



# Stillwater Housing Authority

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# HYDRONIC PIPING

**SECTION 232113  
HYDRONIC PIPING**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. Section includes pipe and fitting materials and joining methods for the following:
1. Copper tube and fittings.
  2. Steel pipe and fittings.
  3. Plastic pipe and fittings.
  4. Piping joining materials.
  5. Transition fittings.
  6. Dielectric fittings.

**1.03 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Piping layout, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
1. Suspended ceiling components.
  2. Other building services.
  3. Structural members.
- B. Qualification Data: For Installer.
- C. Welding certificates.
- D. Field quality-control reports.
- E. Water Analysis: Submit a copy of the water analysis to illustrate water quality available at Project site.

**1.04 QUALITY ASSURANCE**

- A. Installer Qualifications:
1. Installers of Pressure-Sealed Joints: Installers shall be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.
  2. Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP shall be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.
- B. Steel Support Welding: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- C. Pipe Welding: Qualify procedures and operators according to ASME Boiler and Pressure Vessel Code: Section IX.
1. Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
  2. Certify that each welder has passed AWS qualification tests for welding processes involved

and that certification is current.

## PART 2 - PRODUCTS

### 2.01 PERFORMANCE REQUIREMENTS

- A. Hydronic piping components and installation shall be capable of withstanding the following minimum working pressure and temperature unless otherwise indicated:
1. Hot-Water Heating Piping: 150 psig at 200 deg F.
  2. Chilled-Water Piping: 150 psig at 150 deg F.
  3. Makeup-Water Piping: 80 psig at 150 deg F.
  4. Condensate-Drain Piping: 150 deg F.
  5. Safety-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

### 2.02 COPPER TUBE AND FITTINGS

- A. Drawn-Temper Copper Tubing: ASTM B 88, Type L, ASTM B 88, Type M.
- B. Annealed-Temper Copper Tubing: ASTM B 88, Type K.
- C. DWV Copper Tubing: ASTM B 306, Type DWV.
- D. Grooved, Mechanical-Joint, Wrought-Copper Fittings: ASME B16.22.
1. Grooved-End Copper Fittings: ASTM B 75, copper tube or ASTM B 584, bronze casting.
  2. Grooved-End-Tube Couplings: Rigid pattern unless otherwise indicated; gasketed fitting. Ductile-iron housing with keys matching pipe and fitting grooves, prelubricated EPDM gasket rated for minimum 230 deg F for use with housing, and steel bolts and nuts.
- E. Copper or Bronze Pressure-Seal Fittings:
1. Housing: Copper.
  2. O-Rings and Pipe Stops: EPDM.
  3. Tools: Manufacturer's special tools.
  4. Minimum 200-psig working-pressure rating at 250 deg F.
- F. Wrought-Copper Unions: ASME B16.22.

### 2.03 STEEL PIPE AND FITTINGS

- A. Steel Pipe: ASTM A 53/A 53M, black steel with plain ends; welded and seamless, Grade B, and wall thickness as indicated in "Piping Applications" Article.
- B. Cast-Iron Threaded Fittings: ASME B16.4; Classes 125 and 250 as indicated in "Piping Applications" Article.
- C. Malleable-Iron Threaded Fittings: ASME B16.3, Classes 150 and 300 as indicated in "Piping Applications" Article.
- D. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Applications" Article.
- E. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, Classes 25, 125, and 250; raised ground face, and bolt holes spot faced as indicated in "Piping Applications" Article.
- F. Wrought-Steel Fittings: ASTM A 234/A 234M, wall thickness to match adjoining pipe.



- G. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:
  - 1. Material Group: 1.1.
  - 2. End Connections: Butt welding.
  - 3. Facings: Raised face.
- H. Grooved Mechanical-Joint Fittings and Couplings:
  - 1. Joint Fittings: ASTM A 536, Grade 65-45-12 ductile iron; ASTM A 47/A 47M, Grade 32510 malleable iron; ASTM A 53/A 53M, Type F, E, or S, Grade B fabricated steel; or ASTM A 106/A 106M, Grade B steel fittings with grooves or shoulders constructed to accept grooved-end couplings; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
  - 2. Couplings: Ductile- or malleable-iron housing and EPDM or nitrile gasket of central cavity pressure-responsive design; with nuts, bolts, locking pin, locking toggle, or lugs to secure grooved pipe and fittings.
- I. Steel Pressure-Seal Fittings:
  - 1. Housing: Steel.
  - 2. O-Rings and Pipe Stop: EPDM.
  - 3. Tools: Manufacturer's special tool.
  - 4. Minimum 300-psig working-pressure rating at 230 deg F.
- J. Steel Pipe Nipples: ASTM A 733, made of same materials and wall thicknesses as pipe in which they are installed.

## 2.04 PLASTIC PIPE AND FITTINGS

- A. CPVC Plastic Pipe: ASTM F 441/F 441M, with wall thickness as indicated in "Piping Applications" Article.
  - 1. CPVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM F 438 for Schedule 40 pipe; ASTM F 439 for Schedule 80 pipe.
- B. PVC Plastic Pipe: ASTM D 1785, with wall thickness as indicated in "Piping Applications" Article.
  - 1. PVC Plastic Pipe Fittings: Socket-type pipe fittings, ASTM D 2466 for Schedule 40 pipe; ASTM D 2467 for Schedule 80 pipe.

## 2.05 JOINING MATERIALS

- A. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.
  - 1. ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch maximum thickness unless otherwise indicated.
    - a. Full-Face Type: For flat-face, Class 125, cast-iron and cast-bronze flanges.
    - b. Narrow-Face Type: For raised-face, Class 250, cast-iron and steel flanges.
- B. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
- C. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
- D. Solder Filler Metals: ASTM B 32, lead-free alloys. Include water-flushable flux according to ASTM B 813.



- E. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
- F. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
- G. Solvent Cements for Joining Plastic Piping:
  - 1. CPVC Piping: ASTM F 493.
    - a. CPVC solvent cement shall have a VOC content of 490 g/L or less.
    - b. Adhesive primer shall have a VOC content of 550 g/L or less.
    - c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."
  - 2. PVC Piping: ASTM D 2564. Include primer according to ASTM F 656.
    - a. PVC solvent cement shall have a VOC content of 510 g/L or less.
    - b. Adhesive primer shall have a VOC content of 550 g/L or less.
    - c. Solvent cement and adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's (formerly, the California Health Services') "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

## 2.06 TRANSITION FITTINGS

- A. Plastic-to-Metal Transition Fittings:
  - 1. One-piece fitting with one threaded brass or copper insert and one solvent-cement-joint end of material and wall thickness to match plastic pipe material.
- B. Plastic-to-Metal Transition Unions:
  - 1. Brass or copper end, solvent-cement-joint end of material and wall thickness to match plastic pipe material, rubber gasket, and threaded union.

## 2.07 DIELECTRIC FITTINGS

- A. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.
  - a. Standard: ASSE 1079.
  - b. Pressure Rating: 150 psig.
  - c. End Connections: Solder-joint copper alloy and threaded ferrous.
- B. Dielectric Flanges:
  - 1. Description:
    - a. Standard: ASSE 1079.
    - b. Factory-fabricated, bolted, companion-flange assembly.
    - c. Pressure Rating: 150 psig.
    - d. End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.
- C. Dielectric-Flange Insulating Kits:
  - 1. Description:
    - a. Nonconducting materials for field assembly of companion flanges.
    - b. Pressure Rating: 150 psig.
    - c. Gasket: Neoprene or phenolic.

- d. Bolt Sleeves: Phenolic or polyethylene.
- e. Washers: Phenolic with steel backing washers.

D. Dielectric Nipples:

- 1. Description:
  - a. Standard: IAPMO PS 66.
  - b. Electroplated steel nipple, complying with ASTM F 1545.
  - c. Pressure Rating: 300 psig at 225 deg F.
  - d. End Connections: Male threaded or grooved.
  - e. Lining: Inert and noncorrosive, propylene.

**2.08 BYPASS CHEMICAL FEEDER**

- A. Description: Welded steel construction; 125-psig working pressure; 5-gal. capacity; with fill funnel and inlet, outlet, and drain valves.
  - 1. Chemicals: Specially formulated, based on analysis of makeup water, to prevent accumulation of scale and corrosion in piping and connected equipment.

**PART 3 - EXECUTION**

**3.01 PIPING APPLICATIONS**

- A. Mechanical Piping: Reference Mechanical Piping Material Schedule on drawings.
- B. Safety-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed with metal-to-plastic transition fittings for plastic piping systems according to piping manufacturer's written instructions.

**3.02 PIPING INSTALLATIONS**

- A. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. 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. Select system components with pressure rating equal to or greater than system operating pressure.
- K. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
- L. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
- M. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
- N. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
- O. Install branch connections to mains using mechanically formed tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
- P. Install unions in piping, NPS 2 and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
- Q. Install flanges in piping, NPS 2-1/2 and larger, at final connections of equipment and elsewhere as indicated.
- R. Install shutoff valve immediately upstream of each dielectric fitting.
- S. Install sleeves for piping penetrations of walls, ceilings, and floors.
- T. Install sleeve seals for piping penetrations of concrete walls and slabs.
- U. Install escutcheons for piping penetrations of walls, ceilings, and floors.

### 3.03 DIELECTRIC FITTING INSTALLATION

- A. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
- B. Dielectric Fittings for NPS 2 and Smaller: Use dielectric nipples or unions.
- C. Dielectric Fittings for NPS 2-1/2 to NPS 4: Use dielectric flanges, flange kits, or nipples.
- D. Dielectric Fittings for NPS 5 and Larger: Use dielectric flange kits.

### 3.04 HANGERS AND SUPPORTS

- A. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hanger, support, and anchor devices. Comply with the following requirements for maximum spacing of supports.
- B. Install the following pipe attachments:
  - 1. Adjustable steel clevis hangers for individual horizontal piping less than 20 feet long.
  - 2. Adjustable roller hangers and spring hangers for individual horizontal piping 20 feet or longer.
  - 3. Pipe Roller: MSS SP-58, Type 44 for multiple horizontal piping 20 feet or longer, supported on a trapeze.
  - 4. Spring hangers to support vertical runs.
  - 5. Provide copper-clad hangers and supports for hangers and supports in direct contact with



- copper pipe.
- 6. On plastic pipe, install pads or cushions on bearing surfaces to prevent hanger from scratching pipe.
- C. Install hangers for steel piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 7 feet.
  - 2. NPS 1: Maximum span, 7 feet.
  - 3. NPS 1-1/2: Maximum span, 9 feet.
  - 4. NPS 2: Maximum span, 10 feet.
  - 5. NPS 2-1/2: Maximum span, 11 feet.
  - 6. NPS 3 and Larger: Maximum span, 12 feet.
- D. Install hangers for drawn-temper copper piping with the following maximum spacing and minimum rod sizes:
  - 1. NPS 3/4: Maximum span, 5 feet; minimum rod size, 1/4 inch.
  - 2. NPS 1: Maximum span, 6 feet; minimum rod size, 1/4 inch.
  - 3. NPS 1-1/4: Maximum span, 7 feet; minimum rod size, 3/8 inch.
  - 4. NPS 1-1/2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  - 5. NPS 2: Maximum span, 8 feet; minimum rod size, 3/8 inch.
  - 6. NPS 2-1/2: Maximum span, 9 feet; minimum rod size, 3/8 inch.
  - 7. NPS 3 and Larger: Maximum span, 10 feet; minimum rod size, 3/8 inch.
- E. Plastic Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- F. Fiberglass Piping Hanger Spacing: Space hangers according to pipe manufacturer's written instructions for service conditions. Avoid point loading. Space and install hangers with the fewest practical rigid anchor points.
- G. Support vertical runs at roof, at each floor, and at 10-foot intervals between floors.

### 3.05 PIPE JOINT CONSTRUCTION

- A. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
- B. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
- C. Soldered Joints: Apply ASTM B 813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints according to ASTM B 828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B 32.
- D. Brazed Joints: Construct joints according to AWS's "Brazing Handbook," "Pipe and Tube" Chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
- E. 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.

- F. Welded Joints: Construct joints according to AWS D10.12M/D10.12, using qualified processes and welding operators according to "Quality Assurance" Article.
- G. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
- H. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings according to the following:
  - 1. Comply with ASTM F 402 for safe-handling practice of cleaners, primers, and solvent cements.
  - 2. CPVC Piping: Join according to ASTM D 2846/D 2846M Appendix.
  - 3. PVC Pressure Piping: Join ASTM D 1785 schedule number, PVC pipe and PVC socket fittings according to ASTM D 2672. Join other-than-schedule number PVC pipe and socket fittings according to ASTM D 2855.
  - 4. PVC Nonpressure Piping: Join according to ASTM D 2855.
- I. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join according to pipe manufacturer's written instructions.
- J. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.
- K. Mechanically Formed, Copper-Tube-Outlet Joints: Use manufacturer-recommended tool and procedure, and brazed joints.
- L. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.

### 3.06 TERMINAL EQUIPMENT CONNECTIONS

- A. Sizes for supply and return piping connections shall be the same as or larger than equipment connections.
- B. Install control valves in accessible locations close to connected equipment.
- C. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
- D. Install ports for pressure gages and thermometers at coil inlet and outlet connections.

### 3.07 CHEMICAL TREATMENT

- A. Perform an analysis of makeup water to determine type and quantities of chemical treatment needed to keep system free of scale, corrosion, and fouling, and to sustain the following water characteristics:
  - 1. pH: 9.0 to 10.5.
  - 2. "P" Alkalinity: 100 to 500 ppm.
  - 3. Boron: 100 to 200 ppm.
  - 4. Chemical Oxygen Demand: Maximum of 100 ppm. Revise this value if closed system contains glycol.
  - 5. Corrosion Inhibitor:
    - a. Sodium Nitrate: 1000 to 1500 ppm.
    - b. Molybdate: 200 to 300 ppm.
    - c. Chromate: 200 to 300 ppm.



- d. Sodium Nitrate Plus Molybdate: 100 to 200 ppm each.
- e. Chromate Plus Molybdate: 50 to 100 ppm each.
6. Soluble Copper: Maximum of 0.20 ppm.
7. Tolyriazole Copper and Yellow Metal Corrosion Inhibitor: Minimum of 10 ppm.
8. Total Suspended Solids: Maximum of 10 ppm.
9. Ammonia: Maximum of 20 ppm.
10. Free Caustic Alkalinity: Maximum of 20 ppm.
11. Microbiological Limits:
  - a. Total Aerobic Plate Count: Maximum of 1000 organisms/mL.
  - b. Total Anaerobic Plate Count: Maximum of 100 organisms/mL.
  - c. Nitrate Reducers: 100 organisms/mL.
  - d. Sulfate Reducers: Maximum of zero organisms/mL.
  - e. Iron Bacteria: Maximum of zero organisms/mL.
- B. Install bypass chemical feeders in each hydronic system where indicated.
  1. Install in upright position with top of funnel not more than 48 inches above the floor.
  2. Install feeder in minimum NPS 3/4 bypass line, from main with full-size, full-port, ball valve in the main between bypass connections.
  3. Install NPS 3/4 pipe from chemical feeder drain to nearest equipment drain and include a full-size, full-port, ball valve.
- C. Fill system with fresh water and add liquid alkaline compound with emulsifying agents and detergents to remove grease and petroleum products from piping. Circulate solution for a minimum of 24 hours, drain, clean strainer screens, and refill with fresh water.
- D. Add initial chemical treatment and maintain water quality in ranges noted above for the first year of operation.
- E. Fill systems that have antifreeze or glycol solutions with the following concentrations:
  1. Hot-Water Heating Piping: Minimum of <Insert number> percent [ethylene] [propylene] glycol.
  2. Chilled-Water Piping: Minimum of <Insert number> percent [ethylene] [propylene] glycol.
  3. Dual-Temperature Heating and Cooling Water Piping: Minimum of <Insert number> percent [ethylene] [propylene] glycol.
  4. Glycol Cooling-Water Piping: Minimum of <Insert number> percent [ethylene] [propylene] glycol.

### 3.08 FIELD QUALITY CONTROL

- A. Prepare hydronic piping according to ASME B31.9 and as follows:
  1. Leave joints, including welds, uninsulated and exposed for examination during test.
  2. Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.
  3. Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.
  4. Isolate equipment from piping. If a valve is used to isolate equipment, its closure shall be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.
  5. Install safety valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.
- B. Perform the following tests on hydronic piping:
  1. Use ambient temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.
  2. While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.



3. Isolate expansion tanks and determine that hydronic system is full of water.
  4. Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure shall not exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9, "Building Services Piping."
  5. After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.
  6. Prepare written report of testing.
- C. Perform the following before operating the system:
1. Open manual valves fully.
  2. Inspect pumps for proper rotation.
  3. Set makeup pressure-reducing valves for required system pressure.
  4. Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).
  5. Set temperature controls so all coils are calling for full flow.
  6. Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.
  7. Verify lubrication of motors and bearings.

END OF SECTION 232113



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# **WATER TREATMENT FOR CLOSED- LOOP HYDRONIC SYSTEMS**

**SECTION 232513**  
**WATER TREATMENT FOR CLOSED-LOOP HYDRONIC SYSTEMS**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

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

**2.01 SUMMARY**

- A. Section includes the following water treatment for closed-loop hydronic systems:
  - 1. Manual chemical-feed equipment.
  - 2. Chemicals.
  - 3. Flushing and Cleaning

**3.01 DEFINITIONS**

- A. TDS: Total dissolved solids consist of salts and other materials that combine with water as a solution.
- B. TSS: Total suspended solids include both organic and inorganic solids that are suspended in the water. These solids may include silt, plankton, and industrial wastes.

**4.01 ACTION SUBMITTALS**

- A. Product Data: Include rated capacities, operating characteristics, and furnished specialties and accessories for the following products:
  - 1. Bypass feeders.
  - 2. Water meters.
  - 3. Chemical-treatment test equipment.
  - 4. Chemical material safety data sheets.
  - 5. Inhibited propylene glycol.
  - 6. Chemical Inhibitors for Water
  - 7. Chemicals for Inhibitors and cleaning
  - 8. Corrosion Coupon Rack
  - 9. Glycol Feed System
- B. Shop Drawings: Pretreatment and chemical-treatment equipment, showing tanks, maintenance space required, and piping connections to hydronic systems.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include diagrams for power, signal, and control wiring.

**5.01 INFORMATIONAL SUBMITTALS**

- A. Water-Analysis Provider Qualifications: Verification of experience and capability of HVAC water-treatment service provider.
- B. Field quality-control reports.
- C. Water-Treatment Program: Written sequence of operation on an annual basis for the application equipment required to achieve water quality defined in "Performance Requirements" Article.



- D. Water Analysis: Illustrate water quality available at Project site.

#### 6.01 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For sensors, injection pumps, and controllers to include in emergency, operation, and maintenance manuals.

#### 7.01 QUALITY ASSURANCE

- A. HVAC Water-Treatment Service Provider Qualifications: An experienced HVAC water-treatment service provider, capable of analyzing water qualities, installing water-treatment equipment, and applying water treatment as specified in this Section.

### PART 2 - PRODUCTS

#### 1.01 PERFORMANCE REQUIREMENTS

- A. Provide all hardware, chemicals, and other material necessary to maintain HVAC water quality in all systems, as indicated in this Specification. Water quality for hydronic systems shall minimize corrosion, scale buildup, and biological growth for optimum efficiency of hydronic equipment without creating a hazard to operating personnel or the environment.
- B. Base HVAC water treatment on quality of water available at Project site, hydronic system equipment material characteristics and functional performance characteristics, operating personnel capabilities, and requirements and guidelines of authorities having jurisdiction.
- C. Closed hydronic systems, including hot-water heating below 250 deg F, dual-temperature water, chilled water, glycol heating, and glycol heating shall have the following water qualities:
1. pH: Maintain a value within 9.0 to 10.5.
  2. Total Dissolved Solids: Maintain a value within 1500 to 2400ppm as CaCO<sub>3</sub>.
  3. Steel Corrosion Inhibitors: Provide sufficient inhibitors to limit mild steel corrosion to 0.5 mils per year.
  4. Yellow Metal Corrosion Inhibitor: Provide sufficient copper and brass corrosion inhibitors to limit copper corrosion to 0.1 mils per year.
  5. Scale Control: Provide softened water for initial fill and makeup. Where softened water is not used, provide sufficient scale inhibitors to prevent formation of scale and maintain all scale-forming material in solution.
  6. Dispersants: Provide sufficient dispersants to prevent sedimentation of fine particulate matter.
  7. Microbiological Limits:
    - a. Total Aerobic Plate Count: Maintain a maximum value of 1,000 organisms/mL.
    - b. Total Anaerobic Plate Count: Maintain a maximum value of 100 organisms/mL.
    - c. Nitrate Reducers: Maintain a maximum value of 100 organisms/mL.
    - d. Sulfate Reducers: Maintain a maximum value of zero organisms/mL.
    - e. Iron Bacteria: Maintain a maximum value of zero organisms/mL.

#### 2.01 MANUAL CHEMICAL-FEED EQUIPMENT

- A. Bypass Feeders: Provide steel feeders for each closed loop system with corrosion-resistant exterior coating, minimum 3-1/2-inch fill opening in the top, and NPS 3/4 bottom inlet and top side outlet. Provide quarter turn or threaded fill cap with gasket seal and diaphragm to lock the top on the feeder when exposed to system pressure in the vessel.
1. Capacity: 5 gal.
  2. Minimum Working Pressure: 125 psig.

### 3.01 CHEMICAL-TREATMENT TEST EQUIPMENT

- A. Test Kit: Manufacturer-recommended equipment and chemicals in a wall-mounted cabinet for testing pH, corrosion inhibitors, alkalinity, hardness, and other properties recommended by manufacturer.
- B. Corrosion Test-Coupon Assembly: Constructed of corrosive-resistant material, complete with piping, valves, and mild steel and copper coupons. Locate copper coupon downstream from mild steel coupon in the test-coupon assembly.
  - 1. Two-station rack for closed-loop systems. Provide mild steel and copper coupons.

### 4.01 CHEMICALS

- A. Chemicals shall be as recommended by water-treatment system manufacturer, compatible with piping system components and connected equipment, and able to attain water quality specified in "Performance Requirements" Article.

### 5.01 INHIBITED PROPYLENE GLYCOL

- A. Inhibited Propylene Glycol:
  - 1. Propylene glycol with inhibitor additive, to provide freeze protection for heat-transfer fluid and corrosion protection for carbon steel, brass, copper, stainless steel, and cast-iron piping and fittings.
  - 2. Inhibitor creates a passive layer on all surfaces that contact propylene glycol to prevent corrosion and stabilizes fluid pH, to compensate for acids formed from glycol degradation.
  - 3. Concentrated inhibited propylene glycol is to be 95.5 percent propylene glycol by weight and 4.5 percent performance additives.
  - 4. Concentrated inhibited propylene glycol is mixed with water in proper proportion specified in the equipment schedules on the drawings. Premixed heat-transfer fluid may be used, or glycol/water mixture may be prepared at the time of installation. Use only deionized water for mixing.
  - 5. Provide only propylene glycol that is specifically blended for HVAC application. Automotive-type antifreeze is unacceptable.

## PART 3 - EXECUTION

### 1.01 WATER ANALYSIS

- A. Perform an analysis of supply water to determine quality of water available at Project site.

### 2.01 INSTALLATION

- A. Install chemical-application equipment on concrete bases, level and plumb. Maintain manufacturer's recommended clearances. Arrange units, so controls and devices that require servicing are accessible. Anchor chemical tanks and floor-mounting accessories to substrate. Install all chemical application equipment within a spill-containment area without floor drain.
- B. Install water-testing equipment on wall near water-chemical-application equipment.
- C. Bypass Feeders: Install in each closed hydronic systems, including hot-water heating, chilled water, dual-temperature water, glycol heating, and glycol cooling, and equip with the following:
  - 1. Install bypass feeder in a bypass circuit around circulating pumps unless indicated otherwise on Drawings.
  - 2. Install water meter in makeup-water supply.



3. Install test-coupon assembly in bypass circuit around circulating pumps unless otherwise indicated on Drawings.
  4. Install a gate or full-port ball isolation valves on inlet, outlet, and drain below the feeder inlet.
  5. Install a swing check on the inlet after the isolation valve.
- D. Install automatic fluid make-up equipment for glycol water system, and include the following:
1. Chemical solution tanks.
  2. Chemical solution injection pumps.
  3. Water meter in makeup supply to system.
  4. Pressure switch to operate injection pump as necessary to maintain glycol system pressure.

### 3.01 PIPING CONNECTIONS

- A. Piping installation requirement are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to equipment, allow space for service and maintenance.
- C. Make piping connections between HVAC water-treatment equipment and dissimilar-metal piping with dielectric fittings. Dielectric fittings are specified in Section 232113 "Hydronic Piping."
- D. Install shutoff valves on HVAC water-treatment equipment inlet and outlet.

### 4.01 ELECTRICAL CONNECTIONS

- A. Confirm applicable electrical requirements in electrical Sections for connecting electrical equipment.
- B. Ground equipment in accordance with Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

### 5.01 FLUSHING AND CLEANING

- A. All Systems: Confirm system is operational, filled, started, and vented prior to cleaning. Place terminal control valves in open position during cleaning. Add cleaning chemicals as recommended by equipment manufacturer.
- B. Flush and clean all new and reused piping.
- C. Provide a flush/clean plan for approval. Provide and later remove all temporary bypasses, drains, vents, etc. required to flush and clean the system. Temporary components for flushing and cleaning are not indicated on the drawings.
- D. Flush and clean all closed loop mechanical systems. Provide and install all required cleaning chemicals.
- E. Verify that adequate cleaning chemical was added, that cleaning was effective, and test that cleaning chemicals were properly rinsed from the system. Provide a report certifying that cleaning and rinsing was properly executed.



- F. Provide chemical treatment immediately after each system has been cleaned and flushed. Systems shall not stand filled with fluids for periods longer than 48 hours without beginning flushing and cleaning which shall immediately be followed by the chemical treatment process.

#### 6.01 FIELD QUALITY CONTROL

- A. Perform tests and inspections
- B. Tests and Inspections:
1. Inspect field-assembled components and equipment installation, including piping and electrical connections.
  2. Inspect piping and equipment to determine that systems and equipment have been cleaned, flushed, and filled with water, and are fully operational before introducing chemicals for water-treatment system.
  3. Place HVAC water-treatment system into operation and calibrate controls during the preliminary phase of hydronic systems' startup procedures.
  4. Do not enclose, cover, or put piping into operation until it is tested and satisfactory test results are achieved.
  5. Test for leaks and defects. If testing is performed in segments, submit separate report for each test, complete with diagram of portion of piping tested.
  6. Leave uncovered and unconcealed new, altered, extended, and replaced water piping until it has been tested and approved. Expose work that has been covered or concealed before it has been tested and approved.
  7. Cap and subject piping to static water pressure of 50 psig above operating pressure, without exceeding pressure rating of piping system materials. Isolate test source and allow test pressure to stand for four hours. Leaks and loss in test pressure constitute defects.
  8. Repair leaks and defects with new materials, and retest piping until no leaks exist.
- C. Equipment will be considered defective if it does not pass tests and inspections.
- D. Prepare test and inspection reports.
- E. At six-week intervals following Substantial Completion (for a one year duration), perform separate water analyses on hydronic systems to show that automatic chemical-feed systems are maintaining water quality within performance requirements specified in this Section. Submit written reports of water analysis, advising Owner of changes necessary to adhere to "Performance Requirements" Article.
- F. Comply with ASTM D3370 and with the following standards:
1. Silica: ASTM D859.
  2. Acidity and Alkalinity: ASTM D1067.
  3. Iron: ASTM D1068.
  4. Water Hardness: ASTM D1126.

#### 7.01 MAINTENANCE SERVICE

- A. Scope of Maintenance Service: Provide chemicals and service program to maintain water conditions required above, to inhibit corrosion and scale formation for hydronic piping and equipment. Services and chemicals shall be provided for a period of one year from date of Substantial Completion and shall include the following:
1. Initial water analysis and HVAC water-treatment recommendations.
  2. Startup assistance for Contractor to flush the systems, clean with detergents, and initially fill systems with required chemical treatment prior to operation.
  3. Periodic field service and consultation.
  4. Customer report charts and log sheets.

5. Laboratory technical analysis.
6. Analyses and reports of all chemical items concerning safety and compliance with government regulations.

**8.01 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain HVAC water-treatment systems and equipment.

**END OF SECTION 232513**





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# WATER-TUBE BOILERS

**SECTION 235233  
WATER-TUBE BOILERS**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. Section includes gas-fired condensing boilers, trim, and accessories for generating hot water.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include construction details, material descriptions, dimensions of individual components and profiles, and finishes for boilers.
  - 2. Include rated capacities, operating characteristics, and furnished specialties and accessories.

**1.04 INFORMATIONAL SUBMITTALS**

- A. Product Certificates:
  - 1. ASME Stamp Certification and Report: Submit "A," "S," or "PP" stamp certificate of authorization, as required by authorities having jurisdiction, and document hydrostatic testing of piping external to boiler.

**1.05 CLOSEOUT SUBMITTALS**

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

**1.06 WARRANTY**

- A. Manufacturer's Warranty: Manufacturer agrees to repair or replace components of boilers that fail in materials or workmanship within specified warranty period. Where "prorated" is indicated, the boiler manufacturer will cover the indicated percentage of cost of replacement parts. With "prorated" type, covered cost decreases as age of equipment increases.
  - 1. Warranty Period for Wall Hung Fire-Tube Condensing Boilers:
    - a. Heat Exchanger: 10-years from purchase date.
    - b. Parts: 5-years from purchase date.

**PART 2 - PRODUCTS**

**2.01 PERFORMANCE REQUIREMENTS**

- A. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, by a qualified testing agency, and marked for intended location and application.
- B. ASME Compliance: Fabricate and label boilers to comply with ASME Boiler and Pressure Vessel Code.



## **2.02 FINNED WATER-TUBE BOILERS**

- A. Description: Factory-fabricated, -assembled, and -tested boiler, with tubes sealed into headers pressure tight, and set on a steel base; including insulated jacket, flue-gas vent, combustion-air-intake connections, water supply and return connections, and controls.
  - a. Reference Schedule on Drawings..

## **2.03 SOURCE QUALITY CONTROL**

- A. UL Compliance: Test gas-fired boilers having input of more than 400,000 Btu/h for compliance with UL 795. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.
- B. UL Compliance, Gas-Fired: Test gas-fired boilers for compliance with UL 2764. Boilers shall be listed and labeled by a testing agency acceptable to authorities having jurisdiction.

## **PART 3 - EXECUTION**

### **3.01 EXAMINATION**

- A. Examine mechanical spaces for suitable conditions where boilers will be installed.
  - 1. All boiler rooms over 500 square feet shall have a minimum of two (2) exits and shall be located at opposite ends of the boiler room.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### **3.02 BOILER INSTALLATION**

- A. Equipment Mounting:
  - 1. Install floor-mounted boilers on cast-in-place concrete equipment base(s).
  - 2. Install wall-hung boilers where indicated on Drawings using suitable hangers. Comply with manufacturer's mounting instructions.
- B. Install gas-fired boilers according to NFPA 54.
- C. Assemble and install boiler trim.
- D. Install electrical devices furnished with boiler but not specified to be factory mounted.
- E. Install control wiring to field-mounted electrical devices.

### **3.03 PIPING CONNECTIONS**

- A. Comply with requirements for hydronic piping specified in Section 232113 "Hydronic Piping."
- B. Connect piping to boilers, except safety relief valve connections, with flexible connectors of materials suitable for service.
- C. Drawings indicate general arrangement of piping, fittings, and specialties.
- D. When installing piping adjacent to boiler, allow space for service and maintenance of condensing boilers. Arrange piping for easy removal of condensing boilers.

- E. Install condensate drain piping to condensate-neutralization unit and from neutralization unit to nearest floor drain. Piping shall be at least full size of connection. Install piping with a minimum of 2 percent downward slope in direction of flow.
- F. Connect gas piping to boiler gas-train inlet with union. Piping shall be at least full size of gas-train connection. Provide a reducer if required.
- G. Connect hot-water piping to supply- and return-boiler tapplings with shutoff valve, and union or flange at each connection.
- H. Install piping from safety relief valves to nearest floor drain.

### 3.04 DUCT CONNECTIONS

- A. Boiler Venting:
  - 1. Comply with all boiler manufacturer's installation instructions.
  - 2. Utilize vent and intake duct material, size, and configuration as indicated in boiler manufacturer's instructions and to comply with UL 1738.
  - 3. Field fabricate and install boiler vent and combustion-air intake.
  - 4. Utilize vent and intake duct material, size, and configuration as indicated in boiler manufacturer's instructions and to comply with UL 1738.
  - 5. Comply with all boiler manufacturer's installation instructions

### 3.05 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with Section 260519 "Low-Voltage Electrical Power Conductors and Cables."
- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Install electrical devices furnished by manufacturer, but not factory mounted, according to NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

### 3.06 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with Section 260523 "Control-Voltage Electrical Power Cables."
- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.
  - 1. Nameplate shall be laminated acrylic or melamine plastic signs with a black background and engraved white letters at least 1/2 inch high.

### 3.07 FIELD QUALITY CONTROL

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



- B. Perform tests and inspections with the assistance of a factory-authorized service representative:
- C. Tests and Inspections:
  - 1. Perform installation and startup checks in accordance with manufacturer's written instructions.
  - 2. Leak Test: Hydrostatic test. Repair leaks and retest until no leaks exist.
  - 3. Operational Test: Start units to confirm proper motor rotation and unit operation. Adjust air-fuel ratio and combustion.
  - 4. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
    - a. Check and adjust initial operating set points and high- and low-limit safety set points of fuel supply, water level, and water temperature.
    - b. Set field-adjustable switches and circuit-breaker trip ranges as indicated.
- D. Boiler will be considered defective if it does not pass tests and inspections.
- E. Prepare test and inspection reports.
- F. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

### 3.08 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain boilers.
  - 1. Instructor shall be factory trained and certified.
  - 2. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
  - 3. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
  - 4. Obtain Owner sign-off that training is complete.
  - 5. Owner training shall be held at Project site.

END OF SECTION 235233



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# AIR-COOLED, SCROLL WATER CHILLERS



SECTION 236423.13  
AIR-COOLED, SCROLL WATER CHILLERS

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. Section includes packaged, air-cooled, electric-motor-driven, scroll water chillers.

**1.03 DEFINITIONS**

- A. BAS: Building automation system.
- B. COP: Coefficient of performance. The ratio of the rate of heat removal to the rate of energy input using consistent units for any given set of rating conditions.
- C. DDC: Direct digital control.
- D. EER: Energy-efficiency ratio. The ratio of the cooling capacity given in Btu/h to the total power input given in watts at any given set of rating conditions.
- E. GFI: Ground fault interrupt.
- F. IPLV: Integrated part-load value. A single-number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and referenced to AHRI standard rating conditions.
- G. I/O: Input/output.
- H. kW/Ton: The ratio of total power input of the chiller in kilowatts to the net refrigerating capacity in tons at any given set of rating conditions.
- I. NPLV: Nonstandard part-load value. A single number part-load efficiency figure of merit for a single chiller calculated per the method defined by AHRI 550/590 and intended for operating conditions other than the AHRI standard rating conditions.
- J. SCCR: Short-circuit current rating.
- K. TEAO: Totally enclosed air over.
- L. TENV: Totally enclosed nonventilating.

**1.04 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include refrigerant, rated capacities, operating characteristics, and furnished specialties and accessories.
  - 2. Performance at AHRI standard conditions and at conditions indicated.
  - 3. Performance at AHRI standard unloading conditions.
  - 4. Minimum evaporator flow rate.

5. Refrigerant capacity of water chiller.
  6. Oil capacity of water chiller.
  7. Fluid capacity of evaporator.
  8. Characteristics of safety relief valves.
  9. Force and moment capacity of each piping connection.
- B. Shop Drawings: Complete set of manufacturer's prints of water chiller assemblies, control panels, sections and elevations, and unit isolation. Include the following:
1. Assembled unit dimensions.
  2. Weight and load distribution.
  3. Required clearances for maintenance and operation.
  4. Size and location of piping and wiring connections.
  5. Diagrams for power, signal, and control wiring.

#### 1.05 INFORMATIONAL SUBMITTALS

- A. Coordination Drawings:
1. Plans, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:
    - a. Structural supports.
    - b. Piping roughing-in requirements.
    - c. Wiring roughing-in requirements, including spaces reserved for electrical equipment.
    - d. Access requirements, including working clearances for mechanical controls and electrical equipment, and tube pull and service clearances.
  2. Coordination drawings showing plan, section and elevation views, drawn to scale.
  3. Each view to show screened background with the following:
    - a. Column grids, beams, columns, and concrete housekeeping pads.
    - b. Layout with walls, floors, and roofs, including each room name and number.
    - c. Equipment and products of other trades that are located in vicinity of chillers and part of final installation, such as plumbing systems.
- B. Installation instructions.
- C. Source quality-control reports.
- D. Startup service reports.
- E. Sample Warranty: For special warranty.

#### 1.06 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For each water chiller to include in emergency, operation, and maintenance manuals.
- B. Spare Parts List: Recommended spare parts list with quantity for each.
- C. Touchup Paint Description: Detailed description of paint used in application of finish coat to allow for procurement of a matching paint.
- D. Instructional Videos: Including those that are prerecorded and those that are recorded during training.

**1.07 MAINTENANCE MATERIAL SUBMITTALS**

- A. Tool kit to include the following:
1. A tool kit specially designed by chiller manufacturer for use in servicing chiller(s) furnished.
  2. Special tools required to service chiller components not readily available to Owner service personnel in performing routine maintenance.
  3. Lockable case with hinged cover, marked with large and permanent text to indicate the special purpose of tool kit, such as "Chiller Tool Kit." Text size shall be at least 1 inch high.
  4. A list of each tool furnished. Permanently attach the list to underside of case cover. Text size shall be at least 1/2 inch high.
- B. Touchup Paint: Container of paint used for finish coat. Label outside of container with detailed description of paint to allow for procurement of a matching paint in the future.

**1.08 QUALITY ASSURANCE**

- A. AHRI Certification: Certify chiller according to AHRI 590 certification program.

**1.09 DELIVERY, STORAGE, AND HANDLING**

- A. Ship water chillers from the factory fully charged with refrigerant and filled with oil.

**1.10 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of water chillers that fail in materials or workmanship within specified warranty period.
1. Extended warranties include, but are not limited to, the following:
    - a. Complete chiller including refrigerant and oil charge.
  2. Warranty Period: Five years from date of Substantial Completion.

**PART 2 - PRODUCTS**

**2.01 PERFORMANCE REQUIREMENTS**

- A. Site Altitude: Chiller shall be suitable for altitude at which installed without affecting performance indicated. Make adjustments to affected chiller components to account for site altitude.
- B. AHRI Rating: Rate water chiller performance according to requirements in AHRI 550/590.
- C. ASHRAE Compliance: ASHRAE 15 for safety code for mechanical refrigeration.
- D. ASME Compliance: Fabricate and stamp water chiller heat exchangers to comply with ASME Boiler and Pressure Vessel Code.
- E. Comply with NFPA 70.
- F. Comply with requirements of UL 1995, "Heating and Cooling Equipment," and include label by a qualified testing agency showing compliance.
- G. Outdoor Installations:
1. Chiller shall be suitable for outdoor installation indicated. Provide adequate weather protection to ensure reliable service life over a 25-year period with minimal degradation due to exposure to outdoor ambient conditions.



2. Chillers equipped to provide safe and stable operation while achieving performance indicated when operating at extreme outdoor temperatures encountered by the installation. Review historical weather database and provide equipment that can operate at extreme outdoor temperatures recorded over past 30-year period.

## **2.02 MANUFACTURED UNITS**

- A. Description: Factory-assembled and run-tested water chiller complete with compressor(s), compressor motors and motor controllers, evaporator, condenser with fans, electrical power, controls, and indicated accessories.

## **2.03 CABINET**

- A. Base: Galvanized-steel base extending the perimeter of water chiller. Secure frame, compressors, and evaporator to base to provide a single-piece unit.
- B. Frame: Rigid galvanized-steel frame secured to base and designed to support cabinet, condenser, control panel, and other chiller components not directly supported from base.
- C. Casing: Galvanized steel.
- D. Finish: Coat base, frame, and casing with a corrosion-resistant coating capable of withstanding a 500-hour salt-spray test according to ASTM B117.

## **2.04 COMPRESSOR-DRIVE ASSEMBLIES**

- A. Compressors:
  1. Description: Positive-displacement direct drive with hermetically sealed casing.
  2. Each compressor provided with suction and discharge service valves, crankcase oil heater, and suction strainer.
    - a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.
  3. Capacity Control: On-off compressor cycling.
    - a. Digital compressor unloading is an acceptable alternative to achieve capacity control.
  4. Oil Lubrication System: Automatic pump with strainer, sight glass, filling connection, filter with magnetic plug or removable magnet in sump, and initial oil charge.
    - a. Manufacturer's other standard methods of providing positive lubrication are acceptable in lieu of an automatic pump.
  5. Vibration Isolation: Mount individual compressors on vibration isolators.
    - a. For multiple compressor assemblies, it is acceptable to isolate each compressor assembly in lieu of each compressor.
- B. Compressor Motors:
  1. Hermetically sealed and cooled by refrigerant suction gas.
  2. High-torque, two-pole induction type with inherent thermal-overload protection on each phase.
- C. Compressor Motor Controllers:
  1. Across the Line: NEMA ICS 2, Class A, full voltage, nonreversing.

## **2.05 REFRIGERATION**

- A. Refrigerant: R-410A. Classified as Safety Group A1 according to ASHRAE 34.

- B. Refrigerant Compatibility: Parts exposed to refrigerants shall be fully compatible with refrigerants, and pressure components shall be rated for refrigerant pressures.
- C. Refrigerant Circuit: Each circuit shall include an electronic or a thermal-expansion valve, refrigerant charging connections, a hot-gas muffler, compressor suction and discharge shutoff valves, a liquid-line shutoff valve, a replaceable-core filter-dryer, a sight glass with moisture indicator, a liquid-line solenoid valve, and an insulated suction line.
- D. Pressure Relief Device:
  - 1. Comply with requirements in ASHRAE 15, ASHRAE 147, and applicable portions of ASME Boiler and Pressure Vessel Code: Section VIII, Division 1.
  - 2. Select and configure pressure relief devices to protect against corrosion and inadvertent release of refrigerant.
  - 3. ASME-rated, spring-loaded, pressure relief valve; single- or multiple-reseating type. Pressure relief valve(s) shall be provided for each heat exchanger.

## 2.06 EVAPORATOR

- A. Brazed-plate design, as indicated.
- B. Brazed Plate:
  - 1. Direct-expansion, single-pass, brazed-plate design.
  - 2. Type 316 stainless-steel construction.
  - 3. Code Compliance: Tested according to ASME Boiler and Pressure Vessel Code.
  - 4. Fluid Nozzles: Terminate with mechanical-coupling end connections for connection to field piping. Furnish flange adapters to mate to flanged piping.
  - 5. Inlet Strainer: Factory-furnished, 20-mesh strainer for field installation in supply piping to evaporator. Manufacturer has option to factory install strainer.
- C. Flow Switch: Factory-furnished and -installed, thermal-type flow switch wired to chiller operating controls.

## 2.07 AIR-COOLED CONDENSER

- A. Coil(s) with integral subcooling on each circuit.
- B. Copper Tube with Plate Fin Coils:
  - 1. Construct coils of copper tubes mechanically bonded to aluminum or copper fins.
  - 2. Coating: Corrosion resistant.
- C. Aluminum Microchannel Coils:
  - 1. Series of flat tubes containing a series of multiple, parallel-flow microchannels layered between refrigerant header manifolds.
  - 2. Single- or multiple-pass arrangement.
  - 3. Construct fins, tubes, and header manifolds of aluminum alloy treated with a corrosion-resistant coating.
- D. Hail Protection: Provide condenser coils with louvers, baffles, or hoods to protect against hail damage.
- E. Fans: Direct-drive propeller type with statically and dynamically balanced fan blades, arranged for vertical air discharge.
- F. Fan Motors: TENV or TEAO enclosure, with sealed and permanently lubricated bearings, and having built-in overcurrent- and thermal-overload protection.



1. Overcurrent- and thermal-overload protection not integral to motor is acceptable if provided with chiller electrical power package.

- G. Fan Guards: Removable steel safety guards with corrosion-resistant coating.

## 2.08 INSULATION

- A. Closed-cell, flexible, elastomeric thermal insulation complying with ASTM C534/C534M, Type I for tubular materials and Type II for sheet materials.
- B. Adhesive: As recommended by insulation manufacturer.
- C. Factory-applied insulation over all cold surfaces of chiller capable of forming condensation. Components shall include, but not be limited to, evaporator, evaporator water boxes including nozzles, refrigerant suction pipe from evaporator to compressor, cold surfaces of compressor, refrigerant-cooled motor, and auxiliary piping.
1. Apply adhesive to 100 percent of insulation contact surface.
  2. Before insulating steel surfaces, prepare surfaces for paint, and prime and paint as indicated for other painted components. Do not insulate unpainted steel surfaces.
  3. Seal seams and joints to provide a vapor barrier.
  4. After adhesive has fully cured, paint exposed surfaces of insulation to match other painted parts.
  5. Manufacturer has option to factory or field insulate chiller components to reduce potential for damage during installation.
  6. Field-Applied Insulation:
    - a. Components that are not factory insulated shall be field insulated to comply with requirements indicated.
    - b. Manufacturer shall be responsible for chiller insulation whether factory or field installed to ensure that manufacturer is the single point of responsibility for chillers.
    - c. Manufacturer's factory-authorized service representative shall instruct and supervise installation of field-applied insulation.
    - d. After field-applied insulation is complete, paint insulation to match factory-applied finish.

## 2.09 ELECTRICAL

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Factory-installed and -wired switches, motor controllers, transformers, and other electrical devices necessary shall provide a single-point field power connection to water chiller.
- C. House in a unit-mounted, NEMA 250 enclosure with hinged access door with lock and key or padlock and key.
- D. Wiring shall be numbered and color-coded to match wiring diagram.
- E. Each motor shall have branch power circuit and controls with one of the following disconnecting means having SCCR to match main disconnecting means:
  1. NEMA KS 1, heavy-duty, fusible switch with rejection-type fuse clips rated for fuses. Select and size fuses to provide Type 2 protection according to IEC 60947-4-1.
  2. NEMA KS 1, heavy-duty, nonfusible switch.
  3. UL 489, motor-circuit protector (circuit breaker) with field-adjustable, short-circuit trip coordinated with motor locked-rotor amperes.
- F. Each motor shall have overcurrent protection.



- G. Overload relay sized according to UL 1995, or an integral component of water chiller control microprocessor.
- H. Phase-Failure and Undervoltage: Solid-state sensing with adjustable settings.
- I. Power Factor Correction: Capacitors to correct power factor to 0.90-0.95 at full load.
- J. Controls Transformer: Unit-mounted transformer with primary and secondary fuses and sized with enough capacity to operate electrical load plus spare capacity.
- K. Control Relays: Auxiliary and adjustable time-delay relays, or an integral to water chiller microprocessor.
- L. Indicate the following for water chiller electrical power supply:
  - 1. Current, phase to phase, for all three phases.
  - 2. Power factor.
  - 3. Fault log, with time and date of each.

## 2.10 CONTROLS

- A. Factory installed and wired, and functionally tested at factory before shipment.
- B. Standalone, microprocessor based, with all memory stored in nonvolatile memory so that reprogramming is not required on loss of electrical power.
- C. Enclosure: Share enclosure with electrical power devices or provide a separate enclosure of matching construction.
- D. Operator Interface: Keypad or pressure-sensitive touch screen. Multiple-character, digital display. Display the following:
  - 1. Date and time.
  - 2. Operating or alarm status.
  - 3. Operating hours.
  - 4. Temperature of operating set points.
  - 5. Chilled-water entering and leaving temperatures.
  - 6. Refrigerant pressures in evaporator and condenser.
  - 7. Saturation temperature in evaporator and condenser.
  - 8. Elapsed time meter (compressor run status).
  - 9. Percent of maximum motor amperage.
  - 10. Current-limit set point.
  - 11. Number of compressor starts.
  - 12. Alarm history with retention of operational data before unit shutdown.
  - 13. Superheat.
- E. Control Functions:
  - 1. Manual or automatic startup and shutdown time schedule.
  - 2. Capacity control based on evaporator leaving-fluid temperature.
  - 3. Capacity control compensated by rate of change of evaporator entering-fluid temperature.
  - 4. Chilled-water entering and leaving temperatures, control set points, and motor load limit.
  - 5. Current limit and demand limit.
- F. Manual-Reset Safety Controls: The following conditions shall shut down water chiller and require manual reset:
  - 1. Low evaporator pressure or high condenser pressure.

2. Low chilled-water temperature.
  3. Refrigerant high pressure.
  4. High or low oil pressure.
  5. High oil temperature.
  6. Loss of chilled-water flow.
- G. BAS System Interface: Factory-install hardware and software to enable system to monitor, control, and display chiller status and alarms.
1. Communication Interface: ASHRAE 135 BACnet communication interface shall enable control system operator to remotely control and monitor the water chiller from an operator workstation. Control features and monitoring points displayed locally at water chiller control panel shall be available through DDC system for HVAC.

## 2.11 ACCESSORIES

- A. Spring isolators for field installation.
1. Spring Deflection: 2 inches.

## 2.12 MATERIALS

- A. Steel:
1. ASTM A36/A36M for carbon structural steel.
  2. ASTM A568/A568M for steel sheet.
- B. Stainless Steel:
1. Manufacturer's standard grade for casing.
  2. Manufacturer's standard type, ASTM A240/A240M for bare steel exposed to airstream or moisture.
- C. Galvanized Steel: ASTM A653/A653M.
- D. Aluminum: ASTM B209.
- E. Comply with Section 230546 "Coatings for HVAC" for corrosion-resistant coating.
- F. Corrosion-Resistant Coating: Coat with a corrosion-resistant coating capable of withstanding a 3000-hour salt-spray test according to ASTM B117.
1. Standards:
    - a. ASTM B117 for salt spray.
    - b. ASTM D2794 for minimum impact resistance of 100 in-lb
    - c. ASTM B3359 for cross hatch adhesion of 5B.
  2. Application: Spray.
  3. Thickness: 1 mil.
  4. Gloss: Minimum gloss of 60 on a 60-degree meter.

## 2.13 SOURCE QUALITY CONTROL

- A. Perform functional test of water chillers before shipping.
- B. Factory performance test water chillers, before shipping, according to AHRI 550/590.
1. Test the following conditions:
    - a. Design conditions indicated.
    - b. AHRI 550/590 part-load points.

- C. Factory test and inspect evaporator according to ASME Boiler and Pressure Vessel Code: Section VIII, Division 1. Stamp with ASME label.
- D. For water chillers located outdoors, rate sound power level according to AHRI 370 procedure.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Before water chiller installation, examine roughing-in for equipment support, anchor-bolt sizes and locations, piping, controls, and electrical connections to verify actual locations, sizes, and other conditions affecting water chiller performance, maintenance, and operations.
  - 1. Water chiller locations indicated on Drawings are approximate. Determine exact locations before roughing-in for piping, controls, and electrical connections.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 WATER CHILLER INSTALLATION**

- A. Coordinate sizes, locations, and anchoring attachments of structural-steel support structures with actual equipment provided.
- B. Maintain manufacturer's recommended clearances for service and maintenance.
- C. Maintain clearances required by governing code.
- D. Chiller manufacturer's factory-trained service personnel shall charge water chiller with refrigerant if not factory charged and fill with oil if not factory installed.
- E. Install separate devices furnished by manufacturer and not factory installed.
  - 1. Chillers shipped in multiple major assemblies shall be field assembled by chiller manufacturer's factory-trained service personnel.

#### **3.03 PIPING CONNECTIONS**

- A. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 "Hydronic Piping Specialties." Drawings indicate general arrangement of piping, fittings, and specialties.
- B. Where installing piping adjacent to chillers, allow space for service and maintenance.
- C. Evaporator Fluid Connections:
  - 1. Connect to evaporator inlet with shutoff valve, strainer, flexible connector, thermometer, and plugged tee with pressure gage.
  - 2. Connect to evaporator outlet with shutoff valve, flexible connector, flow switch, thermometer, plugged tee with pressure gage, and drain connection with valve.
  - 3. Make connections to water chiller with a union, flange, or mechanical coupling.
- D. Connect each drain connection with a drain valve, full size of drain connection.
- E. Connect each chiller vent connection with an automatic vent, full size of vent connection.

#### **3.04 ELECTRICAL POWER CONNECTIONS**

- A. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."



- B. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- C. Provide nameplate for each electrical connection indicating electrical equipment designation and circuit number feeding connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high. Locate nameplate where easily visible.

### 3.05 CONTROLS CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring between chillers and other equipment to interlock operation as required to provide a complete and functioning system.
- C. Connect control wiring between chiller control interface and DDC system for remote monitoring and control of chillers. Comply with requirements in Section 230923 "Direct Digital Control (DDC) System for HVAC."
- D. Provide nameplate on face of chiller control panel indicating control equipment designation serving chiller and the I/O point designation for each control connection. Nameplate shall be laminated phenolic layers of black with engraved white letters at least 1/2 inch high.

### 3.06 STARTUP SERVICE

- A. Engage a factory-authorized service representative to perform startup service.
- B. Inspect field-assembled components, equipment installation, and piping and electrical connections for proper assemblies, installations, and connections.
- C. Complete installation and startup checks according to manufacturer's written instructions and perform the following:
  - 1. Verify that refrigerant charge is sufficient and water chiller has been leak tested.
  - 2. Verify that pumps are installed and functional.
  - 3. Verify that thermometers and gages are installed.
  - 4. Operate water chiller for run-in period.
  - 5. Check bearing lubrication and oil levels.
  - 6. Verify proper motor rotation.
  - 7. Verify static deflection of vibration isolators, including deflection during water chiller startup and shutdown.
  - 8. Verify and record performance of chilled-water flow and low-temperature interlocks.
  - 9. Verify and record performance of water chiller protection devices.
  - 10. Test and adjust controls and safeties. Replace damaged or malfunctioning controls and equipment.
- D. Visually inspect chiller for damage before starting. Repair or replace damaged components, including insulation. Do not start chiller until damage that is detrimental to operation has been corrected.
- E. Prepare a written startup report that records results of tests and inspections.

### 3.07 DEMONSTRATION

- A. Engage a factory-authorized service representative to train Owner's maintenance personnel to adjust, operate, and maintain water chillers. Video record the training sessions and provide electronic copy to Owner.

1. Instructor shall be factory trained and certified.
2. Provide not less than two hours of training.
3. Train personnel in operation and maintenance and to obtain maximum efficiency in plant operation.
4. Provide instructional videos showing general operation and maintenance that are coordinated with operation and maintenance manuals.
5. Obtain Owner sign-off that training is complete.
6. Owner training shall be held at Project site.

END OF SECTION 236423.13

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# Stillwater Housing Authority

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# FAN COIL UNITS

**SECTION 238219  
FAN COIL UNITS**

**PART 1 - GENERAL**

**1.01 RELATED DOCUMENTS**

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

**1.02 SUMMARY**

- A. Section Includes:
  - 1. Ductless fan coil units and accessories.
  - 2. Ducted fan coil units and accessories.

**1.03 ACTION SUBMITTALS**

- A. Product Data: For each type of product.
  - 1. Include rated capacities, operating characteristics, and furnished specialties and accessories.
- B. Shop Drawings:
  - 1. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and location and size of each field connection.
  - 2. Include diagrams for power, signal, and control wiring.

**1.04 INFORMATIONAL SUBMITTALS**

- A. Coordination Drawings: Floor plans, reflected ceiling plans, and other details, drawn to scale, on which the following items are shown and coordinated with each other, based on input from installers of the items involved:
  - 1. Suspended ceiling components.
  - 2. Structural members to which fan coil units will be attached.
  - 3. Method of attaching hangers to building structure.
  - 4. Size and location of initial access modules for acoustical tile.
  - 5. Items penetrating finished ceiling, including the following:
    - a. Lighting fixtures.
    - b. Air outlets and inlets.
    - c. Speakers.
    - d. Sprinklers.
    - e. Access panels.
  - 6. Perimeter moldings.
- B. Field quality-control reports.

**1.05 CLOSEOUT SUBMITTALS**

- A. Operation and Maintenance Data: For fan coil units to include in emergency, operation, and maintenance manuals.
  - 1. In addition to items specified in Section 017823 "Operation and Maintenance Data," include the following:
    - a. Maintenance schedules and repair part lists for motors, coils, integral controls, and filters.

**1.06 MAINTENANCE MATERIAL SUBMITTALS**

- A. Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
  - 1. Fan Coil Unit Filters: Furnish 1 spare filter for each filter installed.
  - 2. Fan Belts: Furnish 1 spare belt for each unit with belt driven fans.

**1.07 QUALITY ASSURANCE**

- A. Comply with NFPA 70.
- B. ASHRAE Compliance: Applicable requirements in ASHRAE 62.1, Section 5 - "Systems and Equipment" and Section 7 - "Construction and Startup."
- C. ASHRAE/IES 90.1 Compliance: Applicable requirements in ASHRAE/IES 90.1, Section 6 - "Heating, Ventilating, and Air-Conditioning."

**1.08 COORDINATION**

- A. Coordinate layout and installation of fan coil units and suspension system components with other construction that penetrates or is supported by ceilings, including light fixtures, HVAC equipment, fire-suppression-system components, and partition assemblies.

**1.09 WARRANTY**

- A. Special Warranty: Manufacturer agrees to repair or replace components of fan coil units that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: 2 years from date of Substantial Completion.

**PART 2 - PRODUCTS**

**2.01 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. Factory-packaged and -tested units rated according to AHRI 440, ASHRAE 33, and UL 1995.

**2.02 DUCTLESS FAN COIL UNITS**

- A. Fan Coil Unit Configurations: Row split.
  - 1. Number of Heating Coils: One.
  - 2. Number of Cooling Coils: One.
- B. Drain Pans: Corrosion resistant drain pan material. Fabricate pans and drain connections to comply with ASHRAE 62.1.
- C. Chassis: Galvanized steel.
- D. Cabinet: Steel with baked-enamel finish in manufacturer's standard paint color.
  - 1. Ceiling Unit Trim Panel: 4-way supply discharge grille, and panel-type return grille. Return grille shall provide maintenance access to fan coil unit.
  - 2. Steel recessing flanges for recessing fan coil units into ceiling or wall.



- E. Filters: Minimum arrestance and a minimum efficiency reporting value (MERV) according to ASHRAE 52.2 and all addendums.
  - 1. Washable Foam: 70 percent arrestance and MERV 3.
- F. Hydronic Coils: Copper tube with mechanically bonded aluminum fins.
- G. Fan and Motor Board: Removable.
  - 1. Fan: Forward curved, double width, centrifugal; directly connected to motor. Thermoplastic or painted-steel wheels, and aluminum, painted-steel, or galvanized-steel fan scrolls.
  - 2. Motor: Permanently lubricated, multispeed; resiliently mounted on motor board. Comply with requirements in Section 230513 "Common Motor Requirements for HVAC Equipment."
  - 3. Wiring Termination: Connect motor to chassis wiring with plug connection.
- H. Interface with DDC System for HVAC Requirements:
  - 1. Interface relay for scheduled operation.
  - 2. Interface relay to provide indication of fault at the central workstation.
  - 3. Provide BACnet interface for central DDC system for HVAC workstation for the following functions:
    - a. Adjust set points.
    - b. Fan coil unit start, stop, and operating status.
    - c. Data inquiry, including supply- and room-air temperature and humidity.
    - d. Occupied and unoccupied schedules.
- I. Electrical Connection: Factory wire motors and controls for a single electrical connection.

## 2.03 DUCTED FAN COIL UNITS

- A. Fan Coil Unit Configurations: Row split.
  - 1. Number of Heating Coils: One.
  - 2. Number of Cooling Coils: One.
- B. Coil Section Insulation: 1/2-inch-thick, glass fiber complying with ASTM C1071 and attached with adhesive complying with ASTM C916.
  - 1. Surface-Burning Characteristics: Insulation and adhesive shall have a combined maximum flame-spread index of 25 and smoke-developed index of 50 when tested according to ASTM E84 by a qualified testing agency.
  - 2. Airstream Surfaces: Surfaces in contact with the airstream shall comply with requirements in ASHRAE 62.1.
- C. Chassis: Galvanized steel.
- D. Cabinets: Steel with baked-enamel finish in manufacturer's standard paint color.
- E. Hydronic Coils: Copper tube with mechanically bonded aluminum fins.
- F. Direct-Driven Fans: Double width, forward curved, centrifugal; with permanently lubricated, multispeed motor resiliently mounted in the fan inlet. Aluminum or painted-steel wheels, and painted-steel or galvanized-steel fan scrolls.
- G. Interface with DDC System for HVAC Requirements:

1. Interface relay for scheduled operation.
2. Interface relay to provide indication of fault at the central workstation.
3. Provide BACnet interface for central DDC system for HVAC workstation for the following functions:
  - a. Adjust set points.
  - b. Fan coil unit start, stop, and operating status.
  - c. Data inquiry, including supply- and room-air temperature and humidity.
  - d. Occupied and unoccupied schedules.

H. Electrical Connection: Factory wire motors and controls for a single electrical connection.

### **PART 3 - EXECUTION**

#### **3.01 EXAMINATION**

- A. Examine areas, with Installer present, to receive fan coil units for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
- B. Examine roughing-in for piping and electrical connections to verify actual locations before fan coil unit installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

#### **3.02 INSTALLATION**

- A. Install fan coil units level and plumb.
- B. Install fan coil units to comply with NFPA 90A.
- C. Suspend fan coil units from structure with elastomeric hangers.
- D. Verify locations of thermostats, humidistats, and other exposed control sensors with Drawings and room details before installation. Install devices 48 inches above finished floor.
- E. Install new filters in each fan coil unit within two weeks after Substantial Completion.

#### **3.03 CONNECTIONS**

- A. Piping installation requirements are specified in other Sections. Drawings indicate general arrangement of piping, fittings, and specialties. Specific connection requirements are as follows:
  1. Install piping adjacent to machine to allow service and maintenance.
  2. Connect piping to fan coil unit factory hydronic piping package. Install piping package if shipped loose.
  3. Connect condensate drain to indirect waste.
    - a. Install cleanouts in piping at changes of direction.
- B. Connect outside-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.
- C. Connect supply-air and return-air ducts to fan coil units with flexible duct connectors specified in Section 233300 "Air Duct Accessories." Comply with safety requirements in UL 1995 for duct connections.

- D. Ground equipment according to Section 260526 "Grounding and Bonding for Electrical Systems."
- E. Connect wiring according to Section 260519 "Low-Voltage Electrical Power Conductors and Cables."

**3.04 FIELD QUALITY CONTROL**

- A. Perform the following tests and inspections:
  - 1. Operational Test: After electrical circuitry has been energized, start units to confirm proper motor rotation and unit operation.
  - 2. Test and adjust controls and safety devices. Replace damaged and malfunctioning controls and equipment.
- B. Remove and replace malfunctioning units and retest as specified above.
- C. Prepare test and inspection reports.

**3.05 ADJUSTING**

- A. Adjust initial temperature and humidity set points.
- B. Occupancy Adjustments: When requested within 12 months of date of Substantial Completion, provide on-site assistance in adjusting system to suit actual occupied conditions. Provide up to two visits to Project during other-than-normal occupancy hours for this purpose.

**3.06 DEMONSTRATION**

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fan coil units.

**END OF SECTION 238219**



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