SECTION 20 07 19 – piping insulation

1. GENERAL
	* + 1. RELATED DOCUMENTS
				1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
				2. Specifications throughout all Divisions of the Project Manual are directly applicable to this Section, and this Section is directly applicable to them.
			2. SUMMARY
				1. Perform all Work required to provide and install piping insulation, jackets and accessories indicated by the Contract Documents with supplementary items necessary for proper installation.
			3. REFERENCE STANDARDS
				1. The latest published edition of a reference shall be applicable to this Project unless identified by a specific edition date.
				2. All reference amendments adopted prior to the effective date of this Contract shall be applicable to this Project.
				3. All materials, installation and Workmanship shall comply with the applicable requirements and standards addressed within the following references:

ASTM B209 - Aluminum and Aluminum‑Alloy Sheet and Plate.

ASTM C168 - Terminology Relating to Thermal Insulation Materials.

ASTM C177 - Steady‑State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded‑ Hot‑Plate Apparatus.

ASTM C195 - Mineral Fiber Thermal Insulating Cement.

ASTM C335 - Steady‑State Heat Transfer Properties of Horizontal Pipe Insulation.

ASTM C449 - Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement.

ASTM C518 - Steady-State Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus.

ASTM C534 - Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form.

ASTM C547 - Mineral Fiber Pipe Insulation.

ASTM C552 - Cellular Glass Thermal Insulation.

ASTM C578 - Rigid, Cellular Polystyrene Thermal Insulation.

ASTM C585 - Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System).

ASTM C591 - Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.

ASTM C610 - Molded Expanded Perlite Block and Pipe Thermal Insulation.

ASTM C921 - Jackets for Thermal Insulation.

ASTM C1126 - Faced or Unfaced Rigid Celluar Phenolic Thermal Insulation.

ASTM D1056 - Flexible Cellular Materials ‑ Sponge or Expanded Rubber.

ASTM D1667 - Flexible Cellular Materials ‑ Vinyl Chloride Polymers and Copolymers (Closed Cell Foam).

ASTM D2842 - Water Absorption of Rigid Cellular Plastics.

ASTM C795 - Insulation For Use Over Austenitic Steel.

ASTM E84 - Surface Burning Characteristics of Building Materials.

ASTM E96 - Water Vapor Transmission of Materials.

NFPA 255 - Surface Burning Characteristics of Building Materials.

UL 723 - Surface Burning Characteristics of Building Materials.

* + - 1. definitions
				1. Concealed: Areas that cannot be seen by the building occupants.
				2. Interior Exposed: Areas that are exposed to view by the building occupants, including underneath countertops, inside cabinets and closets, and all equipment rooms.
				3. Interior: Areas inside the building exterior envelope that are not exposed to the outdoors.
				4. Exterior: Areas outside the building exterior envelope that are exposed to the outdoors, including building crawl spaces and loading dock areas.
			2. QUALITY ASSURANCE
				1. All piping requiring insulation shall be insulated as specified herein and as required for a complete system. In each case, the insulation shall be equivalent to that specified and materials applied and finished as described in these Specifications.
				2. All insulation, jacket, adhesives, mastics, sealers, etc., utilized in the fabrication of these systems shall meet NFPA for fire resistant ratings (maximum of 25 flame spread and 50 smoke developed ratings) and shall be approved by the insulation manufacturer for guaranteed performances when incorporated into their insulation system, unless a specific product is specified for a specific application and is stated as an exception to this requirement.

Certificates to this effect shall be submitted along with Contractor’s submittal data for this Section of the Specifications.

No material shall be used that, when tested by the ASTM E84‑89 test method, is found to melt, drip or delaminate to such a degree that the continuity of the flame front is destroyed, thereby resulting in an artificially low flame spread rating.

* + - * 1. Application Company Qualifications: Company performing the Work of this Section must have minimum three (3) years’ experience specializing in the trade.
				2. All insulation shall be applied by mechanics skilled in this particular Work and regularly engaged in such occupation.
				3. All insulation shall be applied in strict accordance with these Specifications and with factory printed recommendations on items not herein mentioned. Unsightly, inadequate, or sloppy Work will not be acceptable.
			1. SUBMITTALS
				1. Product Data:

Provide product description, list of materials, “k” value, “R” value, mean temperature range, and thickness for each service and location.

Samples: When requested, submit three (3) samples of any representative size illustrating each insulation type

* + - * 1. Operation and Maintenance Data:

 Indicate procedures that ensure acceptable standards will be achieved. Submit certificates to this effect.

* + - 1. DELIVERY, STORAGE and HANDLING
				1. Deliver materials to the Project Site in original factory packaging, labeled with manufacturer’s identification including product thermal ratings and thickness.
				2. Store insulation in original wrapping and protect from weather and construction traffic. Protect insulation against dirt, water, chemical, and mechanical damage.
				3. Maintain ambient temperatures and conditions required by manufacturers of adhesives, mastics and insulation cements.
1. PRODUCTS
	* + 1. GENERAL
				1. All materials shall meet or exceed all applicable referenced standards, federal, state and local requirements, and conform to codes and ordinances of authorities having jurisdiction.
			2. manufacturers
				1. Insulation:

Owens-Corning (Type P1).

Certainteed Corporation (Type P1).

Johns Manville Corporation (Type P1).

Knauf Corporation (Type P1).

Dow Chemical Company (Type P2).

Armstrong/Armacell (Armaflex) (Type P3).

RBX Industries/Rubatex (Type P3).

Industrial Insulation Group, LLC (Type P4).

Resolco International by (Insul-Phen) (Type P5).

 FOAMGLAS (Cellular Glass) by Pittsburgh Corning (Type P6).

* + - * 1. Jackets:

Childers Products Company.

PABCO.

RPR Products, Inc.

Alpha.

Venture Tape Corporation

Foamglas

* + - 1. Insulation
				1. Type P1: Fiberglass preformed insulation; ASTM C 547; minimum 3.0 lb/cu ft density, ASTM C335,'k' value of 0.23 at 75 degrees F; noncombustible.
				2. Type P2: Molded closed cell polyisocyanurate insulation; ASTM E96, maximum water vapor transmission rating of 0.005 Perm-In; ASTM C518, 'k' value of 0.20 at 75 degrees F; ASTM D2842, water absorption value of 0.05 lb/ft2.
				3. Type P3: Elastomer, closed cell, flexible, insulation; ASTM E96; maximum vapor transmission rating of 0.20 perms; ASTM C 518; 'k' value of 0.27 at 75 degrees F.
				4. Type P4: Mineral Wool; ASTM C 547; preformed insulation high temperature insulation; 'k' value of 0.35 at 300 degrees F.
				5. Type P5: Phenolic closed cell, ASTM C1126 rigid foam, 2.2 lbs. nominal density, CFC free; ASTM C518, 'k' value of 0.13 at 75 degrees F. (Note material thickness limit is 3 inches as tested in accordance with ASTM E84).
				6. Type P5A: Phenolic closed cell insulation; ASTM E96, maximum water vapor transmission rating of 0.02 Perm-In; ASTM C1126 rigid foam, 3.75 lbs. nominal density, CFC free; ASTM C518, 'k' value of 0.16 at 75 degrees F. (Note material thickness limit is 3 inches as tested in accordance with ASTM E84).
				7. Type P5B: Phenolic closed cell insulation; ASTM E96, maximum water vapor transmission rating of 0.02 Perm-In; ASTM C1126 rigid foam, 5.0 lbs. nominal density, CFC free; ASTM C518, ‘k’ value of 0.21 at 75 degrees F. (Note material thickness limit is 3 inches as tested in accordance with ASTM E84).
				8. Type P6: Cellular Glass, ASTM C552, 7.5 lbs./cu.ft, density, ASTM E96 (Wet Cup Method) 0.00 water vapor perm , ASTM C518 ‘k’ value of 0.29 at 75 degrees F.
			2. Jackets
				1. Jacket Materials:

Factory Applied Jackets: White kraft bonded to reinforced foil vapor barrier with self‑sealing adhesive joints.

PVC Jackets: UL listed 25/50 rated per ASTM E 84, UV resistant, minimum insulation thickness 0.020 inches for piping outside diameters up to 18 inches and 0.030 inches for i piping outside diameters above 18 inches. Standard manufactured PVC cover fittings cover system consisting of one-piece, pre-molded, PVC covers with fiberglass inserts manufactured from 20-mils thick, high-impact, ultraviolet-resistant. Use ultraviolet resistant adhesive as recommended by the manufacturer.

Fiberglass Cloth Reinforcing Mesh: #10 glass cloth with minimum weight of 3.9 ounces per square yard.

Aluminum Jackets: ASTM B 209; 0.020 inch thick; smooth finish with factory applied moisture barrier.

Stainless Steel Jackets: Type 304 stainless steel; 0.010 inch thick; smooth finish.

Factory Applied Jacket (like Alpha Style: VR-RHD): Provide factory applied ASJ White triple ply laminate polypropylene, mold resistant, metallized polyester vapor barrier film backing.

Venture 1577 W/U, 0 perm and mold resistant jacket material, 5 ply laminate with 6 mil film on with adhesive on one side.. This mold resistant jacket is to be used with Phenolic closed cell insulation used for applications where Type 5A and 5B insulation is used on existing chilled piping being repaired or being modified.

* + - * 1. Interior Concealed Applications:

Type P1 Insulation: Provide factory applied ASJ white kraft foil vapor barrier.

Type P3 Insulation: Finish coat is not required.

Type P4 Insulation: Cover with a canvas jacket, Adhesive Prime Coat # CP-52 and Childers #CP-50A HV2 lagging adhesive.

Type P5 and P5A, 5B Insulation: Provide Venture jacketing material on piping where condensation can occur or where it is used on existing chilled water piping, equipment drain piping transporting chilled condensate form cooling coils, and roof storm drain piping transporting cold rain water from the building roof.

Type P5 Jacketing material is not required when insulation is used on hot water piping.

Type P6 Insulation: Provide Pittcoat 404 or pre-molded PVC covers per manufacturer’s recommendations. Jacketing material is not required when this type of piping insulation is concealed within a piping chase.

* + - * 1. Interior - Exposed Applications:

Type P1, and P2 Insulation: Provide factory applied ASJ white kraft foil vapor barrier. Also finish with canvas jacket or #10 glass membrane with Childers CP-50 or approved equal finish. Apply sizing for finish painting. Verify jacket is suitable for applications.

Type P3 Insulation: Finish coat is not required.

Type P4 Insulation: Cover with a canvas jacket and Childers CP-50 lagging adhesive.

Type P5 Insulation is used on hot water piping: Provide factory applied ASJ white kraft foil vapor barrier

Type P5 and P5A Insulation: Provide Venture jacketing material on piping where it is used on existing chilled water piping, equipment drain piping transporting chilled condensate form cooling coils, and roof storm drain piping transporting cold rain water from the building roof where condensation can occur.

Type P6 Insulation: Provide triple ply laminate polypropylene, mold resistant with a metal foil and polyester vapor barrier film backing.

All exposed insulated piping within six feet of the floor shall be protected with an aluminum or stainless jacket material to protect the insulation jacketing material from being torn or punctured.

* + - * 1. Exterior Applications:

Insulate piping system as indicated under Interior - Exposed Applications, prior to final jacket installation.

Provide electric heat tracing for all exterior small bore piping 2 inch and smaller where water may be susceptible to freezing due to intermittent flow conditions.

Final jacket cover shall be aluminum or stainless steel jacket having integral moisture barrier with seams located at 2 or 10 o'clock position of horizontal piping. All laps must be minimum 2 inches.

Type P1 Insulation: Finish with #10 glass membrane and Childers CP-11, prior to the final jacket installation.

P6 Insulation for above ground installations: Provide (50 mil thickness) self-sealing non- metallic bituminous compound reinforced with glass fiber membrane with 1 mil aluminum top film jacketing for both chilled water and hot water piping (PITTWRAP CW Plus). Metal jacketing is required where the film jacketing material is exposed to ultraviolet rays.

P6 Insulation for underground installations: Provide factory applied (50 mil thicknesses) self-sealing membrane bituminous compound reinforce with glass fiber for chilled water piping (PITTWRAP IW 50). Metal jacketing material is not required for buried pipe.

* + - 1. Inserts supports and shields
				1. Application: Piping ½ inch diameter or larger for all systems except direct buried.
				2. Shields shall be made of galvanized steel or made of black iron painted on both sides with a minimum two coats of aluminum paint. Required metal shield sizes are as follows:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Nominal IPS (inches) |  | Metal Thickness (gage) |  | Minimum Lengths of Shield (inches) |
| ½ to 1½ |  | 18 |  | 12 |
| 2 |  | 14  |  | 12 |
| 2-½ to 6 |  | 12  |  | 16 |
| 8 and above |  | 10  |  | 20 |

* + - * 1. Depending on the type of pipe support design, stainless steel bands or aluminum bands may be required to keep shield material next to the jacketing material.
				2. Inserts for shields shall be manufactured of 7.5 lb/cu. ft. density cellular glass or 5.0 lb/cu. ft. density cellular phenolic insulating material suitable for the planned temperature range. Provide factory fabricated inserts with integral galvanized pipe saddles. Inserts shall be the same thickness as the adjacent insulation.
			1. Insulation accessories
				1. Insulation Bands: 3/4 inch wide; 0.007 inch thick galvanized steel when exposed to interior environment, .010 inch thick stainless steel or 0.015 inch thick aluminum when exposed to harsh humid interior environment or outside environment.
				2. Metal Jacket Bands: 3/8 inch wide; 0.015 inch thick aluminum or 0.010 inch thick stainless steel to match jacket.
				3. Insulating Cement: ASTM C 195; hydraulic setting mineral wool; Ryder One‑Coat.
				4. Sealants: Use at valves, fittings and where insulation is terminated. Brush apply sealant to end of insulation and continue along pipe surface. Provide Childers CP-70/CP-76 or equivalent sealant.
				5. Adhesives: Use to adhere the longitudinal lap seam of vapor barrier jackets and at butt joints between insulation or fitting covers. Provide Childers CP‑82 or approved equal as general purpose adhesive. Use Childers CP‑97 fibrous adhesive for calcium silicate or when adhering pipe saddles and shields to the insulation.
				6. Primers: Provide Childers CP‑50 diluted 50 percent with water or Pittcoat 300 primer thinned with mineral spirits to cover insulating cements prior to finish coating.
				7. Finish: Provide Childers CP‑30 L.O. as a general purpose finish to coat the longitudinal seams and butt joints of vapor barrier jackets or glass cloth jackets. Use Childers CP‑50 reinforced with glass cloth as an adhesive and sizing for canvas and in other locations as indicated.
1. EXECUTION
	* + 1. PREPARATION
				1. Verify that piping has been pressure tested before applying paint and insulation materials.
				2. Thoroughly clean all surfaces to be insulated as required to remove all oil, grease, loose scale, rust, and foreign matter. Piping must be completely dry at the time of application of primer paint. Painting on piping where condensation is occurring on the pipe surface is strictly prohibited.
				3. Provide primer coat on all piping, to include field welds and over factory applied paint/coating, in total compliance with Contract Documents and compatible with and approved by the insulation manufacturer. Painting must be completed and approved prior to installation of insulation. Paint shall be applied in accordance with the paint manufactures instructions, environment, and pipe surface temperatures.
				4. Painting is not required for piping insulated with P6 cellular glass insulation however piping needs to be dry when using PITTSEAL® CW Sealant, a high performance, MS Polymer based sealant for P6 cellular glass insulation for chilled water applications.
			2. INSTALLATION
				1. Installation shall meet or exceed all applicable federal, state and local requirements, referenced standards and conform to codes and ordinances of authorities having jurisdiction.
				2. Installation of insulation and jacket materials shall be in accordance with manufacturer’s published instructions.
				3. Handle and install materials in accordance with manufacturer’s instructions in the absence of specific instructions herein.
				4. On exposed piping, locate insulation cover seams with the ridge of the lap joint is directed down.
				5. Exposed Insulated piping within six feet of the floor shall be protected with an aluminum or stainless jacket material to protect the insulation.
				6. Insulate fittings, joints and valves with molded insulation of the same material and thickness as adjoining pipe. Open voids and cracks insulation shall be kept at a minimum when placing insulation on abnormal or irregular shapes. Use closed cell or recommended fill material as instructed by the insulation manufacturer to close openings. Fiberglass insulation shall not be used as a fill material on chilled water piping or fittings.
				7. Continue insulation through walls, sleeves, pipe hangers, floors, and other pipe penetrations.
				8. Provide dams in insulation at intervals not to exceed 20 feet on cold piping systems to prevent migration of condensation or fluid leaks. Indicate visually where the dams are located for maintenance personnel to identify and also provide dams at butt joints of insulation at fittings, flanges, valves, and hangers.
				9. Insulate entire system including fittings, valves, flanges and strainers. Use closed cell insulation on cold piping system flexible connections, expansion joints and unions, bevel and seal ends of insulation and continue sealant a minimum of 4 inches along the piping, unless stated otherwise.
				10. For hot piping conveying fluids 180 degrees F or less, do not insulate flanges and unions at equipment, but bevel and seal ends of insulation. Continue sealant a minimum of 4 inches along the piping.
				11. On heating piping systems conveying fluids over 180 degrees F with unions, flanges, valves, strainers and equipment that is anticipated to be removed for maintenance, the insulation shall terminate (beveled to pipe) just prior to the flange or union with vapor barrier sealed to pipe. The tapered segment of insulation shall not interfere with the removal of unions flange bolts or equipment. The unions, flanges, valves and strainers shall be insulated with removable insulated covers with toggle catches or Velcro straps
				12. All sections of molded pipe covering shall be firmly butted together. Where an insulation covering is applied, it shall lap the adjoining section of insulation by at least three inches (3 inches). Where insulation terminates, it shall be neatly beveled and finished. All materials used shall be fire retardant or nonflammable.
				13. Where vapor barriers are required, the vapor barrier shall be on the outside. Extreme care shall be taken that the vapor barrier is unbroken. Joints, etc., shall be sealed. Where insulation with a vapor barrier terminates, seal off with vapor barrier continuous to the surface being insulated. Ends shall not be left raw.
				14. Where pipe chases are tight, adequate provision shall be made at the rough-in stage using offset fittings or other means (except springing the pipe) to ensure that insulation can be applied throughout the length of the pipe.
				15. Paint exposed pipe insulation per Specification 09 91 00.
				16. Where canvas finish is specified, use lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating. Where canvas finish is specified, use lagging adhesive to prevent mildew in securing canvas. Do not use wheat paste. In addition, cover all canvas insulation with a fire retardant coating.

On canvas jacketed systems where seam joints at fittings are rough, they shall be covered with an application of insulating cement and smoothed with a trowel before the canvas is applied with adhesive. The canvas must be free of wrinkles and have a smooth, neat appearance.

* + - * 1. INSERTS, SUPPORTS, AND SHIELDS

Shields

Install between pipe hangers or pipe hanger rolls and inserts. Curved metal shields shall be used between the hangers or support points and at the bottom of insulated pipe.

Hangers shall support the load of the insulated pipe section on the outside of the insulation and shall not be in direct contact with the pipe.

Manufacturer shall be responsible to size the length of shield required to prevent insulation from breaking.

Provide rigid insulation at each support point, a minimum of 2 inches longer than shield length.

Curved metal shields shall be designed to limit the bearing stress on the insulation to 35 psi and shall be curved to fit up to mid-perimeter of the insulated pipe.

When installing phenolic insulation provide a 5 lb. density insert of same thickness and contour as adjoining 3.75 lb. density insulation, between the support shield and piping, and under the finish jacket, on piping 1½ inch diameter or larger, to prevent insulation from sagging at support points. Provide inserts for 180-degree arc and not less than 2 inches more than the length of the pipe support shield or minimum 12 inches long (whichever is greater). Adhere the pipe support shield to insulation with a UL approved adhesive that meets E-84 requirements.

Seal all insulation at supports, protrusions and interruptions. Maintain vapor barrier with finish coat.

* + - 1. MAINTENANCE AND ModificaTIONS TO existing CHILLED WATER SYSTEM PIPING INSULATED WITH PHENOLIC FOAM INSULATION
				1. Reinsulate existing piping systems after repairs have been performed in the same manner as the original installation unless:

The nature of damage to the insulation indicates that the system was not insulated properly, and that installation of flashing will be necessary where leaks occur.

Increasing the thickness of the insulation may be required when condensation occurs.

 Provide insulation expansion joints where large cracks or gaps occur.

* + - * 1. Materials:

When possible carefully remove existing insulation material so it can be reapplied, and provide temporary protection to adjacent insulation material to prevent damage while repairs are underway.

When performing a hot tap, maintenance to a strainer, or adding a mechanical component or similar to an operating chilled water system, apply temporary insulation to prevent moisture damage to exposed insulation material. Qualified insulation subcontractor personnel shall assist in the following:

Strainers; dry the strainer body prior to installing the insulating cap. Ensure that the exposed insulation and insulating cap is dry and free of any contamination. Tape in place then finish with fab cloth and vapor barrier mastic.

Hot tap: to eliminate the possibility of moisture migration into the existing insulation, remove the complete section of the pipe covering where the operation will occur. Apply duct wrap on the raw ends of the adjacent insulation in both directions at a 12 inch length. Use FSK tape to secure the wrap. After completion of the hot tap, remove the temporary insulation and inspect the protected sections to ensure the sections are dry and free from contaminates. Re-insulate and seal the circumferential joints with Foster Product joint sealant 30-45 Foam Seal or equivalent. Apply FSK tape at the seams to match the existing facing system.

Use freezing blankets to install new mechanical components to an existing chilled water piping section. Remove enough insulation to install the freezing blankets plus one additional section in either direction. To eliminate the possibility of moisture migration, remove the complete section of the pipe covering where the operation will occur. Apply duct wrap on the raw ends of the adjacent insulation in both directions at a 12 inch length. Use FSK tape to secure the wrap. After completion of the procedure, remove the temporary insulation and inspect the protected sections to ensure that the insulation sections are dry and free from contaminates. Re-insulate and seal the circumferential joints with a Foster Product joint sealant 30-45 Foam Seal or equivalent. Apply tape at the seams to match the existing facing system.

* + - * 1. MAINTENANCE AND INSPECTION METHODS

Conduct periodic inspections as determined by the Owner, to address the following :

Replace missing insulation and protect adjacent insulation which can become burned or wet after maintenance has been performed to the system.

Repair leaks or spills and remove and replace damaged insulation.

Repair breaks, tears, cracks, or punctures of the vapor barrier or protective covering. Verify that the existing insulation is dry and if wet replace the entire affected section as described in this section.

On piping exposed to the outdoor environment, replace the affected section of insulation as described in this section and use galvanized steel, aluminum or stainless steel to protect the insulation from being crushed due to foot traffic or maintenance equipment. PVC is appropriate for interior areas not subject to foot traffic.

* + - 1. PIPING INSULATION APPLICATION AND THICKNESS SCHEDULE
				1. In no case shall installed piping insulation have insulation thicknesses that are less than what is required by local energy codes and ASHRAE 90.1 (whichever is more stringent), based on comparable insulation conductivity values at the specified mean rating temperature.
				2. Type 5A and 5B insulation is only used where it is being replaced on existing pipe and thickness of the replacement insulation shall match the existing insulation thickness.

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| --- | --- | --- | --- | --- |
| Piping Systems | Location | Type | Pipe Size | InsulationThickness |
| Domestic Cold Water, Soft Water, Make-Up Water | Interior Concealed | P1 | 1-1/2" & Smaller | 1/2” |
| 2" to 4" | 1/2” |
| 5" & Larger | 1/2” |
| Interior Exposed | P5 | 1-1/2" & Smaller | 3/4” |
| 2” to 4” | 3/4” |
| 5” & Larger | 1” |
| Interior Exposed |  P6 | 1-1/2” & Smaller | 1” |
| 2” to 4 | 1” |
| 5” & Larger | 1-1/2” |
| Exterior |  P5 | All Sizes | 1” |
|  P6 |  4” and Smaller | 1” |
| 5” & Larger | 1-1/2” |
| Domestic Hot Water, Tempered Water (Maximum 200 Degrees F) | Interior Concealed | P1 | 1” & Smaller | 1.5" |
| 1-1/2”& Larger | 2” |
| Interior Exposed | P5 | 1-1/2” & Smaller |   |
| 2” to 4” | 1” |
| 5” & Larger | 1-1/2” |
| P6 |  1-1/2” and Smaller | 1-1/2” |
| 2” & Larger | 2” |
| Exterior | P5 | All Sizes | 1-1/2” |
| P6 | All Sizes | 2” |
| Fire Protection Water (40 Degrees F – Nominal) | Exterior | P5 | 4” & Smaller | 3/4” |
| 6” & Larger | 1” |
| P6 | 4” & Smaller | 1” |
| 6 “& Larger | 1-1/2” |
| Underside of all Roof / Overflow Drain Bodies and related horizontal roof drain lines to vertical leader | Interior Exposed | P5 | 2” to 4” | 3/4” |
|
|
|
| 5” & Larger | 1” |
| P6 | 2” to 4” | 1” |
| 5” & Larger | 1-1/2” |
| Interior Concealed | P1 | 2" to 4” | 1/2" |
| 5” & Larger | 1/2” |
| Floor Drain Bodies and related horizontal Sanitary Drain Lines above floor that receive cold condensate drainage. | Interior Exposed | P5 | 2” to 4” | 3/4" |
| 5” & Larger | 1" |
| P6 | 2” to 4” | 1” |
| 5” & Larger | 1-1/2” |
| Interior Concealed | P1 | 2” to 4” | 1/2” |
| 5” & Larger | 1/2" |
| Cold Condensate Drain Lines | Interior | P5 | All Sizes | 3/4” |
| P6 | 4” & Smaller | 1” |
| 6” & Larger | 1-1/2” |
| Interior Concealed | P3 | All Sizes | 3/4” |
| P6 | All Sizes | 1" |
| Heating Hot Water (Maximum 250 Degrees F) |
| Interior  | P1 | 1-1/2” & Smaller | 1-1/2” |
| 2"& Larger  | 2”  |
| Chilled Water | Interior Concealed | P1 | 4" & Smaller | 1-1/2” |
| Larger than 4” | 2" |
| Interior Exposed | P1 | 4” & Smaller | 1-1/2” |
| Larger than 4” | 2” |
| Chiller Plant and AHU Piping Doghouses  | P6 | 4" & Smaller | 1-1/2” |
| Larger than 4” | 2” |
| Refrigerant Suction Piping (35 Degrees F – Nominal) | All | P3 | 2-1/2” & Smaller | 3/4" |
| Heat Recovery Water - 180 degrees F | All | P1 | 6" & Smaller | 1-1/2" |
|  |  |
|  |  |
| 8" & Larger | 2-1/2” |
| Engine Exhaust | All | P4 | Less than 1" | 2-1/2" |
| 1" to 3" | 3" |
| 4" & Larger | 4" |
| Low Pressure Steam, Boiler Feedwater, Steam Condensate Return, Compresses Air Discharge, Boiler Blowdown (201 Degrees F to 250 Degrees F) | All | P1 | 2-1/2" & Smaller | 2" |
| 3” to 6" | 3” |
| 8" & Larger | 3-1/2" |
| P4 | Less than 1-1/2” | 3" |
| 1-1/2” & Larger | 3-1/2" |
| Medium Temp. Hot Water and Steam (251 Degrees F to 350 Degrees F) | All | P4 | Less than 1” | 3-1/2" |
| 1" to < 1-1/2" | 4-1/2" |
| 1-1/2" & Larger | 5" |
| High Temp. Hot Water (351 Degrees F to 400 Degrees F) and Steam (351 Degrees F to 600 Degrees F) | All | P4 | Less than 1” | 2-1/2" |
| 1” to < 4" | 3" |
| 4" & Larger | 4” |
| Brine Systems, Cryogenics (Minus 30 Degrees F to 0 Degrees F) | All | P5 | 3” & Smaller | 1-1/2” |
| 4” and Larger | 2” |
| P6 | 3” & Smaller | 2” |
| 4” and Larger | 2-1/2” |
| Brine Systems, Cryogenics (0 Degrees F to 34 Degrees F) | All | P5 | 5” & Smaller | 1” |
| 6” and Larger | 1-1/2” |
| P6 | 5” & Smaller | 1-1/2” |
| 6” and Larger | 2” |

END OF SECTION 20 07 19