

Section 23 83 16
Radiant Heating and/or Cooling Hydronic Piping
(REHAU Radiant Heating and/or Cooling Systems)

This draft specification is for hydronic radiant heating and/or cooling systems using PEXa pipe. REHAU supplies these systems under the name REHAU Radiant Heating and Cooling Systems.

This draft specification is provided only as an aid in architect's/engineer's development of the final specification and is not intended as a substitute for sound architectural/engineering judgment. The architect/engineer shall be responsible for converting this draft specification into a final specification that meets the functional and aesthetic needs of their client, as well as to comply with all applicable codes.

Part 1 - General

1.01 Summary

- A. Radiant heating and/or cooling systems, where shown on the Drawings and Schedules, shall be hydronic, and shall include the following:
 - 1. Crosslinked polyethylene (PEXa) piping.
 - 2. Stainless steel distribution manifold(s) with balancing and flow control valves where required.
 - 3. Pipe-to-manifold compression nut or cold-expansion compression-sleeve fittings.
 - 4. Cold-expansion compression-sleeve fittings.
 - 5. Pipe fasteners as approved by the manufacturer of the PEXa piping.
 - 6. Controls.

Supervision and field engineering required for the complete and proper function of the system.

1.02 Related Sections

- A. Section 23 01 00 – Operation and Maintenance of HVAC Systems
- B. Section 23 21 00 – Hydronic Piping and Pumps
- C. Section 23 52 00 – Heating Boilers
- D. Section 23 60 00 – Central Cooling Equipment

1.03 References

- A. Publications listed here are part of this specification to the extent they are referenced. Where no specific edition of the standard or publication is identified, the current edition shall apply.
- B. ASTM – American Society for Testing and Materials
 - 1. ASTM D2765 – Standard Test Method for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics
 - 2. ASTM E119 – Standard Test Methods for Fire Tests of Building Construction and Materials
 - 3. ASTM F2657 – Standard Test Method for Outdoor Weathering Exposure of Crosslinked Polyethylene (PEX) Tubing
 - 4. ASTM E84 – Standard Test Method for Surface Burning Characteristics of Building Materials
 - 5. ASTM F876 – Standard Specification for Crosslinked Polyethylene (PEX) Tubing
 - 6. ASTM F877 – Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems
- C. CSA – Canadian Standards Association

1. CSA B137.5 – Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications
 2. CSA B214 – Installation Code for Hydronic Heating Systems
- D. DIN – German Institute for Standardization (Deutsches Institut für Normung)
1. DIN 4726 – Plastic Piping Used in Warm Water Floor Heating (Warmwasser-Fußbodenheizungen und Heizkörperanbindungen - Rohrleitungen aus Kunststoffen)
- E. ISO – International Organization for Standardization
1. ISO 9001 – Quality Management Systems – Requirements
- F. ULC – Underwriters' Laboratories of Canada
1. CAN/ULC S102.2 – Surface Burning Characteristics of Flooring, Floor Covering and Miscellaneous Materials
 2. CAN/ULC S101 – Standard Methods of Fire Endurance Tests of Building Construction and Materials
- G. PPI – Plastic Pipe Institute
1. PPI TR-3 – Policies and Procedures for Developing Hydrostatic Design Basis (HDB), Pressure Design Basis (PDB), Strength Design Basis (SDB), and Minimum Required Strength (MRS) Ratings for Thermoplastic Piping Materials or Pipe
- H. Publications listed here are part of this specification to the extent they are referenced. Where no specific edition of the standard or publication is identified, the current edition shall apply.

1.04 Definitions

- A. Crosslinked polyethylene, or PEX, is a modified polyethylene material which has undergone a change in the molecular structure using a chemical or a physical process whereby the polymer chains are permanently linked to each other.

This specification requires PEX to be designated as PEXa and be manufactured by the high-pressure peroxide method.

1.05 Submittals

- A. Comply with Section 01 33 00, Submittal Procedures. Approval and/or acceptance of all submittals is required prior to fabrication.
- B. Product Data: Submit manufacturer's Technical Manual, submittal forms, catalog cuts, brochures, specifications, and installation instructions. Submit data in sufficient detail to indicate compliance with the contract documents.
1. Submit manufacturer's instructions for installation.
 2. Submit data for equipment, fittings, fasteners and associated items necessary for the installation of the piping and manifolds.
- C. Submit computer-generated system design indicating pipe sizing, spacing, flow rates and temperatures. Design calculations shall be performed on pipe manufacturer's software or equivalent.
- D. Drawings: Provide plans drawn to scale for all installation areas.
1. Indicate dimensions, descriptions of materials, general construction, component connections, anchorage methods and installation procedures.
 2. Indicate design, schematic layout of system, including equipment, critical dimensions and piping/slab penetration details as well as details for protecting exposed PEX piping.
- E. Certification
1. Submit third-party certification results for the piping systems from an accredited testing laboratory.

2. The design shall be approved by a professional appropriately licensed in the jurisdiction where the installation will take place, as being complete and accurate.
3. Fittings shall be third-party certified to applicable referenced standards as part of the manufacturer's PEX piping system.

F. Maintenance Instructions: Submit product instructions for any maintenance required or recommended by manufacturer.

1.06 Quality Assurance

- A. Comply with Section 01 43 00, Quality Assurance.
- B. Manufacturer: Must be a company specializing in the Work of this Section with a minimum of 10 years documented experience.
- C. Pipe shall be manufactured in a facility whose quality management system is ISO 9001 certified.
- D. Crosslinked polyethylene (PEXa) pipe shall conform and be certified to ASTM F876, F877 and CSA B137.5 and shall have the PPI TR-3 listing. Pipes with an oxygen diffusion barrier shall conform to the requirements for oxygen permeability DIN 4726 and shall also have the PPI TR-3 listing.

1.07 Delivery, Storage, and Handling

- A. Comply with Section 01 60 00, Product Requirements.
- B. Deliver and store piping and equipment in shipping containers with labeling in place.
 1. Pipe shall be kept in original packaging until required for installation.
- C. Store piping and equipment in a safe place, dry, enclosed, under cover, in a well-ventilated area.
 1. Do not expose pipe to ultraviolet light beyond exposure limits recommended by manufacturer.
 2. Protect piping and manifolds from entry of contaminating materials. Install suitable plugs in open pipe ends until installation.
 3. Where possible, connect pipes to assembled manifolds to eliminate possibility of contaminants and cross-connections.
 4. Piping shall not be dragged across the ground or other surfaces and shall be stored on a flat surface with no sharp edges.
- D. Protect materials from damage or chemical contamination by other trades.
- E. Pipe, manifolds and fittings shall be protected from oil, grease, paint, direct sunlight and other elements as recommended by manufacturer.

1.08 Warranty

- A. Provide manufacturer's standard written warranty.
 1. The radiant heating pipe manufacturer shall warrant the crosslinked polyethylene pipe to be free from defects in material and workmanship for a period of twenty-five (25) years.
 2. Cold-expansion compression-sleeve fittings shall be warranted to be free from defects in material and workmanship for a period of twenty-five (25) years.
 3. All manifolds, distribution headers, thermostats and actuators shall be warranted to be free from defects in material and workmanship for a period of two (2) years starting at completion of successful pressurized water tests immediately following system installation.

Part 2 - Products

2.01 Acceptable Manufacturer

- A. REHAU Construction LLC, 1501 Edwards Ferry Road, NE; Leesburg, VA 20176; email: rehau.mailbox@rehau.com; website: na.rehau.com; upon whose products and equipment these specifications are based.
- B. No Substitutions allowed.

2.02 Piping

- A. All radiant heating and/or cooling pipe shall be high-density crosslinked polyethylene manufactured using the high-pressure peroxide method with a minimum degree of crosslinking of 70-89% when tested in accordance with ASTM D2765, Method B (PEXa). Pipe shall conform to ASTM F876, and CSA B137.5.
- B. Pipe shall be rated for 100 psi gauge pressure at 180°F temperature (690 kPa @ 82°C), and 80 psi gauge pressure at 200°F temperature (550 kPa @ 93°C).
- C. The pipe shall have a co-extruded oxygen diffusion barrier capable of limiting oxygen diffusion through the pipe to less than 0.32 mg/(m²*d) @ 40°C (104°F) temperature, in accordance with DIN 4726.
- D. Pipe shall be certified by PPI to standard TR-3, with applicable plumbing and mechanical code certifications.
- E. Bend Radius
 - 1. The minimum bend radius for cold bending of the pipe shall be not less than five (5) times the outside diameter.
 - 2. Bends with a radius less than this shall require the use of a bending template as supplied by the pipe manufacturer, and/or hot air.
- F. Compliant to the following standards:
 - 1. ANSI/UL 263 through certification listings with Underwriters Laboratories, Inc. (UL).
 - a. UL Design No. L588 — 1 hour wood frame floor/ceiling assemblies
 - b. UL Design No. K917 — 2 hour concrete floor/ceiling assemblies
 - c. UL Design No. U383 — 1 hour wood stud/gypsum wallboard wall assemblies
 - d. UL Design No. V461 — 1 hour steel stud/gypsum wallboard wall assemblies
- G. Pipe to be manufactured in an ISO 9001 certified production facility.
- H. Pipe to have a Flame Spread Index and a Smoke Developed Index listing to ASTM E84 (in U.S.) or CAN/ULC S102.2 (in Canada). This listing may require the pipe to be installed in a rated insulation material or an approved steel support channel. Confirm manufacturer requirements and/or local codes for specific installation guidelines.

2.03 Fittings

- A. Fittings shall be third-party certified to applicable standards ASTM F877 and CSA B137.5 as part of the manufacturer's PEX piping system, with independent listings from NSF and/or CSA as applicable.
- B. Pipe-to-manifold fittings shall be compression nut manufactured of nickel-plated brass with a barbed insert and a split compression ring or cold-expansion insert manufactured of nickel-plated brass with a PEX-a compression sleeve manufactured in accordance with ASTM F877.
- C. Cold-expansion and compression-sleeve fittings shall be manufactured of brass or PPSU (black) in accordance with ASTM D6394 and compression sleeves manufactured of PEX-a crosslinked polyethylene in accordance with ASTM F877 and shall be approved by the piping manufacturer to be part of a proven cataloged system.

- D. Fittings embedded within the thermal mass or encased behind walls or ceilings shall be cold-expansion compression-sleeve fittings certified to ASTM 877. Where required by the manufacturer, fittings shall be protected from external environmental conditions.

2.04 Manifolds

- A. Distribution manifolds shall be manufactured of copper or stainless steel and be supplied by the piping manufacturer as a proven cataloged part of the manufacturer's system.
- B. Stainless Steel manifolds shall be produced from extruded stainless steel round pipe with tapped holes for connections and be pre-assembled by the manufacturer. 100% of manifolds used shall have been air tested by the manufacturer with no indication of leaks.
- C. Balancing Manifolds
 1. Where required by design, stainless steel balancing manifolds shall be equipped with integral visual flow gauges, circuit balancing and flow control valves, isolation valves with integral thermometer housings, and air vent/fill ports.
 2. Each circuit valve shall be supplied with a manual actuating handle for filling/purging operation.
- D. Copper Manifolds
 1. Copper manifolds shall be manufactured from Type L copper.
 2. Copper and/or brass outlets shall be high-temperature brazed into headers.
 3. Outlets in copper headers shall be made using the T-drill process according to ASTM F2014.

2.05 Controls

- A. Room thermostats shall be low-voltage devices with electronic temperature sensing and shall be supplied by the pipe manufacturer as part of a proven cataloged system.
- B. Circuit actuators shall be low-voltage thermo-electric design for actuation of valves on manifold with visual indication of position, and built-in end switches, and shall be supplied by the pipe manufacturer as part of a proven cataloged system.
- C. Systems operated in cooling mode must include humidity sensors in every zone as well as temperature sensors/thermostats.
- D. Controls must use humidity and temperature sensors to calculate each zone's dew point temperature while in cooling mode. Supply temperatures for radiant cooling must be maintained at a minimum of 3°F (-16°C) above calculated dew point of each zone.
- E. For Radiant Cooling - A System must have the capability to dehumidify zones separately according to response from humidity/temperature sensors.
- F. *Note to Specifier: There are several control strategies that may apply to your specific project. You should consider your requirements and add control specifications to this section as required. Electronic Weather Compensating Mixing controls are recommended, as these match water supply temperature to heat loss, based on outdoor air temperature. Please be aware of the need, in some cases, to regulate the supply water temperature to the radiant heating and/or cooling system so as not to exceed limits of flooring materials.*

2.06 Markings

- A. Pipe shall carry the following markings every three (3) feet (0.9 meters): Manufacturer's name or trademark, nominal size, PEXa 3206 (material designation) SDR9 (standard dimension ratio), ASTM F876/ F877 / F1960, CSA B137.5, NSF-pw, U.P. Code, 160 psi @ 73.4°F / 100 psi @ 180°F / 80 psi @ 200°F, POTABLE TUBING, manufacturing date and footage mark.

- B. Cold expansion PEXa compression-sleeves and fittings shall be marked with manufacturer's designation, production code, and certification markings.

2.07 Packaging

- A. Coiled pipe shall be shipped in protective packaging marked with product name and size.
- B. Straight lengths shall be packed in plastic bags.
- C. Fittings shall be shipped in protective packaging marked with product name and size.

Part 3 - Execution

3.01 Acceptable Installers

- A. As a minimum, installation shall be performed by qualified laborers trained by the manufacturer in the procedures of PEX radiant heating and/or cooling systems and appropriately licensed for the jurisdiction where the installation will take place.

3.02 Examination

- A. Examine areas and conditions under which work of this Section will be performed. Correct conditions detrimental to timely and proper completion of Work. Do not proceed until unsatisfactory conditions are corrected.
- B. Beginning of installation means acceptance of existing conditions.

3.03 Preparation

- A. Coordinate with related trades and manufacturer's recommendations with regard to installation in conjunction with:
 - 1. Reinforcing wire mesh or rebar.
 - 2. Preparation of space for manifold installation.
- B. Prepare the installation site as appropriate:
 - 1. For Concrete Slab-on-Grade: Sub-grade should be compacted, flat and smooth to prevent damage to pipe or insulation. Approved vapor barrier material should be installed. Approved thermal insulation, according to the design, shall be installed. Reinforcing wire mesh, if required by structural design, must be flat and level, with all sharp ends pointing down. Finished grade of the thermal mass must be a minimum of 2 in (51 mm) above the top of PEX heating and/or cooling pipes.
 - 2. For Non-Structural Overpour on Sub-floor: Sub-floor must be structurally sound, clean and free from all construction debris which could potentially damage the pipe. Replace any areas that appear weak. To facilitate installation of pipe, remove all unnecessary studwall baseplates in doorways and other areas. Treat any wood sub-floors with a sealant in accordance with the specifications set forth by the screed installation section, or use pressure-treated wood, as per local code requirements. Finished grade of the thermal mass overpour must be a minimum of 3/4 in (19 mm) above the top of PEX heating and/or cooling pipes.
 - 3. For Structural Concrete Sub-floor: Sub-floor must be clean and free from all construction debris which could potentially damage the pipe. Finished grade of the concrete thermal mass must be a minimum of 2 in (51 mm) above the top of PEX heating and/or cooling pipes.
- C. Preparation of wall cavity for manifold installation: See drawings to determine the width of the wall cabinet (if required) and required wall opening dimensions. Mount the manifold cabinet allowing space for the screed to fill up the front of the pipe opening. If a cabinet is not used, prepare a suitable cavity for the manifold, with a secure mounting plate that will secure the manifold at least 30 in (75 cm)

above floor level. Manifold must be installed in an area that will allow easy access for supply/return piping as well as future access maintenance.

3.04 Installation

- A. Install in accordance with manufacturer's published installation manual and/or published guidelines and final drawings.
- B. Mount manifolds in the locations previously prepared or in previously installed cabinets, if used. Manifolds shall be mounted as level as possible.
- C. Route piping in an orderly manner, according to layout and spacing shown in final drawings. All installation notes shown on the drawings shall be followed.
- D. At connections and fittings, use a PEX pipe cutter to ensure square and clean cuts, and join pipes immediately or cap ends of pipe to seal from contaminants. Where fittings are installed within the thermal mass, they shall be wrapped in tape approved by the manufacturer.
- E. Pipe shall be dispensed using a suitable uncoiling device. Remove twists prior to securing pipe. Pipe shall lie flat on an even plane. Finished grade of a structural slab shall be a minimum of 2 in (51 mm) above the top of PEX heating and/or cooling pipes. Fasten piping at no more than 3 ft (90 cm) intervals, being careful not to twist the pipe. In nonstructural concrete slabs, the finished grade of the thermal mass shall be a minimum of 3/4 in (19 mm) above the top of the PEX and the piping shall be secured every 2 ft (60 cm). Use only fasteners supplied or approved by the manufacturer of the PEX pipe.
- F. Piping that passes through expansion joints shall be covered in protective polyethylene corrugated sleeving (flexible conduit) extending 15 in (38 cm) on each side of the joint. Sleeving shall be secured on pipe to prevent movement during installation of thermal mass.
- G. Where piping exits the thermal mass, a protective conduit shall be placed around the pipe, with the conduit extending a minimum of 6 in (15 cm) into the floor and exiting by a minimum of 6 in (15 cm). For penetrations at manifolds, use rigid PVC bend guides secured in place to prevent movement.
- H. At the time of installation of each circuit of pipe, connect the pipe to the correct manifold outlet and record pipe length for balancing. If manifold is not installed, cap the end of the pipe and label the pipe's circuit numbers along with S for supply and R for return. Connect pipes to manifold as soon as possible and record circuit lengths. All circuits shall be labeled to indicate circuit length and serviced area.
- I. The following precautions shall be taken in areas intended for carpet:
 - 1. Keep pipes 6 in (15 cm) from all wall baseplates.
 - 2. Install metal guards where pipe will pass through wall baseplates and where carpet tack strips will be installed.
- J. The following precautions shall be taken in areas intended for hardwood flooring:
 - 1. Ensure that nailing areas for hardwood flooring, if nailing is required, are clearly marked and known for hardwood installers.
- K. If the radiant heating and/or cooling system substrate material (thermal mass) requires curing and/or has other limitations that can be influenced by the radiant heating and/or cooling system while in operation, then the radiant heating and/or cooling system shall not be put into operation until such time that the substrate material has fully cured or set according to the material requirements of the substrate manufacturer.
- L. The installer shall confirm minimum and maximum exposure temperatures for the substrate material (thermal mass) and shall ensure proper radiant heating and/or cooling operating temperatures.

3.05 Field Quality Control

- A. Filling, Testing & Balancing: Tests of hydronic heating and/or cooling systems shall comply with authorities having jurisdiction, and, where required, shall be witnessed by the building official.
- B. Pressure gauges used in testing and balancing shall show pressure increments of 1 psig and shall be located at or near the lowest points in the distribution system.
- C. Air Test
 - 1. Charge the completed, yet unconcealed pipes with air at a minimum of 40 psig.
 - 2. Do not exceed 150 psig. When air pressure testing with polymer fittings do not exceed 120 psi (825 kPa).
 - 3. Use soap solution to check for leakage at manifold connections.
- D. Water Test
 - 1. Purge air from pipes.
 - 2. Charge the completed, yet unconcealed pipes with water.
 - 3. Take necessary precautions to prevent water from freezing.
 - 4. Check the system for leakage, especially at all pipe joints.
- E. Perform a preliminary pressure test pressurizing the system to the greater of 1.5 times the maximum operating pressure or 100 psig for 30 minutes.
 - 1. As the piping expands, restore pressure, first at 10 minutes into the test and again at 20 minutes.
 - 2. At the end of the 30-minute preliminary test, pressure shall not fall by more than 8 psig from the maximum, and there shall be no leakage.
- F. After successfully performing the preliminary pressure test, perform the main pressure test immediately.
 - 1. The test pressure shall be restored and continued as the main test for 2 hours.
 - 2. The main test pressure shall not fall more than 3 psig after 2 hours.
 - 3. No leakage shall be detected.
- G. Pressure shall be maintained and monitored during installation of the thermal mass.
 - 1. If any leak is detected during installation of thermal mass, leak shall be found immediately, and the area cleared for repair using manufacturer's approved repair coupling.
 - 2. Retest before covering repair.
- H. Complete inspection and furnish test reports supplied by the manufacturer of the system.
- I. All low-voltage equipment shall be tested. The following 3 items should be checked as a minimum:
 - 1. Inputs
 - 2. Outputs
 - 3. Sequence of Operations

3.06 Cleaning

- A. Clean exposed surfaces upon completion of installation using clean, water damp cloth. No cleaning agents are allowed.
- B. Comply with manufacturer's recommendations.

3.07 Protection

- A. Protect installation throughout construction process until date of final completion.
- B. Replace components that cannot be repaired.

END OF SECTION