SECTION 232113.13 - UNDERGROUND HYDRONIC PIPING

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

1. GENERAL
	* + 1. RELATED DOCUMENTS

Retain or delete this article in all Sections of Project Manual.

* + - * 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 the following underground hydronic piping:

Copper tube and fittings.

Steel pipes and fittings.

Ductile-iron pipe and fittings.

Plastic pipe and fittings.

PEX tube and fittings.

Fiberglass pipe and fittings.

Transition fittings.

Pre-engineered conduit piping system.

Pre-engineered cased piping system.

Loose-fill insulation.

* + - 1. DEFINITIONS

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

* + - * 1. Invert: Vertical distance from Project datum reference point to bottom interior pipe surface.

Retain "Reinforced, Thermosetting Resin Fitting (RTRF)" paragraph below if specifying fiberglass pipe.

* + - * 1. Reinforced, Thermosetting Resin Fitting (RTRF): Fittings fabricated of composite materials, largely consisting of a reinforcement material embedded in, or surrounded by, cured thermosetting resin. Most common form of reinforced, thermosetting resin pipe is one in which fiberglass strands form reinforcement.
			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 the following:

Pre-engineered conduit piping system components.

Pre-engineered cased piping system components.

Cased piping.

Loose-fill insulation.

USE PARAGRAPH BELOW WITH EPD REQUIREMENT WHEN PROJECT ESTIMATE IS $1M OR MORE.

* + - * 1. Submit an Environmental Product Declaration (EPD) from the manufacturer for steel pipe within this specification section, if available. A statement of the contractor’s good faith effort to obtain the EPD shall be provided if not available.

Manufacturer-provided EPDs must be Product Specific Type III (Third-Party Reviewed), in adherence with ISO 14025 *Environmental labels and declarations*, ISO 14044 *Environmental management – Life cycle assessment*, and ISO 21930 *Core rules for environmental product declarations of construction products and services.*

* + - * 1. Shop Drawings: For underground hydronic piping.

Show expansion compensators, offsets, and loops with appropriate materials to allow piping movement at required locations. Show anchors and guides that restrain piping movement with calculated loads, and show concrete thrust block dimensions.

Show pipe sizes, locations, inverts, and pitch. Show piping in trench, piping in conduit, and cased pipe with details showing clearances between piping.

Show insulation thickness.

* + - * 1. Qualification Data: For Installer.

Retain "Welding certificates" paragraph below if retaining "Welding Qualifications" paragraph in "Quality Assurance" Article.

* + - * 1. Welding certificates.

Retain "Field quality-control reports" paragraph below if Contractor is responsible for field quality-control testing and inspecting.

* + - * 1. Field quality-control reports.
			1. QUALITY ASSURANCE

Retain "Fiberglass Pipe and Fitting Installers" paragraph below for fiberglass pipe assembly.

* + - * 1. Fiberglass Pipe and Fitting Installers: Provide RTRF and RTRP pipe installation by technicians certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesives and methods.

Retain "Welding Qualifications" paragraph below if shop or field welding is required. If retaining, also retain "Welding certificates" paragraph in "Informational Submittals" Article.

* + - * 1. Welding Qualifications: Qualify procedures and personnel in accordance with ASME Boiler and Pressure Vessel Code: Section IX.

Comply with provisions in ASME B31.9, "Building Services Piping."

Certify that each welder has passed AWS qualification tests for welding processes involved and that certification is current.

* + - * 1. ASME Compliance: Comply with ASME B31.9, "Building Services Piping," for materials, products, and installation.
			1. FIELD CONDITIONS

Retain this article if interruption of existing utility service is required.

* + - * 1. Interruption of Existing Utilities: Do not interrupt utilities serving occupied facilities unless permitted under the following conditions and then only after arranging to provide temporary utility services in accordance with requirements indicated:

Notify [**Director’s Representative] [Director’s Representative**] no fewer than [**two**] <**Insert number**> days in advance of proposed interruption of utility.

Do not proceed with interruption of utility without [**Director’s Representative's] [Director’s Representative's**] written permission.

* + - 1. COORDINATION
				1. Coordinate pipe-fitting pressure classes with products specified in related Sections.
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.

See "Writing Guide" Article in the Evaluations for a discussion of this Section's organization and the most efficient way to revise this Section.

* + - 1. PERFORMANCE REQUIREMENTS
				1. Provide components and installation capable of producing hydronic piping systems with the following minimum working-pressure ratings:

Revise pressure ratings in "Hot-Water Piping," "Chilled-Water Piping," “Condenser-Water Piping” and "High Temperature Hot-Water Piping" subparagraphs below. Coordinate with Section 232113 "Hydronic Piping." Working pressure is equal to relief pressure plus the static height of the system and pumping head. The only working pressure mandated by authorities having jurisdiction is for makeup water.

Hot-Water Piping: [**100 psig] [150 psig] <Insert value> at [200 deg F] <Insert temperature**>.

High Temperature Hot-Water Piping: [**100 psig] <Insert value> at [250 deg F] <Insert temperature**>.

Chilled-Water Piping: [**100 psig] [150 psig] <Insert value> at [100 deg F] <Insert temperature**>.

Condenser-Water Piping: [**100 psig] [150 psig] <Insert value> at [150 deg F] <Insert temperature**>.

Retain "Delegated Design" paragraph below if Contractor is required to assume responsibility for design.

* + - 1. COPPER TUBE AND FITTINGS

Retain this article for direct-bury copper piping.

2016 ASHRAE HANDBOOK - "HVAC Systems and` Equipment," Ch. 46, Table 5, "Application of Pipe, Fittings, and Valves for Heating and Air Conditioning," recommends only ASTM B88 Type K for direct-buried underground service.

Other products, such as ASTM B88 Types L and M may be inserted as an option in "Drawn-Temper Copper Tubing" paragraph below. ASHRAE does not recommend Type L (Type B) for underground use, and it does not recommend Type M (Type C) for use regardless of location.

* + - * 1. Drawn-Temper Copper Tubing: [**ASTM B88, Type K] <Insert type**>.
				2. Wrought-Copper Fittings: ASME B16.22.
				3. Wrought-Copper Unions: ASME B16.22.

See "Copper Tubing" Article in the Evaluations for discussions of solder and brazing materials described in "Solder Filler Metals" and "Brazing Filler Metals" paragraphs below. 2016 ASHRAE HANDBOOK - "HVAC Systems and Equipment," Ch. 46, Table 5 recommends only brazing or silver soldering underground copper pipe.

* + - * 1. Solder Filler Metals: ASTM B32, lead-free silver solder alloys. Include water-flushable flux in accordance with ASTM B813.
				2. Brazing Filler Metals: AWS A5.8, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
			1. STEEL PIPE AND FITTINGS

Retain this article for direct-bury steel piping or to describe materials for carrier pipe for conduit or cased piping. Coordinate selection of type and thickness with choices made in "Piping Application" Article. 2016 ASHRAE HANDBOOK - "HVAC Systems and Equipment" does not recommend steel pipe for direct-burial installation.

* + - * 1. Steel Pipe: ASTM A53, black steel with plain ends; welded and seamless, Grade B, black with plain ends; wall thickness as indicated in "Piping Application" Article.
				2. Cast-Iron Threaded Fittings: ASME B16.4; standard pattern, with threads in accordance with AME B1.20.1; Class 125 and Class 250 as indicated in "Piping Application" Article.
				3. Malleable-Iron Threaded Fittings: ASME B16.3; Class 150 and Class 300 as indicated in "Piping Application" Article.
				4. Malleable-Iron Unions: ASME B16.39; Classes 150, 250, and 300 as indicated in "Piping Application" Article.

Coordinate flange class in "Cast-Iron Pipe Flanges and Flanged Fittings" paragraph below with other products in this Section and in related Sections to match face size and bolt patterns.

* + - * 1. Cast-Iron Pipe Flanges and Flanged Fittings: ASME B16.1, [Approved equivalent]; raised ground face, and bolt holes spot faced.
				2. Wrought-Steel Fittings: ASTM A234, wall thickness to match adjoining pipe.

Flanges and fittings in "Wrought Cast- and Forged-Steel Flanges and Flanged Fittings" paragraph below are available in several classes, materials, facings, and end connections.

* + - * 1. Wrought Cast- and Forged-Steel Flanges and Flanged Fittings: ASME B16.5, including bolts, nuts, and gaskets of the following material group, end connections, and facings:

Material Group: 1.1.

End Connections: Butt welding.

Facings: Raised face.

* + - * 1. Steel Welding Fittings: ASME B16.9 seamless or welded.

Welding Filler Metals: Comply with AWS D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.

In "Grooved-End-Pipe Couplings for Galvanized-Steel Piping" paragraph below, AWWA C606 covers couplings in NPS 3/4 to NPS 24 (DN 20 to DN 600).

* + - * 1. Grooved-End-Pipe Couplings for Galvanized-Steel Piping: AWWA C606 for steel-pipe dimensions. Include ferrous housing sections, EPDM-rubber gaskets suitable for hot and cold water, and bolts and nuts.
				2. Nipples: ASTM A733, made of same materials and wall thicknesses as pipe in which they are installed.
				3. Pipe-Flange Gasket Materials: Suitable for chemical and thermal conditions of piping system contents.

ASME B16.21, nonmetallic, flat, asbestos free, 1/8-inch- maximum thickness unless thickness or specific material is indicated.

Full-Face Type: For flat face, Class 125, cast-iron and -bronze flanges.

Narrow-Face Type: For raised face, Class 250, cast-iron and steel flanges.

* + - * 1. Flange Bolts and Nuts: ASME B18.2.1, carbon steel, unless otherwise indicated.
			1. DUCTILE-IRON PIPE AND FITTINGS

Retain this article for direct-bury ductile-iron piping or to describe materials for carrier pipe for conduit or cased piping.

Pipe in "Mechanical-Joint, Ductile-Iron Pipe" paragraph below is available in NPS 3 to NPS 64 (DN 80 to DN 1600).

* + - * 1. Mechanical-Joint, Ductile-Iron Pipe: AWWA C151/A21.51, centrifugally cast with mechanical-joint bell and plain spigot end.

Fittings in "Standard-Pattern, Mechanical-Joint Fittings" subparagraph below are available in NPS 3 to NPS 48 (DN 80 to DN 1200).

Standard-Pattern, Mechanical-Joint Fittings: AWWA C110/A21.10, ductile or gray iron.

Fittings in "Compact-Pattern, Mechanical-Joint Fittings" subparagraph below are available in NPS 3 to NPS 24 (DN 80 to DN 600).

Compact-Pattern, Mechanical-Joint Fittings: AWWA C153/A21.53, ductile iron.

Glands, Gaskets, and Bolts: AWWA C111/A21.11, ductile- or gray-iron glands, rubber gaskets, and steel bolts.

* + - 1. PLASTIC PIPE AND FITTINGS

Retain this article for direct-bury plastic piping or to describe materials for carrier pipe for conduit or cased piping.

See "Plastic Piping" Article in the Evaluations for discussion of product characteristics and maximum temperatures.

* + - * 1. CPVC Plastic:

Pipe: ASTM F441, Schedules 40 and 80, plain ends. Make joints as indicated in "Piping Application" Article.

Pipe Fittings: Socket-type pipe fittings, ASTM F438 for Schedule 40 pipe; ASTM F439 for Schedule 80 pipe.

Solvent Cements: ASTM F493.

* + - * 1. PVC Plastic:

Pipe: ASTM D1785, Schedules 40 and 80, plain ends. Make joints as indicated in "Piping Application" Article.

Pipe Fittings: Socket-type pipe fittings, ASTM D2466 for Schedule 40 pipe; ASTM D2467 for Schedule 80 pipe.

Solvent Cements: ASTM D2564. Include primer in accordance with ASTM F656.

* + - * 1. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.
			1. PEX TUBE 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 Flow Controls; Conbraco Industries, Inc.

IPEX USA LLC.

Uponor.

Approved equivalent.

* + - * 1. Source Limitations: Obtain PEX tube and fittings from single source from single manufacturer.
				2. Pipe Material: PEX plastic in accordance with ASTM F876.

Retain "Oxygen Barrier" paragraph below for closed-loop hydronic, radiant floor heating, or snow melting applications. 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.

* + - * 1. Oxygen Barrier: Limit oxygen diffusion through the tube to maximum 0.10 mg per cu. m/day at 104 deg F in accordance with 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.
				4. Insulation: [**PEX foam] <Insert insulation**> filling annular space between PEX tubing and jacket; thickness indicated in "Piping Application" Article.
				5. Fittings: Factory-fabricated elbows and tees with manufacturer-furnished fitting insulation kit. Provide fittings recommended by and compatible with carrier pipe.
				6. Jacket: Corrugated HDPE.
			1. FIBERGLASS PIPE AND FITTINGS

Retain this article for direct-bury fiberglass piping or to describe materials for carrier pipe for conduit or cased piping.

RTRP piping is available with ends for other types of joints. See the Evaluations for discussion of product characteristics and maximum temperatures and pressures.

* + - * 1. RTRP: ASTM D2996, filament-wound pipe with tapered bell-and-spigot ends for adhesive joints.
				2. RTRF: Compression or spray up/contact molded of same material, pressure class, and joining method as pipe.
				3. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.
				4. Flanges: ASTM D4024. Full-face gaskets suitable for service, minimum 1/8-inch- thick, 60-70 durometer. ASTM A307, Grade B, hex-head bolts with washers.
			1. TRANSITION 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:

IPEX USA LLC.

Uponor.

Viega LLC.

Approved equivalent.

* + - * 1. Source Limitations: Obtain transition fittings from single source from single manufacturer.
				2. Plastic-to-Metal Transition Fittings: [**CPVC] [and] [PVC**] one-piece fitting with one threaded brass or copper insert and one Schedule 80 solvent-cemented-joint end.
			1. PREENGINEERED CONDUIT PIPING SYSTEM
				1. Description: Factory-fabricated and -assembled, airtight and watertight, drainable, pressure-tested piping with conduit, inner pipe supports, and insulated carrier piping. Fabricate so insulation can be dried in place by forcing dry air through conduit.

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:

Perma-Pipe, Inc.

Rovanco Piping Systems, Inc.

Thermacor Process, L.P.

Approved equivalent.

Source Limitations: Obtain piping system from single source from single manufacturer.

* + - * 1. Carrier Pipe: Materials as indicated in "Piping Application" Article. See Part 3 articles in this Section for required carrier pipe.
				2. Carrier Pipe Insulation:

Retain insulation materials in "Polyurethane Foam Pipe Insulation" subparagraph below that are required in "Piping Application" Article.

Polyurethane Foam Pipe Insulation: Unfaced, preformed, rigid cellular polyurethane material intended for use as thermal insulation.

Comply with ASTM C591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.

Fabricate shapes in accordance with ASTM C450 and ASTM C585.

* + - * 1. Minimum Clearance:

Between Carrier Pipe Insulation and Conduit: 1 inch.

Between Insulation of Multiple Carrier Pipes: 3/16 inch.

Between Bottom of Carrier Pipe Insulation and Conduit: 1 inch.

Between Bottom of Bare, Carrier Pipe and Casing: 1-3/8 inches.

In "Conduit" paragraph below, coordinate conduit material with manufacturers.

* + - * 1. Conduit: [**Spiral wound, steel] <Insert conduit material**>.

Retain "Finish" or "Cover" subparagraph below.

Finish: With two coats of fusion-bonded epoxy, minimum 20 mils thick.

Cover: With polyurethane foam insulation with an HDPE jacket; thickness indicated in "Piping Application" Article.

Piping Supports within Conduit: Corrugated galvanized steel with a maximum spacing of 10 feet.

Fittings: Factory-fabricated and -insulated elbows and tees. Elbows may be bent pipe equal to carrier pipe. Tees shall be factory fabricated and insulated, and shall be compatible with carrier pipe.

Expansion Offsets and Loops: Size casing to contain piping expansion.

Accessories include the following:

Water Shed: Terminal end protector for carrier pipes entering building through floor, 3 inches deep and 2 inches larger than casing; terminate casing 20 inches above the floor level.

Guides and Anchors: Steel plate welded to carrier pipes and to casing, complete with vent and drainage openings inside casing.

End Seals: Steel plate welded to carrier pipes and to casing, complete with drain and vent openings on vertical centerline.

Gland Seals: Packed stuffing box and gland follower mounted on steel plate, welded to end of casing, permitting axial movement of carrier piping, with drain and vent connections on vertical centerline.

Joint Kit: Half-shell, pourable or split insulation and shrink-wrap sleeve.

* + - * 1. Manholes: Black steel with lifting eyes.

Finish: Spray-applied urethane, minimum 30 mils thick.

Access: 30-inch- diameter waterproof cover with gasket, ladder, and two 6-inch vents, one high and one low, extending above grade with rain caps.

Conduit Stub-Outs and Seals: Welded steel with drain and vent openings.

Sump: 12 inches in diameter; 12 inches deep.

Flotation Anchor: Oversized bottom keyed into concrete base.

* + - * 1. Source Quality Control: Factory test conduit to 15 psig for a minimum of two minutes with no change in pressure. Factory test carrier pipe to 150 percent of operating pressure of system. Submit test certificates.
			1. PREENGINEERED CASED PIPING SYSTEM
				1. Description: Factory-fabricated piping with carrier pipe, insulation, and casing.

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:

Perma-Pipe, Inc.

Rovanco Piping Systems, Inc.

Thermacor Process, L.P.

Approved equivalent.

Source Limitations: Obtain piping system from single source from single manufacturer.

* + - * 1. Carrier Pipe: Materials as indicated in "Piping Application" Article. See articles in this Section for required carrier pipe material characteristics.
				2. Carrier Pipe Insulation:

Polyurethane Foam Pipe Insulation: Rigid, cellular, and high-pressure injected between carrier pipe and jacket.

Comply with ASTM C591; thermal conductivity (k-value) shall not exceed 0.165 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.

In "Casing" paragraph below, coordinate conduit material with manufacturers.

* + - * 1. Casing: [**HDPE] [Filament-wound, fiberglass-reinforced polyester resin] [PVC] [0.034-inch- thick, spiral-wound, lock-seam galvanized steel] [0.032-inch- thick, spiral-wound, lock-seam aluminum] [0.025-inch- thick, spiral-wound, lock-seam stainless steel**].
				2. Casing accessories include the following:

Retain "Joint Kit," "Expansion Blanket," and "End Seals" subparagraphs below that apply to systems.

Joint Kit: Half-shell, pourable or split insulation, casing sleeve, and shrink-wrap sleeve.

Expansion Blanket: Elastomeric foam, formed to fit over piping.

End Seals: Shrink wrap the casing material to seal watertight around casing and carrier pipe.

* + - * 1. Manholes: Black steel with lifting eyes.

Finish: Spray-applied urethane, minimum 30 mils thick.

Access: 30-inch- diameter waterproof cover with gasket, ladder, and two 6-inch vents, one high and one low, extending above grade with rain caps.

Conduit Stub-Outs and Seals: Welded steel with drain and vent openings.

Sump: 12 inches in diameter; 12 inches deep.

Floatation Anchor: Oversized bottom keyed into concrete base.

* + - * 1. Cover: With polyurethane foam insulation with an HDPE jacket; thickness indicated in "Piping Application" Article.
				2. Source Quality Control: Factory test carrier pipe to 150 percent of operating pressure of system. Furnish test certificates.

Retain or delete the section below if Loose-Fill insulation is being used. Loose-fill insulation is not commonly used and Pre-insulated piping systems are more common.

* + - 1. LOOSE-FILL INSULATION
				1. Granular, Loose-Fill Insulation: Inorganic, nontoxic, nonflammable, sodium potassium aluminum silicate with calcium carbonate filler. Include chemical treatment that renders insulation hydrophobic.

Source Limitations: Obtain insulation from single source from single manufacturer.

Thermal Conductivity (k-Value): 0.60 at 175 deg F and 0.65 at 300 deg F.

Application Temperature Range: 35 to 800 deg F.

Dry Density: 40 to 42 lb/cu. ft..

Strength: 12,000 lb/sq. ft..

* + - * 1. Insulation at Pipe Joints and Fittings:

Provide pipe system manufacturer's recommended joint and fitting seals, with formed, spray, or loose-fill insulation. Provide pipe system manufacturer's recommended sealants and adhesives required to form watertight boundaries at outer conduit.

1. EXECUTION
	* + 1. EARTHWORK
				1. See Section 312000 "Earth Moving" for excavating, trenching, and backfilling.
			2. PIPING APPLICATION

Retain at least one pipe material in paragraphs below for each service required for Project. Services are specified separately to allow different pipe materials and joining methods for each. If materials and methods are the same for all services, combine the requirements by revising the paragraph titles. In general, pipe materials and joining methods in this article are as listed in the 2016 ASHRAE HANDBOOK - "HVAC Systems and Equipment," Ch. 46, "Pipes, Tubes, and Fittings." The change point for pipe materials and joining methods is specified, in this Section, where the pipe size changes from NPS 2 to NPS 2-1/2 (DN 50 to DN 65). Revise this change point to suit office policy. See "Writing Guide" Article in the Evaluations.

* + - * 1. Hot-Water Heating Piping:

[**NPS 2 and smaller] <Insert pipe size range**> shall be[ **any of**] the following:

Retain one or more of first four subparagraphs below. If retaining more than one type of material and joining method and it is not the intent to give Contractor the option to select materials, delete " any of" option in subparagraph above and identify each material on Drawings. Show points of transition from one material to another.

ASHRAE does not recommend that Type L (Type B) copper be used underground. For this reason, it is not listed below for direct-buried installations.

Type K copper tubing, wrought-copper fittings, and [**soldered] [brazed] [pressure-seal**] joints for direct-buried piping installations.

Type K or Type L copper tubing, wrought-copper fittings, and [**soldered] [brazed**] [**pressure-seal**] joints for jacketed or cased piping installations.

[**Schedule 40] [Schedule 80**] steel pipe; [**Class 50] [Class 51**] ductile-iron pipe; [**Class 125, cast-iron] [Class 150, malleable-iron] [Class 250, cast-iron] [Class 300, malleable-iron**] fittings; cast-iron flanges and flange fittings; and threaded joints.

Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.

CPVC pipe in first subparagraph below has temperature and pressure limitations. See the Evaluations.

[**Schedule 40] [Schedule 80**] CPVC plastic pipe and fittings and solvent-welded joints.

PEX tube and fittings.

Retain "Loose-Fill Insulation" subparagraph below to insulate bare underground piping.

Loose-Fill Insulation: [**Granular] [Powder**].

[**NPS 2-1/2 and larger] <Insert pipe size range**> shall be[ any of] the following:

Retain one or more of first four subparagraphs below. If retaining more than one type of material and joining method and it is not the intent to give Contractor the option to select materials, delete " any of" option in last subparagraph above and identify each material on Drawings. Show points of transition from one material to another.

ASHRAE does not recommend that Type L (Type B) copper be used underground. For this reason, it is not listed below for direct-buried installations.

Type K copper tubing, wrought-copper fittings, and [**soldered] [brazed] [pressure-seal**] joints for direct-buried piping installations.

Type K or Type L copper tubing, wrought-copper fittings, and [**soldered] [brazed] [pressure-seal**] joints for jacketed or cased piping installations.

[**Schedule 40] [Schedule 80**] steel pipe; [**Class 50] [Class 51**] ductile-iron pipe; [**Class 125, cast-iron] [Class 150, malleable-iron] [Class 250, cast-iron] [Class 300, malleable-iron**] fittings; cast-iron flanges and flange fittings; and threaded joints.

Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.

CPVC and RTRP in first two subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40] [Schedule 80**] CPVC plastic pipe and fittings and solvent-welded joints.

RTRP and RTRF with adhesive or flanged joints.

Retain "Loose-Fill Insulation" subparagraph below to insulate bare underground piping.

Loose-Fill Insulation: [**Granular] [Powder**].

Retain "Conduit Piping" or "Cased Piping" subparagraph below.

Conduit Piping: Carrier pipe as indicated in "Hot-Water Piping" Paragraph above with polyurethane carrier-pipe insulation and with [**coated] [coated and insulated**] conduit.

Carrier Pipe Insulation Thickness: [**1 inch] [2 inches] <Insert dimension**>.

Retain "Conduit Insulation Thickness" subparagraph below to require outside of conduit to be insulated.

Conduit Insulation Thickness: [**1 inch] [2 inches] <Insert dimension**>.

Cased Piping: Polyurethane carrier-pipe insulation.

Piping Insulation Thickness: [**1 inch] [2 inches] <Insert dimension**>.

* + - * 1. Chilled-Water Piping:

[**NPS 2 and smaller] <Insert pipe size range**> shall be[ any of] the following:

Retain one or more of first four subparagraphs below. If retaining more than one type of material and joining method and it is not the intent to give Contractor the option to select materials, delete " any of" option in subparagraph above and identify each material on Drawings. Show points of transition from one material to another.

Type K copper tubing, wrought-copper fittings, and [**soldered] [brazed] [pressure-seal**] joints for direct-buried piping installations.

Type K or Type L drawn-temper copper tubing, wrought-copper fittings, and [**soldered] [brazed] [pressure-seal**] joints for jacketed or cased piping installations.

[**Schedule 40] [Schedule 80**] steel pipe; [**Class 50] [Class 51] ductile-iron pipe; [Class 125, cast-iron] [Class 150, malleable-iron] [Class 250, cast-iron] [Class 300, malleable-iron]** fittings; cast-iron flanges and flange fittings; and threaded joints.

Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.

CPVC pipe in first subparagraph below has temperature and pressure limitations. See the Evaluations.

[**Schedule 40] [Schedule 80**] CPVC plastic pipe and fittings and solvent-welded joints.

PEX tube and fittings.

Retain "Loose-Fill Insulation" subparagraph below to insulate bare underground piping.

Loose-Fill Insulation: [**Granular] [Powder**].

[**NPS 2-1/2 and larger] <Insert pipe size range**> shall be[ any of] the following:

Retain one or more of first five subparagraphs below. If retaining more than one type of material and joining method and it is not the intent to give Contractor the option to select materials, delete " any of" option in last subparagraph above and identify each material on Drawings. Show points of transition from one material to another.

Type K, copper tubing, wrought-copper fittings, and [**soldered] [brazed] [pressure-seal]** joints for direct-buried piping installations.

Type K or Type L copper tubing, wrought-copper fittings, and [**soldered] [brazed] [pressure-seal**] joints for jacketed or cased piping installations.

[**Schedule 40] [Schedule 80**] steel pipe; [**Class 50] [Class 51**] ductile-iron pipe; [**Class 125, cast-iron] [Class 150, malleable-iron] [Class 250, cast-iron] [Class 300, malleable-iron**] fittings; cast-iron flanges and flange fittings; and threaded joints.

[**Schedule 40] [Schedule 30] [Schedule 20**] steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

Mechanical-joint, ductile-iron pipe; [**standard-] [or] [compact-]**pattern mechanical-joint fittings; and mechanical joints.

CPVC and RTRP in first two subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40] [Schedule 80**] CPVC plastic pipe and fittings and solvent-welded joints.

RTRP and RTRF with adhesive or flanged joints.

Retain "Loose-Fill Insulation" subparagraph below to insulate bare underground piping.

Loose-Fill Insulation: [**Granular] [Powder**].

Retain "Conduit Piping" or "Cased Piping" subparagraph below.

Conduit Piping: Carrier pipe as indicated in "Chilled-Water Piping" Paragraph above with polyurethane carrier-pipe insulation and with [**coated] [coated and insulated**] conduit.

Carrier Pipe Insulation Thickness: [**1 inch] [2 inches] <Insert dimension**>.

Retain "Conduit Insulation Thickness" subparagraph below to require outside of conduit to be insulated.

Conduit Insulation Thickness: [**1 inch] [2 inches] <Insert dimension**>.

Cased Piping: Polyurethane carrier-pipe insulation.

Piping Insulation Thickness: [**1 inch] [2 inches] <Insert dimension**>.

* + - * 1. Condenser-Water Piping:

[**NPS 2 and smaller] <Insert pipe size range**> shall be[ any of] the following:

Retain one or more of first four subparagraphs below. If retaining more than one type of material and joining method and it is not the intent to give Contractor the option to select materials, delete " any of" option in subparagraph above and identify each material on Drawings. Show points of transition from one material to another.

Type K, copper tubing, wrought-copper fittings, and [**soldered] [brazed] [pressure-seal**] joints for direct-buried piping installations.

Type K or Type L drawn-temper copper tubing, wrought-copper fittings, and [**soldered] [brazed] [pressure-seal**] joints for jacketed or cased piping installations.

[**Schedule 40] [Schedule 80] steel pipe; [Class 50] [Class 51] ductile-iron pipe; [Class 125, cast-iron] [Class 150, malleable-iron] [Class 250, cast-iron] [Class 300, malleable-iron**] fittings; cast-iron flanges and flange fittings; and threaded joints.

Mechanical-joint, ductile-iron pipe; [**standard-] [or] [compact**-]pattern mechanical-joint fittings; and mechanical joints. Schedule 5 steel pipe; steel, pressure-seal couplings and fittings; and pressure-seal joints.

CPVC pipe in first subparagraph below has temperature and pressure limitations. See the Evaluations.

[**Schedule 40] [Schedule 80**] CPVC plastic pipe and fittings and solvent-welded joints.

Retain "Loose-Fill Insulation" subparagraph below to insulate bare underground piping.

Loose-Fill Insulation: [**Granular] [Powder**].

[**NPS 2-1/2 and larger] <Insert pipe size range**> shall be[ **any of]** the following:

Retain one or more of first five subparagraphs below. If retaining more than one type of material and joining method and it is not the intent to give Contractor the option to select materials, delete " any of" option in last subparagraph above and identify each material on Drawings. Show points of transition from one material to another.

Type K, copper tubing, wrought-copper fittings, and [**soldered] [brazed] [pressure-seal**] joints for direct-buried piping installations.

Type K or Type L copper tubing, wrought-copper fittings, and [**soldered] [brazed] [pressure-seal**] joints for jacketed or cased piping installations.

[**Schedule 40] [Schedule 80**] steel pipe; [**Class 50] [Class 51**] ductile-iron pipe; [**Class 125, cast-iron] [Class 150, malleable-iron] [Class 250, cast-iron] [Class 300, malleable-iron**] fittings; cast-iron flanges and flange fittings; and threaded joints.

[**Schedule 40] [Schedule 30] [Schedule 20**] steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

Mechanical-joint, ductile-iron pipe; [**standard-] [or] [compact-**]pattern mechanical-joint fittings; and mechanical joints.

CPVC and RTRP in two subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40] [Schedule 80**] CPVC plastic pipe and fittings and solvent-welded joints.

RTRP and RTRF with adhesive or flanged joints.

* + - 1. PIPING 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 coordination drawings.
				2. Remove standing water in the bottom of trench.
				3. Bed the pipe on a minimum 6-inch layer of pipe system manufacturer's recommended granular fill material with a minimum 6-inch clearance between pipes.
				4. Do not backfill piping trench until field quality-control testing has been completed and results approved.

Coordinate the sizes of drain and vent valves with piping Drawings. Indicate location, quantity, and sizes of drain and vent valves on piping Drawings.

* + - * 1. Install piping at uniform grade of 0.2 percent. Install required fittings to accommodate capped drains at low points and elsewhere as required for system drainage. Install capped manual air vents at high points.

Maintain continuous bedding under piping. Do not leave gaps in pipe bedding, allowing pipe to sag between contact points with the bedding.

* + - * 1. In conduits, install drain valves at low points and manual air vents at high points.
				2. Install components with pressure rating equal to or greater than system operating pressure.
				3. Install piping in straight lines. Do not bend pipe.
				4. Install fittings for changes in direction and branch connections.
				5. See Section 230517 "Sleeves and Sleeve Seals for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.
				6. Secure anchors with concrete thrust blocks. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
				7. Connect to hydronic piping where it passes through the building wall. Hydronic piping inside the building is specified in Section 232113 "Hydronic Piping."

Retain one of first two paragraphs below for valves.

* + - * 1. See Section 230523.13 "Butterfly Valves for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.
				2. See Section 230523.15 Gate Valves for HVAC Piping" for sleeves and mechanical sleeve seals through exterior building walls.
				3. Secure anchors and fittings where piping changes direction, and where elsewhere required by manufacturer's written installation instructions, with concrete thrust blocks. Concrete is specified in Section 033000 "Cast-in-Place Concrete."
				4. See Section 134713 "Cathodic Protection" for cathodic devices and connections to piping and conduit systems.
				5. Apply bitumastic coating to carbon-steel anchors and guides. Pour concrete thrust blocks and anchors. See Section 033000 "Cast-in-Place Concrete" for concrete and reinforcement.
				6. After field quality-control testing is complete, backfill with 6 inches of clean, granular material in accordance with piping system manufacturer's written instructions. If mechanical compaction is required, manually backfill to 12 inches before using mechanical-compaction equipment

Retain or delete the section below if Loose-Fill insulation is being used. Loose-fill insulation is not commonly used and Pre-insulated piping systems are more common.

* + - 1. LOOSE-FILL INSULATION INSTALLATION
				1. Compact and stabilize bottom of trench and bedding to ensure continuous pipe support.
				2. Remove standing water in the bottom of trench before installing pipe.
				3. Bed the pipe on a minimum 6-inch layer of pipe system manufacturer's recommended granular fill material with a minimum 6-inch clearance between the pipes.
				4. Form insulation trench by excavation or by installing drywall side forms to establish required height and width of insulation.
				5. Support piping with proper pitch, separation, and clearance to backfill or side forms using temporary supporting devices that can be removed after backfilling with insulation.
				6. Place insulation and backfill after field quality-control testing has been completed and results approved.
				7. Insulate piping joints at fittings, expansion loops, and offsets with manufacturer-supplied joint insulation kit. Install insulation of thickness appropriate for calculated expansion amount.
				8. Pour loose-fill insulation to required dimension agitating insulation to eliminate voids around piping.
				9. Maintain pipe system manufacturer's recommended separation between adjacent and crossing pipes and other utilities.
				10. Remove temporary hangers and supports.
				11. Cover loose-fill insulation with polyethylene sheet a minimum of 4 mils thick, and empty loose-fill insulation bags on top.
				12. Manually backfill 6 inches of clean fill. If mechanical compaction is required, manually backfill to 12 inches before using mechanical-compaction equipment. Do not compact fill with excavating machinery buckets, wheels, or treads.
			2. JOINT CONSTRUCTION
				1. Join pipe and fittings in accordance with the following requirements and Section 232113 "Hydronic Piping":

Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.

Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.

* + - * 1. Soldered Joints: Apply ASTM B813, water-flushable flux, unless otherwise indicated, to tube end. Construct joints in accordance with ASTM B828 or CDA's "Copper Tube Handbook," using lead-free solder alloy complying with ASTM B32.
				2. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," Ch. 35, "Pipe and Tubing," using copper-phosphorus brazing filler metal complying with AWS A5.8.
				3. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1 or ISO 7-1. Cut threads full and clean using sharp dies. Ream threaded pipe ends to remove burrs and restore full ID. Join pipe fittings and valves as follows:

Apply appropriate tape or thread compound to external pipe threads unless dry seal threading is specified.

Damaged Threads: Do not use pipe or pipe fittings with threads that are corroded or damaged. Do not use pipe sections that have cracked or open welds.

* + - * 1. Welded Joints: Construct joints in accordance with AWS D10.12, using qualified processes and welding operators, in accordance with "Quality Assurance" Article.
				2. Flanged Joints: Select appropriate gasket material, size, type, and thickness for service application. Install gasket concentrically positioned. Use suitable lubricants on bolt threads.
				3. Plastic Piping Solvent-Cemented Joints: Clean and dry joining surfaces. Join pipe and fittings in accordance with the following:

Comply with ASTM F402 for safe-handling practice of cleaners, primers, and solvent cements.

CPVC Piping: Join in accordance with ASTM D2846 Appendix X2.

PVC Pressure Piping: Join ASTM D1785 schedule number PVC pipe and PVC socket fittings in accordance with ASTM D2672. Join other-than-schedule number PVC pipe and socket fittings in accordance with ASTM D2855.

* + - * 1. Fiberglass Bonded Joints: Prepare pipe ends and fittings, apply adhesive, and join in accordance with pipe manufacturer's written instructions.

Retain "Pressure-Sealed Joints" paragraph below for pressure-sealed joints in copper or steel piping.

* + - * 1. Pressure-Sealed Joints: Use manufacturer-recommended tool and procedure. Leave insertion marks on pipe after assembly.
				2. Conduit and Cased Piping Joints: Assemble sections and finish joints with pourable or split insulation and exterior jacket sleeve, and apply shrink-wrap seals.
			1. IDENTIFICATION
				1. Install continuous plastic underground warning tapes during backfilling of trenches for underground hydronic piping. Locate tapes 6 to 8 inches below finished grade, directly over piping.
			2. FIELD QUALITY CONTROL

Retain "Testing Agency," "Manufacturer's Field Service," "Perform tests and inspections," or "Tests and Inspections" paragraph below. Retain first option in first paragraph if Director’s Representative will hire an independent testing agency.

Retain "Manufacturer's Field Service" paragraph below to require a factory-authorized service representative to perform tests and inspections.

* + - * 1. Manufacturer's Field Service: Engage a company field advisor to test and inspect components, assemblies, and equipment installations, including connections.

Retain "Perform tests and inspections" paragraph below to require Contractor to perform tests and inspections and retain option to require Contractor to arrange for the assistance of a factory-authorized service agent.

* + - * 1. Perform tests and inspections[ **with the assistance of a company field advisor**].

Retain "Tests and Inspections" paragraph below with any combination of paragraphs above.

* + - * 1. Tests and Inspections:

Prepare hydronic piping for testing in accordance with ASME B31.9 and as follows:

Leave joints, including welds, uninsulated and exposed for examination during test.

Isolate equipment and instrumentation. Do not subject equipment and instrumentation to test pressure.

Install relief valve set to relieve at pressure no more than one-third higher than test pressure.

Fill system with water. Where there is risk of freezing, perform testing with air or liquid that will not freeze or cause damage to piping system materials.

For hydrostatic testing, install vents at high points to release trapped air while filling system. Remove test liquid at accessible low points.

Test hydronic piping as follows:

Subject hydronic piping to hydrostatic test pressure that is not less than 1.5 times system design pressure.

After hydrostatic test pressure has been applied for 10 minutes, examine joints for leakage. Remake leaking joints using new materials and repeat hydrostatic test until no leaks exist.

Do not pressurize carrier pipe with air.

Maintain test pressure for [**two] [four] <Insert number**> hours with no loss of pressure.

Test conduit as follows:

Seal vents and drains and subject conduit to 15-psig compressed air for four hours with no loss of pressure. Repair leaks and retest.

* + - * 1. Piping will be considered defective if it does not pass tests and inspections.
				2. Prepare test and inspection reports.
				3. When successful testing is complete, flush carrier piping to remove dirt or debris remaining after construction. Drain piping after flushing is complete.
				4. Fill underground piping system with permanent system liquid prior to system testing and balancing.

END OF SECTION 232113.13