SECTION 23 8300
RADIANT HEATING UNITS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Hydronic radiant panel heaters.

B. Electric radiant ceiling panel heaters.

C. Radiant heating hydronic piping.

D. Outdoor electric roof, gutter, and downspout deicing.

1.02 RELATED REQUIREMENTS

A. Section 03 3000 - Cast-in-Place Concrete.

B. Section 07 8400 - Firestopping.

C. Section 08 3100 - Access Doors and Panels.

D. Section 23 0716 - HVAC Equipment Insulation.

E. Section 23 0719 - HVAC Piping Insulation.

F. Section 23 0913 - Instrumentation and Control Devices for HVAC.

G. Section 23 0993 - Sequence of Operations for HVAC Controls.

H. Section 23 2113 - Hydronic Piping.

I. Section 23 2114 - Hydronic Specialties.

J. Section 26 2717 - Equipment Wiring: Electrical characteristics and wiring connections. Installation of room thermostats. Electrical supply to units.

1.03 REFERENCE STANDARDS

A. ASHRAE Std 138 - Method of Testing for Rated Ceiling Panels for Sensible Heating and Cooling; 2013.

B. ASTM B75/B75M - Standard Specification for Seamless Copper Tube; 2011.

C. ASTM E84 - Standard Test Method for Surface Burning Characteristics of Building Materials; 2015a.

D. ASTM F876 - Standard Specification for Crosslinked Polyethylene (PEX) Tubing; 2013a.

E. ASTM F1281 - Standard Specification for Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX-AL-PEX) Pressure Pipe; 2011.

F. ASTM F1807 - Standard Specification for Metal Insert Fittings Utilizing a Copper Crimp Ring for SDR9 Cross-Linked (PEX) Tubing and SDR9 Polyethylene of Raised Temperature (PE-RT) Tubing; 2015.

G. ASTM F1974 - Standard Specification for Metal Insert Fittings for Polyethylene/Aluminum/ Polyethylene and Crosslinked Polyethylene/Aluminum/ Crosslinked Polyethylene Composite Pressure Pipe; 2009 (Reapproved 2015).

H. DIN EN 4726 - Warm Water Surface Heating Systems and Radiator Connecting Systems - Plastics Piping Systems and Multilayer Piping Systems; 2008.

I. DIN 14037-2 - Ceiling Mounted Radiant Panels Supplied with Water at a Temperature Below 120 Degrees C; Part 2: Test Method for Thermal Output; 2003.

J. DIN 14037-3 - Ceiling Mounted Radiant Panels Supplied with Water at a Temperature Below 120 Degrees C; Part 3: Rating Method and Evaluation of Radiant Thermal Output; 2003.

K. NFPA 70 - National Electrical Code; Most Recent Edition Adopted by Authority Having Jurisdiction, Including All Applicable Amendments and Supplements.

1.04 ADMINISTRATIVE REQUIREMENTS

A. Preinstallation Meeting: Conduct a preinstallation meeting one week prior to the start of the work of this section; require attendance by all affected installers.

B. Sequencing: Ensure that utility connections are achieved in an orderly and expeditious manner.

1.05 SUBMITTALS

A. See Section 01 3000 - Administrative Requirements, for submittal procedures.

B. Product Data: Provide data for ceiling panel heaters.

C. Shop Drawings: Indicate ceiling panel heater layout, electrical terminations, thermostats, controls, branch circuit connections, and _____.

D. Manufacturer's Installation Instructions: Indicate installation instructions and recommendations.

E. Field Quality Control Submittals: Indicate test reports, inspection reports, and _____.

F. Project Record Documents: Record actual locations of ceiling panel heaters.

G. Operation and Maintenance Data: Include manufacturer's descriptive literature, operating instructions of equipment and controls, installation instructions, maintenance and repair data, and parts listings.

H. Warranty: Submit manufacturer warranty and ensure that forms have been completed in Owner's name and registered with manufacturer.

1.06 QUALITY ASSURANCE

A. Manufacturer Qualifications: Company specializing in manufacturing products specified in this section, with not less than three years of documented experience.

B. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories Inc. as suitable for the purpose specified and indicated.

C. Copies of Documents at Project Site: Maintain at the project site a copy of each referenced document that prescribes execution requirements.

1.07 WARRANTY

A. See Section 01 7800 - Closeout Submittals, for additional warranty requirements.

PART 2 PRODUCTS

2.01 HYDRONIC RADIANT PANEL HEATERS

A. Manufacturers:
   1. Barcol-Air USA Ltd; _____: www.barcolairusa.com.
   2. Price Industries; _____: www.price-hvac.com.
   3. TWA Panel Systems, inc; _____: www.twapanels.ca.
   4. Substitutions: See Section 01 6000 - Product Requirements.

B. Modular Radiant Ceiling Panels: Heat sinks located behind panel, transfer heat between copper tubes and panel face, and radiate heat to zone.
   1. Water Tubes:
      a. ASTM B75/B75M copper tubing, 1/2 inch minimum nominal diameter.
      b. Water Connections:
         1) Same end only.
         2) Suitable for solder, compression fittings, push-on fittings, or threaded connection.
         3) Protect with removable seals. Prevent introduction of dirt and dust during shipping.
   2. Heat Sink Construction:
      a. Mechanically fasten extruded aluminum and copper pipe to heat sink.
      b. Provide non-hardening heat transfer paste between tubing, heat sink, and panel.
   3. Panel Face: Construct of minimum 18 gage (0.0403 inches) thick aluminum.
   4. Finish:

a. Apply polyester paint, manufacture's standard finish, or _____.
b. Color: As selected by Architect from manufacturer's standard range.
c. Maintain optimal radiative properties, durability, and cleanability.

5. Water Pressure Drop and Heating Output Data: Derive from factory testing in accordance with ASHRAE Std 138 or DIN 14037, Parts 2 and 3.
6. Accessories:
   a. 18 inch stainless steel braided hose with isolation ball valves for supply and return connections.

2.02 RADIANT-HEATING HYDRONIC PIPING

A. Applications:
   1. Provide the following types of hydronic, radiant heating piping for the applications described:
      a. Piping in Exterior Pavement: EPDM.
      b. Piping in Interior Reinforced Concrete Floors: EPDM.
      c. Piping in Level Fill Concrete Floors (Not Reinforced): EPDM.
      d. Piping in Ceilings: EPDM.
      e. Piping in Subfloors: EPDM.

B. Crosslinked Polyethylene (PEX) Pipe and Fittings:
   1. Manufacturers:
      a. Heat Innovations Inc; _____: www.heatinnovations.com.
      b. IPEX Inc; _____: www.ipexamerica.com.
      c. Oventrop Corporation; _____: www.oventrop-us.com.
      d. Substitutions: See Section 01 6000 - Product Requirements.
   2. Pipe Material: PEX plastic according to ASTM F876.
   3. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.000044 grains per cu ft/day at 104 degrees F according to DIN 4726.
   4. Fittings: ASTM F1807, metal insert and copper crimp rings.
   5. Pressure/Temperature Rating: Minimum 100 psig and 180 degrees F.

C. Crosslinked Polyethylene/Aluminum/Crosslinked Polyethylene (PEX/AL/PEX) Pipe and Fittings:
   1. Manufacturers:
      a. Heat Innovations Inc; _____: www.heatinnovations.com.
      b. IPEX Inc; _____: www.ipexamerica.com.
      c. Oventrop Corporation; _____: www.oventrop-us.com.
      d. Substitutions: See Section 01 6000 - Product Requirements.
   2. Pipe Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to ASTM F1281.
   3. Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.0000436996 grains per cu ft/day at 104 degrees F according to DIN 4726.
   4. Fittings: ASTM F1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).
   5. Flame Spread and Smoke Developed Indexes: 25 and 50 or less, respectively, when tested in accordance with ASTM E84.
   6. Pressure/Temperature Rating: Minimum 100 psig and 210 degrees F.

D. EPDM Pipe and Fittings:
   1. Pipe Material: Crosslinked EPDM inner and outer tubes.
   2. Wall Thickness: Minimum 1/8 inch.
   3. Oxygen Barrier: Ductile aluminum foil layer applied to the inner tube to limit oxygen diffusion through the pipe to maximum 0.0000436996 grains per cu ft/day at 104 degrees F according to DIN 4726.
   4. Reinforcing Braid: Braided-aluminum wire between the inner and outer tube.
   5. Fittings: ASTM F1807, copper with stainless-steel crimps or clamps.
   6. Pressure/Temperature Rating: Minimum 100 psig and 210 degrees F.

E. Distribution Manifolds (Manufacturer's Standard):

1. Manifold: Minimum 1 inch, brass, copper, stainless steel, or _____.
2. Main Shutoff Valves:
    a. Factory installed on supply and return connections.
    b. Two-piece brass, bronze, or _____ body.
    c. Ball: Chrome-plated bronze.
    d. Seals: PTFE.
    e. CWP Rating: 150 psig.
    f. Maximum Operating Temperature: 225 degrees F.
3. Manual Air Vents:
    a. Body to consist of bronze, brass, or _____.
    b. Internal Parts: Nonferrous.
    c. Operator: Key furnished with valve or screwdriver bit.
    d. Inlet Connection: 1/2 inch.
    e. Discharge Connection: 1/8 inch.
    f. CWP Rating: 150 psig.
    g. Maximum Operating Temperature: 225 degrees F.
4. Balancing Valves:
    a. Body: Provide plastic, bronze, or _____, plug, globe, or _____ cartridge type.
    b. Plug: EPDM.
    c. Globe Cartridge and Washer: Brass with EPDM composition washer.
    d. Seat: PTFE.
    e. Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.
    f. Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.
    g. Handle Style: Knob, with memory stop to retain set position if used for shutoff.
    h. CWP Rating: Minimum 125 psig.
    i. Maximum Operating Temperature: 250 degrees F.
5. Zone Control Valves:
    a. Body: Provide brass, bronze, or _____, plug, globe, or _____ cartridge type.
    b. Plug: EPDM.
    c. Globe Cartridge and Washer: Brass with EPDM composition washer.
    d. Seat: PTFE.
    e. Actuator: Replaceable electric motor.
    f. CWP Rating: Minimum 125 psig.
    g. Maximum Operating Temperature: 250 degrees F.
6. Thermometers:
    a. Mounted on supply and return connections.
    b. Case: Dry type, metal or plastic, 2 inch diameter.
    c. Element: Bi-metallic coil.
    d. Movement: Mechanical, connecting element and pointer.
    e. Dial: Satin-faced, non-reflective aluminum with permanently etched scale markings.
    f. Pointer: Black metal.
    g. Window: Plastic.
    h. Connector: Rigid, back type.
    i. Thermal System: Bi-metallic coil.
    j. Accuracy: Plus or minus 1 percent of range, 1 scale division, or _____ to maximum of 1.5 percent of range.
7. Mounting Brackets: Provide copper, plastic, rubber-clad steel, or _____, where in contact with manifold.

F. Piping Specialties (Manufacturer's Standard):
1. Cable Ties:
    a. Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.
    b. Minimum Width: 1/8 inch.

c. Minimum Tensile Strength: 20 lb.
d. Temperature Range: Minus 40 degrees F to plus 185 degrees F.

2. Floor Mounting Staples:
   a. Steel, with corrosion-resistant coating and smooth finish without sharp edges.
   b. Minimum Thickness: 3/32 inch.
   c. Width: Minimum, wider than tubing.
3. Floor Mounting Clamps:
   a. Two bolts, steel, with corrosion-resistant coating and smooth finish without sharp edges.
   b. Minimum Thickness: 3/32 inch.
   c. Width: Minimum, wider than tubing.
4. Floor Mounting Tracks:
   a. Aluminum or plastic channel track with smooth finish and no sharp edges.
   b. Minimum Thickness: 1/16 inch.
   c. Slot Width: Snap fit to hold tubing.
5. Heat-Emission Plates:
   a. Formed aluminum suitable for radiant-heating piping.
   b. Minimum Thickness: 1/16 inch.
   c. Slot Width: Snap fit to maintain pressure fit on tubing.

G. Prepackaged Pumping Station:
1. Manufacturers:
   a. IPEX Inc; _____: www.ipexamerica.com.
   b. Oventrop Corporation; _____: www.oventrop-us.com.com.
   c. Slantfin Corporation; _____: www.slantfin.com.
   d. Substitutions: See Section 01 6000 - Product Requirements.
2. Pump:
   a. Maximum Temperature: 230 degrees F.
   b. Maximum Pressure: 145 psig.
3. Mixing Valve: 3-way with adjustable bypass and 24-volt actuator.
4. Accessories:
   a. Ball valves with thermometers, temperature range of 30 to 250 degrees F.
      1) Body and Stem Material: Brass.
      2) Seal: Double-O-ring.
      3) Ball Material: Hard chrome plated brass.
      4) PTFE seats, brass collar nuts.
      5) Thermometers integrated in the handles, with indication of open and shut position.
   b. Check valve, minimum opening, differential pressure 0.30 psig.
   c. Tailpieces.
   d. Two station manifold.
   e. Differential pressure bypass.
   f. Wall mounting bracket.

2.03 OUTDOOR ELECTRIC ROOF, GUTTER, AND DOWNSPOUT DEICING

A. Manufacturers:
1. Danfoss; _____: www.danfoss.com.
2. Delta-Therm Corporation; _____: www.delta-therm.com.
3. WarmlyYours Radiant Inc; _____: www.warmlyyours.com.
4. Substitutions: See Section 01 6000 - Product Requirements.

B. Provide products listed, classified, and labeled by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.

C. Assembly:
1. Factory designed specifically for outdoor applications.

2. Conductors(s): Factory insulated, copper, copper alloy, or _____ heating cable with standard factory coating or plating.
3. Provide factory or field spliced and sealed cold lead with single point connection of sufficient length to reach designated junction boxes or power panel.

D. Controls:
1. Sensing to be based on ambient, moisture, roof, and _____ detection.
2. Controls to be stand-alone.

E. Accessories:
1. Roof clips, hooks, and downspout hangers.
2. Outdoor heating system marker for outdoor electric snow and ice melting system in accordance with NFPA 70, Article 426.

F. Electrical Characteristics:
1. Refer to Section 26 2717.

PART 3 EXECUTION

3.01 EXAMINATION

A. Hydronic Radiant Ceiling Panel Heaters:
1. Examine areas to receive radiant heating units for compliance with requirements for installation tolerances and other conditions affecting performance.
2. Examine roughing-in for hydronic piping connections to verify actual locations prior to installation.
3. Ensure surfaces in contact with radiant heating panels are free of burrs and sharp protrusions.
4. Ensure surfaces are level and plumb.
5. Proceed with installation only after unsatisfactory conditions have been corrected.

B. Hydronic Radiant Heating Piping:
1. Examine surfaces and substrates to receive radiant heating piping for compliance with requirements for installation tolerances and other conditions affecting performance of the Work.
a. Ensure that surfaces and pipes in contact with radiant heating piping are free of burrs and sharp protrusions.
b. Ensure that surfaces and substrates are level and plumb.
2. Proceed with installation only after unsatisfactory conditions have been corrected.

C. Outdoor Roof, Gutter, and Downspout Deicing:
1. Verify field measurements are as shown on Shop Drawings.
2. Any revisions needed to Shop Drawings, or product provided, must be implemented prior to proceeding with installation.
3. Verify the availability of required power, in proper location, and ready for use.

3.02 PREPARATION

A. Clean all surfaces prior to installation.

3.03 INSTALLATION

A. Install in accordance with manufacturer's recommendations.

B. Hydronic Radiant Ceiling Panel Heaters:
1. Install level and plumb.
2. Suspend from structure.
3. Support in grid-type suspended ceiling using grid as support element as follows:
a. Install a minimum of four ceiling support system rods or wires for each panel, located not more than 6 inches from panel corners.
b. Fasten support clips to panel and to ceiling grid members at or near each panel corner with clips designed for the application.

c. For panels of sizes less than ceiling grid, install as indicated on reflected ceiling plan(s) or center of acoustical panel, and support panels independently with at least two 3/4 inch metal channels spanning and secured to ceiling tees.
d. Install at least one independent support rod or wire from structure to tab on panel with breaking strength of the weight of panel at a safety factor of 3.

4. Unless otherwise indicated, install shutoff valve and union or flange at each connection.
5. Provide tamper-proof, balancing valve with memory stop on return piping.
6. Provide float operated automatic air vents with stop valve.
7. Refer to Section 23 2113 and Section 23 2114 for additional requirements.

C. Hydronic Radiant Panel Heaters: Consult manufacturer's installation manual for panels not installed in ceiling systems.

D. Hydronic Radiant Heating Piping:
1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems.
2. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations.
3. Install piping as indicated unless deviations to layout are approved on shop drawings or coordination drawings.
4. Install radiant heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
5. Connect radiant piping to manifold in a reverse-return arrangement.
6. Do not bend pipes in radius smaller than manufacturer's minimum bend radius dimension.
7. Install manifolds accessible locations, or install access panels to provide maintenance access as required in Section 08 3100.
8. Comply with requirements in Sections 23 2113 and 23 2114 for pipes and connections to hydronic systems and for glycol-solution fill requirements.
9. Fire and Smoke Barrier Penetrations:
   a. Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations.
   b. Seal pipe penetrations with firestop materials according to Section 07 8400.
10. Piping in Exterior Pavement:
   a. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
   b. Space cable ties a maximum of 18 inches and at center of turns or bends.
   c. Maintain 3 inch minimum cover.
   d. Install a sleeve of 3/8 inch thick, foam-type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints.
      1) Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.
   e. Maintain minimum 40 psig pressure in piping during concrete placement and continue for 24 hours after placement.
11. Piping in Interior Reinforced Concrete Floors:
   a. Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.
   b. Space cable ties a maximum of 18 inches and at center of turns or bends.
   c. Maintain 2 inch minimum cover.
   d. Install a sleeve of 3/8 inch thick, foam type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints.
   e. Maintain minimum 40 psig pressure in piping during concrete placement and continue for 24 hours after placement.
12. Piping in Level Fill Concrete Floors (Not Reinforced):
   a. Secure piping in concrete floors by attaching pipes to subfloor using tracks, clamps, or staples.

b. Space tracks, clamps, or staples a maximum of 18 inches o.c. and at center turn of bends.
c. Maintain 3/4 inch minimum cover.
d. Install a sleeve of 3/8 inch thick, foam type insulation or PE pipe around tubing and extending for a minimum of 10 inches on each side of slab joints to protect the tubing passing through expansion or control joints.
e. Maintain minimum 40 psig pressure in piping during the concrete pour and continue for 24 hours during curing.

13. Piping in Ceiling:
    a. Secure piping by attaching pipes to ceiling substrate using clamps or staples.
    b. Space clamps or staples a maximum of 18 inches and at center of turns or bends.
    c. Maintain 1-1/2 inch minimum plaster cover.
    d. Maintain minimum 40 psig pressure in piping during the plaster application and continue for 24 hours during curing.
14. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.
15. After system balancing has been completed, mark balancing valves to permanently indicate final position.
16. Perform the following adjustments before operating the system:
    a. Open valves to fully open position.
    b. Check operation of automatic valves.
    c. Set temperature controls so all zones call for full flow.
    d. Purge air from piping.
17. After concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant-heating system as follows:
    a. Start system heating at a maximum of 10 degrees F above the ambient radiant panel temperature and increase 10 degrees F each following day until design temperature is achieved.
    b. For freeze protection, operate at a minimum of 60 degrees F supply-water temperature.

E. Outdoor Roof, Gutter, and Downspout Deicing with Electric Cable:
1. Install in accordance with manufacturer's instructions.
2. Conform to applicable codes.
3. Cable to be laid in gutters, suspended in downspouts as a loop with downspout hanger, suspended in downspouts as a single length with downspout hanger, and attached to the roof with clips in accordance with engineered layout drawings.
4. Cut self regulating cable to length as required.
5. Make self regulating cable connections with kits supplied by the manufacturer and specifically approved by Underwriters Laboratories Inc. (UL), Intertek (ETL), or testing firm acceptable to authority having jurisdiction as suitable for the purpose indicated.
6. Pull stranded wire (cold leads) through conduit from condulets to junction boxes.

3.04 FIELD QUALITY CONTROL

A. See Section 01 4000 - Quality Requirements, for additional requirements.

B. Provide manufacturer's field representative to test, inspect, instruct, and observe.

C. Hydronic Radiant Ceiling Panel Heaters:
1. Inspect for damage to finish.
2. Repair damaged finish to match original finish.
3. Perform the following field tests, inspections, and prepare test reports:
    a. Leak Test:
        1) After installation, fill water tubes and test for leaks.
        2) Repair leaks and retest until no leaks exist.
    b. Operational Test: After electrical circuitry has been energized, start units to conform to proper unit operation.

c. Test and adjust controls and safeties.

4. Manufacturer's Field Service:
   a. Engage a factory-authorized service representative to inspect, test, and adjust field-assembled components and equipment installation, including connections, and to assist in field testing.
   b. Report any findings in writing.
5. Remove and replace damaged and malfunctioning controls and equipment and retest as specified above.

D. Hydronic Radiant Heating Piping
1. Prepare radiant heating piping for testing as follows:
   a. Open all isolation valves and close bypass valves.
   b. Open and verify operation of zone control valves.
   c. Flush with clean water and clean strainers.
2. Perform the following tests and inspections with the assistance of a factory authorized service representative:
   a. Leak Test:
      1) After installation, charge system and test for leaks.
      2) Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than 100 psig.
      3) Repair leaks and retest until no leaks exist.
3. Radiant heating piping will be considered defective if it does not pass tests and inspections.
4. Prepare test and inspection reports.
5. Protect hydronic piping system from damage during construction.

E. Outdoor Roof, Gutter, and Downspout Deicing with Electric Cable:
1. Test continuity of heating cable.
2. Perform insulation resistance (megger) test on each heater section.
3. Minimum acceptable megger reading to be based on recommendations of cable manufacturer.
4. Measure voltage and current at each unit after installation is completed.

3.05 CLEANING

A. Radiant Ceiling Panel Heaters: Remove paint splatters, other spots, dirt, and debris.

B. Outdoor Roof, Gutter, and Downspout Deicing with Electric Cable: Keep automatic control system's sensor(s) clean of dirt and debris.

3.06 CLOSEOUT ACTIVITIES

A. See Section 01 7800 - Closeout Submittals.

B. See Section 01 7900 - Demonstration and Training, for additional requirements.

C. Demonstrate Operation of Controls for the following Equipment:
1. Hydronic Radiant Ceiling Panel Heaters.
2. Outdoor Roof, Gutter, and Downspout Deicing.

3.07 PROTECTION

A. Protect installed products from damage until Date of Substantial Completion.

B. Outdoor Equipment: Touch-up, repair, or replace damaged products before Date of Substantial Completion.

END OF SECTION 23 8300