

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Radiant floor heating and snow melting systems for various applications and control strategies, using Onix™ (EPDM) tubing and appropriate fittings.

1.2 RELATED SECTIONS

- A. Section 02551 – Underground Hydronic Piping
- B. Section 03300 – Concrete
- C. Section 06100 – Rough Carpentry
- D. Section 07210 – Insulation
- E. Section 15093 – Sleeves and Sleeve Seals for HVAC Piping
- F. Section 15181 – Hydronic Piping

1.3 REFERENCES

- A. General: Standards listed by reference, including revisions by issuing authority, form a part of this specification section to the extent indicated. Standards listed are identified by issuing authority, authority abbreviation, designation number, title or other designation established by issuing authority. Standards subsequently referenced herein are referred to by issuing authority abbreviation and standard designation.
- B. ASTM International:
 - 1. ASTM D380 Standard Test Methods for Rubber Hose
 - 2. ASTM D395 Standard Test Methods for Rubber Property – Compression Set
 - 3. ASTM D412 Standard Test Methods for Vulcanized Rubber and Thermoplastic Elastomers - Tension
 - 4. ASTM D413 Standard Test Methods for Rubber Property – Adhesion to Flexible Substrate
 - 5. ASTM D471 Standard Test Method for Rubber Property – Effect of Liquids
 - 6. ASTM D573 Standard Test Method for Rubber – Deterioration in an Air Oven
 - 7. ASTM D1149 Standard Test Method for Rubber Deterioration – Surface Ozone Cracking in a Chamber
- C. Certified to International Code Council (ICC) by NSF:
 - 1. ICC Evaluation Service (ES) Evaluation Report No. ESR 1155
- D. International Code Council (ICC):
 - 1. ICC Evaluation Service (ES) Legacy Report No. 95-47.02

Specification: Onix

- E. Watts Radiant
 - 1. Onix Installation Manual
 - 2. RadiantWorks Professional Software

1.4 SYSTEM DESCRIPTION

- A. Design Requirements:
 - 1. Onix (EPDM) Tubing/Pressure Ratings:
 - a. Tubing shall be rated for continuous working pressures of 100 psi (689 kPa) and 180° F (82° C).
 - b. Tubing shall be rated for a burst pressure of not less than 800 psi (5516 kPa) at 70° F (21° C) or 600 psi (4137 kPa) at 180° F (82° C).
- B. Performance requirements: Provide Hydronic system that is manufactured, fabricated and installed to comply with regulatory agencies and authorities with jurisdiction, and maintain performance criteria stated by the tubing manufacturer without defects, damage, or failure.
 - 1. Onix (EPDM) Tubing
 - a. Show compliance with ASTM D380
 - b. Show compliance with ASTM D395
 - c. Show compliance with ASTM D412
 - d. Show compliance with ASTM D413
 - e. Show compliance with ASTM D471
 - f. Show compliance with ASTM D573
 - g. Show compliance with ASTM D1149

1.5 SUBMITTALS

- A. General: Submit listed submittals in accordance with Conditions of the Contract and Division 1 Submittal Procedures Section.
- B. Product Data: Submit manufacturer's product submittal data and installation instructions for each product.
- C. Shop Drawings – Hydronic System
 - 1. Provide engineering analysis using manufacturer's proprietary software.
 - 2. Provide installation drawings indicating tubing layout, manifold locations, zoning requirements, and manifold schedules with details required for installation of the system.
 - 3. Provide mechanical schematic indicating heat source, mechanical piping and accessories from heat source to manifolds, circulators, water tempering, and zone controls. Indicate supply water temperatures and flow rates to manifolds.
- D. Samples: Submit selection and verification samples of primary materials.
- E. Documentation:
 - 1. Provide manufacturer's detailed instructions for site preparation and product installation.
 - 2. Provide manufacturer's electrical power requirements and heat output in watts delivered to the structure.

3. Provide documentation indicating the installer is trained to install the manufacturer's products, as needed.
- F. Quality Assurance and Control Submittals:
1. Upon request, submit test reports from recognized testing laboratories.
- G. Closeout Submittals – Submit the following:
1. Warranty documents specified
 2. Operation and maintenance data
 3. Manufacturer's field reports as specified in this document
 4. Final as-built tubing layout drawing

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications:
1. Manufacturer shall have a minimum of ten years experience in similar systems.
 2. Manufacturer shall provide products of consistent quality in appearance and physical properties.
 3. Manufacturer shall use the highest quality products in the production of systems and components referenced in this document.
 4. Materials shall be from a single manufacturer to ensure consistent quality and compatibility.
- B. Installer Qualifications:
1. Use and installer with demonstrated experience on projects of similar size and complexity and/or documentation proving successful completion of familiarization training hosted/approved in writing by the system manufacturer.
 2. Electrical rough-in and connections shall be done by a licensed electrician.
- C. Certifications: Provide letters of certification as follows:
1. Installer employs skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed trades person.
- D. Regulatory Requirements and Approvals – Hydronic Systems: Provide a radiant system that complies with the following requirements:
1. International Code Council (ICC):
 - a. International Mechanical Code (IMC)
 - b. International Building Code (IBC)
 - c. ICC Evaluation Service (ES) Evaluation Report No. ESR 1155
 2. International Association of Plumbing and Mechanical Officials (IAPMO):
 - a. Uniform Mechanical Code (UMC)
- E. Pre-installation meetings
1. Verify project requirements, substrate conditions, excavation conditions, system performance requirements, coverings, manufacturer's installation instructions, and warranty requirements.
 2. Review project construction timeline to ensure compliance or discuss modifications as required.
 3. Coordinate with other trade representatives to verify areas of responsibility.

Specification: Onix

4. Establish the frequency (during construction phase of the project) the engineer intends for site visits and inspections by the manufacturer's representative.
- F. Mock-up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 1. Finish areas designated by Architect
 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
 3. Refinish mock-up area as required to produce acceptable work

1.7 DELIVERY, STORAGE, AND HANDLING

- A. General: Comply with Division 1 Product Requirements Section.
- B. Comply with manufacturer's ordering instructions and lead-time requirements to avoid construction delays.
- C. Deliver materials in manufacturer's original, unopened, undamaged containers with identification labels intact.
- D. Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer:
 1. Store tubing in cartons or under cover to avoid dirt or foreign material from entering the tubing.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
- B. Mortar-set Systems: Mortar shall cure for 25 days (or time specified by mortar manufacturer) prior to starting heating systems.

1.9 WARRANTY

- A. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.
- B. Manufacturer's Warranty – Hydronic Systems
 1. Submit, for Owner's acceptance, manufacturer's standard warranty document executed by authorized company official.
 2. Manufacturer's warranty is in addition to, and not a limitation of, other rights Owner may have under contract documents.
 - a. Warranty covers the repair or replacement of any tubing or fittings proven defective.
 - b. Warranty may transfer to subsequent owners.
 - c. Warranty Period for Tubing is 25-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.

- d. Warranty Period for Manifolds and Fittings is 2-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.
- e. Warranty period for Controls and Electrical components is a 2-year, non-prorated warranty against failure due to defect in material or workmanship, beginning with date of substantial completion.

1.10 SYSTEM START-UP

- A. Do not start the system for a minimum of 25 days or as specified by mortar, concrete and/or covering manufacturer as applicable.
- B. Verify all electrical components are installed per local and National Electrical Code (NEC) prior to start-up.

1.11 OWNER'S INSTRUCTIONS

- A. Instruct Owner about operation and maintenance of installed system.
- B. Provide Owner with manufacturer's installation instructions for installed components within the system.
- C. Provide Owner with all operating instructions/documents for sensors and controls.
- D. Provide Owner with copies of any detailed layout drawings and photos of installed product before coverings are installed.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer:
 - Watts Radiant, Inc.
 - (Subsidiary of Watts Water Technologies, Inc.)
 - 4500 E. Progress Place
 - Springfield, MO 65803
 - (800) 276-2419; (417) 864-6108; Fax: (417) 864-8161
 - Web: <http://www.wattsradiant.com>
- B. Substitutions: not permitted

2.2 PRODUCT CHARACTERISTICS

- A. Material: Spiral-braided multi-composite design constructed of:
 - 1. a Durel inner tube,
 - 2. an Aluminum AlumaShield solid oxygen diffusion barrier,
 - 3. a contour extrusion layer,
 - 4. an Aramid reinforced fiber, and,
 - 5. an outer cover of HiGuard.

Specification: Onix

- B. Pressure Ratings: Refer to Design requirements.
- C. Temperature/Pressure Ratings:
 - 1. Tubing shall be capable of withstanding temperatures of -35°F (-37°C) to 325°F (163°C) intermittently without delimitation.
 - 2. Tubing shall be listed to 180°F (82°C) at 100 psi (689 kPa).
 - 3. Tubing shall remain flexible at temperatures down to -35°F (-35°C).
- D. UV Resistance: Tubing shall be UV resistant, so as not to deteriorate when exposed to continuous sunlight.
- E. Crushability: Tubing shall be crush-proof, recovering its original cross-section area after flattening due to construction, site, or installation abuse.
- F. Minimum Bend Radius:
 - 1. $\frac{3}{8}$ " (9.53 mm) Onix has a 3" (76 mm) bend radius
 - 2. $\frac{1}{2}$ " (12.7 mm) Onix has a 4" (102 mm) bend radius
 - 3. $\frac{5}{8}$ " (15.88 mm) Onix has a 5" (127 mm) bend radius
 - 4. $\frac{3}{4}$ " (19.05 mm) Onix has a 6" (152 mm) bend radius
 - 5. 1" (25.4 mm) Onix has a 8" (203 mm) bend radius
- G. Barrier Tubing Type: Watts Radiant Onix Tubing
 - 1. Tubing shall have an oxygen permeation inhibitor.
 - a. The oxygen barrier shall be completely encapsulated in the tubing, protected by an outside cover.
 - b. The oxygen barrier shall be made of a solid aluminum material.
 - c. The resistance shall be consistent across the entire temperature rating 0 to 180°F (-18 to 82°C).
 - 2. Nominal Inside Diameter: Provide tubing with the following nominal inside diameters:
 - a. $\frac{3}{8}$ " (9.53 mm)
 - b. $\frac{1}{2}$ " (12.7 mm)
 - c. $\frac{5}{8}$ " (15.88 mm)
 - d. $\frac{3}{4}$ " (19.05 mm)
 - e. 1" (25.4 mm)

2.3 MANIFOLDS AND FITTINGS

- A. Manifolds (Residential and light Commercial, Stainless Steel)
 - 1. For system compatibility, use 1 or $1\frac{1}{2}$ " (25 – 38mm) Stainless Steel manifolds offered by the respective tubing manufacturer.
 - 2. Manifolds shall provide individual flow control for each loop of the manifold through valve actuators available from the manifold supplier.
 - 3. Manifolds shall feature manual flow balancing capability within the manifold body for balancing unequal loop lengths across the manifold. Balance valves shall not be ball valves.
 - 4. Manifolds accommodate $\frac{3}{8}$ - $\frac{3}{4}$ " (9.5 – 19 mm) Onix tubing.
 - 5. Each manifold location shall have the ability to vent air manually from the system.
 - 6. Stainless Steel 1" (25 mm) Manifolds
 - a. Heavy-duty, DIN Standard, 304 stainless steel

- b. Matching fittings and accessories are made of solid brass and are heavily plated with nickel to match the appearance of the manifold trunk.
 - c. Internal balancing valves
 - d. 0 - 2½ gpm (0 – 0.16 L/sec) flow meters
 - e. Manifold brackets
 - f. All connections are BSP (British Standard Pipe) or straight thread and require the use of the included gasket.
 - g. 2⅛" (54 mm) OC circuit spacing
 - h. 12 gpm (.75 L/sec) maximum flow rate
 - i. 194°F (90°C) maximum operating temperature
 - j. 87 psi (600 kPa) maximum operating pressure
 - k. 2½ gpm (0.16 L/sec) per circuit maximum flow rate
7. Stainless Steel 1½" (38 mm) Manifolds
- a. Heavy-duty, DIN Standard, 304 stainless steel
 - b. Matching fittings and accessories are made of solid brass and are heavily plated with nickel to match the appearance of the manifold trunk.
 - c. Internal balancing valves
 - d. 0 - 4 gpm (0 – 0.25 L/sec) flow meters
 - e. Manifold brackets
 - f. All connections are BSP (British Standard Pipe) or straight thread and require the use of the included gasket.
 - g. 2⅛" (54 mm) OC circuit spacing
 - h. 22 gpm (1.4 L/sec) maximum flow rate
 - i. 194°F (90°C) maximum operating temperature
 - j. 87 psi (600 kPa) maximum operating pressure
 - k. 4 gpm (0.25 L/sec) per circuit maximum flow rate
- B. Manifolds (Commercial, Copper)
- 1. Provide 1" (25 mm) or larger Copper manufactured from L-copper and offered by the respective tubing manufacturer for system compatibility.
 - a. Install manifolds with optional isolation valves located on both the supply and return manifold.
 - b. Each manifold location shall have the ability to vent air manually from the system.
 - 2. Provide Copper manifolds approved for use in systems free of ferrous materials, or isolate ferrous material to eliminate corrosion damage due to oxygen diffusion.
 - 3. Balancing:
 - a. Design individual loop lengths across the manifold with 10% of each other in length.
 - b. Install supply and return piping to the manifold in a reverse-return configuration to ensure self-balancing.
 - c. Where the supply and return piping is in direct-return configuration, use manifolds with balancing valves or balance flow setters on the return leg of each manifold to the mains.
- C. Manifold Mounting Boxes
- 1. Sizes – Watts Radiant manifold mounting boxes come in 3 sizes:
 - a. 15¾" by 28½" by 4¼" (400mm by 724 mm by 108 mm)
 - b. 24½" by 28½" by 4⅜" (622mm by 724 mm by 111 mm)
 - c. 39½" by 28½" by 4⅜" (1003mm by 724 mm by 111 mm)

Specification: Onix

2. Each box shall be designed to be recessed into a 4" or 6" (102 mm or 152 mm) stud wall.
 3. Included elevators can raise the box from 1½" to 4½" (38 – 114 mm) off of the floor.
 4. Each manifold box is constructed of powder-coated sheet metal, providing increased resistance to corrosion and job-site abuse.
 5. Inside Manifold Mounting Brackets:
 - a. Manifold boxes come with 2 fixed horizontal attachment rails and 2 adjustable rails.
 - b. Each Watts Radiant manifold option will utilize different rail positions, depending on the bracket used.
- D. Fittings
1. For system compatibility, use fittings offered by the tubing manufacturer.
 - a. Watts Radiant barbed insert fittings shall be provided.
 - b. Only Watts Radiant SelfTite constant-tension spring clamps or TorqueTite screw clamps are approved.
 - c. Available connections:
 - 1) Sweat
 - 2) NPT
 - 3) BSP
 - d. Material:
 - 1) UNS 31400 Copper Alloy
 - 2) UNS 36000 Copper Alloy
 - 3) UNS 37700 Copper Alloy

2.4 SUPPLY AND RETURN PIPING

- A. Supply-and-Return Piping to the Manifolds (above ground piping):
1. Properly size supply and return distribution piping for the given volume and velocities required at system design.
 2. Use compatible distribution pipe material for all supply fluid temperatures and flows in systems with ferrous components.
 - a. When using Watts Radiant Onix, do not exceed 180°F (82°C) at 100 psi (689 kPa).
 3. Use fittings compatible with piping material. Fittings shall transition from distribution piping to system manifolds.
- B. Supply and Return Piping to the Manifolds (below ground piping):
1. Properly size supply and return distribution piping for the given volume and velocities required at system design.
 2. Use suitable distribution piping material for all supply fluid temperatures and flows in systems with ferrous components.
 - a. When using Watts Radiant Onix, do not exceed 180°F (82°C) at 100 psi (689 kPa).
 3. Use fittings compatible with piping material. Fittings shall transition from distribution piping to system manifolds.

2.5 ROOM TEMPERATURE CONTROLS

- A. Room Temperature Controls:
1. Thermostat: DualTemp, air/floor, digital, 24V
 2. Thermostat: DualTemp, air/floor, digital, battery
 3. Thermostat: DualTemp, air/floor, non-digital, 24V
 4. Thermostat: Digital, programmable, air, 24V
 5. All thermostats shall operate within a one degree differential temperature incorporating pulse-width modulation action.
 6. Install a Watts Radiant Thermostat (heat only) with digital display in each room or zone as required.
 - a. The Watts Radiant DualTemp thermostat shall have the ability to sense the temperature of the air, floor, or a combination of air and floor.
 - b. Each DualTemp shall be equipped with an internal air sensor.
 7. For multiple-zoning control, install the loop(s) per zone and install the individual valve actuators on the respective loop(s) at the manifold.
 - a. Electro-thermal Actuators
 - 1) Watts Radiant Thermal Actuators are a four-wire actuator designed for use with Watts Radiant Stainless Steel manifolds.
 - (a) Actuators are normally closed and will open when power is applied.
 - (b) Actuators shall consume no more than 2.5 watts.
 - (c) Travel time for the actuators is approximately 90 seconds to close the end switch.
 - (d) Each actuator consists of 4 wires, 2 for poser and 2 for an end switch.
 - b. Zone Valve Actuator Control Module: Zone valve actuator controls operate zone valves or circuit thermal actuators by supplying 24VAC.
 - 1) No more than three 2.5 VA actuator valves can be connected to any single zone terminal block.
 - 2) The control system shall be designed for use with the following models of thermostats:
 - (a) Watts Radiant DualTemp (3 or 4 wire)
 - (b) Watts Radiant Air Only thermostats
 - (c) Use only Watts Radiant non-programmable thermostat if using Optional Timer
 - (d) Any 2 wire thermostats with internal battery poser
 - (e) 2 wire thermostats that consume poser shall not be used, as damage to either the thermostat or controller may occur.
 - (1) Never connect a power consuming 2 wire thermostat to the control as damage to the thermostat and/or control may occur.
 - 3) External 24/120 VAC transformer (not included) is required to operate these controls.
 - (a) A 40 VA transformer for a maximum of 12 actuators
 - (b) A 60 VA transformer for a maximum of 18 actuators
 - 4) Master Controls:
 - (a) Equipped with valve and thermostat terminals
 - (b) Incoming 24 volt power connection
 - (c) Two 8 amp, dry contact terminals for pump and boiler operation
 - (1) With end-switch capability, the Zone Control Module activates other relays or controls as required by system control strategy.
 - (2) Control does not use the end-switch wires of a 4 wire actuator

Specification: Onix

- (3) Both 2 wire and 4 wire actuators may be used.
- 5) Slave Controls:
 - (a) The use of Slave units allows the control of more zones utilizing the same pump and boiler.
 - (b) Up to 2 Slave controls can connect to a Master
 - (1) Allows for a maximum of 18 separate zones or thermostat connections
 - (2) Both 2 wire and 4 wire actuators may be used.

2.6 HYDRONIC RADIANT SNOW MELTING CONTROLS

- A. Use sensors/controls provided by manufacturer:
 - 1. HSC-5 Snow Melting Slab Detector
 - a. Slab / Pavement mounted
 - b. Senses actual pavement conditions
 - c. Microprocessor control eliminates ice-bridging
 - d. Provides a low-amperage output relay contact
 - e. Heavy-duty machined brass housing
 - f. Removable top cover
 - g. Plug-in electronic assembly
 - h. 24 VAC
 - 2. LCD-1H Automatic Snow Switch
 - a. Pole-mounted
 - b. Senses both temperature and precipitation
 - c. Isolated 3 Amp resistive/1 Amp inductive relay contact
 - d. 24 VAC

2.7 ACCESSORIES

- A. Provide accessories associated with the installation of the radiant heating system as recommended by or available from the tubing manufacturer.
 - 1. IsoTherm: The IsoTherm provides mixing control and zone pumping all in a compact, unique package that conveniently connects directly to Watts Radiant Stainless Steel manifolds.
 - a. The IsoTherm module includes the following items:
 - 1) Mix Valve
 - 2) 3 speed 1/25 hp Circulator
 - 3) Temperature Guage
 - 4) Maximum Temperature Sensor
 - 5) Trunk Isolation Valves
 - 6) BSP to NPT Transition Nipple
 - b. Mounting:
 - 1) The IsoTherm can be wall mounted with standard cush clamps or other copper pipe mounted brackets.
 - 2) The IsoTherm can be integrated into a standard Watts Radiant manifold box.
 - c. Capacity:
 - 1) Full heat capacity of 51,000 BTU/h with a minimum boiler temperature of 158°F (70°C).

2. Pressure Differential By-pass Valve (for use with 1" Stainless Steel Manifolds only):
 - a. Use Watts Radiant Pressure Differential By-pass Valve with the manifolds incorporating actuators to avoid noise due to excessive water velocity.
 - 1) Eliminates water velocity noise and water hammer.
 - 2) Increases pump life because of minimal pressure surging as actuators open and close.
 - 3) There is always correct and constant flow regardless of the number of actuators or zone valves open.
 - 4) Water flow through the DBP valve shall be 25-30 % of the total flow:
 - (a) The over-pressure shall not exceed 10-15 % of the system pressure drop.
 - (b) If the zones to be by-passed have a maximum pressure drop of 0.5 psi (3.5 kPa), the DBP valve shall be set to accommodate this pressure plus 10-15 %.
 - (c) The DBP valve needs to be installed 'downstream' of the main circulator.
 - (d) Install before the system zones
 - (e) Should connect the supply line with the return line
3. FlowGuard:
 - a. FlowGuards shall be of commercial-quality, non-electronic flow indicator and flow setter.
 - b. Cast brass construction
 - c. Accurate visual flow indication in GPM
 - d. Ability to set fluid flow
 - e. FlowGuards shall allow zone-by-zone control and optimization.
 - f. No special training or electronic instrumentation required,
 - g. Sizes:
 - 1) 1" (25 mm) MNPT ends: 0.5 – 4 gpm (0.03 to 0.25 L/sec) flow meter
 - 2) 1" (25 mm) FNPT ends: 1 – 13 gpm (0.06 to 0.8 L/sec) flow meter
4. Tempering Valves:
 - a. MixTemp 180 Mixing Valve:
 - 1) The MixTemp 180 is a 3 port, non-electric mix valve for use in Hydronic heating systems.
 - (a) Hot, cold, and mix ports are clearly marked "H," "C," and "M."
 - 2) This mix valve shall be capable of delivering water temperatures ranging from 90° to 160°F (32° to 71°C) +/- 3° F.
 - 3) The Hydronic mix valve shall have a cast bronze body.
 - 4) Copper, stainless steel and EPDM internal parts
 - 5) There are no ferrous components to corrode.
 - 6) The actuator for the piston shall have lineal expansion characteristics, and shall be completely filled with a temperature-sensitive wax.
 - 7) Each port on the MixTemp has a union to allow for easy servicing
 - 8) Available in ¾" (19 mm) and 1" (25 mm) female NPT fittings.
 - (a) ¾" Cv = 3.1 gpm (0.195 L/sec)
 - (b) 1" Cv = 3.2 gpm (0.20 L/sec)
 - 9) These mixing valves are not anti-scald valves since they do not have positive shut-off in case of failure of hot or cold water supply. We do not recommend their use for shower service.

Specification: Onix

- 10) Shall have a source of return water cooler than the desired mix temperature to operate properly.
- 11) The mix valve shall not be heated in excess of 200°F (93°C) to prevent the liquid-filled actuator from rupture.
 - (a) To prevent damage, temporarily remove the mixing valve from the unions before soldering near the mix valve.
- b. AllTemp Mixing Valve:
 - 1) The AllTemp shall be a non-electric, 3 port mix valve for use in hydronic heating systems.
 - 2) Valve shall be capable of delivering water temperatures ranging from 100 – 200°F (38 – 93°C).
 - 3) The hydronic mix valve shall have a cast bronze body.
 - 4) Chrome-plated bronze piston
 - 5) The actuator for the piston shall have linear expansion characteristics, and shall be completely filled with a temperature-sensitive liquid communicating with the hydraulically formed brass bellows.
 - 6) The AllTemp is available in 1¼" (32 mm), 1½" (38 mm), and 2" (51 mm) female NPT fittings.
 - (a) 1¼" Cv = 6.1 gpm (0.38 L/sec)
 - (b) 1½" Cv = 6.2 gpm (0.39 L/sec)
 - (c) 2" Cv = 9.1 gpm (0.6 L/sec)
 - 7) Mixing valves are not anti-scald valves since they do not have positive shut-off in case of failure of hot or cold water supply. Do not use for shower service.
 - 8) Shall have a source of cooler return water to operate properly.
 - 9) The mix valve shall not be heated in excess of 230°F (110°C), or the liquid-filled actuator may rupture.
 - (a) To prevent damage, temporarily remove the actuator assembly from the valve body before soldering near the mix valve.
5. Staples: Watts Radiant Foamboard Staples
6. Terminal 90-degree Exit Bend: Terminal Bend Supports

PART 3 EXECUTION

3.1 EXAMINATION

- A. Site Verification of Conditions:
 1. Verify that site conditions are acceptable for installation of the system. Refer to manufacturer's installation manual for information.
 2. Do not proceed with installation of the system until unacceptable conditions are corrected.

3.2 INSTALLATION OF FLOOR HEATING SYSTEMS

- A. Comply with manufacturer's product data, including product technical bulletins, installation instructions and design drawings, including the following:
 1. Installation manuals
 2. Design software engineering and analysis

- B. Slab-On-Grade Installation:
1. Fasten the tubing to the flat mesh or reinforcing bar in accordance with the tubing manufacturer's installation recommendations.
 2. Use closer tubing on-center distances along exterior walls. Increase tubing on-center distances as the installation moves away from the exterior wall as determined by manufacturer analysis.
 3. Staple the tubing to the insulation board.
 4. Install edge insulation where the heated panel directly contacts an exterior wall or panel.
 5. Install tubing at a consistent depth below the surface elevation. Ensure sufficient clearance to avoid control joint saw cutting.
 6. Where tubing crosses metal expansion joints in the concrete, ensure the tubing passes below the joints or is sleeved through the joint.
- C. Pre-Cast Plank Construction with a Cap Pour:
1. Fasten the tubing to the flat mesh or reinforcing bar, or snap into Triple-track or Single-track RailWays in accordance with the tubing manufacturer's installation recommendations.
 2. Use closer tubing on-center distances along exterior walls. Increase tubing on-center distances as the installation moves away from the exterior wall.
 3. Staple the tubing to the insulation board.
 4. Install edge insulation where the heated panel directly contacts an exterior wall or panel.
 5. Install tubing at a consistent depth below the surface elevation. Ensure sufficient clearance to avoid control joint saw cutting.
 6. Where tubing crosses metal expansion joints in the concrete, ensure the tubing passes below the joints or is sleeved through the joint.
- D. Wood Floor Construction with a Lightweight Gypsum Topping:
1. Staple tubing to the wood sub-floor in accordance with the tubing manufacturer's installation recommendations. The attachment method shall not cause abrasions on the tubing.
 2. Use closer tubing on-center distances along exterior walls. Increase tubing on-center distances as the installation moves away from the exterior wall.
 3. Ensure the depth of the lightweight pour is a minimum of $\frac{3}{4}$ " (19 mm) over the outside dimension of the tubing, 1" typical overall thin-slab thickness.
 4. Install reinforcing mesh within the pour for finished flooring of tile or linoleum.
 5. Install wood sleepers along the room perimeter and between the tubing to provide a nailing surface for finished wood floors or carpet tack strips as required. Refer to Section 06100.
 6. Allow lightweight gypsum concrete pour to cure in accordance with the applicator's instructions. Once cured, seal the surface of the floor topping to protect surface from moisture.
 7. Install insulation in the joist cavity below the floor in accordance with the submitted radiant floor design. Refer to Section 07210.
 8. Install edge insulation if the heated panel directly contacts an exterior wall or panel. Refer to Section 07210.
- E. Wood Floor Construction with UnderFloor Heating (Onix tubing attached directly to wood sub-floor):

Specification: Onix

1. Install tubing attached directly to the underside of the wood sub-floor in accordance with the tubing manufacturer's recommendations. The attachment method shall not puncture or cause abrasions to the tubing.
 2. Do not exceed 8" (203 mm) on center tube spacing. Refer to the submitted radiant floor design.
 3. Comply with the tubing manufacturer's installation procedures on proper joist drilling.
 4. Install foil-faced insulation in the lower portion of the joist cavity. Allow an air gap of 2 – 3" (51 – 76 mm) between the wood sub-floor and the top of the insulation. Refer to Section 07210.
 5. Use the recommended amount of insulation in the joist cavity below the floor in accordance with the submitted radiant floor design. Refer to Section 07210.
 6. Use edge insulation equal to the amount of underfloor insulation if the heated panel directly contacts an exterior wall or panel. Refer to Section 07210.
- F. Wood Floor Construction with Joist Heating (tubing suspended in the joist bay):
1. Install tubing within the joist cavity in accordance with the tubing manufacturer's recommendations. The attachment method shall not cause abrasions to the tubing.
 2. Do not exceed 8" (203 mm) on center. Refer to the submitted radiant floor design.
 3. Do not allow tubing within the joist cavity to contact the wood sub-floor.
 4. Refer to the tubing manufacturer's installation procedures on proper joist drilling.
 5. Install foil-faced insulation in the lower portion of the joist cavity. Allow an air gap of 2 – 3" (51 – 76 mm) between the wood sub-floor and the top of the insulation. Refer to Section 07210.
 6. Use the recommended amount of insulation in the joist cavity below the floor in accordance with the submitted radiant floor design. Refer to Section 07210.
 7. Use edge insulation equal to the amount of underfloor insulation if the heated panel directly contacts an exterior wall or panel. Refer to Section 07210.
- G. Wood Floor Construction with SubRay:
1. Install SubRay on top of the wood sub-floor according to the tubing manufacturer's instructions.
 2. Coordinate the finished floor covering layout direction with the direction of the SubRay layout. Comply with the tubing manufacturer's instructions.
 3. Install insulation in the joist cavity below the floor according to the submitted radiant floor design. Install the insulation tight against the wood sub-floor. Refer to Section 07210.
 4. Use the recommended amount of insulation in the joist cavity below the floor in accordance with the submitted radiant floor design. Refer to Section 07210.
 5. Use edge insulation equal to the amount of underfloor insulation if the heated panel directly contacts an exterior wall or panel. Refer to Section 07210.
- H. Glycol and Water Solution:
1. Provide premixed glycol and water solutions.
 2. Do not use ethylene glycol due to toxicity issues. Provide inhibited propylene glycol for hydronic radiant floor heating systems. Refer to the boiler manufacturer's recommendations.

3.3 INSTALLATION OF HYDRONIC SNOW MELTING SYSTEM

- A. Slab-On-Grade Installation:
 - 1. Fasten the tubing to the rewire or rebar in accordance with the tubing manufacturer's installation recommendations.
 - 2. Install tubing at a consistent depth below the surface elevation. Ensure sufficient clearance to avoid control joint saw cutting.
 - 3. Install an extruded polystyrene insulation board at the edge of, and optionally under, the slab, depending on site conditions.
 - 4. Where tubing crosses metal expansion joints in the concrete, ensure that the tubing passes below the joints or is sleeved through the joints in accordance with manufacturer's instructions.

- B. Slab over Steel Deck Installation:
 - 1. Fasten tubing to either rewire or rebar, or snap tubing into Triple or Single-track RailWays in accordance with manufacturer's installation instructions.
 - 2. If rewire or rebar is not used, install the tubing perpendicular to the ribbing on the steel deck.
 - 3. Install either spray-on insulation or insulation board under the steel deck as per the manufacturer's directions.

- C. Brick Pavers over Concrete Slab Installation:
 - 1. Fasten the tubing to the rewire or rebar in accordance with the tubing manufacturer's installation recommendations.
 - 2. Install tubing at a consistent depth below the surface elevation.
 - 3. Install the brick pavers on top of the concrete according to proper masonry practice and guidelines for this application.

- D. Brick Pavers over Sand or Stone Dust Installation:
 - 1. Fasten the tubing to the rewire or rebar in accordance with the tubing manufacturer's recommendations for installation in base material.
 - 2. Install tubing at a consistent depth below the surface elevation.
 - 3. Place a layer of sand over the tubing to a depth that results in the manufacturer's recommended minimum depth when compacted.
 - 4. Install the brick pavers on the compacted material according to proper masonry practice and guidelines for this application.

- E. Asphalt Installation:
 - 1. Fasten the tubing to the rewire or rebar in accordance with the tubing manufacturer's recommendations for installation in sub-base material.
 - 2. Install tubing at a consistent depth below the surface elevation.
 - 3. Ensure that there is a minimum of 2" (51 mm) of material covering the installed tubing.

3.4 FIELD QUALITY CONTROL AND TESTING

- A. Site tests:
 - 1. To ensure system integrity, pressure test the system before covering tubing in concrete or when other trades are working in the vicinity of the tubing.
 - 2. Test all electrical controls in accordance with respective installation manuals.

Specification: Onix

3. System shall be checked after 3 years of operation and every year thereafter. System shall be checked for pH levels to ensure that it is operating within suggested guidelines.

3.5 SYSTEM ADJUSTING

- A. Balancing Across Manifold: Balance all loops across each manifold for equal flow resistance based on actual loop lengths and total manifold flow.
- B. Balancing between manifolds is accomplished with a flow control device installed on the return piping leg from each manifold when direct return piping is used for the supply and return mains or the circuits deviate by more than 10%.

3.6 CLEANING

- A. Remove temporary coverings and protection of adjacent work areas.
- B. Repair or replace damaged installed products.
- C. Clean installed products in accordance with manufacturer's instructions prior to Owner's acceptance.
- D. Remove construction debris from project site and legally dispose of debris.

3.7 DEMONSTRATION

- A. Demonstrate operation of system to Owner or Owner's personnel.
- B. Instruct the Owner or Owner's personnel about the type, concentration and maintenance of the glycol and water solution.
- C. Provide Owner or Owner's personnel with manufacturer's installation, operation, and maintenance instructions for installed components within the system.

3.8 PROTECTION

- A. Protect installed work from damage caused by subsequent construction activity on the site. Provide Owner with copy of photos and drawings of product locations to assist.