SECTION 220716 - PLUMBING EQUIPMENT INSULATION

TIPS:

To view non-printing Editor's Notes that provide guidance for editing, click on MasterWorks/Single-File Formatting/Toggle/Editor's Notes.

To read detailed research, technical information about products and materials, and coordination checklists, click on MasterWorks/Supporting Information.

Content Requests:

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 insulating the following plumbing equipment that is not factory insulated:

The list of plumbing equipment below matches the various equipment items in the schedule articles. Coordinate the revision of list with "Domestic Water Boiler Breeching Insulation Schedule" and "Indoor Equipment Insulation Schedule" articles.

Domestic water boiler breechings.

Domestic water heat exchangers.

Domestic water converters.

Domestic water, [**hot-water**] [**cold-water**] [**and**] [**chilled-water**] pumps.

Domestic water storage tanks.

Domestic water filter housings.

* + - * 1. Related Sections:

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

Section 220719 "Plumbing Piping Insulation."

* + - 1. ACTION SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are submitted and tabbed (for combined submittals).
				4. Product Data: For each type of product. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory and field applied, if any).
				5. Sustainable Design Submittals:
				6. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

Detail removable insulation at equipment connections.

Detail application of field-applied jackets.

Detail application at linkages of control devices.

Detail field application for each equipment type.

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

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

Sheet Form Insulation Materials: 12 inches (300 mm) square.

Sheet Jacket Materials: 12 inches (300 mm) square.

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

* + - 1. INFORMATIONAL SUBMITTALS

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

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

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

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

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

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

Retain "Installer Qualifications" Paragraphparagraph 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.

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

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

Equipment Mockups:

One tank or vessel.

One pump.

<**Insert mockup**>.

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

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

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

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

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

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

Demolish and remove mockups when directed.

* + - 1. 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 220529 "Hangers and Supports for Plumbing Piping and Equipment."
				2. Coordinate clearance requirements with equipment Installer for equipment insulation application.
				3. Coordinate installation and testing of heat tracing.
			2. 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

Manufacturers and products listed in SpecAgent and MasterWorks ParagraphParagraph Builder are neither recommended nor endorsed by the AIA or Deltek. Before inserting names, verify that manufacturers and products listed there comply with requirements retained or revised in descriptions and are both available and suitable for the intended applications. For definitions of terms and requirements for Contractor's product selection, see Section 016000 "Product Requirements."

* + - 1. INSULATION 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 "Domestic Water Boiler Breeching Insulation Schedule" and "Indoor Equipment Insulation Schedule" articles for where insulating materials shall be applied.

See "Product Characteristics" Article in 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: Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C533, Type I or Type II.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3110) Subject to compliance with requirements, provide products by the following or approved equivalent:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457142997).

Approved equivalent.

* + - * 1. [Manufacturers:](http://www.specagent.com/Lookup?ulid=3110) Subject to compliance with requirements, provide products by the following:
				2. [Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457142997).
				3. 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=3111) Subject to compliance with requirements, provide products by the following or approved equivalent:

[Owens Corning](http://www.specagent.com/Lookup?uid=123457231888).

Approved equivalent.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3111) Subject to compliance with requirements, provide products by the following:

[Pittsburgh Corning Corporation](http://www.specagent.com/Lookup?uid=123457142998).

Approved equivalent.

Block Insulation: Type I.

Special-Shaped Insulation: Type III.

Board Insulation: Type IV.

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

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

"Flexible Elastomeric" Paragraphparagraph 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).

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3112) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Aeroflex USA](http://www.specagent.com/Lookup?uid=123457143000).

[Armacell LLC](http://www.specagent.com/Lookup?uid=123457143001).

[K-Flex USA](http://www.specagent.com/Lookup?uid=123457143002).

Approved equivalent.

For operating temperatures higher than 250 deg F (121 deg C), use blanket insulation in "Mineral-Fiber Blanket" Paragraphparagraph below. Retain ASTM C1290 types as follows: Type I for insulation without jackets, Type II for insulation with vinyl jackets, and Type III for insulation with FSK jackets.

* + - * 1. Mineral-Fiber Blanket: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type II, and ASTM C1290, [**Type I**] [**Type II, with factory-applied vinyl jacket**] [**Type III, with factory-applied FSK jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3113) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457143005).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457143007).

[Owens Corning](http://www.specagent.com/Lookup?uid=123457143009).

Approved equivalent.

* + - * 1. High-Temperature, Mineral-Fiber Blanket: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C553, Type V, without factory-applied jacket.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3114) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457143013).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457143016).

[ROCKWOOL](http://www.specagent.com/Lookup?uid=123457143014).

Approved equivalent.

For operating temperatures higher than 250 deg F (121 deg C), use board insulation in "Mineral-Fiber Board" Paragraphparagraph below. ASJs are the most common jacket for equipment applications.

* + - * 1. Mineral-Fiber Board: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type IA or Type IB. Provide insulation [**without factory-applied jacket**] [**with factory-applied ASJ**] [**with factory-applied FSK jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3115) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457143021).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457143022).

[Owens Corning](http://www.specagent.com/Lookup?uid=123457143018).

Approved equivalent.

For operating temperatures higher than 250 deg F (121 deg C), use high-temperature board insulation in "High-Temperature, Mineral-Fiber Board" Paragraphparagraph below.

* + - * 1. High-Temperature, Mineral-Fiber Board: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612, Type III, without factory-applied jacket.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3116) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457143030).

[Owens Corning](http://www.specagent.com/Lookup?uid=123457143027).

[ROCKWOOL](http://www.specagent.com/Lookup?uid=123457143029).

Approved equivalent.

Pipe and tank insulation is used for large-diameter piping and vessels. ASJs 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=3118) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457143034).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457143035).

[Owens Corning](http://www.specagent.com/Lookup?uid=123457143033).

Approved equivalent.

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

Nominal density is 2.5 lb./cu. Ft. (40 kg/cu. M) or more.

Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 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.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3121) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Armacell LLC](http://www.specagent.com/Lookup?uid=123457143038).

[Nomaco](http://www.specagent.com/Lookup?uid=123457143039).

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=3123) Subject to compliance with requirements, provide products by the following or approved equivalent:

[Ramco Insulation, Inc](http://www.specagent.com/Lookup?uid=123457143148).

Approved equivalent.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3124) Subject to compliance with requirements, provide products by the following or approved equivalent:

[Ramco Insulation, Inc](http://www.specagent.com/Lookup?uid=123457143149).

Approved equivalent.

Mineral-fiber, hydraulic-setting cement is suitable for temperatures from 100 to 1200 deg F (38 to 649 deg C) and for a smooth surface.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3125) Subject to compliance with requirements, provide products by the following or approved equivalent:

[Ramco Insulation, Inc](http://www.specagent.com/Lookup?uid=123457143041).

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 F (10 to 427 deg C).

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3126) 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**] or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143150).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143151).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457143154).

[Vimasco Corporation](http://www.specagent.com/Lookup?uid=123457143152).

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 F (minus 73 to plus 93 deg C).

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3127) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457231889).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143043).

Approved equivalent.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3129) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Aeroflex USA](http://www.specagent.com/Lookup?uid=123457143047).

[Armacell LLC](http://www.specagent.com/Lookup?uid=123457143048).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143045).

[K-Flex USA](http://www.specagent.com/Lookup?uid=123457143046).

Approved equivalent.

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

Not all manufacturers comply with sustainability requirements. If sustainability is a 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 F (minus 18 deg C)

Service Temperature Range: 40 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=3130) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143052).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143050).

Approved equivalent.

* + - * 1. ASJ Adhesive, and FSK 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=3133) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143058).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143060).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457143061).

Approved equivalent.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3136) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Dow Consumer Solutions](http://www.specagent.com/Lookup?uid=123457143067).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457143063).

[P.I.C. Plastics, Inc](http://www.specagent.com/Lookup?uid=123457143064).

[Speedline Corporation](http://www.specagent.com/Lookup?uid=123457143065).

Approved equivalent.

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

* + - 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" Paragraphparagraph 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=3139) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143071).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143068).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457143070).

[Vimasco Corporation](http://www.specagent.com/Lookup?uid=123457143069).

Approved equivalent.

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

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

Service Temperature Range: [**0 to plus 180 deg F (Minus 18 to plus 82 deg C)**] [**Minus 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" Paragraphparagraph 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=3142) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143157).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143159).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457143160).

Approved equivalent.

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

Service Temperature Range: 0 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=3145) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143163).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143161).

Approved equivalent.

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

Service Temperature Range: Minus 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=3149) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143072).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143074).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457143078).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457143075).

[Vimasco Corporation](http://www.specagent.com/Lookup?uid=123457143076).

Approved equivalent.

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

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

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

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

* + - 1. LAGGING ADHESIVES
				1. Description: 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=3153) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143166).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143164).

[Vimasco Corporation](http://www.specagent.com/Lookup?uid=123457143165).

Approved equivalent.

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

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

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

Service Temperature Range: [**20 to plus 180 deg F (Minus 6 to plus 82 deg C)**] [**0 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=3158) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143170).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143168).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457143169).

[Pittsburgh Corning Corporation](http://www.specagent.com/Lookup?uid=123457143167).

Approved equivalent.

Permanently flexible, elastomeric sealant.

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

Service Temperature Range: [**Minus 150 to plus 250 deg F (Minus 101 to plus 121 deg C)**] [**Minus 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" Paragraphparagraph below are for sealing metal jacket seams and joints.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3165) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143079).

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143081).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457143082).

Approved equivalent.

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

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

Color: Aluminum.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3167) Subject to compliance with requirements, provide products by the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143084).

Approved equivalent.

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

Service Temperature Range: Minus 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 FABRIC-REINFORCING MESH

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

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

* + - * 1. Woven Glass-Fiber Fabric: Approximately 4 oz./sq. yd. (114 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering equipment.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3171) Subject to compliance with requirements, provide products by the following or approved equivalent:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143176).

Approved equivalent.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3172) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Foster Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457143086).

[Vimasco Corporation](http://www.specagent.com/Lookup?uid=123457143087).

Approved equivalent.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3173) Subject to compliance with requirements, provide products by the following or approved equivalent:

[Alpha Associates, Inc](http://www.specagent.com/Lookup?uid=123457143180).

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 equipment operating at below-ambient temperatures at least part of the time or where a vapor barrier is 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=3174) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457143089).

[P.I.C. Plastics, Inc](http://www.specagent.com/Lookup?uid=123457143090).

[Proto Corporation](http://www.specagent.com/Lookup?uid=123457143091).

[Speedline Corporation](http://www.specagent.com/Lookup?uid=123457143092).

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 Architect**].

Factory-fabricated tank heads and tank side panels.

* + - * 1. Metal Jacket:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3175) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457143095).

[RPR Products, Inc](http://www.specagent.com/Lookup?uid=123457143096).

Approved equivalent.

Aluminum Jacket: Comply with ASTM 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" Subparagraphsubparagraph 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- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**] [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil- (0.063-mm-) thick polysurlyn**].

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

Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**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. Self-Adhesive Outdoor Jacket: 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 crosslaminated polyethylene film covered with [**white**] [**stucco-embossed**] aluminum-foil facing.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3176) Subject to compliance with requirements, provide products by the following or approved equivalent:

[Polyguard Products, Inc](http://www.specagent.com/Lookup?uid=123457143098).

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- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 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=3177) Subject to compliance with requirements, provide products by the following or approved equivalent:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457143185).

Approved equivalent.

* + - * 1. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 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=3178) Subject to compliance with requirements, provide products by the following or approved equivalent:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457143188).

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=3179) Subject to compliance with requirements, provide products by the following or approved equivalent:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457143174).

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=3180) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[3M](http://www.specagent.com/Lookup?uid=123457143104).

[Avery Dennison Corporation, Specialty Tapes Division](http://www.specagent.com/Lookup?uid=123457143100).

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457143103).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457143105).

Approved equivalent.

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

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

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

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

Tensile Strength: [**40 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=3181) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[3M](http://www.specagent.com/Lookup?uid=123457143110).

[Avery Dennison Corporation, Specialty Tapes Division](http://www.specagent.com/Lookup?uid=123457143107).

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457143106).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457143111).

Approved equivalent.

Width: 3 inches (75 mm).

Thickness: 6.5 mils (0.16 mm).

Adhesion: 90 ounces force/inch (1.0 N/mm) in width.

Elongation: 2 percent.

Tensile Strength: 40 lbs.f/inch (7.2 N/mm) 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=3182) Subject to compliance with requirements, provide products by the following or approved equivalent:

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457143113).

Approved equivalent.

Width: 2 inches (50 mm).

Thickness: 6 mils (0.15 mm).

Adhesion: 64 ounces force/inch (0.7 N/mm) in width.

Elongation: 500 percent.

Tensile Strength: 18 lbs.f/inch (3.3 N/mm) in width.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3183) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[3M](http://www.specagent.com/Lookup?uid=123457143120).

[Avery Dennison Corporation, Specialty Tapes Division](http://www.specagent.com/Lookup?uid=123457143117).

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457143116).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457143121).

Approved equivalent.

Width: 2 inches (50 mm).

Thickness: 3.7 mils (0.093 mm).

Adhesion: 100 ounces force/inch (1.1 N/mm) in width.

Elongation: 5 percent.

Tensile Strength: 34 lbs.f/inch (6.2 N/mm) in width.

PVDC tape is a proprietary product offered by ITW Insulation Systems; Illinois Tool Works, Inc under the product names "Saranex 540 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=3184) Subject to compliance with requirements, provide products by the following or approved equivalent:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457143179).

Approved equivalent.

Width: 3 inches (75 mm).

Film Thickness: 2 mils (0.05 mm).

Adhesive Thickness: 1.5 mils (0.04 mm).

Elongation at Break: 145 percent.

Tensile Strength: 20 psi (138 kPa).

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3185) Subject to compliance with requirements, provide products by the following or approved equivalent:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457143183).

Approved equivalent.

Width: 3 inches (75 mm).

Film Thickness: 6 mils (0.15 mm).

Adhesive Thickness: 1.5 mils (0.04 mm).

Elongation at Break: 145 percent.

Tensile Strength: 55 psi (379 kPa).

* + - 1. SECUREMENTS
				1. Bands:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3186) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[ITW Insulation Systems; Illinois Tool Works, Inc](http://www.specagent.com/Lookup?uid=123457143122).

[RPR Products, Inc](http://www.specagent.com/Lookup?uid=123457143123).

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 inch (0.38 mm) thick, [**1/2 inch (13 mm)**] [**3/4 inch (19 mm)**] wide with [**wing seal**] [**or**] [**closed seal**].

Aluminum: ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, [**1/2 inch (13 mm)**] [**3/4 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. Insulation Pins and Hangers:

Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; [**0.106-inch- (2.6-mm-)**] [**0.135-inch- (3.5-mm-)**] diameter shank, length to suit depth of insulation indicated.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3187) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[AGM Industries, Inc](http://www.specagent.com/Lookup?uid=123457143190).

[Gemco](http://www.specagent.com/Lookup?uid=123457143189).

[Midwest Fasteners, Inc](http://www.specagent.com/Lookup?uid=123457143192).

[Nelson Stud Welding](http://www.specagent.com/Lookup?uid=123457143191).

Approved equivalent.

Cupped-Head, Capacitor-Discharge-Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor-discharge welding; [**0.106-inch- (2.6-mm-)**] [**0.135-inch- (3.5-mm-)**] diameter shank, length to suit depth of insulation indicated with integral 1-1/2-inch (38-mm) galvanized carbon-steel washer.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3188) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[AGM Industries, Inc](http://www.specagent.com/Lookup?uid=123457143193).

[CL WARD & Family Inc](http://www.specagent.com/Lookup?uid=123457143197).

[Gemco](http://www.specagent.com/Lookup?uid=123457143194).

[Midwest Fasteners, Inc](http://www.specagent.com/Lookup?uid=123457143195).

Approved equivalent.

Metal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3189) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[AGM Industries, Inc](http://www.specagent.com/Lookup?uid=123457143125).

[Gemco](http://www.specagent.com/Lookup?uid=123457143126).

[Midwest Fasteners, Inc](http://www.specagent.com/Lookup?uid=123457143127).

Approved equivalent.

Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.

Spindle: [**Copper- or zinc-coated, low-carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed, 0.106-inch- (2.6-mm-) diameter shank; length to suit depth of insulation indicated.

Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

Nonmetal, Adhesively Attached, Perforated-Base Insulation Hangers: Baseplate fastened to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3190) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[Gemco](http://www.specagent.com/Lookup?uid=123457143129).

[Midwest Fasteners, Inc](http://www.specagent.com/Lookup?uid=123457143130).

Approved equivalent.

Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.

Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank; length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).

Adhesive: Recommended by hanger manufacturer. Use product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

Self-Sticking-Base Insulation Hangers: Baseplate welded to projecting spindle that is capable of holding insulation, of thickness indicated, securely in position indicated when self-locking washer is in place.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3191) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[AGM Industries, Inc](http://www.specagent.com/Lookup?uid=123457143133).

[Gemco](http://www.specagent.com/Lookup?uid=123457143132).

[Midwest Fasteners, Inc](http://www.specagent.com/Lookup?uid=123457143134).

Approved equivalent.

Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.

Spindle: [**Copper- or zinc-coated, low-carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed; 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.

Adhesive-backed base with a peel-off protective cover.

Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick, [**galvanized-steel**] [**aluminum**] [**stainless steel**] sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3192) Subject to compliance with requirements, provide products by one of the following or approved equivalent:

[AGM Industries, Inc](http://www.specagent.com/Lookup?uid=123457143137).

[Gemco](http://www.specagent.com/Lookup?uid=123457143138).

[Midwest Fasteners, Inc](http://www.specagent.com/Lookup?uid=123457143139).

[Nelson Stud Welding](http://www.specagent.com/Lookup?uid=123457143136).

Approved equivalent.

Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.

Nonmetal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch- (0.41-mm-) thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches (38 mm) in diameter.

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

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

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3194) Subject to compliance with requirements, provide products by the following or approved equivalent:

[C & F Wire](http://www.specagent.com/Lookup?uid=123457143141).

Approved equivalent.

* + - 1. CORNER ANGLES
				1. PVC Corner Angles: [**30-mils (0.8-mm-)**] <**Insert dimension**> thick, minimum 1- by 1-inch (25- by 25-mm) PVC in accordance with ASTM D1784, Class 16354-C, white or color-coded to match adjacent surface.
				2. Aluminum Corner Angles: [**0.040-inch (1.0-mm-)**] <**Insert dimension**> thick, minimum 1- by 1-inch (25- by 25-mm), aluminum in accordance with ASTM B209 (ASTM B209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.
				3. Stainless Steel Corner Angles: [**0.024-inch (0.61-mm-)**] <**Insert dimension**> thick, minimum 1- by 1-inch (25- by 25-mm) stainless steel in accordance with ASTM A240/A240M, [**Type 304**] [**or**] [**Type 316**].
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 and equipment 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 equipment under insulation, although not typically caused by insulation, is an issue that must be considered during design of any plumbing insulation system. The potential for corrosion depends on many factors. Requirements cited in second paragraph represent added measures of protection but are not meant to take the place of proper system design and specification.

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

Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 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 between 32 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 equipment.
				2. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of equipment, 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. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.
				7. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
				8. Install insulation with least number of joints practical.
				9. Install the Work of this Section in accordance with the manufacturer’s printed installation instruction unless otherwise specified.
				10. Provide continuous piping insulation and jacketing when passing thru interior wall, floor, and ceiling construction.
				11. 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 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- (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 inches (100 mm) o.c.

Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward-clinching staples along edge at [**2 inches (50 mm)**] [**4 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.

* + - * 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 inches (100 mm) 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.

Manholes.

Handholes.

Cleanouts.

* + - 1. INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION
				1. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

In first subparagraph below, many manufacturers do not recommend 100 percent coverage of adhesive, because of the effect on the overall insulation system's fire-performance characteristics. Verify application coverage recommendations with insulation manufacturer.

Apply adhesives in accordance with manufacturer's recommended coverage rates per unit area, for [**100**] [**50**] <**Insert number**> percent coverage of tank and vessel surfaces.

Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.

Protect exposed corners with secured corner angles.

Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

Do not weld anchor pins to ASME-labeled pressure vessels.

Select insulation hangers and adhesive that are compatible with service temperature and with substrate.

On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints and 16 inches (400 mm) o.c. in both directions.

Do not over-compress insulation during installation.

Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.

Impale insulation over anchor pins, andpins and attach speed washers.

Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.

Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.

Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.

Stagger joints between insulation layers at least 3 inches (75 mm).

Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.

Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.

For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

* + - * 1. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

Apply [**100**] <**Insert value**> percent coverage of adhesive to surface with manufacturer's recommended adhesive.

Seal longitudinal seams and end joints.

* + - * 1. Insulation Installation on Pumps:

Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a field-adjustable latching mechanism.

Fabricate boxes from [**galvanized steel**] [**aluminum**] [**or**] [**stainless steel**], at least [**0.040 inch (1.0 mm)**] [**0.050 inch (1.3 mm)**] [**0.060 inch (1.6 mm)**] thick.

For below-ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

* + - 1. INSTALLATION OF CALCIUM SILICATE INSULATION
				1. Insulation Installation on Domestic Water Boiler Breechings:

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

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

On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

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

Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.

Embed glass cloth between two 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-inch (38-mm) laps at longitudinal seams and 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, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

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

* + - * 1. Where metal jackets are indicated, install with 2-inch (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 inches (300 mm) o.c. and at end joints.
				2. Where PVDC jackets are indicated, install as follows:

Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. 33-1/2-inch- (850-mm-) circumference limit allows for 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 "fishmouthing," 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 "Equipment Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material" Paragraphparagraph 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. Equipment 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" Subparagraphsubparagraph below for a flat, latex-emulsion size over insulation covering an exterior that is subject to normal use and moderate environments.

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

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

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

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

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

* + - * 1. 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" Paragraphparagraph below to require a factory-authorized service representative to perform tests and inspections.

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

Retain "Perform tests and inspections" Paragraphparagraph 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 Company Service Advisor**].

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

* + - * 1. Tests and Inspections: Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to [**one**] <**Insert number**> location(s) for each type of equipment defined in the "Indoor Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.

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. DOMESTIC WATER BOILER BREECHING INSULATION SCHEDULE

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

* + - * 1. Round, exposed breeching and connector insulation shall be[**one of**] the following:

Retain one or more of "Calcium Silicate," "High-Temperature Mineral-Fiber Blanket," and "High-Temperature Mineral-Fiber Board" subparagraphs below.

Calcium Silicate: 4 inches (100 mm) thick.

High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

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

* + - * 1. Round, concealed breeching and connector insulation shall be[**one of**] the following:

Retain one or more of "Calcium Silicate," "High-Temperature Mineral-Fiber Blanket," and "High-Temperature Mineral-Fiber Board" subparagraphs below.

Calcium Silicate: 4 inches (100 mm) thick.

High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

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

* + - * 1. Rectangular, exposed breeching and connector insulation shall be[**one of**] the following:

Retain one or more of "Calcium Silicate," "High-Temperature Mineral-Fiber Blanket," and "High-Temperature Mineral-Fiber Board" subparagraphs below.

Calcium Silicate: 4 inches (100 mm) thick.

High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

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

* + - * 1. Rectangular, concealed breeching and connector insulation shall be[**one of**] the following:

Retain one or more of "Calcium Silicate," "High-Temperature Mineral-Fiber Blanket," and "High-Temperature Mineral-Fiber Board" subparagraphs below.

Calcium Silicate: 4 inches (100 mm) thick.

High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

* + - 1. INDOOR EQUIPMENT INSULATION SCHEDULE

Equipment insulation schedules in this article specify commonly used insulation materials and thicknesses for each equipment type. LEED Prerequisite EA 2 requires that water heater insulation R-value comply with ASHRAE/IESNA 90.1. Not all materials and thicknesses may be suitable for a specific project. Revise to suit Project after considering all parameters that impact selection.

Flexible elastomeric and polyolefin thicknesses are limited to 1 inch (25 mm) to meet a flame-spread index of 25 and a smoke-developed index of 50. Condensation control and energy efficiency are limited by thickness.

Consider the exposure of installed insulation to damage. Concealed applications have less risk than exposed.

Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.

* + - * 1. Insulate indoor and outdoor equipment that is not factory insulated.

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

* + - * 1. Heat-exchanger (water-to-water for domestic water-heating service) insulation shall be[**one of**] the following:

Retain one or more of "Calcium Silicate," "Cellular Glass," "Mineral-Fiber Blanket," "Mineral-Fiber Board," and "Mineral-Fiber Pipe and Tank" subparagraphs below.

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

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

Mineral-Fiber Blanket: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.

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

* + - * 1. Steam-to-hot-water converter insulation shall be[**one of**] the following:

Retain one or more of "Calcium Silicate," "Cellular Glass," "Mineral-Fiber Blanket," "Mineral-Fiber Board," and "Mineral-Fiber Pipe and Tank" subparagraphs below.

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

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

Mineral-Fiber Blanket: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.

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

* + - * 1. Domestic water pump insulation shall be[**one of**] the following:

Retain one or more of "Cellular Glass," "Mineral-Fiber Blanket," and "Mineral-Fiber Board" subparagraphs below.

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

Mineral-Fiber Blanket: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

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

* + - * 1. Domestic chilled-water (potable) pump insulation shall be[**one of**] the following:

Retain one or more of "Cellular Glass," "Mineral-Fiber Blanket," and "Mineral-Fiber Board" subparagraphs below.

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

Mineral-Fiber Blanket: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

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

* + - * 1. Domestic hot-water pump insulation shall be[**one of**] the following:

Retain one or more of "Cellular Glass," "Mineral-Fiber Blanket," and "Mineral-Fiber Board" subparagraphs below.

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

Mineral-Fiber Blanket: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

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

* + - * 1. Domestic water, domestic chilled-water (potable), and domestic hot-water hydropneumatic tank insulation shall be[**one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Mineral-Fiber Blanket," "Mineral-Fiber Board," "Mineral-Fiber Pipe and Tank," and "Polyolefin" subparagraphs below.

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

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

Mineral-Fiber Blanket: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.

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

ASHRAE/IESNA 90.1 requires an R-value of 12.5 for domestic hot-water storage tanks.

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

* + - * 1. Domestic hot-water storage tank insulation shall be[**one of**] the following, of thickness to provide an R-value of [**12.5**] <**Insert value**>:

Retain one or more of "Cellular Glass," "Mineral-Fiber Blanket," "Mineral-Fiber Board," and "Mineral-Fiber Pipe and Tank" subparagraphs below.

Cellular glass.

Mineral-Fiber Blanket: [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Board: [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-fiber pipe and tank.

Retain first paragraph below if required to control condensation. Retain "one of" option in first paragraph below to allow Contractor to select materials from those retained.

* + - * 1. Domestic water storage tank insulation shall be[**one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Mineral-Fiber Blanket," "Mineral-Fiber Board," "Mineral-Fiber Pipe and Tank," and "Polyolefin" subparagraphs below.

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

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

Mineral-Fiber Blanket: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.

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

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

* + - * 1. Domestic chilled-water (potable) storage tank insulation shall be[**one of**] the following:

Retain one or more of "Cellular Glass," "Flexible Elastomeric," "Mineral-Fiber Blanket," "Mineral-Fiber Board," "Mineral-Fiber Pipe and Tank," and "Polyolefin" subparagraphs below.

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

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

Mineral-Fiber Blanket: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.

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

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

* + - * 1. Domestic water filter-housing insulation shall be[**one of**] the following:

Retain one or more of "Cellular Glass," "Mineral-Fiber Blanket," "Mineral-Fiber Board," and "Mineral-Fiber Pipe and Tank" subparagraphs below.

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

Mineral-Fiber Blanket: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

Mineral-Fiber Pipe and Tank: [**2 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. Equipment, Concealed:

Retain one of six subparagraphs below.

None.

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

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

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

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

<**Insert jacket type**>.

* + - * 1. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces of up to 72 Inches (1800 mm):

Retain one of six subparagraphs below.

None.

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

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

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

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

<**Insert jacket type**>.

* + - * 1. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

Retain one of four subparagraphs below.

None.

[**Painted**]Aluminum, [**Smooth**] [**Stucco Embossed**] with [**1-1/4-Inch- (32-mm-) Deep Corrugations**] [**2-1/2-Inch- (65-mm-) Deep Corrugations**] [**4-by-1-Inch (100-by-25-mm) Box Ribs**]: [**0.032 inch (0.81 mm)**] [**0.040 inch (1.0 mm)**] thick.

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth**] [**Stucco Embossed**], with [**1-1/4-Inch- (32-mm-) Deep Corrugations**] [**2-1/2-Inch- (65-mm-) Deep Corrugations**] [**4-by-1-Inch (100-by-25-mm) Box Ribs**]: [**0.020 inch (0.51 mm)**] [**0.024 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. Equipment, Concealed:

Retain one of six subparagraphs below.

None.

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

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

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

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

<**Insert jacket type**>.

* + - * 1. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces of up to 72 Inches (1800 mm):

Retain one of three subparagraphs below.

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

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

<**Insert jacket type**>.

* + - * 1. Equipment, Exposed, Larger Than 48 Inches (1200 mm) in Diameter or with Flat Surfaces Larger Than 72 Inches (1800 mm):

Retain one of three subparagraphs below.

[**Painted**]Aluminum, [**Smooth**] [**Stucco Embossed**] with [**1-1/4-Inch- (32-mm-) Deep Corrugations**] [**2-1/2-Inch- (65-mm-) Deep Corrugations**] [**4-by-1-Inch (100-by-25-mm) Box Ribs**]: [**0.032 inch (0.81 mm)**] [**0.040 inch (1.0 mm)**] thick.

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth**] [**Stucco Embossed**], with [**1-1/4-Inch- (32-mm-) Deep Corrugations**] [**2-1/2-Inch- (65-mm-) Deep Corrugations**] [**4-by-1-Inch (100-by-25-mm) Box Ribs**]: [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] thick.

<**Insert jacket type**>.

END OF SECTION 220716