 2 - PRODUCTS

2.1 PATHWAYS

A. Conduit and Boxes: Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." Flexible metal conduit shall not be used.

1. Outlet boxes shall be no smaller than 2 inches wide, 3 inches high, and 2-1/2 inches deep.

2.2 BACKBOARDS

A. Backboards: Plywood, fire-retardant treated, 3/4 by 48 by 96 inches. Comply with requirements for plywood backing panels in Division 06 Section "Rough Carpentry".

2.3 UTP CABLE

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

1. Belden CDT Inc.; Electronics Division.
2. Berk-Tek; a Nexans company.
3. CommScope, Inc.
4. Superior Essex Inc.
5. 3M.
6. Tyco Electronics/AMP Netconnect; Tyco International Ltd.

B. Description: 100-ohm, 4-pair UTP, formed into 25-pair binder groups covered with a blue thermoplastic jacket.

1. Comply with ICEA S-90-661 for mechanical properties.
2. Comply with TIA/EIA-568-B.1 for performance specifications.
3. Comply with TIA/EIA-568-B.2, Category 5e.
4. Listed and labeled by an NRTL acceptable to authorities having jurisdiction as complying with UL 444 and NFPA 70 for the following types:

    a. Communications, Plenum Rated: Type CMP, complying with NFPA 262.

2.4 UTP CABLE HARDWARE

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. Hubbell Premise Wiring.
2. Leviton Voice & Data Division.
3. Nordex/CDT; a subsidiary of Cable Design Technologies.
4. Panduit Corp.

B. UTP Cable Connecting Hardware: IDC type, using modules designed for punch-down caps or tools. Cables shall be terminated with connecting hardware of the same category or higher.

C. Connecting Blocks: 110-style for Category 5e. Provide blocks for the number of cables terminated on the block, plus 25 Insert percentage percent spare. Integral with connector bodies, including plugs and jacks where indicated.

2.5 RS-232 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.
2. Plastic insulation.
3. Individual aluminum foil-polyester tape shielded pairs with 100 percent shield coverage.
4. Plastic jacket.
5. Pairs are cabled on common axis with No. 24 AWG, stranded (7x32) tinned copper drain wire.
6. Flame Resistance: Comply with NFPA 262.

2.6 RS-485 CABLE

A. Plenum-Rated Cable: NFPA 70, Type CMP.

1. Paired, 2 pairs, No. 22 AWG, stranded (7x30) tinned copper conductors.

2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Fluorinated ethylene propylene jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.7 LOW-VOLTAGE CONTROL CABLE

A. Plenum-Rated, Paired Lock Cable: NFPA 70, Type CMP.

1. 1 pair, twisted, No. 16 AWG, stranded (19x29) tinned copper conductors.
2. PVC insulation.
3. Unshielded.
4. PVC jacket.
5. Flame Resistance: Comply with NFPA 262.

B. Plenum-Rated, Paired Lock Cable: NFPA 70, Type CMP.

1. 1 pair, twisted, No. 18 AWG, stranded (19x30) tinned copper conductors.
2. Fluorinated ethylene propylene insulation.
3. Unshielded.
4. Plastic jacket.
5. Flame Resistance: NFPA 262, Flame Test.

2.8 CONTROL-CIRCUIT CONDUCTORS

A. Class 1 Control Circuits: Stranded copper, Type THHN-THWN, in raceway complying with UL 83.

B. Class 2 Control Circuits: Stranded copper, Type THHN-THWN, in raceway complying with UL 83.

C. Class 3 Remote-Control and Signal Circuits: Stranded copper, Type TW or TF, complying with UL 83.

2.9 FIRE ALARM WIRE AND CABLE

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

1. Draka USA.
2. Genesis Cable Products; Honeywell International, Inc.
3. West Penn Wire/CDT; a division of Cable Design Technologies.

B. General Wire and Cable Requirements: NRTL listed and labeled as complying with NFPA 70, Article 760.

C. Signaling Line Circuits: Twisted, shielded pair, size as recommended by system manufacturer.

1. Circuit Integrity Cable: Twisted shielded pair, NFPA 70, Article 760, Classification CI, for power-limited fire alarm signal service Type FPL. NRTL listed and labeled as complying with UL 1424 and UL 2196 for a 2-hour rating.

D. Non-Power-Limited Circuits: Solid-copper conductors with 600-V rated, 75 deg C, color-coded insulation.

1. Low-Voltage Circuits: No. 16 AWG, minimum.
2. Line-Voltage Circuits: No. 12 AWG, minimum.
3. Multiconductor Armored Cable: NFPA 70, Type MC, copper conductors, Type TFN/THHN conductor insulation, copper drain wire, copper armor with outer jacket with red identifier stripe, NTRL listed for fire alarm and cable tray installation, plenum rated, and complying with requirements in UL 2196 for a 2-hour rating.

2.10 IDENTIFICATION PRODUCTS

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. Brady Corporation
2. HellermannTyton.
3. Panduit Corp.

B. Comply with UL 969 for a system of labeling materials, including label stocks, laminating adhesives, and inks used by label printers.

C. Comply with requirements in Division 26 Section "Identification for Electrical Systems."

2.11 SOURCE QUALITY CONTROL

A. Testing Agency: Engage a qualified testing agency to evaluate cables.

B. Factory test UTP and optical fiber cables on reels according to TIA/EIA-568-B.1.

C. Factory test UTP cables according to TIA/EIA-568-B.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 INSTALLATION OF PATHWAYS

A. Comply with TIA/EIA-569-A for pull-box sizing and length of conduit and number of bends between pull points.

B. Comply with requirements in Division 26 Section "Raceway and Boxes for Electrical Systems." for installation of conduits and wireways.

C. Install manufactured conduit sweeps and long-radius elbows whenever possible.

D. Pathway Installation in Equipment Rooms:

1. Position conduit ends adjacent to a corner on backboard where a single piece of plywood is installed or in the corner of room where multiple sheets of plywood are installed around perimeter walls of room.
2. Install cable trays to route cables if conduits cannot be located in these positions.
3. Secure conduits to backboard when entering room from overhead.
4. Extend conduits 3 inches above finished floor.
5. Install metal conduits with grounding bushings and connect with grounding conductor to grounding system.

E. Backboards: Install backboards with 96-inch dimension vertical. Butt adjacent sheets tightly, and form smooth gap-free corners and joints.

3.2 INSTALLATION OF CONDUCTORS AND CABLES

A. Comply with NECA 1.

B. General Requirements for Cabling:

1. Comply with TIA/EIA-568-B.1.
2. Comply with BICSI ITSIM, Ch. 6, "Cable Termination Practices."
3. Install 110-style IDC termination hardware unless otherwise indicated.
4. Terminate all conductors; no cable shall contain unterminated elements. Make terminations only at indicated outlets, terminals, and cross-connect and patch panels.
5. Cables may not be spliced. Secure and support cables at intervals not exceeding 30 inches and not more than 6 inches from cabinets, boxes, fittings, outlets, racks, frames, and terminals.
6. Bundle, lace, and train conductors to terminal points without exceeding manufacturer's limitations on bending radii, but not less than radii specified in BICSI ITSIM, "Cabling Termination Practices" Chapter. Install lacing bars and distribution spools.
7. Do not install bruised, kinked, scored, deformed, or abraded cable. Do not splice cable between termination, tap, or junction points. Remove and discard cable if damaged during installation and replace it with new cable.
8. Cold-Weather Installation: Bring cable to room temperature before dereeling. Heat lamps shall not be used for heating.
9. Pulling Cable: Comply with BICSI ITSIM, Ch. 4, "Pulling Cable." Monitor cable pull tensions.

C. UTP Cable Installation:

1. Comply with TIA/EIA-568-B.2.
2. Do not untwist UTP cables more than 1/2 inch from the point of termination to maintain cable geometry.

D. Separation from EMI Sources:

1. Comply with BICSI TDMM and TIA/EIA-569-A recommendations for separating unshielded copper voice and data communication cable from potential EMI sources, including electrical power lines and equipment.
2. Separation between open communications cables or cables in nonmetallic raceways and unshielded power conductors and electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 5 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 12 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 24 inches.

3. Separation between communications cables in grounded metallic raceways and unshielded power lines or electrical equipment shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: A minimum of 2-1/2 inches.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 6 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 12 inches.

4. Separation between communications cables in grounded metallic raceways and power lines and electrical equipment located in grounded metallic conduits or enclosures shall be as follows:

   a. Electrical Equipment Rating Less Than 2 kVA: No requirement.
   b. Electrical Equipment Rating between 2 and 5 kVA: A minimum of 3 inches.
   c. Electrical Equipment Rating More Than 5 kVA: A minimum of 6 inches.

5. Separation between Cables and Electrical Motors and Transformers, 5 kVA or HP and Larger: A minimum of 48 inches.
6. Separation between Cables and Fluorescent Fixtures: A minimum of 5 inches.

3.3 FIRE ALARM WIRING INSTALLATION

A. Comply with NECA 1 and NFPA 72.

B. Wiring Method: Install wiring in metal raceway according to Division 26 Section "Raceway and Boxes for Electrical Systems."

1. Install plenum cable in environmental air spaces, including plenum ceilings.
2. Fire alarm circuits and equipment control wiring associated with the fire alarm system shall be installed in a dedicated raceway system. This system shall not be used for any other wire or cable.

C. Wiring Method:

1. Cables and raceways used for fire alarm circuits, and equipment control wiring associated with the fire alarm system, may not contain any other wire or cable.
2. Fire-Rated Cables: Use of 2-hour, fire-rated fire alarm cables, NFPA 70, Types MI and CI, is not permitted.
3. Signaling Line Circuits: Power-limited fire alarm cables shall not be installed in the same cable or raceway as signaling line circuits.

D. Wiring within Enclosures: Separate power-limited and non-power-limited conductors as recommended by manufacturer. Install conductors parallel with or at right angles to sides and back of the enclosure. Bundle, lace, and train conductors to terminal points with no excess. Connect conductors that are terminated, spliced, or interrupted in any enclosure associated with the fire alarm system to terminal blocks. Mark each terminal according to the system's wiring diagrams. Make all connections with approved crimp-on terminal spade lugs, pressure-type terminal blocks, or plug connectors.

E. Cable Taps: Use numbered terminal strips in junction, pull, and outlet boxes, cabinets, or equipment enclosures where circuit connections are made.

F. Color-Coding: Color-code fire alarm conductors differently from the normal building power wiring. Use one color-code for alarm circuit wiring and another for supervisory circuits. Color-code audible alarm-indicating circuits differently from alarm-initiating circuits. Use different

colors for visible alarm-indicating devices. Paint fire alarm system junction boxes and covers red.

G. Risers: Install at least two vertical cable risers to serve the fire alarm system. Separate risers in close proximity to each other with a minimum one-hour-rated wall, so the loss of one riser does not prevent the receipt or transmission of signals from other floors or zones.

H. Wiring to Remote Alarm Transmitting Device: 1-inch conduit between the fire alarm control panel and the transmitter. Install number of conductors and electrical supervision for connecting wiring as needed to suit monitoring function.

3.4 CONTROL-CIRCUIT CONDUCTORS

A. Minimum Conductor Sizes:

1. Class 1 remote-control and signal circuits, No. 14 AWG.
2. Class 2 low-energy, remote-control and signal circuits, No. 16 AWG.
3. Class 3 low-energy, remote-control, alarm and signal circuits, No. 12 AWG.

3.5 CONNECTIONS

A. Comply with requirements in Division 28 Section "Video Surveillance" for connecting, terminating, and identifying wires and cables.

B. Comply with requirements in Division 28 Section "Fire Detection and Alarm" for connecting, terminating, and identifying wires and cables.

3.6 FIRESTOPPING

A. Comply with requirements in Division 07 Section "Penetration Firestopping."

B. Comply with TIA/EIA-569-A, "Firestopping" Annex A.

C. Comply with BICSI TDMM, "Firestopping Systems" Article.

3.7 GROUNDING

A. For communications wiring, comply with ANSI-J-STD-607-A and with BICSI TDMM, "Grounding, Bonding, and Electrical Protection" Chapter.

B. For low-voltage wiring and cabling, comply with requirements in Division 26 Section "Grounding and Bonding for Electrical Systems."

3.8 IDENTIFICATION

A. Identify system components, wiring, and cabling complying with TIA/EIA-606-A. Comply with requirements for identification specified in Division 26 Section "Identification for Electrical Systems."

3.9 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:

1. Visually inspect UTP and optical fiber cable jacket materials for UL or third-party certification markings. Inspect cabling terminations to confirm color-coding for pin assignments, and inspect cabling connections to confirm compliance with TIA/EIA-568-B.1.
2. Visually inspect cable placement, cable termination, grounding and bonding, equipment and patch cords, and labeling of all components.
3. Test UTP 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/EIA-568-B.2. Perform tests with a tester that complies with performance requirements in "Test Instruments (Normative)" Annex, complying with measurement accuracy specified in "Measurement Accuracy (Informative)" Annex. Use only test cords and adapters that are qualified by test equipment manufacturer for channel or link test configuration.

C. Document data for each measurement. Print data for submittals in a summary report that is formatted using Table 10.1 in BICSI TDMM as a guide, or transfer the data from the instrument to the computer, save as text files, print, and submit.

D. End-to-end cabling will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

END OF SECTION 28 0513

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SECTION 28 2300 – VIDEO SURVEILLANCE

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 video surveillance system consisting of cameras, data transmission wiring, and a control station with its associated equipment.

1.3 DEFINITIONS

A. AGC: Automatic gain control.

B. CCTV: Closed Circuit Television

C. CCD: Charge-coupled device.

D. MPEG: Moving picture experts group.

E. NTSC: National Television System Committee.

F. UPS: Uninterruptible power supply.

1.4 SUBMITTALS

A. Product Data: For each type of product indicated, including dimensions and data on features, performance, electrical characteristics, ratings, and finishes.

B. Shop Drawings: Detail assemblies of standard components that are custom assembled for specific application on this Project.

1. Functional Block Diagram: Show single-line interconnections between components for signal transmission and control. Show cable types and sizes.
2. Dimensioned plan and elevations of equipment racks, control panels, and consoles. Show access and workspace requirements.
3. UPS: Sizing calculations.
4. Wiring Diagrams: Power, signal, and control wiring, and grounding.

C. Equipment List: Include every piece of equipment by model number, manufacturer, serial number, location, and date of original installation. Add pretesting record of each piece of equipment, listing name of person testing, date of test, set points of adjustments, name and description of the view of preset positions, description of alarms, and description of unit output responses to an alarm.

D. Field quality-control test reports.

E. Operation and Maintenance Data: For cameras, power supplies, infrared illuminators, monitors, videotape recorders, digital video recorders, video switches, and control-station 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. Lists of spare parts and replacement components recommended to be stored at the site for ready access.

1.5 QUALITY ASSURANCE

A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.

B. Comply with NECA 1.

C. Comply with NFPA 70.

D. Electronic data exchange between video surveillance system with an access control system shall comply with SIA TVAC.

1.6 PROJECT CONDITIONS

A. Environmental Conditions: Capable of withstanding the following environmental conditions without mechanical or electrical damage or degradation of operating capability:

1. Control Station: Rated for continuous operation in ambient temperatures of 60 to 85 deg F and a relative humidity of 20 to 80 percent, noncondensing.
2. Interior, Controlled Environment: System components, except central-station control unit, installed in temperature-controlled interior environments shall be rated for continuous operation in ambient temperatures of 36 to 122 deg F dry bulb and 20 to 90 percent relative humidity, noncondensing. NEMA 250, Type 1 enclosures.
3. Exterior Environment: System components installed in locations exposed to weather shall be rated for continuous operation in ambient temperatures of minus 30 to plus 122 deg F dry bulb and 20 to 90 percent relative humidity, condensing. Rate for continuous operation when exposed to rain as specified in NEMA 250, winds up to 85 mph. NEMA 250, Type 4X enclosures.

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. Available Manufacturers: Provide products by the following:
   a. Axis Communications

2.2 SYSTEM REQUIREMENTS

A. Video signal format shall comply with the NTSC standard composite video, interlaced. Composite video signal termination shall be 75 ohms.

B. Surge Protection: Protect components from voltage surges originating external to equipment housing and entering through power, communication, signal, control, or sensing leads. Include surge protection for external wiring of each conductor entry connection to components.

1. Minimum Protection for Power Connections 120 V and More: Auxiliary panel suppressors complying with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits."
2. Minimum Protection for Communication, Signal, Control, and Low-Voltage Power Connections: Comply with requirements in Division 26 Section "Transient-Voltage Suppression for Low-Voltage Electrical Power Circuits" as recommended by manufacturer for type of line being protected.

2.3 STANDARD CAMERAS

A. Manufacturers:

1. Axis M32 Network Camera Series.

B. Camera:

1. Vandal resistant casing and metal encapsulated electronics
2. Operate between 0 degrees C and 50 degrees C (32 to 122 degrees F)
3. Equipped with 10BASE-T/100BASE-TX ethernet interface.
4. Progressive scan sensor, varifocal lens and provide images down to 0.9 lux.
5. Provide video streams of HDTV 720p (1280x720) resolution at 30 fps.
6. Support simultaneous JPEG and H.264 video streams
7. Power over Ethernet.
8. Accept static IP address as well as provided by a DHCP.
9. Provide text overlay date/time stamp.
10. Provide password level access with camera tampering alarm and video motion detection.
11. Built in web server
12. Supported by open and published API.

2.4 VIDEO ENCODERS

A. Manufacturers:

1. Axis Communications.

2.5 SIGNAL TRANSMISSION COMPONENTS

A. Cable: CAT 6 ethernet cable

PART 3 - EXECUTION

3.1 WIRING

A. Wiring Method: Install cables in cable tray. Where run in walls or behind or above hard surfaces, run in conduit.

B. Wiring within Enclosures: Bundle, lace, and train conductors to terminal points with no excess and without exceeding manufacturer's limitations on bending radii. Provide and use lacing bars and distribution spools.

C. Grounding: Provide independent-signal circuit grounding recommended in writing by manufacturer.

3.2 VIDEO SURVEILLANCE SYSTEM INSTALLATION

A. Install cameras and infrared illuminators level and plumb.

B. Install cameras with 84-inch- minimum clear space below cameras and their mountings. Change type of mounting to achieve required clearance.

C. Set pan unit and pan-and-tilt unit stops to suit final camera position and to obtain the field of view required for camera. Connect all controls and alarms, and adjust.

D. Install power supplies and other auxiliary components at control stations, unless otherwise indicated.

E. Install tamper switches on components indicated to receive tamper switches, arranged to detect unauthorized entry into system component enclosures, and mounted in self-protected, inconspicuous positions.

F. Identify system components, wiring, cabling, and terminals according to Division 26 Section "Identification of Electrical Systems."

3.3 FIELD QUALITY CONTROL

A. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect field-assembled components and equipment installation and supervise pretesting, testing, and adjusting of video surveillance equipment.

B. Inspection: Verify that units and controls are properly installed, connected, and labeled, and that interconnecting wires and terminals are identified.

C. Pretesting: Align and adjust system and pretest components, wiring, and functions to verify that they comply with specified requirements. Conduct tests at varying lighting levels, including day and night scenes as applicable. Prepare video surveillance equipment for acceptance and operational testing as follows:

1. Prepare equipment list described in Part 1 "Submittals" Article.
2. Verify operation of auto-iris lenses.
3. Set back-focus of fixed focal length lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image. Adjust until image is in focus with and without the filter.
4. Set back-focus of zoom lenses. At focus set to infinity, simulate nighttime lighting conditions by using a dark glass filter of a density that produces a clear image.

Additionally, set zoom to full wide angle and aim camera at an object 50 to 75 feet away. Adjust until image is in focus from full wide angle to full telephoto, with the filter in place.

5. Set and name all preset positions; consult Owner's personnel.
6. Connect and verify responses to alarms.
7. Verify operation of control-station equipment.

D. Test Schedule: Schedule tests after pretesting has been successfully completed and system has been in normal functional operation for at least 14 days. Provide a minimum of 10 days' notice of test schedule.

E. Operational Tests: Perform operational system tests to verify that system complies with Specifications. Include all modes of system operation. Test equipment for proper operation in all functional modes.

F. Remove and replace malfunctioning items and retest as specified above.

G. Record test results for each piece of equipment.

H. Retest: Correct deficiencies identified by tests and observations and retest until specified requirements are met.

3.4 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 and to optimize performance of the installed equipment. Tasks shall include, but are not limited to, the following:

1. Check cable connections.
2. Check proper operation of cameras and lenses. Verify operation of auto-iris lenses and adjust back-focus as needed.
3. Adjust all preset positions; consult Owner's personnel.
4. Recommend changes to cameras, lenses, and associated equipment to improve Owner' utilization of video surveillance system.
5. Provide a written report of adjustments and recommendations.

3.5 CLEANING

A. Clean installed items using methods and materials recommended in writing by manufacturer.

B. Clean video surveillance system components, including camera-housing windows, lenses, and monitor screens.

3.6 DEMONSTRATION

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

1. Train Owner's maintenance personnel on procedures and schedules for troubleshooting, servicing, and maintaining equipment.
2. Demonstrate methods of determining optimum alignment and adjustment of components and settings for system controls.

3. Review equipment list and data in maintenance manuals. Refer to Division 01 Section "Operation and Maintenance Data"

END OF SECTION 28 2300

SECTION 28 3111 - DIGITAL, ADDRESSABLE FIRE-ALARM SYSTEM

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Fire-alarm control unit.
2. Manual fire-alarm boxes.
3. System smoke detectors.
4. Nonsystem smoke detectors.
5. Heat detectors.
6. Notification appliances.
7. Remote annunciator.
8. Addressable interface device.

1.2 ACTION SUBMITTALS

A. Product Data: For each type of product, including furnished options and accessories.

B. Shop Drawings: For fire-alarm system.

1. Comply with recommendations and requirements in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
2. Include plans, elevations, sections, details, and attachments to other work.
3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
4. Detail assembly and support requirements.
5. Include voltage drop calculations for notification-appliance circuits.
6. Include battery-size calculations.
7. Include input/output matrix.
8. Include statement from manufacturer that all equipment and components have been tested as a system and meet all requirements in this Specification and in NFPA 72.
9. Include performance parameters and installation details for each detector.
10. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
11. Include plans, sections, and elevations of heating, ventilating, and air-conditioning ducts, drawn to scale; coordinate location of duct smoke detectors and access to them.

    a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
    b. Show field wiring required for HVAC unit shutdown on alarm.
    c. Locate detectors according to manufacturer's written recommendations.

12. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.

C. General Submittal Requirements:

1. Submittals shall be approved by authorities having jurisdiction prior to submitting them to Architect.
2. Shop Drawings shall be prepared by persons with the following qualifications:

    a. Trained and certified by manufacturer in fire-alarm system design.
    b. NICET-certified, fire-alarm technician; Level IV minimum.
    c. Licensed or certified by authorities having jurisdiction.

1.3 INFORMATIONAL SUBMITTALS

A. Qualification Data: For Installer.

B. Field quality-control reports.

C. Sample warranty.

1.4 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following and deliver copies to authorities having jurisdiction:

    a. Comply with the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.
    b. Provide "Fire Alarm and Emergency Communications System Record of Completion Documents" according to the "Completion Documents" Article in the "Documentation" section of the "Fundamentals" chapter in NFPA 72.
    c. Complete wiring diagrams showing connections between all devices and equipment.
    d. Riser diagram.
    e. Record copy of site-specific software.
    f. Provide "Inspection and Testing Form" according to the "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:

        1) Equipment tested.
        2) Frequency of testing of installed components.
        3) Frequency of inspection of installed components.
        4) Requirements and recommendations related to results of maintenance.
        5) Manufacturer's user training manuals.

    g. Manufacturer's required maintenance related to system warranty requirements.
    h. Abbreviated operating instructions for mounting at fire-alarm control unit and each annunciator unit.

B. Software and Firmware Operational Documentation:

1. Software operating and upgrade manuals.
2. Program Software Backup: On magnetic media or compact disk, complete with data files.
3. Device address list.
4. Printout of software application and graphic screens.

1.5 QUALITY ASSURANCE

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

B. Installer Qualifications: Installation shall be by personnel certified by NICET as fire-alarm Level IV technician.

C. NFPA Certification: Obtain certification according to NFPA 72 by an NRTL (nationally recognized testing laboratory).

1.6 WARRANTY

A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail in materials or workmanship within specified warranty period.

1. Warranty Extent: All equipment and components not covered in the Maintenance Service Agreement.
2. Warranty Period: Two years from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 SYSTEM DESCRIPTION

A. Source Limitations for Fire-Alarm System and Components: Components shall be compatible with, and operate as an extension of, existing system. Provide system manufacturer's certification that all components provided have been tested as, and will operate as, a system.

B. Noncoded, UL-certified addressable system, with multiplexed signal transmission and horn/strobe evacuation.

C. Automatic sensitivity control of certain smoke detectors.

D. All components provided shall be listed for use with the selected system.

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

2.2 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. Carbon monoxide detectors.
6. Automatic sprinkler system water flow.
7. Fire-extinguishing system operation.
8. Fire standpipe system.
9. Dry system pressure flow switch.

B. Fire-alarm signal shall initiate the following actions:

1. Continuously operate alarm notification appliances.
2. Identify alarm and specific initiating device at fire-alarm control unit and remote annunciators.
3. Transmit an alarm signal to the remote alarm receiving station.
4. Unlock electric door locks in designated egress paths.
5. Release fire and smoke doors held open by magnetic door holders.
6. Switch heating, ventilating, and air-conditioning equipment controls to fire-alarm mode.
7. Close smoke dampers in air ducts of designated air-conditioning duct systems.
8. Activate preaction system.
9. Activate elevator power shunt trip.
10. Activate emergency lighting control.
11. Activate emergency shutoffs for gas and fuel supplies.
12. Record events in the system memory.
13. Insert signal-initiating actions.

C. Supervisory signal initiation shall be by one or more of the following devices and actions:

1. Valve supervisory switch.
2. High- or low-air-pressure switch of a dry-pipe or preaction sprinkler system.
3. Loss of communication with any panel on the network.

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 communication with any addressable sensor, input module, relay, control module, or remote annunciator.
4. Loss of primary power at fire-alarm control unit.
5. Ground or a single break in internal circuits of fire-alarm control unit.
6. Abnormal ac voltage at fire-alarm control unit.
7. Break in standby battery circuitry.
8. Failure of battery charging.
9. Abnormal position of any switch at fire-alarm control unit or annunciator.

E. System Supervisory Signal Actions:

1. Initiate notification appliances.
2. Identify specific device initiating the event at fire-alarm control unit and remote annunciators.
3. After a time delay of 200 seconds, transmit a trouble or supervisory signal to the remote alarm receiving station.

2.3 FIRE-ALARM CONTROL UNIT

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

1. Bosch Security Systems.
2. Faraday.
3. Fike Corporation.
4. Fire-Lite Alarms.

5. GAMEWELL.
6. GE UTC Fire & Security; A United Technologies Company.
7. Keltron Corporation.
8. Mircom Technologies, Ltd.
9. Notifier.
10. Siemens Industry, Inc.; Fire Safety Division.
11. Silent Knight.
12. SimplexGrinnell LP.

B. General Requirements for Fire-Alarm Control Unit:

1. Field-programmable, microprocessor-based, modular, power-limited design with electronic modules, complying with UL 864.
2. Addressable Initiation Device Circuits: The FACP shall indicate which communication zones have been silenced and shall provide selective silencing of alarm notification appliance by building communication zone.
3. Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: The FACP shall be listed for releasing service.

C. Alphanumeric Display and System Controls: Arranged for interface between human operator at fire-alarm control unit and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and the programming and control menu.

1. Annunciator and Display: Liquid-crystal type, 80 characters, minimum.
2. Keypad: Arranged to permit entry and execution of programming, display, and control commands.

D. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:

1. Pathway Class Designations: NFPA 72, Class B.
2. Pathway Survivability: Level 1.

E. Notification-Appliance Circuit:

1. Audible appliances shall sound in a three-pulse temporal pattern, as defined in NFPA 72.
2. Where notification appliances provide signals to sleeping areas, the alarm signal shall be a 520-Hz square wave with an intensity 15 dB above the average ambient sound level or 5 dB above the maximum sound level, or at least 75 dBA, whichever is greater, measured at the pillow.
3. Visual alarm appliances shall flash in synchronization where multiple appliances are in the same field of view, as defined in NFPA 72.
4. 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. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls shall be connected to fire-alarm system.

G. 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.

H. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to a remote alarm station.

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 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.

2.4 MANUAL FIRE-ALARM BOXES

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

1. AMSECO - A Potter Brand.
2. Bosch Security Systems.
3. Cooper Wheelock.
4. Faraday.
5. Federal Signal Corporation.
6. Fike Corporation.
7. Fire-Lite Alarms.
8. GAMEWELL.
9. GE UTC Fire & Security; A United Technologies Company.
10. Keltron Corporation.
11. Mircom Technologies, Ltd.
12. Notifier.
13. Siemens Industry, Inc.; Fire Safety Division.
14. Silent Knight.
15. SimplexGrinnell LP.
16. System Sensor.

B. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38.

1. Double-action mechanism, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to fire-alarm control unit.
2. Station Reset: Key- or wrench-operated switch.

2.5 SYSTEM SMOKE DETECTORS

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

1. Bosch Security Systems.
2. Faraday.
3. Fenwal Protection Systems; A UTC Fire & Security Company.
4. Fire-Lite Alarms.

5. GAMEWELL.
6. GE UTC Fire & Security; A United Technologies Company.
7. Gentex Corporation.
8. Harrington Signal, Inc.
9. Keltron Corporation.
10. Mircom Technologies, Ltd.
11. Notifier.
12. Siemens Industry, Inc.; Fire Safety Division.
13. Silent Knight.
14. SimplexGrinnell LP.
15. System Sensor.

B. General Requirements for System Smoke Detectors:

1. Comply with UL 268; operating at 24-V dc, nominal.
2. Detectors shall be four-wire type.
3. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to fire-alarm control unit.
4. Base Mounting: Detector and associated electronic components shall be mounted in a twist-lock module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
5. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
6. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.
7. Remote Control: Unless otherwise indicated, detectors shall be digital-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 of combination smoke- and heat-detection units shall be selectable at fire-alarm control unit for 15 or 20 deg F (8 or 11 deg C) per minute.
    b. Sensitivity levels based on time of day.

C. 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.).

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

1. Detector address shall be accessible from fire-alarm control unit and shall be able to identify the detector's location within the system and its sensitivity setting.
2. An operator at fire-alarm control unit, having the designated access level, shall be able to manually access the following for each detector:

    a. Primary status.

b. Device type.
c. Present average value.
d. Present sensitivity selected.
e. Sensor range (normal, dirty, etc.).

3. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with the supplied detector for smoke detection in HVAC system ducts.
4. Each sensor shall have multiple levels of detection sensitivity.
5. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
6. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.6 NONSYSTEM SMOKE DETECTORS

A. General Requirements for Nonsystem Smoke Detectors:
1. Nonsystem smoke detectors shall meet the monitoring for integrity requirements in NFPA 72.

B. Single-Station Smoke Detectors:

1. Comply with UL 217; suitable for NFPA 101, residential occupancies; operating at 120-V ac with 9-V dc battery as the secondary power source. Provide with "low" or "missing" battery chirping-sound device.
2. Auxiliary Relays: One Form A and one Form C, both rated at 0.5 A.
3. Audible Notification Appliance: Piezoelectric sounder rated at 90 dBA at 10 feet (3 m) according to UL 464.
4. Visible Notification Appliance: 177-cd strobe.
5. Heat sensor, 135 deg F (57 deg C) combination rate-of-rise and fixed temperature.
6. Test Switch: Push to test; simulates smoke at rated obscuration.
7. Tandem Connection: Allow tandem connection of number of indicated detectors; alarm on one detector shall actuate notification on all connected detectors.
8. Plug-in Arrangement: Detector and associated electronic components shall be mounted in a plug-in module that connects to a fixed base. Provide terminals in the fixed base for connection to building wiring.
9. Self-Restoring: Detectors shall not require resetting or readjustment after actuation to restore them to normal operation.
10. Integral Visual-Indicating Light: LED type, indicating detector has operated and power-on status.

2.7 HEAT DETECTORS

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

1. Bosch Security Systems.
2. Faraday.
3. Fire-Lite Alarms.
4. GAMEWELL.
5. GE UTC Fire & Security; A United Technologies Company.
6. Gentex Corporation.
7. Harrington Signal, Inc.
8. Keltron Corporation.

9. Mircom Technologies, Ltd.
10. Notifier.
11. Siemens Industry, Inc.; Fire Safety Division.
12. Silent Knight.
13. SimplexGrinnell LP.
14. System Sensor.

B. General Requirements for Heat Detectors: Comply with UL 521.

1. Temperature sensors shall test for and communicate the sensitivity range of the device.

C. Heat Detector, Combination Type: Actuated by either a fixed temperature or a rate of rise.

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.

2.8 NOTIFICATION APPLIANCES

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

1. Cooper Wheelock.
2. Federal Signal Corporation.
3. GE UTC Fire & Security; A United Technologies Company.
4. Gentex Corporation.
5. Harrington Signal, Inc.
6. Keltron Corporation.
7. Mircom Technologies, Ltd.
8. Siemens Industry, Inc.; Fire Safety Division.
9. SimplexGrinnell LP.
10. System Sensor.

B. General Requirements for Notification Appliances: Connected to notification-appliance signal circuits, zoned as indicated, equipped for mounting as indicated, and with screw terminals for system connections.

1. Combination Devices: Factory-integrated audible and visible devices in a single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.

C. Chimes: Vibrating type.

D. Visible Notification Appliances: Xenon strobe lights complying 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. Mounting: Wall mounted unless otherwise indicated.
2. Flashing shall be in a temporal pattern, synchronized with other units.
3. Strobe Leads: Factory connected to screw terminals.
4. Mounting Faceplate: Factory finished, white.

2.9 REMOTE ANNUNCIATOR

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

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

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

2.10 ADDRESSABLE INTERFACE DEVICE

A. 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.

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.

C. Control Module:

1. Operate notification devices.
2. Operate solenoids for use in sprinkler service.

2.11 DIGITAL ALARM COMMUNICATOR TRANSMITTER

A. Digital alarm communicator transmitter shall be acceptable to the remote central station and shall comply with UL 632.

B. Functional Performance: Unit shall receive an alarm, supervisory, or trouble signal from fire-alarm control unit and automatically capture [one] [two] telephone line(s) and dial a preset number for a remote central station. When contact is made with central station(s), signals shall be transmitted. If service on either line is interrupted for longer than 45 seconds, transmitter shall initiate a local trouble signal and transmit the signal indicating loss of telephone line to the remote alarm receiving station over the remaining line. Transmitter shall automatically report telephone service restoration to the central station. If service is lost on both telephone lines, transmitter shall initiate the local trouble signal.

C. Local functions and display at the digital alarm communicator transmitter shall include the following:

1. Verification that both telephone lines are available.
2. Programming device.
3. LED display.
4. Manual test report function and manual transmission clear indication.

5. Communications failure with the central station or fire-alarm control unit.

D. Digital data transmission shall include the following:

1. Address of the alarm-initiating device.
2. Address of the supervisory signal.
3. Address of the trouble-initiating device.
4. Loss of ac supply.
5. Loss of power.
6. Low battery.
7. Abnormal test signal.
8. Communication bus failure.

E. Secondary Power: Integral rechargeable battery and automatic charger.

F. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.1 EQUIPMENT INSTALLATION

A. Comply with NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install all electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."

B. Install wall-mounted equipment, with tops of cabinets not more than 78 inches (1980 mm) above the finished floor.

C. Manual Fire-Alarm Boxes:

1. Install manual fire-alarm box in the normal path of egress within 60 inches (1520 mm) of the exit doorway.
2. Mount manual fire-alarm box on a background of a contrasting color.
3. The operable part of manual fire-alarm box shall be between 42 inches (1060 mm) and 48 inches (1220 mm) above floor level. All devices shall be mounted at the same height unless otherwise indicated.

D. Smoke- or Heat-Detector Spacing: Comply with NFPA 72.

E. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend the full width of duct. Tubes more than 36 inches (9100 mm) long shall be supported at both ends.

F. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within a dwelling or suite, they shall be connected so that the operation of any smoke alarm causes the alarm in all smoke alarms to sound.

G. Remote Status and Alarm Indicators: Install in a visible location near each smoke detector, sprinkler water-flow switch, and valve-tamper switch that is not readily visible from normal viewing position.

H. Audible Alarm-Indicating Devices: Install not less than 6 inches (150 mm) below the ceiling. Install bells and horns on flush-mounted back boxes with the device-operating mechanism concealed behind a grille. Install all devices at the same height unless otherwise indicated.

I. Visible Alarm-Indicating Devices: Install adjacent to each alarm bell or alarm horn and at least 6 inches (150 mm) below the ceiling. Install all devices at the same height unless otherwise indicated.

J. Device Location-Indicating Lights: Locate in public space near the device they monitor.

3.2 PATHWAYS

A. Pathways above recessed ceilings and in nonaccessible locations may be routed exposed.

1. Exposed pathways located less than 96 inches (2440 mm) above the floor shall be installed in EMT.

B. Pathways shall be installed in EMT.

C. Exposed EMT shall be painted red enamel.

3.3 CONNECTIONS

A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in Section 087100 "Door Hardware." Connect hardware and devices to fire-alarm system.

1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.

B. Make addressable connections with a supervised interface device to the following devices and systems. Install the interface device less than 36 inches (910 mm) from the device controlled. Make an addressable confirmation connection when such feedback is available at the device or system being controlled.

1. Smoke dampers in air ducts of designated HVAC duct systems.
2. Magnetically held-open doors.
3. Electronically locked doors and access gates.
4. Alarm-initiating connection to elevator recall system and components.
5. Alarm-initiating connection to activate emergency lighting control.
6. Alarm-initiating connection to activate emergency shutoffs for gas and fuel supplies.
7. Supervisory connections at valve supervisory switches.
8. Supervisory connections at low-air-pressure switch of each dry-pipe sprinkler system.
9. Supervisory connections at elevator shunt-trip breaker.
10. Supervisory connections at fire-extinguisher locations.

3.4 IDENTIFICATION

A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in Section 260553 "Identification for Electrical Systems."

B. Install framed instructions in a location visible from fire-alarm control unit.

3.5 GROUNDING

A. Ground fire-alarm control unit and associated circuits; comply with IEEE 1100. Install a ground wire from main service ground to fire-alarm control unit.

B. Ground shielded cables at the control panel location only. Insulate shield at device location.

3.6 FIELD QUALITY CONTROL

A. Field tests shall be witnessed by authorities having jurisdiction.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

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" chapter.
   b. Comply with the "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 the "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" chapter in NFPA 72 and the "Inspection and Testing Form" in the "Records" section of the "Inspection, Testing and Maintenance" chapter in NFPA 72.

C. Reacceptance Testing: Perform reacceptance testing to verify the proper operation of added or replaced devices and appliances.

D. Fire-alarm system will be considered defective if it does not pass tests and inspections.

E. Prepare test and inspection reports.

F. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.

G. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.7 SOFTWARE SERVICE AGREEMENT

A. Comply with UL 864.

B. Technical Support: Beginning at Substantial Completion, service agreement shall include software support for two years.

C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within two years from date of Substantial Completion. Upgrading software shall include operating system and new or revised licenses for using software.

1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

3.8 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system.

END OF SECTION 28 3111

SECTION 31 1000 - SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Protecting existing trees, shrubs, groundcovers, plants, and grass to remain.
2. Removing existing trees, shrubs, groundcovers, plants, and grass.
3. Clearing and grubbing.
4. Stripping and stockpiling topsoil.
5. Removing above- and below-grade site improvements.
6. Disconnecting and capping or sealing site utilities.
7. Temporary erosion and sedimentation control measures.

B. Related Sections include the following:

1. Division 01 Section "Temporary Facilities and Controls" for temporary utilities, temporary construction and support facilities, temporary security and protection facilities, and temporary erosion and sedimentation control procedures.
2. Division 01 Section "Execution" for verifying utility locations and for recording field measurements.
3. Division 02 Section "Structure Demolition" for demolition of buildings, structures, and site improvements.
4. Division 02 Section "Selective Structure Demolition" for partial demolition of buildings or structures undergoing alterations.
5. Division 31 Section "Earth Moving" for soil materials, excavating, backfilling, and site grading.
6. Division 32 Section "Turf and Grasses" for finish grading including preparing and placing planting soil mixes and testing of topsoil material.

1.2 DEFINITIONS

A. Topsoil: Natural or cultivated surface-soil layer containing organic matter and sand, silt, and clay particles; friable, pervious, and black or a darker shade of brown, gray, or red than underlying subsoil; reasonably free of subsoil, clay lumps, gravel, and other objects more than 2 inches(50 mm) in diameter; and free of subsoil and weeds, roots, toxic materials, or other nonsoil materials.

B. Tree Protection Zone: Area surrounding individual trees or groups of trees to be protected during construction, and defined by the drip line of individual trees or the perimeter drip line of groups of trees, unless otherwise indicated.

1.3 MATERIAL OWNERSHIP

A. Except for stripped topsoil or other materials indicated to remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.4 PROJECT CONDITIONS

A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.

1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

B. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.

C. Utility Locator Service: Notify MISS DIG for area where Project is located before site clearing.

D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

PART 2 - PRODUCTS]

2.1 SOIL MATERIALS

A. Satisfactory Soil Materials: Requirements for satisfactory soil materials are specified in Division 31 Section "Earth Moving."

1. Obtain approved borrow soil materials off-site when satisfactory soil materials are not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect and maintain benchmarks and survey control points from disturbance during construction.

B. Locate and clearly flag trees and vegetation to remain or to be relocated.

C. Protect existing site improvements to remain from damage during construction.

1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

A. Comply with the Soil Erosion and Sedimentation Control permit issued by the Barry County.

B. Inspect, repair, and maintain erosion and sedimentation control measures during construction until permanent vegetation has been established.

C. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE PROTECTION

A. Erect and maintain temporary fencing around tree protection zones before starting site clearing. Remove fence when construction is complete.

1. Do not store construction materials, debris, or excavated material within fenced area.
2. Do not permit vehicles, equipment, or foot traffic within fenced area.
3. Maintain fenced area free of weeds and trash.

B. Do not excavate within tree protection zones, unless otherwise indicated.

C. Where excavation for new construction is required within tree protection zones, hand clear and excavate to minimize damage to root systems. Use narrow-tine spading forks, comb soil to expose roots, and cleanly cut roots as close to excavation as possible.

1. Cover exposed roots with burlap and water regularly.
2. Temporarily support and protect roots from damage until they are permanently redirected and covered with soil.
3. Coat cut faces of roots more than 1-1/2 inches(38 mm) in diameter with an emulsified asphalt or other approved coating formulated for use on damaged plant tissues.
4. Backfill with soil as soon as possible.

D. Repair or replace trees and vegetation indicated to remain that are damaged by construction operations, in a manner approved by Architect.

3.4 UTILITIES

A. Locate, identify, disconnect, and seal or cap off utilities indicated to be removed.

1. Arrange with utility companies to shut off indicated utilities.

B. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.

C. Excavate for and remove underground utilities indicated to be removed.

3.5 CLEARING AND GRUBBING

A. Remove obstructions, trees, shrubs, grass, and other vegetation to permit installation of new construction.

1. Do not remove trees, shrubs, and other vegetation indicated to remain or to be relocated.
2. Cut minor roots and branches of trees indicated to remain in a clean and careful manner where such roots and branches obstruct installation of new construction.

3. Grind stumps and remove roots, obstructions, and debris extending to a depth of 18 inches(450 mm) below exposed subgrade.
4. Use only hand methods for grubbing within tree protection zone.

3.6 TOPSOIL STRIPPING

A. Remove sod and grass before stripping topsoil.

B. Strip topsoil to whatever depths are encountered in a manner to prevent intermingling with underlying subsoil or other waste materials.

1. Remove subsoil and nonsoil materials from topsoil, including trash, debris, weeds, roots, and other waste materials.

C. Stockpile topsoil materials away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile surplus topsoil to allow for respreading deeper topsoil.

3.7 SITE IMPROVEMENTS

A. Remove existing above- and below-grade improvements as indicated and as necessary to facilitate new construction.

B. Remove slabs, paving, curbs, gutters, and aggregate base as indicated.

1. Unless existing full-depth joints coincide with line of demolition, neatly saw-cut length of existing pavement to remain before removing existing pavement. Saw-cut faces vertically.
2. Paint cut ends of steel reinforcement in concrete to remain to prevent corrosion.

3.8 DISPOSAL

A. Disposal: Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

1. Comply at all time with the environmental reports and recommendations related to potential site contaminants and transport.

2. Test all material to be hauled off-site prior to removal. Obtain written clearance from the Owner that material may be hauled off-site.

3. Separate recyclable materials produced during site clearing from other nonrecyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities.

END OF SECTION 31 1000

SECTION 31 2000 - EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Preparing subgrades for slabs-on-grade, walks, pavements, lawns and grasses, and exterior plants.
2. Excavating and backfilling for buildings and structures.
3. Drainage course for slabs-on-grade.
4. Subbase course for concrete slabs-on-grade, walks, and pavements.
5. Subbase course for asphalt paving.
6. Excavating and backfilling for utility trenches.

B. Related Sections include the following:

1. Division 01 Section "Unit Prices" for unit-price rock excavation and authorized additional excavation provisions.
2. Division 01 Section "Construction Progress Documentation" for recording preexcavation and earth moving progress.
3. Division 01 Section "Temporary Facilities and Controls" for temporary controls, utilities, and support facilities.
4. Division 31 Section "Site Clearing" for temporary erosion and sedimentation control measures, site stripping, grubbing, stripping and stockpiling topsoil, and removal of above- and below-grade improvements and utilities.
5. Division 33 Section "Subdrainage" for drainage of foundations.
6. Division 33 Section "Turf and Grasses" for finish grading, including preparing and placing topsoil and planting soil for lawns.
7. Division 33 Section "Plants" for planting bed establishment and tree and shrub pit excavation and planting.
8. Division 33 Sections for installing underground mechanical and electrical utilities and buried mechanical and electrical structures.

C. Unit Prices: The Work of this Section is affected by Unit Prices. Refer to Division 1 Section “Unit Prices” for general requirements applicable to unit prices.

1. Unit Price 1: Supplemental Excavation, Satisfactory Soil Fill: Unit price for unforeseen excavation due to unsatisfactory soil conditions and replacement with satisfactory soil. Unit of measurement shall be cubic yard.
2. Unit Price 2: Supplemental Excavation, Engineered Fill: Unit price for unforeseen excavation due to unsatisfactory soil conditions and replacement with engineered fill. Unit of measurement shall be cubic yard.

1.2 DEFINITIONS

A. Backfill: Soil material used to fill an excavation.

1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.

2. Final Backfill: Backfill placed over initial backfill to fill a trench.

B. Base Course: Course placed between the subbase course and hot-mix asphalt paving.

C. Bedding Course: Course placed over the excavated subgrade in a trench before laying pipe.

D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

E. Drainage Course: Course supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. Authorized additional excavation and replacement material will be paid for according to Contract provisions changes in the Work.
2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

G. Fill: Soil materials used to raise existing grades.

H. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.

I. Subbase Course: Course placed between the subgrade and base course for hot-mix asphalt pavement, or course placed between the subgrade and a concrete slab-on-grade, cement concrete pavement, or a cement concrete or hot-mix asphalt walk.

J. Subgrade: Surface or elevation remaining after completing excavation, or top surface of a fill or backfill immediately below subbase, drainage fill, or topsoil materials.

K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.

1.3 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Architect and then only after arranging to provide temporary utility services according to requirements indicated.

1. Notify Architect not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Architect's written permission.
3. Contact utility-locator service for area where Project is located before excavating.

B. Demolish and completely remove from site existing underground utilities indicated to be removed. Coordinate with utility companies to shut off services if lines are active.

PART 2 - PRODUCTS

2.1 SOIL MATERIALS

A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.

B. Satisfactory Soils: ASTM D 2487 Soil Classification Groups GW, GP, GM, SW, SP, and SM, or a combination of these groups; free of rock or gravel larger than 2 inches(75 mm) in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter.

C. Unsatisfactory Soils: Soil Classification Groups GC, SC, CL, ML, OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.

1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.

D. Subbase Material: MDOT Class II material.

E. Base Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 95 percent passing a 1-1/2-inch(37.5-mm) sieve and not more than 8 percent passing a No. 200(0.075-mm) sieve.

F. Engineered Fill: MDOT Class II material or naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; with at least 90 percent passing a 1-1/2-inch(37.5-mm) sieve and not more than 12 percent passing a No. 200(0.075-mm) sieve.

G. Bedding Course: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940; except with 100 percent passing a 1-inch(25-mm) sieve and not more than 8 percent passing a No. 200(0.075-mm) sieve.

H. Drainage Course: Narrowly graded mixture of [washed]crushed stone, or crushed or uncrushed gravel; ASTM D 448; coarse-aggregate grading Size 57; with 100 percent passing a 1-1/2-inch(37.5-mm) sieve and 0 to 5 percent passing a No. 8(2.36-mm) sieve.

I. Filter Material: Narrowly graded mixture of natural or crushed gravel, or crushed stone and natural sand; ASTM D 448; coarse-aggregate grading Size 67; with 100 percent passing a 1-inch(25-mm) sieve and 0 to 5 percent passing a No. 4(4.75-mm) sieve.

J. Sand: ASTM C 33; fine aggregate, natural, or manufactured sand.

K. Impervious Fill: Clayey gravel and sand mixture capable of compacting to a dense state.

2.2 GEOTEXTILES

A. Subsurface Drainage Geotextile: Nonwoven needle-punched geotextile, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.

2. Grab Tensile Strength: 157 lbf(700 N); ASTM D 4632.
3. Sewn Seam Strength: 142 lbf(630 N); ASTM D 4632.
4. Tear Strength: 56 lbf(250 N); ASTM D 4533.
5. Puncture Strength: 56 lbf(250 N); ASTM D 4833.
6. Apparent Opening Size: No. 60(0.250-mm) sieve, maximum; ASTM D 4751.
7. Permittivity: 0.2 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

B. Separation Geotextile: Woven geotextile fabric, manufactured for separation applications, made from polyolefins or polyesters; with elongation less than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

1. Survivability: Class 2; AASHTO M 288.
2. Grab Tensile Strength: 247 lbf(1100 N); ASTM D 4632.
3. Sewn Seam Strength: 222 lbf(990 N); ASTM D 4632.
4. Tear Strength: 90 lbf(400 N); ASTM D 4533.
5. Puncture Strength: 90 lbf(400 N); ASTM D 4833.
6. Apparent Opening Size: No. 60(0.250-mm) sieve, maximum; ASTM D 4751.
7. Permittivity: 0.02 per second, minimum; ASTM D 4491.
8. UV Stability: 50 percent after 500 hours' exposure; ASTM D 4355.

2.3 CONTROLLED LOW-STRENGTH MATERIAL

A. Controlled Low-Strength Material: Low-density, self-compacting, flowable concrete material as follows:

1. Portland Cement: ASTM C 150, Type I, II, or III.
2. Fly Ash: ASTM C 618, Class C or F.
3. Normal-Weight Aggregate: ASTM C 33, 3/4-inch(19-mm) nominal maximum aggregate size.
4. Water: ASTM C 94/C 94M.
5. Air-Entraining Admixture: ASTM C 260.

PART 3 - EXECUTION

3.1 PREPARATION

A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earthwork operations.

B. Preparation of subgrade for earthwork operations including removal of vegetation, topsoil, debris, obstructions, and deleterious materials from ground surface is specified in Division 31 Section "Site Clearing."

C. Protect and maintain erosion and sedimentation controls, which are specified in Division 31 Section "Site Clearing," during earthwork operations.

D. Provide protective insulating materials to protect subgrades and foundation soils against freezing temperatures or frost.

3.2 DEWATERING

A. Prevent surface water and ground water from entering excavations, from ponding on prepared subgrades, and from flooding Project site and surrounding area.

B. Protect subgrades from softening, undermining, washout, and damage by rain or water accumulation.

1. Reroute surface water runoff away from excavated areas. Do not allow water to accumulate in excavations. Do not use excavated trenches as temporary drainage ditches.
2. Install a dewatering system, specified in Division 31 Section "Dewatering," to keep subgrades dry and convey ground water away from excavations. Maintain until dewatering is no longer required.

3.3 EXPLOSIVES

A. Explosives: Do not use explosives.

3.4 EXCAVATION

A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.

1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

B. Excavation for Structures: Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch(25 mm). If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.

1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.

C. Excavation for Walks and Pavements: Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

D. Excavation for Utility Trenches: Excavate trenches to indicated gradients, lines, depths, and elevations.

1. Beyond building perimeter, excavate trenches to allow installation of top of pipe below frost line.
2. Excavate trenches to uniform widths to provide the following clearance on each side of pipe or conduit. Excavate trench walls vertically from trench bottom to 12 inches(300 mm) higher than top of pipe or conduit, unless otherwise indicated.

a. Clearance: 12 inches(300 mm) each side of pipe or conduit.

3. Trench Bottoms: Excavate and shape trench bottoms to provide uniform bearing and support of pipes and conduit. Shape subgrade to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits. Remove projecting stones and sharp objects along trench subgrade.

   a. Excavate trenches 6 inches(150 mm) deeper than elevation required in rock or other unyielding bearing material, 4 inches(100 mm) deeper elsewhere, to allow for bedding course.

3.5 SUBGRADE INSPECTION

A. Proof-roll subgrade below the building slabs and pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

1. Completely proof-roll subgrade in one direction. Limit vehicle speed to 3 mph(5 km/h).
2. Proof-roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons(13.6 tonnes).
3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Architect, and replace with compacted backfill or fill as directed.

B. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Architect, without additional compensation.

3.6 UNAUTHORIZED EXCAVATION

A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi(17.2 MPa), may be used when approved by Architect.

1. Fill unauthorized excavations under other construction or utility pipe as directed by Architect.

3.7 STORAGE OF SOIL MATERIALS

A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

3.8 BACKFILL

A. General: Place backfill on subgrades free of mud, frost, snow, or ice. Place and compact backfill in excavations promptly, but not before completing the following:

1. Construction below finish grade including, where applicable, subdrainage, dampproofing, waterproofing, and perimeter insulation.
2. Surveying locations of underground utilities for Record Documents.

3. Testing and inspecting underground utilities.
4. Removing concrete formwork.
5. Removing trash and debris.
6. Removing temporary shoring and bracing, and sheeting.
7. Installing permanent or temporary horizontal bracing on horizontally supported walls.

B. Utility Trench Backfill: Place backfill on subgrades free of mud, frost, snow, or ice.

1. Place and compact bedding course on trench bottoms and where indicated. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
2. Backfill trenches excavated under footings and within 18 inches(450 mm) of bottom of footings with satisfactory soil; fill with concrete to elevation of bottom of footings. Concrete is specified in Division 03 Section "Cast-in-Place Concrete."
3. Provide 4-inch-(100-mm-) thick, concrete-base slab support for piping or conduit less than 30 inches(750 mm) below surface of roadways. After installing and testing, completely encase piping or conduit in a minimum of 4 inches(100 mm) of concrete before backfilling or placing roadway subbase.
4. Place and compact initial backfill of subbase material, free of particles larger than 1 inch(25 mm) in any dimension, to a height of 12 inches(300 mm) over the utility pipe or conduit.

    a. Carefully compact initial backfill under pipe haunches and compact evenly up on both sides and along the full length of utility piping or conduit to avoid damage or displacement of piping or conduit. Coordinate backfilling with utilities testing.

5. Backfill voids with satisfactory soil while installing and removing shoring and bracing.
6. Place and compact final backfill of satisfactory soil to final subgrade elevation.
7. Install warning tape directly above utilities, 12 inches(300 mm) below finished grade, except 6 inches(150 mm) below subgrade under pavements and slabs.

C. Soil Fill: Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material. Place and compact fill material in layers to required elevations as follows:

1. Under grass and planted areas, use satisfactory soil material.
2. Under walks and pavements, use satisfactory soil material.
3. Under steps and ramps, use engineered fill.
4. Under building slabs, use engineered fill.
5. Under footings and foundations, use engineered fill.

3.9 SOIL MOISTURE CONTROL

A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.

1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
2. Remove and replace, or scarify and air dry otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

3.10 COMPACTION OF SOIL BACKFILLS AND FILLS

A. Place backfill and fill soil materials in layers not more than 12 inches(300 mm) in loose depth for material compacted by heavy compaction equipment, and not more than 6 inches(150 mm) in loose depth for material compacted by hand-operated tampers.

B. Place backfill and fill soil materials evenly on all sides of structures to required elevations, and uniformly along the full length of each structure.

C. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 698:

1. Under structures, building slabs, steps, and pavements, scarify and recompact top 12 inches(300 mm) of existing subgrade and each layer of backfill or fill soil material at 95 percent.

    a. Under slabs on grade, place 6 inches(152 mm) compacted depth of sand

2. Under walkways, scarify and recompact top 6 inches(150 mm) below subgrade and compact each layer of backfill or fill soil material at 92 percent.
3. Under lawn or unpaved areas, scarify and recompact top 6 inches(150 mm) below subgrade and compact each layer of backfill or fill soil material at 90 percent.
4. For utility trenches, compact each layer of initial and final backfill soil material at 95 percent.

3.11 GRADING

A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.

B. Site Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to required elevations within the following tolerances:

1. Lawn or Unpaved Areas: Plus or minus 1 inch(25 mm.
2. Walks: Plus or minus 1/2 inch(13 mm).
3. Pavements: Plus or minus 1/4 inch(6.5 mm).

C. Grading inside Building Lines: Finish subgrade to a tolerance of 1/2 inch(13 mm) when tested with a 10-foot(3-m) straightedge.

3.12 SUBSURFACE DRAINAGE

A. Subdrainage Pipe: Specified in Division 33 Section "Subdrainage."

B. Subsurface Drain: Place subsurface drainage geotextile around perimeter of subdrainage trench. Place a 6-inch(150-mm) course of filter material on subsurface drainage geotextile to support subdrainage pipe. Encase subdrainage pipe in a minimum of 12 inches(300 mm) of filter material, placed in compacted layers 6 inches(150 mm) thick, and wrap in subsurface drainage geotextile, overlapping sides and ends at least 6 inches(150 mm).

1. Compact each filter material layer to 85 percent of maximum dry unit weight according to ASTM D 698.

2. Extend filter material at footing drain to foundation drainage panel.

3.13 SUBBASE AND BASE COURSES

A. Place subbase course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place subbase course under pavements and walks as follows:

1. Install separation geotextile on prepared subgrade according to manufacturer's written instructions, overlapping sides and ends.
2. Place base course material over subbase course under hot-mix asphalt pavement.
3. Shape subbase course to required crown elevations and cross-slope grades.
4. Place subbase course 6 inches(150 mm) or less in compacted thickness in a single layer.
5. Place subbase course that exceeds 6 inches(150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches(150 mm) thick or less than 3 inches(75 mm) thick.
6. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

C. Pavement Shoulders: Place shoulders along edges of subbase and base course to prevent lateral movement. Construct shoulders, at least 12 inches(300 mm) wide, of satisfactory soil materials and compact simultaneously with each subbase and base layer to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.14 DRAINAGE COURSE

A. Place drainage course on subgrades free of mud, frost, snow, or ice.

B. On prepared subgrade, place and compact drainage course under cast-in-place concrete slabs-on-grade and at footing drains as follows:

1. Place drainage course that exceeds 6 inches(150 mm) in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches(150 mm) thick or less than 3 inches(75 mm) thick.
2. Compact each layer of drainage course to required cross sections and thicknesses to not less than 95 percent of maximum dry unit weight according to ASTM D 698.

3.15 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified independent geotechnical engineering testing agency to perform field quality-control testing.

B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earthwork only after test results for previously completed work comply with requirements.

C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Architect.

D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2922, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:

1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least 1 test for every 2000 sq. ft.(186 sq. m) or less of paved area or building slab, but in no case fewer than 3 tests.
2. Foundation Wall Backfill: At each compacted backfill layer, at least 1 test for each 100 feet(30 m) or less of wall length, but no fewer than 2 tests.
3. Trench Backfill: At each compacted initial and final backfill layer, at least 1 test for each 150 feet(46 m) or less of trench length, but no fewer than 2 tests.

E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil to depth required; recompact and retest until specified compaction is obtained.

3.16 PROTECTION

A. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.

B. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions.

C. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.

1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

D. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 31 2000

SECTION 31 2319 - DEWATERING

PART 1 - GENERAL

1.1 SUMMARY

A. Section includes construction dewatering.

1.2 PERFORMANCE REQUIREMENTS

A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

1.3 SUBMITTALS

A. Shop Drawings: For dewatering system. Show arrangement, locations, and details of wells and well points; locations of risers, headers, filters, pumps, power units, discharge lines, piezometers, and flow-measuring devices; and means of discharge, control of sediment, and disposal of water.

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

1.4 QUALITY ASSURANCE

A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning dewatering. Comply with hauling and disposal regulations of authorities having jurisdiction.

1.5 PROJECT CONDITIONS

A. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements, establishing exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks and record existing elevations.

1. During dewatering, regularly resurvey benchmarks, maintaining an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 INSTALLATION

A. Provide temporary grading to facilitate dewatering and control of surface water.

B. Monitor dewatering systems continuously.

C. Protect and maintain temporary erosion and sedimentation controls, which are specified in Division 01 Section "Temporary Facilities and Controls" and Division 31 Section "Site Clearing" during dewatering operations.

D. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.

1. Space well points or wells at intervals required to provide sufficient dewatering.
2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.

E. Before excavating below ground-water level, place system into operation to lower water to specified levels. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.

F. Provide an adequate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Install sufficient dewatering equipment to drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.

1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.

G. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.

1. Maintain piezometric water level a minimum of 24 inches(600 mm) below surface of excavation.

H. Provide standby equipment on site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.

1. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches(900 mm) below overlying construction.

END OF SECTION 31 2319

SECTION 32 1216 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:
   1. Hot-mix asphalt paving.
   2. Hot-mix asphalt paving overlay.
   3. Pavement-marking paint.

B. Related Sections:

   1. Division 31 Section "Earth Moving" for aggregate subbase and base courses and for aggregate pavement shoulders.

1.2 SUBMITTALS

A. Product Data: For each type of product indicated. Include technical data and tested physical and performance properties.
   1. Job-Mix Designs: For each job mix proposed for the Work.

B. Material Certificates: For each paving material, from manufacturer.

1.3 QUALITY ASSURANCE

A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by the Michigan Department of Transportation.

B. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of MDOT for asphalt paving work.

C. Preinstallation Conference: Conduct conference at Project site.

1.4 PROJECT CONDITIONS

A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:

   1. Tack Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
   2. Asphalt Base Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
   3. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) at time of placement.

B. Pavement-Marking Paint: Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 deg F (4.4 deg C) for oil-based materials 55 deg F (12.8 deg C) for water-based materials, and not exceeding 95 deg F (35 deg C).

PART 2 - PRODUCTS

2.1 AGGREGATES

A. Coarse Aggregate: ASTM D 692, sound; angular crushed stone, crushed gravel, or cured, crushed blast-furnace slag.

B. Fine Aggregate: ASTM D 1073 or AASHTO M 29, sharp-edged natural sand or sand prepared from stone, gravel, cured blast-furnace slag, or combinations thereof.

C. Mineral Filler: ASTM D 242 or AASHTO M 17, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

A. Asphalt Binder: AASHTO M 320 or AASHTO MP 1a, PG 64-22.

B. Tack Coat: AASHTO M 140 emulsified asphalt.

2.3 AUXILIARY MATERIALS

A. Herbicide: Commercial chemical for weed control, registered by the EPA. Provide in granular, liquid, or wettable powder form.

B. Pavement-Marking Paint: MPI #97 Latex Traffic Marking Paint.

1. Color: Yellow for parking spaces.

2. Color: Blue for barrier free spaces.

C. Glass Beads: AASHTO M 247, Type 1.

2.4 MIXES

A. Hot-Mix Asphalt: Dense, hot-laid, hot-mix asphalt plant mixes approved by the MDOT and complying with the following requirements:
1. Base Course: MDOT 13A.
2. Surface Course: MDOT 36A.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.

B. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 PATCHING

A. Hot-Mix Asphalt Pavement: Saw cut perimeter of patch and excavate existing pavement section to sound base. Excavate rectangular or trapezoidal patches, extending 12 inches (300 mm) into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Remove excavated material. Recompact existing unbound-aggregate base course to form new subgrade.

B. Portland Cement Concrete Pavement: Break cracked slabs and roll as required to reseat concrete pieces firmly.

1. Remove disintegrated or badly cracked pavement. Excavate rectangular or trapezoidal patches, extending into adjacent sound pavement, unless otherwise indicated. Cut excavation faces vertically. Recompact existing unbound-aggregate base course to form new subgrade.

C. Tack Coat: Apply uniformly to vertical surfaces abutting or projecting into new, hot-mix asphalt paving at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

D. Patching: Fill excavated pavements with hot-mix asphalt base mix for full thickness of patch and, while still hot, compact flush with adjacent surface.

3.3 SURFACE PREPARATION

A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.

B. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).

1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.4 HOT-MIX ASPHALT PLACING

A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand to areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.

1. Spread mix at minimum temperature of 250 deg F (121 deg C).
2. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.

C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.5 JOINTS

A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.

1. Clean contact surfaces and apply tack coat to joints.
2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."

3.6 COMPACTION

A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.

1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).

B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:

1. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent nor greater than 96 percent.

D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.

E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.

F. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.

G. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.7 INSTALLATION TOLERANCES

A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:

1. Base Course: Plus or minus 1/2 inch (13 mm).
2. Surface Course: Plus 1/4 inch (6 mm), no minus.

B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:

1. Base Course: [1/4 inch (6 mm)] <Insert size>.
2. Surface Course: [1/8 inch (3 mm)] <Insert size>.
3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).

3.8 PAVEMENT MARKING

A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Architect.

B. Allow paving to age for 3 days before starting pavement marking.

C. Sweep and clean surface to eliminate loose material and dust.

D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).

1. Broadcast glass beads uniformly into wet pavement markings at a rate of 6 lb/gal. (0.72 kg/L).

3.9 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Replace and compact hot-mix asphalt where core tests were taken.

C. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.10 DISPOSAL

A. Except for material indicated to be recycled, remove excavated materials from Project site and legally dispose of them in an EPA-approved landfill.

END OF SECTION 32 1216

SECTION 32 1313 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Driveways.
2. Roadways.
3. Parking lots.
4. Curbs and gutters.
5. Walks.

1.2 SUBMITTALS

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

B. Samples: For each exposed product and for each color and texture specified.

C. Other Action Submittals:

1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.

1.3 QUALITY ASSURANCE

A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

B. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

A. Recycled Content: Provide steel reinforcement with an average recycled content of steel so postconsumer recycled content plus one-half of preconsumer recycled content is not less than 25 percent.

B. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel wire into flat sheets.

C. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497M, flat sheet.

D. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420); deformed.

E. Plain-Steel Wire: ASTM A 82/A 82M, as drawn.

F. Deformed-Steel Wire: ASTM A 496/A 496M.

G. Dowel Bars: zinc coated (galvanized) after fabrication according to ASTM A 767/A 767M, Class I coating. Cut bars true to length with ends square and free of burrs.

H. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.2 CONCRETE MATERIALS

A. Cementitious Material: Use the following cementitious materials, of same type, brand, and source throughout Project:

1. Portland Cement: ASTM C 150, white portland cement Type I.

B. Normal-Weight Aggregates: ASTM C 33, Class 4S, uniformly graded. Provide aggregates from a single source.

C. Water: Potable and complying with ASTM C 94/C 94M.

D. Air-Entraining Admixture: ASTM C 260.

E. Chemical Admixtures: Admixtures certified by manufacturer to be compatible with other admixtures and to contain not more than 0.1 percent water-soluble chloride ions by mass of cementitious material.

F. Color Pigment: none.

2.3 CURING MATERIALS

A. Absorptive Cover: AASHTO M 182.

B. Moisture-Retaining Cover: ASTM C 171, polyethylene film or white burlap-polyethylene sheet.

C. Water: Potable.

D. Evaporation Retarder: Waterborne, monomolecular, film forming, manufactured for application to fresh concrete.

E. White, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 2, Class B, dissipating.

2.4 RELATED MATERIALS

A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber.

2.5 CONCRETE MIXTURES

A. Prepare design mixtures, proportioned according to ACI 301 (ACI 301M), with the following properties:

1. Compressive Strength (28 Days): 4000 psi (27.6 MPa)] .
2. Maximum Water-Cementitious Materials Ratio at Point of Placement: 0.50.
3. Slump Limit: 4 inches (100 mm), plus or minus 1 inch (25 mm).
4. Air Content: 6 percent plus or minus 0.5 percent.

B. Chemical Admixtures: Use admixtures according to manufacturer's written instructions.

2.6 CONCRETE MIXING

A. Ready-Mixed Concrete: Measure, batch, and mix concrete materials and concrete according to ASTM C 94/C 94M. Furnish batch certificates for each batch discharged and used in the Work.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.

B. Remove loose material from compacted subbase surface immediately before placing concrete.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.

B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.

B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.

C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.

D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving.

E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

B. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, placing, and consolidating concrete.

C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.

D. Screed paving surface with a straightedge and strike off.

E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

A. General: Do not add water to concrete surfaces during finishing operations.

B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.

1. Burlap Finish: Drag a seamless strip of damp burlap across float-finished concrete, perpendicular to line of traffic, to provide a uniform, gritty texture.
2. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
3. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

C. Slip-Resistive Aggregate Finish: Before final floating, spread slip-resistive aggregate finish on paving surface according to manufacturer's written instructions.

1. Cure concrete with curing compound recommended by slip-resistive aggregate manufacturer. Apply curing compound immediately after final finishing.
2. After curing, lightly work surface with a steel wire brush or abrasive stone and water to expose nonslip aggregate.

3.7 CONCRETE PROTECTION AND CURING

A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.

B. Comply with ACI 306.1 for cold-weather protection.

C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.

D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.

E. Curing Methods: Cure concrete by moisture curing, moisture-retaining-cover curing, curing compound, or a combination of these.

3.8 PAVING TOLERANCES

A. Comply with tolerances in ACI 117 and as follows:

1. Elevation: 1/4 inch (6 mm).
2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
3. Surface: Gap below 10-foot- (3-m-) long, unleveled straightedge not to exceed 1/2 inch (13 mm).
4. Joint Spacing: 3 inches (75 mm).
5. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
6. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.9 REPAIRS AND PROTECTION

A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Architect.

B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.

C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

END OF SECTION 32 1313

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SECTION 32 3113 - FENCES

PART 1 GENERAL

1.01 Related Documents

A. Drawings and general provisions of the contract apply to this section.

1.02 Summary

A. This section includes the following:

1. Polyvinyl chloride (PVC) fence and gate components.
2. Gate hardware.
3. Reinforcing steel for concrete-filled, reinforced fence posts.
4. Concrete for post footings and for concrete filled reinforced fence posts

B. Related sections: The following sections contain requirements that relate to this section.

1. Section 31 2000-Earth Moving
2. Section 03 3000-Cast-in-Place concrete

1.03 Definitions

A. Posts are the vertical structure support members of the fence.
B. Rails are the horizontal structural support members of the fence or gate frame.
C. Pickets are the vertical, non-structural members between bottom and top rails.
D. Gate Uprights are the vertical structural support members of the gate frame.

1.04 Submittals

A. General: Submit the following according to the conditions of the contract.
B. Product Data: In the form of manufacturer’s technical data, specifications, and installations for fence, posts, gate uprights, post caps, gates, gate hardware and accessories.
C. Samples for verification of PVC color in form of 3-inch lengths of actual product to be used in color selection.
D. Shop Drawings showing fence design.

1.05 Quality Assurance

A. Installer Qualifications: Engage an experienced installer who has at least three years experience and has completed at least five PVC fence projects with same material and of similar scope to that indicated for this project with a successful construction record of in-service performance.
B. Single-Source Responsibility: Obtain PVC fences and gates, including accessories, fittings, and fastenings, from a single source.

1.06 Project Conditions

A. Field Measurements: Verify layout information for fences and gates shown on the drawings in relation to the property survey and existing structures. Verify dimensions by field measurements.

1.07 Warranty

A. Manufacturer's Warranty: Lifetime non-prorated limited warranty applies to original homeowner/consumer, or 30 year non-prorated limited warranty applies to commercial applications.

PART 2 PRODUCTS

2.01 Fence Materials

A. General: Provide PVC fence materials recognized to be of type indicated and tested to show compliance with indicated performances.
B. Available Manufacturer: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the work include:

1. Bufftech, 231 Ship Canal Parkway, Buffalo, NY 14218 (800) 333-0569
2. Style Name Monarch
   Height 6'H minimum.
3. Color Match Bufftech white.

2.02 Polyvinyl Chloride (PVC) Fence Components

A. General: Posts, rails, pickets, gate uprights, post caps, and accessories shall be of high impact, Ultra Violet (U.V.) resistant, rigid PVC, and shall comply with ASTM D 1784, Class 14344B.
B. Fence Posts: One piece extruded, of lengths indicated and pre-routed to receive rails at spacing indicated.

1. Cross Section: 5" x 5" minimum
2. Wall Thickness: 0.170" minimum
3. Corner Radius: 3/8" R minimum

C. Rails: One piece extruded, of lengths indicated pre-routed to receive pickets at spacing indicated.

1. Cross Section: 1-3/4" X 3-1/2" (Nominal 2" x 4") minimum
2. Wall Thickness: 0.100" minimum
3. Corner Radius: 13/32" R minimum

D. Pickets: One piece extruded, of lengths indicated.

1. Cross Section: 7/8" X 3" minimum
2. Wall Thickness: 0.060" minimum
3. Corner Radius: 3/16" R minimum
4. Pieces per 8' section 8 pieces
5. Cross Section: 7/8" X 1-1/2" minimum

6. Wall Thickness: 0.060" minimum
7. Corner Radius: 3/16" R minimum
8. Pieces per 8' section 9 pieces
9. Picket Spacing: 3" .

E. Gate Uprights: One piece extruded, of lengths indicated.

1. Cross Section: 2 ½" X 4" minimum
2. Wall Thickness: 0.120" minimum
3. Corner Radius: 3/16" R minimum

F. Post Caps: Molded, one piece.

1. Cross Section: Match post or gate upright cross section.
2. Thickness: 0.095" minimum.
3. Configuration: Flat or four-sided as required for installation to top of posts and gate.

G. Accessories: Manufacturers' standard gate brace, screw caps, rail end reinforcers, and other accessories as required.

2.03 Miscellaneous Materials

A. Stiffener Channels: Galvanized steel structural channel. Configure channels for concealed installation within PVC rails with pre-drilled holes for drainage. Aluminum extruded channel available upon request.

1. Cross Section: 3.00" x 3.00" x 1.500" hourglass shape to grip picket.
2. Thickness: 0.040 Gauge (minimum).

B. Fasteners and Anchorage: Stainless Steel. All fasteners to be concealed or colored heads to match. Provide sizes as recommended by fence manufacturer.
C. PVC Cement: As recommended by fence manufacturer.

2.04 Gate Hardware and Accessories

A. General: Provide hardware and accessories for each gate according to the following requirements:
B. Hinges: Size and material to suit gate size, non lift-off type, self closing, glass filled nylon with adjuster plate, offset to permit 120 degree gate opening. Provide one pair of hinges for each gate.

1. Color: Black.

C. Latch: Manufacturers' standard self latching, glass filled nylon and stainless steel composition single or dual access gravity latch. Provide one latch per gate.

1. Finish: Match gate hinge finish.

D. Hardware: Stainless Steel. Provide sizes as recommended by fence manufacturer.

1. Finish: Match gate hinge finish.

2.05 Concrete

A. Concrete: Provide concrete consisting of portland cement per ASTM C 150, aggregates per ASTM C 33, and potable water. Mix materials to obtain concrete with a minimum 28-day compressive strength of 2000 psi. Use at lease four sacks of cement per cubic yard, 1-inch maximum size aggregate, 3-inch maximum slump. Use ½ inch maximum size aggregate in post where required.
B. Packages Concrete Mix: Mix dry-packaged normal-weight concrete conforming to ASTM C 387 with clean water to obtain a 2 to 3 inch slump.

2.06 Reinforcement for Filled Posts

A. Reinforcing Steel:

1. Steel Reinforcing Bars: ASTM A 615. Grade 60. Deformed (#4 or ½"). Install 2 bars for each post to a length of 6'H feet.

PART 3 EXECUTION

3.01 Installation, General

A. Install fence in compliance with manufacturer's written instructions. During installation, PVC components shall be carefully handled and stored to avoid contact with abrasive surfaces. Install components in sequence as recommended by fence manufacturer.

1. Install fencing as indicated on the drawings provided.
2. Variations from the installation indicated must be approved.
3. Variations from the fence and gate installation indicated and all costs for removal and replacement will be the responsibility of the contractor.

3.02 Fence Installation

A. Excavation: Drill or hand-excavate (using post hole digger) holes for posts to diameters and spacings indicated, in firm, undisturbed or compacted soil.

1. If not indicated on drawings, excavate holes for each post to a minimum diameter of 12" inches.
2. Unless otherwise indicated, excavate hole depths not less than 30 inches or to frost line.

B. Posts: Install posts in one piece, plumb and in line. Space a maximum of 8' feet o.c. unless otherwise indicated. Enlarge excavation as required to provide clearance indicated between post and side of excavation.

1. Protect portion of posts above ground from concrete splatter. Place concrete around posts and vibrate or tamp for consolidation. Check each post for vertical and top alignment and hold in position during placement and finishing operations.

a. Unless otherwise indicated, terminate top of concrete footings 3 inches below adjacent grade and trowel to a crown to shed water.
b. Secure posts in position for manufacturers' recommendations until concrete sets.
c. After installation of rails and unless otherwise indicated, install reinforcing in posts in opposing corners of post as shown and fill end and gate posts with concrete to level as

indicated. Concrete fill shall completely cover the reinforcing steel and gate hardware fasteners. Consolidate the concrete by striking the post face with a rubber mallet, carefully tamping around the exposed post bottom.

d. Install post caps. Use #8 screws, nylon washers and snap caps.
e. Remove concrete splatters from PVC fence materials with care to avoid scratching.

C. Top and Bottom Rails: Install rails in one piece into routed hole fabricated into posts to receive top and bottom rails, and middle where necessary. Except at sloping terrain, install rails level.

1. Prior to installation of rails into posts, insert concealed steel channel stiffeners in top rail, where necessary. Bottom rails shall include minimum (2) ¼" drainage holes.
2. At posts to receive concrete fill, tape rail ends to prevent seepage when filling post with concrete.

D. Middle Rails: Where necessary, install middle rails in one piece into routed hole in posts with larger holes facing down. Except at sloping terrain, install middle rails level. Secure mid rail to pickets with 2-#8 x 1-1/2" screws evenly spaced.

1. At posts to receive concrete fill, tape rail ends to prevent seepage when filling post with concrete.

E. Pickets: Install pickets in one piece as per manufacturer recommendations. Install pickets plumb.
F. Fence Installation at Sloping Terrain: At sloping terrain rails may be racked (sloped) or stepped to comply with manufacturers' recommendations.

3.03 Gate Installation

A. Assemble gate per manufacturer's recommendations. Bottom rail shall include minimum (2) ¼" drainage holes.
B. Assemble gate prior to fence installation to accurately locate hinge and latch post. Align gate horizontal rails with fence horizontal rails.
C. Install gates plumb, level, and secure for full opening without interference according to manufacturer's instructions.
D. Gate Latch Installation. Install gate latch according to manufacturer's instructions. Adjust for smooth, trouble-free operation.
E. Allow minimum 72 hours to let concrete set-up before opening gates.

3.04 Adjusting and Cleaning

A. Remove all traces of dirt and soiled areas.

3.05 Demonstration

A. Instruct the owner's personnel on proper operation and maintenance of fence components.

END OF SECTION 32 3113

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SECTION 32 8400 – PLANTING IRRIGATION

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of contract, including general and supplementary conditions and specifications sections, apply to work of this section.

1.2 DESCRIPTION OF WORK

A. Install a complete and working underground irrigation system according to plans and specifications provided.

1.3 QUALITY ASSURANCE

A. Manufacturer's Qualifications: Irrigation products (i.e.: sprinklers, valves, controllers) shall be by a single manufacturer. All irrigation system components shall be supplied by the regionally authorized distributors to provide single source responsibility for warranty service and operations to conform to specifications in all respects.

B. Contractor's Qualifications: Irrigation contractor must meet the following criteria:

1. Irrigation contractor to have established business for a minimum of 3 years.

2. Irrigation contractor to be insured and capable of bonding.

3. Irrigation contractor must have previous experience installing similar size jobs.

1.4 RELATED SECTIONS/WORK

A. Section - Electrical

1. Electrical Contractor to supply the following:
   a. 115V Power for the controllers at locations indicated on drawing.

B. Section - General
   a. Sleeving for the irrigation system (see general notes on drawing for size and type specified.)
   b. Cores through wall for irrigation entry and exit and conduit sleeves (size and type as specified on drawing.)
   c. Point of connection: All plumbing up to the irrigation contractor's point of connection as specified on drawings.
   d. Meters, meter pits, and taps: See general notes on drawing for size and type specified.

1.5 JOB CONDITIONS

A. Site Conditions:

1. The Contractor shall coordinate his work with that of other trades wherever possible.

   a. Existing Utilities and Conditions

1. Before excavation, the Contractor shall obtain location of all cables, conduits, sewers, septic tanks, and other underground utilities, and shall be cautious as not to damage them. If such obstacles conflict with the proposed work, the Contractor shall immediately notify the owner's representative for arrangements for relocation.

2. In the event of damage, the contractor shall repair or replace these lines to the satisfaction of the Owner's Representative.

2. It is the Irrigation Contractor's responsibility to verify that all sleeving is installed under paving in locations as shown on Drawings.

1.6 SUBMITTALS

A. Submit manufacturer's data sheets for all materials (sprinkler heads, valves, controllers, dripperline, tubing, and pipe) and all other related items to owner's representative.

B. Submit contractor's qualification form with bid form.

1.7 CHANGE ORDERS

Any necessary changes in the design due to site conditions require a written authorization by the owner's representative prior to installation.

PART 2 - PRODUCTS

2.1 ACCEPTABLE MANUFACTURERS

A. All sprinkler heads, valves and controllers for this project shall be manufactured by The Toro Company, Riverside, CA. There will be no product substitutions.

2.2 MATERIALS

A. PIPE

1. PVC Pipe: All PVC pipe shall be pressure pipe as manufactured by J-M Manufacturing or Cresline Plastic Pipe Company. High-impact virgin polyvinyl-chloride (PVC-1120) conforming to NSF Standard 14 and ASTM D-2241 for thermoplastic pipe with minimum 160 PSI test strength. Pipe shall have standard thermoplastic pipe dimension ratio of SDR-26 and shall be marked or stamped every 5 feet to indicate brand, strength rating, size and standards. See drawing for sizes specified.

2. Polyethylene Pipe: All polyethylene pipe specified on plan shall be high-density (HD) flexible, non-toxic polyethylene made from 100% virgin polyethylene material, and all sizes shall have a minimum 100 PSI working pressure rating (ASTM D2239) conforming to NSF standard for thermoplastic pipe dimension ratio of SDR-15. All polyethylene pipe shall be continuously and permanently marked with the manufacturer's name, materials, size and schedule. Pipe shall conform to the U.S. Department of Commerce Commercial Standard CS255-63-PE-3408 or latest revision thereof. Pipe shall be suitable for potable water and shall bear the "NSF" trademark. See drawing for sizes specified.

B. PIPE SLEEVES:

1. Pipe Size	Sleeve size	Sleeve Type
¾" to 1"	2-inch	PVC 160 or Sch.40 DWV pipe
1-1/4" to 1-1/2"	3-inch	PVC 160 or Sch 40 DWV pipe
2"	4-inch	PVC 160 or Sch 40 DWV pipe
2-1/2" to3 "	6-inch	PVC 160 or Sch 40 DWV pipe
4-inch	8-inch	PVC 160 or Sch 40 DWV pipe
6-inch	10-inch	PVC 160 or Sch 40 DWV pipe

(Sleeve sizes and locations are based on a single pipe being installed in a sleeve. Contractor shall verify sleeve sizes with drawing.)

C. FITTINGS

1. PVC Pipe Fittings: All fittings 1-1/2" through 3 " shall be Schedule 40 PVC solvent weld, type 1, meeting the requirements of ASTM D-2466. No saddles allowed. All 4" fittings shall be gasketed joint Harco PVC Class 200 meeting ASTM D1784 DR21 requirements. Bell shall be gasket joint conforming to ASTM3139 with gaskets conforming to ASTM F477. Fittings 6" and larger shall be Harco Ductile Iron Fittings manufactured with a grade of 65-45-12 in accordance with ASTM A-536. Fittings shall have deep push-on joints with gaskets meeting ASTM F-477 requirements.

2. Polyethylene Fittings: All fittings 1-1/4" and smaller downstream of control valve shall be plastic or insert type fittings where applicable. All 1-1/4" fittings shall be double clamped with all stainless steel worm gear clamps. All 1" and smaller fittings shall be clamped with all stainless steel worm gear clamps or all stainless steel crimp clamps.

D. VALVES AND VALVE BOXES

1. Valves: Type and size as specified on drawings.

2. Valve Boxes: All valves shall be protected by a two-piece valve box assembly consisting of a removable cover and box. Enclosure shall be rigid plastic material composed of fibrous components chemically inert and unaffected by moisture, corrosion and temperature changes. Boxes shall be sized as follows:

   Minimum of a 10" valve box and cover shall be used for all automatic valves 1-1/2" and smaller and for all manual gate valves and quick coupling valves.

   Side walls to extend at least 2 inches below the bottom of the valve body; for deep mainline appropriate extensions shall be used to reach depth of valves. Valve box shall not bear directly on pipe. Manufacturer shall be Pentek or Carson.

E. BACKFLOW PREVENTION DEVICES: Type and size as specified on drawings.

F. QUICK COUPLING VALVES: Type and size as specified on drawings.

G. SPRINKLER HEADS: Type and size as specified on drawings.

H. CONTROLLERS: Type and size as specified on drawings.

I. BOOSTER PUMP: Type and size as specified on drawings (if applicable).

J. SOLVENT AND PRIMER: Solvent and primer used on PVC pipe shall meet the requirements of ASTM D-2564 and shall be approved by the National Sanitation Foundation. All solvent and primer shall be used in accordance with manufacturer's specification. Primer shall be purple in color. Solvent shall be used as is from original container. No thinner shall be added to the solvent to change its viscosity. If viscosity or consistency is unsuitable, the solvent shall not be used.

K. SWING JOINTS:

1. All sprinkler heads 6 GPM or less shall be attached to the piping with two-elbow joints consisting of 3/8" flexible pipe and coordinating elbows.

2. All quick coupling valves shall be attached to the piping with a PVC three elbow swing joint assembly with a brass thread to match the inlet size of the quick coupler, Spears or Lasco.

L. WIRE AND WIRE SPLICES

1. Wire: All wire shall be 600 volt soft annealed copper, PVC insulated, UL approved, type UF. Wire sizes shall be as called for on drawing.

2. Wire splices: All 24volt wire connections shall be made using water-tight 3M DBY connectors. All field splices shall be contained in a 6" valve box.

M. SPARE PARTS

1. Provide (5) rotors and (5) sprays. All sprinkler heads shall be complete with nozzles. Provide one (1) electric valve of each size.

PART 3 - EXECUTION

3.1 LAYOUT AND STAKING

A. Piping Layout: Piping layout is diagrammatic. Irrigation contractor shall verify site conditions. Any deviations from the plan shall be approved by the owner's representative prior to installation.

B. Staking: All sprinkler heads, valves and mainline line routing shall be staked prior to installation for approval upon request of Owner's Representative.

3.2 SYSTEM DESIGN

A. Design is based on information and criteria provided by the Owner, Owner's Representative and/or Architect. Any deviation from the drawing requires a written authorization by the owner's representative prior to installation. Water and pressure requirements shall be as noted on drawings and verified by the Irrigation Contractor.

3.3 TRENCHING

A. Trenches shall be excavated so that irrigation lines are installed with the following minimum depths for pipe cover:

1. All polyethylene lateral pipe: Minimum depth - 10".

2. All PVC lateral pipe 3/4" and 1": Minimum depth - 12".

3. All PVC pipe: Depth as specified below:

1-1/2" - 2" pipe size	16" cover
2-1/2" - 4" pipe size	20" cover
6" - 8" pipe size	24" cover
10" pipe size	30" cover

4. All wire:
   115V power wire - 24" or as required by code.
   24V control wire - 14" or as required by code.

B. All PVC piping shall be trenched. PVC pipe 2-1/2" and smaller may be pulled with approval of owner's representative if proper soil conditions exist and minimum depth requirements are maintained

C. Polyethylene distribution pipe may be pulled, with approval of owner's representative, if proper soil conditions and minimum depth requirements are maintained.

D. Trench excavation in excess of required depth shall have bottom graded and tamped prior to any pipe placement.

E. Where trenching of PVC or polyethylene pipe lines is not possible because of adverse soil conditions or obstructions, and backhoe operation is required, provide labor, materials and equipment for this operation, including full trench backfilling with soil if required in opinion of owner's representative. Site restoration of these areas shall be as directed by owner's representative. It shall be a part of this contract and shall be performed in the following manner:
   a. Return to grade with native soil.
      Backfill material shall be free from debris, including rocks, large stones, clay clumps or other unsuitable substances and care shall be taken to prevent settling and damage to pipe during and after backfilling operations. When backfilling, soil shall be tamped in 6-inch layers with a minimum of 6 inches of acceptable soil in turf areas and 12 inches in plant bed areas.

F. Depth of sleeves shall be as noted on installation details on drawing.

G. Pavement: Where existing pavement must be cut to install irrigation system, cut smoothly in straight lines 6 inches wider than trench.

1. Excavate to required depth and width.

2. Remove cut-out pavement and excavated material from the site.

3. Backfill with dry sand fill material, placing in 6-inch lifts.

4. Repair or replace pavement cuts with equivalent materials and finishes.

5. At walkways, jack piping under paving material, if possible.

3.4 INSTALLATION

A. GENERAL: Unless otherwise indicated, comply with requirements of Uniform Plumbing Code.

B. PIPING:

1. All mainlines and headers shall be kept to a minimum to 2 feet from all existing or proposed trees.

2. Polyethylene pipe connections shall be made with insert fittings held tightly in place with worm gear driven stainless steel clamps and screws at ferrules. Pipe sizes 1-1/4" and larger in diameter shall be double clamped.

3. PVC pipe shall be laid on solid undisturbed soil or on thoroughly compacted full bed of sand so as to assure full bedding, proper alignment and minimum slope for drainage.

4. PVC pipe ends and PVC fittings shall be thoroughly cleaned for full depth of fitting with liquid cleaner cement. Method of application shall be in accordance with manufacturer's recommendations for solvent weld connections.

5. Lay pipe on solid sub-base, uniformly sloped without humps or depressions.

6. At wall penetrations, pack the opening around pipe with non-shrink grout. At exterior face, leave perimeter slot approximately 1/2 inch wide by 4/5 inch deep. Fill this slot with backer rod and an acceptable elastomeric sealant.

7. Install PVC pipe in dry weather when temperature is above 40 degrees F (4 degrees C) in strict accordance with manufacturer's instructions. Allow joints to cure at least 24 hours at temperature above 40 degrees F (4 degrees C) before testing, unless otherwise recommended by manufacturer.

C. Connection to Water Source: Point of connection shall be as indicated on drawings. Contractor shall verify point of connection with landscape architect or owner's representative.

D. Cross Connection Protection: Install according to state and local plumbing codes. All piping shall be galvanized steel pipe or copper pipe.

E. Sprinkler Heads: Flush circuit lines with full head of water and install heads after flushing is complete.

1. Install lawn heads at manufacturer's recommended heights.

2. Install shrubbery heads flush with grade as indicated on drawing.

3. Locate part-circle heads to maintain minimum distance of 4 inches from walls and 2 inches from other boundaries, unless otherwise indicated.

4. All irrigation heads shall be installed on swing joints or as specified on drawing.

5. All nozzles shall match sprinkler head manufacturer.

F. Dielectric Protection: Use dielectric fittings at connections where pipes of dissimilar metals are joined.

3.5 THRUST BLOCKS

A. Provide concrete thrust blocks on thrust side of mainline pipe wherever pipe changes direction at tees, bends, or dead ends, and at any other location where thrust is to be expected.

B. Refer to pipe manufacturer's recommendations for type and method of thrust blocks.

3.6 TESTING AND INSPECTION

A. The Owner's authorized representative shall be responsible for inspection of the Contractor's work while such work is in progress. The Contractor will be notified of any work which does not meet the installation instructions and will be required to correct such work.

B. Upon completion of construction, the contractor will test the entire system under the normal working conditions. Upon visual inspection of the ground, should any leak be found, it shall be promptly repaired. All components will be checked for proper operation. Any malfunctioning equipment or leak shall be repaired and retested until it is in satisfactory working condition.

3.7 BALANCE AND ADJUSTMENT

A. Contractor shall balance and adjust various components of sprinkler system to maximize performance and efficiency. This includes synchronization of controllers, adjustments to pressure regulators, pressure relief valves, part circle sprinkler heads, individual station adjustments, and any other adjustments necessary to obtain optimum performance of system.

B. The contractor shall flush all lines and evacuate all air and debris from the system.

C. Adjust all electric remote control valve pressure regulators and flow control stems for system balance and optimum performance.

3.8 DRAWINGS OF RECORD/ OWNER'S MANUAL

A. Drawings of record: After completion of system and before final payment, contractor shall furnish to owner a reproducible copy of a drawing of record of the entire system showing Techline and accessory components (if applicable), sprinkler heads, valves, drains, controllers and pipelines to scale with dimensions where required.

B. Owner's Manual: After completion of the system and before final payment, contractor shall provide to the owner, instruction sheets including maintenance and operations manual and parts lists covering all operating equipment that shall be bound into a folder and furnished to the owner. Contractor shall also provide all necessary special tools for maintaining the system.

3.9 MAINTENANCE, GUARANTEE AND WARRANTY.

A. After completion, testing and acceptance of the system, instruct owner in the operation and maintenance of the system. Following acceptance, thoroughly flush and drain the system for winter, and in the following spring, put the system into operation at no additional expense to the owner.

B. For a period of 1 year from the date of final acceptance of work on the contract, contractor shall provide a labor warranty to promptly furnish and install, without cost to the owner, any and all parts which prove defective in material or workmanship.

C. A full 5-year manufacturer's warranty on all sprinkler heads, electric valves and controllers shall be provided by the Irrigation Contractor. Any part proven to be defective within the 5 year warranty period shall be replaced with no cost to the owner for parts. After the 1 year labor warranty has expired, the owner shall be responsible for the labor to replace defective sprinkler heads, electric valves or controllers.

D. Pipe warranty installation data form shall be filled out and forwarded to the company and warranty presented to the owner after completion and prior to payment.

END OF SECTION 32 8400

SECTION 32 9200 - TURF AND GRASSES

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Seeding.

1.2 DEFINITIONS

A. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

B. Finish Grade: Elevation of finished surface of planting soil.

C. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

D. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

E. Pests: Living organisms that occur where they are not desired or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

F. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

G. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or top surface of a fill or backfill before planting soil is placed.

H. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

I. Surface Soil: Whatever soil is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil, but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 ACTION SUBMITTALS

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

1.4 INFORMATIONAL SUBMITTALS

A. Certification of grass seed.

1. Certification of each seed mixture for turfgrass sod.

B. Product certificates.

1.5 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

1. Pesticide Applicator: State licensed, commercial.

B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.

1. The soil-testing laboratory shall oversee soil sampling.
2. Report suitability of tested soil for turf growth.

a. State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
b. Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of conformance with state and federal laws, as applicable.

B. Sod: Harvest, deliver, store, and handle sod according to requirements in "Specifications for Turfgrass Sod Materials" and "Specifications for Turfgrass Sod Transplanting and Installation" in TPI's "Guideline Specifications to Turfgrass Sodding." Deliver sod in time for planting within 24 hours of harvesting. Protect sod from breakage and drying.

1.7 MAINTENANCE SERVICE

A. Initial Turf Maintenance Service: Provide full maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after each area is planted and continue until acceptable turf is established but for not less than the following periods:

1. Seeded Turf: 90 days from date of Substantial Completion.

a. When initial maintenance period has not elapsed before end of planting season, or if turf is not fully established, continue maintenance during next planting season.

PART 2 - PRODUCTS

2.1 SEED

A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Journal of Seed Technology; Rules for Testing Seeds" for purity and germination tolerances.

B. Grass Seed Mix: Proprietary seed mix as follows:

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

a. Earth Carpet Sun and Shade mix

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through No. 60 (0.25-mm) sieve.

B. Sulfur: Granular, biodegradable, containing a minimum of 90 percent sulfur, and with a minimum of 99 percent passing through No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through No. 40 (0.425-mm) sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 (0.30-mm) sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings.

B. Sphagnum Peat: Partially decomposed sphagnum peat moss, finely divided or of granular texture, with a pH range of 3.4 to 4.8.

C. Muck Peat: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent.

D. Wood Derivatives: Decomposed, nitrogen-treated sawdust, ground bark, or wood waste; of uniform texture and free of chips, stones, sticks, soil, or toxic materials.

E. 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.

2.4 FERTILIZERS

A. Bonemeal: Commercial, raw or steamed, finely ground; a minimum of 1 percent nitrogen and 10 percent phosphoric acid.

B. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

C. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

D. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.5 PLANTING SOILS

A. Planting Soil: Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

1. Ratio of Loose Compost to Topsoil by Volume: 1:4.
2. Weight of Commercial Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): 5 lbs.

2.6 MULCHES

A. Hydro Mulch: Wood fiber and Cellulose Hydroseed sprayed mulch.

2.7 PESTICIDES

A. General: Pesticide, registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 TURF AREA PREPARATION

A. Newly Graded Subgrades: Loosen subgrade to a minimum depth of 6 inches (150 mm). Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Spread supplemental planting soil to a depth of 4 inches (100 mm) if existing topsoil is not satisfactory to obtain good growing medium. but not less than required to meet finish grades after light rolling and natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

B. Unchanged Subgrades: If turf is to be planted in areas unaltered or undisturbed by excavating, grading, or surface-soil stripping operations, prepare surface soil as follows:

   1. Remove existing grass, vegetation, and turf. Do not mix into surface soil.

   2. Loosen surface soil to a depth of at least 6 inches (150 mm). Apply soil amendments and fertilizers according to planting soil mix proportions and mix thoroughly into top 4 inches (100 mm) of soil. Till soil to a homogeneous mixture of fine texture.

   3. Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, trash, and other extraneous matter.
   4. Legally dispose of waste material, including grass, vegetation, and turf, off Owner's property.

C. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Grade to within plus or minus 1/2 inch (13 mm) of finish elevation. Roll and rake, remove ridges, and fill depressions to meet finish grades. Limit finish grading to areas that can be planted in the immediate future.

D. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.

E. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

3.2 SEEDING

A. Drill seed grass seed at a total rate of 6 to 8 lb/1000 sq. ft.

B. Hydromulch over drilled seed within 24 hours with mulch and applied starter fertilizer.

C. Protect seeded areas with slopes exceeding 1:4 with erosion control blanket tacked in place with wooden pins.

3.3 TURF MAINTENANCE

A. Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.

B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain height appropriate for species without cutting more than 1/3 of grass height. Remove no more than 1/3 of grass-leaf growth in initial or subsequent mowings.

C. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

3.4 SATISFACTORY TURF

A. Turf installations shall meet the following criteria as determined by Architect:

1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. (0.92 sq. m) and bare spots not exceeding 5 by 5 inches (125 by 125 mm).

B. Use specified materials to reestablish turf that does not comply with requirements and continue maintenance until turf is satisfactory.

END OF SECTION 32 9200

SECTION 32 9300 - PLANTS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Plants.
2. Planting soils.

1.2 DEFINITIONS

A. Backfill: The earth used to replace or the act of replacing earth in an excavation.

B. Duff Layer: The surface layer of native topsoil that is composed of mostly decayed leaves, twigs, and detritus.

C. Finish Grade: Elevation of finished surface of planting soil.

D. Manufactured Topsoil: Soil produced off-site by homogeneously blending mineral soils or sand with stabilized organic soil amendments to produce topsoil or planting soil.

E. Pesticide: A substance or mixture intended for preventing, destroying, repelling, or mitigating a pest. This includes insecticides, miticides, herbicides, fungicides, rodenticides, and molluscicides. It also includes substances or mixtures intended for use as a plant regulator, defoliant, or desiccant.

F. Pests: Living organisms that occur where they are not desired, or that cause damage to plants, animals, or people. These include insects, mites, grubs, mollusks (snails and slugs), rodents (gophers, moles, and mice), unwanted plants (weeds), fungi, bacteria, and viruses.

G. Planting Soil: Standardized topsoil; existing, native surface topsoil; existing, in-place surface soil; imported topsoil; or manufactured topsoil that is modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

H. Root Flare: Also called "trunk flare." The area at the base of the plant's stem or trunk where the stem or trunk broadens to form roots; the area of transition between the root system and the stem or trunk.

I. Subgrade: Surface or elevation of subsoil remaining after excavation is complete, or the top surface of a fill or backfill before planting soil is placed.

J. Subsoil: All soil beneath the topsoil layer of the soil profile, and typified by the lack of organic matter and soil organisms.

K. Surface Soil: Soil that is present at the top layer of the existing soil profile at the Project site. In undisturbed areas, the surface soil is typically topsoil; but in disturbed areas such as urban environments, the surface soil can be subsoil.

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated, including soils.

B. Samples of mineral mulch.

1.4 INFORMATIONAL SUBMITTALS

A. Product certificates.

B. Maintenance Instructions: Recommended procedures to be established by Owner for maintenance of plants during a calendar year.

1.5 QUALITY ASSURANCE

A. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

1. Pesticide Applicator: State licensed, commercial.

B. Soil Analysis: For each unamended soil type, furnish soil analysis and a written report by a qualified soil-testing laboratory.

1. The soil-testing laboratory shall oversee soil sampling.
2. Report suitability of tested soil for plant growth.

a. State recommendations for nitrogen, phosphorus, and potash nutrients and soil amendments to be added to produce satisfactory planting soil suitable for healthy, viable plants.
b. Report presence of problem salts, minerals, or heavy metals; if present, provide additional recommendations for corrective action.

C. Provide quality, size, genus, species, and variety of plants indicated, complying with applicable requirements in ANSI Z60.1.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Do not prune trees and shrubs before delivery. Protect bark, branches, and root systems from sun scald, drying, wind burn, sweating, whipping, and other handling and tying damage. Do not bend or bind-tie trees or shrubs in such a manner as to destroy their natural shape. Provide protective covering of plants during shipping and delivery. Do not drop plants during delivery and handling.

B. Handle planting stock by root ball.

C. Store bulbs, corms, and tubers in a dry place at 60 to 65 deg F (16 to 18 deg C) until planting.

D. Deliver plants after preparations for planting have been completed, and install immediately. If planting is delayed more than six hours after delivery, set plants and trees in their appropriate aspect (sun, filtered sun, or shade), protect from weather and mechanical damage, and keep roots moist.

1.7 WARRANTY

A. Special Warranty: Installer agrees to repair or replace plantings and accessories that fail in materials, workmanship, or growth within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Death and unsatisfactory growth, except for defects resulting from abuse, lack of adequate maintenance, or neglect by Owner, or incidents that are beyond Contractor's control.
b. Structural failures including plantings falling or blowing over.

2. Warranty Periods from Date of Substantial Completion:

a. Trees, Shrubs, Vines, and Ornamental Grasses: 12 months.
b. Ground Covers, Biennials, Perennials, and Other Plants: Six months.

1.8 MAINTENANCE SERVICE

A. Initial Maintenance Service: Provide maintenance by skilled employees of landscape Installer. Maintain as required in Part 3. Begin maintenance immediately after plants are installed and continue until plantings are acceptably healthy and well established but for not less than maintenance period below.

1. Maintenance Period for Trees and Shrubs: 12 months from date of Substantial Completion.
2. Maintenance Period for Ground Cover and Other Plants: Six months from date of Substantial Completion.

PART 2 - PRODUCTS

2.1 PLANT MATERIAL

A. General: Furnish nursery-grown plants true to genus, species, variety, cultivar, stem form, shearing, and other features indicated in Plant Schedule or Plant Legend shown on Drawings and complying with ANSI Z60.1; and with healthy root systems developed by transplanting or root pruning. Provide well-shaped, fully branched, healthy, vigorous stock, densely foliated when in leaf and free of disease, pests, eggs, larvae, and defects such as knots, sun scald, injuries, abrasions, and disfigurement.

B. Root-Ball Depth: Furnish trees and shrubs with root balls measured from top of root ball, which shall begin at root flare according to ANSI Z60.1. Root flare shall be visible before planting.

2.2 INORGANIC SOIL AMENDMENTS

A. Lime: ASTM C 602, agricultural liming material containing a minimum of 80 percent calcium carbonate equivalent and as follows:

1. Class: T, with a minimum of 99 percent passing through No. 8 (2.36-mm) sieve and a minimum of 75 percent passing through No. 60 (0.25-mm) sieve.

B. Sulfur: Granular, biodegradable, and containing a minimum of 90 percent sulfur, with a minimum of 99 percent passing through No. 6 (3.35-mm) sieve and a maximum of 10 percent passing through No. 40 (0.425-mm) sieve.

C. Iron Sulfate: Granulated ferrous sulfate containing a minimum of 20 percent iron and 10 percent sulfur.

D. Aluminum Sulfate: Commercial grade, unadulterated.

E. Perlite: Horticultural perlite, soil amendment grade.

F. Agricultural Gypsum: Minimum 90 percent calcium sulfate, finely ground with 90 percent passing through No. 50 (0.30-mm) sieve.

G. Sand: Clean, washed, natural or manufactured, and free of toxic materials.

H. Diatomaceous Earth: Calcined, 90 percent silica, with approximately 140 percent water absorption capacity by weight.

I. Zeolites: Mineral clinoptilolite with at least 60 percent water absorption by weight.

2.3 ORGANIC SOIL AMENDMENTS

A. Compost: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch (25-mm) sieve; soluble salt content of 5 to 10 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

2.4 FERTILIZERS

A. Superphosphate: Commercial, phosphate mixture, soluble; a minimum of 20 percent available phosphoric acid.

B. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:

1. Composition: 1 lb/1000 sq. ft. (0.45 kg/92.9 sq. m) of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.

C. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:

1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

2.5 PLANTING SOILS

A. Planting Soil ASTM D 5268 topsoil, with pH range of 5.5 to 7, a minimum of 2 percent organic material content. Verify suitability of soil to produce viable planting soil. Clean soil of roots, plants, sod, stones, clods, clay lumps, pockets of coarse sand, concrete slurry, concrete layers

or chunks, cement, plaster, building debris, and other extraneous materials harmful to plant growth. Mix soil with the following soil amendments and fertilizers in the following quantities to produce planting soil:

1. Ratio of Loose Compost to Topsoil by Volume: 1:4.
2. Weight of Slow-Release Fertilizer per 1000 Sq. Ft. (92.9 Sq. m): 5 lbs.

2.6 MULCHES

A. Organic Mulch: Shredded hardwood.

2.7 WEED-CONTROL BARRIERS

A. Nonwoven Geotextile Filter Fabric: Polypropylene or polyester fabric, 3 oz./sq. yd. (101g/sq. m) minimum.

2.8 PESTICIDES

A. General: Pesticide registered and approved by EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

PART 3 - EXECUTION

3.1 PLANTING AREA ESTABLISHMENT

A. Loosen subgrade of planting areas to a minimum depth of 8 inches (200 mm. Remove stones larger than 1 inch (25 mm) in any dimension and sticks, roots, rubbish, and other extraneous matter and legally dispose of them off Owner's property.
   1. Spread supplemental planting soil to a depth of 4 inches (100 mm) but not less than required to meet finish grades after natural settlement. Do not spread if planting soil or subgrade is frozen, muddy, or excessively wet.

B. Finish Grading: Grade planting areas to a smooth, uniform surface plane with loose, uniformly fine texture. Roll and rake, remove ridges, and fill depressions to meet finish grades.

3.2 EXCAVATION FOR TREES AND SHRUBS

A. Planting Pits and Trenches: Excavate circular planting pits with sides sloping inward at a 45-degree angle. Excavations with vertical sides are not acceptable. Trim perimeter of bottom leaving center area of bottom raised slightly to support root ball and assist in drainage away from center. Do not further disturb base. Ensure that root ball will sit on undisturbed base soil to prevent settling. Scarify sides of planting pit smeared or smoothed during excavation.

   1. Excavate approximately two times as wide as ball diameter.
   2. Do not excavate deeper than depth of the root ball, measured from the root flare to the bottom of the root ball.

B. Subsoil and topsoil removed from excavations may be used as planting soil if soil is loose and has adequate organic material. Supplement existing soil with good manufactured planting material.

3.3 TREE, SHRUB, AND VINE PLANTING

A. Before planting, verify that root flare is visible at top of root ball according to ANSI Z60.1.

B. Remove stem girdling roots and kinked roots. Remove injured roots by cutting cleanly; do not break.

C. Set stock plumb and in center of planting pit or trench with root flare 1 inch (25 mm) above adjacent finish grades.

1. Use planting soil for backfill.
2. Balled and Burlapped: After placing some backfill around root ball to stabilize plant, carefully cut and remove burlap, rope, and wire baskets from tops of root balls and from sides, but do not remove from under root balls. Remove pallets, if any, before setting. Do not use planting stock if root ball is cracked or broken before or during planting operation.
3. Container-Grown: Carefully remove root ball from container without damaging root ball or plant.
4. Backfill around root ball in layers, tamping to settle soil and eliminate voids and air pockets. When planting pit is approximately one-half filled, water thoroughly before placing remainder of backfill. Repeat watering until no more water is absorbed.
5. Continue backfilling process. Water again after placing and tamping final layer of soil.

D. When planting on slopes, set the plant so the root flare on the uphill side is flush with the surrounding soil on the slope; the edge of the root ball on the downhill side will be above the surrounding soil. Apply enough soil to cover the downhill side of the root ball.

3.4 TREE, SHRUB, AND VINE PRUNING

A. Remove only dead, dying, or broken branches. Do not prune for shape.

B. Prune, thin, and shape trees, shrubs, and vines according to standard professional horticultural and arboricultural practices. Unless otherwise indicated by Architect, do not cut tree leaders; remove only injured, dying, or dead branches from trees and shrubs; and prune to retain natural character.

3.5 GROUND COVER AND PLANT PLANTING

A. Set out and space ground cover and plants other than trees, shrubs, and vines as indicated on plans in even rows with triangular spacing.

B. Use planting soil for backfill.

C. Dig holes large enough to allow spreading of roots.

D. Work soil around roots to eliminate air pockets and leave a slight saucer indentation around plants to hold water.

E. Water thoroughly after planting, taking care not to cover plant crowns with wet soil.

F. Protect plants from hot sun and wind; remove protection if plants show evidence of recovery from transplanting shock.

3.6 PLANTING AREA MULCHING

A. Mulch backfilled surfaces of planting areas and other areas indicated.

1. Trees and Tree-like Shrubs in Turf Areas: Apply organic mulch ring of 3-inch (75-mm) in a 20-inch radius around trunks or stems. Do not place mulch within 3 inches (75 mm) of trunks or stems.
2. Organic Mulch in Planting Areas: Apply 3-inch (75-mm) average thickness of mulch over whole surface of planting area, and finish level with adjacent finish grades. Do not place mulch within 3 inches (75 mm) of trunks or stems.

3.7 PLANT MAINTENANCE

A. Maintain plantings by pruning, cultivating, watering, weeding, fertilizing, mulching, restoring planting saucers, resetting to proper grades or vertical position, and performing other operations as required to establish healthy, viable plantings. Spray or treat as required to keep trees and shrubs free of insects and disease.

B. Fill in as necessary soil subsidence that may occur because of settling or other processes. Replace mulch materials damaged or lost in areas of subsidence.

C. Apply treatments as required to keep plant materials, planted areas, and soils free of pests and pathogens or disease. Use practices to minimize the use of pesticides and reduce hazards.

D. Apply pesticides and other chemical products and biological control agents in accordance with authorities having jurisdiction and manufacturer's written recommendations. Coordinate applications with Owner's operations and others in proximity to the Work. Notify Owner before each application is performed.

E. Protect plants from damage due to landscape operations and operations of other contractors and trades. Maintain protection during installation and maintenance periods. Treat, repair, or replace damaged plantings.

END OF SECTION 32 9300

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SECTION 33 0500 - COMMON WORK RESULTS FOR UTILITIES

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes the following:

1. Piping joining materials.
2. Dielectric fittings.
3. Sleeves.
4. Identification devices.
5. Grout.
6. Piping system common requirements.
7. Equipment installation common requirements.

1.2 DEFINITIONS

A. Exposed Installations: Exposed to view outdoors or subject to outdoor ambient temperatures and weather conditions.

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

1.3 ACTION SUBMITTALS

A. Product Data: For the following:

1. Dielectric fittings.
2. Identification devices.

1.4 QUALITY ASSURANCE

A. Comply with ASME A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

PART 2 - PRODUCTS

2.1 PIPING JOINING MATERIALS

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

1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch (3.2-mm) maximum thickness, unless otherwise 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.

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

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

D. 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.

E. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

2.2 DIELECTRIC FITTINGS

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

B. Dielectric Unions:

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

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Hart Industries, International, Inc.
e. Watts Water Technologies, Inc.
f. Zurn Plumbing Products Group; Wilkins Div.

3. Description: Factory fabricated, union, NPS 2 (DN 50) and smaller.

a. Pressure Rating: 150 psig (1035 kPa) minimum at 180 deg F (82 deg C).
b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded ferrous.

C. Dielectric Flanges:

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

a. Capitol Manufacturing Co.
b. Central Plastics Company.
c. Epco Sales, Inc.
d. Watts Water Technologies, Inc.

3. Description: Factory-fabricated, bolted, companion-flange assembly, NPS 2-1/2 to NPS 4 (DN 65 to DN 100) and larger.

a. Pressure Rating: 150 psig (1035 kPa) minimum.
b. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

D. Dielectric Couplings:

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

a. Calpico, Inc.
b. Lochinvar Corporation.

3. Description: Galvanized-steel coupling with inert and noncorrosive, thermoplastic lining, NPS 3 (DN 80) and smaller.

a. Pressure Rating: 300 psig (2070 kPa) at 225 deg F (107 deg C).
b. End Connections: Threaded.

E. Dielectric Nipples:

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

a. Perfection Corporation.
b. Precision Plumbing Products, Inc.
c. Victaulic Company.

3. Description: Electroplated steel nipple with inert and noncorrosive, thermoplastic lining.

a. Pressure Rating: [300 psig (2070 kPa) at 225 deg F (107 deg C).
b. End Connections: Threaded or grooved.

2.3 SLEEVES

A. Mechanical sleeve seals for pipe penetrations are specified in Section 22 0517 "Sleeves and Sleeve Seals for Plumbing Piping."

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

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

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

2.4 IDENTIFICATION DEVICES

A. Equipment Nameplates: Metal permanently fastened to equipment with data engraved or stamped.

1. Data: Manufacturer, product name, model number, serial number, capacity, operating and power characteristics, labels of tested compliances, and essential data.
2. Location: Accessible and visible.

B. Snap-on Plastic Pipe Markers: Manufacturer's standard preprinted, semirigid, snap-on type. Include color-coding according to ASME A13.1, unless otherwise indicated.

C. Pressure-Sensitive Pipe Markers: Manufacturer's standard preprinted, color-coded, pressure-sensitive-vinyl type with permanent adhesive.

D. Pipes with OD, Including Insulation, Less Than 6 Inches (150 mm): Full-band pipe markers, extending 360 degrees around pipe at each location.

E. Pipes with OD, Including Insulation, 6 Inches (150 mm) and Larger: Either full-band or strip-type pipe markers, at least three times letter height and of length required for label.

F. Lettering: Use piping system terms indicated and abbreviate only as necessary for each application length.

1. Arrows: Either integrally with piping system service lettering to accommodate both directions of flow, or as separate unit on each pipe marker to indicate direction of flow.

G. Plastic Tape: Manufacturer's standard color-coded, pressure-sensitive, self-adhesive vinyl tape, at least 3 mils (0.08 mm) thick.

1. Width: 1-1/2 inches (40 mm) on pipes with OD, including insulation, less than 6 inches (150 mm); 2-1/2 inches (65 mm) for larger pipes.
2. Color: Comply with ASME A13.1, unless otherwise indicated.

H. Valve Tags: Stamped or engraved with 1/4-inch (6.4-mm) letters for piping system abbreviation and 1/2-inch (13-mm) sequenced numbers. Include 5/32-inch (4-mm) hole for fastener.

1. Material: 0.032-inch- (0.8-mm-) thick, aluminum.
2. Material: 0.0375-inch- (1-mm-) thick stainless steel.
3. Material: 3/32-inch- (2.4-mm-) thick plastic laminate with 2 black surfaces and a white inner layer.
4. Material: Valve manufacturer's standard solid plastic.
5. Size: 1-1/2 inches (40 mm) in diameter, unless otherwise indicated.
6. Shape: As indicated for each piping system.

I. Valve Tag Fasteners: Brass, wire-link or beaded chain; or brass S-hooks.

J. Plastic Equipment Markers: Manufacturer's standard laminated plastic, in the following color codes:

1. Green: Cooling equipment and components.
2. Yellow: Heating equipment and components.
3. Brown: Energy reclamation equipment and components.
4. Blue: Equipment and components that do not meet criteria above.
5. Hazardous Equipment: Use colors and designs recommended by ASME A13.1.
6. Terminology: Match schedules as closely as possible. Include the following:

   a. Name and plan number.
   b. Equipment service.
   c. Design capacity.
   d. Other design parameters such as pressure drop, entering and leaving conditions, and speed.

7. Size: 2-1/2 by 4 inches (65 by 100 mm) for control devices, dampers, and valves; 4-1/2 by 6 inches (115 by 150 mm) for equipment.

2.5 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 (34.5-MPa), 28-day compressive strength.
3. Packaging: Premixed and factory packaged.

PART 3 - EXECUTION

3.1 DIELECTRIC FITTING APPLICATIONS

A. Dry Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 (DN 50) and Smaller: Dielectric unions.

2. NPS 2-1/2 (DN 65) and Larger: Dielectric flanges.

B. Wet Piping Systems: Connect piping of dissimilar metals with the following:

1. NPS 2 (DN 50) and Smaller: Dielectric couplings or dielectric nipples.

2. NPS 2-1/2 (DN 65) and Larger: Dielectric nipples.

3.2 PIPING INSTALLATION

A. Install piping according to the following requirements and utilities 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 the Coordination Drawings.

C. 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.

D. Install piping to permit valve servicing.

E. Install piping at indicated slopes.

F. Install piping free of sags and bends.

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

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

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

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

K. Install sleeves for pipes passing through concrete and masonry walls 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 equipment areas or other wet areas 2 inches (50 mm) above finished floor level.

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

a. Steel Pipe Sleeves: For pipes smaller than NPS 6 (DN 150).
b. Steel Sheet Sleeves: For pipes NPS 6 (DN 150) and larger, penetrating gypsum-board partitions.

L. Verify final equipment locations for roughing-in.

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

3.3 PIPING JOINT CONSTRUCTION

A. Join pipe and fittings according to the following requirements and utilities 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. 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. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.

F. Grooved Joints: Assemble joints with grooved-end pipe coupling with coupling housing, gasket, lubricant, and bolts according to coupling and fitting manufacturer's written instructions.

G. Pressure-Sealed Joints: Assemble joints for plain-end copper tube and mechanical pressure seal fitting with proprietary crimping tool to according to fitting manufacturer's written instructions.

H. Plastic Piping Solvent-Cemented 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 Pressure Piping: Join schedule number ASTM D 1785, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule-number PVC pipe and socket fittings according to ASTM D 2855.
5. PVC Nonpressure Piping: Join according to ASTM D 2855.
6. PVC to ABS Nonpressure Transition Fittings: Join according to ASTM D 3138 Appendix.

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

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

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

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

L. Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.

3.4 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. Install dielectric fittings at connections of dissimilar metal pipes.

3.5 EQUIPMENT INSTALLATION

A. Install equipment level and plumb, unless otherwise indicated.

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

C. Install equipment to allow right of way to piping systems installed at required slope.

3.6 IDENTIFICATION

A. Piping Systems: Install pipe markers on each system. Include arrows showing normal direction of flow.

1. Plastic markers, with application systems. Install on insulation segment if required for hot noninsulated piping.
2. Locate pipe markers on exposed piping according to the following:

    a. Near each valve and control device.
    b. Near each branch, excluding short takeoffs for equipment and terminal units. Mark each pipe at branch if flow pattern is not obvious.
    c. Near locations where pipes pass through walls or floors or enter inaccessible enclosures.
    d. At manholes and similar access points that permit view of concealed piping.
    e. Near major equipment items and other points of origination and termination.

B. Equipment: Install engraved plastic-laminate sign or equipment marker on or near each major item of equipment.

1. Lettering Size: Minimum 1/4 inch (6.4 mm) high for name of unit if viewing distance is less than 24 inches (610 mm), 1/2 inch (13 mm) high for distances up to 72 inches (1800 mm), and proportionately larger lettering for greater distances. Provide secondary lettering two-thirds to three-fourths of size of principal lettering.
2. Text of Signs: Provide name of identified unit. Include text to distinguish among multiple units, inform user of operational requirements, indicate safety and emergency precautions, and warn of hazards and improper operations.

C. Adjusting: Relocate identifying devices that become visually blocked by work of this or other Divisions.

3.7 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 base.

3. Install epoxy-coated anchor bolts for supported equipment that extend through concrete base, and anchor into structural concrete floor.
4. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
5. Install anchor bolts to elevations required for proper attachment to supported equipment.
6. Install anchor bolts according to anchor-bolt manufacturer's written instructions.
7. Use 3000-psi (20.7-MPa), 28-day compressive-strength concrete and reinforcement as specified in Section 03 3000 "Cast-in-Place Concrete."

3.8 ERECTION OF METAL SUPPORTS AND ANCHORAGES

A. Refer to Section 05 5000 "Metal Fabrications" for structural steel.

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

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

3.9 GROUTING

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

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

C. Provide forms as required for placement of grout.

D. Avoid air entrapment during placement of grout.

E. Place grout, completely filling equipment bases.

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

G. Place grout around anchors.

H. Cure placed grout.

END OF SECTION 33 0500

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SECTION 33 1113 - FACILITY WATER DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes water-distribution piping and related components outside the building for water service, and fire-service mains.

B. Utility-furnished products include water meters that will be furnished to the site, ready for installation.

1.2 ACTION SUBMITTALS

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

B. Shop Drawings: Detail precast concrete vault assemblies and indicate dimensions, method of field assembly, and components.

1.3 INFORMATIONAL SUBMITTALS

A. Field quality-control test reports.

1.4 CLOSEOUT SUBMITTALS

A. Operation and maintenance data.

1.5 QUALITY ASSURANCE

A. Regulatory Requirements:
   1. Comply with requirements of utility company supplying water. Include tapping of water mains and backflow prevention.
   2. Comply with MDEQ standards for potable-water-service piping, including materials, installation, testing, and disinfection.
   3. Comply with MDEQ standards for fire-suppression water-service piping, including materials, hose threads, installation, and testing.

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

C. Comply with ASTM F 645 for selection, design, and installation of thermoplastic water piping.

D. Comply with FMG's "Approval Guide" or UL's "Fire Protection Equipment Directory" for fire-service-main products.

E. NFPA Compliance: Comply with NFPA 24 for materials, installations, tests, flushing, and valve and hydrant supervision for fire-service-main piping for fire suppression.

1.6 PROJECT CONDITIONS

A. Interruption of Existing Water-Distribution Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary water-distribution service according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of water-distribution service without Construction Manager's written permission.

1.7 COORDINATION

A. Coordinate connection to water main with utility company.

PART 2 - PRODUCTS

2.1 PIPE AND FITTINGS

A. Soft Copper Tube: ASTM B 88, Type K, water tube, annealed temper.
   1. Copper, Solder-Joint Fittings: ASME B16.18, cast-copper-alloy or ASME B16.22, wrought-copper, solder-joint pressure type. Furnish only wrought-copper fittings if indicated.

B. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151, with mechanical-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Mechanical-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Glands, Gaskets, and Bolts: AWWA C111, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

C. Push-on-Joint, Ductile-Iron Pipe: AWWA C151, with push-on-joint bell and plain spigot end unless grooved or flanged ends are indicated.
   1. Push-on-Joint, Ductile-Iron Fittings: AWWA C110, ductile- or gray-iron standard pattern or AWWA C153, ductile-iron compact pattern.
   2. Gaskets: AWWA C111, rubber.

2.2 JOINING MATERIALS

A. Refer to Section 330500 "Common Work Results for Utilities" for commonly used joining materials.

2.3 PIPING SPECIALTIES

A. Transition Fittings: Manufactured fitting or coupling same size as, with pressure rating at least equal to and ends compatible with, piping to be joined.

B. Tubular-Sleeve Pipe Couplings:
   1. Description: Metal, bolted, sleeve-type, reducing or transition coupling, with center sleeve, gaskets, end rings, and bolt fasteners and with ends of same sizes as piping to be joined.

a. Standard: AWWA C219.

2.4 GATE VALVES

A. AWWA, Cast-Iron Gate Valves:
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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Nonrising-Stem, Resilient-Seated Gate Valves:
   a. Description: Gray- or ductile-iron body and bonnet; with bronze or gray- or ductile-iron gate, resilient seats, bronze stem, and stem nut.
      1) Standard: AWWA C509.
      2) Minimum Pressure Rating: 200 psig (1380 kPa).
      3) End Connections: Mechanical joint.
      4) Interior Coating: Complying with AWWA C550.

2.5 GATE VALVE ACCESSORIES AND SPECIALTIES

A. Tapping-Sleeve 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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
   a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
   b. East Jordan Iron Works, Inc.
   c. Mueller Co.; Water Products Div.
   d. U.S. Pipe and Foundry Company.
4. Description: Sleeve and valve compatible with drilling machine.
   a. Standard: MSS SP-60.
   b. Tapping Sleeve: Cast- or ductile-iron or stainless-steel, two-piece bolted sleeve with flanged outlet for new branch connection. Include sleeve matching size and type of pipe material being tapped and with recessed flange for branch valve.
   c. Valve: AWWA, cast-iron, nonrising-stem, resilient-seated gate valve with one raised face flange mating tapping-sleeve flange.

B. Valve Boxes: Comply with AWWA M44 for cast-iron valve boxes. Include top section, adjustable extension of length required for depth of burial of valve, plug with lettering "WATER," and bottom section with base that fits over valve and with a barrel approximately 5 inches (125 mm) in diameter.
1. Operating Wrenches: Steel, tee-handle with one pointed end, stem of length to operate deepest buried valve, and socket matching valve operating nut.

C. Indicator Posts: UL 789, FMG-approved, vertical-type, cast-iron body with operating wrench, extension rod, and adjustable cast-iron barrel of length required for depth of burial of valve.

2.6 FIRE HYDRANTS

A. Dry-Barrel Fire Hydrants:

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:
2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
   a. American Cast Iron Pipe Co.; Waterous Co. Subsidiary.
   b. East Jordan Iron Works, Inc.
   c. Mueller Co.; Water Products Div.
   d. U.S. Pipe and Foundry Company.
4. Description: Freestanding, with one NPS 4-1/2 (DN 115) and two NPS 2-1/2 (DN 65) outlets, 5-1/4-inch (133-mm) main valve, drain valve, and NPS 6 (DN 150) mechanical-joint inlet. Include interior coating according to AWWA C550. Hydrant shall have cast-iron body, compression-type valve opening against pressure and closing with pressure.
   a. Standard: AWWA C502.
   b. Pressure Rating: 150 psig (1035 kPa).

2.7 FIRE DEPARTMENT CONNECTIONS

A. Fire Department Connections:
   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:
   2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
   3. Basis-of-Design Product: Subject to compliance with requirements, provide a comparable product by one of the following:
      a. Elkhart Brass Mfg. Co., Inc.
      b. Fire End & Croker Corporation.
      c. Guardian Fire Equipment, Inc.
      d. Kidde Fire Fighting.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Refer to Section 31 2000 "Earth Moving" for excavating, trenching, and backfilling.

3.2 PIPING SYSTEMS - COMMON REQUIREMENTS

A. See Section 33 0500 "Common Work Results for Utilities" for piping-system common requirements.

3.3 PIPING INSTALLATION

A. Water-Main Connection: Arrange with utility company for tap of size and in location indicated in water main.

B. Comply with NFPA 24 for fire-service-main piping materials and installation.

1. Install copper tube and fittings according to CDA's "Copper Tube Handbook."

C. Install ductile-iron, water-service piping according to AWWA C600 and AWWA M41.

D. Bury piping with depth of cover over top at least 5.5 feet.

E. Extend water-service piping and connect to water-supply source and building-water-piping systems at outside face of building wall in locations and pipe sizes indicated.
1. Terminate water-service piping at building wall until building-water-piping systems are installed. Terminate piping with caps, plugs, or flanges as required for piping material. Make connections to building-water-piping systems when those systems are installed.

F. Sleeves are specified in Section 22 0517 "Sleeves and Sleeve Seals for Plumbing Piping."

G. Mechanical sleeve seals are specified in Section 22 0517 "Sleeves and Sleeve Seals for Plumbing Piping."

H. Install underground piping with restrained joints at horizontal and vertical changes in direction. Use restrained-joint piping, thrust blocks, anchors, tie-rods and clamps, and other supports.

3.4 JOINT CONSTRUCTION

A. See Section 33 0500 "Common Work Results for Utilities" for basic piping joint construction.

B. Make pipe joints according to the following:
1. Ductile-Iron Piping, Gasketed Joints for Water-Service Piping: AWWA C600 and AWWA M41.
2. Ductile-Iron Piping, Gasketed Joints for Fire-Service-Main Piping: UL 194.
3. with elastomeric seals and lubricant according to ASTM D 2774 or ASTM D 3139 and pipe manufacturer's written instructions.
4. Dissimilar Materials Piping Joints: Use adapters compatible with both piping materials, with OD, and with system working pressure.

3.5 ANCHORAGE INSTALLATION

A. Anchorage, General: Install water-distribution piping with restrained joints. Anchorages and restrained-joint types that may be used include the following:
1. Locking mechanical joints.
2. Set-screw mechanical retainer glands.
3. Bolted flanged joints.
4. Heat-fused joints.
5. Pipe clamps and tie rods.

B. Install anchorages for tees, plugs and caps, bends, crosses, valves, and hydrant branches. Include anchorages for the following piping systems:
1. Gasketed-Joint, Ductile-Iron, Water-Service Piping: According to AWWA C600.
2. Fire-Service-Main Piping: According to NFPA 24.

C. Apply full coat of asphalt or other acceptable corrosion-resistant material to surfaces of installed ferrous anchorage devices.

3.6 VALVE INSTALLATION

A. AWWA Gate Valves: Comply with AWWA C600 and AWWA M44. Install each underground valve with stem pointing up and with valve box.

B. UL/FMG, Gate Valves: Comply with NFPA 24. Install each underground valve and valves in vaults with stem pointing up and with vertical cast-iron indicator post.

C. MSS Valves: Install as component of connected piping system.

D. Corporation Valves and Curb Valves: Install each underground curb valve with head pointed up and with service box.

3.7 WATER METER INSTALLATION

A. Install water meters, piping, and specialties according to utility company's written instructions.

B. Water Meters: Install displacement-type water meters, NPS 2 (DN 50) and smaller, in meter boxes with shutoff valves on water meter inlets. Include valves on water meter outlets and valved bypass around meters unless prohibited by authorities having jurisdiction.

C. Water Meters: Install compound-type water meters, NPS 3 (DN 80) and larger, in meter vaults. Include shutoff valves on water meter inlets and outlets and valved bypass around meters. Support meters, valves, and piping on brick or concrete piers.

3.8 BACKFLOW PREVENTER INSTALLATION

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

B. Do not install backflow preventers that have relief drain in vault or in other spaces subject to flooding.

C. Do not install bypass piping around backflow preventers.

D. Support NPS 2-1/2 (DN 65) and larger backflow preventers, valves, and piping near floor and on brick or concrete piers.

3.9 WATER METER BOX INSTALLATION

A. Install water meter boxes in paved areas flush with surface.

B. Install water meter boxes in grass or earth areas with top [2 inches (50 mm)] <Insert dimension> above surface.

3.10 FIRE HYDRANT INSTALLATION

A. General: Install each fire hydrant with separate gate valve in supply pipe, anchor with restrained joints or thrust blocks, and support in upright position.

B. Wet-Barrel Fire Hydrants: Install with valve below frost line. Provide for drainage.

C. AWWA Fire Hydrants: Comply with AWWA M17.

D. UL/FMG Fire Hydrants: Comply with NFPA 24.

3.11 FIRE DEPARTMENT CONNECTION INSTALLATION

A. Install protective pipe bollards on two sides of each fire department connection. Pipe bollards are specified in Section 05 5000 "Metal Fabrications."

3.12 CONNECTIONS

A. See Section 33 0500 "Common Work Results for Utilities" for piping connections to valves and equipment.

B. Connect water-distribution piping to utility water main as left by the City of Kalamazoo.

C. Connect water-distribution piping to interior domestic water and fire-suppression piping.

3.13 FIELD QUALITY CONTROL

A. Piping Tests: Conduct piping tests before joints are covered and after concrete thrust blocks have hardened sufficiently. Fill pipeline 24 hours before testing and apply test pressure to stabilize system. Use only potable water.

B. Hydrostatic Tests: Test at not less than one-and-one-half times working pressure for two hours.
   1. Increase pressure in 50-psig (350-kPa) increments and inspect each joint between increments. Hold at test pressure for 1 hour; decrease to 0 psig (0 kPa). Slowly increase again to test pressure and hold for 1 more hour. Maximum allowable leakage is 2 quarts (1.89 L) per hour per 100 joints. Remake leaking joints with new materials and repeat test until leakage is within allowed limits.

C. Prepare reports of testing activities.

3.14 CLEANING

A. Clean and disinfect water-distribution piping as follows:
   1. Purge new water-distribution piping systems and parts of existing systems that have been altered, extended, or repaired before use.
   2. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in NFPA 24 for flushing of piping. Flush piping system with clean, potable water until dirty water does not appear at points of outlet.
   3. Use purging and disinfecting procedure prescribed by authorities having jurisdiction or, if method is not prescribed by authorities having jurisdiction, use procedure described in AWWA C651 or do as follows:
      a. Fill system or part of system with water/chlorine solution containing at least 50 ppm of chlorine; isolate and allow to stand for 24 hours.

b. Drain system or part of system of previous solution and refill with water/chlorine solution containing at least 200 ppm of chlorine; isolate and allow to stand for 3 hours.
c. After standing time, flush system with clean, potable water until no chlorine remains in water coming from system.
d. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedure if biological examination shows evidence of contamination.

B. Prepare reports of purging and disinfecting activities.

END OF SECTION 33 1113

SECTION 33 1313 - FACILITY SANITARY SEWERS

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes gravity-flow, nonpressure sanitary sewerage outside the building.

1.2 SUBMITTALS

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

B. Shop Drawings: For manholes. Include plans, elevations, sections, details, and frames and covers.

C. Field quality-control test reports.

1.3 PROJECT CONDITIONS

A. Interruption of Existing Sanitary Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings, NPS 15(DN 375) and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

B. PVC Sewer Pipe and Fittings, NPS 8(DN 200) and Smaller: ASTM F 891, Schedule 40 solid wall with solvent sealed joints using ASTM D 2855 solvent cement.

2.2 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76(ASTM C 76M), Class III, with bell-and-spigot ends, and gasketed joints with ASTM C 443(ASTM C 443M), rubber gaskets.

2.3 NONPRESSURE-TYPE PIPE COUPLINGS

A. Unshielded, Flexible Couplings: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.4 CLEANOUTS

A. Description: Cast-iron cleanout with threaded adjustable housing, flanged ferrule, brass cleanout plug, and round cast-iron heavy-duty, secured, scoriated cover. Wade Model 6000Z-75-179 or equivalent.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company.
      b. MIFAB Manufacturing Inc.
      c. Smith, Jay R. Mfg. Co.
      d. Wade Div.; Tyler Pipe.
      e. Zurn Specification Drainage Operation; Zurn Plumbing Products Group.
   2. Top-Loading Classification: Medium duty.
   3. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.5 MANHOLES

A. Standard Precast Concrete Manholes: ASTM C 478(ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   1. Diameter: 48 inches(1200 mm) minimum, unless otherwise indicated.
   2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
   3. Base Section: 6-inch(150-mm) minimum thickness for floor slab and 4-inch(100-mm) minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
   4. Riser Sections: 4-inch(100-mm) minimum thickness, and of length to provide depth indicated.
   5. Top Section: Eccentric-cone type, unless flat-slab-top type is indicated. Top of cone of size that matches grade rings.
   6. Joint Sealant: ASTM C 990(ASTM C 990M), bitumen or butyl rubber.
   7. Resilient Pipe Connectors: ASTM C 923(ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   8. Steps: Individual FRP steps, or ASTM A 615/A 615M, deformed, 1/2-inch(13-mm) steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch(300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches(1500 mm).
   9. Grade Rings: Reinforced-concrete rings, 6- to 9-inch(150- to 225-mm) total thickness, to match diameter of manhole frame and cover.
   10. Manhole Frames and Covers: Ferrous; 24-inch(610-mm) ID by 7- to 9-inch(175- to 225-mm) riser with 4-inch-(100-mm-) minimum width flange and 26-inch-(660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "SANITARY SEWER."
       a. Material: ASTM A 536, Grade 60-40-18 ductile iron, unless otherwise indicated.

2.6 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
   1. Cement: ASTM C 150, Type II.
   2. Fine Aggregate: ASTM C 33, sand.
   3. Coarse Aggregate: ASTM C 33, crushed gravel.
   4. Water: Potable.

B. Portland Cement Design Mix: 4000 psi(27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60(420 MPa), deformed steel.

C. Manhole Channels and Benches: Factory or field formed from concrete. Portland cement design mix, 4000 psi(27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio. Include channels and benches in manholes.
   1. Channels: Concrete invert, formed to same width as connected piping, with height of vertical sides to three-fourths of pipe diameter. Form curved channels with smooth, uniform radius and slope.
      a. Invert Slope: 2 percent through manhole.
   2. Benches: Concrete, sloped to drain into channel.
      a. Slope: 4 percent.

D. Ballast and Pipe Supports: Portland cement design mix, 3000 psi(20.7 MPa) minimum, with 0.58 maximum water/cementitious materials ratio.
   1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
   2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60(420 MPa), deformed steel.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, backfilling, and warning tapes are specified in Division 31 Section "Earth Moving."

3.2 PIPING APPLICATIONS

A. Pipe couplings and fittings with pressure ratings at least equal to piping rating may be used in applications below, unless otherwise indicated.
   1. Use nonpressure-type flexible couplings where required to join gravity-flow, nonpressure sewer piping, unless otherwise indicated.
      a. Unshielded, increaser/reducer-pattern, flexible couplings for pipes with different OD.

B. Gravity-Flow, Nonpressure Sewer Piping: Use any of the following pipe materials for each size range:

3.3 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewerage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction, unless fittings are indicated. Use fittings for branch connections, unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, nonpressure, drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
   2. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
   3. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

F. Clear interior of piping and manholes of dirt and superfluous material as work progresses. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plug in end of incomplete piping at end of day and when work stops.

3.4 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure, drainage piping according to the following:
   1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
   2. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.
   3. Join dissimilar pipe materials with nonpressure-type, flexible couplings.

3.5 MANHOLE INSTALLATION

A. General: Install manholes complete with appurtenances and accessories indicated.

B. Install precast concrete manhole sections with sealants according to ASTM C 891.

C. Form continuous concrete channels and benches between inlets and outlet.

D. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches(76 mm) above finished surface elsewhere, unless otherwise indicated.

3.6 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches(450 by 450 by 300 mm) deep. Set with tops 1 inch(25 mm) above surrounding grade.

C. Set cleanout frames and covers in concrete pavement with tops flush with pavement surface.

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's sanitary building drains specified in Division 22.

B. Make connections to existing piping and underground structures so that finished work will conform as nearly as practicable to the requirements specified for new work and with municipal storm system requirements.

3.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches(600 mm) of backfill is in place, and again at completion of Project.
   1. Submit separate report for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.
      b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 95 percent of piping diameter.
      c. Crushed, broken, cracked, or otherwise damaged piping.
   3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
   4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
   1. Do not enclose, cover, or put into service before inspection and approval.
   2. Complete mandrel test on all flexible piping installations.
   3. Schedule tests and inspections at least 24 hours' advance notice.
   4. Submit separate report for each test.
   5. Hydrostatic Tests: Only if specifically requested by Construction Manager. Test sanitary sewerage according to requirements of authorities having jurisdiction and the following:
      a. Allowable leakage is maximum of 50 gal./inch of nominal pipe size per mile(4.6 L/millimeter of nominal pipe size per kilometer) of pipe, during 24-hour period.
      b. Close openings in system and fill with water.
      c. Purge air and refill with water.
      d. Disconnect water supply.
      e. Test and inspect joints for leaks.

6. Air Tests: Only if specifically requested by Construction Manager. Test sanitary sewerage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
   a. Option: Test plastic gravity sewer piping according to ASTM F 1417.
   b. Option: Test concrete gravity sewer piping according to ASTM C 924(ASTM C 924M).

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 33 1313

SECTION 33 2100 – SANITARY LIFT STATION SYSTEM

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 this Section.

1.2 SUMMARY

A. This Section includes sanitary lift station systems consisting of the following:

1. Lift station wet well precast structure.
2. Sewage pumps.
3. Lift station controls.
4. Force main piping
5. Aluminum wet well hatch.

1.3 SUBMITTALS

A. Product Data: Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for the following:

1. Wet well schematics.
2. Pumps.
3. Controls.
4. Pipe and fittings.
5. Wet well hatch.

B. Shop Drawings: Include manhole openings, covers, pipe connections, and accessories for the following precast, reinforced-concrete structures:

1. Wet well structure.

1.4 PROJECT CONDITIONS

A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:

1. Notify Engineer not less than two days in advance of proposed utility interruptions.
2. Do not proceed with utility interruptions without Engineer 's written permission.

PART 2 - PRODUCTS

2.1 LIFT STATION WETWELL

A. Standard Precast Concrete Manholes: ASTM C 478(ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   1. Diameter: 72 inches (1800 mm) minimum, unless otherwise indicated.
   2. Base Section: 6-inch (150-mm) minimum thickness for floor slab and 4-inch (100-mm) minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
   3. Riser Sections: 4-inch (100-mm) minimum thickness, and of length to provide depth indicated.
   4. Top Section: Flat-slab-top type is indicated.
   5. Joint Sealant: ASTM C 990(ASTM C 990M), bitumen or butyl rubber.
   6. Resilient Pipe Connectors: ASTM C 923(ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   7. Steps: None required.
   8. Grade Rings: Reinforced-concrete rings, 6- to 9-inch(150- to 225-mm) total thickness, to match diameter of manhole frame and cover.
   9. Frames and Covers: Bilco aluminum hatch Type J-4AL H20, 36” x 36” or approved equal.

2.2 PVC GRAVITY PIPE AND FITTINGS

A. PVC Type PSM Sewer Piping:

   1. Pipe: ASTM D 3034, SDR 26, PVC Type PSM sewer pipe with bell-and-spigot ends for gasketed joints.
   2. Fittings: ASTM D 3034, PVC with bell ends.
   3. Gaskets: ASTM F 477, elastomeric seals.

2.3 HDPE FORCEMAIN PIPE

A. HDPE Type III, Class C, Category 5, Grade P34, ASTM D1248
   1. Pressure Rating: SDR 11 (160 psi) minimum.
   2. Pipe Joining: Butt fused equipment and methods in strict accordance with pipe Manufacturer’s recommendations and ASTM D3261.

2.4 LIFT STATION EQUIPMENT

A. Pumps:
   1. Provide two submersible grinder pumps in accordance with the City of Hastings and MDEQ requirements. Pumps shall be specified as follows:
      a. Capable of a flow rate of 60 gpm at 77 TDH.
      b. 3 phase, 230 volts
      c. 2 Hp
      d. Wilo, MTS 40-143 grinder pumps.

B. Pump Control System:
   1. Provide a duplex control system as follows:
      a. Elapsed time meter.
      b. Alarm horn and light.
      c. Alarm dialer system.
      d. NEMA4X enclosure
      e. Cycle counter
      f. Redundant off
      g. Mounted outside on weather resistant frame and stand. Coordinate location with owner and Construction Manager.

PART 3 - EXECUTION

3.1 EXAMINATION

A. Survey the area for lift station system installation. Locate and mark existing utilities, underground structures, and aboveground obstructions before beginning and avoid disruption of and damage to services.

B. Examine soil structure, materials, and conditions.

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

3.2 PREPARATION

A. Clean exposed surfaces of tanks and other structures and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

B. Backfill all excavations with clean, uncompacted sand in preparation for future absorption system.

3.3 EARTHWORK

A. Excavating, trenching, and backfilling for structures and pipe and fittings are specified in Division 2 Section "Earthwork."

   1. Stockpile topsoil for reuse in finish grading without intermixing with other excavated material. Stockpile materials away from edge of excavation and do not store within drip line of remaining trees.
   2. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.

B. Excavating and Backfilling for Lift Station Structures: As follows:

   1. Excavate sufficient width and length for tanks to a depth determined by structure inlet elevation. Provide level bottom.
   2. Backfill with excavated soil, mounding soil above original grade without compacting.

3.4 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground sanitary sewer piping. Location and arrangement of piping layout take into account design considerations. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. When installing pipe under streets or other obstructions that cannot be disturbed, use pipe-jacking process of microtunneling.

F. Install gravity-flow, nonpressure, drainage piping according to the following:

1. Install piping pitched down in direction of flow, at minimum slope of 1 percent unless otherwise indicated.
2. Install piping with 48-inch (1220-mm minimum cover.
3. Install PVC Type PSM sewer piping according to ASTM D 2321 and ASTM F 1668.

3.5 PIPE JOINT CONSTRUCTION AND PIPING INSTALLATION

A. Join and install solvent-cement-type PVC pipe and fittings according to ASTM D 2855 and ASTM F 402.

B. Install distribution PVC piping according to ASTM D 2321.

C. Join dissimilar pipe materials with standard manufactured couplings and fittings made for that purpose.

3.6 CONNECTIONS

A. Connect sanitary sewerage piping to lift station and pumps.

B. Connect piping between lift station pumps and outlet sanitary manhole.

3.7 FIELD QUALITY CONTROL

A. System Tests: Perform testing of completed lift station system piping and structures according to authorities having jurisdiction.

B. Allow for inspection of installation and startup of all system components by the owner and Barry County Health Department.

3.8 CLEANING

A. Clear interior of piping and structures of dirt and other superfluous material as work progresses.

B. Maintain swab or drag in piping, and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of workday or when work stops.

END OF SECTION 33 2100

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SECTION 33 4100 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes gravity-flow, nonpressure storm drainage outside the building

1.2 SUBMITTALS

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

B. Shop Drawings: For underground structures. Include plans, elevations, sections, details, and frames, covers, and grates.

C. Field quality-control test reports.

1.3 PROJECT CONDITIONS

A. Interruption of Existing Storm Drainage Service: Do not interrupt service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary service according to requirements indicated:
   1. Notify Construction Manager no fewer than two days in advance of proposed interruption of service.
   2. Do not proceed with interruption of service without Construction Manager's written permission.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to Part 3 "Piping Applications" Article for applications of pipe, fitting, and joining materials.

2.2 PE PIPE AND FITTINGS

A. Corrugated PE Pipe and Fittings NPS 12 to NPS 60 (DN 300 to DN 1500): AASHTO M 294M, Type S, with smooth waterway for coupling joints.
   1. Soiltight Couplings: AASHTO M 294M, corrugated, matching pipe and fittings.

2.3 PVC PIPE AND FITTINGS

A. PVC Sewer Pipe and Fittings, NPS 15(DN 375) and Smaller: ASTM D 3034, SDR 35, with bell-and-spigot ends for gasketed joints with ASTM F 477, elastomeric seals.

B. PVC Sewer Pipe and Fittings, NPS 8(DN 200) and Smaller: ASTM F 891, Schedule 40 solid wall with solvent sealed joints using ASTM D 2855 solvent cement.

2.4 CONCRETE PIPE AND FITTINGS

A. Reinforced-Concrete Sewer Pipe and Fittings: ASTM C 76(ASTM C76M), Class III, with bell-and-spigot ends, and gasketed joints with ASTM C 443(ASTM C 443M), rubber gaskets.

2.5 NONPRESSURE-TYPE PIPE COUPLINGS

A. Unshielded Flexible Couplings: Elastomeric sleeve with corrosion-resistant-metal tension band and tightening mechanism on each end.

2.6 CLEANOUTS

A. Description: Cast-iron cleanout with threaded adjustable housing, flanged ferrule, brass cleanout plug, and round cast-iron heavy-duty, secured, scoriated cover. Wade Model 6000Z-75-179 or equivalent.
   1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
      a. Josam Company.
      b. MIFAB Manufacturing Inc.
      c. Smith, Jay R. Mfg. Co.
      d. Wade Div.; Tyler Pipe.
      e. Zurn Industries, Inc.; Zurn Specification Drainage Operation.
   2. Sewer Pipe Fitting and Riser to Cleanout: ASTM A 74, Service class, cast-iron soil pipe and fittings.

2.7 MANHOLES

A. Standard Precast Concrete Manholes: ASTM C 478(ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
   1. Diameter: 48 inches(1200 mm) minimum, unless otherwise indicated.
   2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
   3. Base Section: 6-inch(150-mm) minimum thickness for floor slab and 4-inch(100-mm) minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
   4. Riser Sections: 4-inch(100-mm) minimum thickness, and of length to provide depth indicated.
   5. Top Section: Eccentric-cone type unless flat-slab-top type is indicated. Top of cone of size that matches grade rings.
   6. Joint Sealant: ASTM C 990(ASTM C 990M), bitumen or butyl rubber.
   7. Resilient Pipe Connectors: ASTM C 923(ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
   8. Steps: Individual FRP steps, or ASTM A 615/A 615M, deformed, 1/2-inch(13-mm) steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor

steps into sidewalls at 12- to 16-inch(300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches(1500 mm).

9. Grade Rings: Reinforced-concrete rings, 6- to 9-inch(150- to 225-mm) total thickness, to match diameter of manhole frame and cover.
10. Frames and Covers: Ferrous; 24-inch(610-mm) ID by 7- to 9-inch(175- to 225-mm) riser with 4-inch-(100-mm-) minimum width flange and 26-inch-(660-mm-) diameter cover. Include indented top design with lettering cast into cover, using wording equivalent to "STORM SEWER."
    a. Material: ASTM A 536, Grade 60-40-18 ductile iron, unless otherwise indicated.

2.8 CONCRETE

A. General: Cast-in-place concrete according to ACI 318/318R, ACI 350R, and the following:
1. Cement: ASTM C 150, Type II.
2. Fine Aggregate: ASTM C 33, sand.
3. Coarse Aggregate: ASTM C 33, crushed gravel.
4. Water: Potable.

B. Ballast and Pipe Supports: Portland cement design mix, 3000 psi(20.7 MPa) minimum, with 0.58 maximum water-cementitious materials ratio.
1. Reinforcement Fabric: ASTM A 185, steel, welded wire fabric, plain.
2. Reinforcement Bars: ASTM A 615/A 615M, Grade 60(420 MPa), deformed steel.

2.9 CATCH BASINS

A. Standard Precast Concrete Catch Basins: ASTM C 478(ASTM C 478M), precast, reinforced concrete, of depth indicated, with provision for sealant joints.
1. Diameter: 48 inches(1200 mm) minimum, unless otherwise indicated.
2. Ballast: Increase thickness of precast concrete sections or add concrete to base section, as required to prevent flotation.
3. Base Section: 6-inch(150-mm) minimum thickness for floor slab and 4-inch(100-mm) minimum thickness for walls and base riser section, and having separate base slab or base section with integral floor.
4. Riser Sections: 4-inch(100-mm) minimum thickness, and of length to provide depth indicated.
5. Top Section: Eccentric-cone type unless flat-slab-top type is indicated. Top of cone of size that matches grade rings.
6. Joint Sealant: ASTM C 990(ASTM C 990M), bitumen or butyl rubber.
7. Resilient Pipe Connectors: ASTM C 923(ASTM C 923M), cast or fitted into manhole walls, for each pipe connection.
8. Steps: Individual FRP steps, or ASTM A 615/A 615M, deformed, 1/2-inch(13-mm) steel reinforcing rods encased in ASTM D 4101, PP, wide enough to allow worker to place both feet on 1 step and designed to prevent lateral slippage off of step. Cast or anchor steps into sidewalls at 12- to 16-inch(300- to 400-mm) intervals. Omit steps if total depth from floor of manhole to finished grade is less than 60 inches(1500 mm).
9. Grade Rings: Reinforced-concrete rings, 6- to 9-inch(150- to 225-mm) total thickness, to match diameter of manhole frame and cover.
10. Frames and Covers: Ferrous; 24-inch(610-mm) ID by 7- to 9-inch(175- to 225-mm) riser with 4-inch-(100-mm-) minimum width flange. Provide grates as indicated on drawings.
    a. Material: ASTM A 536, Grade 60-40-18 ductile iron, unless otherwise indicated.

2.10 YARD DRAINS

A. PVC Inline Drains: ASTM D 3034 and F 1336, PVC of the diameter indicated.

B. Grates: ASTM A-48-83, Class 30B heavy-duty, cast-iron, sewer pipe bell flange capable of supporting H-25 loading. Paint grates black.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, backfilling, and warning tapes are specified in Division 31 Section "Earth Moving."

3.2 PIPING INSTALLATION

A. General Locations and Arrangements: Drawing plans and details indicate general location and arrangement of underground storm drainage piping. Location and arrangement of piping layout take design considerations into account. Install piping as indicated, to extent practical. Where specific installation is not indicated, follow piping manufacturer's written instructions.

B. Install piping beginning at low point, true to grades and alignment indicated with unbroken continuity of invert. Place bell ends of piping facing upstream. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions for using lubricants, cements, and other installation requirements.

C. Install manholes for changes in direction unless fittings are indicated. Use fittings for branch connections unless direct tap into existing sewer is indicated.

D. Install proper size increasers, reducers, and couplings where different sizes or materials of pipes and fittings are connected. Reducing size of piping in direction of flow is prohibited.

E. Install gravity-flow, nonpressure drainage piping according to the following:
   1. Install piping pitched down in direction of flow, at minimum slope of 1 percent, unless otherwise indicated.
   2. Install piping below frost line.
   3. Install PVC sewer piping according to ASTM D 2321 and ASTM F 1668.
   4. Install reinforced-concrete sewer piping according to ASTM C 1479 and ACPA's "Concrete Pipe Installation Manual."

F. Clear interior of piping and manholes of dirt and superfluous material as work progresses.

3.3 PIPE JOINT CONSTRUCTION

A. Join gravity-flow, nonpressure drainage piping according to the following:
   1. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.
   2. Join PVC sewer piping according to ASTM D 2321 and ASTM D 3034 for elastomeric-gasket joints.

3. Join dissimilar pipe materials with nonpressure-type flexible couplings.

3.4 CLEANOUT INSTALLATION

A. Install cleanouts and riser extensions from sewer pipes to cleanouts at grade. Use cast-iron soil pipe fittings in sewer pipes at branches for cleanouts and cast-iron soil pipe for riser extensions to cleanouts. Install piping so cleanouts open in direction of flow in sewer pipe.

B. Set cleanout frames and covers in earth in cast-in-place-concrete block, 18 by 18 by 12 inches(450 by 450 by 300 mm) deep. Set with tops 1 inch(25 mm) above surrounding grade.

C. Set cleanout frames and covers in pavement with tops flush with pavement surface.

3.5 MANHOLE INSTALLATION

A. General: Install manholes, complete with appurtenances and accessories indicated.

B. Install precast concrete sections with sealants according to ASTM C 891.

C. Set tops of frames and covers flush with finished surface of manholes that occur in pavements. Set tops 3 inches(76 mm) above finished surface elsewhere, unless otherwise indicated.

3.6 CATCH BASIN INSTALLATION

A. General: Install catch basins, complete with appurtenances and accessories indicated.

B. Install precast concrete sections with sealants according to ASTM C 891.

C. Set tops of frames and covers at elevations indicated.

3.7 CONNECTIONS

A. Connect nonpressure, gravity-flow drainage piping to building's storm building drains specified in Division 22.

B. Make connections to existing piping and underground structures so that finished work will conform as nearly as practicable to the requirements specified for new work and with municipal storm system requirements.

3.8 FIELD QUALITY CONTROL

A. Inspect interior of piping to determine whether line displacement or other damage has occurred. Inspect after approximately 24 inches(600 mm) of backfill is in place, and again at completion of Project.
   1. Submit separate report for each system inspection.
   2. Defects requiring correction include the following:
      a. Alignment: Less than full diameter of inside of pipe is visible between structures.

b. Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
c. Crushed, broken, cracked, or otherwise damaged piping.
d. Infiltration: Water leakage into piping.
e. Exfiltration: Water leakage from or around piping.

3. Replace defective piping using new materials, and repeat inspections until defects are within allowances specified.
4. Reinspect and repeat procedure until results are satisfactory.

B. Test new piping systems, and parts of existing systems that have been altered, extended, or repaired, for leaks and defects.
1. Do not enclose, cover, or put into service before inspection and approval.
2. Test completed piping systems according to requirements of authorities having jurisdiction.
3. Schedule tests and inspections by authorities having jurisdiction with at least 24 hours' advance notice.
4. Submit separate report for each test.
5. Air Tests: Test storm drainage according to requirements of authorities having jurisdiction, UNI-B-6, and the following:
a. Option: Test plastic gravity sewer piping according to ASTM F 1417.

C. Leaks and loss in test pressure constitute defects that must be repaired.

D. Replace leaking piping using new materials, and repeat testing until leakage is within allowances specified.

END OF SECTION 33 4100

SECTION 33 4600 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

A. This Section includes subdrainage systems for foundations, pavements.

B. Related Sections include the following:
   1. Division 07 waterproofing Sections for molded-sheet drainage panels.

1.2 SUBMITTALS

A. Product Data: For each type of drainage panel indicated.

PART 2 - PRODUCTS

2.1 PIPING MATERIALS

A. Refer to the "Piping Applications" Article in Part 3 for applications of pipe, fitting, and joining materials.

2.2 PERFORATED-WALL PIPES AND FITTINGS

A. Perforated PE Pipe and Fittings:
   1. NPS 6(DN 150) and Smaller: ASTM F 405 or AASHTO M 252, Type CP; corrugated, for coupled joints.
   2. Couplings: Manufacturer's standard, band type.

B. Perforated PVC Sewer Pipe and Fittings: ASTM D 2729, bell-and-spigot ends, for loose joints.

2.3 SPECIAL PIPE COUPLINGS

A. Comply with ASTM C 1173, elastomeric, sleeve-type, reducing or transition coupling, for joining underground nonpressure piping. Include ends of same sizes as piping to be joined and corrosion-resistant metal tension band and tightening mechanism on each end.

2.4 CLEANOUTS

A. Cast-Iron Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing; and secured, scoriated, Medium-Duty Loading class, cast-iron cover. Include cast-iron ferrule and countersunk, brass cleanout plug.

B. Copper-Alloy Cleanouts: ASME A112.36.2M; with round-flanged, cast-iron housing with clamping device; and scoriated, Medium-Duty Loading class, copper-alloy cover. Include countersunk, brass cleanout plug.

C. PVC Cleanouts: ASTM D 3034, PVC cleanout threaded plug and threaded pipe hub.

2.5 SOIL MATERIALS

A. Backfill, drainage course, impervious fill, and satisfactory soil materials are specified in Division 31 Section "Earth Moving."

2.6 GEOTEXTILE FILTER FABRICS

A. Description: Fabric of PP or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft.(4480 to 13 440 L/min. per sq. m) when tested according to ASTM D 4491.
   1. Structure Type: Nonwoven, needle-punched continuous filament or woven, monofilament or multifilament.
   2. Style(s): Flat and sock.

PART 3 - EXECUTION

3.1 EARTHWORK

A. Excavating, trenching, and backfilling are specified in Division 31 Section "Earth Moving."

3.2 PIPING APPLICATIONS

A. Underground Subdrainage Piping:
   1. Perforated PE pipe and fittings, couplings, and coupled joints.
   2. Perforated PVC sewer pipe and fittings for loose, bell-and-spigot joints.

B. Underslab Subdrainage Piping:
   1. Perforated PE pipe and fittings, couplings, and coupled joints.
   2. Perforated PVC sewer pipe and fittings and loose, bell-and-spigot joints.

C. Header Piping:
   1. PE drainage tubing and fittings, couplings, and coupled joints.
   2. PVC sewer pipe and fittings, couplings, and coupled joints.

3.3 CLEANOUT APPLICATIONS

A. In Underground Subdrainage Piping:
   1. At Grade in Earth: PVC cleanouts.
   2. At Grade in Paved Areas: Cast-iron cleanouts.

B. In Underslab Subdrainage Piping:
   1. In Equipment Rooms and Unfinished Areas: Cast-iron cleanouts.
   2. In Finished Areas: Copper-alloy cleanouts.

3.4 FOUNDATION DRAINAGE INSTALLATION

A. Place impervious fill material on subgrade adjacent to bottom of footing after concrete footing forms have been removed. Place and compact impervious fill to dimensions indicated, but not less than 6 inches(150 mm) deep and 12 inches(300 mm) wide.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches(100 mm).

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for foundation subdrainage.

F. Add drainage course to width of at least 6 inches(150 mm) on side away from wall and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping to width of at least 6 inches(150 mm) on side away from footing and 6 inches(150 mm) above top of pipe and extend to cover minimum 6 inches(150 mm) of bottom of drainage panel.

H. Install drainage course and wrap top of drainage course with flat-style geotextile filter fabric.

I. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches(100 mm).

3.5 UNDERSLAB DRAINAGE INSTALLATION

A. Excavate for underslab drainage system after subgrade material has been compacted but before drainage course has been placed. Include horizontal distance of at least 6 inches(150 mm) between drainage pipe and trench walls. Grade bottom of trench excavations to required slope, and compact to firm, solid bed for drainage system.

B. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

C. Place supporting layer of drainage course over compacted subgrade and geotextile filter fabric, to compacted depth of not less than 4 inches(100 mm).

D. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

E. Install drainage piping as indicated in Part 3 "Piping Installation" Article for underslab subdrainage.

F. Add drainage course to width of at least 6 inches(150 mm) on both sides and to top of pipe to perform tests.

G. After satisfactory testing, cover drainage piping with drainage course to elevation of bottom of slab, and compact and wrap top of drainage course with flat-style geotextile filter fabric.

3.6 RETAINING-WALL DRAINAGE INSTALLATION

A. Lay flat-style geotextile filter fabric in trench and overlap trench sides.

B. Place supporting layer of drainage course over compacted subgrade to compacted depth of not less than 4 inches(100 mm).

C. Encase pipe with sock-style geotextile filter fabric before installing pipe. Connect sock sections with adhesive or tape.

D. Install drainage piping as indicated in Part 3 "Piping Installation" Article for retaining-wall subdrainage.

E. Add drainage course to width of at least 6 inches(150 mm) on side away from wall and to top of pipe to perform tests.

F. After satisfactory testing, cover drainage piping to width of at least 6 inches(150 mm) on side away from footing and above top of pipe to within 12 inches(300 mm) of finish grade.

G. Place drainage course in layers not exceeding 3 inches(75 mm) in loose depth; compact each layer placed and wrap top of drainage course with flat-style geotextile filter fabric.

H. Place layer of flat-style geotextile filter fabric over top of drainage course, overlapping edges at least 4 inches(100 mm).

I. Fill to Grade: Place satisfactory soil fill material over compacted drainage course. Place material in loose-depth layers not exceeding 6 inches(150 mm). Thoroughly compact each layer. Fill to finish grade.

3.7 PIPING INSTALLATION

A. Install piping beginning at low points of system, true to grades and alignment indicated, with unbroken continuity of invert. Bed piping with full bearing in filtering material. Install gaskets, seals, sleeves, and couplings according to manufacturer's written instructions and other requirements indicated.
   1. Foundation Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent and with a minimum cover of 36 inches(915 mm), unless otherwise indicated.
   2. Underslab Subdrainage: Install piping pitched down in direction of flow, at a minimum slope of 0.5 percent.
   3. Lay perforated pipe with perforations down.
   4. Excavate recesses in trench bottom for bell ends of pipe. Lay pipe with bells facing upslope and with spigot end entered fully into adjacent bell.

B. Use increasers, reducers, and couplings made for different sizes or materials of pipes and fittings being connected. Reduction of pipe size in direction of flow is prohibited.

C. Install PE piping according to ASTM D 2321.

D. Install PVC piping according to ASTM D 2321.

3.8 PIPE JOINT CONSTRUCTION

A. Cast-Iron Soil Pipe and Fittings: Hub and spigot, with rubber compression gaskets according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook." Use gaskets that match class of pipe and fittings.

B. Join PE pipe, tubing, and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties."

C. Join perforated, PE pipe and fittings with couplings for soil-tight joints according to AASHTO's "Standard Specifications for Highway Bridges," Division II, Section 26.4.2.4, "Joint Properties"; or according to ASTM D 2321.

D. Join PVC pipe and fittings according to ASTM D 3034 with elastomeric seal gaskets according to ASTM D 2321.

E. Join perforated PVC pipe and fittings according to ASTM D 2729, with loose bell-and-spigot joints.

F. Special Pipe Couplings: Join piping made of different materials and dimensions with special couplings made for this application. Use couplings that are compatible with and fit materials and dimensions of both pipes.

3.9 CLEANOUT INSTALLATION

A. Cleanouts for Foundation Subdrainage:
   1. Install cleanouts from piping to grade. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
   2. In vehicular-traffic areas, use NPS 4(DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 18 by 18 by 12 inches(450 by 450 by 300 mm) in depth. Set top of cleanout flush with grade. Cast-iron pipe may also be used for cleanouts in nonvehicular-traffic areas.
   3. In nonvehicular-traffic areas, use NPS 4(DN 100) PVC pipe and fittings for piping branch fittings and riser extensions to cleanout. Set cleanout frames and covers in a cast-in-place concrete anchor, 12 by 12 by 4 inches(300 by 300 by 100 mm) in depth. Set top of cleanout plug 1 inch(25 mm) above grade.

B. Cleanouts for Underslab Subdrainage:
   1. Install cleanouts and riser extensions from piping to top of slab. Locate cleanouts at beginning of piping run and at changes in direction. Install fittings so cleanouts open in direction of flow in piping.
   2. Use NPS 4(DN 100) cast-iron soil pipe and fittings for piping branch fittings and riser extensions to cleanout flush with top of slab.

3.10 CONNECTIONS

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

B. Connect low elevations of subdrainage system to building's solid-wall-piping storm drainage system.

C. Where required, connect low elevations of foundation and underslab subdrainage to stormwater sump pumps.

3.11 FIELD QUALITY CONTROL

A. Testing: After installing drainage course to top of piping, test drain piping with water to ensure free flow before backfilling. Remove obstructions, replace damaged components, and repeat test until results are satisfactory.

3.12 CLEANING

A. Clear interior of installed piping and structures of dirt and other superfluous material as work progresses. Maintain swab or drag in piping and pull past each joint as it is completed. Place plugs in ends of uncompleted pipe at end of each day or when work stops.

END OF SECTION 33 4600