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SECTION 232113 - HYDRONIC PIPING

1. GENERAL
	* + 1. SUMMARY
				1. Section Includes:

Fiberglass pipe and fittings.

Piping joining materials.

Dielectric fittings.

* + - 1. ACTION SUBMITTALS

Action submittals are submittals requiring responsive action and return of reviewed documents to Contractor.

* + - * 1. Product Data: For each type of the following:

Pipe and tube.

Fittings.

Joining materials.

Transition fittings.

Retain "Delegated Design Submittals" Paragraph below if design services have been delegated to Contractor.

* + - * 1. Delegated Design Submittals:

Design calculations and detailed fabrication and assembly of pipe anchors and alignment guides, hangers and supports for multiple pipes, expansion joints and loops, and attachments of the same to the building structure.

Locations of pipe anchors, alignment guides, and expansion joints and loops.

Locations of and details for penetrations, including sleeves and sleeve seals for exterior walls, floors, basement, and foundation walls.

Locations of and details for penetration and firestopping for fire- and smoke-rated wall and floor and ceiling assemblies.

* + - 1. INFORMATIONAL SUBMITTALS

Informational submittals are submittals that require review by Architect, but they do not require Architect's responsive action and return of reviewed documents to Contractor, provided submittals comply with requirements. If rejected, submittals with responsive action must be returned to Contractor.

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

* + - * 1. Coordination Drawings: Piping layout, or BIM model, drawn to scale, indicating the items described in this Section, and coordinated with all building trades.

Coordinate "Qualification Data" Paragraph below with qualification requirements in Section 014000 "Quality Requirements" and as may be supplemented in "Quality Assurance" Article.

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

Retain "Welding certificates" Paragraph below if retaining "Steel Support Welding" or "Pipe Welding" Paragraph in "Quality Assurance" Article.

* + - * 1. Welding certificates.
			1. QUALITY ASSURANCE
				1. Installer Qualifications:

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

Installers of Pressure-Sealed Joints: Installers are to be certified by pressure-seal joint manufacturer as having been trained and qualified to join piping with pressure-seal pipe couplings and fittings.

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

Fiberglass Pipe and Fitting Installers: Installers of RTRF and RTRP are to be certified by manufacturer of pipes and fittings as having been trained and qualified to join fiberglass piping with manufacturer-recommended adhesive.

Retain "Steel Support Welding" and "Pipe Welding" paragraphs below for welded supports or piping. Retain "Welding certificates" Paragraph in "Informational Submittals" Article if retaining below.

* + - * 1. Steel Support Welding: Qualify procedures and personnel in accordance with AWS D1.1/D1.1M.
				2. Pipe Welding: Qualify procedures and operators in accordance with ASME Boiler and Pressure Vessel Code: Section IX.

Comply with ASME B31.9 for materials, products, and installation.

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

* + - 1. WARRANTY

Delete this article if polypropylene piping (PP-R or PP-RCT) product type is not retained.

When warranties are required and available, verify with Owner's counsel that special warranties stated in this article are not less than remedies available to Owner under prevailing local laws. Most manufacturers offer 10-year extended warranties on their equipment. Verify available warranties and warranty periods.

* + - * 1. PP-R and PP-RCT Manufacturer's Warranty: Manufacturer agrees to repair or replace PP-R and PP-RCT pipe and fittings that fail in materials or workmanship within 10 years from date of Substantial Completion.

Warranty is to cover labor and material costs of repairing and/or replacing defective materials and repairing any incidental damage caused by failure of the piping system due to defects in materials or manufacturing.

Warranty is to be in effect only upon submission by Contractor to manufacturer of valid pressure/leak documentation indicating that the system was tested and passed manufacturer's pressure/leak test and any other manufacturer requirements.

1. PRODUCTS
	* + 1. PERFORMANCE REQUIREMENTS

Performance requirements in this article are for the piping system. Individual components may have higher pressure or temperature ratings.

* + - * 1. Hydronic piping components and installation are to be capable of withstanding the following minimum working pressures and temperatures unless otherwise indicated:

Pressures and temperatures below are provided for information only and should be inserted for each Project as the working pressures and temperatures are unique.

Hot-Water Heating Piping: [**100 psig**] <**Insert psig**> at [**200 deg F**] [**180 deg F**] <**Insert temperature**>.

Chilled-Water Piping: [**150 psig**] <**Insert psig**> at [**73 deg F**] <**Insert temperature**>.

Dual-Temperature Heating- and Cooling-Water Piping: [**100 psig**] <**Insert psig**> at [**180 deg F**] <**Insert temperature**>.

Condenser-Water Piping: [**150 psig**] <**Insert psig**> at [**73 deg F**] <**Insert temperature**>.

Glycol Cooling-Water Piping: [**150 psig**] <**Insert psig**> at [**150 deg F**] <**Insert temperature**>.

Makeup-Water Piping: [**80 psig**] [**150 psig**] <**Insert value**> at [**73 deg F**] [**150 deg F**] <**Insert temperature**>.

Condensate-Drain Piping: [**150 deg F**] [**180 deg F**] <**Insert temperature**>.

Air-Vent Piping: [**180 deg F**] [**200 deg F**] <**Insert temperature**>.

Pressure-Relief-Valve-Inlet and -Outlet Piping: Equal to the pressure of the piping system to which it is attached.

* + - 1. FIBERGLASS PIPE AND FITTINGS

Fiberglass pipe and fittings are not listed in Ch. 46, "Pipes, Tubes, and Fittings," of the 2016 ASHRAE HVAC Systems and Equipment Handbook.

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. Flanges: ASTM D4024; full-face gaskets suitable for the service, minimum 1/8-inch thick, 60-70 durometer. Provide ASTM A307, Grade B, hex head bolts with washers.
			1. PIPING JOINING MATERIALS
				1. 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 otherwise indicated.

Full-Face Type: For flat-face, Class 125, cast-iron and cast-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.
				2. Plastic, Pipe-Flange Gasket, Bolts, and Nuts: Type and material recommended by piping system manufacturer unless otherwise indicated.

See the Evaluations for discussions of solder and brazing materials described in "Solder Filler Metals" and "Brazing Filler Metals" paragraphs below.

* + - * 1. Solder Filler Metals: ASTM B32, lead-free alloys.
				2. Flux: ASTM B813, water flushable.
				3. Brazing Filler Metals: AWS A5.8/A5.8M, BCuP Series, copper-phosphorus alloys for joining copper with copper; or BAg-1, silver alloy for joining copper with bronze or steel.
				4. Welding Filler Metals: Comply with AWS D10.12M/D10.12 for welding materials appropriate for wall thickness and chemical analysis of steel pipe being welded.
				5. Solvent Cements for CPVC Piping: ASTM F493.

Subparagraph below applies to LEED v4, IgCC/ASHRAE 189.1, and Green Globes. VOC content limit is that for CPVC welding compounds.

Solvent cement shall have a VOC content of 490 g/L or less.

Subparagraph below applies to LEED v4.

Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

Subparagraph below applies to IgCC/ASHRAE 189.1.

Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

Subparagraph below applies to Green Globes.

Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

* + - * 1. Solvent Cements for PVC Piping: ASTM D2564. Include primer in accordance with ASTM F656.

Subparagraph below applies to LEED v4, IgCC/ASHRAE 189.1, and Green Globes. VOC content limit is that for PVC welding compounds.

Solvent cement shall have a VOC content of 510 g/L or less.

Subparagraph below applies to LEED v4, IgCC/ASHRAE 189.1, and Green Globes. VOC content limit is that for adhesive primers for plastic.

Adhesive primer shall have a VOC content of 550 g/L or less.

Subparagraph below applies to LEED v4.

Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

Subparagraph below applies to IgCC/ASHRAE 189.1.

Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

Subparagraph below applies to Green Globes.

Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

Subparagraph below applies to LEED v4.

Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

Subparagraph below applies to IgCC/ASHRAE 189.1.

Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

Subparagraph below applies to Green Globes.

Adhesive primer shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit or 33 mcg/cu. m and that of acetaldehyde shall not exceed 9 mcg/cu. m.

* + - * 1. Fiberglass Pipe Adhesive: As furnished or recommended by pipe manufacturer.

Subparagraph below applies to LEED v4, IgCC/ASHRAE 189.1, and Green Globes. VOC content limit is that for fiberglass.

Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated in accordance with 40 CFR 59, Subpart D (EPA Method 24).

Subparagraph below applies to LEED v4.

Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

Subparagraph below applies to IgCC/ASHRAE 189.1.

Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." Formaldehyde emissions shall not exceed 9 mcg/cu. m or 7 ppb, whichever is less.

Subparagraph below applies to Green Globes.

Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers." The building concentration of formaldehyde shall not exceed half of the indoor recommended exposure limit, or 33 mcg/cu. m, and that of acetaldehyde shall not exceed 9 mcg/cu. m.

* + - 1. DIELECTRIC FITTINGS
				1. General Requirements: Assembly of copper alloy and ferrous materials with separating nonconductive insulating material. Include end connections compatible with pipes to be joined.

Fittings in "Dielectric Flanges" Paragraph below are available in NPS 1-1/2 to NPS 4 (DN 40 to DN 100).

* + - * 1. Dielectric Flanges:

Retain "Basis-of-Design Product" Subparagraph and list of manufacturers below to identify a specific product or a comparable product from manufacturers listed.

Basis-of-Design Product: Subject to compliance with requirements, provide **Zurn Industries, LLC; Model DUXLC** or comparable product by one of the following:

<**Insert manufacturer's name**>

Source Limitations: Obtain dielectric flanges from single manufacturer.

Description:

Standard: ASSE 1079.

Factory-fabricated, bolted, companion-flange assembly.

Revise pressure rating in "Pressure Rating" Subparagraph below to suit Project, or insert other options for specific applications.

Pressure Rating: [**125 psig minimum at 180 deg F**] [**150 psig**] [**175 psig**] [**300 psig**] <**Insert value**>.

End Connections: Solder-joint copper alloy and threaded ferrous; threaded solder-joint copper alloy and threaded ferrous.

1. EXECUTION
	* + 1. PIPING APPLICATIONS

This article is organized to first present the service and pipe size or size range, and then to present optional piping materials and joining methods. Retain the services and sizes and size ranges applicable to Project; then retain the selected piping materials and joining methods. Coordinate selection of piping materials and joining methods with piping materials described in Part 2.

* + - * 1. Hot-Water Heating Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

Retain one or more of six subparagraphs below.

[**Type K**] [**Type L**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**pressure-seal**] [**grooved mechanical**] [**mechanically formed tee**] joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe; [**Class 125, cast-iron**] [**Class 150, malleable-iron**] [**Class 250, cast-iron**] [**Class 300, malleable-iron**] fittings; and [**threaded**] [**grooved mechanical**] joints.

Schedule 5, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 316**] <**Insert type**>, stainless steel pressure-seal fittings; and pressure-seal joints.

[**Schedule 10**] [**Schedule 40**] <**Insert schedule number**>, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 304**] <**Insert type**>, grooved mechanical joint coupling and fittings; and grooved mechanical joints.

Piping materials in subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40**] <**Insert schedule number**>, CPVC plastic pipe and fittings and solvent-welded joints.

RTRP and RTRF with adhesive joints.

* + - * 1. Hot-Water Heating Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

Retain one or more of first five subparagraphs below.

[**Type K**] [**Type L**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**grooved mechanical**] joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe; [**Class 125, cast-iron**] [**Class 150, malleable-iron**] [**Class 250 cast-iron**] [**Class 300 malleable-iron**] fittings; welded joints, cast-iron flanges, flange-fittings, and flanged joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe; grooved mechanical joint coupling and fittings; and grooved mechanical joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe, plain-end mechanical joint couplings and fittings; and plain-end mechanical joints.

[**Schedule 10**] [**Schedule 40**] <**Insert schedule number**>, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 304**] <**Insert type**>, grooved mechanical joint coupling and fittings; and grooved mechanical joints.

Piping materials in subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40**] <**Insert schedule number**>, CPVC plastic pipe and fittings and solvent-welded joints.

RTRP and RTRF with adhesive or flanged joints.

* + - * 1. Chilled-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to be Any of the Following:

Retain one or more of first four subparagraphs below.

[**Type K**] [**Type L**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**pressure-seal**] [**grooved mechanical**] [**mechanically formed tee**] joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B steel pipe; [**Class 125, cast-iron**] [**Class 150, malleable-iron**] [**Class 250, cast-iron**] [**Class 300, malleable-iron**] fittings; and [**threaded**] [**grooved mechanical**] joints.

Schedule 5, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 316**] <**Insert type**>, stainless steel pressure-seal fittings; and pressure-seal joints.

[**Schedule 10**] [**Schedule 40**] <**Insert schedule number**>, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 304**] <**Insert type**>, grooved mechanical joint coupling and fittings; and grooved mechanical joints.

Piping materials in subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40**] <**Insert schedule number**>, CPVC plastic pipe and fittings and solvent-welded joints.

[**PP-R**] [**PP-RCP**] plastic piping and fittings with heat fusion joints.

RTRP and RTRF with adhesive or flanged joints.

* + - * 1. Chilled-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

Retain one or more of eight subparagraphs below.

[**Type K**] [**Type L**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**grooved mechanical**] joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe; grooved mechanical joint coupling and fittings; and grooved mechanical joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe, plain-end mechanical joint coupling and fittings; and plain-end mechanical joints.

[**Schedule 10**] [**Schedule 40**] <**Insert schedule number**>, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 304**] <**Insert type**>, grooved mechanical joint coupling and fittings; and grooved, mechanical joints.

Piping materials in subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40**] <**Insert schedule number**>, CPVC plastic pipe and fittings and solvent-welded joints.

RTRP and RTRF with adhesive or flanged joints.

[**PP-R**] [**PP-RCP**] plastic piping and fittings with heat fusion joints.

* + - * 1. Dual-Temperature Heating- and Cooling-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

Retain one or more of seven subparagraphs below.

[**Type K**] [**Type L**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**pressure-seal**] [**grooved mechanical**] [**mechanically formed tee**] joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B steel pipe; [**Class 125, cast-iron**] [**Class 150, malleable-iron**] [**Class 250, cast-iron**] [**Class 300, malleable-iron**] fittings; and [**threaded**] [**grooved mechanical**] joints.

Schedule 5, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 316**] <**Insert Type**> stainless steel pressure-seal couplings and fittings; and pressure-seal joints.

[**Schedule 10**] [**Schedule 40**] <**Insert schedule number**>, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 304**] <**Insert type**>, grooved mechanical joint coupling and fittings; and grooved mechanical joints.

Piping materials in subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40**] <**Insert schedule number**>, CPVC plastic pipe and fittings and solvent-welded joints.

[**PP-R**] [**PP-RCP**] plastic piping and fittings with heat fusion joints.

RTRP and RTRF with adhesive or flanged joints.

* + - * 1. Dual-Temperature Heating and Cooling-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

Retain one or more of seven subparagraphs below.

[**Type K**] [**Type L**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**grooved mechanical**] joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B steel pipe, [**Class 125, cast-iron**] [**Class 150, malleable-iron**] [**Class 250 cast-iron**] [**Class 300 malleable-iron**] fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B steel pipe; grooved mechanical joint coupling and fittings; and grooved mechanical joints.

[**Schedule 40**] <**Insert schedule number**>, steel pipe, plain-end mechanical joint couplings and fittings; and plain-end mechanical joints.

[**Schedule 10**] [**Schedule 40**] <**Insert schedule number**>, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 304**] <**Insert type**>, grooved mechanical joint coupling and fittings; and grooved mechanical joints.

Piping materials in subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40**] <**Insert schedule number**>, CPVC plastic pipe and fittings and solvent-welded joints.

RTRP and RTRF with adhesive or flanged joints.

* + - * 1. Condenser-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

Retain one or more of first four subparagraphs below.

[**Type K**] [**Type L**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**pressure-seal**] [**grooved mechanical**] [**mechanically formed tee**] joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe; [**Class 125, cast-iron**] [**Class 150, malleable-iron**] [**Class 250 cast-iron**] [**Class 300 malleable-iron**], fittings; and [**threaded**] [**grooved mechanical**] joints.

Schedule 5, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 316**] <**Insert type**>, stainless steel pressure-seal couplings and fittings; and pressure-seal joints.

[**Schedule 10**] [**Schedule 40**] <**Insert schedule number**>, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 304**] <**Insert type**>, grooved mechanical joint coupling and fittings; and grooved mechanical joints.

Piping materials in subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40**] <**Insert schedule number**>, CPVC plastic pipe and fittings and solvent-welded joints.

[**PP-R**] [**PP-RCP**] plastic piping and fittings with heat fusion joints.

RTRP and RTRF with adhesive joints.

* + - * 1. Condenser-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

Retain one or more of first five subparagraphs below.

[**Type K**] [**Type L**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**grooved mechanical**] joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe, [**Class 125, cast-iron**] [**Class 150, malleable-iron**] [**Class 250 cast-iron**] [**Class 300 malleable-iron**] fittings; welded joints, cast-iron flanges and flange-fittings; and flanged joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe; grooved, mechanical joint coupling and fittings; and grooved mechanical joints.

[**Schedule 40**] <**Insert schedule number**>, steel pipe, plain-end mechanical joint coupling and fittings; and plain-end mechanical joints.

[**Schedule 10**] [**Schedule 40**] <**Insert schedule number**>, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 304**] <**Insert type**>, grooved mechanical joint coupling and fittings; and grooved mechanical joints.

Piping materials in subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40**] <**Insert schedule number**>, CPVC plastic pipe and fittings and solvent-welded joints.

RTRP and RTRF with adhesive or flanged joints.

[**PP-R**] [**PP-RCP**] piping and fittings with heat fusion joints.

* + - * 1. Glycol Cooling-Water Piping, Aboveground, NPS 2 (DN 50) and Smaller, to Be Any of the Following:

Retain one or more of first four subparagraphs below.

[**Type K**] [**Type L**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**pressure-seal**] [**grooved mechanical**] [**mechanically formed tee**] joints.

[**Schedule 40**] <**Insert schedule number**>, steel pipe; [**Class 125, cast-iron**] [**Class 150, malleable-iron**] [**Class 250, cast-iron**] [**Class 300, malleable-iron**] fittings; and threaded joints.

Schedule 5, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 316**] <**Insert type**>, stainless steel pressure-seal couplings and fittings; and pressure-seal joints.

[**Schedule 10**] [**Schedule 40**] <**Insert schedule number**>, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 304**] <**Insert type**>, grooved mechanical joint coupling and fittings; and grooved mechanical joints.

Piping material subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40**] <**Insert schedule number**>, CPVC plastic pipe and fittings and solvent-welded joints.

[**PP-R**] [**PP-RCP**] plastic piping and fittings with heat fusion joints.

RTRP and RTRF with adhesive or flanged joints.

* + - * 1. Glycol Cooling-Water Piping, Aboveground, NPS 2-1/2 (DN 65) and Larger, to Be Any of the Following:

Retain one or more of first five subparagraphs below.

[**Type K**] [**Type L**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**grooved mechanical**] joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe, wrought-steel fittings and wrought-cast or forged-steel flanges and flange fittings, and welded and flanged joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe; grooved, mechanical joint coupling and fittings; and grooved mechanical joints.

[**Schedule 40**] <**Insert schedule number**>, Grade B, steel pipe, plain-end mechanical joint coupling and fittings; and plain-end mechanical joints.

[**Schedule 10**] [**Schedule 40**] <**Insert schedule number**>, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 304**] <**Insert type**>, grooved mechanical joint coupling and fittings; and grooved mechanical joints.

Piping materials in subparagraphs below have temperature and pressure limitations. See the Evaluations.

[**Schedule 40**] <**Insert schedule number**>, CPVC plastic pipe and fittings and solvent-welded joints.

RTRP and RTRF with adhesive or flanged joints.

[**PP-R**] [**PP-RCP**] plastic piping and fittings with heat fusion joints.

* + - * 1. Makeup-Water Piping Installed Aboveground to Be Any of the Following:

Retain one or more six subparagraphs below.

[**Type K**] [**Type L**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**pressure-seal**] [**mechanical grooved**] [**mechanically formed tee**] joints.

[**Schedule 40**] <**Insert schedule number**>, CPVC plastic pipe and fittings, and solvent-welded joints.

Schedule 5, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 316**] <**Insert type**>, stainless steel pressure-seal couplings and fittings; and pressure-seal joints.

[**Schedule 10**] [**Schedule 40**] <**Insert schedule number**>, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 304**] <**Insert type**>, grooved mechanical joint coupling and fittings; and grooved mechanical joints.

[**PP-R**] [**PP-RCP**] plastic piping and fittings with heat fusion joints.

RTRP and RTRF with adhesive joints.

* + - * 1. Condensate-Drain Piping Installed Aboveground to Be Any of the Following:

Retain one or both of first two subparagraphs below.

[**Type K**] [**Type L**] [**Type DWV**] <**Insert type**>, drawn-temper copper tubing, wrought-copper fittings, and [**soldered**] [**brazed**] [**pressure-seal**] [**grooved mechanical**] [**mechanically formed tee**] joints.

[**Schedule 40**] <**Insert schedule number**>, PVC plastic pipe and fittings and solvent-welded joints.

Schedule 5, [**Type 304**] <**Insert type**>, stainless steel pipe; [**Type 316**] <**Insert type**>, stainless steel pressure-seal couplings and fittings; and pressure-seal joints.

[**PP-R**] [**PP-RCP**] plastic piping and fittings with heat fusion joints.

* + - * 1. Air-Vent Piping:

Inlet: Same as service where installed with metal-to-plastic transition fittings for plastic piping systems, according to piping manufacturer's written instructions.

Outlet: Type K, annealed-temper copper tubing with soldered or flared joints.

* + - * 1. Pressure-Relief-Valve-Inlet and -Outlet Piping for Hot-Water Piping: Same materials and joining methods as for piping specified for the service in which safety valve is installed, with metal-to-plastic transition fittings for plastic piping systems, according to piping manufacturer's written instructions.
			1. INSTALLATION OF PIPING

Coordinate piping installations and specialty arrangements with Drawings. If Drawings are explicit enough, these requirements may be reduced or omitted.

* + - * 1. Drawing plans, schematics, and diagrams indicate general location and arrangement of piping systems. Indicated locations and arrangements are used to size pipe and calculate friction loss, expansion, and other design considerations. Install piping as indicated unless deviations to layout are approved on coordination drawings.
				2. Install piping in concealed locations unless otherwise indicated and except in equipment rooms and service areas.
				3. Install piping indicated to be exposed and piping in equipment rooms and service areas at right angles or parallel to building walls. Diagonal runs are prohibited unless specifically indicated otherwise.
				4. Install piping above accessible ceilings to allow sufficient space for ceiling panel removal.
				5. Install piping to permit valve servicing.
				6. Install piping at indicated slopes.
				7. Install piping free of sags and bends.
				8. Install fittings for changes in direction and branch connections.
				9. Install piping to allow application of insulation.
				10. Select system components with pressure rating equal to or greater than system operating pressure.
				11. Install groups of pipes parallel to each other, spaced to permit applying insulation and servicing of valves.
				12. Install drains, consisting of a tee fitting, NPS 3/4 ball valve, and short NPS 3/4 threaded nipple with cap, at low points in piping system mains and elsewhere as required for system drainage.
				13. Install piping at a uniform grade of 0.2 percent upward in direction of flow.
				14. Reduce pipe sizes using eccentric reducer fitting installed with level side up.
				15. Install branch connections to mains using [**mechanically formed** ]tee fittings in main pipe, with the branch connected to the bottom of the main pipe. For up-feed risers, connect the branch to the top of the main pipe.
				16. Install valves according to Section 230523 "General-Duty Valves for HVAC Piping."
				17. Install air vents and pressure-relief valves in accordance with Section 232116 "Hydronic Piping Specialties."
				18. Install unions in piping, [**NPS 2**] <**Insert pipe size**> and smaller, adjacent to valves, at final connections of equipment, and elsewhere as indicated.
				19. Install flanges in piping, [**NPS 2-1/2**] <**Insert pipe size**> and larger, at final connections of equipment and elsewhere as indicated.
				20. Install shutoff valve immediately upstream of each dielectric fitting.
				21. Comply with requirements in Section 230500 "Common Work Results for HVAC" for installation of expansion loops, expansion joints, anchors, and pipe alignment guides.
				22. Comply with requirements in Section 230553 "Identification for HVAC Piping and Equipment" for identifying piping.
				23. Install sleeves for piping penetrations of walls, ceilings, and floors. Comply with requirements for sleeves specified in Section 230500 "Common Work Results for HVAC."

Retain first paragraph below for piping that penetrates an exterior concrete wall or concrete slab.

* + - * 1. Install sleeve seals for piping penetrations of concrete walls and slabs. Comply with requirements for sleeve seals specified in Section 230500 "Common Work Results for HVAC."
				2. Install escutcheons for piping penetrations of walls, ceilings, and floors. Comply with requirements for escutcheons specified in Section 230500 "Common Work Results for HVAC."
			1. JOINT CONSTRUCTION
				1. Ream ends of pipes and tubes and remove burrs. Bevel plain ends of steel pipe.
				2. Remove scale, slag, dirt, and debris from inside and outside of pipe and fittings before assembly.
				3. 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.
				4. Brazed Joints: Construct joints in accordance with AWS's "Brazing Handbook," "Pipe and Tube" chapter, using copper-phosphorus brazing filler metal complying with AWS A5.8/A5.8M.
				5. Threaded Joints: Thread pipe with tapered pipe threads in accordance with ASME B1.20.1. 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 D10.12M/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/D2846M Appendix.

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.

PVC Nonpressure Piping: Join in accordance with ASTM D2855.

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

Retain "Grooved Joints" Paragraph below for grooved-end pipe couplings for copper or steel pipe.

* + - * 1. Grooved Joints: Assemble joints with coupling and gasket, lubricant, and bolts. Cut or roll grooves in ends of pipe based on pipe and coupling manufacturer's written instructions for pipe wall thickness. Use grooved-end fittings and rigid, grooved-end-pipe couplings.

Retain "Plain-End Mechanical-Coupled Joints" Paragraph below for plain-end mechanical-coupled steel pipes.

* + - * 1. Plain-End Mechanical-Coupled Joints: Prepare, assemble, and test joints in accordance with manufacturer's written installation instructions.

Retain "Mechanically Formed Tee Fittings" Paragraph below for mechanically formed outlets in place of tee fittings in copper pipe.

* + - * 1. Mechanically Formed Tee Fittings: Use manufacturer-recommended tools, procedure, and brazed joints.

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

* + - * 1. Pressure-Seal Joints: Use manufacturer-recommended tools and procedure. Leave insertion marks on pipe after assembly.
			1. INSTALLATION OF DIELECTRIC FITTINGS
				1. Install dielectric fittings in piping at connections of dissimilar metal piping and tubing.
				2. Dielectric Fittings for NPS 2 (DN 50) and Smaller: Use dielectric [**nipples**] [**unions**].
				3. Dielectric Fittings for NPS 2-1/2 to NPS 4 (DN 65 to DN 100): Use dielectric [**flanges**] [**flange kits**] [**nipples**].
				4. Dielectric Fittings for NPS 5 (DN 125) and Larger: Use dielectric flange kits.
			2. INSTALLATION OF HANGERS AND SUPPORTS

Retain first paragraph below for projects in areas that require seismic restraints.

* + - * 1. Comply with requirements for seismic-restraint devices specified in Section 230548 "Vibration and Seismic Controls for HVAC."
				2. Comply with requirements in Section 230529 "Hangers and Supports for HVAC Piping and Equipment" for hangers, supports, and anchor devices.
				3. Install hangers for [**copper tubing**] [**and**] [**steel piping**], with maximum horizontal spacing and minimum rod diameters, to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
				4. Install hangers for plastic piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
				5. Install hangers for fiberglass piping, with maximum horizontal spacing and minimum rod diameters, to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
				6. Support horizontal piping within [**12 inches**] <**Insert dimension**> of each fitting and coupling.
				7. Support vertical runs of [**copper tubing**] [**and**] [**steel piping**] to comply with MSS SP-58, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
				8. Support vertical runs of [**CPVC**] [**PVC**] [**PP-R**] [**and**] [**PP-RCP**] piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
				9. Support vertical runs of fiberglass piping to comply with manufacturer's written instructions, locally enforced codes, and authorities having jurisdiction requirements, whichever are most stringent.
			1. TERMINAL EQUIPMENT CONNECTIONS
				1. Sizes for supply and return piping connections are to be the same as or larger than equipment connections.
				2. Install control valves in accessible locations close to connected equipment.
				3. Install bypass piping with globe valve around control valve. If parallel control valves are installed, only one bypass is required.
				4. Install ports for pressure gauges and thermometers at coil inlet and outlet connections. Comply with requirements in Section 230500 "Common Work Results for HVAC."
			2. IDENTIFICATION
				1. Identify system components. Comply with requirements for identification materials and installation in Section 230553 "Identification for HVAC Piping and Equipment."
			3. SYSTEM STARTUP
				1. Perform the following before operating the system:

Open manual valves fully.

Inspect pumps for proper rotation.

Set makeup pressure-reducing valves for required system pressure.

Inspect air vents at high points of system and determine if all are installed and operating freely (automatic type), or bleed air completely (manual type).

Set temperature controls so all coils are calling for full flow.

Inspect and set operating temperatures of hydronic equipment, such as boilers, chillers, cooling towers, to specified values.

Verify lubrication of motors and bearings.

* + - 1. FIELD QUALITY CONTROL
				1. Prepare hydronic piping in accordance with ASME B31.9 and as follows:

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

Provide temporary restraints for expansion joints that cannot sustain reactions due to test pressure. If temporary restraints are impractical, isolate expansion joints from testing.

Flush hydronic piping systems with clean water; then remove and clean or replace strainer screens.

Isolate equipment from piping. If a valve is used to isolate equipment, its closure is to be capable of sealing against test pressure without damage to valve. Install blinds in flanged joints to isolate equipment.

Install pressure-relief valve, set at a pressure no more than one-third higher than test pressure, to protect against damage by expanding liquid or other source of overpressure during test.

* + - * 1. Perform the following tests on hydronic piping:

Procedures in subparagraphs below are paraphrased from ASME B31.9.

Use ambient-temperature water as a testing medium unless there is risk of damage due to freezing. Another liquid that is safe for workers and compatible with piping may be used.

While filling system, use vents installed at high points of system to release air. Use drains installed at low points for complete draining of test liquid.

Isolate expansion tanks and determine that hydronic system is full of water.

Subject piping system to hydrostatic test pressure that is not less than 1.5 times the system's working pressure. Test pressure is not to exceed maximum pressure for any vessel, pump, valve, or other component in system under test. Verify that stress due to pressure at bottom of vertical runs does not exceed 90 percent of specified minimum yield strength or 1.7 times the "SE" value in Appendix A in ASME B31.9.

After hydrostatic test pressure has been applied for at least 10 minutes, examine piping, joints, and connections for leakage. Eliminate leaks by tightening, repairing, or replacing components, and repeat hydrostatic test until there are no leaks.

Prepare written report of testing.

END OF SECTION 232113