

SECTION 23 21 13

HYDRONIC PIPING

1. GENERAL
	1. SECTION INCLUDES

\*\* NOTE TO SPECIFIER \*\* Delete system types not required.

* + 1. Crosslinked Polyethylene, Engel Method (PEX-a) pipe and fittings for the following applications:
			1. Heating hot-water piping, aboveground.
			2. Heating hot-water piping installed belowground and within slabs.
			3. Chilled-water piping, aboveground.
			4. Chilled-water piping installed belowground and within slabs.
			5. Condenser-water piping.
			6. Makeup-water piping, aboveground.
			7. Makeup-water piping installed belowground and within slabs.
		2. Polypropylene random copolymer with modified crystallinity and temperature resistance
		(PP-RCT) pipe and fittings for the following applications:
			1. Heating hot-water piping, aboveground.
			2. Heating hot-water piping installed belowground and within slabs.
			3. Chilled-water piping, aboveground.
			4. Chilled-water piping installed belowground and within slabs.
			5. Condenser-water piping.
			6. Makeup-water piping, aboveground.
			7. Makeup-water piping installed belowground and within slabs.
	1. RELATED SECTIONS

\*\* NOTE TO SPECIFIER \*\* Delete any sections below not relevant to this project; add others as required.

* + 1. Section 23 05 29 ‒ Hangers and Supports for HVAC and Piping Equipment
	1. REFERENCES

\*\* NOTE TO SPECIFIER \*\* Delete references from the list below that are not required by the text of the edited section.

* + 1. ASTM International (ASTM):
			1. ASTM D2657 Standard Practice for Heat Fusion Joining of Polyolefin Pipe and Fittings.
			2. ASTM D2765 Test Methods for Determination of Gel Content and Swell Ratio of Crosslinked Ethylene Plastics.
			3. ASTM D6394 Specification for Sulfone Plastics (SP).
			4. ASTM E84 Standard Test Method for Surface Burning Characteristics of Building Materials.
			5. ASTM E119 Standard Test Methods for Fire Tests of Building Construction and Materials.
			6. ASTM E814 Standard Test Method for Fire Tests of Through-Penetration Fire Stops.
			7. ASTM F876 Standard Specification for Crosslinked Polyethylene (PEX) Tubing.
			8. ASTM F877 Standard Specification for Crosslinked Polyethylene (PEX) Plastic Hot- and Cold-Water Distribution Systems.
			9. ASTM F1960 Standard Specification for Cold Expansion Fittings with PEX Reinforcing Rings for Use with Crosslinked Polyethylene (PEX) Tubing.
			10. ASTM F2389 Standard Specification for Pressure-rated Polypropylene (PP) Piping Systems.
		2. American National Standards Institute (ANSI) / National Sanitation Foundation (NSF):
			1. NSF/ANSI Standard 359 Valves for Crosslinked Polyethylene (PEX) Water Distribution Tubing Systems.
		3. American National Standards Institute (ANSI) / Underwriters Laboratories, Inc. (UL):
			1. UL/ANSI 263 Standard for Safety for Fire Tests of Building Construction and Materials.
			2. UL/ANSI 2846 Standard for Fire Test of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics.
		4. American Society of Mechanical Engineers (ASME):
			1. ASME B16.5 Pipe Flanges and Flanged Fittings: NPS 1/2 through NPS 24 Metric/Inch Standard.
			2. ASME B16.51 Copper and Copper Alloy Press-Connect Pressure Fittings.
		5. Canadian Standards Association (CSA):
			1. CAN/CSA B137.5 Crosslinked Polyethylene (PEX) Tubing Systems for Pressure Applications.
			2. CSA B242-05 Groove-and Shoulder-Type Mechanical Pipe Couplings.
			3. CSA B137.11 Polypropylene (PP-R) Pipe and Fittings for Pressure Applications.
		6. German Institute for Standardization (DIN) (Deutsches Institut für Normung):
			1. DIN 4726 Warm Water Surface Heating Systems and Radiator Connecting Systems ‒ Plastics Piping Systems and Multilayer Piping Systems.
		7. German Welding Society (DVS) (Deutscher Verband für Schweißen):
			1. DVS 2207-11: 2017 Welding Thermoplastic Materials – Heated Element Welding of Pipes, Piping Parts, and Sheets made of Polypropylene.
		8. International Code Council (ICC):
			1. International Mechanical Code (IMC)
		9. International Association of Plumbing and Mechanical Officials (IAPMO):
			1. Uniform Mechanical Code (UMC)
			2. R&T K-12775 Research and Testing – Pressure Rated Polypropylene Piping Systems.
		10. International Organization for Standardization (ISO):
			1. ISO 15874 Plastics Piping Systems for Hot and Cold Water Installations – Polypropylene (PP).
		11. Plastics Pipe Institute (PPI):
			1. PPI Technical Report TR-4.
		12. Underwriters Laboratories (UL):
			1. UL 2846 Standard for Fire Tests of Plastic Water Distribution Plumbing Pipe for Visible Flame and Smoke Characteristics.
		13. Uponor, Inc.:
			1. Uponor PEX Piping Systems Design and Installation Manual, current edition.
			2. Uponor PEX Piping Systems Installation Guide, current edition.
			3. Uponor PP-RCT Piping Systems Manual, current edition.
			4. Uponor PP-RCT Piping Systems Installation Guide, current edition.
	1. SUBMITTALS
		1. Submit under provisions of Section 01 30 00 ‒ Administrative Requirements.
		2. Product Data: Submit manufacturer’s product submittal data and installation instructions.
		3. Shop Drawings: Provide installation drawings indicating: piping layout, size dimension by installation segment, vault locations, support fixtures and schedules with all details required for installation of the system. Note that if using PEX or PP-RCT where metallic piping was the basis of design, the contractor shall provide shop drawings clearly indicating that the design has been adjusted, as required, to maintain scheduled flow and pressure drops. Any design requiring re-sizing of pumps shall not be permitted.
		4. Samples: Submit selection and verification samples of piping.
		5. Quality Assurance/Control Submittals:
			1. Test Reports: Upon request, submit test reports from recognized testing laboratories.
			2. Submit the following documentation.
				1. Manufacturer’s certificate stating that products comply with specified requirements.
				2. Manufacturer’s flow schedule for the distribution system.
				3. Documentation that the installer is trained to install the manufacturer’s products.
		6. Closeout Submittals: Submit the following documents.
			1. Warranty documents specified herein.
			2. Operation and maintenance data.
			3. Manufacturer’s field reports specified herein.
			4. Final as-built piping layout drawing.
	2. QUALITY ASSURANCE
		1. Installer Qualifications: Use an installer with demonstrated experience on projects of similar size and complexity and who has been trained by Uponor or an Uponor-approved trainer.

\*\* NOTE TO SPECIFIER \*\* Paragraph below should list obligations for compliance with specific code requirements particular to this section. Typically, general statements to comply with a particular code are addressed in Conditions of the Contract and Division 1 Regulatory Requirements Section. Avoid repetitive statements.

* + - 1. Regulatory requirements and approvals: Ensure the piping distribution system complies with all applicable codes and regulations.
			2. Certifications: Provide letters of certification indicating: Installer uses skilled workers holding a trade qualification license or equivalent, or apprentices under the supervision of a licensed tradesperson.

\*\* NOTE TO SPECIFIER \*\* Retain paragraph below if pre-installation meeting is required.

* + - 1. Pre-installation Meetings:
				1. Verify project requirements, excavation conditions, system performance requirements, manufacturer’s installation instructions and warranty requirements.
				2. Review project construction timeline to ensure compliance or discuss modifications as required.
				3. Interface with other trade representatives to verify areas of responsibility.
				4. Establish the frequency and construction phase the project engineer intends for site visits and inspections by the piping manufacturer’s representative.
		1. Installer Qualifications for PEX: Installer shall have successfully completed the Uponor Piping Systems Training Course (formerly Uponor AquaPEX® Certification) and is able to provide proof/verification. Course shall be conducted by the manufacturer or a manufacturer’s representative.
		2. Installer Qualifications for PP-RCT: Installer shall have successfully completed a training course on fusion tool use and connections and carry a current certification or qualification from the fusion tool manufacturer or pipe and fittings manufacturer.

\*\* NOTE TO SPECIFIER \*\* Retain paragraph below if data logging is required by owner.

* + 1. Data Logging of PP-RCT Butt-fusion Joints: Installer shall provide digital verification of the fusion process for each butt-fusion joint completed. Installer shall have been trained on the use of the data logging software by the fusion tool manufacturer or the pipe and fittings manufacturer.

\*\* NOTE TO SPECIFIER \*\* Article below should include specific protection and environmental conditions required during storage. Coordinate article below with Division 1 Product Requirements Section.

* 1. DELIVERY, STORAGE and HANDLING
		1. General: Comply with Division 1 Product Requirement Section.
		2. Comply with manufacturer’s ordering instructions and lead-time requirements to avoid construction delays.
		3. Delivery: Deliver materials in manufacturer’s original, unopened, undamaged containers with identification labels intact.
		4. Storage and Protection: Store materials protected from exposure to harmful environmental conditions and at temperature and humidity conditions recommended by the manufacturer.
			1. If product is delivered in damaged packaging, recipient shall notify manufacturer within 24 hours.
			2. Store PEX and/or PP-RCT piping in original packaging or in containers or under cover to avoid dirt or foreign material from entering the piping.
			3. Do not expose white or blue PEX and/or PP-RCT piping to direct sunlight for more than one month. Do not expose red PEX piing to direct sunlight for more than six months.
			4. Store piping in the original shipping packaging on a flat surface to prevent unwanted deformation. Follow manufacturer’s stacking height guidelines.

\*\* NOTE TO SPECIFIER \*\* Coordinate article below with Conditions of the Contract and with Division 1 Closeout Submittals (Warranty) Section. Use this article to require special or extended warranty or bond covering the work of this section.

* 1. WARRANTY
		1. Project Warranty: Refer to Conditions of the Contract for project warranty provisions.
		2. Manufacturer's Warranty:
			1. PEX-a manufacturer and PP-RCT provider system warranty shall cover piping and fittings from defect for a duration of 25 years from the date of installation. Refer to manufacturer’s warranty for complete details.
1. PRODUCTS
	1. MANUFACTURERS
		1. Acceptable manufacturer: Uponor, located at: 5925 148th St. W.; Apple Valley, MN, 55124; toll-free: 800-321-4739; tel: 952-891-2000;
		email: NAspecifications@uponor.com; web: [uponor.com](http://www.uponor.com).

\*\* NOTE TO SPECIFIER \*\* Delete one of the following two paragraphs; coordinate with requirements of Division 1 section on product options and substitutions.

* + 1. Substitutions: Not permitted.
		2. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 ‒ Product Requirements.
	1. PEX-A PIPE AND FITTINGS
		1. PEX-a (Engel-Method Crosslinked Polyethylene) Piping: SDR 9, ASTM F876 and F877 (CAN/CSA-B137.5) by Uponor (Wirsbo hePEX™) with an oxygen barrier meeting DIN 4726.
		2. Pre-insulated PEX-a Piping (1/2 inch through 2 inch nominal pipe size): PEX-a piping, with a closed-cell polyethylene foam insulation.
		3. Fittings for PEX-a piping: Elbows, adapters, couplings, plugs, tees and multiport tees (1/2 inch through 3 inch nominal pipe size): ASTM F1960 cold-expansion fittings in brass or engineered polymer (EP) manufactured by the pipe manufacturer, utilizing cold-expansion PEX-a reinforcing rings made of same material as the pipe. Fittings shall be third-party certified to NSF 14 and ASTM F1960 and shall comply with ASTM F876 and ASTM F877.
	2. TRANSITION FITTINGS FOR PEX PIPE
		1. PEX-to-Metal Transition Fittings:
			1. Manufacturers: Provide transition fittings from the same manufacturer as the piping.
			2. PEX-a-to-threaded transition: One-piece brass fitting with one male or female threaded end and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
			3. PEX-a-to-copper sweat transition: One-piece brass fitting with one sweat adapter end and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
			4. PEX-a-to-copper-press transition: One-piece lead-free (LF) brass fitting with one ASME B16.51 copper press end and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
			5. PEX-a-to-flange transition: Two-piece fitting with one steel flange conforming to ASME B16.5 and one lead-free (LF) brass adapter conforming to ASTM F1960.
			6. PEX-a-to-groove transition: One-piece lead-free (LF) brass fitting with one CSA B242-05 groove end in either iron pipe size (IPS) or copper tube size (CTS) and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
		2. PEX-to-CPVC Transition Fittings:
			1. PEX-a-to-CPVC transition: Thermoplastic fitting with one ASTM D1784 spigot or socket end and one ASTM F1960 cold-expansion end, with PEX-a reinforcing cold-expansion ring.
		3. PEX-to-PP-RCT Transition Fittings [1-1/4 inch nominal (40 mm) through 2 inch nominal (63 mm)]:
			1. PEX-a-to-PP-RCT transition: ASTM F1960 cold-expansion end with PEX-a reinforcing cold-expansion ring by MIP or FIP to one PP-RCT socket by male or female threaded by fusion ASTM F2389 end.
		4. PEX-to-PP-RCT Transition Fittings [2-1/2 inch nominal (75 mm) through 3 inch nominal (90 mm)]:
			1. PEX-a-to-PP-RCT transition: ASTM F1960 cold-expansion end with PEX-a reinforcing cold-expansion ring by ASME/ANSI B16.5 flange to one PP-RCT flange adapter and ASME/ANSI B16.5 flange.
	3. VALVES FOR PEX PIPE
		1. PEX-to-PEX, Brass Ball Valves (1/2 inch through 2 inch nominal pipe size):
			1. Full-port ball valve: Two-piece, ASTM F1960 cold-expansion ends, with PEX-a reinforcing cold-expansion ring.
			2. In compliance with 250 CWP, NSF/ANSI 359, ASTM F1960, ASTM F877 (CAN/CSA B137.5).
	4. PP-RCT PIPE AND FITTINGS
		1. Mechanical Pipe: Uponor PP-RCT mechanical pipe with fiber layer, manufactured from a
		PP-RCT resin meeting the requirements of ASTM F2389 or CSA B137.11. SDR shall be determined by project requirements for temperature and pressure.
		2. Fittings for PP-RCT pipe: Uponor PP-RCT certified as complying with ASTM F2389 (CSA B137.11):

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| * + - 1. Socket fusion type: For sizes 1/2 inch nominal (20 mm) through 4 inch nominal

(125 mm).* + - 1. Butt fusion type or socket fusion type using coupling: For size 4 inch nominal (125 mm) pipe-to-pipe and pipe-to-flange adapter connections.
			2. Butt fusion type: For sizes 2 inch (63 mm) and larger.
	1. TRANSITION FITTINGS FOR PP-RCT PIPE
		1. PP-RCT-to-Metal Transition Fittings:
			1. PP-RCT socket fusion to flange transition [1-1/2 inch nominal (50 mm) through 4 inch nominal (125 mm)]: Steel flange conforming to ASME B16.5 with one PP-RCT socket fusion ASTM F2389 end.
			2. PP-RCT butt fusion to flange transition [4 inch nominal (125 mm) through 12 inch nominal (315 mm)]: Steel flange conforming to ASME B16.5 with one PP-RCT butt fusion ASTM F2389 end.
			3. PP-RCT-to-threaded transition (NPT) [1/2 inch nominal (20 mm) through 2 inch nominal (63 mm)]: One PP-RCT socket fusion ASTM F2389 end and one brass male or female threaded adapter.
		2. PP-RCT-to-PEX Transition Fittings [1 inch nominal (32 mm) and smaller]:
			1. PP-RCT to PEX-a transition: One PP-RCT socket fusion adapter by male or female threaded by fusion ASTM F2389 end with ASTM F1960 cold-expansion end with PEX-a reinforcing cold-expansion ring.
			2. PP-RCT to PEX-a saddle transition: One PP-RCT saddle fusion end and one ASTM F1960 cold-expansion end with PEX-a reinforcing cold-expansion ring.
	2. VALVES FOR PP-RCT PIPE
		1. Valves shall be manufactured in accordance with the manufacturer’s specifications and shall comply with the performance requirements of ASTM F 2389 or CSA B137.11.
		2. PP-RCT-to-PP-RCT, Ball Valves [1/2 inch nominal (20 mm) through 2 inch nominal (63 mm) pipe size]:
			1. Recommended manufacturers: Red-White model 1501PAB or Webstone H10170W series
			2. Full-port ball valve: PP-RCT or brass body with chrome-plated ball and polyfusion ends.
			3. In compliance with NSF/ANSI 14.
		3. PP-RCT-to-PEX-a, Ball Valves [1/2 inch nominal (20 mm) through 1 inch nominal (32 mm) pipe size]:
			1. Recommended manufacturers: Red-White model 1516AB
			2. Full-port ball valve: PP-RCT body with chrome-plated ball and one ASTM F1960 end and one polyfusion end.
			3. In compliance with ANSI/NSF 14, 61 and 372.
		4. PP-RCT-to-PP-RCT Flange Butterfly Valves [2-1/2 inch nominal (75 mm) to 12 inch (315 mm) nominal pipe size]:
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* + - 1. Recommended manufacturers: Apollo model LD145 or NIBCO model LC-2000
				1. Iron, single-flange butterfly valves with aluminum-bronze disc:
				2. Standard: MSS SP-67 & API 609
				3. CWP Rating for Valves NPS 2 to NPS 12): 200 psig (1380 kPa).
				4. Body Design: Lug type, suitable for bidirectional dead-end service at rated pressure without use of downstream flange.
				5. Body Material: ASTM A126, cast iron, or ASTM A536, ductile iron.
				6. Seat: [EPDM] [NBR].
				7. Stem: One-piece or two-piece stainless steel.
				8. Disc: Aluminum bronze
1. EXECUTION
	1. EXAMINATION
		1. Site Verification of Conditions: Verify that site conditions are acceptable for installation of the hydronic piping distribution system. Do not proceed with installation until unacceptable conditions are corrected.
	2. INSTALLATION
		1. Install hydronic piping according to approved shop drawings or coordination drawings.
		2. Comply with manufacturer’s product data, including product technical bulletins, installation instructions, and design drawings, including the following:
			1. Uponor PEX Piping Systems Installation Guide, current edition.
			2. Uponor PEX Piping Systems Design and Installation Manual, current edition.
			3. Uponor PP-RCT Piping Systems Manual, current edition.
			4. Uponor PP-RCT Piping Systems Installation Guide, current edition.

\*\* NOTE TO SPECIFIER \*\* Delete below if not required.

* + 1. PEX-a Hangers and Supports (1/2 inch through 3 inch nominal pipe size):
			1. Horizontal PEX-a piping: Install supports suitable for PEX-a piping in compliance with local codes, the Uponor PEX Piping Systems Design and Installation Manual (PDIM), current edition, and the Uponor PEX Piping Systems Installation Guide, current edition.
				1. Note: Per ICC PMG-1006, the above maximum hanger spacing requirements may be extended with the use of a continuous support channel such as Uponor PEX-a Pipe Support.
			2. Horizontal PEX-a piping with PEX-a Pipe Support: Install supports for PEX-a piping with PEX-a Pipe Support, a 23-gauge, galvanized-steel, horizontal support channel, in accordance with manufacturer's recommendations and the following maximum spacing:
				1. 3 inch nominal and smaller: Maximum span, 8 feet (2.4 m).
				2. Support 1-1/2 inch and smaller fittings within 12 inches (0.3 m).
				3. Install clamps and fixed points per the Uponor PEX Piping Systems Design and Installation Manual (PDIM), current edition, and the Uponor PEX Piping Systems Installation Guide, current edition.
			3. Vertical PEX-a piping: Install supports suitable for PEX-a piping in compliance with local codes, the Uponor PEX Piping Systems Design and Installation Manual (PDIM), current edition, and the Uponor PEX Piping Systems Installation Guide, current edition:
				1. Support vertical in-wall piping every 5 feet (1.5 m).
				2. Support riser piping at the base of each floor and every 5 feet (1.5 m) vertically.

Refer to the Uponor PEX Piping Systems Design and Installation Manual for additional requirements.

* + 1. PP-RCT Hangers and Supports:
			1. Horizontal PP-RCT piping: Install supports suitable for PP-RCT piping in compliance with local codes, the Uponor PP-RCT Piping Systems Manual, current edition, and the Uponor PP-RCT Piping Systems Installation Guide, current edition.
			2. To minimize linear expansion, use fixed points and expansion arms or loops in accordance with the Uponor PP-RCT Piping Systems Manual, current edition, and the Uponor PP-RCT Piping Systems Installation Guide, current edition.
			3. Vertical piping: Support vertical piping at each floor penetration and as specified in the applicable plumbing or mechanical code.
			4. Do not over tighten riser clamps on the pipe.
			5. Hot-water and cold-water piping clamps and supports shall be rubber, vinyl, or felt lined and shall be free of sharp edges that may gouge the pipe.
		2. Piping Schedule:
			1. Belowground / under-building slab, mechanical piping (1/2 inch through 12 inch) shall be the following:

\*\* NOTE TO SPECIFIER \*\* Use for field-insulated PEX.

* + - * 1. 1/2 inch through 3 inch: PEX-a piping with engineered polymer (EP) or brass F1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer’s recommendations.
				2. 1/2 inch through 2 inch: Pre-insulated PEX-a piping with PEX-foam insulation with engineered polymer (EP) or brass ASTM F1960 cold-expansion fittings. Use the fewest possible joints and install per manufacturer’s recommendations.

\*\* NOTE TO SPECIFIER \*\* Use for pre-insulated PEX. Amend below per application.

* + - 1. Belowground / under-building slab, mechanical piping [12 inch (315 mm) and smaller] shall be the following:
				1. PP-RCT mechanical pipe: Fiber composite layer, SDR 7.4, 9, 11, or 17.6 pipe, with socket fusion type fittings for 4 inch (125 mm) and smaller and butt fusion type connections for 2 inch (63 mm) and larger.
			2. Aboveground mechanical piping (1/2 inch through 3 inch) shall be the following:
				1. PEX-a piping with engineered polymer (EP) or brass ASTM F1960 cold-expansion fittings.
			3. Aboveground mechanical piping [1/2 inch (20 mm) and larger] shall be the following:
				1. PP-RCT mechanical pipe: Fiber composite layer, SDR 7.4, 9, 11, or 17.6 pipe, with socket-fusion type fittings for 1/2 inch (20 mm) to 4 inch (125 mm).
				2. PP-RCT mechanical pipe: Fiber composite layer, SDR 9, 11, or 17.6 pipe, with butt-fusion type fittings for fitting 2 inch (63 mm) through 12 inch (315 mm).
		1. PEX-a connections: Install per manufacturer's recommendations. Use manufacturer-recommended cold-expansion tool for ASTM F1960 connections.
		2. PP-RCT connections: Fusion connections shall be made in accordance with DVS 2207-11: 2017 and manufacturer’s specifications and the following:
			1. Socket-fusion type: For sizes 1/2 inch nominal (20 mm) to 4 inches nominal (125 mm)
			2. Butt-fusion type: For sizes 2 inch (63 mm) and larger.
		3. Fusion machines, equipment, and tools: As suggested by the pipe manufacturer or specified.
		4. Joint preparation, setting, alignment, fusion process, cooling times and working pressures: In accordance with DVS 2207-11: 2017 and the pipe and fitting manufacturer’s specifications.
	1. FIELD QUALITY CONTROL
		1. Pressure testing PEX pipe and fittings: Pressure test PEX-a piping systems in accordance with local code and manufacturer’s requirements.
		2. Pressure testing PP-RCT pipe and fittings: Pressure test PP-RCT piping systems in accordance with local code and manufacturer’s requirements.
	2. CLEANING AND FLUSHING
		1. Remove temporary coverings and protection of adjacent work areas.
		2. Repair or replace damaged installed products.
		3. Clean the installed products in accordance with manufacturer’s instructions prior to Owner’s acceptance.
		4. Remove construction debris from project site and legally dispose of debris.
		5. Flush the system with fresh potable water to remove any potential debris from installation.
		6. If disinfection is required, follow the manufacturer’s chemical compatibility guidelines for flushing agents.
	3. DEMONSTRATION
		1. Demonstrate operation of the piping distribution system to Owner’s personnel.
	4. PROTECTION
		1. Protect installed work from UV exposure or damage caused by subsequent construction activity on the site.

END OF SECTION