SECTION 230719 - HVAC PIPING INSULATION

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

This Section uses the term "Architect." Change this term to match that used to identify the design professional as defined in the General and Supplementary Conditions.

Verify that Section titles referenced in this Section are correct for this Project's Specifications; Section titles may have changed.

1. GENERAL
   * + 1. RELATED DOCUMENTS

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

* + - * 1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
      1. SUMMARY
         1. Section includes insulation for HVAC piping systems.
      2. QUALITY ASSURANCE

Retain "Installer Qualifications" Paragraph below if available at Project location. Apprenticeship programs are usually associated with union shops. Other craft training programs are available.

* + - * 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.

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 and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

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

Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

* + - 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 material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
      1. COORDINATION
         1. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC 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 paragraph 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.
         2. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1. PRODUCTS
   * + 1. INSULATION MATERIALSINSULATION MATERIALS

If retaining more than one type of insulation in this article, indicate where each type applies in insulation system schedules.

* + - * 1. Comply with requirements in "Piping Insulation Schedule, General," "Indoor Piping Insulation Schedule," "Outdoor, Aboveground Piping Insulation Schedule," and "Outdoor, Underground Piping Insulation Schedule" articles for where insulating materials shall be applied.

See "Product Characteristics" Article in the Evaluations for comparisons and temperature ranges for insulation material properties.

* + - * 1. Products shall not contain asbestos, lead, mercury, or mercury compounds.
        2. Products that come into contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871.
        3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795.
        4. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
        5. Calcium Silicate: Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I.

Prefabricated Fitting Covers: Comply with ASTM C450 and ASTM C585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3195) Subject to compliance with requirements, [provide products by the following] [provide products by one of the following] [available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following]:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457177408).

General Insulation Company Inc.

American Mechanical Insulation Sales Inc.

Approved equivalent.

* + - * 1. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3196) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Pittsburgh Corning Corporation](http://www.specagent.com/Lookup?uid=123457177312).

Owens Corning

McMaster-Carr

Approved equivalent.

Preformed Pipe Insulation without Jacket: Type II, Class 1, without jacket.

Preformed Pipe Insulation with Jacket: Type II, Class 2, with factory-applied [**ASJ**] [**ASJ-SSL**] jacket.

Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.

Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

"Flexible Elastomeric" Paragraph below is unsuitable for temperatures of lower than minus 70 deg F (minus 57 deg C) and higher than 220 deg F (104 deg C).

In "Flexible Elastomeric" Paragraph, sheet material option is included for larger piping. Tubular materials are generally only available in sections of up to 8 to 10 inches, (200 to 250 mm), depending on manufacturer.

* + - * 1. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534/C534M, Type I for tubular materials, Type II for sheet materials.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3197) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Aeroflex USA](http://www.specagent.com/Lookup?uid=123457177314).

[Armacell LLC](http://www.specagent.com/Lookup?uid=123457177315).

[K-Flex USA](http://www.specagent.com/Lookup?uid=123457177316).

Approved equivalent.

* + - * 1. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547.

An ASJ requires field-applied adhesive and staples. An ASJ-SSL does not require field-applied adhesive and staples, resulting in reduced installation labor.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3199) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457177318).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457177319).

[Manson Insulation Inc](http://www.specagent.com/Lookup?uid=123457177320).

Approved equivalent.

Preformed Pipe Insulation: Type I, Grade A[**, without factory-applied jacket**][**with factory-applied ASJ**][**with factory-applied ASJ-SSL**].

850 deg F850 deg F (454 deg C).

Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.

Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

Pipe and tank insulation is used for large-diameter piping and vessels. ASJ is commonly used.

* + - * 1. Mineral-Fiber, Pipe and Tank: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C1393.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3201) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457177416).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457177415).

[Manson Insulation Inc](http://www.specagent.com/Lookup?uid=123457177417).

Approved equivalent.

Semirigid board material with factory-applied [**ASJ**] [**FSK**] jacket.

Nominal density is 2.5 lb/cu. ft.2.5 lb/cu. ft. (40 kg/cu. m) or more.

Thermal conductivity (k-value) at 100 deg F100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less.

Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

Phenolic insulation is available in Grades 1 and 2. Grade 1 has a lower thermal conductivity than Grade 2. Grade 2 is not commercially available.

* + - * 1. Phenolic: Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3202) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Resolco Inc](http://www.specagent.com/Lookup?uid=123457177420).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457177416).

Polyguard Products

Approved equivalent.

Preformed Pipe Insulation: Type III[**, without factory-applied jacket**] [**, with factory-applied ASJ**].

Factory fabricate shapes in accordance with ASTM C450 and ASTM C585.

Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

* + - * 1. Polyisocyanurate: Preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation. Comply with ASTM C591.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3203) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457177425).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457139375).

GLT Products

Approved equivalent.

Preformed insulation[**, without factory-applied jacket**] [**, with factory-applied ASJ**] [**, with factory-applied ASJ-SSL**] [**, with field-applied PVDC jacket**] [**, with field-applied PVDC-SSL**].

Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F0.19 Btu x in./h x sq. ft. x deg F (0.027 W/m x K) at 75 deg F75 deg F (24 deg C) after 180 days of aging.

Flame-spread index shall be 25 or less, and smoke-developed index shall be 50 or less for thicknesses of up to 1 inch1 inch (25 mm) as tested in accordance with ASTM E84.

Fabricate shapes in accordance with ASTM C450 and ASTM C585.

Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

In "Polyolefin" Paragraph below, sheet material option is included for larger piping. Tubular materials are generally only available in sections of up to 4 inches (100 mm); consult manufacturer.

* + - * 1. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C534/C534M or ASTM C1427, Type I, Grade 1, for tubular materials and with Type II, Grade 1, for sheet materials.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3204) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Armacell LLC](http://www.specagent.com/Lookup?uid=123457177323).

Approved equivalent.

Polystyrene is for outdoor use only; its flame-spread/smoke-developed indexes are unsuitable for most indoor applications.

* + - * 1. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes in accordance with ASTM C450 and ASTM C585.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3205) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457177427).

Johns Manville

PermaTherm Pipe Insulation Systems

Approved equivalent.

* + - 1. INSULATING CEMENTS

Mineral-fiber insulating cement is suitable for temperatures from 100 to 1600 deg F (38 to 871 deg C). Vermiculite insulating cement is suitable for temperatures from 100 to 1800 deg F (38 to 982 deg C).

* + - * 1. Mineral-Fiber Insulating Cement: Comply with ASTM C195.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3206) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Ramco Insulation, Inc](http://www.specagent.com/Lookup?uid=123457177428).

Foundry Services & Supplies

GLT Products

Approved equivalent.

* + - * 1. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3207) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Ramco Insulation, Inc](http://www.specagent.com/Lookup?uid=123457177429).

VITCAS

The Strong Company Inc.

Approved equivalent.

* + - * 1. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3208) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Ramco Insulation, Inc](http://www.specagent.com/Lookup?uid=123457177326).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457139375).

Foster Citra Utama

Approved equivalent.

* + - 1. ADHESIVES

MIL-A-3316C was the only standard available when this Section was updated. MIL-A-3316C was last updated in 1990.

* + - * 1. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
        2. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F50 to 800 deg F (10 to 427 deg C).

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3209) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177430).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177432).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457177433).

Approved equivalent.

* + - * 1. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg Fminus 100 to plus 200 deg F (minus73 to plus 93 deg C).

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3210) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177328).

Owens Corning

GLT Products

Approved equivalent.

* + - * 1. Phenolic and Polyisocyanurate Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300 deg Fminus 75 to plus 300 deg F (minus 59 to plus 149 deg C).

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3211) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177435).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177436).

Bostik

Approved equivalent.

* + - * 1. Flexible Elastomeric and Polyolefin Adhesive: Solvent-based adhesive.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3212) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Armacell LLC](http://www.specagent.com/Lookup?uid=123457139391).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177333).

[K-Flex USA](http://www.specagent.com/Lookup?uid=123457177331).

Approved equivalent.

Not all manufacturer comply with sustainability requirements. If sustainability is Project goal, consult manufacturers.

Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84.

Wet Flash Point: Below 0 deg F0 deg F (minus 18 deg C).

Service Temperature Range: 40 to 200 deg F40 to 200 deg F (4 to plus 93 deg C).

Color: [**Black**] <**Insert color**>.

* + - * 1. Mineral-Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3213) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177335).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177337).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457177338).

Approved equivalent.

* + - * 1. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140 deg Fminus 20 to plus 140 deg F (29 to plus 60 deg C).

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3214) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177443).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177444).

3M

Approved equivalent.

* + - * 1. ASJ Adhesive and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A, for bonding insulation jacket lap seams and joints.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3215) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177341).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177340).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457177343).

Approved equivalent.

* + - * 1. PVC Jacket Adhesive: Compatible with PVC jacket.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3216) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457177345).

[P.I.C. Plastics, Inc](http://www.specagent.com/Lookup?uid=123457177346).

[Speedline Corporation](http://www.specagent.com/Lookup?uid=123457177347).

Approved equivalent.

* + - 1. MASTICS AND COATINGS

Mastic and coating terminology is used interchangeably in this article. Manufacturers refer to vapor-barrier formulations and vapor-retarder formulations as "mastics" or "coatings." Low-permeance mastics and coatings are termed "vapor retarders." Products with a perm rating of greater than 1.0 are called "breathable." Consider ambient conditions and operating temperatures when selecting mastics and coatings. Consider using water-based mastics and coatings for environmental reasons.

LEED 2009 IEQ Credit 4.1 does not address requirements for mastics and coatings. LEED 2009 IEQ Credit 4.2 does address requirements for mastics and coatings. LEED v4 EQ Credit, "Low-Emitting Materials," does address requirements for mastics and coatings.

* + - * 1. Materials shall be compatible with insulation materials, jackets, and substrates.

Verify that products listed comply with water-vapor permeance requirements. Require proof of performance and certified test reports from vapor-barrier mastic manufacturer, to support product literature claims.

Retain "Vapor-Retarder Mastic, Water Based"; "Vapor-Retarder Mastic, Solvent Based, Indoor Use"; "Vapor-Retarder Mastic, Solvent Based, Outdoor Use"; or "Breather Mastic" Paragraph below. Consider insulation type and operating conditions when selecting mastics and coatings.

* + - * 1. Vapor-Retarder Mastic, Water Based: Suitable for indoor use on below-ambient services.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3217) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177353).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177351).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457177352).

Approved equivalent.

Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.

In "Service Temperature Range" Subparagraph below, more manufacturers can comply if first option is retained; consult manufacturers.

Service Temperature Range: [**0 to plus 180 deg F0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] [**Minus 20 to plus 180 deg FMinus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**].

Retain MIL-PRF-19565C in first subparagraph below for vapor-retarder mastics and coatings if applicable to Project.

Comply with MIL-PRF-19565C, Type II, for permeance requirements[**, with supplier listing on DOD QPD - Qualified Products Database**].

Color: [**White**] <**Insert color**>.

Retain "Vapor-Retarder Mastic, Solvent Based, Indoor Use" Paragraph below if low-VOC mastics and coatings are not required, or if a lower permeance is required.

* + - * 1. Vapor-Retarder Mastic, Solvent Based, Indoor Use: Suitable for indoor use on below-ambient services.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3218) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177354).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177357).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457177355).

Approved equivalent.

Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.

Service Temperature Range: 0 to 180 deg F0 to 180 deg F (Minus 18 to plus 82 deg C).

Color: [**White**] <**Insert color**>.

* + - * 1. Vapor-Retarder Mastic, Solvent Based, Outdoor Use: Suitable for outdoor use on below-ambient services.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3219) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177449).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177448).

Stego Industries

Approved equivalent.

Water-Vapor Permeance: Comply with ASTM E96/E96M or ASTM F1249.

Service Temperature Range: Minus 50 to plus 220 deg FMinus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).

Color: [**White**] <**Insert color**>.

* + - * 1. Breather Mastic: Water based; suitable for indoor and outdoor use on above-ambient services.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3220) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177358).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177360).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457177361).

Approved equivalent.

Water-Vapor Permeance: ASTM E96/E96M, greater than 1.0 perm1.0 perm (0.66 metric perm) at manufacturer's recommended dry film thickness.

In "Service Temperature Range" Subparagraph below, more manufacturers can comply if first option is retained; consult manufacturers.

Service Temperature Range: [**0 to plus 180 deg F0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] [**Minus 20 to plus 180 deg FMinus 20 to plus 180 deg F (Minus 29 to plus 82 deg C)**].

Color: [**White**] <**Insert color**>.

* + - 1. LAGGING ADHESIVES
         1. Adhesives shall comply with MIL-A-3316C, Class I, Grade A, and shall be compatible with insulation materials, jackets, and substrates.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3221) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177457).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177458).

[Vimasco Corporation](http://www.specagent.com/Lookup?uid=123457139511).

Approved equivalent.

Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over pipe insulation.

In "Service Temperature Range" Subparagraph below, more manufacturers can comply if first option is retained; consult manufacturers.

Service Temperature Range: [**20 to plus 180 deg F20 to plus 180 deg F (Minus 6 to plus 82 deg C)**] [**0 to plus 180 deg F0 to plus 180 deg F (Minus 18 to plus 82 deg C)**].

Color: White.

* + - 1. SEALANTS

Sealants are categorized into "joint sealants" and "flashing sealants." Joint sealants are primarily used for vapor-sealing longitudinal seams and butt joints of insulation materials. Flashing sealants are primarily used for sealing jacket and mastic materials.

* + - * 1. Materials shall be as recommended by the insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
        2. Joint Sealants:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3222) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177465).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177467).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457177463).

Approved equivalent.

Permanently flexible, elastomeric sealant.

In "Service Temperature Range" Subparagraph below, more manufacturers can comply if first option is retained; consult manufacturers.

Service Temperature Range: [**Minus 150 to plus 250 deg FMinus 150 to plus 250 deg F (Minus 101 to plus 121 deg C)**] [**Minus 100 to plus 300 deg FMinus 100 to plus 300 deg F (Minus 73 to plus 149 deg C)**].

Color: White or gray.

Materials in "FSK and Metal Jacket Flashing Sealants" Paragraph below are for sealing metal jacket seams and joints.

* + - * 1. FSK and Metal Jacket Flashing Sealants:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3224) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177366).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177365).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457177368).

Approved equivalent.

Fire- and water-resistant, flexible, elastomeric sealant.

Service Temperature Range: Minus 40 to plus 250 deg FMinus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

Color: Aluminum.

* + - * 1. ASJ Flashing Sealants and PVDC and PVC Jacket Flashing Sealants:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3225) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177370).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457139424).

Insultherm

Approved equivalent.

Fire- and water-resistant, flexible, elastomeric sealant.

Service Temperature Range: Minus 40 to plus 250 deg FMinus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).

Color: White.

* + - 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.

* + - 1. FIELD-APPLIED REINFORCING MESH

Both glass-fiber- and polyester-reinforcing meshes are acceptable.

Retain "Woven Glass-Fiber Mesh" and "Woven Polyester Mesh" paragraphs below to give Contractor option to use either glass-fiber or polyester mesh.

* + - * 1. Woven Glass-Fiber Mesh: Approximately 2 oz./sq. yd.2 oz./sq. yd. (68 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in.10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm) for covering pipe and pipe fittings.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3229) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177478).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457139424).

ACP Composites

Approved equivalent.

* + - * 1. Woven Polyester Mesh: Approximately 1 oz./sq. yd.1 oz./sq. yd. (34 g/sq. m) with a thread count of 10 strands by 10 strands/sq. in.10 strands by 10 strands/sq. in. (4 strands by 4 strands/sq. mm), in a Leno weave, for pipe.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3230) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457177479).

[Vimasco Corporation](http://www.specagent.com/Lookup?uid=123457177480).

ARDEX Americas

Approved equivalent.

* + - 1. FIELD-APPLIED CLOTHS
         1. Woven Glass-Fiber Cloth: Comply with MIL-C-20079H, Type I, plain weave, and presized a minimum of 8 oz./sq. yd.8 oz./sq. yd. (271 g/sq. m).

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3231) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Alpha Associates, Inc](http://www.specagent.com/Lookup?uid=123457177481).

Approved equivalent.

* + - 1. FIELD-APPLIED JACKETS

Insulation jackets in this article are for field application. ASTM C1136, Type I, is for use over insulation on pipes operating at below-ambient temperatures at least part of the time or where a vapor barrier is required. ASTM C1136, Type II, is for use over insulation on pipes operating above-ambient temperatures or where a vapor retarder is not required.

* + - * 1. Field-applied jackets shall comply with ASTM C1136, Type I, unless otherwise indicated.

A properly sealed FSK jacket, common with most forms of factory-applied jackets for mineral-fiber insulation, complies with vapor-retarder requirements of ASTM C1136, Type I.

* + - * 1. FSK Jacket: Aluminum-foil-face, fiberglass-reinforced scrim with kraft-paper backing.

Although other thicknesses for PVC jackets are available, a flame-spread index of 25 and a smoke-developed index of 50 apply only to thicknesses of 30 mils (0.8 mm) and less.

* + - * 1. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3232) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Airex Manufacturing](http://www.specagent.com/Lookup?uid=123457177376).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457177375).

[P.I.C. Plastics, Inc](http://www.specagent.com/Lookup?uid=123457177374).

Approved equivalent.

Adhesive: As recommended by jacket material manufacturer.

PVC jackets are available in several colors. Colored jackets may be used to replace field painting. UV rays fade colors in exterior applications. Some colors (black, gray, and white) do not fade as quickly as other colors (red, orange, and green). Colored jackets have different emissivity and are not recommended for outdoor use.

Color: [**White**] [**Color-code jackets based on system. Color as selected by Director’s Representative**].

Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.

Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

* + - * 1. Metal Jacket:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3233) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457177484).

[RPR Products, Inc](http://www.specagent.com/Lookup?uid=123457177483).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457139432).

Approved equivalent.

Aluminum Jacket: Comply with ASTM B209ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

[**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].

Finish and thickness are indicated in field-applied jacket schedules.

Among the three moisture barriers in "Moisture Barrier for Indoor Applications" Subparagraph below, 1-mil (0.025-mm) barrier provides the least protection against galvanic corrosion, 3-mil (0.075-mm) barrier offers better protection, and polysurlyn barrier offers the best protection. For most indoor applications, 1-mil (0.025-mm) barrier is adequate. For outdoor applications, retain either 3-mil (0.075-mm) or polysurlyn barrier.

Moisture Barrier for Indoor Applications: [**1-mil-1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**] [**3-mil-3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil-2.5-mil- (0.063-mm-) thick polysurlyn**].

Moisture Barrier for Outdoor Applications: [**3-mil-3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil-2.5-mil- (0.063-mm-) thick polysurlyn**].

Factory-Fabricated Fitting Covers:

Same material, finish, and thickness as jacket.

Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.

Tee covers.

Flange and union covers.

End caps.

Beveled collars.

Valve covers.

Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

Stainless Steel Jacket: ASTM A240/A240M.

[**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].

Material, finish, and thickness are indicated in field-applied jacket schedules.

Among the three moisture barriers in "Moisture Barrier for Indoor Applications" Subparagraph below, 1-mil (0.025-mm) barrier provides the least protection against galvanic corrosion, 3-mil (0.075-mm) barrier offers better protection, and polysurlyn barrier offers the best protection. For most indoor applications, 1-mil (0.025-mm) barrier is adequate.

Moisture Barrier for Indoor Applications: [**1-mil-1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**] [**3-mil-3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil-2.5-mil- (0.063-mm-) thick polysurlyn**].

Moisture Barrier for Outdoor Applications: [**3-mil-3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil-2.5-mil- (0.063-mm-) thick polysurlyn**].

Factory-Fabricated Fitting Covers:

Same material, finish, and thickness as jacket.

Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.

Tee covers.

Flange and union covers.

End caps.

Beveled collars.

Valve covers.

Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

* + - * 1. Underground Direct-Buried Jacket: 125-mil-125-mil- (3.2-mm-) thick vapor barrier and waterproofing membrane, consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3234) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Pittsburgh Corning Corporation](http://www.specagent.com/Lookup?uid=123457177486).

[Polyguard Products, Inc](http://www.specagent.com/Lookup?uid=123457177485).

MFM Building Products Corp.

Approved equivalent.

* + - * 1. Self-Adhesive Outdoor Jacket: 60-mil-60-mil- (1.5-mm-) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross-laminated polyethylene film covered with [**white**] [**stucco-embossed**] aluminum-foil facing.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3235) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Polyguard Products, Inc](http://www.specagent.com/Lookup?uid=123457177377).

3M

FlexClad

Approved equivalent.

PVDC and PVDC-SSL jackets in "PVDC Jacket for Indoor Applications," "PVDC Jacket for Outdoor Applications," and "PVDC-SSL Jacket" paragraphs below are proprietary products offered by ITW Insulation Systems, Illinois Tool Works, Inc., under the product names "Saranex 540 CX Vapor Retarder Film" and "Saranex 560 CX Vapor Retarder Film."

* + - * 1. PVDC Jacket for Indoor Applications: 4-mil-4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm0.02 perm (0.013 metric perm) when tested in accordance with ASTM E96/E96M and with a flame-spread index of 10 and a smoke-developed index of 20 when tested in accordance with ASTM E84.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3236) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457177453).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457139432).

FlexClad

Approved equivalent.

* + - * 1. PVDC Jacket for Outdoor Applications: 6-mil-6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm0.01 perm (0.007 metric perm) when tested in accordance with ASTM E96/E96M and with a flame-spread index of 25 and a smoke-developed index of 50 when tested in accordance with ASTM E84.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3237) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457177456).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457139432).

FlexClad

Approved equivalent.

* + - * 1. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3238) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457177462).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457139432).

FlexClad

Approved equivalent.

* + - 1. TAPES
         1. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3239) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[3M Industrial Adhesives and Tapes Division](http://www.specagent.com/Lookup?uid=123457177383).

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457177379).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457177384).

Approved equivalent.

Width: [**3 inches3 inches (75 mm)**] <**Insert value**>.

Thickness: [**11.5 mils11.5 mils (0.29 mm)**] <**Insert value**>.

Adhesion: [**90 ounces force/inch90 ounces force/inch (1.0 N/mm)**] <**Insert value**> in width.

Elongation: [**2**] <**Insert number**> percent.

Tensile Strength: [**40 lbf/inch40 lbf/inch (7.2 N/mm)**] <**Insert value**> in width.

ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

* + - * 1. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C1136.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3240) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[3M Industrial Adhesives and Tapes Division](http://www.specagent.com/Lookup?uid=123457177389).

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457177385).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457177390).

Approved equivalent.

Width: [**3 inches3 inches (75 mm)**] <**Insert value**>.

Thickness: [**6.5 mils6.5 mils (0.16 mm)**] <**Insert value**>.

Adhesion: [**90 ounces force/inch90 ounces force/inch (1.0 N/mm)**] <**Insert value**> in width.

Elongation: [**2**] <**Insert number**> percent.

Tensile Strength: [**40 lbf/inch40 lbf/inch (7.2 N/mm)**] <**Insert value**> in width.

FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

* + - * 1. PVC Tape: White vapor-retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3241) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[3M Industrial Adhesives and Tapes Division](http://www.specagent.com/Lookup?uid=123457177394).

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457177391).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457139432).

Approved equivalent.

Width: [**2 inches2 inches (50 mm)**] <**Insert value**>.

Thickness: [**6 mils6 mils (0.15 mm)**] <**Insert value**>.

Adhesion: [**64 ounces force/inch64 ounces force/inch (0.7 N/mm)**] <**Insert value**> in width.

Elongation: [**500**] <**Insert number**> percent.

Tensile Strength: 18 lbf/inch18 lbf/inch (3.3 N/mm) in width.

* + - * 1. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3242) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[3M Industrial Adhesives and Tapes Division](http://www.specagent.com/Lookup?uid=123457177399).

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457177395).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457177400).

Approved equivalent.

Width: [**2 inches2 inches (50 mm)**] <**Insert value**>.

Thickness: [**3.7 mils3.7 mils (0.093 mm)**] <**Insert value**>.

Adhesion: [**100 ounces force/inch100 ounces force/inch (1.1 N/mm)**] <**Insert value**> in width.

Elongation: [**5**] <**Insert number**> percent.

Tensile Strength: [**34 lbf/inch34 lbf/inch (6.2 N/mm)**] <**Insert value**> in width.

PVDC tape is a proprietary product offered by ITW Insulation Systems, Illinois Tool Works, Inc., under the product names "Saranex 520 CX Vapor Retarder Tape" and "Saranex 560 CX Vapor Retarder Tape."

* + - * 1. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3243) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457177474).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457139432).

SARANEX

Approved equivalent.

Width: [**3 inches3 inches (75 mm)**] <**Insert value**>.

Film Thickness: [**2 mils2 mils (0.05 mm)**] <**Insert value**>.

Adhesive Thickness: [**1.5 mils1.5 mils (0.04 mm)**] <**Insert value**>.

Elongation at Break: [**120**] <**Insert number**> percent.

Tensile Strength: [**20 psi20 psi (138 kPa)**] <**Insert value**> in width.

* + - * 1. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3244) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457177477).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457139432).

SARANEX

Approved equivalent.

Width: [**3 inches3 inches (75 mm)**] <**Insert value**>.

Film Thickness: [**6 mils6 mils (0.15 mm)**] <**Insert value**>.

Adhesive Thickness: [**1.5 mils1.5 mils (0.04 mm)**] <**Insert value**>.

Elongation at Break: [**145**] <**Insert number**> percent.

Tensile Strength: [**55 psi55 psi (379 kPa)**] <**Insert value**> in width.

* + - 1. SECUREMENTS
         1. Bands:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3246) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457177401).

[RPR Products, Inc](http://www.specagent.com/Lookup?uid=123457177402).

McMaster Carr

Approved equivalent.

Wing seals are primarily used for fastening bands together. Closed seals are occasionally used for large, 84-inch- (2130-mm-) diameter applications and where fastening bands are used with springs. Wing seals are reusable; closed seals are not.

Stainless Steel: ASTM A240/A240M, [**Type 304**] [**or**] [**Type 316**]; 0.015 inch0.015 inch (0.38 mm) thick, [**1/2 inch1/2 inch (13 mm)**] [**3/4 inch3/4 inch (19 mm)**] wide with [**wing seal**] [**or**] [**closed seal**].

Aluminum: ASTM B209ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch0.020 inch (0.51 mm) thick, [**1/2 inch1/2 inch (13 mm)**] [**3/4 inch3/4 inch (19 mm)**] wide with [**wing seal**] [**or**] [**closed seal**].

Springs are used for large, 84-inch- (2130-mm-) diameter applications and on applications with rapid changes in expansion and contraction.

Springs: Twin spring set constructed of stainless steel, with ends flat and slotted to accept metal bands. Spring size is determined by manufacturer for application.

* + - * 1. Staples: Outward-clinching insulation staples, nominal 3/4 inch3/4 inch (19 mm) wide, stainless steel or Monel.

In "Wire" Paragraph below, stainless steel is the most common wire used and is best suited for all applications.

* + - * 1. Wire: [**0.080-inch0.080-inch (2.0-mm)** nickel-copper alloy] [**0.062-inch0.062-inch (1.6-mm)** soft-annealed, stainless steel] [**0.062-inch0.062-inch (1.6-mm)** soft-annealed, galvanized steel].

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3247) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[C & F Wire](http://www.specagent.com/Lookup?uid=123457177404).

American Wire Works

Gerard Daniel Worldwide

Approved equivalent.

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 metal pipe under insulation, although not typically caused by insulation, is an issue that must be considered during design of any HVAC 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 mils5 mils (0.127 mm) thick and an epoxy finish 5 mils5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F140 and 300 deg F (60 and 149 deg C). 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 F32 and 300 deg F (0 and 149 deg C) 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, soften, or otherwise attack insulation or jacket in either wet or dry state.
         4. Install insulation with longitudinal seams at top and bottom 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.
         7. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.
         8. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
         9. Install insulation with least number of joints practical.
         10. 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.

Cover circumferential joints with 3-inch-3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward-clinching staples along both edges of strip, spaced 4 inches4 inches (100 mm) o.c.

Overlap jacket longitudinal seams at least 1-1/2 inches1-1/2 inches (38 mm). 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 [**2 inches2 inches (50 mm)**] [**4 inches4 inches (100 mm)**] 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 more than 25 percent of its nominal thickness.
        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 inches4 inches (100 mm)] <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.

* + - 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 inches2 inches (50 mm) 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 inches2 inches (50 mm).

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.

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," Plate No. 41A.

* + - * 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 fittings**] made from same material and density as that of adjacent pipe insulation. Each piece shall be 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 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. 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 to fit. 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 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 shall conform 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 inches2 inches (50 mm) 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 CALCIUM SILICATE INSULATION
         1. Insulation Installation on Straight Pipes and Tubes:

Secure single-layer insulation with stainless steel bands at 12-inch12-inch (300-mm) intervals, and tighten bands without deforming insulation materials.

Install two-layer insulation with joints tightly butted and staggered at least 3 inches3 inches (75 mm). Secure inner layer with wire spaced at 12-inch12-inch (300-mm) intervals. Secure outer layer with stainless steel bands at 12-inch12-inch (300-mm) intervals.

Apply a skim coat of mineral-fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.

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

Install preformed 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.

Finish flange insulation same as pipe insulation.

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

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

When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.

Finish fittings insulation same as pipe insulation.

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

Install mitered segments of calcium silicate 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.

Finish valve and specialty insulation same as pipe insulation.

* + - 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 factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches6 inches (150 mm) o.c.

For insulation with factory-applied 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 preformed 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.

Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch1 inch (25 mm), and seal joints with flashing sealant.

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

Install preformed 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 sections of cellular-glass insulation. Secure insulation materials with wire or bands.

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

Install preformed 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 mitered sections of 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 preformed valve covers manufactured of same material as that of pipe insulation when available.

When preformed 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 MINERAL-FIBER 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 factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at 6 inches6 inches (150 mm) o.c.

For insulation with factory-applied 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 preformed 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 mineral-fiber blanket insulation.

Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch1 inch (25 mm), and seal joints with flashing sealant.

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

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

When preformed 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 preformed sections of same material as that of straight segments of pipe insulation when available.

When preformed sections are not available, install mitered 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-inch12-inch (300-mm) intervals, and tighten bands without deforming insulation materials.

Install two-layer insulation with joints tightly butted and staggered at least 3 inches3 inches (75 mm). Secure inner layer with 0.062-inch0.062-inch (1.6-mm) wire spaced at 12-inch12-inch (300-mm) intervals. Secure outer layer with stainless steel bands at 12-inch12-inch (300-mm) 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 factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at 6 inches6 inches (150 mm) o.c.

For insulation with factory-applied 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 preformed 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.

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

Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.

For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic.

All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

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

Install preformed pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, and same thickness as that of adjacent pipe insulation, not to exceed 1-1/2-inch1-1/2-inch (38-mm) thickness.

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

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

Install preformed 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 sections of polyisocyanurate 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 POLYSTYRENE INSULATION
         1. Insulation Installation on Straight Pipes and Tubes:

Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3- and 9-o'clock positions on the pipe.

For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive or tape, as recommended by insulation material manufacturer, and seal with vapor-barrier mastic.

All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

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

Install preformed pipe insulation to outer diameter of pipe flange.

Make width of insulation section same as overall width of flange and bolts, and make thickness same as that of adjacent pipe insulation, not to exceed 1-1/2 inches1-1/2 inches (38 mm).

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

* + - * 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 section of polystyrene 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 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-inch2-inch (50-mm) overlap at seams and joints.

Embed glass cloth between two 0.062-inch-0.062-inch- (1.6-mm-) 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-inch1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch-3-inch- (75-mm-) 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 and for horizontal applications, install with 1-inch1-inch (25-mm) 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-inch2-inch (50-mm) 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 inches12 inches (300 mm) o.c. and at end joints.
        2. Where PVDC jackets are indicated, install as follows:

Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.

Wrap factory-presized jackets around individual pipe insulation sections, with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches2 inches (50 mm) over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.

Continuous jacket can be spiral-wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.

Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches33-1/2 inches (850 mm) or less. The 33-1/2-inch-33-1/2-inch- (850-mm-) circumference limit allows for 2-inch-2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fish mouthing," and use PVDC tape along lap seal to secure joint.

Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

* + - 1. FINISHES

Coordinate "Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material" Paragraph below with Section 0991143 "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 0991143 "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 Director’s Representative. 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. Director’s Representative 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 company field advisor to test and inspect components, assemblies, and equipment installations, including connections.

Retain "Perform tests and inspections" Paragraph below to require Contractor to perform tests and 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 company field advisor].

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 Director’s Representative, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be 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.

Materials and thicknesses in schedules below are for single-layer applications. If multilayer applications are needed, insert additional requirements.

* + - 1. PIPING INSULATION SCHEDULE, GENERAL
         1. Insulation conductivity and thickness per pipe size shall comply with schedules in this Section or with requirements of authorities having jurisdiction, whichever is more stringent.
         2. 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.
         3. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

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.

Piping insulation schedules in articles below specify commonly used insulation materials and thicknesses by pipe size range for each service. LEED Prerequisite EA 2 requires that pipe insulation thickness comply with ASHRAE/IESNA 90.1 table titled "Minimum Pipe Insulation Thickness." Not all materials and thicknesses may be suitable for a specific project. Revise to suit Project after considering all parameters that impact selection. See the Evaluations for more information and guidance.

Polyisocyanurate thickness is limited to 1 inch (25 mm) to comply with a flame-spread index of 25 and a smoke-developed index of 50. Condensation control and energy efficiency are limited by thickness.

Tubular flexible elastomeric is not available in sizes of larger than NPS 6 (DN 150). Larger pipe sizes require sheets to be cut to size. Thickness is limited to 1 inch (25 mm) to comply with a flame-spread index of 25 and a smoke-developed index of 50. Condensation control and energy efficiency are limited by thickness.

Tubular polyolefin is not available in sizes larger than NPS 4 (DN 100). Larger pipe sizes require sheets to be cut to size. Thickness is limited to 1 inch (25 mm) to comply with a flame-spread index of 25 and a smoke-developed index of 50. Condensation control and energy efficiency are limited by thickness.

* + - 1. INDOOR PIPING INSULATION SCHEDULE
         1. Condensate and Equipment Drain Water below 60 Deg F60 Deg F (16 Deg C):

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

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

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

Cellular Glass: [**1-1/2 inches1-1/2 inches (38 mm)**] <**Insert dimension**> thick.

Flexible Elastomeric: [**3/4 inch3/4 inch (19 mm)**] [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1/2 inch1/2 inch (13 mm)**] [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Phenolic: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Polyolefin: [**3/4 inch3/4 inch (19 mm)**] [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

* + - * 1. Chilled Water and Brine, 40 Deg F40 Deg F (5 Deg C) and below:

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

[**NPS 3NPS 3 (DN 80)**] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

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

Cellular Glass: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1 inch1 inch (25 mm)**] [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Phenolic: [**1 inch1 inch (25 mm)**] [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

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

[**NPS 4NPS 4 (DN 100) to NPS 12NPS 12 (DN 300)**] <**Insert pipe size range**>: Insulation shall be[**one of**] the following:

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

Cellular Glass: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1-1/2 inches1-1/2 inches (38 mm)**] [**22 inches (50 mm)**] <**Insert dimension**> thick.

Phenolic: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

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

[**NPS 14NPS 14 (DN 350)**] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

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

Cellular Glass: [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, [**Preformed Pipe Insulation, Type I,**] [**or**] [**Pipe and Tank Insulation**]: [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Phenolic: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Chilled Water and Brine, Above 40 Deg F and below 60 Deg F40 Deg F (5 Deg C):

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

[**NPS 1-1/42NPS 12 (DN 300)**] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

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

Cellular Glass: [**1 -1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Flexible Elastomeric: [**10.5 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**10.5 inch1 inch (25 mm)**] [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Phenolic: [**10.5 inch1 inch (25 mm)**] [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**10.5 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Polyolefin: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

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

[**NPS 1-1/24NPS 14 (DN 350)**] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

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

Cellular Glass: [**21-1/2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber [**Preformed Pipe Insulation, Type I,**] [**or**] [**Pipe and Tank Insulation**]: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Phenolic: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Condenser-water supply and return piping located indoors and operating in range of between 55 to 105 deg F (13 to 41 deg C) is not always insulated. If condenser-water system operates as part of a water-side economizer cycle or if Project requires condensation control, piping should be insulated.

* + - * 1. Condenser-Water Supply and Return:

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

[**NPS 1-1/42NPS 12 (DN 300)**] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

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

Cellular Glass: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Flexible Elastomeric: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1 inch1 inch (25 mm)**] [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Phenolic: [**1 inch1 inch (25 mm)**] [**1-1/2 inches1-1/2 inches (38 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Polyolefin: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

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

[**NPS 1-1/24NPS 14 (DN 350)**] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

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

Cellular Glass: [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, [**Preformed Pipe Insulation, Type I**] [**or**] [**Pipe and Tank Insulation**]: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Phenolic: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Heating-Hot-Water Supply and Return, 200 Deg F200 Deg F (93 Deg C) and Below:

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

[**NPS 1-1/42NPS 12 (DN 300)**] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

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

Cellular Glass: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe, Type I: [**1-1/2 inch1 inch (25 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Phenolic: [**1 inch1 inch (25 mm)**] [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**1-1/2 inch1 inch (25 mm)**] <**Insert dimension**> thick.

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

[**NPS 14-1/2NPS 14 (DN 350)**] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

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

Cellular Glass: [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, [**Preformed Pipe Insulation, Type I**] [**or**] [**Pipe and Tank Insulation**]: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Phenolic: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Heating-Hot-Water Supply and Return, Above 200 Deg F and below 250 Deg F200 Deg F (93 Deg C):

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

[**NPS 3/43NPS 3/4 (DN 20)**] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

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

Calcium Silicate: [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2-1/2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

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

[**NPS 14NPS 1 (DN 25)**] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

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

Calcium Silicate: [**3 inches3 inches (75 mm)**] [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**3 inches3 inches (75 mm)**] [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe, Type I: [**3 inches3 inches (75 mm)**] [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

In the "Steam and Steam Condensate, Boiler Blowdown, Vents, Drains(, and Safety Relief Vents) 350 Deg F (177 Deg C) and Below" Paragraph below, option is indicated, because some Eengineers choose to not insulate items that are not hot during normal operating conditions. Verify requirements with authorities having jurisdiction before making selection.

* + - * 1. Steam and Steam Condensate, Boiler Blowdown, Vents, Drains[**, and Safety Relief Vents**] 350 Deg F350 Deg F (177 Deg C) and Below:

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

[**NPS 3/4NPS 3/4 (DN 20)**] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

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

Calcium Silicate: [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1-1/2 inches1-1/2 inches (38 mm)**] [**23 inches2 inches (50 mm)**] <**Insert dimension**> thick.

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

[**NPS 1 to NPS 1-1/4NPS 1 (DN 25)**] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

Retain one or more of "Calcium Silicate," "Cellular Glass," and "Mineral-Fiber, (Preformed Pipe Insulation, Type I,) (or) (Pipe and Tank Insulation)" subparagraphs below.

Calcium Silicate: [**3 inches3 inches (75 mm)**] [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**3 inches3 inches (75 mm)**] [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, [**Preformed Pipe Insulation, Type I**] [**or**] [**Pipe and Tank Insulation**]: [**3 inches3 inches (75 mm)**] [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

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

Retain one or more of "Calcium Silicate," "Cellular Glass," and "Mineral-Fiber, (Preformed Pipe Insulation, Type I,) (or) (Pipe and Tank Insulation)" subparagraphs below.

Calcium Silicate: [**4.5 inches**] <**Insert dimension**> thick.

Cellular Glass: [**4.5 inches**] <**Insert dimension**> thick.

Mineral-Fiber, [**Preformed Pipe Insulation, Type I**] [**or**] [**Pipe and Tank Insulation**]: [**4.5 inches**] <**Insert dimension**> thick.

In the "Steam and Steam Condensate, Boiler Blowdown, Vents, Drains(, and Safety Relief Vents) above 350 Deg F (177 Deg C)" Paragraph below, option is indicated, because some Eengineers choose to not insulate items that are not hot during normal operating conditions. Verify requirements with authorities having jurisdiction before making selection.

* + - * 1. Steam and Steam Condensate, Boiler Blowdown, Vents, Drains[**, and Safety Relief Vents**] Above 350 Deg F350 Deg F (177 Deg C):

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

[**NPS 3/4NPS 3/4 (DN 20)**] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

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

Calcium Silicate: [**24.5 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**2 inches2 inches (50 mm)**] [**34.5 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1-1/24-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

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

[**NPS 1NPS 1 (DN 25)**] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

Retain one or more of "Calcium Silicate," "Cellular Glass," and "Mineral-Fiber, (Preformed Pipe Insulation, Type I,) (or) (Pipe and Tank Insulation)" subparagraphs below.

Calcium Silicate: [**35 inches3 inches (75 mm)**] [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**35 inches3 inches (75 mm)**] [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, [**Preformed Pipe Insulation, Type I**] [**or**] [**Pipe and Tank Insulation**]: [**35 inches3 inches (75 mm)**] [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

* + - * 1. Refrigerant Suction and Hot-Gas Piping:

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

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

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

Cellular Glass: [**1-1/2 inches1-1/2 inches (38 mm)**] <**Insert dimension**> thick.

Flexible Elastomeric: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Phenolic: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

* + - * 1. Polyolefin: **[1 inch1 inch (25 mm)] <Insert dimension**> thick.
        2. Refrigerant Suction and Hot-Gas Flexible Tubing:

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

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

Retain one of or both "Flexible Elastomeric" and "Polyolefin" subparagraphs below.

Flexible Elastomeric: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

* + - * 1. Polyolefin: [**2 inches2 inches (50 mm)**] <Insert dimension> thick.
        2. Refrigerant Liquid Piping:

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

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

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

Cellular Glass: [**1-1/2 inches1-1/2 inches (38 mm)**] <**Insert dimension**> thick.

Flexible Elastomeric: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Phenolic: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

* + - * 1. Polyolefin: [**1 inch1 inch (25 mm)**] <Insert dimension> thick.
        2. Dual-Service Heating and Cooling, 40 to 200 Deg F40 to 200 Deg F (5 to 93 Deg C):

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

[**NPS 12NPS 12 (DN 300)**] <**Insert pipe size**> and Smaller: Insulation shall be[**one of**] the following:

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

Cellular Glass: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**1 inch1 inch (25 mm)**] [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Phenolic: [**1 inch1 inch (25 mm)**] [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

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

[**NPS 14NPS 14 (DN 350)**] <**Insert pipe size**> and Larger: Insulation shall be[**one of**] the following:

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

Cellular Glass: [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, [**Preformed Pipe Insulation, Type I**] [**or**] [**Pipe and Tank Insulation**]: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Phenolic: [**1-1/2 inches1-1/2 inches (38 mm)**] [**2 inches2 inches (50 mm)**] [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Heat-Recovery Piping:

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

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

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

Cellular Glass: [**1-1/2 inches1-1/2 inches (38 mm)**] <**Insert dimension**> thick.

Flexible Elastomeric: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, [**Preformed Pipe Insulation, Type I**] [**or**] [**Pipe and Tank Insulation**]: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Phenolic: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**1 inch1 inch (25 mm)**] <**Insert dimension**> thick.

* + - 1. OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

In addition to other criteria, insulate outdoor piping for freeze protection.

* + - * 1. Chilled Water and Brine:

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

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

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

Cellular Glass: [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Flexible Elastomeric: [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Phenolic: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polyolefin: [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Polystyrene: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

* + - * 1. Condenser-Water Supply and Return:

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

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

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

Cellular Glass: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Flexible Elastomeric: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Phenolic: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polyolefin: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polystyrene: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

* + - * 1. Heating-Hot-Water Supply and Return, 200 Deg F200 Deg F (93 Deg C) and Below:

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

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

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

Cellular Glass: [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Phenolic: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

* + - * 1. Heating-Hot-Water Supply and Return, Above 200 Deg F200 Deg F (93 Deg C):

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

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

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

Calcium Silicate: [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

In the "Steam and Steam Condensate(, and Safety Relief Vents), 350 Deg F (177 Deg C) and Below" Paragraph below, option is indicated, because some Eengineers choose to not insulate items that are not hot during normal operating conditions. Verify requirements with authorities having jurisdiction before making selection.

* + - * 1. Steam and Steam Condensate[**, and Safety Relief Vents**], 350 Deg F350 Deg F (177 Deg C) and Below:

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

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

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

Calcium Silicate: [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

In the "Steam and Steam Condensate(, and Safety Relief Vents), Above 350 Deg F (177 Deg C)" Paragraph below, option is indicated, because some Eengineers choose to not insulate items that are not hot during normal operating conditions. Verify requirements with authorities having jurisdiction before making selection.

* + - * 1. Steam and Steam Condensate[**, and Safety Relief Vents**], Above 350 Deg F350 Deg F (177 Deg C):

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

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

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

Calcium Silicate: [**5 inches5 inches (125 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**5 inches5 inches (125 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

* + - * 1. Refrigerant Suction and Hot-Gas Piping:

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

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

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

Cellular Glass: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Flexible Elastomeric: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Phenolic: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polyolefin: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polystyrene: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

* + - * 1. Refrigerant Suction and Hot-Gas Flexible Tubing:

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

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

Retain one of or both "Flexible Elastomeric" and "Polyolefin" subparagraphs below.

Flexible Elastomeric: [**2 inches2 inches (50 mm)**] <Insert dimension> thick.

Polyolefin: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

* + - * 1. Refrigerant Liquid Piping:

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

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

Retain one of or both "Flexible Elastomeric" and "Polyolefin" subparagraphs below.

Flexible Elastomeric: [**1 inch1 inch (25 mm)**] [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

* + - * 1. Polyolefin: [**1 inch1 inch ((25 mm))**] [**2 inches2 inches (50 mm)**] <Insert dimension> thick.
        2. Heat-Recovery Piping:

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

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

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

Cellular Glass: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Flexible Elastomeric: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Phenolic: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polyolefin: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polystyrene: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

* + - * 1. Dual-Service Heating and Cooling:

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

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

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

Cellular Glass: [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Phenolic: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Polyisocyanurate: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

* + - * 1. Fuel Oil Piping, Heated:

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

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

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

Cellular Glass: [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.

Mineral-Fiber, Preformed Pipe Insulation, Type I: [**2 inches2 inches (50 mm)**] <**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 for applications of below 250 deg F (121 deg C), because of its moisture-resistant properties.

* + - * 1. Insulation for belowground piping is specified in Section 232113.13 "Underground Hydronic Piping" and Section 232213.13 "Underground Steam and Condensate Heating Piping."
        2. Chilled Water, All Sizes: Cellular glass, [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.
        3. Condenser-Water Supply and Return, All Sizes: Cellular glass, [**2 inches2 inches (50 mm)**] <**Insert dimension**> thick.
        4. Heating-Hot-Water Supply and Return, All Sizes, 200 Deg F200 Deg F (93 Deg C) and Below: Cellular glass, [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.
        5. Heating-Hot-Water Supply and Return, All Sizes, Above 200 Deg F and below 250 Deg F200 Deg F (93 Deg C):

Retain one of or both "Calcium Silicate" and "Cellular Glass" subparagraphs below.

Calcium Silicate: [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Steam and Steam Condensate, All Sizes3/4 inches and smaller, 350 Deg F350 Deg F (177 Deg C) and Below:

Retain one of or both "Calcium Silicate" and "Cellular Glass" subparagraphs below.

Calcium Silicate: [**44 inches4 inches (100 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**4 inches4 inches (100 mm)**] <**Insert dimension**> thick.

* + - * 1. Steam and Steam Condensate, [1 inch and 1-1/4 inch], 350 Deg F and Below:

Retain one of or both "Calcium Silicate" and "Cellular Glass" subparagraphs below.

Calcium Silicate: [**4.5 inches**] <**Insert dimension**> thick.

Cellular Glass: [**4.5 inches**] <**Insert dimension**> thick.

* + - * 1. Steam and Steam Condensate, [1-1/2 inch and larger], 350 Deg F and Below:

Retain one of or both "Calcium Silicate" and "Cellular Glass" subparagraphs below.

Calcium Silicate: [**5 inches**] <**Insert dimension**> thick.

Cellular Glass: [**5 inches**] <**Insert dimension**> thick.

* + - * 1. Steam and Steam Condensate, All Sizes, Above 350 Deg F350 Deg F (177 Deg C):

Retain one of or both "Calcium Silicate" and "Cellular Glass" subparagraphs below.

Calcium Silicate: [**5 inches5 inches (125 mm)**] <**Insert dimension**> thick.

Cellular Glass: [**5 inches5 inches (125 mm)**] <**Insert dimension**> thick.

* + - * 1. Dual-Service Heating and Cooling, All Sizes, 40 to 200 Deg F40 to 200 Deg F (4 to 93 Deg C): Cellular glass, [**3 inches3 inches (75 mm)**] <**Insert dimension**> thick.
        2. Fuel Oil Piping, All Sizes, Heated: Cellular glass, [**2 inches2 inches (50 mm)**] <**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 mils20 mils (0.5 mm)**] [**30 mils30 mils (0.8 mm)**] thick.

Use paragraph below for projects other than office of mental health where insulated piping is required to be sheet metal jacketed. This includes power houses and heating plants.

Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch0.016 inch (0.41 mm)**] [**0.020 inch0.020 inch (0.51 mm)**] [**0.024 inch0.024 inch (0.61 mm)**] [**0.032 inch0.032 inch (0.81 mm)**] [**0.040 inch0.040 inch (1.0 mm)**] thick.

Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch0.016 inch (0.41 mm)**] [**0.020 inch0.020 inch (0.51 mm)**] [**0.024 inch0.024 inch (0.61 mm)**] [**0.032 inch0.032 inch (0.81 mm)**] thick.

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch0.010 inch (0.25 mm)**] [**0.016 inch0.016 inch (0.41 mm)**] [**0.020 inch0.020 inch (0.51 mm)**] [**0.024 inch0.024 inch (0.61 mm)**] thick.

<**Insert jacket type**>.

* + - * 1. Piping, Exposed:

Retain one of six subparagraphs below.

None.

[**PVC**] [**PVC, Color-Coded by System**]: [**20 mils20 mils (0.5 mm)**] [**30 mils30 mils (0.8 mm)**] thick.

Use paragraph below for projects other than office of mental health where insulated piping is required to be sheet metal jacketed. This includes power houses and heating plants.

Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch0.016 inch (0.41 mm)**] [**0.020 inch0.020 inch (0.51 mm)**] [**0.024 inch0.024 inch (0.61 mm)**] [**0.032 inch0.032 inch (0.81 mm)**] [**0.040 inch0.040 inch (1.0 mm)**] thick.

Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch0.016 inch (0.41 mm)**] [**0.020 inch0.020 inch (0.51 mm)**] [**0.024 inch0.024 inch (0.61 mm)**] [**0.032 inch0.032 inch (0.81 mm)**] thick.

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch0.010 inch (0.25 mm)**] [**0.016 inch0.016 inch (0.41 mm)**] [**0.020 inch0.020 inch (0.51 mm)**] [**0.024 inch0.024 inch (0.61 mm)**] 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 mils20 mils (0.5 mm)**] [**30 mils30 mils (0.8 mm)**] thick.

Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch0.016 inch (0.41 mm)**] [**0.020 inch0.020 inch (0.51 mm)**] [**0.024 inch0.024 inch (0.61 mm)**] [**0.032 inch0.032 inch (0.81 mm)**] [**0.040 inch0.040 inch (1.0 mm)**] thick.

Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch0.016 inch (0.41 mm)**] [**0.020 inch0.020 inch (0.51 mm)**] [**0.024 inch0.024 inch (0.61 mm)**] [**0.032 inch0.032 inch (0.81 mm)**] thick.

Stainless Steel, [**Type 304**] [**Type 316**] [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch0.010 inch (0.25 mm)**] [**0.016 inch0.016 inch (0.41 mm)**] [**0.020 inch0.020 inch (0.51 mm)**] [**0.024 inch0.024 inch (0.61 mm)**] thick.

<**Insert jacket type**>.

* + - * 1. Piping, Exposed:

Retain one of four subparagraphs below.

PVC: [**20 mils20 mils (0.5 mm)**] [**30 mils30 mils (0.8 mm)**] [**40 mils40 mils (1.0 mm)**] thick.

[**Painted**]Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.016 inch0.016 inch (0.41 mm)**] [**0.020 inch0.020 inch (0.51 mm)**] [**0.024 inch0.024 inch (0.61 mm)**] [**0.032 inch0.032 inch (0.81 mm)**] [**0.040 inch0.040 inch (1.0 mm)**] thick.

Stainless Steel, [**Type 304**] [**Type 316**] [**Type 304**] [**or**] [**Type 316**], [**Smooth No. 2B Finish**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.010 inch0.010 inch (0.25 mm)**] [**0.016 inch0.016 inch (0.41 mm)**] [**0.020 inch0.020 inch (0.51 mm)**] [**0.024 inch0.024 inch (0.61 mm)**] 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 230719