SECTION 238316 - RADIANT-HEATING HYDRONIC PIPING

Revise this Section by deleting and inserting text to meet Project-specific requirements.

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
	* + 1. RELATED DOCUMENTS

Revise this Section by deleting and inserting text to meet Project-specific requirements.

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			1. SUMMARY
				1. Section includes radiant-heating piping, including:

PEX pipe and fittings

PEX-AL-PEX pipe and fittings

Distribution manifolds

Piping specialties

Controls

* + - 1. DEFINITIONS

Retain terms that remain after this Section has been edited for a project.

* + - * 1. CWP: Cold working pressure.
				2. PEX: Crosslinked polyethylene.
				3. PEX/AL/PEX: Crosslinked polyethylene/aluminum/crosslinked polyethylene.
				4. PTFE: Polytetrafluoroethylene plastic.
			1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).
				4. Product Data: For each type of product.

Include data for piping, fittings, manifolds, specialties, and controls; include pressure and temperature ratings, oxygen-barrier performance, fire-performance characteristics, and water-flow and pressure-drop characteristics.

* + - * 1. Shop Drawings: Show piping layout and details drawn to scale, including valves, manifolds, controls, and support assemblies, and their attachments to building structure.

Shop Drawing Scale: **[1/4 inch = 1 foot] <Insert scale>**.

Retain "Coordination Drawings" paragraph below for situations where limited space necessitates maximum utilization for efficient installation of different components or if coordination is required for installation of products and materials by separate installers. Coordinate paragraph with other Sections specifying products listed below. Preparation of coordination drawings requires the participation of each trade involved in installations within the limited space.

* + - * 1. Coordination Drawings: Reflected ceiling plan(s) and other details, drawn to scale, on which the following items are shown and coordinated with each other, using input from installers of the items involved:

Suspended ceiling components.

Structural members to which radiant-heating piping will be attached.

Items penetrating finished ceiling, including the following:

Lighting fixtures.

Air outlets and inlets.

Speakers.

Sprinklers.

Access panels.

**<Insert item>**.

Perimeter moldings.

* + - 1. CLOSEOUT SUBMITTALS
				1. Operation and Maintenance Data: For radiant-heating piping valves and equipment to include in operation and maintenance manuals.
1. PRODUCTS

Manufacturers and products listed in SpecAgent and Masterworks Paragraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications.

* + - 1. PEX PIPE AND FITTINGS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Apollo Valves; a part of Aalberts Integrated Piping Systems.

Elkhart Products Corporation; a part of Aalberts Integrated Piping Systems.

FloorHeat LLC.

Heat Innovations Inc.

HeatLink Group Inc.

Infloor Radiant Heating Inc.

IPEX USA LLC.

MrPex Systems Inc.

REHAU.

SharkBite, A Division of Reliance Worldwide Corporation.

Sioux Chief Manufacturing Company, Inc.

Uponor.

Vanguard Piping Systems, Inc.

Viega LLC.

Warmboard, Inc.

Watts Radiant; A WATTS Brand.

Zurn Industries, LLC.

Approved equivalent.

* + - * 1. Pipe Material: PEX plastic according to ASTM F876.

See discussion in the Evaluations about oxygen barrier in "Oxygen Barrier" paragraph below. The referenced standard is the only standard used by plastic-tubing manufacturers that describes how to test and measure oxygen diffusion in plastic tube. It is a German national standard and is available in English; see the Evaluations for information about where it can be obtained.

* + - * 1. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
				2. Fittings: **[ASTM F1807, metal insert and copper crimp rings] [ASTM F1960, cold expansion fittings and reinforcing rings]**.
				3. Pressure/Temperature Rating: Minimum 100 psig and 180 deg F.
			1. PEX/AL/PEX PIPE AND FITTINGS
				1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Heat Innovations Inc](http://www.specagent.com/Lookup?uid=123457140912).

[IPEX USA LLC](http://www.specagent.com/Lookup?uid=123457140909).

[Uponor](http://www.specagent.com/Lookup?uid=123457140911).

[Viega LLC](http://www.specagent.com/Lookup?uid=123457140910).

[Watts Radiant; A WATTS Brand](http://www.specagent.com/Lookup?uid=123457140914).

Approved equivalent.

* + - * 1. Pipe Material: PEX plastic bonded to the inside and outside of a welded aluminum tube according to ASTM F1281.

See discussion in the Evaluations about oxygen barrier in "Oxygen Barrier" paragraph below. The referenced standard is the only standard used by plastic-tubing manufacturers that describes how to test and measure oxygen diffusion in plastic tube. It is a German national standard and is available in English; see the Evaluations for information about where it can be obtained.

* + - * 1. Oxygen Barrier: Limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
				2. Fittings: ASTM F1974, metal insert fittings with split ring and compression nut (compression joint) or metal insert fittings with copper crimp rings (crimp joint).
				3. Flame-Spread and Smoke-Developed Indices: 25 and 50 or less, respectively, tested according to ASTM E84.
				4. Pressure/Temperature Rating: Minimum 100 psig and 210 deg F.
			1. EPDM PIPE AND FITTINGS

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=3630) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Watts Radiant; A WATTS Brand](http://www.specagent.com/Lookup?uid=123457140915).

Approved equivalent.

* + - * 1. Pipe Material: Crosslinked EPDM inner and outer tubes.
				2. Wall Thickness: Minimum 0.125 inch.

See discussion in the Evaluations about oxygen barrier in "Oxygen Barrier" paragraph below. The referenced standard is the only standard used by plastic-tubing manufacturers that describes how to test and measure oxygen diffusion in plastic tube. It is a German national standard and is available in English; see the Evaluations for information about where it can be obtained.

* + - * 1. Oxygen Barrier: Ductile aluminum foil layer applied to the inner tube to limit oxygen diffusion through the pipe to maximum 0.10 mg per cu. m/day at 104 deg F according to DIN 4726.
				2. Reinforcing Braid: Braided-aluminum wire between the inner and outer tube.
				3. Fittings: ASTM F1807, copper with stainless-steel crimps or clamps.
				4. Pressure/Temperature Rating: Minimum 100 psig and 210 deg F.
			1. DISTRIBUTION MANIFOLDS
				1. Manifold: Minimum NPS 1, **[brass] [copper] [modular plastic] [or] [stainless steel]**.

Some plastic modular manifolds do not have main shutoff valves. Each piping loop on manifold has its own supply and return shutoff.

* + - * 1. Main Shutoff Valves:

Factory installed on supply and return connections.

**[Two] [Three]**-piece body.

Body: Brass or bronze.

Ball: Chrome-plated bronze.

Seals: PTFE.

CWP Rating: 150 psig.

Maximum Operating Temperature: 225 deg F.

* + - * 1. Manual Air Vents:

Body: Bronze.

Internal Parts: Nonferrous.

Operator: Key furnished with valve, or screwdriver bit.

Inlet Connection: NPS 1/2.

Discharge Connection: NPS 1/8.

CWP Rating: 150 psig.

Maximum Operating Temperature: 225 deg F.

* + - * 1. Balancing Valves:

Body: Plastic or bronze, ball or plug, or globe cartridge type.

Ball or Plug: Brass or stainless steel.

Globe Cartridge and Washer: Brass with EPDM composition washer.

Seat: PTFE.

Retain "Visual Flow Indicator" or "Differential Pressure Gage Connections" subparagraph below.

Visual Flow Indicator: Flowmeter with visible indication in a clear plastic cap at top of valve.

Differential Pressure Gage Connections: Integral seals for portable meter to measure loss across calibrated orifice.

Handle Style: Lever or knob, with memory stop to retain set position if used for shutoff.

CWP Rating: Minimum 125 psig.

Maximum Operating Temperature: 250 deg F.

* + - * 1. Zone Control Valves:

Body: Plastic or bronze, ball or plug, or globe cartridge type.

Ball or Plug: Brass or stainless steel.

Globe Cartridge and Washer: Brass with EPDM composition washer.

Seat: PTFE.

Actuator: Replaceable electric motor.

CWP Rating: Minimum 125 psig.

Maximum Operating Temperature: 250 deg F.

* + - * 1. Thermometers:

Mount on supply and return connections.

Case: Dry type, metal or plastic, **[2-inch] <Insert dimension>** diameter.

Element: Bourdon tube or other type of pressure element.

Movement: Mechanical, connecting element and pointer.

Dial: Satin-faced, nonreflective aluminum with permanently etched scale markings.

Pointer: Black metal.

Window: Plastic.

Connector: Rigid, back type.

Thermal System: Liquid- or mercury-filled bulb in copper-plated steel, aluminum, or brass stem.

Accuracy: Plus or minus 1 percent of range or plus or minus 1 scale division to maximum of 1.5 percent of range.

* + - * 1. Mounting Brackets: Copper, or plastic- or copper-clad steel, where in contact with manifold.
			1. PIPING SPECIALTIES

Cable ties are used to tie piping to reinforcing wire or bars in concrete floors.

* + - * 1. Cable Ties:

Fungus-inert, self-extinguishing, one-piece, self-locking, Type 6/6 nylon cable ties.

Minimum Width: 1/8 inch.

Tensile Strength: 20 lb, minimum.

Temperature Range: Minus 40 to plus 185 deg F.

Floor mounting staples are used to attach piping to floor, wall, or ceiling substrate.

* + - * 1. Floor Mounting Staples:

Steel, with corrosion-resistant coating and smooth finish without sharp edges.

Minimum Thickness: 3/32 inch.

Width: Minimum, wider than tubing.

Floor mounting clamps are used to attach piping to floor, wall, or ceiling substrate.

* + - * 1. Floor Mounting Clamps:

Two bolts, steel, with corrosion-resistant coating and smooth finish without sharp edges.

Minimum Thickness: 3/32 inch.

Width: Minimum, wider than tubing.

Floor mounting tracks are used to control spacing and attach piping to floor, wall, or ceiling substrate.

* + - * 1. Floor Mounting Tracks:

Aluminum or plastic channel track with smooth finish and no sharp edges.

Minimum Thickness: 1/16 inch.

Slot Width: Snap fit to hold tubing.

Slot Spacing: **[2-inch] [3-inch] <Insert dimension>** intervals.

Grooved panels are used to control pipe spacing and to attach and maintain pipe contact with subfloor. Subfloor in "Channeled Subfloor" paragraph below is a proprietary product of Warmboard.

* + - * 1. Channeled Subfloor:

Plywood, APA-rated subfloor panel, composed of premium, tongue-and-groove, seven-layer, Douglas fir structural subfloor panels.

Particleboard manufactured to comply with Federal Housing Authority standards of less than 0.3-ppm formaldehyde.

Clad panel with minimum 0.025-inch- thick aluminum recessed in the grooves sized to maintain contact with radiant piping.

Modular interlocking blocks are used to control pipe spacing and to maintain pipe contact with subfloor.

* + - * 1. Modular Interlocking Blocks:

Polypropylene snap-together blocks with grooves to support piping.

Galvanized sheet metal or aluminum emission plates.

Natural mineralboard cover panel.

Heat-emission plates are required for joist-space piping installation below the occupied space.

* + - * 1. Heat-Emission Plates:

Formed aluminum suitable for radiant-heating piping.

Minimum Thickness: 1/16 inch.

Slot Width: Snap fit to maintain pressure fit on tubing.

* + - 1. CONTROLS

Retain first paragraph below and delete remainder of this article if controls are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

* + - * 1. Temperature-control devices and sequence of operations are specified in Section 230923 "Direct Digital Control (DDC) System for HVAC" and Section 230993.11 "Sequence of Operations for HVAC DDC."

Retain and revise remainder of this article to specify controls in this Section.

* + - * 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Apollo Valves; a part of Aalberts Integrated Piping Systems.

Danfoss Inc.

HeatLink Group Inc.

Honeywell Building Solutions; Honeywell International, Inc.

Infloor Radiant Heating Inc.

IPEX USA LLC.

Oventrop Corporation.

REHAU.

Slant/Fin Corp.

tekmar; A WATTS Brand.

Vanguard Piping Systems, Inc.

Viega LLC.

Watts Radiant; A WATTS Brand.

Zurn Industries, LLC.

Approved equivalent.

Retain "Wall-Mounted Thermostat" paragraph below for room temperature control of radiant panels in ceilings and floors.

* + - * 1. Wall-Mounted Thermostat:

Minimum temperature range from **[50 to 90 deg F] <Insert temperature range>**.

Manually operated with on-off switch.

Day and night setback and clock program with minimum four periods per day.

Operate pumps or open zone control valves if room temperature falls below the thermostat setting, and stop pumps or close zone control valves when room temperature rises above the thermostat setting.

Retain "Heated-Panel Thermostat" paragraph below to limit temperature a heated panel will achieve to satisfy room thermostat.

* + - * 1. Heated-Panel Thermostat:

Remote bulb unit with adjustable temperature range from **[50 to 90 deg F] <Insert temperature range>**.

Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected pump or zone control valve.

Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing radiant-panel temperature.

Stop pump or close zone control valves if heated-panel thermostat setting is exceeded.

Corrosion-resistant, waterproof control enclosure.

Retain "Heated-Panel Thermostat with Outdoor Temperature Reset" paragraph below to limit temperature a heated panel will achieve to satisfy room thermostat and limit supply-water temperatures within outdoor temperature ranges.

* + - * 1. Heated-Panel Thermostat with Outdoor Temperature Reset:

Remote bulb unit with adjustable temperature range from **[50 to 90 deg F] <Insert temperature range>**.

Snap action; open-on-rise, single-pole switch with minimum current rating adequate for connected pump or zone control valve.

Remote bulb on capillary tube, resistance temperature device, or thermistor for directly sensing radiant-panel and outdoor-air temperature.

Operate zone control valves to reset supply-water temperature inversely with outdoor-air temperature as follows:

Low outdoor-air temperature, **[0 deg F] <Insert temperature>** with high supply-water temperature **[110 deg F] <Insert temperature>**.

High outdoor-air temperature, **[60 deg F] <Insert temperature>** with low supply-water temperature **[70 deg F] <Insert temperature>**.

Corrosion-resistant, waterproof control enclosure.

Retain "Precipitation and Temperature Sensor" paragraph below to operate radiant-heating panel for snow melting on pavement.

* + - * 1. Precipitation and Temperature Sensor:

**[Microprocessor-based] [Automatic]** control with manual on, automatic, and standby/reset switch.

Precipitation and temperature sensors shall sense the surface conditions of pavement and shall be programmed to operate pump and zone control valves as follows:

Retain and revise required features in first four subparagraphs below. Verify availability with manufacturer.

Temperature Span: **[34 to 44 deg F] <Insert temperature range>**.

Adjustable Delay Off Span: **[30 to 90] <Insert numbers>** minutes.

Start Pump or Open Zone Control Valves: Following **[two] <Insert number>**-minute delay if ambient temperature is below set point and precipitation is detected.

Stop Pump or Close Zone Control Valves: On detection of a dry surface plus time delay.

Corrosion-proof and waterproof enclosure suitable for outdoor mounting, for controls and precipitation and temperature sensors.

Minimum 30-A contactor to start pump and open valves.

Precipitation sensor shall be mounted in pavement.

Provide relay with contacts to indicate operational status, on or off, for interface with central HVAC control-system workstation.

1. EXECUTION
	* + 1. EXAMINATION
				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.

Ensure that surfaces and pipes in contact with radiant-heating piping are free of burrs and sharp protrusions.

Ensure that surfaces and substrates are level and plumb.

* + - * 1. Proceed with installation only after unsatisfactory conditions have been corrected.
			1. APPLICATIONS

Retain this article if pipe materials vary among several locations; delete to require piping materials to be the same in all applications. Consult manufacturers for specific piping recommendations. Piping sizes must be shown on Drawings.

* + - * 1. Install the following types of radiant-heating piping for the applications described:

Piping in Exterior Pavement: **[EPDM] [PEX] [PEX/AL/PEX]**.

Piping in Interior Reinforced-Concrete Floors: **[EPDM] [PEX] [PEX/AL/PEX]**.

Piping in Level Fill Concrete Floors (Not Reinforced): **[EPDM] [PEX] [PEX/AL/PEX]**.

Piping in Ceilings: **[EPDM] [PEX] [PEX/AL/PEX]**.

Piping in Subfloors: **[EPDM] [PEX] [PEX/AL/PEX]**.

Piping below Wood Floors: **[EPDM] [PEX] [PEX/AL/PEX]**.

* + - 1. INSTALLATION
				1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicate piping locations and arrangements if such were used to size pipe and calculate friction loss, expansion, pump sizing, and other design considerations. Install piping as indicated unless deviations to layout are approved on Shop Drawings or coordination drawings.
				2. Install radiant-heating piping continuous from the manifold through the heated panel and back to the manifold without piping joints in heated panels.
				3. Connect radiant piping to manifold in a reverse-return arrangement.
				4. Do not bend pipes in radii smaller than manufacturer's minimum bend radius dimensions.
				5. Install manifolds in accessible locations, or install access panels to provide maintenance access as required in Section 083113 "Access Doors and Frames."
				6. Comply with requirements in Section 232113 "Hydronic Piping" and Section 232116 Hydronic Piping Specialties" for pipes and connections to hydronic systems and for glycol-solution fill requirements.
				7. Fire- and Smoke-Barrier Penetrations: Maintain indicated fire rating of walls, partitions, ceilings, and floors at pipe penetrations. Seal pipe penetrations with firestop materials according to Section 078413 "Penetration Firestopping."
				8. Piping in Exterior Pavement:

Consult manufacturer for minimum dimensions required in subparagraphs below.

Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.

Space cable ties a maximum of **[18 inches] <Insert dimension>** o.c. and at center of turns or bends.

Maintain **[3-inch] <Insert dimension>** minimum cover.

Install a sleeve of 3/8-inch- thick, foam-type insulation or PE pipe around tubing and extending for a minimum of **[10 inches] <Insert dimension>** on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.

Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.

* + - * 1. Piping in Interior Reinforced-Concrete Floors:

Consult manufacturer for minimum dimensions required in subparagraphs below.

Secure piping in concrete floors by attaching pipes to reinforcement using cable ties.

Space cable ties a maximum of **[18 inches] <Insert dimension>** o.c. and at center of turns or bends.

Maintain **[2-inch] <Insert dimension>** minimum cover.

Install a sleeve of 3/8-inch- thick, foam-type insulation or PE pipe around tubing and extending for a minimum of **[10 inches] <Insert dimension>** on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.

Maintain minimum 40-psig pressure in piping during concrete placement and continue for 24 hours after placement.

* + - * 1. Piping in Level Fill Concrete Floors (Not Reinforced):

Consult manufacturer for minimum dimensions required in subparagraphs below.

Secure piping in concrete floors by attaching pipes to subfloor using tracks, clamps, or staples.

Space tracks, clamps, or staples a maximum of **[18 inches] <Insert dimension>** o.c. and at center of turns or bends.

Maintain **[3/4-inch] <Insert dimension>** minimum cover.

Install a sleeve of 3/8-inch- thick, foam-type insulation or PE pipe around tubing and extending for a minimum of **[10 inches] <Insert dimension>** on each side of slab joints to protect the tubing passing through expansion or control joints. Anchor sleeve to slab form at control joints to provide maximum clearance for saw cut.

Maintain minimum 40-psig pressure in piping during the concrete pour and continue for 24 hours during curing.

* + - * 1. Piping in Ceiling:

Consult manufacturer for minimum dimensions required in subparagraphs below.

Secure piping by attaching pipes to ceiling substrate using clamps or staples.

Space clamps or staples a maximum of **[18 inches] <Insert dimension>** o.c. and at center of turns or bends.

Maintain **[1-1/2-inch] <Insert dimension>** minimum plaster cover.

Maintain minimum 40-psig pressure in piping during the plaster application and continue for 24 hours during curing.

* + - * 1. Piping in Subfloor:

Secure piping by laying in subfloor channels or modular interlocking blocks.

Use straight channel panels or blocks in the center and curved channel panels or blocks at the ends.

Finish floor with mineralboard panel cover or finished floor surface.

* + - * 1. Piping below Wood Floor:

Consult manufacturer for minimum dimensions required in subparagraphs below.

Secure piping by attaching pipes to subfloor using heat-emission plates, clamps, or staples.

Space heat-emission plates, clamps, or staples a maximum of **[4 inches] <Insert dimension>** o.c. and at center of turns or bends.

Install heat-emission plates on underside of wood subfloor with maximum space between plates, as noted above, to maintain pipe contact with floor.

* + - * 1. Revise locations and elevations from those indicated as required to suit field conditions and ensure integrity of piping and as approved by Architect.
				2. After system balancing has been completed, mark balancing valves to permanently indicate final position.
				3. Perform the following adjustments before operating the system:

Open valves to fully open position.

Check operation of automatic valves.

Set temperature controls so all zones call for full flow.

Purge air from piping.

* + - * 1. After concrete or plaster heating panel has cured as recommended by concrete or plaster supplier, operate radiant-heating system as follows:

Start system heating at a maximum of 10 deg F above the ambient radiant-panel temperature and increase 10 deg F each following day until design temperature is achieved.

For freeze protection, operate at a minimum of 60 deg F supply-water temperature.

* + - 1. FIELD QUALITY CONTROL
				1. Prepare radiant-heating piping for testing as follows:

Open all isolation valves and close bypass valves.

Open and verify operation of zone control valves.

Flush with clean water and clean strainers.

* + - * 1. Perform the following tests and inspections**[ with the Company Field Advisor per OGS Spec Section 014216]**:

Leak Test: After installation, charge system and test for leaks. Subject piping to hydrostatic test pressure that is not less than 1.5 times the design pressure but not more than **[100 psig] <Insert value>**. Repair leaks and retest until no leaks exist.

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

* + - * 1. Radiant-heating piping will be considered defective if it does not pass tests and inspections.
				2. Prepare test and inspection reports.
				3. Protect hydronic piping system from damage during construction.

END OF SECTION 238316