2. Use purging and disinfecting procedures prescribed by authorities having jurisdiction; if methods are not prescribed, use procedures described in either AWWA C651 or AWWA C652 or follow procedures described below:
    a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
    b. Fill and isolate system according to either of the following:
        i. Fill system or part thereof with water/chlorine solution with at least 50 ppm (50 mg/L) of chlorine. Isolate with valves and allow to stand for 24 hours.
        ii. Fill system or part thereof with water/chlorine solution with at least 200 ppm (200 mg/L) of chlorine. Isolate and allow to stand for three hours.
    c. Flush system with clean, potable water until no chlorine is in water coming from system after the standing time.
    d. Repeat procedures if biological examination shows contamination.
    e. Submit water samples in sterile bottles to authorities having jurisdiction.

B. Clean non-potable domestic water piping as follows:
    1. Purge new piping and parts of existing piping that have been altered, extended, or repaired before using.
    2. Use purging procedures prescribed by authorities having jurisdiction or; if methods are not prescribed, follow procedures described below:
        a. Flush piping system with clean, potable water until dirty water does not appear at outlets.
        b. Submit water samples in sterile bottles to authorities having jurisdiction. Repeat procedures if biological examination shows contamination.

C. Prepare and submit reports of purging and disinfecting activities. Include copies of water-sample approvals from authorities having jurisdiction.

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

3.12 PIPING SCHEDULE

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

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

C. Fitting Option: Extruded-tee connections and brazed joints may be used on aboveground copper tubing.

D. Under-building-slab, domestic water, building-service piping, NPS 3 and smaller, shall be the following:
    1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.

E. Under-building-slab, domestic water, building-service piping, NPS 4 to NPS 8 and larger, shall be one of the following:
    1. Soft copper tube, ASTM B 88, Type K (ASTM B 88M, Type A); wrought-copper, solder-joint fittings; and brazed joints.

2. Mechanical-joint, ductile-iron pipe; standard-pattern, mechanical-joint fittings; and mechanical joints.

F. Aboveground domestic water piping, NPS 2 and smaller, shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper, solder-joint fittings; and soldered joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper push-on-joint fittings; and push-on joints.

G. Aboveground domestic water piping, NPS 2-1/2 to NPS 4 shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper, solder-joint fittings; and brazed joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); copper pressure-seal-joint fittings; and pressure-sealed joints.
3. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); grooved-joint, copper-tube appurtenances; and grooved joints.

H. Aboveground domestic water piping, NPS 5 to NPS 10 shall be one of the following:

1. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B); cast- or wrought-copper, solder-joint fittings; and [brazed] [soldered] joints.
2. Hard copper tube, ASTM B 88, Type L (ASTM B 88M, Type B) ; grooved-joint, copper-tube appurtenances; and grooved joints.
3. Stainless-steel Schedule 10 pipe, grooved-joint fittings, and grooved joints.

3.13 VALVE SCHEDULE

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

1. Shutoff Duty: Use ball or gate valves for piping NPS 2 and smaller. Use butterfly, ball, or gate valves with flanged ends for piping NPS 2-1/2 and larger.
2. Throttling Duty: Use ball or globe valves for piping NPS 2 and smaller. Use butterfly or ball valves with flanged ends for piping NPS 2-1/2 and larger.
3. Hot-Water Circulation Piping, Balancing Duty: Calibrated balancing valves.
4. Drain Duty: Hose-end drain valves.

B. Use check valves to maintain correct direction of domestic water flow to and from equipment.

C. Iron grooved-end valves may be used with grooved-end piping.

END OF SECTION 221116

SECTION 221123

FACILITY NATURAL-GAS PIPING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 SUMMARY

A. Section Includes:

1. Pipes, tubes, and fittings.
2. Piping specialties.
3. Piping and tubing joining materials.
4. Valves.
5. Pressure regulators.
6. Concrete bases.

B. Contractor shall field verify all existing conditions prior to commencing work, including incoming gas pressure, pipe sizes, etc., as required to extend existing gas piping to new water heaters as shown on the plumbing drawings.

1.03 DEFINITIONS

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

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

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

1.04 PERFORMANCE REQUIREMENTS

A. Minimum Operating-Pressure Ratings:

1. Piping and Valves: 100 psig (690 kPa) minimum unless otherwise indicated.
2. Service Regulators: 65 psig (450 kPa) minimum unless otherwise indicated.

B. Natural-Gas System Pressures within Existing Buildings: Contractor shall field verify.

C. Delegated Design: Design restraints and anchors for natural-gas piping and equipment, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

1.05 ACTION SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

B. Product Data: For each type of the following:

1. Piping specialties.
2. Valves. Include pressure rating, capacity, settings, and electrical connection data of selected models.

3. Pressure regulators. Indicate pressure ratings and capacities.

C. Shop Drawings: For facility natural-gas piping layout. Include plans, piping layout and elevations, sections, and details for fabrication of pipe anchors, hangers, supports for multiple pipes, alignment guides, expansion joints and loops, and attachments of the same to building structure. Detail location of anchors, alignment guides, and expansion joints and loops.

1. Shop Drawing Scale: 1/4 inch per foot (1:50).
2. Detail mounting, supports, and valve arrangements for service meter assembly and pressure regulator assembly.

D. Delegated-Design Submittal: For natural-gas piping and equipment indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1. Detail fabrication and assembly of seismic restraints.
2. Design Calculations: Calculate requirements for selecting seismic restraints.

1.06 INFORMATIONAL SUBMITTALS

A. Coordination Drawings: Plans and details, drawn to scale, on which natural-gas piping is shown and coordinated with other installations, using input from installers of the items involved.

B. Site Survey: Plans, drawn to scale, on which natural-gas piping is shown and coordinated with other services and utilities.

C. Qualification Data: For qualified professional engineer.

D. Welding certificates.

E. Field quality-control reports.

1.07 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For pressure regulators to include in emergency, operation, and maintenance manuals.

1.08 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

1.09 QUALITY ASSURANCE

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

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

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.

1.10 DELIVERY, STORAGE, AND HANDLING

A. Handling Flammable Liquids: Remove and dispose of liquids from existing natural-gas piping according to requirements of authorities having jurisdiction.

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

C. Store and handle pipes and tubes having factory-applied protective coatings to avoid damaging coating, and protect from direct sunlight.

D. Protect stored PE pipes and valves from direct sunlight.

1.11 PROJECT CONDITIONS

A. Perform site survey, research public utility records, and verify existing utility locations. Contact utility-locating service for area where Project is located.

B. Interruption of Existing Natural-Gas Service: Do not interrupt natural-gas service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide purging and startup of natural-gas supply according to requirements indicated:

1. Notify Construction Manager no fewer than two days in advance of proposed interruption of natural-gas service.

2. Do not proceed with interruption of natural-gas service without Construction Manager's written permission.

1.12 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

B. Coordinate requirements for access panels and doors for valves installed concealed behind finished surfaces.

PART 2 - PRODUCTS

2.01 PIPES, TUBES, AND FITTINGS

A. Steel Pipe: ASTM A 53/A 53M, black steel, Schedule 40, Type E or S, Grade B.

1. Malleable-Iron Threaded Fittings: ASME B16.3, Class 150, standard pattern.

2. Wrought-Steel Welding Fittings: ASTM A 234/A 234M for butt welding and socket welding.

3. Unions: ASME B16.39, Class 150, malleable iron with brass-to-iron seat, ground joint, and threaded ends.

4. Forged-Steel Flanges and Flanged Fittings: ASME B16.5, minimum Class 150, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

a. Material Group: 1.1.

b. End Connections: Threaded or butt welding to match pipe.

c. Lapped Face: Not permitted underground.

d. Gasket Materials: ASME B16.20, metallic, flat, asbestos free, aluminum o-rings, and spiral-wound metal gaskets.

e. Bolts and Nuts: ASME B18.2.1, carbon steel aboveground and stainless steel underground.

5. Protective Coating for Underground Piping: Factory-applied, three-layer coating of epoxy, adhesive, and PE.

a. Joint Cover Kits: Epoxy paint, adhesive, and heat-shrink PE sleeves.

6. Mechanical Couplings:

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

i. Dresser Piping Specialties; Division of Dresser, Inc.

ii. Smith-Blair, Inc.

b. Steel flanges and tube with epoxy finish.

c. Buna-nitrile seals.

d. Stainless-steel bolts, washers, and nuts.

e. Coupling shall be capable of joining PE pipe to PE pipe, steel pipe to PE pipe, or steel pipe to steel pipe.

f. Steel body couplings installed underground on plastic pipe shall be factory equipped with anode.

g. Tubing in first paragraph below is limited in application to 0.5 psig (3.45 kPa) and less and NPS 1 (DN 25) and smaller. Verify acceptability with authorities having jurisdiction before retaining.

2.02 PIPING SPECIALTIES

A. Appliance Flexible Connectors:

1. Indoor, Fixed-Appliance Flexible Connectors: Comply with ANSI Z21.24.
2. Indoor, Movable-Appliance Flexible Connectors: Comply with ANSI Z21.69.
3. Outdoor, Appliance Flexible Connectors: Comply with ANSI Z21.75.
4. Corrugated stainless-steel tubing with polymer coating.
5. Operating-Pressure Rating: 0.5 psig (3.45 kPa).
6. End Fittings: Zinc-coated steel.
7. Threaded Ends: Comply with ASME B1.20.1.
8. Maximum Length: 72 inches (1830 mm.)

B. Quick-Disconnect Devices: Comply with ANSI Z21.41.

1. Copper-alloy convenience outlet and matching plug connector.
2. Nitrile seals.
3. Hand operated with automatic shutoff when disconnected.
4. For indoor or outdoor applications.
5. Adjustable, retractable restraining cable.

C. Weatherproof Vent Cap: Cast- or malleable-iron increaser fitting with corrosion-resistant wire screen, with free area at least equal to cross-sectional area of connecting pipe and threaded-end connection.

2.03 JOINING MATERIALS

A. Joint Compound and Tape: Suitable for natural gas.

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

C. Brazing Filler Metals: Alloy with melting point greater than 1000 deg F (540 deg C) complying with AWS A5.8/A5.8M. Brazing alloys containing more than 0.05 percent phosphorus are prohibited.

2.04 MANUAL GAS SHUTOFF VALVES

A. See "Aboveground Manual Gas Shutoff Valve Schedule" Articles for where each valve type is applied in various services.

B. General Requirements for Metallic Valves, NPS 2 and Smaller: Comply with ASME B16.33.

1. CWP Rating: 125 psig (862 kPa).
2. Threaded Ends: Comply with ASME B1.20.1.
3. Dryseal Threads on Flare Ends: Comply with ASME B1.20.3.
4. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Listing: Listed and labeled by an NRTL acceptable to authorities having jurisdiction for valves 1 inch and smaller.
6. Service Mark: Valves 1-1/4 inches to NPS 2 shall have initials "WOG" permanently marked on valve body.

C. General Requirements for Metallic Valves, NPS 2-1/2 and Larger: Comply with ASME B16.38.

1. CWP Rating: 125 psig (862 kPa).
2. Flanged Ends: Comply with ASME B16.5 for steel flanges.
3. Tamperproof Feature: Locking feature for valves indicated in "Underground Manual Gas Shutoff Valve Schedule" and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
4. Service Mark: Initials "WOG" shall be permanently marked on valve body.

D. Two-Piece, Full-Port, Bronze Ball Valves with Bronze Trim: MSS SP-110.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. BrassCraft Manufacturing Company; a Masco company.
    b. Conbraco Industries, Inc.; Apollo Div.
    c. Lyall, R. W. & Company, Inc.
    d. McDonald, A. Y. Mfg. Co.
    e. Perfection Corporation; a subsidiary of American Meter Company.
2. Body: Bronze, complying with ASTM B 584.
3. Ball: Chrome-plated bronze.
4. Stem: Bronze; blowout proof.
5. Seats: Reinforced TFE; blowout proof.
6. Packing: Threaded-body packnut design with adjustable-stem packing.
7. Ends: Threaded, flared, or socket as indicated in and "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
8. CWP Rating: 600 psig (4140 kPa).
9. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
10. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

E. Bronze Plug Valves: MSS SP-78.

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

a. Lee Brass Company.

b. McDonald, A. Y. Mfg. Co.

2. Body: Bronze, complying with ASTM B 584.
3. Plug: Bronze.
4. Ends: Threaded, socket, or flanged as indicated in "Aboveground Manual Gas Shutoff Valve Schedule" Articles.
5. Operator: Square head or lug type with tamperproof feature where indicated.
6. Pressure Class: 125 psig (862 kPa).
7. Listing: Valves NPS 1 and smaller shall be listed and labeled by an NRTL acceptable to authorities having jurisdiction.
8. Service: Suitable for natural-gas service with "WOG" indicated on valve body.

2.05 LABELING AND IDENTIFYING

A. Detectable Warning Tape: Acid- and alkali-resistant, PE film warning tape manufactured for marking and identifying underground utilities, a minimum of 6 inches wide and 4 mils (0.1 mm) thick, continuously inscribed with a description of utility, with metallic core encased in a protective jacket for corrosion protection, detectable by metal detector when tape is buried up to 30 inches deep; colored yellow.

PART 3 - EXECUTION

3.01 EXAMINATION

A. Examine roughing-in for natural-gas piping system to verify actual locations of piping connections before equipment installation.

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

3.02 PREPARATION

A. Close equipment shutoff valves before turning off natural gas to premises or piping section.

B. Inspect natural-gas piping according to NFPA 54 California Plumbing Code to determine that natural-gas utilization devices are turned off in piping section affected.

C. Comply with NFPA 54 California Plumbing Code requirements for prevention of accidental ignition.

3.03 INDOOR PIPING INSTALLATION

A. Comply with NFPA 54California Plumbing Code for installation and purging of natural-gas piping.

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

C. Arrange for pipe spaces, chases, slots, sleeves, and openings in building structure during progress of construction, to allow for mechanical installations.

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

E. 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.

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

G. Locate valves for easy access.

H. Install natural-gas piping at uniform grade of 2 percent down toward drip and sediment traps.

I. Install piping free of sags and bends.

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

K. Verify final equipment locations for roughing-in.

L. Comply with requirements in Sections specifying gas-fired appliances and equipment for roughing-in requirements.

M. Drips and Sediment Traps: Install drips at points where condensate may collect, including service-meter outlets. Locate where accessible to permit cleaning and emptying. Do not install where condensate is subject to freezing.

    1. Construct drips and sediment traps using tee fitting with bottom outlet plugged or capped. Use nipple a minimum length of 3 pipe diameters, but not less than 3 inches (75 mm) long and same size as connected pipe. Install with space below bottom of drip to remove plug or cap.

N. Extend relief vent connections for line regulators, and overpressure protection devices to outdoors and terminate with weatherproof vent cap.

O. Conceal pipe installations in walls, pipe spaces, utility spaces, above ceilings, below grade or floors, and in floor channels unless indicated to be exposed to view.

P. Concealed Location Installations: Except as specified below, install concealed natural-gas piping and piping installed under the building in containment conduit constructed of steel pipe with welded joints as described in Part 2. Install a vent pipe from containment conduit to outdoors and terminate with weatherproof vent cap.

    1. Above Accessible Ceilings: Natural-gas piping, fittings, valves, and regulators may be installed in accessible spaces without containment conduit.

    2. In Floors: Install natural-gas piping with welded or brazed joints and protective coating in cast-in-place concrete floors. Cover piping to be cast in concrete slabs with minimum of 1-1/2 inches (38 mm) of concrete. Piping may not be in physical contact with other metallic structures such as reinforcing rods or electrically neutral conductors. Do not embed piping in concrete slabs containing quick-set additives or cinder aggregate.

    3. In Floor Channels: Install natural-gas piping in floor channels. Channels must have cover and be open to space above cover for ventilation.

    4. In Walls or Partitions: Protect tubing installed inside partitions or hollow walls from physical damage using steel striker barriers at rigid supports.

        a. Exception: Tubing passing through partitions or walls does not require striker barriers.

    5. Prohibited Locations:

        a. Do not install natural-gas piping in or through circulating air ducts, clothes or trash chutes, chimneys or gas vents (flues), ventilating ducts, or dumbwaiter or elevator shafts.

        b. Do not install natural-gas piping in solid walls or partitions.

Q. Use eccentric reducer fittings to make reductions in pipe sizes. Install fittings with level side down.

R. Connect branch piping from top or side of horizontal piping.

S. Install unions in pipes NPS 2 and smaller, adjacent to each valve, at final connection to each piece of equipment. Unions are not required at flanged connections.

T. Do not use natural-gas piping as grounding electrode.

U. Install strainer on inlet of each line-pressure regulator and automatic or electrically operated valve.

V. Install pressure gage upstream and downstream from each line regulator. Pressure gages are specified in Section 220519 "Meters and Gages for Plumbing Piping."

W. Install sleeves for piping penetrations of walls, ceilings, and floors.

X. Install sleeve seals for piping penetrations of concrete walls and slabs.

Y. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.04 VALVE INSTALLATION

A. Install manual gas shutoff valve for each gas appliance ahead of corrugated stainless-steel tubing, aluminum, or copper connector.

B. Install regulators and overpressure protection devices with maintenance access space adequate for servicing and testing.

C. Install earthquake valves aboveground outside buildings according to listing.

3.05 PIPING JOINT CONSTRUCTION

A. Ream ends of pipes and tubes and remove burrs.

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

C. Threaded Joints:

1. Thread pipe with tapered pipe threads complying with ASME B1.20.1.
2. Cut threads full and clean using sharp dies.
3. Ream threaded pipe ends to remove burrs and restore full inside diameter of pipe.
4. Apply appropriate tape or thread compound to external pipe threads unless dryseal threading is specified.
5. 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.

D. Welded Joints:

1. Construct joints according to AWS D10.12/D10.12M, using qualified processes and welding operators.
2. Bevel plain ends of steel pipe.
3. Patch factory-applied protective coating as recommended by manufacturer at field welds and where damage to coating occurs during construction.

E. Flanged Joints: Install gasket material, size, type, and thickness appropriate for natural-gas service. Install gasket concentrically positioned.

3.06 HANGER AND SUPPORT INSTALLATION

A. Install seismic restraints on piping as required.

B. Comply with requirements for pipe hangers and supports specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

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

1. NPS 1 and Smaller: Maximum span, 96 inches minimum rod size, 3/8 inch (10 mm).
2. NPS 1-1/4: Maximum span, 108 inches ; minimum rod size, 3/8 inch.
3. NPS 1-1/2 and NPS 2: Maximum span, 108 inches; minimum rod size, 3/8 inch.
4. NPS 2-1/2 to NPS 3-1/2: Maximum span, 10 feet; minimum rod size, 1/2 inch.
5. NPS 4 and Larger: Maximum span, 10 feet; minimum rod size, 5/8 inch.

3.07 CONNECTIONS

A. Connect to utility's gas main according to utility's procedures and requirements.

B. Install natural-gas piping electrically continuous, and bonded to gas appliance equipment grounding conductor of the circuit powering the appliance according to NFPA 70.

C. Install piping adjacent to appliances to allow service and maintenance of appliances.

D. Connect piping to appliances using manual gas shutoff valves and unions. Install valve within 72 inches (1800 mm) of each gas-fired appliance and equipment. Install union between valve and appliances or equipment.

E. Sediment Traps: Install tee fitting with capped nipple in bottom to form drip, as close as practical to inlet of each appliance.

3.08 LABELING AND IDENTIFYING

A. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for piping and valve identification.

B. Install detectable warning tape directly above gas piping, 12 inches below finished grade, except 6 inches below subgrade under pavements and slabs.

3.09 PAINTING

A. Comply with requirements in Section 09900 "Painting" for painting interior and exterior natural-gas piping.

B. Paint exposed, exterior metal piping, valves, service regulators, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Alkyd System: MPI EXT 5.1D.
    a. Prime Coat: Alkyd anticorrosive metal primer.
    b. Intermediate Coat: Exterior alkyd enamel matching topcoat.
    c. Topcoat: Exterior alkyd enamel (gloss).
    d. Color: Gray.

C. Paint exposed, interior metal piping, valves, service regulators, earthquake valves, and piping specialties, except components, with factory-applied paint or protective coating.

1. Latex Over Alkyd Primer System: MPI INT 5.1Q.
    a. Prime Coat: Alkyd anticorrosive metal primer.
    b. Intermediate Coat: Interior latex matching topcoat.
    c. Topcoat: Interior latex (semi-gloss).
    d. Color: Gray.

2. Alkyd System: MPI INT 5.1E.
    a. Prime Coat: Alkyd anticorrosive metal primer.
    b. Intermediate Coat: Interior alkyd matching topcoat.
    c. Topcoat: Interior alkyd [(semi-gloss).
    d. Color: Gray.

D. Damage and Touchup: Repair marred and damaged factory-applied finishes with materials and by procedures to match original factory finish.

3.10 FIELD QUALITY CONTROL

A. Perform tests and inspections.

B. Tests and Inspections:
    1. Test, inspect, and purge natural gas according to NFPA 54 California Plumbing Code and authorities having jurisdiction.

C. Natural-gas piping will be considered defective if it does not pass tests and inspections.

D. Prepare test and inspection reports.

3.11 DEMONSTRATION

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

3.12 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES LESS THAN 0.5 PSIG (3.45 kPa)

A. Aboveground, branch piping NPS 1 and smaller shall be the following:
    1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:
    1. Steel pipe with malleable-iron fittings and threaded joints.
    2. Steel pipe with wrought-steel fittings and welded joints.

3.13 INDOOR PIPING SCHEDULE FOR SYSTEM PRESSURES MORE THAN 0.5 PSIG (3.45 kPa) AND LESS THAN 5 PSIG (34.5 kPa)

A. Aboveground, branch piping NPS 1 and smaller shall be the following:
    1. Steel pipe with malleable-iron fittings and threaded joints.

B. Aboveground, distribution piping shall be one of the following:
    1. Steel pipe with malleable-iron fittings and threaded joints.
    2. Steel pipe with steel welding fittings and welded joints.

3.14 ABOVEGROUND MANUAL GAS SHUTOFF VALVE SCHEDULE

A. Valves for pipe sizes NPS 2 and smaller at service meter shall be one of the following:
    1. Two-piece, full-port, bronze ball valves with bronze trim.
    2. Bronze plug valve.

B. Valves for pipe sizes NPS 2-1/2 and larger at service meter shall be one of the following:
    1. Two-piece, full-port, bronze ball valves with bronze trim.
    2. Bronze plug valve.
    3. Cast-iron, non-lubricated plug valve.

C. Distribution piping valves for pipe sizes NPS 2 and smaller shall be one of the following:
    1. Two-piece, full-port, bronze ball valves with bronze trim.
    2. Bronze plug valve.
D. Distribution piping valves for pipe sizes NPS 2-1/2 and larger shall be one of the following:
    1. Two-piece, full-port, bronze ball valves with bronze trim.
    2. Bronze plug valve.
    3. Cast-iron, lubricated plug valve.
E. Valves in branch piping for single appliance shall be one of the following:
    1. One-piece, bronze ball valve with bronze trim.
    2. Two-piece, full-port, bronze ball valves with bronze trim.
    3. Bronze plug valve.

END OF SECTION 231123

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SECTION 221316

SANITARY AND GREASE WASTE AND VENT PIPING

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 SUMMARY

A. This Section includes sanitary and grease waste and vent piping systems, from a point outside the facility or as indicated on the Plumbing Plans to all equipment inside the facility.

B. Furnish all labor, materials, sleeves, hangers, supports, tools, equipment and perform all work and services necessary for furnishing and installation of a complete sanitary and grease waste and vent piping system. Although all work is not specifically shown or specified, all appurtenances and devices incidental to or necessary for a sound, secure, complete and compatible installation shall be furnished and installed as part of this work.

C. Materials specified in this Section include the following:

1. Extra heavy or service weight hub and spigot (below ground)
2. Service weight No-Hub pipe and fittings (above and below ground).
3. Service weight No-Hub heavy duty couplings (above and below ground).

D. Related Sections include the following:

1. Division 31 Section "Excavation, Backfilling and Compacting for Utilities" for excavation and backfill.
2. Division 07 Section "Firestopping" for fire barrier sealers.
3. Division 22 Section "Basic Plumbing Materials and Methods."
4. Division 22 Section "Hangers and Supports for Plumbing Piping and Equipment."
5. Division 22 Section "Identification for Plumbing Piping and Equipment."

1.03 DEFINITIONS

A. Sanitary and Grease Waste and Vent Piping: Piping inside the building that conveys waste water and vapors from fixtures and equipment throughout the building.

B. Service Entrance Piping: Sanitary sewerage piping to a point outside the building as indicated on the Underground Plumbing Plans.

C. Sewerage Piping: Building sewer piping outside building that conveys sanitary sewerage from building.

1.04 PERFORMANCE REQUIREMENTS

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

1. Soil, Waste, Grease and Vent Piping: 10-foot head of water (30 kPa).

B. Seismic Performance: Soil, waste, and vent piping and support and installation shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1.05 SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

1. Product Data for Hub and spigot pipe and fittings; No-hub pipe, fittings, and heavy duty couplings, and vent caps. Provide manufacturers catalog information and testing records. Provide certification letter from manufacturer, with legal name and address of actual manufacturer.
2. Shop Drawings: For underground and above ground storm and overflow drainage systems and all plumbing chases. Include plans, elevations, sections, and details.
3. Field Test Reports: Indicate and interpret test results for compliance with performance requirements.

1.06 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

1.07 QUALITY ASSURANCE

A. Each pipe and fitting shall be marked with the following:
   1. Manufactures name or the USPTO Registered Trademark of the Manufacturer.
   2. Country of Origin.
   3. Date of Manufacture (pipe only).

B. Comply with the provisions of ASME B31.9 "Building Services Piping," for materials, products, and installation.

1.08 DRAWING SCHEDULE

A. Comply with Plumbing Plans, Schedules and Details for model numbers, symbols, and additional information concerning products specified in this Section.

PART 2 - PRODUCTS

2.01 PIPING MATERIALS MANUFACTURERS

A. Manufacturers: Subject to compliance with requirements, provide products in each category, by one of the following listed from that category:
   1. Hub and Spigot and No-Hub Cast Iron Pipe and Fittings:
      a. AB&I, Oakland, California.
      b. Charlotte Pipe & Foundry Company, Charlotte, North Carolina.
      c. Tyler Pipe Industries, Tyler, Texas.
      d. Or equal.
   2. No-Hub Heavyweight Couplings:
      a. Anaco, Inc., Oakland, California; Husky SD4000-Orange Shield.
      b. Clamp-All Corporation, Haverhill, MA; Clamp All Hi Torque 125.
      c. Or equal.
   3. Vent Caps:
      a. J.R. Smith.
      b. Zurn
      c. Or equal.

2.02 PIPING MATERIALS

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

2.03 HUB-AND-SPIGOT, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 74, Service class.

B. Gaskets: ASTM C 564, rubber.

C. Calking Materials: ASTM B 29, pure lead and oakum or hemp fiber.

2.04 HUBLESS, CAST-IRON SOIL PIPE AND FITTINGS

A. Pipe and Fittings: ASTM A 888 or CISPI 301.

B. Sovent Stack Fittings: ASME B16.45 or ASSE 1043, hubless, cast-iron aerator and deaerator drainage fittings.

C. Heavy-Duty, Hubless-Piping Couplings for above slab installation:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. ANACO-Husky.
    b. Clamp-All Corp.
    c. Dallas Specialty & Mfg. Co.
    d. MIFAB, Inc.
    e. Mission Rubber Company; a division of MCP Industries, Inc.
    f. Stant.
    g. Tyler Pipe.
2. Standards: ASTM C 1277 and ASTM C 1540.
3. Description: Stainless-steel shield with stainless-steel bands and tightening devices; and ASTM C 564, rubber sleeve with integral, center pipe stop.

D. Cast-Iron, Hubless-Piping Couplings for below slab installation:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. MG Piping Products Company.
2. Standard: ASTM C 1277.
3. Description: Two-piece ASTM A 48/A 48M, cast-iron housing; stainless-steel bolts and nuts; and ASTM C 564, rubber sleeve with integral, center pipe stop.

2.05 COPPER TUBE AND FITTINGS

A. Copper DWV Tube: ASTM B 306, drainage tube, drawn temper.

B. Copper Drainage Fittings: ASME B16.23, cast copper or ASME B16.29, wrought copper, solder-joint fittings.

C. Hard Copper Tube: ASTM B 88, Type L and Type M (ASTM B 88M, Type B and Type C), water tube, drawn temper.

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

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

D. Solder: ASTM B 32, lead free with ASTM B 813, water-flushable flux.

2.06 SPECIALTY PIPE FITTINGS

A. Transition Couplings:

1. General Requirements: Fitting or device for joining piping with small differences in OD's or of different materials. Include end connections same size as and compatible with pipes to be joined.

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

3. Unshielded, Non-pressure Transition Couplings:

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

i. Dallas Specialty & Mfg. Co.

ii. Fernco Inc.

iii. Mission Rubber Company; a division of MCP Industries, Inc.

iv. Plastic Oddities; a division of Diverse Corporate Technologies, Inc.

b. Standard: ASTM C 1173.

c. Description: Elastomeric, sleeve-type, reducing or transition pattern. Include shear ring and corrosion-resistant-metal tension band and tightening mechanism on each end.

d. Sleeve Materials:

i. For Cast-Iron Soil Pipes: ASTM C 564, rubber.

ii. For Plastic Pipes: ASTM F 477, elastomeric seal or ASTM D 5926, PVC.

iii. For Dissimilar Pipes: ASTM D 5926, PVC or other material compatible with pipe materials being joined.

4. Shielded, Non-pressure Transition Couplings:

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

i. Cascade Waterworks Mfg. Co.

ii. Mission Rubber Company; a division of MCP Industries, Inc.

b. Standard: ASTM C 1460.

c. Description: Elastomeric or rubber sleeve with full-length, corrosion-resistant outer shield and corrosion-resistant-metal tension band and tightening mechanism on each end.

5. Pressure Transition Couplings:

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

i. Cascade Waterworks Mfg. Co.

ii. Dresser, Inc.

iii. EBAA Iron, Inc.

iv. JCM Industries, Inc.

v. Romac Industries, Inc.

vi. Smith-Blair, Inc.; a Sensus company.

vii. The Ford Meter Box Company, Inc.

viii. Viking Johnson.

b. Standard: AWWA C219.

c. Description: Metal, sleeve-type same size as, with pressure rating at least equal to, and ends compatible with, pipes to be joined.

d. Center-Sleeve Material: Stainless steel.

e. Gasket Material: Natural or synthetic rubber.

f. Metal Component Finish: Corrosion-resistant coating or material.

2.07 VENT CAPS

A. Provide vandal proof vent cap for all sanitary vent terminations.

B. Bottom of all vent caps shall be a minimum of 12-inches above roof.

C. Vent caps shall be as manufactured by J.R. Smith Figure 1748, vandal proof hooded type vent cap, galvanized cast iron with recessed allan socket set screws.

PART 3 - EXECUTION

3.01 EARTH MOVING

A. Comply with requirements for excavating, trenching, and backfilling specified in Section 312000 "Grading."

3.02 PIPING INSTALLATION

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

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

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

E. Install piping to permit valve servicing.

F. Install piping at indicated slopes.

G. Install piping free of sags and bends.

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

I. Install piping to allow application of insulation.

J. Make changes in direction for soil and waste drainage and vent piping using appropriate branches, bends, and long-sweep bends. Sanitary tees and short-sweep 1/4 bends may be used on vertical stacks if change in direction of flow is from horizontal to vertical. Use long-turn, double Y-branch and 1/8-bend fittings if two fixtures are installed back to back or side by

side with common drain pipe. Straight tees, elbows, and crosses may be used on vent lines. Do not change direction of flow more than 90 degrees. Use proper size of standard increasers and reducers if pipes of different sizes are connected. Reducing size of drainage piping in direction of flow is prohibited.

K. Lay buried building drainage piping beginning at low point of each system. Install true to grades and alignment indicated, with unbroken continuity of invert. Place hub ends of piping upstream. Install required gaskets according to manufacturer's written instructions for use of lubricants, cements, and other installation requirements. Maintain swab in piping and pull past each joint as completed.

L. Install soil and waste drainage and vent piping at the following minimum slopes unless otherwise indicated:

1. Building and Horizontal Sanitary Drain: 2 percent downward in direction of flow for piping NPS 3 and smaller; 1 percent downward in direction of flow for piping NPS 4 and larger.
2. Vent Piping: 1 percent down toward vertical fixture vent or toward vent stack.

M. Install cast-iron soil piping according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook," Chapter IV, "Installation of Cast Iron Soil Pipe and Fittings."

1. Install encasement on underground piping according to ASTM A 674 or AWWA C105/A 21.5.

N. Install aboveground copper tubing according to CDA's "Copper Tube Handbook."

O. Plumbing Specialties:

1. Install cleanouts at grade and extend to where building sanitary drains connect to building sanitary sewers in sanitary drainage gravity-flow piping. Install cleanout fitting with closure plug inside the building in sanitary drainage force-main piping.
2. Install drains in sanitary drainage gravity-flow piping.

P. Do not enclose, cover, or put piping into operation until it is inspected and approved by authorities having jurisdiction.

Q. Install sleeves for piping penetrations of walls, ceilings, and floors.

R. Install sleeve seals for piping penetrations of concrete walls and slabs. Install escutcheons for piping penetrations of walls, ceilings, and floors.

3.03 JOINT CONSTRUCTION

A. Join hub-and-spigot, cast-iron soil piping with gasket joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for compression joints.

B. Join hub-and-spigot, cast-iron soil piping with calked joints according to CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for lead-and-oakum calked joints.

C. Join hubless, cast-iron soil piping according to CISPI 310 and CISPI's "Cast Iron Soil Pipe and Fittings Handbook" for hubless-piping coupling joints.

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. Join copper tube and fittings with soldered joints according to ASTM B 828. Use ASTM B 813, water-flushable, lead-free flux and ASTM B 32, lead-free-alloy solder.

3.04 SPECIALTY PIPE FITTING INSTALLATION

A. Transition Couplings:

1. Install transition couplings at joints of piping with small differences in OD's.
2. In Drainage Piping: Shielded, non-pressure transition couplings.
3. In Aboveground Force Main Piping: Fitting-type transition couplings.
4. In Underground Force Main Piping:
    a. NPS 1-1/2 (DN 40) and Smaller: Fitting-type transition couplings.
    b. NPS 2 (DN 50) and Larger: Pressure transition couplings.

3.05 VALVE INSTALLATION

A. General valve installation requirements are specified in Section 220523 "General-Duty Valves for Plumbing Piping."

B. Shutoff Valves:

1. Install shutoff valve on each sewage pump discharge.
2. Install gate or full-port ball valve for piping NPS 2 and smaller.
3. Install gate valve for piping NPS 2-1/2 and larger.

C. Check Valves: Install swing check valve, between pump and shutoff valve, on each sewage pump discharge.

3.06 HANGER AND SUPPORT INSTALLATION

A. Comply with requirements for pipe hanger and support devices and installation specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."

1. Install carbon-steel pipe hangers for horizontal piping in noncorrosive environments.
2. Install carbon-steel pipe support clamps for vertical piping in noncorrosive environments.
3. Vertical Piping: MSS Type 8 or Type 42, clamps.
4. Install individual, straight, horizontal piping runs:
    a. 100 Feet and Less: MSS Type 1, adjustable, steel clevis hangers.
    b. Longer Than 100 Feet: MSS Type 43, adjustable roller hangers.
5. Multiple, Straight, Horizontal Piping Runs 100 Feet or Longer: MSS Type 44, pipe rolls. Support pipe rolls on trapeze.

B. Support horizontal piping and tubing within 12 inches of each fitting and coupling.

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

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

E. Install hangers for cast-iron soil piping with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/2 and NPS 2 60 inches with 3/8-inch rod.
2. NPS 3: 60 inches with 1/2-inch rod.
3. NPS 4 and NPS 5: 60 inches with 5/8-inch rod.

4. NPS 6 and NPS 8: 60 inches with 3/4-inch rod.
5. Spacing for 10-foot lengths may be increased to 10 feet. Spacing for fittings is limited to 60 inches

F. Install supports for vertical cast-iron soil piping every 15 feet.

G. Install hangers for copper tubing with the following maximum horizontal spacing and minimum rod diameters:

1. NPS 1-1/4 (DN 32): 72 inches (1800 mm) with 3/8-inch (10-mm) rod.
2. NPS 1-1/2 and NPS 2 (DN 40 and DN 50): 96 inches (2400 mm) with 3/8-inch (10-mm) rod.
3. NPS 2-1/2 (DN 65): 108 inches (2700 mm) with 1/2-inch (13-mm) rod.
4. NPS 3 and NPS 5 (DN 80 and DN 125): 10 feet (3 m) with 1/2-inch (13-mm) rod.
5. NPS 6 (DN 150): 10 feet (3 m) with 5/8-inch (16-mm) rod.

H. Install supports for vertical copper tubing every 10 feet (3 m).

I. Support piping and tubing not listed above according to MSS SP-69 and manufacturer's written instructions.

3.07 CONNECTIONS

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

B. Connect soil and waste piping to exterior sanitary sewerage piping. Use transition fitting to join dissimilar piping materials.

C. Connect drainage and vent piping to the following:

1. Plumbing Fixtures: Connect drainage piping in sizes indicated, but not smaller than required by plumbing code.
2. Plumbing Fixtures and Equipment: Connect atmospheric vent piping in sizes indicated, but not smaller than required by authorities having jurisdiction.
3. Plumbing Specialties: Connect drainage and vent piping in sizes indicated, but not smaller than required by plumbing code.
4. Install test tees (wall cleanouts) in conductors near floor and floor cleanouts with cover flush with floor.

D. Where installing piping adjacent to equipment, allow space for service and maintenance of equipment.

3.08 IDENTIFICATION

A. Identify exposed sanitary waste and vent piping. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.09 FIELD QUALITY CONTROL

A. During installation, notify authorities having jurisdiction at least 24 hours before inspection must be made. Perform tests specified below in presence of authorities having jurisdiction.

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

B. Re-inspection: If authorities having jurisdiction find that piping will not pass test or inspection, make required corrections and arrange for re-inspection.

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

D. Test sanitary drainage and vent piping according to procedures of authorities having jurisdiction or, in absence of published procedures, as follows:

1. Test for leaks and defects in new piping and parts of existing piping that have been altered, extended, or repaired. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.

2. Leave uncovered and unconcealed new, altered, extended, or replaced drainage and vent piping until it has been tested and approved. Expose work that was covered or concealed before it was tested.

3. Roughing-in Plumbing Test Procedure: Test drainage and vent piping except outside leaders on completion of roughing-in. Close openings in piping system and fill with water to point of overflow, but not less than 10-foot head of water (30 kPa). From 15 minutes before inspection starts to completion of inspection, water level must not drop. Inspect joints for leaks.

4. Finished Plumbing Test Procedure: After plumbing fixtures have been set and traps filled with water, test connections and prove they are gastight and watertight. Plug vent-stack openings on roof and building drains where they leave building. Introduce air into piping system equal to pressure of 1-inch wg (250 Pa). Use U-tube or manometer inserted in trap of water closet to measure this pressure. Air pressure must remain constant without introducing additional air throughout period of inspection. Inspect plumbing fixture connections for gas and water leaks.

5. Repair leaks and defects with new materials and retest piping, or portion thereof, until satisfactory results are obtained.

6. Prepare reports for tests and required corrective action.

3.10 CLEANING AND PROTECTION

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

B. Protect drains during remainder of construction period to avoid clogging with dirt and debris and to prevent damage from traffic and construction work.

C. Place plugs in ends of uncompleted piping at end of day and when work stops.

3.11 PIPING SCHEDULE

A. Aboveground, soil, waste, grease and vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings; heavy-duty hubless-piping couplings; and coupled joints.

3. Copper DWV tube, copper drainage fittings, and soldered joints.

4. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

B. Aboveground, soil, waste, grease and vent piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil pipe and fittings; gaskets; and gasketed joints.

2. Hubless, cast-iron soil pipe and fittings ; heavy-duty hubless-piping couplings; and coupled joints.

3. Dissimilar Pipe-Material Couplings: Unshielded, non-pressure transition couplings.

C. Underground, soil, waste, grease and vent piping NPS 4 and smaller shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; cast-iron hubless-piping couplings; and coupled joints.
3. .
4. Dissimilar Pipe-Material Couplings: Unshielded non-pressure transition couplings.

D. Underground, soil, waste and grease piping NPS 5 and larger shall be any of the following:

1. Service class, cast-iron soil piping; gaskets; and gasketed joints.
2. Hubless, cast-iron soil pipe and fittings; cast-iron hubless-piping couplings; coupled joints.
3. Dissimilar Pipe-Material Couplings: Unshielded non-pressure transition couplings.

END OF SECTION 221316

SECTION 223400

FUEL-FIRED, DOMESTIC-WATER HEATERS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 SUMMARY

A. Section Includes:

1. Commercial, gas-fired, domestic-water heaters to replace existing to be removed. The new temporary domestic water heater shall be atmospheric type to match existing.
2. Domestic-water heater accessories.

1.03 PERFORMANCE REQUIREMENTS

A. Seismic Performance: Commercial domestic-water heaters shall withstand the effects of earthquake motions determined according to ASCE/SEI 7.

1. The term "withstand" means "the unit will remain in place without separation of any parts from the device when subjected to the seismic forces specified and the unit will be fully operational after the seismic event."

1.04 ACTION SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

B. Product Data: For each type and size of domestic-water heater indicated. Include rated capacities, operating characteristics, electrical characteristics, and furnished specialties and accessories.

C. Shop Drawings:

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

1.05 INFORMATIONAL SUBMITTALS

A. Seismic Qualification Certificates: For fuel-fired, domestic-water heaters, accessories, and components, from manufacturer.

1. Basis for Certification: Indicate whether withstand certification is based on actual test of assembled components or on calculation.
2. Dimensioned Outline Drawings of Equipment Unit: Identify center of gravity and locate and describe mounting and anchorage provisions.
3. Detailed description of equipment anchorage devices on which the certification is based and their installation requirements.

B. Product Certificates: For each type of commercial, gas-fired, domestic-water heater, from manufacturer.

C. Domestic-Water Heater Labeling: Certified and labeled by testing agency acceptable to authorities having jurisdiction.

D. Source quality-control reports.

E. Field quality-control reports.

F. Warranty: Sample of special warranty.

1.06 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For fuel-fired, domestic-water heaters to include in emergency, operation, and maintenance manuals.

1.07 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

1.08 QUALITY ASSURANCE

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

B. ASHRAE/IESNA Compliance: Fabricate and label fuel-fired, domestic-water heaters to comply with ASHRAE/IESNA 90.1.

C. ASME Compliance:

1. Where ASME-code construction is indicated, fabricate and label commercial, domestic-water heater storage tanks to comply with ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.

2. Where ASME-code construction is indicated, fabricate and label commercial, finned-tube, domestic-water heaters to comply with ASME Boiler and Pressure Vessel Code: Section IV.

D. NSF Compliance: Fabricate and label equipment components that will be in contact with potable water to comply with NSF 61, "Drinking Water System Components - Health Effects."

1.09 COORDINATION

A. Coordinate sizes and locations of concrete bases with actual equipment provided.

1.10 WARRANTY

A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of fuel-fired, domestic-water heaters that fail in materials or workmanship within specified warranty period.

1. Failures include, but are not limited to, the following:

a. Structural failures including storage tank and supports.

b. Faulty operation of controls.

c. Deterioration of metals, metal finishes, and other materials beyond normal use.

2. Warranty Periods: From date of Substantial Completion.

a. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

i. Storage Tank: Three years.

ii. Controls and Other Components: One year.

PART 2 - PRODUCTS

2.01 COMMERCIAL, GAS-FIRED, STORAGE, DOMESTIC-WATER HEATERS

A. Commercial, Gas-Fired, Storage, Domestic-Water Heaters:

1. Basis-of-Design Product: Subject to compliance with requirements, provide PVI Industries, LLC to match existing, or comparable product by one of the following:
    a. PVI Industries.
    b. Lochinvar Corporation.
    c. Smith, A. O. Water Products Co.; a division of A. O. Smith Corporation.
    d. State Industries.

B. Capacity and Characteristics:
    1. Refer to Schedule on Drawings

2.02 DOMESTIC-WATER HEATER ACCESSORIES

A. Domestic-Water Expansion Tanks: As scheduled on the Drawings.

B. Drain Pans: Corrosion-resistant metal with raised edge. Comply with ANSI/CSA LC 3. Include dimensions not less than base of domestic-water heater, and include drain outlet not less than NPS 3/4 (DN 20) with ASME B1.20.1 pipe threads or with ASME B1.20.7 garden-hose threads.

C. Piping-Type Heat Traps: Field-fabricated piping arrangement according to ASHRAE/IESNA 90.1.

D. Heat-Trap Fittings: ASHRAE 90.2.

E. Manifold Kits: Domestic-water heater manufacturer's factory-fabricated inlet and outlet piping for field installation, for multiple domestic-water heater installation. Include ball-, butterfly-, or gate-type shutoff valves to isolate each domestic-water heater and memory-stop balancing valves to provide balanced flow through each domestic-water heater.

F. Comply with requirements for ball valves specified in Section 220523 "General-Duty Valves for Plumbing Piping"

G. Gas Shutoff Valves: ANSI Z21.15/CSA 9.1-M, manually operated. Furnish for installation in piping.

H. Automatic Gas Valves: ANSI Z21.21/CSA 6.5, appliance, electrically operated, on-off automatic valve.

I. Combination Temperature-and-Pressure Relief Valves: Include relieving capacity at least as great as heat input, and include pressure setting less than domestic-water heater working-pressure rating. Select relief valves with sensing element that extends into storage tank.
    1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

J. Pressure Relief Valves: Include pressure setting less than domestic-water heater working-pressure rating.
    1. Gas-Fired, Domestic-Water Heaters: ANSI Z21.22/CSA 4.4-M.

K. Vacuum Relief Valves: ANSI Z21.22/CSA 4.4-M.

2.03 SOURCE QUALITY CONTROL

A. Factory Tests: Test and inspect assembled domestic-water heaters specified to be ASME-code construction, according to ASME Boiler and Pressure Vessel Code.

B. Hydrostatically test commercial domestic-water heaters to minimum of one and one-half times pressure rating before shipment.

C. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 1 for retesting and re-inspecting requirements and for requirements for correcting the Work.

D. Prepare test and inspection reports.

PART 3 - EXECUTION

3.01 DOMESTIC-WATER HEATER INSTALLATION

A. Commercial, Domestic-Water Heater Mounting: Install commercial domestic-water heaters on concrete base. Comply with requirements for concrete base specified in Section 033000 "Cast-in-Place Concrete."

1. Maintain manufacturer's recommended clearances.
2. Arrange units so controls and devices that require servicing are accessible.
3. Install dowel rods to connect concrete base to concrete floor. Unless otherwise indicated, install dowel rods on 18-inch centers around the full perimeter of concrete base.
4. For supported equipment, install epoxy-coated anchor bolts that extend through concrete base and anchor into structural concrete floor.
5. Place and secure anchorage devices. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
6. Install anchor bolts to elevations required for proper attachment to supported equipment.
7. Anchor domestic-water heaters to substrate.

B. Install domestic-water heaters level and plumb, according to layout drawings, original design, and referenced standards. Maintain manufacturer's recommended clearances. Arrange units so controls and devices needing service are accessible.

1. Install shutoff valves on domestic-water-supply piping to domestic-water heaters and on domestic-hot-water outlet piping. Comply with requirements for shutoff valves specified in Section 220523 "General-Duty Valves for Plumbing Piping

C. Install gas-fired, domestic-water heaters according to NFPA 54.

1. Install gas shutoff valves on gas supply piping to gas-fired, domestic-water heaters without shutoff valves.
2. Install gas pressure regulators on gas supplies to gas-fired, domestic-water heaters without gas pressure regulators if gas pressure regulators are required to reduce gas pressure at burner.
3. Install automatic gas valves on gas supplies to gas-fired, domestic-water heaters if required for operation of safety control.
4. Comply with requirements for gas shutoff valves, gas pressure regulators, and automatic gas valves specified in Section 221123 "Facility Natural-Gas Piping."

D. Install commercial domestic-water heaters with seismic-restraint devices. Install combination temperature-and-pressure relief valves in top portion of storage tanks. Use relief valves with sensing elements that extend into tanks. Extend commercial-water-heater relief-valve outlet, with drain piping same as domestic-water piping in continuous downward pitch, and discharge by positive air gap onto closest floor drain.

E. Install water-heater drain piping as indirect waste to spill by positive air gap into open drains or over floor drains. Install hose-end drain valves at low points in water piping for domestic-water heaters that do not have tank drains.

F. Install thermometer on outlet piping of domestic-water heaters. Comply with requirements for thermometers specified in Section 220519 "Meters and Gages for Plumbing Piping."

G. Assemble and install inlet and outlet piping manifold kits for multiple domestic-water heaters. Fabricate, modify, or arrange manifolds for balanced water flow through each domestic-water heater. Include shutoff valve and thermometer in each domestic-water heater inlet and outlet, and throttling valve in each domestic-water heater outlet.

H. Install piping-type heat traps on inlet and outlet piping of domestic-water heater storage tanks without integral or fitting-type heat traps.

I. Fill domestic-water heaters with water.

J. Charge domestic-water compression tanks with air.

3.02 CONNECTIONS

A. Comply with requirements for domestic-water piping specified in Section 221116 "Domestic Water Piping."

B. Comply with requirements for gas piping specified in Section 221123 "Facility Natural-Gas Piping."

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

D. Where installing piping adjacent to fuel-fired, domestic-water heaters, allow space for service and maintenance of water heaters. Arrange piping for easy removal of domestic-water heaters.

3.03 IDENTIFICATION

A. Identify system components. Comply with requirements for identification specified in Section 220553 "Identification for Plumbing Piping and Equipment."

3.04 FIELD QUALITY CONTROL

A. Perform tests and inspections.

1. Manufacturer's Field Service: Engage a factory-authorized service representative to inspect components, assemblies, and equipment installations, including connections, and to assist in testing.

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

3. Operational Test: After electrical circuitry has been energized, start units to confirm proper operation.

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

B. Domestic-water heaters will be considered defective if they do not pass tests and inspections. Comply with requirements in Division 1 for retesting and reinspecting requirements.

C. Prepare test and inspection reports.

3.05 DEMONSTRATION

A. Train Owner's maintenance personnel to adjust, operate, and maintain commercial, gas-fired, storage, domestic-water heaters.

END OF SECTION 223400

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SECTION 230010

BASIC HVAC REQUIREMENTS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

B. This Section and following Sections govern, wherever applicable, the Work of Division-23 as if printed in each Section of Division-23.

1. Section 23 05 00, "Common Work Results for HVAC."
2. Section 23 05 53, "Identification for HVAC."
3. Section 23 07 00, "HVAC Insulation."
4. Section 23 05 29, "Hangers and Supports for HVAC."

1.02 SUMMARY

A. Furnish all labor, materials, tools, equipment, and services for all mechanical Work as specified and indicated, in accord with provisions of Contract Documents. Completely coordinate with Work of all other trades. Although such Work is not specifically indicated, furnish and install all supplementary or miscellaneous items, appurtenances and devices incidental to or necessary for a sound, secure and complete installation.

B. Drawings, Use and Interpretation:

1. Drawings are diagrammatic and indicate general arrangement of systems and equipment, except when specifically dimensioned or detailed.
2. For exact locations of building elements, refer to dimensioned architectural and structural drawings.
3. Field measurements take precedence over dimensioned drawings.
4. Piping plans are intended to show size, capacity, approximate location, direction and general relationship of one work phase to another, but not the exact detail or arrangement.
5. Field verify locations and arrangement of all existing systems and equipment.
6. For any conflict in the Drawings and/or Specifications the more stringent requirements shall apply. Any such conflict shall be brought to the attention of the Architect/Engineer for resolution prior to construction of such items.

C. Installation of all systems and equipment is subject to clarification as indicated in reviewed Shop Drawings with field coordination.

1. Generally, layout pipelines requiring gravity drainage first; followed by large pipe mains and electrical conduit.
2. This procedure is intended to promote orderly installation, but not to establish trade precedence.
3. Dimensions indicated are limiting dimensions.
4. Do not use equipment exceeding dimensions indicated on detail drawings or arrangements that reduce required clearances or exceed specified maximum dimensions.

5. Pipe hanger and support installation: See Section 23 05 29.

D. Description of systems: Furnish and install all materials resulting, upon completion, in functioning systems in compliance with performance requirements specified, and any modifications resulting from reviewed Shop Drawings with field coordination.

E. Seismic requirements: See Section 23 05 29, "Hangers and Supports for HVAC."

1.03 WORK SPECIFIED UNDER OTHER DIVISIONS

A. Concrete housekeeping pads and curbs for mechanical equipment: Division 03 Specifications.

B. Motor controls and power wiring: Division 26, Electrical Sections, unless specified otherwise.

C. Finish painting: Division 09 Specifications, unless specified otherwise.

1.04 QUALITY ASSURANCE

A. Perform all work in accord with following rules (codes, standards and regulations):

1. Codes:

a.	2010 California Building Code	CBC
b.	2010 California Fire Code	CFC
c.	2010 California Electrical Code	CNEC
d.	2010 California Plumbing Code	CPC
e.	2010 California Mechanical Code	CMC
f.	2008 California Energy Code	CEC
g.	California Occupational Safety Health Act	OSHA
h.	California Code of Regulations	CCR
i.	Local Codes, Ordinances, and Amendments.	

2. Standards:

a.	Air Conditioning, Heating, and Refrigeration Institute	AHRI
b.	Air Diffusion Council	ADC
c.	Air Movement and Control Association, Inc.	AMCA
d.	American Bearing Manufacturers Association	ABMA
e.	American National Standards Institute	ANSI
f.	American Society of Heating, Refrigeration, and Air Conditioning Engineers	ASHRAE
g.	American Society of Mechanical Engineers	ASME
h.	American Society of Plumbing Engineers	ASPE
i.	American Society of Testing and Materials	ASTM
j.	American Water Works Association	AWWA
k.	American Welding Society	AWS
l.	Associated Air Balance Council	AABC
m.	Factory Mutual	FM
n.	International Association of Plumbing and Mechanical Officials	IAPMO

o.	Institute of Boiler and Radiator Manufacturers	IBR
p.	Manufacturer's Standardization Society of the Valves and Fittings Industry	MSS
q.	National Electrical Manufacturers Association	NEMA
r.	National Electrical Testing Association	NETA
s.	National Environmental Balancing Bureau	NEBB
t.	National Fire Protection Association	NFPA
u.	Plumbing and Piping Industry Council	PPIC
v.	Sheet Metal and Air Conditioning Contractors National Association, Inc.	SMACNA
w.	Underwriters' Laboratories	UL

3. Regulations:

a.	California State Fire Marshal	CSFM
b.	California State Department of Public Health	CSDPH
c.	Safety Orders of Division of Industrial Safety	SODIS

4. Where standards of Drawings and Specifications for materials and/or workmanship are higher than those of applicable rules, Drawings and Specifications shall take precedence; otherwise the rules shall govern.
5. Nothing in these Drawings or Specifications is to be interpreted as permitting work not conforming to the rules.
6. Should there be any direct conflict between the rules and the Specifications, the rules shall govern.
7. Charges for all materials and labor required for the compliance with rules and regulations shall be included in the Contract Price.

B. Certifications: Provide proof of code compliance for equipment as follows:

1. Electrical Equipment and Safety Devices: Per applicable standards of NEC; UL listed or classified.
2. Pressure Vessels and Pressure Safety Devices: Per applicable standards and bear label of ASME.
3. Energy Conservation: Comply with applicable codes. Provide equipment and materials certified by manufacturer per California energy code as applicable.
4. Equipment: Provide UL listed or classified equipment where required by code officials. Verify such requirements.

C. Repair or replace, to the satisfaction of the Owner, any damage to Work of this Section and damage caused by Work of this Section.

D. Workmanship shall be first class throughout and performed only by competent and experienced workmen in a manner satisfactory to the Owner. Constant supervision of the Work, either by the Contractor or his competent representative, shall be maintained.

E. Work shall be installed so as not to delay the progress of construction and shall be properly coordinated with other trades.

F. Use only new materials in perfect condition. Inspect all materials upon arrival at job site and immediately remove defective items from site.

1.05 DEFINITIONS

A. "Piping" includes, in addition to pipe, all fittings, flanges, valves, hangers and other accessories related to such piping.

B. "Wiring" includes in addition to conductors, all raceway, conduit, fittings, boxes, switches, hangers and other accessories related to such wiring.

C. "Concealed" means hidden from sight in chases, furred spaces, shafts, hung ceilings or embedded in construction.

D. "Exposed" means not installed underground or "concealed" as defined above.

E. "Provide" means to furnish and install.

1.06 SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

B. General:

1. Comply with the requirements of Article 3.11 of the General Conditions and the specific requirements of the Sections of Division 23.
2. Submit all similar equipment together as part of the same submittal. For example:
    a. All pumps shall be contained in the same submittal.
    b. All chillers shall be contained in the same submittal.
    c. Etc.
3. Contractor shall review all submittals prepared by each supplier and mark all copies as acceptable to the Contractor. This acceptance shall signify that all required service connections are shown and in the proper location to meet the installation requirements and that the equipment can fit in the space allowed.
4. Do not order equipment until submittals have been reviewed and approved by the Architect/Engineer.
5. Each item submitted shall be labeled or identified the same as on the Drawings.
6. Mark submittal "Exactly as Specified" or accompanied by a letter from the supplier explaining in detail what difference, if any, exists between the submitted item and the specified item. Failure to point out the differences will be considered cause for disapproval. The Architect/Engineer will not assume any responsibility for differences concealed or otherwise not brought to their attention, and the Contractor will be required to correct any deficiencies or differences discovered at a later date, and assume responsibility for any delays, damage, and/or expenses incurred by others due to such action.
7. Brands or trade names are mentioned to set standards of quality only; use no substitute materials, however, unless approved in writing by the Architect/Engineer. Approval of substitute materials does not relieve the Contractor of responsibility for providing a workable and functioning system as specified.
8. Submittals will be checked for general conformance with the design concept but acceptance by the Architect/Engineer in no manner is meant to verify that dimensions, quantities, or location of services are as necessary to meet the job requirements. This remains the responsibility of the Contractor.

C. Shop Drawings:

1. General: Prepare and submit plans, sections, details and diagrams to required scales for specified areas. Drawings shall be coordinated, dimensioned and indicate equipment, pipe, fire protection, and electrical in relation to architectural and structural

features. Include Minor piping, drains, air vents, etc. Indicate exact locations and elevations of valves, piping specialties, access doors, dampers etc.

2. Required Drawings: Prepare and submit drawings for all areas and all mechanical work, unless specifically excluded below under Deviation Drawings. Scale shall be minimum 3/8" = 1'-0" (1:30) in mechanical rooms, fan rooms, and mechanical areas, and minimum 1/4" = 1'-0" (1:50) elsewhere.

D. Product Data:

1. General: Manufacturer's specifications, data sheets, certified drawings, and installation instructions. Include physical and performance data such as weights, sizes, capacities, required clearances, performance curves, acoustical characteristics, finishes, color selection, location and size of field connections, and accessories. Include certified drawings on major equipment such as boilers, water chillers, cooling towers, air handling units, controls, pumps, and tanks.
2. Motors: Submit manufacturer's name, type, RPM, HP (KW), full load amps, efficiency, and power factor.
3. Part Load Performance: Submit equipment data to indicate performance characteristics throughout ranges of possible load conditions.
4. Include operating weight and location of center of gravity of each item of equipment in manufacturer's cut sheet for purposes of seismic calculation.

E. Test Reports:

1. Manufacturer's Tests:
    a. Factory Tests: As specified for specific equipment.
    b. Field Tests: As specified.
2. System Pressure Tests: As specified under Paragraph Testing. Test log of pressure tests on each system. Indicate date of test, scope of test, test pressure, duration, and observers.
3. Balancing Reports: As specified under Section "Testing, Adjusting and Balancing".

F. Operating and Maintenance Manuals: Include, but not limited to, the following:

1. List of all equipment with Manufacturer's name, model number, and local representative, service facilities and normal channel of supply for each item. Include phone number and address of service facilities
2. System Description: Description of start-up, operating, and shutdown procedures.
3. Controls: Diagrams and description of operation sequence of each system.
4. Equipment: Manufacturer's brochures, ratings, certified shop drawings, lubrication charts and data, parts lists with part numbers, and belt and sheave data. Mark each sheet with equipment identification number and actual installed condition.
5. Materials and Accessories: Manufacturer's brochures parts lists with part numbers and lubrication data where applicable. Mark each sheet with equipment identification number or system and location of installation; and to specifically identify which options are provided (in case where data sheet shows multiple options).
6. Certificate of factory tests, field tests and code compliance as specified.
7. Wiring and controls schematics.
8. Trouble shooting directions.
9. Maintenance procedures and frequencies.

10. Description of special tools.
11. Copies of warranties.
12. Safety precautions.
13. Emergency contingencies.

G. Record Documents:

1. Comply with the requirements of Division 01 and Section 23 05 53, "Identification for HVAC."
2. Indicate mains and branches of piping systems, with valves and control devices located and numbered per valve schedule, concealed unions located, and with items requiring maintenance located (i.e. traps, strainers, expansion compensators, vents, etc.). Indicate actual inverts and horizontal locations of underground piping.
3. Indicate equipment locations (exposed and concealed), dimensioned from prominent building lines.
4. Identify approved substitutions, Contract Modifications, and actual equipment and materials installed.

1.07 SUBSTITUTIONS

A. General:

1. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.
2. Base manufacturer is indicated in equipment schedules.
3. In Specification, additional acceptable manufacturer(s) may be indicated.
4. Other manufacturers, materials, or methods shall not be used unless approved in writing by the Architect/Engineer.
5. The burden of proof as to the equality of any proposed substitute manufacturer, material, or method shall be upon the Contractor.
6. The Architect's/Engineer's decision shall be final.

B. Requests for substitution review and acceptance shall be accomplished by table of comparison listing pertinent features of both specified and proposed materials, such as materials of construction, performance, dimensions, weights, replacement or maintenance access, motor type, horsepower, voltage, phase, service factor. Review of proposed substitutions will not be made until receipt of satisfactory comparison tabulation.

C. Submittal of substitutions shall be limited to one proposal for each type or kind of item, unless otherwise permitted by Architect. If first proposed product submittal is rejected, Contractor shall then submit the first-named or scheduled product.

D. Contractor shall be responsible for all costs and coordination due to the substitution, such as impacts on electrical requirements, weight, openings in slabs and roofs, structural framing, housekeeping pad size, etc.

1.08 JOB CONDITIONS

A. Cause as little interference or interruption of existing utilities and services as possible. Schedule Work which will cause interference or interruption in advance with Construction Manager.

B. Examine Contract Documents to determine how other Work will affect execution of mechanical Work.

C. Establish lines and levels for each system and coordinate with other systems to prevent conflicts and maintain proper clearances and accessibility.

1.09 PRODUCTS, STORAGE AND HANDLING

A. Conform to the requirements specified in Division 01 Specification Sections.

B. Protect all equipment and materials from weather and dust.

C. Pipe: Cap openings against entry by foreign matter.

1.10 WARRANTY

A. Conform to the requirements of General Conditions and Division 01 Specification Sections.

PART 2 - PRODUCTS

2.01 GENERAL

A. Materials for mechanical work: Use only prime quality, new materials, apparatus and equipment.

2.02 MATERIALS AND EQUIPMENT

A. General:

1. Standard products of manufacturer specified.
2. Where more than one piece of equipment is required on any item, furnish by the same manufacturer, except where specified otherwise.
3. Install same manufacturer, except as otherwise specified.
4. Install materials and equipment in accordance with manufacturer's instructions.

B. Deliver materials or equipment to site in the manufacturer's original unopened, labeled containers and adequately protect against moisture, tampering or damage from improper handling or storage. Do not deliver to site before items are ready for installation, unless adequate security is provided.

C. Factory Applied Finishes: Repair and/or refinish work damaged by the Work of this Division, to the Architect's/Engineer's satisfaction. Obtain finishing materials from equipment manufacturer.

D. Comply with the requirements for substitutions specified elsewhere in this Section.

2.03 MANUFACTURERS

A. Qualifications: Firms regularly engaged in manufacture of products specified, of types and capacities required, whose products have been in satisfactory use in similar service for not less than 5 years, unless otherwise specified.

B. Subject to compliance with requirements specified, provide material or product from one of the manufacturers listed for each item.

PART 3 - EXECUTION

3.01 GENERAL

A. When changes in location of any Work are required, obtain approval of Architect/Engineer before making change.

B. Do not change indicated sizes without approval of Architect/Engineer.

C. Provide all necessary offsets and crossovers in piping, whether indicated or not.

D. Install piping parallel to walls and vertically plumb.

E. Examine areas and conditions under which mechanical system materials and products are to be installed. Do not proceed with work until unsatisfactory conditions have been corrected in manner acceptable to installer.

F. Provide safety sign for each piece of exposed mechanical equipment that may start automatically.

3.02 EXCAVATING, TRENCHING, AND BACKFILLING

A. General: Lay pipe to required lines and grades. Place fittings and valves at required locations and with joints centered, spigots home, and valve stems plumb.

1. Subsurface Explorations: Whenever necessary to determine location of existing underground utility structures, examine available records and make explorations and excavations necessary to determine utility locations. Cost of such explorations and excavations shall be included in the base bid.

2. Obstructions Caused by Other Utility Structures: Where grades or alignment of pipe is obstructed by existing utility structures such as conduits, pipes, branch connections to main sewers, or main drains, permanently support, relocate, remove, or reconstruct obstruction.

3. Protecting Underground and Surface Structures: Provide temporary support and adequate protection and maintenance of underground and surface utility structures, drains, sewers, and other obstructions encountered in progress of the Work. Protect poles, fences, trees, and other property unless their removal is authorized. Satisfactorily restore any property damaged.

4. Deviations: Make no deviation from required line or grade without written permission.

B. Comply with the requirements of Division 02 Specifications for excavation and backfilling Work.

3.03 CUTTING AND PATCHING

A. Locate openings and sleeves to permit neat installation of piping, and equipment.

3.04 CONSTRUCTION WASTE MANAGEMENT AND DISPOSAL

A. Manage construction waste produced by Work of this Section in accordance with provisions of Division 01 Specifications.

3.05 INSTALLATION OF EQUIPMENT AND DEVICES

A. Install all equipment in accord with manufacturer's recommendations and in accordance with the equipment's listing (if applicable).

B. Access:

1. Install all equipment and devices to permit easy access for maintenance.

2. Maintain easy access to all equipment and devices installed as part of Division-23 Work, including but not limited to, motors, drives, valves, and actuators.

3. Proper access shall include:

a. Valves may be operated.

b. Control devices may be adjusted.

c. Equipment access panels may be fully opened.

d. Normal maintenance work such as replacement of filters, lubrication of bearings, etc., may be performed readily within arm's reach of access opening.

4. Relocate items which interfere with access.

C. Provide all necessary anchoring devices and supports.

1. Use structural supports suitable for equipment, or as indicated.

2. Check loadings and dimensions of equipment with Shop Drawings.

3. Do not cut or weld to building structural members, unless specifically indicated.

4. Provide all required equipment supports, including those not detailed on architectural and mechanical Drawings.

5. Comply with Section 23 05 29, "Hangers and Supports for HVAC."

D. Verify that equipment will fit support layouts indicated.

1. Where substitute equipment is used, revise indicated supports to fit, at no additional cost to the Owner.

E. Coordinate size and location of roof penetrations, floor penetrations, and wall openings with Work of other Sections.

F. Install grade-mounted and floor mounted equipment on 6-inch (150 mm) high concrete pad, 6-inches (150 mm) larger on each side than base of unit, unless otherwise specified, indicated, or equipment manufacturer's recommendation calls for. Coordinate size and location of equipment pads and curbs with Work of other Sections.

G. In Mechanical Areas, coordinate with Plumbing Work such that locations of floor drains, floor sinks, etc. are coordinated with locations of equipment and housekeeping pads. Locate drains to properly serve equipment and to result in orderly routing of drain piping, while minimizing tripping hazards, etc.

3.06 INSTALLATION OF EQUIPMENT FURNISHED BY OWNER OR OTHER DIVISION

A. Provide rough-in and final connections to all equipment requiring mechanical services.

B. Install all fittings, valves, and other items furnished as integral part of equipment, but shipped loose.

3.07 FIELD QUALITY CONTROL

A. Perform indicated tests to demonstrate workmanship, operation, and performance.

1. Conduct tests in presence of inspectors of agencies having jurisdiction, if required.

2. Furnish all lubricating materials required for test.

B. Repair or replace equipment and systems found inoperative or defective and re-test.

1. If equipment or system fails re-test, replace it with products which conform to Contract Documents.

2. Continue remedial measures and re-tests until satisfactory results are obtained.

3.08 TESTING

A. General: Provide labor and test equipment including test pumps, gages, instruments and other equipment required. Use test quality pressure gages, instruments and other equipment required. Use test quality pressure gages with range of approximately twice test pressure. Use calibrated gages and instruments.

B. Piping:

1. General: Remove from systems, during testing, equipment which would be damaged by test pressure. Replace removed equipment after testing. Systems may be tested in sections as work progresses; however, any previously tested portion shall become a part of any later test of composite system.
2. Correct leaks by remaking joints with new material; makeshift remedies will not be permitted. Test time accrues only while full test pressure is on system. Test before backfilling, concealing, insulating or making connections to potable water system.
3. Test Schedule: Test each section of systems at one and one-half (1-1/2) times the maximum working pressure of that section, but at not less than scheduled test pressure. Obtain maximum working pressures from Architect if not indicated on Drawings. Unless indicated otherwise, scheduled tolerance is "no pressure loss", except that due to temperature change, in 24 hour period.

TEST SCHEDULE

System	Test Medium	Test Pressure	Tolerance
Chilled Water	Water	150 psig (1040 kPa)	
Chemical Feed	Water	150 psig (1040 kPa)	

C. Valves:
1. General Service Valves: Test bonnets for tightness. Test operate from closed-to-open-to-closed position while under test pressure.
2. Automatic Valves: Test, including solenoid valves, water regulating valves, pressure reducing valves, pressure relief valves, safety valves and temperature and pressure relief valves for proper operation at settings indicated.
3. Safety Valves: Test relief valves, safety relief valves, safety valves and temperature and pressure relief valves 3 times.

D. Piping Specialties: Test thermometers, pressure gages, flow measuring devices, and water meters for accurate indication; automatic water feeders, air vents, vacuum breakers, and other specialties for proper performance.

E. Hangers and Supports: With systems in normal operation, test hangers, supports and rods to insure they are plumb and supporting proper share of load. Additionally support systems and equipment that sway, crawl, or vibrate.

F. Water Chillers: Test proper operation of control functions including operating thermostats, low-limits, capacity control, and electrical interlock with auxiliary equipment.

G. Buried Pipe and Equipment Wrapping and Coating: Test surfaces with standard 8,000 to 10,000 volt electrical holiday detector.

H. Other Materials and Equipment:
1. Rotation: Verify.
2. Motor Amperage: Verify operating motor amperage does not exceed motor nameplate rating.
3. Pump Shut-Off Discharge Head: Verify actual head corresponds to submittal data.
4. Test as specified: As recommended by equipment manufacturer; and as otherwise necessary or directed to assure they are complete, operable, and ready for use.

I. Testing and Demonstration:

1. Testing by Contractor:

   a. Test entire system, including each function and point thereof, for proper operation. Conducted by installer and equipment manufacturer.

   b. Conduct preliminary tests to check installation for defects. Conduct final tests to cover total systems throughout building after work is completed.

   c. Tests shall prove continuity and proper operation in all aspects of entire installation. Tests shall conform to local code requirements, if any.

   d. At Owner's option, allow Owner or Owner's representatives to witness all or a portion of the testing.

   e. At completion of field testing, certify in writing that Work is complete and that control system is operational, including calibration of instrumentation and sequences prior to functional testing and integrated testing phases of commissioning.

2. Demonstration:

   a. At completion of field testing, demonstrate the system, including controls, to the Owner's representatives.

   b. Give 14 days notice in writing before the demonstration.

   c. Just prior to demonstration, at the job site, demonstrate the simulation methods, test gear, and equipment to be used in the demonstration.

   d. At time of demonstration:

      i. Provide adequate number of technicians thoroughly familiar with systems to be tested to manage test procedures and assignments.

      ii. Provide instruments, tools and equipment for verification and adjustment, including adequate number of portable 2-way radio communication equipment.

   e. If the demonstrations do not successfully show compliance with specified and correct performance, then at Owner's option the demonstration may be halted and rescheduled until contractor corrects and retests the system.

3.09 ADJUSTING AND CLEANING

A. Inspect all equipment and put in good working order.

B. Clean all exposed and concealed items.

   1. Clean air surfaces of all coils, fans (including fan wheels and motors), air handler plenums and air filter frames.

   2. Clean specialties such as traps and strainers.

C. Equipment and Materials: Remove foreign materials including dirt, grease, splashed paint, and plaster, etc. Restore damaged finishes to original condition.

D. Piping: Flush clean interior of water piping. Upon completion of flushing, completely drain systems at low points; remove, clean, and replace strainer baskets and refill systems.

E. Chilled Water System: After specified flushing, draining, and refilling, cleanse system with one pound (0.45 kg) of trisodium phosphate (TSP) for each 60 gallons (227 liters) of water in system. Circulate water for 24 hours with all pumps running. Upon completion of process, completely drain system at all low points; remove, clean, replace strainer baskets, refill system, and immediately add chemical treatment.

F. Adjusting: Adjust equipment and system components as indicated or as otherwise required to result in intended system operation. Thereafter, as a result of system operation, or as directed, make readjustments as necessary to refine performance and to effect complete system tune-up.

3.10 SPECIAL TOOLS

A. Furnish to Owner not later than when Owner takes possession of equipment.

B. Definition of Special Tools: Identified in or otherwise implied by, the manufacturer's operation and maintenance manuals for the furnished equipment, or which are otherwise required for the operation, with the manufacturer's recommended procedures for operation, adjustment and maintenance. Special tools do not include those required for major repairs normally done by factory trained or otherwise specialized service personnel, nor do they include those normally found in the possession of Owner's on site maintenance personnel.

3.11 MANUFACTURER'S START-UP ASSISTANCE

A. Where the services of a factory authorized service representative are specified for the start-up of certain pieces of equipment, arrange to have the manufacturer of such equipment perform start-up and check-out service. Manufacturer shall provide a letter which shall be on the manufacturer's letterhead, shall list the equipment, shall certify that the equipment has been examined, that it has been installed in accordance with the manufacturer's installation instructions, started up, adjusted, and checked out in accordance with the manufacturer's instructions, and is operating properly. The letter shall be addressed to the Owner and shall be signed by an authorized representative of the manufacturer.

3.12 PUTTING SYSTEMS IN OPERATION - START UP

A. Prior to final acceptance, at time agreed to by Owner and Architect, put all systems into satisfactory operation.

B. At first cooling season following final acceptance, start up systems not started due to lack of seasonal design load or operation of the central system.

C. Operate all systems in good working order for period of fourteen (14) working days.

D. Perform services in accordance with manufacturer's written start-up instructions. Test control and demonstrate compliance with requirements. Replace damaged or malfunctioning controls and equipment.

E. Maintenance and Operation Training:

1. As a part of the maintenance and operating instructions, review data in operating and maintenance manual, including preventative maintenance schedule and procedures, and procedures for obtaining repair parts and technical assistance. Demonstrate all phases of operation including start-up and shut-down.

2. Schedule training with Owner, provide at least seven (7)-day notice to Architect/Engineer.

END OF SECTION 23 00 10

SECTION 23 05 00

COMMON WORK RESULTS FOR HVAC

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

B. Comply with the requirements of Section 23 00 10, "Basic HVAC Requirements."

1.02 SUMMARY

A. This Section describes basic materials and methods applicable to other Division 23 Sections.

1.03 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

PART 2 - PRODUCTS

2.01 MOTORS

A. Motor controls and power wiring:

1. Provided as part of Division 26 Work, unless indicated otherwise, including motor control switches, starters, disconnects, conduit and wiring, except for low voltage control wiring required for temperature controls.
2. Where equipment is specified with factory pre-wired controls and is furnished instead with components shipped loose, mechanical contractor shall be responsible for coordinating the complete installation and assume any additional costs.

B. Motors:

1. Ball or roller bearing type, with starting and running characteristics consistent with torque and speed requirements of driven machine.
2. Use motors rated in accord with NEMA performance standards to carry full nameplate load continuously at maximum temperature rise of 72 deg F (40 deg C) above ambient with service factor of 1.15.
3. Inverter Ready and meet requirements of NEMA MG-1 part 31.
4. Where substitute manufacturers are provided with different control panels, starters, or electrical characteristics from scheduled equipment, contractor shall coordinate complete installation and assume any additional costs.
5. Do not allow power requirements of driven machine to exceed nominal nameplate rating of motor furnished.
6. Do not include service factor when selecting motor horsepower.
7. Motors exposed to moisture or rain shall be totally enclosed, fan cooled (TEFC).
8. Motor electrical power characteristics: 460 volt, 3 phase, 60 Hz for 1/2 hp and larger; 115 volt, 1 phase, 60 Hz for smaller than 1/2 hp, unless noted otherwise.
9. Efficiency:

a. Requirements apply to all motors, 1/2 hp and larger, except for refrigeration compressors, and for fans which run only in fire/smoke mode.

b. Ratings in accordance with IEEE 112b Rating Method.

c. Motor full-load efficiencies shall meet the requirements of the local energy code, and/or the following, whichever is more stringent:

i. Motors shall be labeled as NEMA "Premium" Efficient, with efficiencies as follows, based on 1750 RPM.;

	% Efficiency	
HP	ODP	TEFC
1/2	80.5	78.5
3/4	82.5	80.0
1	85.5	85.5
1-1/2	86.5	86.5
2	86.5	86.5
3	89.5	89.5
5	89.5	89.5
7-1/2	91.0	91.7
10	91.7	91.7
15	93.0	92.4

2.02 VARIABLE FREQUENCY DRIVES (VFD's)

A. Manufacturers: Asea Brown Boveri, Danfoss, Reliance, York, Toshiba, Yaskawa, Square D, or approved equal. Service facility to include inventory of spare parts and trained personnel for start up, adjustment and repair.

B. General:

1. Provide VFD for each pump. VFD shall serve as starter.

a. Upon starting, VFD shall start at low speed and ramp up to setpoint speed in 10 seconds (adjustable).

2. VFD shall convert 460 volt, plus or minus 10%, 3-phase, 60 hertz utility power to adjustable voltage/ frequency, 3-phase, A-C power for stepless motor control from 5% to 105% of base speed.

3. Receive external start/stop signal from respective chiller. (Wiring and connection by Section 23 09 00.)

4. VFD shall have manual adjustment of output frequency and motor speed. Output speed will be set by TAB Balancer; coordinate with Section 23 05 93.

5. Pulse width modulated type.

6. UL listed per UL-508C. Comply with applicable standards of ANSI, NEC, and IEEE-519.

7. Warranty: Provide 24-month warranty from date of start-up. Warranty shall include parts, labor, travel time, and all related expenses.

8. Provide full speed bypass with manual selector switch.

9. Provide Operating and Maintenance Manuals as specified in Section 23 00 10.

10. Motor noise as a result of the VFD shall be limited to 3 dBA above across-the-line operation noise, measured 3-feet (1m) from the motor centerline, for any speed from 5% tro 105% of rated full speed.

C. Ratings:

1. VFD Efficiency: Not less than 95% at full motor speed nor 87% at 60% motor speed.
2. Power Factor: For VFD and motor together, not less than 0.97 at full speed and not less than 0.80 at 50% motor speed.
3. Minimum/Maximum Adjustable Speed: Factory set at 15/60 Hz. respectively.
4. Ambient Temperature: 32 to 122 deg F (0 to 50 deg C).

D. Harmonic Distortion:

1. Total harmonic distortion (THD) caused by VFD's shall be less than 5%. Provide input line filters, if required, to ensure compliance with IEEE Standard 519-latest edition, "Guide for Harmonic Control and Reactive Compensation for Static Power Converters".

E. Safety Features:

1. Output Current Limit: 110% of inverter rating.
2. Output Over Current Trip: Within 50 micro-seconds.
3. Input Under Voltage Trip: 15% below rated input voltage.
4. Input Over Voltage Trip: 1,000 volts DC in DC bus.
5. Over Temperature Trip: In excess of VFD rating.
6. Phase loss protection.
7. DC bus undervoltage protection.
8. DC bus overvoltage protection.
9. Power semiconductor protection.
10. Ground fault protection.

F. Automatic Reset/Restart:

1. Safety trip automatic reset and restart upon termination of cause of trip.
2. Output Over Current Trip: Maximum five restart attempts, after which manual reset required.
3. Auto restart upon resumption of power after power outage.
4. Other Trips: Unlimited number of restart attempts.

G. Enclosure:

1. NEMA 3R for exposed outdoor installation.
2. Controls on Cover Panel:
    a. Bypass switch marked "Bypass Line Voltage" and "Automatic".
    b. Speed control potentiometer marked 0 to 100% in 5% increments.
    c. Automatic reset/restart.
    d. Electrical disconnect switch.
3. Indications on Cover Panel:
    a. Speed indicating meter.
    b. LED's:
        i. Power on.
        ii. Automatic operation.

iii. Line voltage bypass operation.

iv. Each safety trip, separately.

H. Required Tests:

1. Field test each VFD according to NETA's "Inspection and Test Procedures for Adjustable Speed Drive Systems" in Acceptance Testing Specifications – latest edition.

2. Test bypass (line voltage) operation.

I. Provide factory-trained start-up for each VFD.

PART 3 - EXECUTION - NOT USED

END OF SECTION 23 05 00

SECTION 23 05 29

HANGERS AND SUPPORTS FOR HVAC

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 SUMMARY

A. Work Included in this Section:

1. Supports for piping and equipment.
2. Seismic restraints.
3. Other Work as indicated.

B. Work Specified Elsewhere:

1. Basic requirements for mechanical work are specified in Section 23 00 10, "Basic HVAC Requirements."
2. Flexible pipe connectors are specified in Section 23 20 00, "HVAC Piping and Pumps."

1.03 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of supports and anchors, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 5 years.

B. Codes and Standards:

1. Code Compliance: Comply with applicable codes pertaining to product materials and installation of supports and anchors.
2. UL and FM Compliance: Provide products which are UL-listed and FM approved.
3. MSS Standard Compliance:
    a. Provide pipe hangers and supports of which materials, design, and manufacture comply with MSS SP-58. Select and apply pipe hangers and supports, complying with MSS SP-69.
    b. Fabricate and install pipe hangers and supports, complying with MSS SP-89.
    c. Terminology used in this section is defined in MSS SP-90.
4. SMACNA:
    a. Seismic Restraint Manual Guidelines for Mechanical Systems - latest edition.
    b. Standards for duct supports.

C. Corrosion Resistance: Provide hot-dip galvanized steel, cadmium plating, or other approved corrosion resistant materials for exterior work and for work which will be subject to outdoor exposure during construction.

D. Coordination:

1. Coordinate resiliently supported work with other trades to avoid rigid contact with the building. Inform other trades such as drywall, plastering, or electrical, to avoid any contact which would reduce the vibration isolation.

E. Conflicts and Discrepancies:

1. Bring to the Architect's attention prior to installation any conflicts with other trades which will result in unavoidable contact to equipment, piping, etc., described herein, due to inadequate space, etc. Corrective work necessitated by conflicts after installation shall be at Contractor's expense.

2. Bring to the Architect's attention prior to installation any discrepancies between the Specifications and field conditions, changes required due to specific equipment selection, etc., prior to installation. Corrective work necessitated by discrepancies after installation shall be at Contractor's expense.

1.04 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

1.05 SEISMIC RESTRAINTS

A. Provide supports, attachments, and seismic restraints designed and installed in compliance with the requirements defined in applicable Codes and Standards, including the following:

1. California Building Code, Chapters 16 and 17.

2. California Mechanical Code, Section 304.

B. Provide seismic restraints for the following mechanical equipment and systems, as required by Code, unless specifically exempted in the Codes:

1. Mechanical equipment and associated piping.

2. Piping.

3. Control Panels.

4. Tanks and vessels, including content.

C. Do not degrade the following by seismic provisions:

1. Insulation vapor barrier on chilled water piping.

2. Thermal expansion / contraction compensation.

1.06 SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

B. Support and Bracing Shop Drawings: Submit plans, sections, details, and other information necessary to describe supports, hangers and seismic bracing for all mechanical systems, equipment, and piping. Submittal shall indicate location and type of all hangers, supports and seismic bracing.

1.07 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

PART 2 - PRODUCTS

2.01 HORIZONTAL PIPING HANGERS AND SUPPORTS

A. General:

1. Except as otherwise indicated, provide factory-fabricated horizontal piping hangers and supports complying with MSS SP-58, of one of the following MSS types listed,

selected by Installer to suit horizontal-piping systems, in accordance with MSS SP-69 and manufacturer's published product information.

2. Use only one type by one manufacturer for each piping service.
3. Select size of hangers and supports to exactly fit pipe size for bare piping, and to exactly fit around piping insulation with saddle or shield for insulated piping.

B. Adjustable Steel Clevises Hangers: MSS Type 1.

C. Yoke Type Pipe Clamps: MSS Type 2.

D. Steel Double Bolt Pipe Clamps: MSS Type 3.

E. Steel Pipe Clamps: MSS Type 4.

F. Pipe Hangers: MSS Type 5.

G. Adjustable Swivel Pipe Rings: MSS Type 6.

H. Adjustable Steel Band Hangers: MSS Type 7.

I. Adjustable Band Hangers: MSS Type 9.

J. Adjustable Swivel Rings, Band Type: MSS Type 10.

K. Split Pipe Rings: MSS Type 11.

L. Extension Split Pipe Clamps: MSS Type 12.

M. U-Bolts: MSS Type 24.

N. Clips: MSS Type 26.

O. Pipe Slides and Slide Plates: MSS Type 35, including one of the following plate types:

1. Plate: Unguided type.
2. Plate: Guided type.
3. Plate: Hold-down clamp type.

P. Pipe Saddle Supports: MSS Type 36, including steel pipe base-support and cast-iron floor flange.

Q. Pipe Stanchion Saddles: MSS Type 37, including steel pipe base support and cast-iron floor flange.

R. Adjustable Pipe Saddle Supports: MSS Type 38, including steel pipe base support and cast-iron floor flange.

S. Single Pipe Rolls: MSS Type 41.

T. Adjustable Roller Hangers: MSS Type 43.

U. Pipe Roll Stands: MSS Type 44.

V. Pipe Rolls and Plates: MSS Type 45.

W. Adjustable Pipe Roll Stands: MSS Type 46.

2.02 VERTICAL PIPING CLAMPS

A. General: Except as otherwise indicated, provide factory-fabricated vertical piping clamps complying with MSS SP-58, of one of the following types listed, selected by Installer to suit vertical piping systems, in accordance with MSS SP-69 and manufacturer's published product information. Select size of vertical piping clamps to exactly fit pipe size of bare pipe. Provide felt-lined or copper-plated clamps for copper-piping systems.

B. Two-Bolt Riser Clamps: MSS Type 8.

C. Four-Bolt Riser Clamps: MSS Type 42.

2.03 HANGER-ROD ATTACHMENTS

A. General: Except as otherwise indicated, provide factory-fabricated hanger-rod attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit horizontal-piping hangers and building attachments, in accordance with MSS SP-69 and manufacturer's published product information. Use only one type by one manufacturer for each piping service. Select size of hanger-rod attachments to suit hanger rods.

B. Steel Turnbuckles: MSS Type 13.

C. Steel Clevises: MSS Type 14.

D. Swivel Turnbuckles: MSS Type 15.

E. Malleable Iron Sockets: MSS Type 16.

F. Steel Weldless Eye Nuts: MSS Type 17.

2.04 ATTACHMENTS

A. General: Except as otherwise indicated, provide factory-fabricated attachments complying with MSS SP-58, of one of the following MSS types listed, selected by Installer to suit building substrate conditions, in accordance with MSS SP-69 and manufacturer's published product information. Select size of attachments to suit hanger rods. Powder-actuated fastening systems are not acceptable.

B. Attachments to Concrete:

1. Poured-in-Place Concrete Inserts: MSS Type 18.
2. Concrete Wedge Anchors:
    a. Tested and qualified for performance in cracked concrete per ACI 355.2 and ICC-ES AC 193.
    b. Steel threaded stud with an integral cone expander and a three-segment expansion clip. The stud shall be manufactured from carbon steel and the expansion clip shall have two undercutting embossments per segment and be manufactured from either high strength steel alloy or 316 stainless steel.
    c. Similar to Simpson "Strong Bolt 2" or approved equal.
    d. Install per manufacturer's instructions.
3. Concrete Screw Anchors:
    a. Tested in accordance with ASTM E 488 for the effects of fatigue, and tested and qualified for performance in cracked concrete per ACI 355.2 and ICC-ES AC 193.
    b. 360-degree contact with the base material shall not require oversized holes for installation. Fasteners shall be manufactured from carbon steel, and heat-treated. Anchors shall be zinc plated in accordance with ASTM B 633 or mechanically galvanized in accordance with ASTM B 695.
    c. Similar to Simpson "Titen HD" or approved equal.
    d. Install per manufacturer's instructions. Anchors shall not be reused after initial installation.

C. Powder-driven concrete inserts: Not allowed.

2.05 INSULATED PIPE SUPPORTS (PIPE SHIELDS)

A. All insulated lines shall be protected at the point of support by insulated pipe supports provided and installed by the pipe erector.

B. All insulated pipe supports shall be load rated. Load ratings shall be established by pipe support manufacturer based upon testing and analysis in conformance with the latest edition of the following codes:

C. ASME B31.1, MSS SP-58, MSS SP-69, and MSS SP-89.

D. Manufacturer: Pipe Shields Incorporated (PSI), Michigan, or B-Line. Model numbers listed are those of PSI.

E. Approved Insulated Pipe Supports:

1. Pipe supported on rod hangers: PSI Model A-Series and D-Series.
2. Pipe supported on Flat Surfaces: PSI Model A-Series and B-Series.
3. Pipe supported on pipe rolls: Use Models A3000, A4000, A5000, A6000, A8000, A8200 and A8400.
4. Pipe Guides: Use Model B-3000 and/or B7000 Series.
5. Anchors: Use Model C4000 Series.
6. Riser Pipe Supports: Use Model E1000 Series.

F. Insulation:

1. 360° insulation, encased in 360° sheet metal shield.
2. Provide assembly of same thickness as adjoining pipe insulation.
3. Insulating Material:
   a. Chilled Water Piping: Urethane foam; 100 psi (690 kPa) compressive strength.

2.06 MANUFACTURERS OF HANGERS AND SUPPORTS

A. Manufacturer: Subject to compliance with requirements, provide hangers and supports of one of the following:

1. B-Line Systems, Inc.
2. Elcen Metal Products Co.
3. Fee & Mason Mfg. Co.; Div. Figgie International ITT Grinnel Corp.
4. Superstrut.
5. Tolco.

2.07 MISCELLANEOUS MATERIALS

A. Auxiliary Steel:

1. Provide auxiliary structural steel as required for supports, anchors, guides, seismic restraints and vibration isolators.
2. All structural steel systems to be designed in accordance with AISC Steel Handbook.
3. Comply with NEMA Std.ML-1.
4. All systems to be secured to building structure in a method acceptable to and approved by the Project Structural Engineer.
5. Steel Work: Fabricate neatly. Grind off excess burrs and welding spatter. Paint with rust inhibitive primer.

B. Steel Plates, Shapes and Bars: Provide products complying with ASTM A 36.

C. Cement Grout: Portland cement, ASTM C 150, Type I; and clean, natural sand, ASTM C 404, Size No. 2. Mix at ratio of 1 part cement to 2-1/2 parts sand, by volume, with minimum water required for placement and hydration.

D. Steel Trapezes: Fabricate from steel shapes selected for loads required; weld steel in accordance with AWS standards.

PART 3 - EXECUTION

3.01 GENERAL

A. Install devices in accordance with manufacturer's recommendations.

B. Examine areas and conditions under which supports and anchors are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 PREPARATION

A. Prior to installation of hangers, supports, anchors and associated Work, Installer shall meet at Project site with Contractor, installer of each component of associated Work, inspection and testing agency representatives (if any), installers of other Work requiring coordination with Work of this Section and Architect/Engineer for purpose of reviewing material selections and procedures to be followed in performing the Work in compliance with requirements specified.

3.03 INSTALLATION OF ATTACHMENTS

A. Install attachments at required locations within concrete or on structural steel for proper piping support. Space attachments within maximum piping span length indicated in MSS SP-69, or per schedules below, whichever is more severe. Install additional attachments where support is required for additional concentrated loads, including valves, flanges, guides, strainers, expansion joints, and at changes in direction of piping.

1. HVAC Steel Pipe Schedule:

Nominal Pipe Size		Maximum Span		Minimum Rod Size	
inches	(mm)	feet	(meters)	inches	(mm)
3/4	(20)	6	(1.8)	3/8	(10)
1	(25)	7	(2.1)	3/8	(10)
1-1/4 to 1-1/2	(32-40)	9	(2.7)	3/8	(10)
2	(50)	10	(3.0)	3/8	(10)
2-1/2	(65)	11	(3.4)	1/2	(12)
3	(80)	12	(3.7)	1/2	(12)
4	(100)	14	(4.3)	5/8	(16)

B. Maximum tension load per attachment or insert shall not exceed manufacturer's published rating.

C. Powder-Driven Concrete Inserts: Not allowed.

3.04 INSTALLATION OF HANGERS AND SUPPORTS

A. General: Install hangers, supports, clamps and attachments to support piping properly; comply with MSS SP-69. Arrange for grouping of parallel runs of horizontal piping to be supported together. Install supports with maximum spacings complying with MSS SP-69. Where piping of various sizes is to be supported together by trapeze hangers, space hangers for smallest pipe size or install intermediate supports for smaller diameter pipe. Do not use wire or perforated metal to support piping, and do not support piping from other piping. Install in accordance with SMACNA "Seismic Restraint Manual Guidelines for Mechanical Systems."

B. Install hangers and supports complete with necessary inserts, bolts, rods, nuts, washers and other accessories. Except as otherwise indicated for exposed continuous pipe runs, install hangers and supports of same type and style as installed for adjacent similar piping.

C. Prevent electrolysis in support of copper tubing by the use of hangers and supports which are copper plated, felt-lined, or by other recognized industry methods.

D. Provisions for movement: Install hangers and supports to allow controlled movement of piping systems and to permit freedom of movement between pipe anchors, and to facilitate action of expansion joints, expansion loops, expansion bends and similar units.

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

F. Pipe slopes: Install hangers and supports to provide indicated pipe slopes per Section 23 05 00, "Common Work Results for HVAC.", and so that maximum pipe deflections allowed by ANSI B31 Pressure Piping Codes are not exceeded.

G. Insulated piping: Comply with the following installation requirements:

1. Provide insulated pipe support (pipe shield) at each support of insulated piping.
2. Select model of insulated pipe support according to published recommendations of insulated pipe support manufacturer, based on pipe size, pipe material, fluid medium, fluid temperature, support spacing, and type of support.
3. Submit tabulation showing proposed uses of insulated pipe supports for different applications.

3.05 EQUIPMENT SUPPORTS

A. Concrete housekeeping pads and curbs will be provided as Work of Division 3. Furnish to Contractor, scaled layouts of all required bases, with dimensions of bases, and location to column center lines. Furnish templates, anchor bolts, and accessories, necessary for base construction.

B. Provide structural steel stands to support equipment not floor mounted or hung from structure. Construct of structural steel members or steel pipe and fittings. Provide factory-fabricated tank saddles for tanks mounted on steel stands.

3.06 SEISMIC RESTRAINTS

A. General:

1. Install in accordance with Codes and SMACNA guidelines.

B. Equipment:

1. All seismic restraints shall be anchored in place with equipment in operation for proper operating clearances.

C. Piping:

1. Seismic restraint spacing shall be in accordance with hanger spacing.
2. Compensate for thermal movement in the piping systems.

D. Install with materials and methods as specified and as indicated on Drawings.

E. Provide all materials and labor for equipment anchorage and seismic restraints.

F. Adjust restraints to limit movement of flexibly supported work to 1/4 inch (6 mm) in all directions.

3.07 ADJUSTING AND CLEANING

A. Hanger adjustment: Adjust hangers so as to distribute loads equally on attachments.

B. Support adjustment: Provide grout under supports so as to bring piping and equipment to proper level and elevations.

C. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

END OF SECTION 23 05 29

SECTION 23 05 53

IDENTIFICATION FOR HVAC

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 SUMMARY

A. This Section describes the requirements for identification of mechanical work.

1.03 QUALITY ASSURANCE

A. Codes and Standards:

1. ANSI Standards: Comply with ANSI A13.1 for lettering size, length of color field, colors, and viewing angles of identification devices.

1.04 SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

B. Product data: Submit manufacturer's technical product data and installation instructions for each identification material and device required.

1.05 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

PART 2 - PRODUCTS

2.01 ACCEPTABLE MANUFACTURERS

A. Manufacturer: Subject to compliance with requirements, provide mechanical identification materials of one of the following:

1. Allen Systems, Inc.
2. Brady (W.H.) Co.; Signmark Div.
3. Industrial Safety Supply Co., Inc.
4. Seton Name Plate Corp.
5. Idento Metal Products Co.

2.02 PLASTIC PIPE MARKERS

A. Pressure-sensitive type: Provide manufacturer's standard pre-printed, permanent adhesive, color-coded, pressure-sensitive vinyl pipe markers, complying with ANSI A13.1.

B. Provide full-band pipe markers, extending 360 degrees around pipe at each location, fastened by one of the following methods:

1. Snap-on application of pre-tensioned semi-rigid plastic pipe marker.
2. Adhesive lap joint in pipe marker overlap.
3. Laminated or bonded application of pipe marker to pipe (or insulation).

4. Taped to pipe (or insulation) with color-coded plastic adhesive tape, not less than 3/4 inch (19 mm) wide; full circle at both ends of pipe marker, tape lapped 1-1/2 inches (38 mm).

C. Lettering: Comply with piping system nomenclature as specified, scheduled or shown, and abbreviate only as necessary for each application length.

1. Arrows: Print each pipe marker with arrows indicating direction of flow, either integrally with piping system service lettering (to accommodate both directions), or as a separate unit of plastic.

2.03 PLASTIC EQUIPMENT MARKERS

A. General: Provide manufacturer's standard laminated plastic, color coded equipment markers.

B. Nomenclature: Include the following, matching terminology on schedules as closely as possible:

1. Name and plan number.
2. Equipment service.
3. Design capacity.

C. Size: Provide approximate 4-1/2 x 6 inch (115 x 150 mm) for equipment.

2.04 LETTERING AND GRAPHICS

A. General: Coordinate names, abbreviations and other designations used in mechanical identification work, with corresponding designations shown in schedules. If not indicated, provide as recommended by manufacturers or as required for proper identification and operation/maintenance of mechanical systems and equipment.

PART 3 - EXECUTION

3.01 GENERAL INSTALLATION REQUIREMENTS

A. Coordination: Where identification is to be applied to surfaces which require insulation, painting or other covering or finish, including valve tags in finished mechanical spaces, install identification after completion of covering and painting. Install identification prior to installation of acoustical ceilings and similar removable concealment.

3.02 PIPING SYSTEM IDENTIFICATION

A. Locate pipe markers and color bands as follows:

1. Supply and return piping at each chiller.
2. Supply and return mains at Pumping Package.
3. Supply and return piping mains near connections to existing.

3.03 MECHANICAL EQUIPMENT IDENTIFICATION

A. General: Install engraved plastic laminate sign or plastic equipment marker on or near each major item of mechanical equipment and each operational device, as specified herein if not otherwise specified for each item or device. Provide signs for the following general categories of equipment and operational devices:

1. Pumping Package:
   a. Pumps.
   b. Pump VFD's.
   c. Expansion tank.

d. Air separator.

e. Chemical feeder.

2. Chillers.

B. Lettering size: Minimum 1/2 inch (12 mm) high.

3.04 SIGNAGE

A. Provide sign attached to pumping package control panel, constructed of engraved plastic laminate with 3/4-inch letters:

"Operating Procedures for Chillers and Pumps

1. One chiller and one pump run at all times, whenever there is a cooling demand in existing jail.
2. Each chiller has dedicated pump, interlocked with chiller.
3. Electrical selector switch allows power to only one chiller at a time.
4. Lead/lag switch-over is performed manually. To switch from one chiller to the other:
   a. Stop operating chiller.
   b. Reposition chiller electrical selector switch.
   c. Start other chiller."

B. Provide sign attached to each chiller's control panel, constructed of engraved plastic laminate with 3/4-inch letters:

"Chiller operating procedures are posted at skid-mounted Pumping Package."

3.05 ADJUSTING AND CLEANING

A. Adjusting: Relocate any mechanical identification device which has become visually blocked by Work of this Division or other Divisions.

B. Cleaning: Clean face of identification devices.

END OF SECTION 23 05 53

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SECTION 23 05 93

TESTING, ADJUSTING AND BALANCING FOR HVAC

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

B. Basic installation requirements are specified in Section 23 00 10, "Basic HVAC Requirements."

1.02 DESCRIPTION OF WORK

A. Extent of testing, adjusting, and balancing (TAB) work required by this Section is indicated on Drawings and Schedules, and by requirements of this Section; and is defined to include, but is not necessarily limited to, air distribution systems, hydronic distribution systems, and associated equipment and apparatus of mechanical work. The Work consists of setting speed and volume (flow) adjusting facilities provided for systems, recording data, conducting tests, preparing and submitting reports, and recommending modifications to work as required by Contract Documents.

B. Component types of testing, adjusting, and balancing specified in this Section includes the following as applied to mechanical equipment:

1. Chillers.
2. Pumps.
3. HVAC piping systems.

C. Related Work Specified in Other Sections:

1. Division-23 Sections for installation and start-up of equipment to be tested, adjusted, and balanced.
2. Division-23 Sections for pressure testing of piping and ductwork systems; not Work of this Section.
3. Division-26 Sections for electrical hook-up and wiring of equipment to be tested, adjusted, and balanced; not Work of this Section.

1.03 QUALITY ASSURANCE

A. Tester's qualifications: Member of Associated Air Balance Council (AABC) or National Environmental Balancing Bureau (NEBB), firm with at least 5-years of successful testing, adjusting, and balancing experience on projects with testing and balancing requirements similar to those required for this Project, who is not Installer of system to be tested, and is otherwise independent of the Project.

B. Codes and Standards:

1. AABC or NEBB Compliance: Comply with latest edition of "AABC National Standards" or "NEBB Procedural Standards for TAB", as applicable to mechanical air and hydronic distribution systems, and associated equipment and apparatus.
2. Industry Standards: Comply with ASHRAE recommendations pertaining to measurements, instruments, and testing, adjusting, and balancing, except as otherwise indicated.
3. Special TAB procedure required by product manufacturer, such as for air bar diffusers.

1.04 SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

B. Within 30 calendar days after commencement of Division-23 Work, submit the following for approval:

1. Name of testing, adjusting, and balancing (TAB) company.
2. Certificate of AABC or NEBB membership.
3. Proof of satisfactory balancing Work with list of at least three (3) HVAC systems.

C. Within 30 calendar days after Architect's approval of TAB company, TAB company shall review Contract Documents. Advise Architect if any additional balancing devices (such as balancing valves, test fittings, etc.) are required by TAB company to properly perform specified and required TAB functions.

D. Maintenance data: Include in maintenance manuals, copies of certified test reports, identification of instruments, and data on Engineer; in accordance with requirements of Division 1.

E. Report Content:

1. Water Balance:

a. Pumps:

i. Number, service, model, and size.
ii. Water flowrate in GPM (L/s).
iii. Pressures: Suction, discharge, and total.
iv. Voltage: Rated and actual.
v. Amperage: Rated and actual.

b. Chillers:

i. Number, model and size.
ii. Voltage: Rated and actual.
iii. Amperage: Rated and actual.
iv. Pressures: inlet and outlet of evaporator.

1.05 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

1.06 JOB CONDITIONS

A. Do not proceed with testing, adjusting, and balancing Work until Work has been completed and is operable. Ensure that there is no latent residual Work still to be completed.

B. Do not proceed until Work scheduled for testing, adjusting, and balancing is clean and free from debris, dirt, and discarded building materials.

PART 2 - PRODUCTS

2.01 TEST AND BALANCE INSTRUMENTS

A. Utilize test and balance instruments and equipment for TAB work required, of type, precision, and capacity as recommended in AABC or NEBB TAB standards.

PART 3 - EXECUTION

3.01 TEST PROCEDURES

A. Examine installed Work and conditions under which testing is to be done to ensure that Work has been completed, cleaned, and is operable. Do not proceed with TAB work until unsatisfactory conditions have been corrected in manner acceptable to Tester.

B. Test, adjust and balance environmental systems and components, as indicated, in accordance with procedures outlined in applicable standards of subparagraph "Codes and Standards" above.

C. Prepare report of test results, including instrumentation calibration reports, in format recommended by applicable standards.

3.02 WATER BALANCING

A. Adjust water quantities to tolerance range of zero to plus 10% of specified flow rates.

B. Determine the proper VFD speed for the chilled water pumps to maintain proper flowrate (GPM) through chiller and to existing building. Record setpoint for Owner's information. Verify proper operation at all operating conditions, including when building has full cooling load and at night time.

END OF SECTION 23 05 93

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SECTION 23 07 00

HVAC INSULATION

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 DESCRIPTION OF WORK

A. Extent of mechanical insulation required by this Section is as specified.

B. Types of mechanical insulation specified in this Section include the following:

1. Piping System Insulation.
2. Equipment Insulation.
3. Other insulation as indicated.

C. Related Work Specified in Other Sections:

1. Basic installation requirements are specified in Section 23 00 10, "Basic HVAC Requirements."
2. Insulated pipe supports (pipe shields), and other support and vibration isolation materials are specified in Section 23 05 29, "Hangers and Supports for HVAC."
3. Identification devices for piping and equipment are specified in Section 23 05 53, "Identification for HVAC."

1.03 QUALITY ASSURANCE

A. Manufacturer's qualifications: Firms regularly engaged in manufacture of mechanical insulation products, of types and sizes required, whose products have been in satisfactory use in similar service for not less than 3 years.

B. Installer's qualifications: Firm with at least 5 years successful installation experience on projects with mechanical insulations similar to that required for this Project.

C. Insulation products shall be formaldehyde-free.

D. K Values: Thermal conductivity in BTU-in/hr. sq.ft. deg.F.

E. Density: In pound/cu.ft. (pcf).

F. Vapor Permeability, in perms: (0.02 perms = 0.02 grains/hr x sq. ft x inch Hg.)

1.04 SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

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

C. Maintenance data: Submit maintenance data and replacement material lists for each type of mechanical insulation. Include this data and product data in maintenance manual.

1.05 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

1.06 DELIVERY, STORAGE, AND HANDLING

A. Deliver insulation, coverings, cements, adhesives, and coatings to site in containers with manufacturer's stamp or label, affixed showing fire hazard indexes of products.

B. Protect insulation against dirt, water, and chemical and mechanical damage. Do not install damaged or wet insulation; remove from Project site.

PART 2 - PRODUCTS

2.01 GENERAL

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

1. Armacell.
2. CertainTeed Corp.
3. Knauf Fiber Glass GmbH.
4. Johns Manville.
5. Owens-Corning Fiberglas Corp.
6. K-Flex USA.
7. Aero Flex USA.

2.02 PIPING INSULATION MATERIALS

A. Elastomeric Foam Piping Insulation: Closed cell. Maximum K-value of 0.245 btuh inch/sq.ft. deg F at 75 deg F (0.0353 W/m deg C at 24 deg C) mean temperature. Maximum vapor permeance of 0.08 perms. Meet 25 flame / 50 smoke rating for thicknesses up to 2.0-inch (50mm). Insulation shall be free of CFC, HFC, and HCFC. Provide with paintable all-service vapor barrier jacket.

1. Pipe sizes up to 6-inches (150 mm): Preformed, one-piece insulation. Armacell AP/Armaflex, K-Flex USA Insul-Tube 180, or approved equal.

B. Fittings and Valves: Manville Zeston, Speed-Line, or approved equal. Premolded PVC fitting covers over pre-cut insulation of same thickness as adjacent piping. Do not use for engine exhaust piping.

C. Bands, wires, and cement: As recommended by insulation manufacturer for applications indicated.

D. Adhesives, sealers, and protective finishes: As recommended by insulation manufacturer for applications indicated.

2.03 EQUIPMENT INSULATION MATERIALS

A. Flexible equipment insulation:

1. Elastomeric Foam: Closed cell sheet and roll. Maximum K-value of 0.245 btuh inch/sq.ft.deg F at 75 deg F (0.0353 w/m deg C at 24 deg C) mean temperature. Maximum vapor permeance of 0.08 perms. Meet 25 flame/50 smoke rating for thicknesses up to 2-inch (50 mm). Armacell AP/Armaflex, K-Flex USA Insul-Sheet 1800, or approved equal.

B. Jacketing material for equipment insulation: Provide pre-sized glass cloth jacketing material, not less than 7.8 ounces per square yard (264 g/sq.m), or metal jacket at Installer's option, except as otherwise indicated.

C. Equipment insulation compounds: Provide adhesives, cements, sealers, mastics and protective finishes as recommended by insulation manufacturer for applications indicated.

D. Equipment insulation accessories: Provide staples, bands, wire, wire netting, tape, corner angles, anchors and stud pins as recommended by insulation manufacturer for applications indicated.

PART 3 - EXECUTION

3.01 GENERAL

A. Examine areas and conditions under which mechanical insulation is to be installed. Do not proceed with Work of this Section until unsatisfactory conditions have been corrected in manner acceptable to Installer.

3.02 PIPING SYSTEM 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 after acceptance of pressure testing.

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

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

E. Insulate valves, fittings and similar items in each piping system with equivalent thickness and composition of insulation as applied to adjoining pipe run. Factory molded, precut or job fabricated units may be used in accordance with manufacturer's published recommendations. Cover with premolded PVC fitting covers for fiberglass insulation.

F. Maintain integrity of vapor-barrier jackets on cold pipe insulation, including at valves and fittings. Protect vapor barrier to prevent puncture or other damage. Do not use staples. Follow recommendations of insulation manufacturer for applications indicated.

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

H. Insulation shall be butted against insulated pipe supports, as specified in Section 23 05 29, "Hangers and Supports for HVAC." Apply wet coat of vapor barrier lap cement on butt joints and seal joints with 3 inches (75 mm) wide vapor barrier tape or band.

I. If grooved piping system is employed where piping insulation is specified, insulate all mechanical joints as specified for pipe fittings. Maintain thermal expansion capability of grooved piping system intact.

J. Elastormeric Foam insulation:

1. Install per manufacturer's published recommendations.
2. Cut custom pieces from insulation sheets for use at elbows, valves, Victaulic fittings, strainers, and other irregular surfaces. Follow manufacturer's published recommendations. Obtain manufacturer's cutting templates.
3. Seal all joints completely with proper adhesive such as Armacell 520 BLV (low VOC) or K-Flex USA Contact Adhesive. Apply adhesive to both sides of all joints.
4. Enclose in continuous PVC jacket. Provide sealants to result in watertight finished installation.

K. For insulated valves installed out-of-doors, provide removable weatherproof PVC cover at each valve to completely enclose and protect the insulation. Provide continuous vapor barrier.

L. Insulate chilled water piping entirely.

M. Minimum pipe insulation thickness:

1. Insulation thicknesses (inch / mm) for system type and pipe diameters per following table based on specified K factor. Comply with California Title 24 as a minimum, unless a more stringent requirement is specified.

	Pipe Diameter in inches (mm)											
Piping System	Runout		Up to 1" (25 mm)		1-1/4 to 2" (32-50 mm)		2-1/2" to 4" (65-100 mm)		5" to 6" (125-150 mm)		8" & Larger (200 mm & larger)	
	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm	inch	mm
Chilled Water												
40-60°F (4.4-16°C)	0.5	12	0.5	12	0.5	12	1.0	25	1.0	25	1.0	25

2. Runouts mean 1 inch (25 mm) maximum pipe size and 12 feet (3.66 m) maximum length branch connection to individual fixture or terminal reheat unit.

3. Insulate supply and return piping.

3.03 EQUIPMENT INSULATION

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

B. Install insulation materials with smooth and even surfaces and on clean and dry surfaces. Redo poorly fitted joints. Do not use mastic or joint sealer as filler for gapping joints and excessive voids resulting from poor workmanship.

C. Apply insulation using staggered joint method for both single and double layer construction, where feasible. Apply each layer of insulation separately.

D. Coat insulated surfaces with layer of insulating cement, troweled in workmanlike manner, leaving smooth continuous surface. Fill in scored block, seams, chipped edges and depressions, and cover over wire netting and joints with cement of sufficient thickness to remove surface irregularities.

E. Cover insulated surfaces with all-service jacketing neatly fitted and firmly secured. Lap seams at least 2 inches (50 mm). Apply over vapor barrier where applicable.

F. Provide removable insulation sections to cover parts of equipment which must be opened periodically for maintenance; include metal vessel covers, fasteners, flanges, frames and accessories.

G. Insulate the following:

1. Chilled water system expansion tank and air separator: With 1-1/2 inches (38 mm) thick rigid insulation or 1 inch (25 mm) thick flexible insulation.

2. For chilled water pump volutes, apply insulation with adhesive to inside of removable stainless steel box. Box shall enclose volute, shall be installed with vapor-tight seals or gaskets, shall be bolted in place, and shall be fully removable.

END OF SECTION 23 07 00

SECTION 23 09 00

INSTRUMENTATION AND CONTROL FOR HVAC

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

B. Related Requirements Specified in Other Sections:

1. Basic installation requirements are specified in Section 23 00 10, "Basic HVAC Requirements."
2. Requirements for basic mechanical materials and methods are specified in Section 23 05 00, "Common Work Results for HVAC."
3. Support and vibration isolation materials are specified in Section 23 05 29, "Hangers and Supports for HVAC."

1.02 DESCRIPTION OF WORK

A. Relocate existing Operator's Work Station (OWS) in existing jail. New location is as identified by Owner.

B. Connect new monitoring points to existing DDC control system, for monitoring purposes.

C. Provide interlock between chillers and pumps.

D. This is a performance Specification. Provide hardware, equipment, wiring, software, inputs, outputs, graphics, and controllers, in quantities and locations as required, to meet the functions and performance specified and indicated.

E. Control wiring, both line voltage and low voltage, related conduit, and transformers to serve controls components and to achieve specified monitored points is Work of this Section.

F. Electrical Power: Control power to all BMS equipment and devices is part of this Section. Coordinate with electrical Work to determine acceptable electrical panels and circuits at which to obtain power.

1.03 QUALITY ASSURANCE

A. Manufacturer:

1. Subject to meeting all specified features and performance, acceptable control vendors include:
    a. Athena Engineering, San Dimas, CA.
    b. Other control vendor, if pre-approved by County.
2. Installation shall be by trained electricians and mechanics under direct employment of the controls manufacturer or their authorized agent.

B. Control components shall be products of the same manufacturer only, unless indicated otherwise.

C. Comply with all codes and local regulations, including the energy code. Meet all requirements of local authorities and State Fire Marshal for functions, sequences, equipment, and software.

D. Electrical standards: Provide electrical products which have been tested, listed and labeled by Underwriters' Laboratories (UL) and comply with NEMA standards. Electrical work shall be installed per NEC.

E. All electronic equipment shall conform to the requirements of FCC Regulation, Part 15, Section 15, Governing Radio Frequency Electromagnetic Interference and be so labeled.

1.04 SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

B. Include project record documents, and operation and maintenance manuals. All information shall be contained in three ring binders, logically divided into sections with a detailed table of contents for each binder and each section. All information shall be either letter size or folded 11" x 17" size.

C. Product data:

1. Submit manufacturer's specifications, catalog cuts, and technical bulletins for each control device and equipment, including installation instructions and start-up instructions. Clearly identify, by use of symbol or tag number, the service of each item. All irrelevant information shall be marked out leaving only pertinent data.

D. Points List: Complete with proposed address identification, type, alarm properties, and description.

E. Test Reports at Project Completion: Reports of field testing indicating proper performance of all systems and points.

F. Operation and Maintenance Manuals: All information shall be contained in three ring binders, logically divided into sections with a detailed table of contents for each binder and each section. All information shall be either letter size or folded 11" x 17" size.

PART 2 - PRODUCTS

2.01 MATERIALS, DEVICES, AND EQUIPMENT

A. Electronic Sensors:

1. Sensor Quality: All sensors shall be of commercial or industrial grade quality and shall be installed according to the Manufacturer's recommendations.

2. Sensor Specifications: Requirements for reporting accuracy and control accuracy are specified in Part 3 – Execution of this Section.

3. Pipe mounted temperature sensors: Rod-and-tube type for linear output, furnished complete with separable protecting wells filled with heat conductive compound, factory calibrated and tamper-proof. Thermowells for all immersion sensors shall be stainless steel or brass as required for application, and shall meet temperature and pressure ratings of piping system.

4. Turbine Type Pipe Flow Measuring Devices:

a. Manufacturer: Data Industrial, Onicon, or approved equal.

b. Model (Numbers are Data Industrial unless otherwise noted):

i. Model 226 SS. Hot tap insertion type, with full-port ball valve.

c. Construction: Stainless steel, glass reinforced nylon impellors, ultrahigh molecular weight polyethylene bearing, tungsten carbide shaft, EPDM O-rings.

d. Accuracy: ± 1% of full scale; Linearity: ± 1%; Repeatability: ± 0.3%; Rangeability: 30:1; Flow rate 1-30 feet per second (1-10 m per second).

e. Maximum Pressure: 400 psig (2760 kPa).

f. Maximum Temperature: 221°F (105°C).

g. Provide each Flow Measuring Device with compatible analog signal transmitter by same manufacturer. Model 500. With NEMA 4X waterproof enclosure.

i. Output: 4-20 mA. Input: 0-110 Hz.

ii. Linearity: 1% or better.

iii. Operating Temperature Range: 32 to 131°F (0 to 55°C).

h. Furnish with pipe well, to be installed under Mechanical Work.

PART 3 - EXECUTION

3.01 GENERAL

A. Install system and materials in accordance with manufacturer's instructions.

3.02 INSTALLATION

A. Examination:

1. Prior to starting work, carefully inspect installed work of other trades and verify that such work is complete to the point where work of this Section may properly commence.

2. Notify the Architect in writing of conditions detrimental to the proper and timely completion of the work.

B. Accessibility: Locate and install components for easy accessibility.

C. Where control devices are installed on insulated piping, provide standoff brackets or thermowells sized to clear insulation thickness. Provide extended sensing elements, and other accessories as required. Coordinate with the work of Section 23 20 00 for the proper location of sensor wells and taps.

D. Integrate controls with equipment furnished controls for proper system operation.

E. Coordinate with Section 23 05 93, "Testing, Adjusting and Balancing for HVAC," prior to commencement of balancing. Advise balancing agency regarding related controls.

F. Calibrate sensors, thermostats, and instruments in place, using methods recommended by device manufacturer.

G. Wiring and Conduit:

1. Provide all wiring and conduit required to serve all controls components which are the Work of this Section and to achieve specified monitored points.

2. Coordinate with Electrical Work to determine acceptable electrical panels at which to obtain power.

3. Provide transformers as required to serve control components. Verify that transformers are not overloaded, and provide additional transformers as required.

4. Line voltage wiring:

a. Install in conduit and in accordance with the NEC and with the requirements given in Electrical Specifications for this Project.

5. Low Voltage Wiring:

a. Install within conduit, without splices between terminal points, color-coded. Install in neat workmanlike manner, securely fastened. Install in accordance with NEC.

H. Final Adjustment:

1. After completion of installation, adjust sensors and control devices for proper operation. Final adjustment shall be performed by factory-trained personnel in direct employ of control systems contractor.

I. Relocate existing Operator's Work Station (OWS) in existing jail. New location is as identified by Owner.

J. Instructions and Training:

1. General:

a. Provide training by a qualified technician who is familiar with the operation of the control system installed, during normal working hours on weekdays.

b. Instruct Owner's operating personnel in all aspects of system operation and maintenance.

2. Training:

a. During testing, on-site maintenance personnel may be assigned by the Owner to observe and participate.

b. Provide training for Owner's operations and maintenance personnel. Location to be at the jobsite.

c. Follow-up Training On-Site: Provide additional session at 4-weeks after system acceptance.

3.03 SYSTEM PERFORMANCE

A. Performance Standards. The system shall conform to the following:

1. Point Scan. All changes of state and changes of analog values shall be transmitted over the high-speed network such that any data used or displayed at a controller or workstation shall have been current within previous sixty (60) seconds.

2. Alarm Response Time. The maximum time from when an object goes into alarm to when it is annunciated at the workstation shall not exceed fifteen (15) seconds.

3. Multiple Alarm Annunciation. All workstations on the network shall receive alarms within five (5) seconds of each other.

B. Reporting Accuracy. The system shall report all values with an end-to-end accuracy as listed or better than those listed in Table 1.

Table 1: Reporting Accuracy

Measured Variable	Reported Accuracy
Water Temperature:	±0.5°F (±0.3°C)
Water Flow:	±5% of full scale

3.04 POINTS LIST

A. Control Points:

1. General: Continuously monitor at existing operator's workstation in existing jail for indication, trend logs, and alarms, as specified, the following data and control points.

2. Points

a. All digital inputs of system Points List:

i. Status.

ii. Value.

iii. Alarm Condition.

iv. Automatic/Manual status.

v. Operator override.

b. All analog inputs of system Points List:

i. Status.

ii. Value with units.

iii. Alarm Condition.

iv. Automatic/Manual status.

v. Operator override.

3. Monitor the following points at the existing Operator's Work Station:

a. Run status for each chiller.

b. All monitored points available through software interface card at each chiller. Coordinate with Section 23 60 00.

c. Run status for each pump.

d. Chilled water supply temp.

e. Chilled water return temp.

f. Chilled water flow (gpm).

g. Chilled water load, in tons, calculated.

h. High chilled water temperature alarm.

i. Low chilled water gpm alarm.

3.05 SEQUENCES OF OPERATION

A. When chiller is energized to start, start respective chilled water pump. Provide required wiring within conduit between chillers and pump VFD's.

1. Interlock pump CHWP-01 with chiller CH-01.

2. Interlock pump CHWP-02 with chiller CH-02.

END OF SECTION 23 09 00

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SECTION 23 20 00

HVAC PIPING AND PUMPS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 SUMMARY

A. Work of this Section:

1. Chilled water pumping package including pumps, expansion tank, and air separators.
2. Chilled water piping.
3. Miscellaneous piping such as pump drains, continuation from plumbing make-up water and air vents.
4. Installation of control items furnished under "Control Systems," such as insertion thermometer and sensor wells, flow sensor wells, etc.
5. Other Work as indicated.

B. Related Work Specified in Other Sections:

1. Basic requirements for mechanical work are specified in Section 23 00 10, "Basic HVAC Requirements."
2. Pressure testing of piping is specified in Section 23 00 10, "Basic HVAC Requirements."
3. Flushing and cleaning of piping is specified in Section 23 00 10, "Basic HVAC Requirements."
4. Basic requirements for mechanical materials and methods are specified in Section 23 05 00, "Common Work Results for HVAC."
5. Supports and seismic restraints are specified in Section 23 05 29.
6. Insulated pipe supports (pipe shields), and other support and vibration isolation materials are specified in Section 23 05 29, "Hangers and Supports for HVAC."
7. Insulation of piping and equipment is specified in Section 23 07 00.

1.03 QUALITY ASSURANCE

A. ASME label for pressure vessels and pressure relief valves.

B. ASME "Boiler and Pressure Vessel Code", Section IX, "Welding and Brazing Qualification" for qualifications for welding processes and operators.

1.04 CODES AND STANDARDS

A. Pipes and Pipe Fittings:

1. Welding: Qualify welding procedures, welders and operators in accordance with ASME B31.1, or ASME B31.9, as applicable, for shop and project site welding of piping work.
    a. Certify welding of piping Work using Standard Procedure Specifications by, and welders tested under supervision of, National Certified Pipe Welding Bureau (NCPWB).

2. Brazing: Certify brazing procedures, brazers, and operators in accordance with ASME Boiler and Pressure Vessel Code, Section IX, for shop and job-site brazing of piping work.
3. Gaskets for flanged joints: ANSI Standards A21.11, B16.20 or B16.21.

B. Valves:

1. MSS Compliance: Mark valves in accordance with MSS-SP-25 "Standard Marking System for Valves, Fittings, Flanges and Unions".
2. ANSI Compliance: For face-to-face and end-to-end dimensions of flanged- or welded-end valve bodies, comply with ANSI B16.10 "Face-to-Face and End-to-End Dimensions of Ferrous Valves".
3. Comply with the following standards for valves:
    a. Butterfly Valves: MSS SP-67.
    b. Ball Valves: MSS SP-72
    c. Cast Iron Swing Check Valves: MSS SP-71.

1.05 SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

B. Product data: Submit for all equipment and materials, including:

1. Pipes and Pipe Fittings: Submit schedule showing pipe material data, sizes, fitting type k factor, working pressure for each service.
2. Submit valve schedule showing Manufacturer's figure number, size, location, and valve features for each required valve.
3. Submit schedule showing manufacturer's figure number, size, location, and features for each required piping specialty.
    a. Strainers: include pressure drop curve or chart for each type and size.
    b. Meters and gauges: include scale range for each service.
4. Grooved joint couplings and fittings shall be shown on product dimension drawings and product submittals, specifically identified with the applicable style or series number.
5. Pumps: Include performance curve with selection point clearly indicated.
6. Expansion tanks, air separators, specified hydronic specialties, including pressure drop curves.

C. Shop Drawings: Scaled layout drawings of HVAC piping systems including, but not limited to, pipe sizes, locations, elevations, penetrations through walls, beams and floors, air vents at high points, drains at low points, equipment and device connections, temperature control provisions, etc.

D. Welder's certificates: Certifying that welders meet the quality requirements specified in Quality Assurance.

E. Concrete Valve Box: Submit detailed fully-dimensioned drawing in plan and section. Include existing piping. Submit after existing conditions for underground piping are established.

1.06 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

1.07 DELIVERY, STORAGE, AND HANDLING

A. Provide factory-applied plastic end-caps on each length of pipe and tube. Maintain end-caps through shipping, storage and handling as required to prevent pipe-end damage and eliminate dirt and moisture from inside of pipe and tube.

B. Where possible, store pipe and tube inside and protected from weather. Where necessary to store outside, elevate above grade and enclose with durable, waterproof wrapping.

C. Protect flanges and fittings from moisture and dirt by inside storage and enclosure, or by packaging with durable, waterproof wrapping.

1.08 WARRANTY

A. As specified elsewhere.

PART 2 - PRODUCTS

2.01 CHILLED WATER PUMPING PACKAGE

A. Provide a fully assembled, UL listed, pre-piped and wired, chilled water pumping package. Suitable for exposed outdoor installation.

B. Manufacturer: FlowTherm (a division of California Hydronics Corporation), Syncroflow, Canaris, or approved equal. Flowtherm is the basis of design.

C. Components shall include the following:

1. Two (2) pumps with suction diffusers, as specified in this Section and as scheduled on the Drawings.
2. Expansion tank, as specified in this Section and as scheduled on the Drawings.
3. Air separator, as specified in this Section and as scheduled on the Drawings.
4. Manual bypass chemical feeder, as specified in this Section.
5. Isolation valves, strainers, check valves, thermometers, gauges, inter-connecting piping, and other devices as specified in this Section and as shown on piping diagram on Drawings.
6. Trim accessory items shall include automatic air vents, ASME code safety pressure relief valves, pressure reducing fill valve, and connection point for make-up water.
7. Electrical:
    a. VFD for each pump, as specified in Section 23 05 00.
    b. Separate point of electrical connection at each VFD.
    c. Power wiring between VFD's and pumps.
    d. Provide current sensor for each pump, with set of dry contacts to indicate pump run status, for connection under Section 23 09 00.

D. All components shall be supported and seismically braced to comply with Codes and Section 23 05 29.

E. All components shall be mounted on a structural steel baseplate covered with ¼-inch steel decking. The structural skid shall be sand blasted, cleaned and primed with inorganic zinc. The entire assembled unit shall be finished with a heavy coat of exterior-grade machine enamel.

F. Comply with piping diagram on Drawings.

G. Insulation: Not included as part of factory package. Insulation of piping, expansion tank, and air separator shall be field-installed, as Work of Section 23 07 00.

2.02 PUMPS

A. General:

1. Manufacturers: Bell and Gossett, Pacific, Aurora, Armstrong, Taco, or approved equal.
2. Type and Operating Conditions: As scheduled.
3. Pump Casings: Class 30 cast iron, unless otherwise specified; with gauge tappings, vent valve, and drain plug.
4. Impellers: Cast bronze, enclosed type, exterior surfaces machined, dynamically balanced and keyed to shaft, and secured by locking cap screw.
5. Shaft and Shaft Sleeve: Steel, heat treated, ground, and polished of adequate size to minimize deflection with bronze shaft sleeve.
6. Mechanical Seals:
    a. Internally flushed mechanical seal with ceramic seal seat and carbon seal ring.
    b. Suitable for continuous operation at 175 psig and 225 deg F (1210 kPa and 107 deg C).
7. Motors: As specified in Section 23 05 00, "Common Work Results for HVAC." TEFC type. Size motors and select pumps so that motor nameplate rating is not exceeded through the entire range of pump curve for the impeller diameter selected.
8. Bearings: Deep groove ball type, capable of both radial and thrust type loads, grease lubricated and regreasable.
9. Vibration: As specified in Section 23 05 00, "Common Work Results for HVAC."
10. Factory Test: Comply with Hydraulic Institute Standards.
11. Finish: Painted with at least one coat of high grade machinery enamel prior to shipment.

B. Frame Mounted, End-Suction Pumps:

1. Frame mounted, single stage, end suction design with a foot mounted volute to allow servicing of the impeller and bearing assembly without disturbing piping connections.
2. Baseplates: Fabricated steel or cast iron with drip collection chamber graded to drain connection. Pipe drain connection to open sight drain.
3. Flexible Couplings: Center drop design coupler, capable of absorbing torsional vibration; employed between pump and motor; shielded by a coupler guard securely fastened to the base.

2.03 PUMP SUCTION DIFFUSERS

A. General: Where specifically indicated, pump suction diffuser may be used in lieu of a long-radius elbow and strainer. Construct unit with angle pattern cast-iron body, threaded for 2 inches (50 mm) and smaller, flanged for 2-1/2 inches (65 mm) and larger, pressure rated for 175 psi (1206 kPa). Provide inlet vanes with length 2-1/2 times pump suction diameter or greater; 3/16 inch (5 mm) 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; disposable fine mesh strainer to fit over cylinder strainer; permanent magnet located in flow stream, removable for cleaning; adjustable foot support designed to carry weight of suction piping; blowdown tapping in bottom, gage tapping in side.

B. Grooved-End: Flanged outlet with grooved inlet connections, rated to 300 psi (2070 kPa). Ductile iron (ASTM A-536) body, 304 stainless steel frame and perforated sheet diffuser. Removable 304 stainless steel start-up pre-filter, drain connections, and base support boss. Victaulic Series 731-I and W731-I.

C. Manufacturer:

1. Amtrol, Inc.
2. Armstrong Pumps, Inc.
3. Bell & Gossett ITT; Fluid Handling Div.
4. Taco.
5. Victaulic.

2.04 EXPANSION TANK

A. Wessels, Bell & Gossett, Taco, Amtrol, Armstrong; pressurized replaceable bladder type; sizes and capacities as indicated.

B. Prepressurized: As indicated.

C. Certification: ASME stamped.

D. Ratings: Maximum working pressure 75 psig at 240 deg F (520 kPa at 115 deg C).

2.05 AIR SEPARATOR

A. Provide system line size air separator, rated 125 psig at 240 deg F (860 kPa at 115 deg C). Without strainer.

B. ASME stamp for 125 psig (860 kPa).

C. Bell and Gossett Rolairtrol, Taco, Amtrol, Armstrong, or approved equal.

2.06 BYPASS CHEMICAL FEEDER

A. Five gallon (20 liter) bypass feeder, designed per ASME, rating of 200 psi (1380 kPa) and 212 deg F. (100 deg C).

B. Provide a one year supply of recommended formulas of chemicals for the prevention of scale, corrosion and biological growth in all systems. All formulations shall be compatible with system construction materials, including pump seals, and meet or exceed all environmental regulations.

2.07 STEEL PIPE AND PIPE FITTINGS

A. Black Steel Pipe: ASTM A 53, A 106 or A 120; except comply with ASTM A 53 or A 106 where close coiling or bending is required and underground chilled water and heating water service. Schedule 40 unless noted otherwise.

B. Malleable-Iron Threaded Fittings: ANSI B16.3; plain or galvanized as indicated.

C. Malleable-Iron Threaded Unions: ANSI B16.39; selected by Installer for proper piping fabrication and service requirements, including style, end connections, and metal-to-metal seats (iron, bronze or brass); plain or galvanized as indicated.

D. Threaded Pipe Plugs: ANSI B16.14.

E. Steel Flange Joints:

1. ANSI B16.5 raised-face flange to mate with steel or ductile iron flange or valve.

2. ANSI B16.1 flat-face flange to mate with cast iron flange or valve. Use full-face gasket.

3. Select gasket materials to suit service of piping system in which installed, and provide materials that will not be detrimentally affected by chemical and thermal conditions of fluid being carried.

F. Wrought-Steel Buttwelding Fittings: ANSI B16.9, except ANSI B16.28 for short-radius elbows and returns; rated to match connected pipe.

G. Pipe Nipples: Fabricated from same pipe as used for connected pipe; except do not use less than Schedule 80 pipe where length remaining unthreaded is less than 1-1/2-inch (40 mm), and where pipe size is less than 1-1/2-inch (40 mm), and do not thread nipples full length (no close-nipples).

2.08 GROOVED JOINT PIPING PRODUCTS

A. General: Where specifically indicated as being acceptable, and at Installer's option, mechanical grooved pipe couplings and fittings may be used for steel piping systems having operating conditions not exceeding 230 degrees F (110 degrees C), excluding steam piping and any other service not recommended by manufacturer, in lieu of welded, flanged, or threaded methods, and may also be used as unions, seismic joints, flexible connections, expansion joints, expansion compensators, or vibration reducers. All grooved end material shall be of one manufacturer.

B. Manufacturer: Subject to compliance with requirements, provide grooved piping products of one of the following:

1. Victaulic Co. of America. Victaulic model numbers are listed below.

2. Gustin-Bacon

3. ITT Grinnell Corp.

4. Stockham Valves & Fittings, Inc.

C. Coupling Housings: Ductile iron conforming to ASTM A 536.

D. Coupling Housings Description: Grooved mechanical type, which engages grooved or shouldered pipe ends, encasing an elastomeric gasket which bridges pipe ends to create seal. Cast in two parts, secure together during assembly with nuts and bolts.

1. Standard Couplings, 2-1/2-inch through 12-inch (65mm through 300mm): Ductile iron housings and synthetic rubber gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.

a. Rigid Type: Housings shall be cast with offsetting, angle-pattern bolt pads to provide system rigidity and support and hanging in accordance with ASME B31.1 and B31.9. Victaulic Style 07 or 107.

b. Flexible Type: Use in locations where vibration attenuation and stress relief are required. Victaulic Style 75, 77 or 177.

E. Gaskets: Mechanical grooved coupling design, pressure responsive so that internal pressure serves to increase seal's tightness, constructed of elastomers having properties as designated by ASTM D 2000.

1. Water Services: EDPM Grade E, with green color code identification.

2. Other Services: As recommended by Manufacturer.

F. Bolts and Nuts: Heat-treated carbon steel, ASTM A 183, minimum tensile 110,000 psi (760 MPa).

G. Branch Stub-Ins: Upper housing with full locating collar for rigid positioning engaging machine-cut hole in pipe, encasing elastomeric gasket conforming to pipe outside diameter around hole, and lower housing with positioning lugs, secured together during assembly with nuts and bolts. Victaulic Style 920 and 920N.

H. Fittings: Grooved or shouldered end design to accept grooved mechanical couplings.

1. Ductile Iron: ASTM A 536.
2. Fabricated Steel: ASTM A 53, Type F for 3/4-inch to 1-1/2-inch (20 to 40 mm); Type E or S, Grade B for 2-inch to 20-inches (50 to 500 mm).
3. Steel: ASTM A 234.

I. Flange Adapters: ASTM A536 ductile iron castings, flat faced, designed for incorporating flanges with ANSI Class 125, 150, or 300 bolt-hole patterns to a grooved piping system. Victaulic Style 741, 743, or W741.

J. Grooves: Conform to the following:

1. Standard Steel: Square cut, or roll grooved.
2. Lightweight Steel: Roll grooved.

2.09 MISCELLANEOUS PIPING MATERIALS/PRODUCTS

A. Welding Materials: Provide welding materials to comply with installation requirements.

1. Comply with Section II, Part C, ASME Boiler and Pressure Vessel Code for welding materials.

B. Soldering Materials: Provide soldering materials to comply with installation requirements.

1. Tin-Antimony Solder: ASTM B 32, Grade 95TA.
2. Silver-Lead Solder: ASTM B 32, Grade 96TS.

C. Brazing Materials: Provide brazing materials to comply with installation requirements.

1. Comply with SFA-5.8, Section II, ASME Boiler and Pressure Vessel Code for brazing filler metal materials.

D. Gaskets for Flanged Joints: ANSI B16.21; full-faced for cast-iron flanges; raised-face for steel flanges, unless otherwise indicated.

2.10 PIPING SERVICES

A. Chilled Water:

1. 2 inches (50 mm) and smaller: Schedule 40, black steel; threaded malleable iron.
2. 2-1/2 inches (65 mm) and larger: Schedule 40, black steel; grooved joints.

B. Relief:

1. From Safety Valves, Relief Valves, and Safety-Relief Valves: Same type piping as specified for system being served.
2. Refrigerant Relief from Refrigerating Equipment:
   a. 2 inches (50 mm) and Smaller: Schedule 40, black steel; threaded malleable iron.
   b. 2-1/2 inches (65 mm) and Larger: Schedule 40, black steel; buttweld. (**At Contractor's option: Grooved joint may be used in Mechanical Rooms and other exposed areas.)

2.11 VALVES

A. General:

1. Comply with ASME B31.9 for building services piping, and ASME B31.1 for power piping.
2. Provide valves of types indicated and pressure and temperature ratings as required.
3. Provide end connections which properly mate with pipe, tube, and equipment connections.

B. Valve Design: Gate valves shall have rising stem (RS), or rising outside screw and yoke (OS&Y) stems, except, non-rising (NRS) stem valves may be used where headroom prevents full extension of rising stems.

C. Sizes: Unless otherwise indicated, provide valves of same size as upstream pipe size.

D. Operators: Provide the following special operator features:

1. Handwheels, fastened to valve stem, for valves other than quarter turn.
2. Lever Handle on quarter-turn valves 6-inch (150 mm) and smaller, except for plug valves. Provide one wrench for every 10 plug valves.
3. Chain-wheel operators for valves 2-1/2-inch (65 mm) and larger where installed in exposed locations 6-feet (1.8 m) or higher above finished floor elevation. Extend chains to an elevation of 5-feet (1.5 m) above finished floor elevation.
4. Furnish adjustable memory stop for butterfly valves that are utilized for balancing.

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

F. Valve End Connections: Comply with the following standards.

1. Flanged: ANSI B16.1 (cast iron), ANSI B16.5, (steel), or ANSI B16.24 (bronze).
2. Threads: ANSI B2.1.
3. Butt-Welding: ANSI B16.25.
4. Flangeless: Valve bodies manufactured to fit between flanges complying with ANSI B16.1 (cast iron), ANSI B16.5 (steel), or ANSI B16.24 (bronze).
5. Grooved: ANSI and manufacturer's standards.

G. Pressure Ratings: Unless otherwise indicated, the specified pressure ratings are for saturated steam. The equivalent rated pressure for non-shock cold water, oil, or gas is higher.

Rated Saturated Steam Pressure		Non-Shock Oil, Water, Gas Pressure	
PSI	kPa	PSI	kPa
125	862	200	1380
150	1035	300	2069

H. Identification: Provide valves with manufacturer's name (or trademark), seat end (if applicable), and pressure rating clearly marked on valve body.

I. Unless otherwise specified, use products by the following manufacturers:

1. Crane, Fairbanks, Grinnell, Hamond, Jenkins, Lunkenheimer, Nibco, Powell, Stockham, Walworth, Centerline, Demco, Keystone.
2. Valve model number specified refers to Stockham.

2.12 VALVE MODELS

A. Ball Valves:

1. 1-inch (25 mm) and Smaller: 150 psi (1035 kPa), bronze body, stainless steel ball, full port, bronze trim, 2-piece construction, TFE seats and seals.

	Threaded Ends	Solder Ends
Stockham:	S-216BRRT	S-216BRRS

2. 1-1/4-inch to 2-inch (32 to 50 mm): 150 psi (1035 kPa), bronze body, stainless steel ball, full port, 3-piece body, TFE seats with bronze trim.

	Threaded Ends	Solder Ends
Stockham:	S-216BRRT	S-216BRRS

B. Butterfly Valves:

1. 2-1/2-inch (65 mm) and Larger: 150 psi (1035 kPa), cast-iron body, stainless steel stem, extended neck, aluminum bronze disc, reinforced resilient EPDM seat, manual lever and lock.

	Wafer	Lug
Stockham:	LG-512-BS3E	LG-712-BS3E

2. Where butterfly valves are used as shutoffs for terminal or equipment removal or repair, select lug-body type valves. Select wafer type valves for other applications. Provide gear operators on butterfly valves 8-inch (203 mm) and larger.

C. Swing Check Valves:

1. 2-inch (50 mm) and Smaller: Class 125, bronze body, horizontal swing, regrinding type, Y-pattern, renewable disc.

	Threaded Ends	Solder Ends
Stockham:	B-319	B-309

2. 2-1/2-inch (65 mm) and Larger: Class 125, iron body, bolted bonnet, horizontal swing, renewable seat and disc, flanged ends; Stockham, G-931.

D. Grooved End Valves:

1. Valve End Connections: ANSI and manufacturer's standards.
2. Butterfly Valves:
    a. Victaulic Vic-300 MasterSeal, 2-1/2-inch through 12-inch (65mm through 300mm).
    b. Victaulic AGS Vic-300, 14 inch through 24-inch (350mm through 600mm).
3. Swing Check Valves:
    a. Victaulic Series 712, 2-1/2-inch through 4-inch (65mm through 100mm).
4. Wafer Check Valves:
    a. Victaulic 716, 779 and W715.

2.13 SHUT-OFF VALVE SERVICES

A. Provide as follows, unless otherwise indicated:

B. Chilled water:

1. 2 inches (50 mm) and smaller: Ball valves.
2. 2-1/2 inches (65 mm) and larger: Butterfly valves.

2.14 PIPING SPECIALITIES

A. General: Provide factory-fabricated piping specialties recommended by manufacturer for use in service indicated. Provide piping specialties of types and pressure ratings indicated for each service or, if not indicated, provide proper selection as determined by Installer to comply with installation requirements. Provide sizes as indicated, and connections, which properly mate with pipe, tube, equipment connections. Where more than one type is indicated, selection is Installer's option.

B. Y-Type Strainers:

1. General: Provide strainers full line size of connecting piping, with ends matching piping system materials. Select strainers for 125 psi (860 kPa) working pressure, bottom drain connection, with Type 304 stainless steel screens; perforations as follows:
   a. 2-inch (50 mm) and smaller = 20 mesh.
   b. 2-1/2-inch to 5-inch (65 to 125 mm) = 1/16-inch (1.6 mm).
2. Threaded Ends, 2-inch (50 mm) and Smaller: Bronze body, screwed screen retainer with centered blowdown fitted with pipe plug.
3. Flanged Ends, 2-1/2-inch (65 mm) and Larger: Cast-iron body, bolted screen retainer with off-center blowdown fitted with pipe plug.
4. Butt Welded Ends, 2-1/2-inch (65 mm) and Larger: Schedule 40 cast carbon steel body, bolted screen retainer with off-center blowdown fitted with pipe plug.
5. Grooved ends, 2-1/2-inch (65 mm) and Larger: Wye pattern, ductile-iron or malleable-iron body and access end cap, access coupling with EPDM gasket. Victaulic Style 732.
6. Manufacturer: Armstrong, Hoffman, Victaulic, Watts, Bailey, Muessco.

C. Unions:

1. Malleable-iron, Class 150 for low pressure service and class 250 for high pressure service; hexagonal stock, with ball-and-socket joints, metal-to-metal bronze seating surfaces; female threaded ends.

D. Dielectric Unions and Flanges:

1. General: Provide standard products recommended by manufacturer for use in service indicated, which effectively isolate ferrous from non-ferrous piping (electrical conductance), prevent galvanic action, and stop corrosion. Pressure rating equal to or greater than that of nearby valves.
2. Manufacturer:
   a. B & K Industries, Inc.
   b. Capital Mfg. Co.; Div. of Harsco Corp.
   c. Eclipse, Inc.

d. Epco Sales, Inc.

e. Perfection Corp.

f. Rockford-Eclipse Div.

g. Victaulic/Clearflow.

h. Calpico.

E. Thermometers:

1. Case: Die cast aluminum finished in baked epoxy enamel, glass front, spring secured, 9-inch (230 mm) long.

2. Adjustable Joint: Die cast aluminum, finished to match case, 180 degrees adjustment in vertical plane, 360 degrees adjustment in horizontal plane, with locking device.

3. Tube and Capillary: Filled with alcohol-based, non-mercury liquid. Magnifying lens, 1% scale range accuracy, shock mounted.

4. Scale: Satin faced, non-reflective aluminum, permanently etched markings.

5. Stem: Copper-plated steel, or brass, for separable socket, length to suit installation.

6. Range: Conform to the following:

a. Chilled Water: 0 deg to 100 deg F with 2 deg F scale divisions (-17 deg to 38 deg C with 1 deg C scale divisions)

7. Manufacturer: Ernst, Marshalltown, Trerice, Weiss.

F. Thermometer Wells:

1. General: Provide thermometer wells constructed of brass or stainless steel, pressure rated to match piping system design pressure. Provide 2-inch (50 mm) extension for insulated piping. Provide cap nut with chain fastened permanently to thermometer well.

2. Manufacturer: Same as thermometers or Victaulic VIC-O-WELL.

G. Pressure Gages:

1. Type: General use, 1% accuracy, ANSI B40.1 grade A, phospher bronze bourdon type, bottom connection.

2. Case: Drawn steel or brass, glass lens, 4-1/2-inch (115 mm) diameter.

3. Connector: Brass with 1/4-inch (6 mm) male NPT. Provide protective syphon when used for steam service.

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

5. Range: Dial range approximately twice the system working pressure (in feet w.c.).

6. Manufacturer: U.S. Gauge, Marsh, Trerice, Weiss.

H. Pressure Gage Cocks:

1. General: Provide pressure gage cocks between pressure gages and gage tees on piping systems. Construct gage cock of brass with 1/4-inch NPT (6 mm) female on each end, and "T" handle brass plug.

2. Syphon: 1/4-inch (6 mm) straight coil constructed of brass tubing with 1/4-inch NPT (6 mm) male on each end.

3. Snubber: 1/4-inch (6 mm) brass bushing with corrosion resistant porous metal disc, through which pressure fluid is filtered. Select disc material for fluid served and pressure rating.

4. Manufacturer: Same as for pressure gages.

I. Test Fittings:

1. General: Provide temperature and pressure gage connector plugs pressure rated for 500 psi and 200 deg F (3450 kPa and 93 deg C). Construct of brass and finish in nickel-plate, equip with 1/2-inch NPS (12 mm) fitting, with self-sealing valve core type neoprene gasketed orifice suitable for inserting 1/8-inch (3.2 mm) O.D. probe assembly from dial type insertion pressure gage. Equip orifice with gasketed screw cap and chain. Provide extension, length equal to insulation thickness, for insulated piping.

2. Manufacturer: Peterson.

2.15 MECHANICAL SLEEVE SEALS

A. General: Modular mechanical type, consisting of interlocking synthetic rubber links shaped to continuously fill annular space between pipe and sleeve, connected with bolts and pressure plates which cause rubber sealing elements to expand when tightened, providing watertight seal and electrical insulation.

B. Sleeve: To be furnished by same manufacturer of seals; Schedule 40 galvanized steel pipe or Century line sleeves, with integral anchor and waterstop collar.

C. Manufacturer: Thunderline Link Seal, Metraflex Metraseal, or approved equal.

2.16 FLEXIBLE PIPE CONNECTORS:

A. Manufacturers: Mason, Metraflex, or approved equal. Mason model numbers are given below.

B. EPDM-Sphere Type: Manufactured of multiple plies of Kevlar tire cord fabric and peroxide-cured EPDM, molded and cured in hydraulic presses.. Rated at 235 psig and 210 deg F (1620 kPa and 99 deg C). Mason Safeflex or approved equal. Provide with control cables in accordance with the manufacturer's recommendations, to limit expansion. Cables shall be slack under normal system operation.

1. 2-inch (50 mm) and Smaller: Single sphere. Threaded connections. Mason SFU.

2. 2-1/2-inch and larger: Double sphere. Ductile iron floating flanges. Molded-in ductile iron reinforcing ring between the two spheres. Mason SFDEJ.

2.17 VENT VALVES

A. Manual vent valves: Provide manual vent valves designed to be operated manually with screwdriver or thumbscrew, 1/8 inch NPS (3 mm) connection. Provide each manual vent with inverted copper U-tube to allow venting into hand-held can.

B. Automatic vent valves: Provide automatic vent valves designed to vent automatically with float principle, stainless steel float and mechanisms, cast-iron body, pressure rated for 125 psig (860 kPa), 1/2 inch (12 mm) NPS inlet and outlet connections.

2.18 WATER RELIEF VALVES

A. General: Provide water relief valves as indicated, of size and capacity as selected by Installer for proper relieving capacity, in accordance with ASME Boiler and Pressure Vessel Code.

B. Manufacturer:

1. Amtrol, Inc.

2. Bell & Gossett ITT; Fluid Handling Div.
3. Spirax Sarco.
4. Watts Regulator Co.

2.19 PRESSURE REDUCING VALVES

A. Where indicated; cast-iron or brass body, low inlet pressure check valve, inlet strainer, non-corrosive valve seat and stem, factory-set at operating pressure.

B. Manufacturer: Same as Relief Valves.

2.20 FLOW MEASURING DEVICES

A. Specified under Section 23 09 00, "Instrumentation and Control for HVAC."

2.21 UNDERGROUND PRECAST CONCRETE VALVE BOX

A. Precast Units: Interlocking, mating sections, complete with accessory items, hardware and features as indicated. Include concrete knockout panels for piping entrance.

B. Size box to allow sufficient interior room to allow installation of future piping.

C. Design structure according to ASTM C 858.

D. Structural Design Loading: ASTM C 857, Class A-16.

E. Fabricate according to ASTM C 858.

F. Joint Sealant: Continuous extrusion of asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground water level at grade.

G. Source Quality Control: Inspect structures according to ASTM C 1037.

H. Accessories:

1. Piping Supports: As specified in this Section and Section 23 05 29.
2. Manhole Frames and Covers: Cast iron with cast-in legend "PIPING". Machine cover-to-frame bearing surfaces.
3. Provide cast iron steps from manhole to floor of valve box.
4. Sump Frame and Grate: Comply with Federal Specifications RR-F-621, Type VII for frame and Type I for cover.
5. Sealing Compound: Nonhardening, safe for human skin contact, not deleterious to insulation, and workable at temperatures as low as 33 deg F. Capable of withstanding temperature of 300 deg F without slump and of adhering to clean surfaces of concrete, masonry, insulation materials, common metals, and HDPE pipe.

PART 3 - EXECUTION

3.01 GENERAL

A. General: Examine areas and conditions under which HVAC piping systems materials and products are to be installed. Do not proceed with Work until unsatisfactory conditions have been corrected.

3.02 INSTALLATION OF CHILLED WATER PUMPING PACKAGE

A. Install on concrete housekeeping pad. Coordinate size with general contractor.

B. Provide flexible pipe connectors at points of piping connection.

C. Manufacturer's representative shall provide a minimum of 2 hours for start-up service and adjustments.

D. Manufacturer's representative shall instruct the Owner's operating personnel in the operation procedures and safety considerations.

E. Provide a complete and detailed operation and maintenance manual to the Owner. Include a wiring control diagram, operation and maintenance instructions, individual components parts list, and service instructions.

3.03 PIPING INSTALLATION

A. General: Install pipes and pipe fittings in accordance with recognized industry practices which will achieve permanently-leakproof piping systems, capable of performing each indicated service without piping failure. Install each run with minimum joints and couplings, but with adequate and accessible unions for disassembly and maintenance/replacement of valves and equipment. Reduce sizes (where indicated) by use of reducing fittings. Align piping accurately at connections, within 1/16-inch (1.6 mm) misalignment tolerance.

B. Locate piping runs, except as otherwise indicated, vertically and horizontally (pitched to drain) and avoid diagonal runs wherever possible. Orient horizontal runs parallel with walls and column lines. Locate runs as shown or described by diagrams, details and notations or, if not otherwise indicated, run piping in shortest route which does not obstruct usable space or block access for servicing building and its equipment. Hold piping close to walls, overhead construction, columns and other clearance to 1/2-inch (12 mm) where furring is shown for enclosure or concealment of piping, but allow for insulation thickness, if any. Where possible, locate insulated piping for 1-inch (25 mm) clearance outside insulation. Wherever possible in finished and occupied spaces, conceal piping from view, by locating in column enclosures, in hollow wall construction or above suspended ceilings; do not encase horizontal runs in solid partitions, except as indicated.

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

D. Comply with ASME B 31 Series for Pressure Piping.

E. Pressures: Do not install piping, valves or piping specialties where exposed to system pressures greater than their rated working pressures.

F. Sloping, Air Venting and Draining:

1. Slope piping at 1-inch per 40-feet (0.2%).
2. Provide eccentric reducers for changes in horizontal chilled water piping, top side flat.
3. Connect branch piping to top of mains.
4. Install piping so entire system is drainable with drain valves at low points.
5. Provide Drain valves and hose adaptors at all low points in piping.
6. Provide manual air vents at all high points and at all elbows down in HVAC water piping.

G. Install piping free of sags and bends. Support requirements are specified in Section 23 05 29, "Hangers and Supports for HVAC."

H. Fittings:

1. Provide standard, manufactured fittings in all cases. Field fabricated fittings are prohibited. Bushings are prohibited on pressure piping.

2. Weld-O-Lets and Thread-O-Lets may be used for non-galvanized steel piping if main pipe size is at least three standard pipe sizes larger than branch pipe, e.g. 2-inch (50 mm) main and 1-inch (25 mm) branch.

3. Provide insulating couplings at connections of ferrous piping to non-ferrous piping.

I. Shutoff valves: Install on inlet and outlet of each mechanical equipment item, and on inlet of each hydronic terminal, and elsewhere as indicated.

J. Flow Measuring Devices:

1. Provide straight lengths of piping upstream and downstream from flow measuring devices, as recommended by manufacturer.

K. Drain valves: Install on each mechanical equipment item located to completely drain equipment for service or repair. Install at base of each riser, at base of each rise or drop in piping system, and elsewhere where indicated or required to completely drain hydronic piping system.

3.04 PIPING SYSTEM JOINTS

A. General: Provide joints of type indicated in each piping system.

B. Thread pipe in accordance with ANSI B2.1; cut threads full and clean using sharp dies. Ream threaded ends to remove burrs and restore full inside diameter. Apply pipe joint compound, or pipe joint tape (Teflon) where recommended by pipe/fitting manufacturer, on male threads at each joint and tighten joint to leave not more than 3 threads exposed.

C. Weld pipe joints in accordance with ASME Code for Pressure Piping, B31.

D. Flanged Joints: Match flanges within piping system, and at connections with valves and equipment. Clean flange faces and install gaskets. Tighten bolts to provide uniform compression of gaskets.

1. Provide raised-face flange to mate with a steel flange, ductile iron valve, etc.

2. Provide flat-face flange and full-face gasket to mate with a cast iron flange, cast iron valve, etc.

E. Grooved Pipe Joints:

1. Assemble joints with coupling and gasket, lubricant, and bolts.

2. Groove ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness.

3. Grooved joint piping systems shall be installed in accordance with the manufacturer's guidelines and recommendations.

4. The gasket style and elastomeric material (grade) shall be verified as suitable for the intended service as specified.

5. Grooved end shall be clean and free from indentations, projections and roll marks in the area from pipe end to groove.

6. A factory trained field representative shall provide on-site training to contractor's field personnel in the use of the grooving tool, and installation of grooved piping products. Factory trained representative shall periodically review the product installation. Contractor shall remove and replace any improperly installed products.

3.05 INSTALLATION OF VALVES

A. General: Except as otherwise indicated, comply with the following requirements:

1. Install valves where required for proper operation and isolation of equipment, including valves in branch lines where necessary to isolate sections of piping.

Locate valves so as to be accessible and so that separate support can be provided when necessary.

2. Install valves with stems pointed up, in vertical position where possible, but in no case with stems pointed downward from horizontal plane unless unavoidable. Install valve drains with hose-end adapter for each valve that must be installed with stem below horizontal plane.

B. Insulation: Where insulation is indicated, install extended-stem valves, arranged in proper manner to receive insulation.

C. Renewable Seats: Select and install valves with renewable seats, except where otherwise indicated.

D. Vent valves:

1. Manual vent valves: Install manual vent valves on each hydronic terminal at highest point, and on each hydronic piping drop in direction of flow for mains, branches, and runouts, and elsewhere as indicated. Install at all water piping system high points. Provide access to each vent valve. Install copper U-tube at discharge of each vent valve to direct discharge water into hand-held can.

3.06 INSTALLATION OF PIPING SPECIALTIES

A. Y-Type Strainers: Install Y-type strainers full size of pipeline, in accordance with manufacturer's installation instructions. Install pipe nipple and ball valve in strainer blow down connection, full size of connection.

1. Locate Y-type strainers in supply line ahead of the following equipment, and elsewhere as indicated, if integral strainer is not included in equipment:

a. Pumps.

2. Install Y-type strainers with basket down.

B. Dielectric Unions and Flanges: Install at each piping joint between ferrous and non-ferrous piping. Comply with manufacturer's installation instructions.

C. Thermometers:

1. General: Install thermometers in vertical upright position, and tilted so as to be easily read by observer standing on floor.

2. Thermometer Wells: Install in piping tee where indicated and insertion thermostats for temperature controls, in vertical upright position. Fill well with oil or graphite, secure cap.

D. Pressure Gages:

1. General: Install pressure gages in piping tee with pressure gage cock, located on pipe at most readable position.

2. Pressure Gage Cocks: Install in piping tee with snubber.

3. Gage Connector Plugs: Install in piping tee where indicated, and required for balancing; located on pipe at most readable position. Secure cap.

E. Test Fittings: Install where indicated and where required for balancing.

3.07 PIPING EXPANSION PROVISIONS

A. Expansion Joints for Grooved Piping: For piping systems fabricated from cut grooved pipe and couplings, following method may be used for expansion compensation.

1. Combination Couplings and Nipples: Provide expansion joints constructed of cut grooved short pipe nipples and couplings, designed by manufacturer to suit intended

service. Provide removable ties to hold joint compressed or expanded during piping fabrication, depending on application. Select couplings and gasket materials to match balance of piping system.

B. Comply with the requirements of Section 23 05 29, "Hangers and Supports for HVAC," for anchors and pipe alignment guides.

3.08 UNDERGROUND VALVE BOX INSTALLATION

A. Elevation: Install valve box at elevation to match elevation of existing underground piping.

B. Set manhole cover flush with grade in paved areas, and at 10-inches above grade in non-paved areas.

C. Access: Install cast-iron frame and cover. Provide 36-inch diameter manhole cover.

D. Install precast collars and rings to support frame and cover and to connect cover with roof opening. Provide moisture-tight joints and waterproof grouting for cast-iron frame to chimney.

E. Install units level and plumb and with orientation and depth coordinated with connecting piping.

F. Support units on a level bed of crushed stone or gravel, graded from the 1-inch sieve to the 0.2-inch sieve and compacted to the same density as adjacent undisturbed earth.

G. Watertightness: Make internal inspection of valve boxes 3 months after completing construction for indications of water ingress. Where leakage is noted, remove water and seal leak sources. Reinspect after 2 months and reseal remaining leak sources. Repeat process at 2-month intervals until leaks are corrected.

H. Clean internal surfaces of valve boxes. Remove foreign material.

3.09 CLEANING, FLUSHING, INSPECTING

A. General: Clean exterior surfaces of installed piping systems of superfluous materials, and prepare for application of specified coatings (if any). Flush out piping systems as specified in Section 23 00 10, "Basic HVAC Requirements." Inspect each run of each system for completion of joints, supports and accessory items.

1. Inspect pressure piping in accordance with procedures of ASME B31 Series.

B. Add water treatment chemicals to bypass feeder, and add chemicals to chilled water system at proper concentration to prevent scale, corrosion, and biological growth. Analyze water conditions at start-up, and at one month and six months after start-up.

3.10 ADJUSTING AND CLEANING OF VALVES

A. Valve Adjustment: After piping systems have been tested and put into service, but before final testing, adjusting, and balancing, inspect each valve for possible leaks. Adjust or replace packing to stop leaks, replace valve if leak persists.

B. Cleaning: Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.11 ADJUSTING AND CLEANING OF PIPING SPECIALTIES

A. Adjusting: Adjust faces of meters and gages to proper angle for best visibility.

B. Cleaning: Clean windows of meters and gages and factory-finished surfaces. Replace cracked or broken windows, repair any scratched or marred surfaces with manufacturer's touch-up paint.

END OF SECTION 23 20 00

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SECTION 23 60 00

COOLING EQUIPMENT

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 SUMMARY

A. Work includes:

1. Installation and start-up of water chillers, and other equipment as specified or scheduled. Chillers shall be furnished by the Owner.
2. Installation, including required verification and supervision of wiring and piping connections installation.
3. Adjustments for proper operation.

B. Related Work Specified in Other Sections:

1. Basic mechanical installation requirements are specified in Section 23 00 10, "Basic HVAC Requirements."
2. Basic mechanical materials and methods are specified in Section 23 05 00, "Common Work Results for HVAC."
3. Support and vibration isolation materials are specified in Section 23 05 29, "Hangers and Supports for HVAC."
4. Identification is specified in Section 23 05 53, "Identification for HVAC."
5. Mechanical insulation is specified in Section 23 07 00, "HVAC Insulation."
6. Concrete housekeeping pads are specified in other Sections.

1.03 SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

B. Scale plan drawing showing chillers, housekeeping pads, chiller clearances, piping, valves, and adjacent buildings and other site items.

PART 2 - PRODUCTS

2.01 GENERAL

A. Coordinate with the Work of Section 23 09 00 "Instrumentation and Control for HVAC."

2.02 WATER CHILLERS - ROTARY SCREW, AIR-COOLED

A. The chillers shall be Owner Furnished and Contractor Installed. Specification is provided for reference only. Coordinate with Owner to determine exact chillers purchased.

B. Manufacturer: Carrier, McQuay, Trane, York, or approved equal.

C. Unit to be completely weatherproof, designed for outdoor installation.

D. Sizes, Efficiencies, and Capacities: As scheduled.

E. Capacity and power input certified per AHRI-590-Latest Edition.

F. Acceptable refrigerant: HFC-134a.

G. Evaporator tube fouling factor per AHRI-590-Latest Edition.

H. Fully factory wired for single point field electrical power connection with factory mounted disconnect including a circuit breaker located in each circuits power panel.

I. Fully factory piped for single point field chilled water supply and return pipe connection.

J. Refrigeration Section:

1. Minimum two (2) rotary screw compressors with capacity control slide valves.
2. Crankcase heater for each compressor to evaporate refrigerant returning to crankcase during shutdown. Energize heater when compressor is not running.
3. Each refrigerant circuit (minimum of two circuits) shall be completely independent of each other with one compressor per circuit. Each circuit shall include an oil separator, electronic expansion valve, compressor suction valve, discharge check valve, liquid line shutoff valves, replaceable core filter-driers, sight glass with moisture indicator and insulated suction line.
4. Suction and discharge service valves at each compressor.
5. Provide pre-piped gauge board with pressure gauges for suction and discharge refrigerant pressures or digital display of pressures on microprocessor.
6. Provide ammeters for each compressor or digital display of % RLA on microprocessor.
7. Automatic lead-lag function to even out compressor run time and compressor starts.

K. Evaporator: Flanged (or grooved joint) connections, water in tubes, removable water boxes or plates at each end, seamless copper tubes individually removable at each end, factory insulated. Water side tested at 215 psig (1482 kPa) with 150 psig (1035 kPa) working pressure. Refrigerant side working pressure of 200 psig (1380 kPa). Evaporator shall be mechanically cleanable.

L. Condenser: Air-cooled coils with aluminum fins mechanically bonded to copper tubes with integral subcooler. Design working pressure of 425 psig (2900 kPa). Direct drive vertical discharge fans, statically and dynamically balanced. Refrigeration cycle suitable for operation at 125 deg. F ambient with compressor loading logic. Fan guards and coil guards shall be PVC, chrome, or zinc coated. Condenser fan motors shall be factory fused. Low ambient head pressure control: chiller shall be provided with VFD head pressure control on first two fans to permit operation down to 0 F ambient.

M. Provide pressure relief valve(s).

N. Motor Starter for each compressor: Wye-Delta Type. NEMA 3R or 12 or UL-listed outdoor enclosure. Starter shall be designed using current generation of reliable solid-state technology. Each starter shall provide controlled motor acceleration and deceleration and shall protect the compressor from phase rotation, electronic thermal overload, over/under current, stalled motor single phase, high load current and current unbalance. Across the line starters are not acceptable. Integral fused transformer for all control power. Protection for motor current overload, phase reversal, phase loss, low line voltage, and distribution fault. Provide lockable through-the-door disconnect operating handle external to panel, clearly visible from outside of unit indicating power on or off.

O. Enclosure:

1. House components in 0.1046 inch/12 gage (2.657 mm) thick steel frame mounted on structural steel base.

2. Frame, control panel, and electrical panel shall be protected from corrosion either by G90 (Z275) galvanizing conforming to ASTM A653/A924, or by baked on powder paint coating to withstand 500-hour salt spray fog test in accordance with ASTM B117.

P. Controls:

1. Chiller shall have integral microprocessor based controls to maintain leaving chilled water temperature at setpoint. Microprocessor shall provide protection against high discharge pressure, loss of refrigerant, loss of water flow, freeze protection and low refrigerant pressure. Controls shall include auto/stop switch, set point adjustment, anti-recycle timer and digital display with water temperature and setpoint on a 4-line by 20-character LCD display with all messages in English, including the 6 previous faults time and date stamped kept in a revolving memory.
2. Provide automatic lead-lag between the two refrigerant circuits/compressors.
3. Provide contacts to start remote chilled water pump.
4. Provide software interface card to communicate all monitored points and alarms to the Building Management System using BACnet or LonWorks protocol. Coordinate with Section 23 09 00, "Instrumentation and Control for HVAC." Points shall include all alarms, alarm history, and real-time KW input to chiller.
5. Control Panel: Factory mounted, microprocessor-based, complete controls including capacity modulation from 15% to 100%; machine stop at 15%, automatic restart; anti-recycle timer; evaporator and lube oil pressure gages or digital display. Automatic shutdown protection with manual reset for low evaporator refrigerant temperature, low evaporator refrigerant pressure, high condenser refrigerant pressure, high compressor discharge temperature, high motor temperature, and low oil flow. Automatic shutdown protection with automatic reset when condition is corrected for loss of chilled water flow. All monitoring and control parameters easily read on illuminated alphanumeric display. Provide menu driven display that indicates operating code, last six diagnostic codes with date and time, chilled water setpoint, leaving chilled water temperature, and current limit set point. Safety shutdown messages to include cause of shutdown and type of restart required.
6. Controller shall utilize following components to automatically take action to prevent unit shutdown due to abnormal operating conditions, as follows:
    a. High pressure switch set 20 psig (138 kPa) below factory pressure trip to automatically unload compressor to help prevent high pressure condenser control trip. One switch for each compressor, with indicating light.
    b. Motor surge protector set at 95% of compressor RLA to automatically unload compressor to help prevent overcurrent trip. One protector for each compressor, with indicating light.
    c. Low pressure switch set 5 psig (34 kPa) above factory low pressure trip to automatically unload the compressor to help prevent low evaporator temperature trip. One switch for each compressor, with indicating light.
    d. In case of shutdown, chiller will continue to run in unloaded state, and will continue to produce some chilled water in attempt to meet cooling load. However, if chiller reaches trip-out limits, chiller controls will take the chiller off line for protection, and manual reset will be required. Once "near-trip" condition is corrected, chiller will return to normal operation and can then produce full load cooling.
7. High ambient operation; for chiller operation above 115F (46C) to 125F, chiller shall be provided with a thermostat controlled control panel ventilation fan and inlet grille

with filter. Controller shall include adaptive logic to control compressor loading to maintain chiller operation and prevent shutdown.

8. Chiller shall be equipped with control logic to handle the low temperatures associated with thermal storage charging operation.
9. Chiller shall be provided with water flow switch for field installation.
10. Soft-load function to prevent chiller from operating at full load during the chilled water pull down period.

PART 3 - EXECUTION

3.01 CHILLER INSTALLATION

A. Install chillers on concrete housekeeping pads in accordance with manufacturer's installation instructions.

B. Coordinate with General Contractor regarding proper location of housekeeping pads.

C. Piping Connections:

1. As indicated.
2. Provide piping as required from each pressure relief device(s).
3. Provide auxiliary piping for oil coolers, etc., required for chillers in accordance with manufacturer's instructions, if required.
4. Install pipe elbows and shut-off valves at evaporator.
5. Install water flow switches in evaporator if required to result in complete installation.

3.02 CLEANING

A. Clean factory-finished surfaces. Repair any marred or scratched surfaces with manufacturer's touch-up paint.

3.03 FIELD QUALITY CONTROL (N.I.C. – BY CHILLER MANUFACTURER)

A. Provide the services, to include a written report, of a factory authorized service representative on-site to supervise the field assembly of the components, installation, and piping and electrical connections. Perform refrigerant leak testing and pressure testing; recharge if required.

3.04 START-UP AND DEMONSTRATION (N.I.C. – BY CHILLER MANUFACTURER)

A. Provide the services of a factory authorized service representative on-site to provide start-up service and to demonstrate and train the Owner's maintenance personnel, regarding water chillers, compressors, condensing units and cooling towers. Comply with manufacturer's instructions.

B. Train the Owner's maintenance personnel on-site on start-up and shut-down procedures, troubleshooting procedures, and servicing and preventative maintenance schedules and procedures, for chillers and cooling towers. Review with the Owner's personnel, the data contained in the Operating and Maintenance Manuals. Provide minimum 16-hours of training for chillers, and 8 hours for cooling towers.

END OF SECTION 23 60 00

SECTION 26 05 00

COMMON WORK RESULTS FOR ELECTRICAL

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 SUMMARY

A. Section includes common electrical installation requirements.

B. Related Sections include the following:

1. Division 01 Section 01 31 13 "Project Coordination."

PART 2 - NOT USED

PART 3 - EXECUTION

3.01 COMMON REQUIREMENTS FOR ELECTRICAL INSTALLATION

A. Comply with NECA 1.

B. Measure indicated mounting heights to bottom of unit for suspended items and to center of unit for wall-mounting items.

C. Headroom Maintenance: If mounting heights or other location criteria are not indicated, arrange and install components and equipment to provide maximum possible headroom consistent with these requirements.

D. Equipment: Install to facilitate service, maintenance, and repair or replacement of components of both electrical equipment and other nearby installations. Connect in such a way as to facilitate future disconnecting with minimum interference with other items in the vicinity.

E. Right of Way: Give to sloped piping systems and ductwork.

3.02 PROJECT COORDINATION DRAWINGS

A. General: Assist with the coordination and preparation of 3D models and coordination drawings per Section 01 31 13 Project Coordination.

3.03 SLEEVE INSTALLATION FOR ELECTRICAL PENETRATIONS

A. Electrical penetrations occur when raceways, cables, wireways, cable trays, or busways penetrate concrete slabs, concrete or masonry walls, or fire-rated floor and wall assemblies.

B. Concrete Slabs and Walls: Install sleeves for penetrations unless core-drilled holes or formed openings are used. Install sleeves during erection of slabs and walls.

C. Use pipe sleeves unless penetration arrangement requires rectangular sleeved opening.

D. Fire-Rated-Assembly Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at raceway and cable penetrations. 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. Seal raceway and cable penetration sleeves

with firestop materials. Comply with requirements in Section 07 84 13 "Penetration Firestopping."

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 raceway or cable, unless indicated otherwise.

H. Seal space outside of sleeves with grout for penetrations of concrete and masonry

1. Promptly pack grout solidly between sleeve and wall so no voids remain. Tool exposed surfaces smooth; protect grout while curing.

I. Interior Penetrations of Non-Fire-Rated Walls and Floors: Seal annular space between sleeve and raceway or cable, using joint sealant appropriate for size, depth, and location of joint. Comply with requirements in Section 07 92 00 "Joint Sealants.".

J. Roof-Penetration Sleeves: Seal penetration of individual raceways and cables with flexible boot-type flashing units applied in coordination with roofing work.

K. Aboveground, Exterior-Wall Penetrations: Seal penetrations using steel pipe sleeves and mechanical sleeve seals. Select sleeve size to allow for 1-inch annular clear space between pipe and sleeve for installing mechanical sleeve seals.

L. Underground, Exterior-Wall Penetrations: Install cast-iron pipe sleeves. Size sleeves to allow for 1-inch annular clear space between raceway or cable and sleeve for installing mechanical sleeve seals.

3.04 FIRESTOPPING

A. Apply firestopping to penetrations of fire-rated floor and wall assemblies for electrical installations to restore original fire-resistance rating of assembly. Firestopping materials and installation requirements are specified in Section 07 84 13 "Penetration Firestopping."

END OF SECTION 260500

SECTION 260519

LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 SUMMARY

A. Section Includes:

1. Building wires and cables rated 600 V and less.
2. Connectors, splices, and terminations rated 600 V and less.

1.03 DEFINITIONS

A. VFC: Variable frequency controller.

1.04 ACTION SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

B. Product Data: For each type of product.

1.05 INFORMATIONAL SUBMITTALS

A. Qualification Data: For testing agency.

B. Field quality-control reports.

1.06 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

PART 2 - PRODUCTS

2.01 CONDUCTORS AND CABLES

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

1. Alcan Products Corporation; Alcan Cable Division.
2. Alpha Wire.
3. Belden Inc.
4. Encore Wire Corporation.
5. General Cable Technologies Corporation.
6. Southwire Incorporated.

B. Copper Conductors: Comply with NEMA WC 70/ICEA S-95-658.

C. Conductor Insulation: Comply with NEMA WC 70/ICEA S-95-658 for Type THHN-2-THWN-2.

D. Multiconductor Cable: Comply with NEMA WC 70/ICEA S-95-658 for Type SO with ground wire.

E. VFC Cable:

1. Comply with UL 1277, UL 1685, and NFPA 70 for Type TC-ER cable.

2.02 CONNECTORS AND SPLICES

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

1. AFC Cable Systems, Inc.
2. Gardner Bender.
3. Hubbell Power Systems, Inc.
4. Ideal Industries, Inc.
5. Ilsco; a branch of Bardes Corporation.
6. NSi Industries LLC.
7. O-Z/Gedney; a brand of the EGS Electrical Group.
8. 3M; Electrical Markets Division.
9. Tyco Electronics.

B. Description: Factory-fabricated connectors and splices of size, ampacity rating, material, type, and class for application and service indicated.

2.03 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 NFPA 70.

PART 3 - EXECUTION

3.01 CONDUCTOR MATERIAL APPLICATIONS

A. Feeders: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

B. Branch Circuits: Copper. Solid for No. 10 AWG and smaller; stranded for No. 8 AWG and larger.

3.02 CONDUCTOR INSULATION AND MULTICONDUCTOR CABLE APPLICATIONS AND WIRING METHODS

A. Provide factory-fabricated color coded (Refer to Section 26 05 53, "Identification for Electrical Systems," for color coding standard), low voltage (600 volts and less) wire of sizes, ratings, materials and types indicated for each service. Where not indicated, provide proper selection as determined by Installer to comply with project's installation requirements and CEC standards.

B. Type THW-75 degree C or THWN-75 degree C rated insulation for feeders, motors and equipment connections. 60 degree C ampacity of conductors will be used for #1 AWG and smaller, 75 degree C ampacity will be used for #1/0 AWG and larger.

C. Type THW-75 degree C, THWN-75 degree C or THHN-90 degree C rated insulation wiring for lighting and receptacle branch circuits, and control wiring; #12 AWG minimum for lighting and receptacles, #14 AWG minimum for control, signal and communication wiring. 60 degree C. ampacity of conductors will be used for all sizes.

D. Type XHHW wiring for conductors above roof, on top of roof or inside built-up roofing materials.

E. Type AF wiring for conductors to incandescent fixtures, and surface or pendant mounted fluorescent and other ballasted fixtures subject to high temperature for voltages up to 300V, and type 3F-2 for voltage above 300V.

F. Type XHHW or THHN for conductors within a ballast compartment.

3.03 INSTALLATION OF CONDUCTORS AND CABLES

A. Conceal cables in finished walls, ceilings, and floors unless otherwise indicated.

B. Complete raceway installation between conductor and cable termination points according to Section 260533 "Raceways and Boxes for Electrical Systems" prior to pulling conductors and cables.

C. Use manufacturer-approved pulling compound or lubricant where necessary; compound used must not deteriorate conductor or insulation. Do not exceed manufacturer's recommended maximum pulling tensions and sidewall pressure values.

D. Use pulling means, including fish tape, cable, rope, and basket-weave wire/cable grips, that will not damage cables or raceway.

E. Install exposed cables parallel and perpendicular to surfaces of exposed structural members, and follow surface contours where possible.

F. Support cables according to Section 26 05 29 "Hangers and Supports for Electrical Systems."

3.04 CONNECTIONS

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

B. Make splices, terminations, and taps that are compatible with conductor material and that possess equivalent or better mechanical strength and insulation ratings than unspliced conductors.

C. Wiring at Outlets: Install conductor at each outlet, with at least 6 inches of slack.

3.05 IDENTIFICATION

A. Identify and color-code conductors and cables according to Section 260553 "Identification for Electrical Systems."

B. Identify each spare conductor at each end with identity number and location of other end of conductor, and identify as spare conductor.

3.06 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."

3.07 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 07 84 13 "Penetration Firestopping."

3.08 FIELD QUALITY CONTROL

A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.

B. Perform the following tests and inspections with the assistance of a factory-authorized service representative:

1. After installing conductors and cables and before electrical circuitry has been energized, test service entrance and feeder conductors and conductors feeding the following critical equipment and services 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. Infrared Scanning: After Substantial Completion, but not more than 60 days after Final Acceptance, perform an infrared scan of each splice in conductors No. 3 AWG and larger. Remove box and equipment covers so splices are accessible to portable scanner. Correct deficiencies determined during the scan.

    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 and Inspection Reports: Prepare a written report to record the following:

    1. Procedures used.

    2. Results that comply with requirements.

    3. Results that do not comply with requirements and corrective action taken to achieve compliance with requirements.

D. Cables will be considered defective if they do not pass tests and inspections.

END OF SECTION 260519

SECTION 26 05 26

GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 SUMMARY

A. Section includes grounding and bonding systems and equipment.

B. Section includes grounding and bonding systems and equipment, plus the following special applications:

1. Underground distribution grounding.
2. Foundation steel electrodes.

1.03 ACTION SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

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

1.04 INFORMATIONAL SUBMITTALS

A. As-Built Data: Plans showing dimensioned as-built locations of grounding features specified in "Field Quality Control" Article, including the following:

1. Test wells.
2. Ground rods.
3. Ground rings.
4. Grounding arrangements and connections for separately derived systems.
5. Grounding for sensitive electronic equipment.

B. Qualification Data: For testing agency and testing agency's field supervisor.

C. Field quality-control reports.

1.05 CLOSEOUT SUBMITTALS

A. Operation and Maintenance Data: For grounding to include in emergency, operation, and maintenance manuals.

1. In addition to items specified in Section 01730 "Operation and Maintenance Data," include the following:

a. Instructions for periodic testing and inspection of grounding features at test wells based on NFPA 70B.

i. Tests shall determine if ground-resistance or impedance values remain within specified maximums, and instructions shall recommend corrective action if values do not.

ii. Include recommended testing intervals.

1.06 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

1.07 QUALITY ASSURANCE

A. Testing Agency Qualifications: Member company of NETA or an NRTL.

1. Testing Agency's Field Supervisor: Certified by NETA to supervise on-site testing.

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

C. Comply with UL 467 for grounding and bonding materials and equipment.

PART 2 - PRODUCTS

2.01 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.

2.02 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.

2.03 CONDUCTORS

A. Insulated Conductors: Copper wire or cable insulated for 600 V unless otherwise required by applicable Code or authorities having jurisdiction.

B. Bare Copper Conductors:

1. Solid Conductors: ASTM B 3.
2. Stranded Conductors: ASTM B 8.
3. Tinned Conductors: ASTM B 33.
4. Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG conductor, 1/4 inch in diameter.
5. Bonding Conductor: No. 4 or No. 6 AWG, stranded conductor.

6. Bonding Jumper: Copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

7. Tinned Bonding Jumper: Tinned-copper tape, braided conductors terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.

C. Grounding Bus: Predrilled rectangular bars of annealed copper, 1/4 by 4 inches in cross section, with 9/32-inch holes spaced 1-1/8 inches apart. Stand-off insulators for mounting shall comply with UL 891 for use in switchboards, 600 V and shall be Lexan or PVC, impulse tested at 5000 V.

2.04 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.

D. Bus-Bar Connectors: Mechanical type, cast silicon bronze, solderless exothermic-type wire terminals, and long-barrel, two-bolt connection to ground bus bar.

2.05 GROUNDING ELECTRODES

A. Ground Rods: Copper-clad steel; 3/4 inch by 10 feet.

B. Chemical-Enhanced Grounding Electrodes: Copper tube, straight or L-shaped, charged with nonhazardous electrolytic chemical salts.

1. Termination: Factory-attached No. 4/0 AWG bare conductor at least 48 inches long.

2. Backfill Material: Electrode manufacturer's recommended material.

PART 3 - EXECUTION

3.01 APPLICATIONS

A. Conductors: Install solid conductor for No. 10 Insert number AWG and smaller, and stranded conductors for No. 8 AWG and larger unless otherwise indicated.

B. Underground Grounding Conductors: Install bare copper conductor, No. 4/0 AWG minimum.

1. Bury at least 24 inches below grade.

2. Duct-Bank Grounding Conductor: Bury 12 inches above duct bank when indicated as part of duct-bank installation.

C. Grounding Bus: Install in electrical equipment rooms, in rooms housing service equipment, and elsewhere as indicated.

1. Install bus horizontally, on insulated spacers 2 inches minimum from wall, 6 inches above finished floor unless otherwise indicated.

2. Where indicated on both sides of doorways, route bus up to top of door frame, across top of doorway, and down; connect to horizontal bus.

D. Conductor Terminations and Connections:

1. Pipe and Equipment Grounding Conductor Terminations: Bolted connectors.

2. Underground Connections: Welded connectors except at test wells and as otherwise indicated.

3. Connections to Ground Rods at Test Wells: Bolted connectors.
4. Connections to Structural Steel: Welded connectors.

3.02 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.

3.03 EQUIPMENT GROUNDING

A. 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.

B. 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.

3.04 INSTALLATION

A. Grounding Conductors: Route along shortest and straightest paths possible unless otherwise indicated or required by Code. Avoid obstructing access or placing conductors where they may be subjected to strain, impact, or damage.

B. Ground Rods: Drive rods until tops are 2 inches below finished floor or final grade unless otherwise indicated.

1. Interconnect ground rods with grounding electrode conductor below grade and as otherwise indicated. Make connections without exposing steel or damaging coating if any.

C. Test Wells: Ground rod driven through drilled hole in bottom of handhole. Handholes are specified in Section 260543 "Underground Ducts and Raceways for Electrical Systems," and shall be at least 12 inches deep, with cover.

1. Test Wells: Install at least one test well for each service unless otherwise indicated. Install at the ground rod electrically closest to service entrance. Set top of test well flush with finished grade or floor.

D. 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.

E. 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.

F. Bonding Interior Metal Ducts: Bond metal air ducts to equipment grounding conductors of associated fans, blowers, electric heaters, and air cleaners. Install tinned bonding jumper to bond across flexible duct connections to achieve continuity.

G. Grounding for Steel Building Structure: Install a driven ground rod at base of each corner column and at intermediate exterior columns at distances not more than 60 feet apart.

H. Ground Ring: Install a grounding conductor, electrically connected to each building structure ground rod and to each steel column, extending around the perimeter of building.

1. Install tinned-copper conductor not less than No. 2/0 AWG for ground ring and for taps to building steel.

2. Bury ground ring not less than 24 inches from building's foundation.

I. Concrete-Encased Grounding Electrode (Ufer Ground): Fabricate according to NFPA 70; use a minimum of 20 feet of bare copper conductor not smaller than No. 4 AWG.

1. Bond grounding conductor to reinforcing steel in at least four locations and to anchor bolts. Extend grounding conductor below grade and connect to building's grounding grid or to grounding electrode external to concrete.

3.05 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. After installing grounding system but before permanent electrical circuits have been energized, test for compliance with requirements.

2. Inspect physical and mechanical condition. Verify tightness of accessible, bolted, electrical connections with a calibrated torque wrench according to manufacturer's written instructions.

3. Test completed grounding system at each location where a maximum ground-resistance level is specified, at service disconnect enclosure grounding terminal, at ground test wells, and at individual ground rods. Make tests at ground rods before any conductors are connected.

a. Measure ground resistance no fewer than two full days after last trace of precipitation and without soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance.

b. Perform tests by fall-of-potential method according to IEEE 81.

4. Prepare dimensioned Drawings locating each test well, ground rod and ground-rod assembly, and other grounding electrodes. Identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location, and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.

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

D. Prepare test and inspection reports.

E. Report measured ground resistances that exceed the following values:

1. Power and Lighting Equipment or System with Capacity of 1000 kVA and Less: 3 ohms.
2. Panelboards Serving Electronic Equipment: 3 ohm(s).
3. Pad-Mounted Equipment: 5 ohms.

F. Excessive Ground Resistance: If resistance to ground exceeds specified values, notify Architect promptly and include recommendations to reduce ground resistance.

END OF SECTION 260526

SECTION 26 05 29

HANGERS AND SUPPORTS FOR ELECTRICAL SYSTEMS

PART 1 - GENERAL

1.01 GENERAL REQUIREMENTS

A. Division 0, Contract requirements and Division 1, General Conditions apply to this section.

1.02 SUMMARY

A. This Section includes the following:

1. Hangers and supports for electrical equipment and systems.
2. Construction requirements for concrete bases.

B. Related Sections include the following:

1. Section 26 05 48.16 "Seismic Controls for Electrical Systems" for products and installation requirements necessary for compliance with seismic criteria.

1.03 DEFINITIONS

A. EMT: Electrical metallic tubing.

B. IMC: Intermediate metal conduit.

C. RMC: Rigid metal conduit.

1.04 PERFORMANCE REQUIREMENTS

A. Delegated Design: Design supports for multiple raceways, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.

B. Design supports for multiple raceways capable of supporting combined weight of supported systems and its contents.

C. Design equipment supports capable of supporting combined operating weight of supported equipment and connected systems and components.

D. Rated Strength: Adequate in tension, shear, and pullout force to resist maximum loads calculated or imposed for this Project, with a minimum structural safety factor of five times the applied force.

1.05 ACTION SUBMITTALS

A. Provide in accordance with Article 3.11 of the General Conditions.

B. Product Data: For the following:

1. Steel slotted support systems.
2. Nonmetallic slotted support systems.

C. Shop Drawings: Signed and sealed by a qualified professional engineer. Show fabrication and installation details and include calculations for the following:

1. Trapeze hangers. Include Product Data for components.
2. Steel slotted channel systems. Include Product Data for components.
3. Nonmetallic slotted channel systems. Include Product Data for components.
4. Equipment supports.

1.06 INFORMATIONAL SUBMITTALS

A. Welding certificates.

1.07 SUBSTITUTIONS

A. Substitutions will be considered per Article 3.3 of the Instruction to Bidders of the Bid Package Section 00003.

1.08 QUALITY ASSURANCE

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

B. Comply with NFPA 70.

1.09 COORDINATION

A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified together with concrete Specifications.

B. Coordinate installation of roof curbs, equipment supports, and roof penetrations. These items are specified in Section 077200 "Roof Accessories."

PART 2 - PRODUCTS

2.01 SUPPORT, ANCHORAGE, AND ATTACHMENT COMPONENTS

A. Steel Slotted Support Systems: Comply with MFMA-4, factory-fabricated components for field assembly.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.
    c. ERICO International Corporation.
    d. GS Metals Corp.
    e. Thomas & Betts Corporation.
    f. Unistrut; Atkore International.
    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. Nonmetallic Slotted Support Systems: Structural-grade, factory-formed, glass-fiber-resin channels and angles with 9/16-inch- diameter holes at a maximum of 8 inches o.c., in at least 1 surface.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    a. Allied Tube & Conduit.
    b. Cooper B-Line, Inc.
    c. Fabco Plastics Wholesale Limited.

d. Seasafe, Inc.

2. Fittings and Accessories: Products of channel and angle manufacturer and designed for use with those items.
3. Fitting and Accessory Materials: Same as channels and angles, except metal items may be stainless steel.
4. Rated Strength: Selected to suit applicable load criteria.

C. Raceway and Cable Supports: As described in NECA 1 and NECA 101.

D. 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.

E. 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.

F. Structural Steel for Fabricated Supports and Restraints: ASTM A 36/A 36M, steel plates, shapes, and bars; black and galvanized.

G. Mounting, Anchoring, and Attachment Components: Items for fastening electrical items or their supports to building surfaces include the following:

1. Powder-Actuated Fasteners: Threaded-steel stud, for use in hardened portland cement concrete, steel, or wood, with tension, shear, and pullout capacities appropriate for supported loads and building materials where used.
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        i. Hilti, Inc.
        ii. ITW Ramset/Red Head; Illinois Tool Works, Inc.
        iii. MKT Fastening, LLC.
        iv. Simpson Strong-Tie Co., Inc.
2. Mechanical-Expansion Anchors: Insert-wedge-type, zinc-coated steel, for use in hardened portland cement concrete with tension, shear, and pullout capacities appropriate for supported loads and building materials in which used.
    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
        i. Cooper B-Line, Inc.
        ii. Empire Tool and Manufacturing Co., Inc.
        iii. Hilti, Inc.
        iv. ITW Ramset/Red Head; Illinois Tool Works, Inc.
        v. MKT Fastening, LLC.
3. Concrete Inserts: Steel or malleable-iron, slotted support system units similar to MSS Type 18; complying with MFMA-4 or MSS SP-58.
4. Clamps for Attachment to Steel Structural Elements: MSS SP-58, type suitable for attached structural element.
5. Through Bolts: Structural type, hex head, and high strength. Comply with ASTM A 325.

6. Toggle Bolts: All-steel springhead type.
7. Hanger Rods: Threaded steel.

2.02 FABRICATED METAL EQUIPMENT SUPPORT ASSEMBLIES

A. Description: Welded or bolted, structural-steel shapes, shop or field fabricated to fit dimensions of supported equipment.

B. Materials: Comply with requirements in Section 055000 "Metal Fabrications" for steel shapes and plates.

PART 3 - EXECUTION

3.01 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 scheduled in NECA 1, where its Table 1 lists maximum spacings less than stated in NFPA 70. Minimum rod size shall be 1/4 inch 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 and smaller raceways serving branch circuits and communication systems above suspended ceilings and for fastening raceways to trapeze supports.

3.02 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.

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 thick or greater. Do not use for anchorage to lightweight-aggregate concrete or for slabs less than 4 inches thick.

6. To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts or beam clamps (MSS Type 19, 21, 23, 25, or 27) complying with MSS SP-69 or spring-tension clamps.
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 by means that meet seismic-restraint strength and anchorage requirements.

E. Drill holes for expansion anchors in concrete at locations and to depths that avoid reinforcing bars.

3.03 INSTALLATION OF FABRICATED METAL SUPPORTS

A. Comply with installation requirements in Section 05 50 00 "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.

3.04 CONCRETE BASES

A. Construct concrete bases of dimensions indicated but not less than 4 inches larger in both directions than supported unit, and so anchors will be a minimum of 10 bolt diameters from edge of the base.

B. Use 3000-psi, 28-day compressive-strength concrete. Concrete materials, reinforcement, and placement requirements are specified in Section 03 30 00 "Cast-in-Place Concrete."

C. Anchor equipment to concrete base.

1. Place and secure anchorage devices. Use supported equipment manufacturer's setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.
2. Install anchor bolts to elevations required for proper attachment to supported equipment.
3. Install anchor bolts according to anchor-bolt manufacturer's written instructions.

3.05 PAINTING

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

1. Apply paint by brush or spray to provide minimum dry film thickness of 2.0 mils.

B. Touchup: Comply with requirements in Section 09 91 13 "Exterior Painting" Section 09 91 23 "Interior Painting" and Section 09 96 00 "High Performance Coatings" for cleaning and touchup painting of field welds, bolted connections, and abraded areas of shop paint on miscellaneous metal.

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

END OF SECTION 260529

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