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SECTION 220719 - PLUMBING PIPING INSULATION

1. GENERAL
	* + 1. SUMMARY
				1. Section includes insulating the following plumbing piping services:

The list of plumbing piping below matches the various piping systems in the schedule articles. Coordinate the revision of list below with "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles.

Domestic cold-water piping.

Domestic hot-water piping.

Domestic recirculating hot-water piping.

Domestic chilled-water piping for drinking fountains.

Sanitary waste piping exposed to freezing conditions.

Storm-water piping exposed to freezing conditions.

Roof drains and rainwater leaders.

Supplies and drains for handicap-accessible lavatories and sinks.

* + - * 1. Related Sections:

Retain subparagraph below to cross-reference requirements Contractor might expect to find in this Section but are specified in other Sections.

Section 220716 "Plumbing Equipment Insulation" for equipment insulation.

* + - 1. ACTION SUBMITTALS
				1. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied if any).
				2. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.

Detail attachment and covering of heat tracing inside insulation.

Detail insulation application at pipe expansion joints for each type of insulation.

Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.

Detail removable insulation at piping specialties, equipment connections, and access panels.

Detail application of field-applied jackets.

Detail application at linkages of control devices.

Retain "Samples" Paragraph below to verify products with Samples.

* + - * 1. Samples: For each type of insulation and jacket indicated. Identify each Sample, describing product and intended use. Sample sizes are as follows:

Preformed Pipe Insulation Materials: 12 inches long by NPS 2.

Jacket Materials for Pipe: 12 inches long by NPS 2.

Sheet Jacket Materials: 12 inches square.

Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

* + - 1. INFORMATIONAL SUBMITTALS

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

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

Retain "Material Test Reports" Paragraph below if surface-burning characteristics specified in "Quality Assurance" Article are specified to be verified by an independent testing agency.

* + - * 1. Material Test Reports: From a qualified testing agency acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated. Include dates of tests and test methods employed.

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 "Installer Qualifications" Paragraph below if available at Project location. Apprenticeship programs are usually associated with union shops. Other craft training programs may be available. Not all programs are certified by the Department of Labor, Bureau of Apprenticeship and Training. Verify availability of programs within the Project location area before retaining option in paragraph below.

* + - * 1. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.

If retaining "Mockups" Paragraph below, indicate location, size, and other details of mockups on Drawings or by inserts. Revise if only one mockup is required. Edit mockups to retain those specific to Project. Provide additional mockup requirements if applicable.

* + - * 1. Mockups: Before installing insulation, build mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Build mockups in the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

Piping Mockups:

One 10-foot section of NPS 2 straight pipe.

One each of a 90-degree threaded, welded, and flanged elbow.

One each of a threaded, welded, and flanged tee fitting.

One NPS 2 or smaller valve and one NPS 2-1/2 or larger valve.

Four support hangers, including hanger shield and insert.

One threaded strainer and one flanged strainer with removable portion of insulation.

One threaded reducer and one welded reducer.

One pressure temperature tap.

One mechanical coupling.

One union.

<**Insert mockup**>

For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.

Notify Architect [**seven**] <**Insert number**> days in advance of dates and times when mockups will be constructed.

Obtain Architect's approval of mockups before starting insulation application.

Retain first subparagraph below if mockups are not only for establishing appearance factors.

Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.

Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.

Demolish and remove mockups when directed.

* + - * 1. Comply with the following applicable standards and other requirements specified for miscellaneous components:

Supply and Drain Protective Shielding Guards: ICC A117.1.

* + - 1. DELIVERY, STORAGE, AND HANDLING

Retain this article to require shipping container markings. Container marking is an option in ASTM International standards; default condition does not include the marking in this article unless specified in the Contract.

* + - * 1. Packaging: Insulation system materials are to be delivered to the Project site in unopened containers. The packaging is to include name of the manufacturer, fabricator, type, description, and size[**, as well as ASTM standard designation and maximum use temperature**].
			1. COORDINATION
				1. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 220529 "Hangers and Supports for Plumbing Piping and Equipment."
				2. Coordinate clearance requirements with piping Installer for piping insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

Retain subparagraph below for projects that have heat tracing on piping.

* + - * 1. Coordinate installation and testing of heat tracing.
			1. SCHEDULING
				1. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
1. PRODUCTS
	* + 1. PERFORMANCE REQUIREMENTS

When fire-performance characteristics are important requirements, verify surface-burning characteristics of insulation materials by an independent testing agency and require test report submittals.

* + - * 1. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products in accordance with ASTM E84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation, jacket materials, adhesive, mastic, tapes, and cement material containers with appropriate markings of applicable testing agency.

[**All Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]

[**All Insulation Installed Indoors; Outdoors-Installed Insulation in Contact with Airstream: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]

[**All Insulation Installed Indoors and Outdoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.**]

* + - 1. FACTORY-APPLIED JACKETS

Coordinate types of factory-applied jacket insulation materials selected and types of factory-applied jackets indicated in insulation system schedules.

For insulation materials with factory-applied jackets for use on applications of greater than 140 deg F (60 deg C), specify sufficient insulation thickness to maintain outer surface temperature of insulation below 140 deg F (60 deg C). 140 deg F (60 deg C) surface temperature is set by OSHA for personnel protection.

* + - * 1. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C1136, Type I.

ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136, Type I.

FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136, Type II.

ASJ+: Aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C1136 Types I, II, III, IV, and VII.

PSK Jacket: Aluminum foil fiberglass reinforced scrim with polyethylene backing, complying with ASTM C1136, Type II.

* + - 1. PROTECTIVE SHIELDING GUARDS
				1. Protective Shielding Pipe Covers :

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; Z8946-NT** or comparable product by one of the following:

<**Insert manufacturer's name**>

Description: Manufactured plastic wraps for covering plumbing fixture [**hot-water supply**] [**hot- and cold-water supplies**] and trap and drain piping. Comply with Americans with Disabilities Act (ADA) requirements.

1. EXECUTION
	* + 1. EXAMINATION
				1. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

Verify that systems to be insulated have been tested and are free of defects.

Verify that surfaces to be insulated are clean and dry.

* + - * 1. Proceed with installation only after unsatisfactory conditions have been corrected.
			1. PREPARATION

Retain one of first two paragraphs below. Corrosion of pipe under insulation, although not typically caused by insulation, is an issue that must be considered during design of any plumbing insulation system. The potential for corrosion depends on many factors. Requirements cited in second paragraph represent added measures of protection but are not meant to take the place of proper system design and specification.

* + - * 1. Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
				2. Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

Carbon Steel: Coat carbon steel operating at a service temperature of between 32 and 300 deg F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

* + - * 1. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
				2. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.
			1. GENERAL INSTALLATION REQUIREMENTS
				1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of piping, including fittings, valves, and specialties.
				2. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of pipe system, as specified in insulation system schedules.
				3. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, compress, or otherwise damage insulation or jacket.
				4. Install insulation with longitudinal seams at top and bottom (12 o'clock and 6 o'clock positions) of horizontal runs.
				5. Install multiple layers of insulation with longitudinal and end seams staggered.
				6. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.

Definition of "wet" and its negative impacts may vary depending on type of insulation. Some types of insulation are not adversely impacted by wet conditions. Other types of insulation are very much adversely impacted. Retaining option in first paragraph below allows the engineer/specifier, in consultation with the insulation manufacturer, to make the decision regarding when replacement of wet insulation is necessary.

* + - * 1. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet during storage or in the installation process before being properly covered and sealed in accordance with Contract Documents[**, unless otherwise approved by the engineer-of-record**].
				2. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
				3. Install insulation with least number of joints practical.
				4. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

Install insulation continuously through hangers and around anchor attachments.

For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends attached to structure with vapor-barrier mastic.

Install insert materials and insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.

Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

* + - * 1. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
				2. Install insulation with factory-applied jackets as follows:

Draw jacket tight and smooth, but not to the extent of creating wrinkles or areas of compression in the insulation.

Cover circumferential joints with 3-inch- wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches o.c.

Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at 4 inches o.c.

For below-ambient services, apply vapor-barrier mastic over staples.

Cover joints and seams with tape, in accordance with insulation material manufacturer's written instructions, to maintain vapor seal.

Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints and at ends adjacent to pipe flanges and fittings.

* + - * 1. Cut insulation in a manner to avoid compressing insulation.
				2. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
				3. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least [**4 inches**] <**Insert value**> beyond damaged areas. Adhere, staple, and seal patches in similar fashion to butt joints.
				4. For above-ambient services, do not install insulation to the following:

Vibration-control devices.

Testing agency labels and stamps.

Nameplates and data plates.

Cleanouts.

* + - 1. PENETRATIONS
				1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

Seal penetrations with flashing sealant.

For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.

Seal jacket to roof flashing with flashing sealant.

* + - * 1. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.
				2. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

Seal penetrations with flashing sealant.

For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.

Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.

Seal jacket to wall flashing with flashing sealant.

* + - * 1. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
				2. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire-rated walls and partitions.

Comply with requirements in Section 078413 "Penetration Firestopping" for firestopping and fire-resistive joint sealers.

* + - * 1. Insulation Installation at Floor Penetrations:

Pipe: Install insulation continuously through floor penetrations.

Seal penetrations through fire-rated assemblies. Comply with requirements in Section 078413 "Penetration Firestopping."

* + - 1. GENERAL PIPE INSULATION INSTALLATION
				1. Requirements in this article generally apply to all insulation materials, except where more specific requirements are specified in various pipe insulation material installation articles below.

Where pipe expansion is anticipated, detail expansion compensation for insulation on Drawings and indicate intervals for its occurrence. See the Midwest Insulation Contractors Association's "National Commercial & Industrial Insulation Standards."

* + - * 1. Insulation Installation on Fittings, Valves, Strainers, Flanges, Mechanical Couplings, and Unions:

Install insulation over fittings, valves, strainers, flanges, mechanical couplings, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.

Insulate pipe elbows using [**preformed fitting insulation**] [**or**] [**mitered or routed fittings**] made from same material and density as that of adjacent pipe insulation. Each piece is butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

Insulate tee fittings with [**preformed fitting insulation**] [**or**] [**sectional pipe insulation**] of same material and thickness as that used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.

Insulate valves using [**preformed fitting insulation**] [**or**] [**sectional pipe insulation**] of same material, density, and thickness as that used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.

Insulate strainers using [**preformed fitting insulation**] [**or**] [**sectional pipe insulation**] of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers, so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.

Insulate flanges, mechanical couplings, and unions, using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than 2 times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Stencil or label the outside insulation jacket of each union with the word "union" matching size and color of pipe labels.

Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.

For services not specified to receive a field-applied jacket, except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing, using PVC tape.

* + - * 1. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

Coordinate paragraph below with Drawings.

* + - * 1. Install removable insulation covers at locations indicated. Installation conforms to the following:

Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as that of adjoining pipe insulation.

When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union at least 2 times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.

Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.

When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.

Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

* + - 1. INSTALLATION OF CELLULAR-GLASS INSULATION
				1. Insulation Installation on Straight Pipes and Tubes:

Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.

Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.

For insulation with jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

* + - * 1. Insulation Installation on Pipe Flanges:

Install prefabricated pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.

Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

* + - * 1. Insulation Installation on Pipe Fittings and Elbows:

Install prefabricated sections of same material as that of straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.

When preformed sections of insulation are not available, install mitered or routed sections of cellular-glass insulation. Secure insulation materials with wire or bands.

* + - * 1. Insulation Installation on Valves and Pipe Specialties:

Install prefabricated sections of cellular-glass insulation to valve body.

Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

* + - 1. INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION
				1. Seal longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
				2. Insulation Installation on Pipe Flanges:

Install pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as that of pipe insulation.

Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

* + - * 1. Insulation Installation on Pipe Fittings and Elbows:

Install sections of pipe insulation and miter if required in accordance with manufacturer's written instructions.

Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

* + - * 1. Insulation Installation on Valves and Pipe Specialties:

Install prefabricated valve covers manufactured of same material as that of pipe insulation when available.

When prefabricated valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

* + - 1. INSTALLATION OF GLASS-FIBER AND MINERAL WOOL INSULATION
				1. Insulation Installation on Straight Pipes and Tubes:

Secure each layer of preformed pipe insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.

Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

For insulation with jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches o.c.

For insulation with jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

* + - * 1. Insulation Installation on Pipe Flanges:

Install prefabricated pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with glass-fiber or mineral-wool blanket insulation.

Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

* + - * 1. Insulation Installation on Pipe Fittings and Elbows:

Install prefabricated sections of same material as that of straight segments of pipe insulation when available.

When prefabricated insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

* + - * 1. Insulation Installation on Valves and Pipe Specialties:

Install prefabricated sections of same material as that of straight segments of pipe insulation when available.

When prefabricated sections are not available, install fabricated sections of pipe insulation to valve body.

Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

* + - 1. INSTALLATION OF PHENOLIC INSULATION
				1. General Installation Requirements:

Secure single-layer insulation with stainless steel bands at 12-inch intervals, and tighten bands without deforming insulation materials.

Install two-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.

* + - * 1. Insulation Installation on Straight Pipes and Tubes:

Secure each layer of insulation to pipe with wire or bands, and tighten bands without deforming insulation materials.

Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

For insulation with jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches o.c.

For insulation with jackets with vapor retarders on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic and flashing sealant.

* + - * 1. Insulation Installation on Pipe Flanges:

Install prefabricated pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as that of pipe insulation. Where voids are difficult to fill with block insulation, fill the voids with a fibrous insulation material suitable for the specific operating temperature.

* + - * 1. Insulation Installation on Pipe Fittings and Elbows:

Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

* + - * 1. Insulation Installation on Valves and Pipe Specialties:

Install preformed insulation sections of same material as that of straight segments of pipe insulation. Secure according to manufacturer's written instructions.

Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

* + - 1. INSTALLATION OF POLYOLEFIN INSULATION
				1. Insulation Installation on Straight Pipes and Tubes:

Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive[**, or via self-seal mechanism**] to eliminate openings in insulation that allow passage of air to surface being insulated.

* + - * 1. Insulation Installation on Pipe Flanges:

Install pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.

Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyolefin sheet insulation of same thickness as that of pipe insulation.

Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

* + - * 1. Insulation Installation on Pipe Fittings and Elbows:

Install mitered sections of polyolefin pipe insulation.

Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

* + - * 1. Insulation Installation on Valves and Pipe Specialties:

Install cut sections of polyolefin pipe and sheet insulation to valve body.

Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

* + - 1. INSTALLATION OF FIELD-APPLIED JACKETS
				1. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.

Embed glass cloth between two 0.062-inch- thick coats of lagging adhesive.

Completely encapsulate insulation with coating, leaving no exposed insulation.

* + - * 1. Where FSK jackets are indicated, install as follows:

Draw jacket material smooth and tight.

Install lap or joint strips with same material as jacket.

Secure jacket to insulation with manufacturer's recommended adhesive.

Install jacket with 1-1/2-inch laps at longitudinal seams and 3-inch- wide joint strips at end joints.

Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

* + - * 1. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints. Seal with manufacturer's recommended adhesive.

Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.

* + - * 1. Where metal jackets are indicated, install with 2-inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches o.c. and at end joints.
			1. FINISHES

Coordinate "Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material" Paragraph below with Section 099113 "Exterior Painting" and Section 099123 "Interior Painting." If specifying PVC jackets, consult jacket manufacturers to determine suitable paint products and revise painting Sections to suit Project.

* + - * 1. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099113 "Exterior Painting" and Section 099123 "Interior Painting."

Retain paint system in "Flat Acrylic Finish" Subparagraph below for a flat, latex-emulsion size over insulation covering an exterior that is subject to normal use and moderate environments.

Flat Acrylic Finish: [**Two**] <**Insert number**> finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.

Finish Coat Material: Interior, flat, latex-emulsion size.

* + - * 1. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.
				2. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.
				3. Do not field paint aluminum or stainless steel jackets.
			1. FIELD QUALITY CONTROL

Inspections in this article are destructive. Retain if workmanship quality is an important requirement. Architect should be prepared to reject all work if defective work is discovered in sample inspection.

Retain one of first four paragraphs below. Retain first paragraph below if Owner will hire an independent testing agency.

* + - * 1. Owner will engage a qualified testing agency to perform tests and inspections.

Retain first paragraph below to require Contractor to hire an independent testing agency.

* + - * 1. Engage a qualified testing agency to perform tests and inspections.

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 factory-authorized service representative 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 inspection, 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 factory-authorized service representative**].

Retain test requirements in "Tests and Inspections" Paragraph below with any combination of paragraphs above.

* + - * 1. Tests and Inspections: Inspect pipe, fittings, strainers, and valves, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection is limited to [**three**] <**Insert number**> locations of straight pipe, [**three**] <**Insert number**> locations of threaded fittings, [**three**] <**Insert number**> locations of welded fittings, [**two**] <**Insert number**> locations of threaded strainers, [**two**] <**Insert number**> locations of welded strainers, [**three**] <**Insert number**> locations of threaded valves, and [**three**] <**Insert number**> locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.

See Section 014000 "Quality Requirements" for retesting and reinspecting requirements and Section 017300 "Execution" for requirements for correcting the Work.

* + - * 1. All insulation applications will be considered defective if they do not pass tests and inspections.
				2. Prepare test and inspection reports.
			1. PIPING INSULATION SCHEDULE, GENERAL
				1. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
				2. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

Drainage piping located in crawl spaces.

Retain "Underground piping" Subparagraph below only if underground piping is present and not to be insulated. If underground piping is in Project and is to be insulated, see "Outdoor, Underground Piping Insulation Schedule" and "Underground, Field-Applied Insulation Jacket" articles below.

Underground piping.

Chrome-plated pipes and fittings unless there is a potential for personnel injury.

* + - 1. INDOOR PIPING INSULATION SCHEDULE
				1. Domestic Cold Water:

Retain "one of" option in first subparagraph below to allow Contractor to select materials from those retained.

[**NPS 1**] <**Insert pipe size**> and Smaller: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," "Phenolic," and "Polyolefin" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Flexible Elastomeric: [**1/2 inch**] [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.

Phenolic: [**1 inch**] <**Insert dimension**> thick.

Polyolefin: [**1/2 inch**] [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

Retain "one of" option in subparagraph below to allow Contractor to select materials from those retained.

[**NPS 1-1/4**] <**Insert pipe size**> and Larger: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," "Phenolic," and "Polyolefin" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

Phenolic: [**1 inch**] <**Insert dimension**> thick.

Polyolefin: [**1 inch**] <**Insert dimension**> thick.

* + - * 1. Domestic Hot and Recirculated Hot Water:

Retain "one of" option in first subparagraph below to allow Contractor to select materials from those retained.

[**NPS 1-1/4**] <**Insert pipe size**> and Smaller: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," "Phenolic," and "Polyolefin" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Flexible Elastomeric: [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.

Phenolic: [**1 inch**] <**Insert dimension**> thick.

Polyolefin: [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

Retain "one of" option in subparagraph below to allow Contractor to select materials from those retained.

[**NPS 1-1/2**] <**Insert pipe size**> and Larger: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," "Phenolic," and "Polyolefin" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

Phenolic: [**1 inch**] <**Insert dimension**> thick.

Polyolefin: [**1 inch**] <**Insert dimension**> thick.

* + - * 1. Domestic Chilled Water (Potable):

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," "Phenolic," and "Polyolefin" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

Phenolic: [**1 inch**] <**Insert dimension**> thick.

Polyolefin: [**1 inch**] <**Insert dimension**> thick.

* + - * 1. Stormwater and Overflow:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," "Phenolic," and "Polyolefin" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

Phenolic: [**1 inch**] <**Insert dimension**> thick.

Polyolefin: [**1 inch**] <**Insert dimension**> thick.

* + - * 1. Roof Drain and Overflow Drain Bodies:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," "Phenolic," and "Polyolefin" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Flexible Elastomeric: [**1 inch**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

Phenolic: [**1 inch**] <**Insert dimension**> thick.

Polyolefin: [**1 inch**] <**Insert dimension**> thick.

Retain "Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities" Paragraph below for personnel protection.

* + - * 1. Exposed Sanitary Drains, Domestic Water, Domestic Hot Water, and Stops for Plumbing Fixtures for People with Disabilities:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one or more of "Flexible Elastomeric," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," and "Polyolefin" subparagraphs below.

Flexible Elastomeric: [**1/2 inch**] [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.

Polyolefin: [**1/2 inch**] [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

* + - * 1. Sanitary Waste Piping Where Heat Tracing Is Installed:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," and "Phenolic" subparagraphs below.

Cellular Glass: [**2 inches**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1-1/2 inches**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1-1/2 inches**] <**Insert dimension**> thick.

Phenolic: [**1-1/2 inches**] <**Insert dimension**> thick.

* + - * 1. Floor Drains, Traps, and Sanitary Drain Piping within [**10 Feet**] <**Insert distance**> of Drain Receiving Condensate and Equipment Drain Water below 60 Deg F:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," "Phenolic," and "Polyolefin" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Flexible Elastomeric: [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1/2 inch**] [**1 inch**] <**Insert dimension**> thick.

Phenolic: [**1 inch**] <**Insert dimension**> thick.

Polyolefin: [**3/4 inch**] [**1 inch**] <**Insert dimension**> thick.

* + - * 1. Hot Service Drains:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one of or both "Cellular Glass" and "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

* + - * 1. Hot Service Vents:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one of or both "Cellular Glass" and "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

* + - 1. OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE
				1. Domestic Water Piping:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation Type II," "Phenolic," and "Polyolefin" subparagraphs below.

Cellular Glass: [**2 inches**] <**Insert dimension**> thick.

Flexible Elastomeric: [**2 inches**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**2 inches**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**2 inches**] <**Insert dimension**> thick.

Phenolic: [**2 inches**] <**Insert dimension**> thick.

Polyolefin: [**2 inches**] <**Insert dimension**> thick.

* + - * 1. Domestic Hot and Recirculated Hot Water:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," "Phenolic," and "Polyolefin" subparagraphs below.

Cellular Glass: [**2 inches**] <**Insert dimension**> thick.

Flexible Elastomeric: [**2 inches**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**2 inches**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**2 inches**] <**Insert dimension**> thick.

Phenolic: [**2 inches**] <**Insert dimension**> thick.

Polyolefin: [**2 inches**] <**Insert dimension**> thick.

* + - * 1. Sanitary Waste Piping Where Heat Tracing Is Installed:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Glass-Fiber, Preformed Pipe Insulation, Type I," "Mineral Wool, Preformed Pipe Insulation, Type II," and "Phenolic" subparagraphs below.

Cellular Glass: [**2 inches**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**2 inches**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**2 inches**] <**Insert dimension**> thick.

Phenolic: [**2 inches**] <**Insert dimension**> thick.

* + - * 1. Hot Service Drains:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Glass-Fiber, Preformed Pipe Insulation, Type I," and "Mineral Wool, Preformed Pipe Insulation, Type II" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

* + - * 1. Hot Service Vents:

Retain "one of" option in "All Pipe Sizes" Subparagraph below to allow Contractor to select materials from those retained.

All Pipe Sizes: Insulation is[ **one of**] the following:

Retain one or more of "Cellular Glass," "Glass-Fiber, Preformed Pipe Insulation, Type I," and "Mineral Wool, Preformed Pipe Insulation, Type II" subparagraphs below.

Cellular Glass: [**1-1/2 inches**] <**Insert dimension**> thick.

Glass-Fiber, Preformed Pipe Insulation, Type I: [**1 inch**] <**Insert dimension**> thick.

Mineral Wool, Preformed Pipe Insulation, Type II: [**1 inch**] <**Insert dimension**> thick.

* + - 1. OUTDOOR, UNDERGROUND PIPING INSULATION SCHEDULE

Insulation specified in this article is limited to those insulation types that have high compressive strength. Other insulation types may be considered acceptable and should be evaluated on a project basis. Cellular glass is best suited, because of its moisture-resistant properties, for applications of below 250 deg F (121 deg C).

* + - * 1. Sanitary Waste Piping, All Sizes, Where Heat Tracing Is Installed: Cellular glass, [**2 inches**] <**Insert dimension**> thick.
				2. Chilled Water, All Sizes: Cellular glass, [**2 inches**] <**Insert dimension**> thick.
			1. INDOOR, FIELD-APPLIED JACKET SCHEDULE

Possible variations of jackets by location are endless. This article specifies locations in two broad categories: concealed and exposed. Revise if additional delineation is necessary.

* + - * 1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
				2. If more than one material is listed, selection from materials listed is Contractor's option.
				3. Piping, Concealed:

Retain one of six subparagraphs below.

None.

[**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.

Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.

Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.

<**Insert jacket type**>.

* + - * 1. Piping, Exposed:

Retain one of six subparagraphs below.

None.

[**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.

Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.

Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.

<**Insert jacket type**>.

* + - 1. OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

Possible variations of jackets by location are endless. This article specifies locations in two broad categories: concealed and exposed. Revise if additional delineation is necessary.

30-mil (0.8-mm) or heavier PVC is recommended for outdoor applications. 40-mil (1.0-mm) PVC does not comply with a flame-spread index of 25 and a smoke-developed index of 50; however, a flame-spread or smoke-developed index is not a requirement for outdoor applications.

0.024-inch (0.61-mm) or heavier aluminum is recommended for outdoor applications.

Painted aluminum increases surface emissivity and provides added chemical resistance. See the Evaluations for discussion of emissivity.

0.016-inch (0.41-mm) or heavier stainless steel is recommended for outdoor applications.

Z-shaped locking seam is recommended for metal jackets located in unprotected applications that are exposed to severe weather.

* + - * 1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
				2. If more than one material is listed, selection from materials listed is Contractor's option.
				3. Piping, Concealed:

Retain one of six subparagraphs below.

None.

[**PVC**] [**PVC, Color-Coded by System**]: [**20 mils**] [**30 mils**] thick.

Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.

Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] thick.

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.

<**Insert jacket type**>.

* + - * 1. Piping, Exposed:

Retain one of four subparagraphs below.

PVC: [**20 mils**] [**30 mils**] [**40 mils**] thick.

[**Painted** ]Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] [**0.032 inch**] [**0.040 inch**] thick.

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.010 inch**] [**0.016 inch**] [**0.020 inch**] [**0.024 inch**] thick.

<**Insert jacket type**>.

* + - 1. UNDERGROUND, FIELD-APPLIED INSULATION JACKET
				1. For underground direct-buried piping applications, install underground direct-buried jacket over insulation material.

END OF SECTION 220719