SECTION 210700 - FIRE-SUPPRESSION SYSTEMS INSULATION

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

1. GENERAL
	* + 1. RELATED DOCUMENTS
				1. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.
			2. SUMMARY
				1. Section includes insulating the following fire protection piping services:

**List of fire-suppression equipment and piping below matches the various equipment items and piping systems in the schedule articles. Coordinate revision of list below with "Equipment Insulation Schedule"; "Indoor Piping Insulation Schedule"; and "Outdoor, Aboveground Piping Insulation Schedule" articles.**

Engine coolant piping for remote radiator of engine-driven fire pump.

Engine exhaust piping and silencer.

Indoor and outdoor equipment.

Outdoor piping.

* + - 1. SUBMITTALS

**Only request submittals needed to verify compliance with Project requirements.**

* + - * 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 specified 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).

* + - * 1. Sustainable Design Submittals:
				2. Shop Drawings:

Include plans, elevations, sections, and attachment details.

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

Detail attachment and covering of heat tracing inside insulation.

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

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

Detail removable insulation at piping specialties and equipment connections.

Detail application of field-applied jackets.

Detail application at linkages of control devices.

Detail field application for fire-suppression water storage tanks.

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

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

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

Sheet Form Insulation Materials: 12 inches square.

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

Sheet Jacket Materials: 12 inches square.

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

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

* + - * 1. Material Test Reports: From the manufacturer Company Service Advisor acceptable to authorities having jurisdiction indicating, interpreting, and certifying test results for compliance of insulation materials, sealers, attachments, cements, and jackets, with requirements indicated per manufacturing requirements and drawings and specifications. Include dates of tests and test methods employed.

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

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

**Retain "Installer Qualifications" Paragraph below if available at Project location. Apprenticeship programs are usually associated with union shops. Other craft training programs 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. Include test date and test methods.**

* + - * 1. Surface-Burning Characteristics: For insulation and related materials. Comply with ASTM E84 “Standard Test Method for Surface Burning Characteristics of Building Materials”; testing by a qualified testing agency. Identify products 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" Paragraph below, indicate location, size, and other details of mockups on Drawings or by inserts. Revise if only one mockup is required. Edit mockups to retain those specific to Project. Provide additional mockup requirements if applicable.**

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

Piping Mockups:

One 10-foot section of NPS 2 straight pipe.

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

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

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

Four support hangers including hanger shield and insert.

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

One threaded reducer and one welded reducer.

One pressure temperature tap.

One mechanical coupling.

One union.

<**Insert mockup**>.

Equipment Mockups:

One tank or vessel.

<**Insert mockup**>.

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

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

Obtain Director’s Representative'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.

Remove mockups when directed by the Director’s Representative.

* + - 1. DELIVERY, STORAGE, AND HANDLING

**Retain this article to require shipping container markings. Container marking is an option in ASTM 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 clearance requirements with piping Installer for piping insulation application and with equipment Installer for equipment insulation application. Before preparing piping Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
				2. 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 Paragraph 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.**

* + - 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 "Diesel Engine Exhaust Insulation Schedule"; "Equipment Insulation Schedule"; "Piping Insulation Schedule, General"; "Indoor Piping Insulation Schedule"; and "Outdoor, Aboveground Piping Insulation Schedule" articles for where insulating materials shall be applied.

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

* + - * 1. Products shall not contain asbestos, lead, mercury, or mercury compounds.
				2. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested in accordance with ASTM C871 “Standard Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate and Sodium Ions”.
				3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable in accordance with ASTM C795 “Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel”.
				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 “Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation”, Type I or Type II.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1134) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457203007).

Thermal Pipe Shields Inc. TPS Industrial Insulations

Approved equivalent.

Prefabricated Fitting Covers: Comply with ASTM C450 “Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging” and ASTM C585 “Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)” for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges.

* + - * 1. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Comply with ASTM C552 “Standard Specification for Cellular Glass Thermal Insulation”.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1136) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Owens Corning](http://www.specagent.com/Lookup?uid=123457203136).

SPI: Specialty Products and Insulation

Multiglass Insulation Ltd.

Approved equivalent.

Block Insulation: Type I.

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

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

Special-Shaped Insulation: Type III.

Board Insulation: Type IV.

Factory fabricate shapes in accordance with ASTM C450 “Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging” and ASTM C585 “Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)”.

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

**"Flexible Elastomeric" Paragraph below is unsuitable for temperatures lower than minus 70 deg F and higher than 220 deg F.**

* + - * 1. Flexible Elastomeric: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C534 “Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form”, Type I for tubular materials and Type II for sheet materials.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1138) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Aeroflex USA](http://www.specagent.com/Lookup?uid=123457203028).

[Armacell LLC](http://www.specagent.com/Lookup?uid=123457203029).

[K-Flex USA](http://www.specagent.com/Lookup?uid=123457203030).

Approved equivalent.

**The most common jacket for equipment applications is ASJ, and the most common jacket for plenum applications is FSK.**

* + - * 1. Mineral-Fiber Board: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C612 “Standard Specification for Mineral Fiber Block and Board Thermal Insulation”, Type IA or Type IB. For equipment applications, 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: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Owens Corning

Roxul

Thermafiber

Approved equivalent.

* + - * 1. Mineral-Fiber, Preformed Pipe: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C547 “Standard Specification for Mineral Fiber Pipe Insulation”.

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Owens Corning

Roxul

Thermafiber

Approved equivalent.

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

850 deg F.

Factory fabricate shapes in accordance with ASTM C450 “Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging” and ASTM C585 “Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)”.

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

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

* + - * 1. Mineral-Fiber, Pipe and Tank: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C1393 “Standard Specification for Perpendicularly Oriented Mineral Fiber Roll and Sheet Thermal Insulation for Pipes and Tanks”.

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

Owens Corning

Roxul

Thermafiber

Approved equivalent.

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

Nominal density is 2.5 lb/cu. ft. or more.

Thermal conductivity (k-value) at 100 deg F is 0.29 Btu x in./h x sq. ft. x deg F or less.

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

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

* + - * 1. Phenolic: Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C1126 “Standard Specification for Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation”.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1147) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457203270).

[Polyguard Products, Inc](http://www.specagent.com/Lookup?uid=123457203272).

[Resolco Inc](http://www.specagent.com/Lookup?uid=123457203031).

Approved equivalent.

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

Factory fabricate shapes in accordance with ASTM C450 “Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging” and ASTM C585 “Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)”.

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

* + - * 1. Polyisocyanurate: Preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation. Comply with ASTM C591 “Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation”.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1150) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Dyplast Products](http://www.specagent.com/Lookup?uid=123457203035).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457203670).

Approved equivalent.

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

Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in./h x sq. ft. x deg F at 75 deg F after 180 days of aging.

Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1 inch as tested in accordance with ASTM E84 “Standard Test Method for Surface Burning Characteristics of Building Materials”.

Fabricate shapes in accordance with ASTM C450 “Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging” and ASTM C585 “Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)”.

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

* + - 1. INSULATING CEMENTS

**Mineral-fiber insulating cement is suitable for temperatures from 100 to 1600 deg F. Vermiculite insulating cement is suitable for temperatures from 100 to 1800 deg F.**

* + - * 1. Mineral-Fiber Insulating Cement: Comply with ASTM C195 “Standard Specification for Mineral Fiber Thermal Insulating Cement”.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1156) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Ramco Insulation, Inc](http://www.specagent.com/Lookup?uid=123457203041).

Insulco, Division of MFS, Inc.

P.K. Insulation Mfg. Co., Inc.

Johns Manville

Rock Wool Manufacturing Company

Approved equivalent.

* + - * 1. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C196 “Standard Specification for Expanded or Exfoliated Vermiculite Thermal Insulating Cement”.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1159) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Ramco Insulation, Inc](http://www.specagent.com/Lookup?uid=123457203042).

P. K. Insulation Mfg. Co., Inc.

Approved equivalent.

**Mineral-fiber, hydraulic-setting cement is suitable for temperatures from 100 to 1200 deg F and for a smooth surface.**

* + - * 1. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C449 “Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement”.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1161) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Ramco Insulation, Inc](http://www.specagent.com/Lookup?uid=123457203043).

Johns Manville: A Berkshire Hathaway Company

Foundry Service & Supplies

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.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1164) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203045).

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203047).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457203048).

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.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1167) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203051).

Masterbond

Sika

Approved equivalent.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1170) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Aeroflex USA](http://www.specagent.com/Lookup?uid=123457203053).

[Armacell LLC](http://www.specagent.com/Lookup?uid=123457203054).

[K-Flex USA](http://www.specagent.com/Lookup?uid=123457203056).

Approved equivalent.

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

Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less as tested in accordance with ASTM E84 “Standard Test Method for Surface Burning Characteristics of Building Materials.

Wet Flash Point: Below 0 deg F.

Service Temperature Range: 40 to 200 deg F.

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

* + - * 1. Mineral-Fiber Adhesive: Comply with MIL-A-3316C “Adhesives, Fire-Resistant, Thermal Insulation”, Class 2, Grade A.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1172) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203057).

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203059).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457203060).

Approved equivalent.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1179) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203062).

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203063).

Approved equivalent.

* + - * 1. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C “Adhesives, Fire-Resistant, Thermal Insulation”, 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203014).

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203016).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457203017).

Approved equivalent.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=3136) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457203019).

[Proto Corporation](http://www.specagent.com/Lookup?uid=123457203895).

[The Dow Chemical Company](http://www.specagent.com/Lookup?uid=123457203022).

Approved equivalent.

**Not all manufacturers comply with sustainability requirements. If sustainability is 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 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"; or "Breather Mastic" Paragraph below. Consider insulation type and operating conditions when selecting mastics and coatings.**

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1183) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203896).

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203064).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457203897).

Approved equivalent.

Water-Vapor Permeance: Comply with ASTM E96 “Standard Test Methods for Water Vapor Transmission of Materials” or ASTM F1249 “Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infared Sensor”.

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

Service Temperature Range: [**0 to plus 180 deg F**] [**Minus 20 to plus 180 deg F**].

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

Comply with MIL-PRF-19565C “Coating Compounds, Thermal Insulation, Fire and Water-Resistant, Vapor Barrier”, Type II, for permeance requirements[**, with supplier listing on DOD's Qualified Products Database**].

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

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1185) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203067).

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203069).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457203898).

Approved equivalent.

Water-Vapor Permeance: Comply with ASTM E96 “Standard Test Methods for Water Vapor Transmission of Materials” or ASTM F1249 “Standard Test Method for Water Vapor Transmission Rate Through Plastic Film and Sheeting Using a Modulated Infared Sensor”.

Service Temperature Range: Minus 50 to plus 220 deg F.

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=1188) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203070).

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203072).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457203073).

Approved equivalent.

Water-Vapor Permeance: ASTM E96 “Standard Test Methods for Water Vapor Transmission of Materials”, greater than 1.0 perm at manufacturer's recommended dry film thickness.

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

Service Temperature Range: [**0 to plus 180 deg F**] [**Minus 20 to plus 180 deg F**].

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

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1190) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203078).

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203079).

Approved equivalent.

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

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

Service Temperature Range: [**20 to plus 180 deg F**] [**0 to plus 180 deg F**].

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 insulation manufacturer and shall be compatible with insulation materials, jackets, and substrates.
				2. Joint Sealants:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1191) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203899).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457203902).

[Owens Corning](http://www.specagent.com/Lookup?uid=123457203932).

Approved equivalent.

Permanently flexible, elastomeric sealant.

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

Service Temperature Range: [**Minus 150 to plus 250 deg F**] [**Minus 100 to plus 300 deg F**].

Color: White or gray.

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

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1193) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203008).

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203010).

[Mon-Eco Industries, Inc](http://www.specagent.com/Lookup?uid=123457203011).

Approved equivalent.

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

Service Temperature Range: Minus 40 to plus 250 deg F.

Color: Aluminum.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1194) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203081).

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203940).

Approved equivalent.

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

Service Temperature Range: Minus 40 to plus 250 deg F.

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 above 140 deg F, specify sufficient insulation thickness to maintain outer surface temperature of insulation below 140 deg F. 140 deg F 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 “Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation”, Type I.

ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C1136 “Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation”, Type I.

FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C1136 “Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation”, Type II.

* + - 1. FIELD-APPLIED FABRIC-REINFORCING MESH

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

**Retain "Woven Glass-Fiber Fabric for Pipe Insulation," "Woven Glass-Fiber Fabric for Equipment Insulation," and "Woven Polyester Fabric" paragraphs below to give Contractor option to use glass-fiber or polyester fabric.**

* + - * 1. Woven Glass-Fiber Fabric for Pipe Insulation: Approximately 4 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in. for covering pipe and pipe fittings.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1198) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203083).

Owens Corning

BGF Industries: A Porcher Industries Company

Textech

Approved equivalent.

* + - * 1. Woven Glass-Fiber Fabric for Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. in. for covering equipment.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1199) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Childers Brand; H. B. Fuller Construction Products](http://www.specagent.com/Lookup?uid=123457203084).

HexForce

Approved equivalent.

* + - * 1. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. in., in a Leno weave.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1200) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Foster Brand; H. B. Fuller](http://www.specagent.com/Lookup?uid=123457203085).

[Vimasco Corporation](http://www.specagent.com/Lookup?uid=123457203086).

Approved equivalent.

* + - 1. FIELD-APPLIED CLOTHS
				1. Woven Glass-Fiber Fabric: Comply with MIL-C-20079H “Cloth, Glass; Tape, Textile Glass; and Thread, Glass and Wire-Reinforced Glass”, Type I, plain weave, and presized a minimum of 8 oz./sq. yd..

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1201) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Alpha Associates, Inc](http://www.specagent.com/Lookup?uid=123457203087).

Auburn Manufacturing, Inc.

AB Tech

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 and pipes operating at below-ambient temperatures at least part of the time or where a vapor barrier is required. ASTM C1136, Type II, is for use over insulation on pipes operating above-ambient temperatures or where a vapor retarder is not required.**

* + - * 1. Field-applied jackets shall comply with ASTM C1136 “Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation”, 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.**

* + - * 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 and less.**

* + - * 1. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D1784 “Standard Classification and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds”, 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=1202) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Airex Manufacturing Inc](http://www.specagent.com/Lookup?uid=123457203939).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457203091).

[Proto Corporation](http://www.specagent.com/Lookup?uid=123457203088).

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

Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, and end caps.

Factory-fabricated tank heads and tank side panels.

* + - * 1. Metal Jacket:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1203) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457203938).

ITW Insulation Systems: Illinois Tool Works, Inc.

RPR Products, Inc.

Approved equivalent.

Aluminum Jacket: Comply with ASTM B209 “Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate”; Alloy 3003, 3005, 3105, or 5005; Temper H-14.

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

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

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

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

Moisture Barrier for Outdoor Applications: [**3-mil- thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil- 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 unavailable.

Stainless Steel Jacket: ASTM A240 “Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications”.

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

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

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

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

Moisture Barrier for Outdoor Applications: [**3-mil- thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil- 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 unavailable.

* + - * 1. Self-Adhesive Outdoor Jacket: 60-mil- 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, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[MFM Building Products Corp](http://www.specagent.com/Lookup?uid=123457203937).

[Polyguard Products, Inc](http://www.specagent.com/Lookup?uid=123457203024).

W.R. Meadows

Keene Building Products

Approved equivalent.

* + - 1. TAPES
				1. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C1136 “Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation”.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1204) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[3M Industrial Adhesives and Tapes Division](http://www.specagent.com/Lookup?uid=123457203100).

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457203096).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457203101).

Approved equivalent.

Width: [**3 inches**] <**Insert value**>.

Thickness: [**11.5 mils**] <**Insert value**>.

Adhesion: [**90 ounces force/inch**] <**Insert value**> in width.

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

Tensile Strength: [**40 lbf/inch**] <**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 “Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation”.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1205) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[3M Industrial Adhesives and Tapes Division](http://www.specagent.com/Lookup?uid=123457203106).

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457203102).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457203107).

Approved equivalent.

Width: 3 inches.

Thickness: 6.5 mils.

Adhesion: 90 ounces force/inch in width.

Elongation: 2 percent.

Tensile Strength: 40 lbf/inch 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=1206) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457203108).

XFasten

3M

Approved equivalent.

Width: 2 inches.

Thickness: 6 mils.

Adhesion: 64 ounces force/inch in width.

Elongation: 500 percent.

Tensile Strength: 18 lbf/inch in width.

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1208) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[3M Industrial Adhesives and Tapes Division](http://www.specagent.com/Lookup?uid=123457203936).

[Ideal Tape Co., Inc., an American Biltrite Company](http://www.specagent.com/Lookup?uid=123457203112).

[Knauf Insulation](http://www.specagent.com/Lookup?uid=123457203117).

Approved equivalent.

Width: 2 inches.

Thickness: 3.7 mils.

Adhesion: 100 ounces force/inch in width.

Elongation: 5 percent.

Tensile Strength: 34 lbf/inch in width.

* + - 1. SECUREMENTS
				1. Bands:

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1215) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457203935).

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

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

Pabco-Childers Metals

Approved equivalent.

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

Stainless Steel: ASTM A240 “Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications”, [**Type 304**] [**or**] [**Type 316**]; 0.015 inch thick, [**1/2 inch**] [**3/4 inch**] wide with [**wing seal**] [**or**] [**closed seal].**

Aluminum: ASTM B209 “Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate”; Alloy 3003, 3005, 3105, or 5005; Temper H-14; 0.020 inch thick, [**1/2 inch**] [**3/4 inch**] wide with [**wing seal**] [**or**] [**closed seal**].

**Springs are used for large, 84-inch-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:

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=1219) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[AGM Industries, Inc](http://www.specagent.com/Lookup?uid=123457203121).

[Gemco](http://www.specagent.com/Lookup?uid=123457203122).

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

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

Approved equivalent.

Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

Spindle: [**Copper- or zinc-coated, low carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed, 0.106-inch- 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.

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=1221) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[AGM Industries, Inc](http://www.specagent.com/Lookup?uid=123457203125).

[Gemco](http://www.specagent.com/Lookup?uid=123457203126).

Midwest Fasteners, Inc.

Approved equivalent.

Baseplate: Galvanized carbon-steel sheet, 0.030 inch thick by 2 inches square.

Spindle: [**Copper- or zinc-coated, low-carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed, 0.106-inch- 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- 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 in diameter.

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1222) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[AGM Industries, Inc](http://www.specagent.com/Lookup?uid=123457203129).

[Gemco](http://www.specagent.com/Lookup?uid=123457203130).

Midwest Fasteners, Inc.

Nelson Stud Welding.

Approved equivalent.

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

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

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

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

[Manufacturers:](http://www.specagent.com/Lookup?ulid=1223) Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:

[C & F Wire Products](http://www.specagent.com/Lookup?uid=123457203134).

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457203933).

ACS Industries, Inc.

Approved equivalent.

* + - 1. CORNER ANGLES
				1. PVC Corner Angles: [**30 mils**] <**Insert dimension**> thick, minimum 1 by 1 inch, PVC in accordance with ASTM D1784 “Standard Classification and Basis for Specification for Rigid Poly(Vinyl Chloride) (PVC) Compounds and Chlorinated Poly(Vinyl Chloride) (CPVC) Compounds”, Class 16354-C. White or color-coded to match adjacent surface.
				2. Aluminum Corner Angles: [**0.040 inch**] <**Insert dimension**> thick, minimum 1 by 1 inch, aluminum in accordance with ASTM B209 “Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate” Alloy 3003, 3005, 3105, or 5005; Temper H-14.
				3. Stainless Steel Corner Angles: [**0.024 inch**] <**Insert dimension**> thick, minimum 1 by 1 inch, stainless steel in accordance with ASTM A240 “Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications”, [**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 and 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 and piping under insulation, although not typically caused by insulation, is an issue that must be considered during design of any fire-suppression systems insulation. 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 epoxy primer 5 mils thick and epoxy finish 5 mils thick if operating in a temperature range of between 140 and 300 deg F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

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

* + - * 1. Coordinate insulation installation with the tradesman installing heat tracing. Comply with requirements for heat tracing that apply to insulation.
				2. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless steel surfaces, use demineralized water.
			1. GENERAL INSTALLATION REQUIREMENTS
				1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment and piping including fittings, valves, and specialties.
				2. Install insulation materials, forms, vapor barriers or retarders, jackets, and of thicknesses required for each item of equipment and pipe system as specified in insulation system schedules.
				3. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
				4. Install insulation with longitudinal seams at top and bottom of horizontal runs.
				5. Install multiple layers of insulation with longitudinal and end seams staggered.
				6. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
				7. Keep insulation materials dry during storage, application, and finishing. Replace insulation materials that get wet.
				8. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended in writing by insulation material manufacturer.
				9. Install insulation with least number of joints practical.
				10. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

Install insulation continuously through hangers and around anchor attachments.

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

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

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

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

Draw jacket tight and smooth.

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

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

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

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

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

* + - * 1. Cut insulation in a manner to avoid compressing insulation 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 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. PENETRATIONS
				1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

Seal penetrations with flashing sealant.

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

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

Seal jacket to roof flashing with flashing sealant.

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

Seal penetrations with flashing sealant.

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

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

Seal jacket to wall flashing with flashing sealant.

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

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

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

Pipe: Install insulation continuously through floor penetrations.

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

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

Maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.

Do not overcompress insulation during installation.

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

Impale insulation over anchor pins 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 from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center 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 o.c. Use this network for securing insulation with tie wire or bands.

Stagger joints between insulation layers at least 3 inches.

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: Install insulation over entire surface of tanks.

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

Seal longitudinal seams and end joints.

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

**Where pipe expansion is anticipated, detail expansion compensation for insulation on Drawings and indicate intervals for its occurrence. See the Midwest Insulation Contractors Association's "National Commercial & Industrial Insulation Standards," Plate No. 41A.**

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

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

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

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

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

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

Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.

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

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

Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

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

**Coordinate paragraph below with Drawings.**

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

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

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

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

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

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

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

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

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

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

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

Install preformed pipe insulation to outer diameter of pipe flange.

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

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

Finish flange insulation same as pipe insulation.

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

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

When preformed insulation sections of insulation are unavailable, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.

Finish fittings insulation same as pipe insulation.

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

Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

Finish valve and specialty insulation same as pipe insulation.

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

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

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

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

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

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

Install preformed pipe insulation to outer diameter of pipe flange.

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

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

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

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

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

When preformed sections of insulation are unavailable, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

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

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

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

Install insulation to flanges as specified for flange insulation application.

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

Install pipe insulation to outer diameter of pipe flange.

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

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

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

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

Install mitered sections of pipe insulation.

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

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

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

When preformed valve covers are unavailable, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

Install insulation to flanges as specified for flange insulation application.

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

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

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

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

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

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

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

Install preformed pipe insulation to outer diameter of pipe flange.

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

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

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

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

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

When preformed insulation elbows and fittings are unavailable, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

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

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

When preformed sections are unavailable, install mitered sections of pipe insulation to valve body.

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

Install insulation to flanges as specified for flange insulation application.

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

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

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

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

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

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

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

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

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

Install preformed pipe insulation to outer diameter of pipe flange.

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

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

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

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

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

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

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

Install insulation to flanges as specified for flange insulation application.

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

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

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

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

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

Install preformed pipe insulation to outer diameter of pipe flange.

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

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

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

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

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

Install preformed sections of polyisocyanurate insulation to valve body.

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

Install insulation to flanges as specified for flange insulation application.

* + - 1. 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 overlap at seams and joints.

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

Completely encapsulate insulation with coating, leaving no exposed insulation.

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

Draw jacket material smooth and tight.

Install lap or joint strips with same material as jacket.

Secure jacket to insulation with manufacturer's recommended adhesive.

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

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

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

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

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

**Coordinate "Equipment and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material" Paragraph below with Section 099114 "Exterior Painting (MPI Standards)" 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 and Pipe Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Section 099114 "Exterior Painting (MPI Standards)" and Section 099123 "Interior Painting."

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

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

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

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

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

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

* + - * 1. Testing and inspections as per manufacturing requirements, drawings, and specifications..

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

**Retain "Manufacturer's Field Service" Paragraph below to require a factory-authorized service representative to perform tests and inspections.**

* + - * 1. Manufacturer's Field Service: Installing contractor shall provide a company field advisor per OGS spec section 014216 to test and inspect components, assemblies, and equipment installations, including connections.

**Retain "Perform tests and inspections" Paragraph below to require Contractor to perform tests and inspections 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 field advisor per OGS spec section 014216 and witnessed by the Director’s Representative.

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

* + - * 1. Tests and Inspections:

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

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

* + - * 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. DIESEL ENGINE EXHAUST INSULATION SCHEDULE

**Insulate engine exhaust for personnel protection. Consider jacket material when determining thickness. A painted metal jacket can impact insulation thickness. Flexible exhaust pipe does not need to be insulated.**

* + - * 1. Indoor and Outdoor, Exposed, Rigid, Engine Exhaust Pipe and Silencer:

Calcium Silicate: [**4 inches**] <**Insert dimension**> thick.

* + - 1. EQUIPMENT INSULATION SCHEDULE

**Equipment insulation schedules in this article specify commonly used insulation materials and thicknesses for each equipment type. Thickness options comply with ASHRAE/IES 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. See the Evaluations for more information and guidance.**

**Polyisocyanurate thickness is limited to 1 inch to meet a flame-spread index of 25 and a smoke-developed index of 50. Condensation control and energy efficiency are limited by thickness.**

**Flexible elastomeric and polyolefin thicknesses are limited to 1 inch 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.**

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

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

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

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

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

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

Mineral-Fiber Board: [**1 inch**] <**Insert dimension**> thick and [**2-lb/cu. ft.**] [**3-lb/cu. ft.**] [**6-lb/cu. ft.**] nominal density.

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

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

* + - 1. PIPING INSULATION SCHEDULE, GENERAL
				1. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
				2. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:

Indoor fire-suppression piping.

Underground piping.

**Piping insulation schedules in articles below specify commonly used insulation materials and thicknesses by pipe size range for each service. Thickness options comply with ASHRAE/IES 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. Do not duplicate requirements inserted in Part 2. See the Evaluations for more information and guidance.**

**Polyisocyanurate thickness is limited to 1 inch to meet a flame-spread index of 25 and a smoke-developed index of 50. Condensation control and energy efficiency are limited by thickness.**

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

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

* + - 1. INDOOR PIPING INSULATION SCHEDULE

**Insulate engine coolant piping for remote radiator of engine-driven fire pump for personnel protection. Consider jacket material when determining thickness. A painted metal jacket can impact insulation thickness.**

* + - * 1. Indoor Engine Coolant Piping for Remote Radiator of Engine-Driven Fire Pump:

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

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

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

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

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

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

* + - * 1. Indoor Engine Exhaust Piping and Silencer:

All Pipe Sizes: Insulation shall be the following:

Calcium Silicate: [**4 inches**] <**Insert dimension**> thick.

* + - 1. OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

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

* + - * 1. Fire-Suppression Water Piping:

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

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

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

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

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

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

**Insulate engine coolant piping for remote radiator of engine-driven fire pump for personnel protection. Consider jacket material when determining thickness. A painted metal jacket can impact insulation thickness.**

* + - * 1. Outdoor Engine Coolant Piping for Remote Radiator of Engine-Driven Fire Pump:

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

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

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

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

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

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

* + - * 1. Outdoor Engine Exhaust Piping and Silencer:

All Pipe Sizes: Insulation shall be the following:

Calcium silicate: [**4 inches**] <**Insert dimension**> thick.

**Insulate engine exhaust for personnel protection. Consider jacket material when determining thickness. A painted metal jacket can impact insulation thickness.**

* + - * 1. Outdoor Fire-Suppression Piping Filled with Water:

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

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

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

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

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

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

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

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

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

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

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

**Retain one of five subparagraphs below.**

None.

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

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

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

<**Insert jacket type**>.

* + - * 1. Piping, Exposed:

**Retain one of six subparagraphs below.**

None.

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

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

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

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

<**Insert jacket type**>.

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

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

**30-mil or heavier PVC is recommended for outdoor applications. 40-mil PVC does not meet 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 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 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**] [**30 mils**] thick.

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

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

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

<**Insert jacket type**>.

* + - * 1. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:

**Retain one of three subparagraphs below.**

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

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

<**Insert jacket type**>.

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

**Retain one of three subparagraphs below.**

[**Painted**]Aluminum, [**Smooth**] [**Stucco Embossed**] with [**1-1/4-Inch- Deep Corrugations**] [**2-1/2-Inch- Deep Corrugations**] [**4-by-1-Inch Box Ribs**]: [**0.032 inch**] [**0.040 inch**] thick.

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth**] [**Stucco Embossed**], with [**1-1/4-Inch- Deep Corrugations**] [**2-1/2-Inch- Deep Corrugations**] [**4-by-1-Inch Box Ribs**]: [**0.020 inch**] [**0.024 inch**] thick.

<**Insert jacket type**>.

* + - * 1. Outdoor Exposed Piping:

**Retain one of four subparagraphs below.**

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

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

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

<**Insert jacket type**>.

END OF SECTION 210700