SECTION 230700 - HVAC INSULATION

This Section includes insulation applied to HVAC ductwork, equipment and piping systems.

Manufacturers found in SpecAgent for this Section were identified as representative and not as an endorsement for meeting the requirements of this specification.

This Section includes performance, proprietary, and descriptive type specifications. Edit to avoid conflicts among requirements.

This Section includes the term Architect/Engineer. "Architect" is used in AIA contract documents; "Engineer" is used in EJCDC contract documents. Retain appropriate term.

See the Drawing Coordination Considerations for information needed to coordinate this specification Section with the Drawings.

1. GENERAL
	* + 1. SUMMARY
				1. Section Includes:

HVAC piping insulation, jackets and accessories.

HVAC equipment insulation, jackets and accessories.

HVAC ductwork insulation, jackets, and accessories.

* + - * 1. Related Sections:

Section 078400 - Firestopping: Product requirements for firestopping for placement by this section.

Section 099114 – Exterior Painting: Execution requirements for painting insulation jackets and covering specified by this section.

Section 099123 – Interior Painting: Execution requirements for painting insulation jackets and covering specified by this section.

* + - 1. REFERENCES

List reference standards included within text of this section. Edit the following for Project conditions.

* + - * 1. ASTM International:

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

ASTM A666 - Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.

ASTM B209 - Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.

ASTM C195 - Standard Specification for Mineral Fiber Thermal Insulating Cement.

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

ASTM C450 - Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging.

ASTM C533 - Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation.

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

ASTM C547 - Standard Specification for Mineral Fiber Pipe Insulation.

ASTM C553 - Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications.

ASTM C578 - Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation.

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

ASTM C591 - Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation.

ASTM C612 - Standard Specification for Mineral Fiber Block and Board Thermal Insulation.

ASTM C795 - Standard Specification for Thermal Insulation for Use in Contact with Austenitic Stainless Steel.

ASTM C921 - Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation.

ASTM C1071 - Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material).

ASTM C1136 - Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation.

ASTM C1290 - Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts.

ASTM D1785 - Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120.

ASTM D4637 - Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane.

ASTM E96 - Standard Test Methods for Water Vapor Transmission of Materials.

ASTM E162 - Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source.

* + - * 1. Sheet Metal and Air Conditioning Contractors:

SMACNA - HVAC Duct Construction Standard - Metal and Flexible.

* + - * 1. Underwriters Laboratories Inc.:

UL 1978 - Standard for Safety for Grease Ducts.

* + - 1. SUBMITTALS
				1. Submittals for this section are subject to the re-evaluation fee identified in Article 4 of the General Conditions.
				2. Manufacturer’s installation instructions shall be provided along with product data.
				3. Submittals shall be provided in the order in which they are specified and tabbed (for combined submittals).

Only request submittals needed to verify compliance with Project requirements.

* + - * 1. Section 013300 - Submittal Procedures: Submittal procedures.
				2. Product Data: Submit product description, thermal characteristics and list of materials and thickness for each service, and location.

Include the following paragraph for submission of physical samples for selection of finish, color, texture, and other properties.

* + - * 1. Samples: Submit [**two**] <**\_\_\_\_\_\_\_\_**> samples of representative size illustrating each insulation type.
				2. Manufacturer's Installation Instructions: Submit manufacturers published literature indicating proper installation procedures.
				3. Manufacturer's Certificate: Certify products meet or exceed specified requirements.
			1. QUALITY ASSURANCE

Use smoke developed index of 50 within plenums.

Verify flame spread index and smoke developed index with types of insulation specified in body of section. Some insulation types included in this section are not allowed to be used in plenums.

* + - * 1. Test pipe insulation for maximum flame spread index of 25 and maximum smoke developed index of not exceeding [**450**] [**50**] in accordance with ASTM E84.
				2. Pipe insulation manufactured in accordance with ASTM C585 (Standard Practice for Inner and Outer Diameters of Rigid Thermal Insulation for Nominal Sizes of Pipe and Tubing (NPS System)) for inner and outer diameters.
				3. Factory fabricated fitting covers manufactured in accordance with ASTM C450 (Standard Practice for Fabrication of Thermal Insulating Fitting Covers for NPS Piping, and Vessel Lagging).
				4. Duct insulation, Coverings, and Linings: Maximum 25/50 flame spread/smoke developed index, when tested in accordance with ASTM E84, using specimen procedures and mounting procedures of ASTM E 2231.

Include the following paragraph only when cost of acquiring specified standards is justified.

* + - * 1. Maintain [**one copy**] [**<\_\_\_\_\_\_\_\_> copies**] of [**each**] document on site.
			1. QUALIFICATIONS
				1. Manufacturer: Company specializing in manufacturing products specified in this section with minimum [**three**] <**\_\_\_\_\_\_\_\_**> years [**documented**] experience.
				2. Applicator: Company specializing in performing Work of this section [**with minimum [three] <\_\_\_\_\_\_\_\_> years [documented] experience**] [**approved by manufacturer**].
			2. PRE-INSTALLATION MEETINGS
				1. Section 013000 - Administrative Requirements: Pre-installation meeting.
				2. Convene minimum [**one**] <**\_\_\_\_\_\_\_\_**> week prior to commencing work of this section.
			3. DELIVERY, STORAGE, AND HANDLING
				1. Accept materials on site in original factory packaging, labeled with manufacturer's identification, including product density and thickness.
				2. Protect insulation from weather and construction traffic, dirt, water, chemical, and damage, by storing in original wrapping.
			4. ENVIRONMENTAL REQUIREMENTS
				1. Install insulation only when ambient temperature and humidity conditions are within range recommended by manufacturer.
				2. Maintain temperature before, during, and after installation for minimum period of [**24**] <**\_\_\_\_\_\_\_\_**> hours.
			5. FIELD MEASUREMENTS
				1. Verify field measurements prior to fabrication.
			6. WARRANTY

This article extends warranty period beyond one year. Extended warranties increase construction costs and Owner enforcement responsibilities. Specify warranties with caution.

* + - * 1. Furnish [**five**] <**\_\_\_\_\_\_\_\_**> year manufacturer warranty for manmade fiber.
1. PRODUCTS
	* + 1. MANUFACTURER

In this article, list manufacturers acceptable for this Project.

* + - * 1. Glass Fiber and Mineral Fiber Insulation

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

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

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

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

[Owens Corning](http://www.specagent.com/Lookup?uid=123457177321).

Approved equivalent.

* + - * 1. Closed Cell Elastomeric Insulation

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

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

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

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

Approved equivalent.

* + - * 1. Polyisocyanurate Foam Insulation

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

[Johns Manville; a Berkshire Hathaway company](http://www.specagent.com/Lookup?uid=123457231878).

Approved equivalent.

* + - * 1. Extruded Polystyrene Insulation

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

Alfa Alpek

Cellofoam

Styrotech

Approved equivalent.

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

* + - * 1. Furnish materials in accordance with [**[State] [Municipality] of <\_\_\_\_\_\_\_\_> [Highways] [Public Work's] standards.**]

Edit the following descriptive specifications to identify project requirements and to eliminate conflicts with products specified above.

* + - 1. PIPE INSULATION

Generally, pipe insulation is specified with factory provided vapor barrier jacket. When another type of jacket or finish is desired delete factory jacket or choose insulation without jacket and then specify insulation with jacket and finish from choices included in Pipe Insulation Jacket article.

* + - * 1. TYPE P-1: ASTM C547 (Standard Specification for Mineral Fiber Pipe Insulation), molded glass fiber pipe insulation. [**Conform to ASTM C795 for application on Austenitic stainless steel.**]

Thermal Conductivity: 0.23 at 75 degrees F.

Operating Temperature Range: 0 to 850 degrees F.

Vapor Barrier Jacket: ASTM C1136 (Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation), Type I, factory applied reinforced foil kraft with self-sealing adhesive joints.

Jacket Temperature Limit: minus 20 to 150 degrees F.

When multiple layers of glass fiber pipe insulation are required, inner layer should be the following type without vapor barrier jacket. Also consider specifying multiple layers with staggered joints to reduce heat loss.

* + - * 1. TYPE P-2: ASTM C547 (Standard Specification for Mineral Fiber Pipe Insulation), molded glass fiber pipe insulation. [**Conform to ASTM C795 for application on Austenitic stainless steel.**]

Thermal Conductivity: 0.23 at 75 degrees F.

Operating Temperature Range: 0 to 850 degrees F.

The following insulation is suitable for nominal pipe sizes of 10 inches and larger.

* + - * 1. TYPE P-3: ASTM C612 (Standard Specification for Mineral Fiber Block and Board Thermal Insulation); semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket. [**Conform to ASTM C795 for application on Austenitic stainless steel.**]

Thermal Conductivity: 0.27 at 75 degrees F.

Operating Temperature Range: 0 to 650 degrees F.

Vapor Barrier Jacket: ASTM C1136 (Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation), Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.

Jacket Temperature Limit: minus 20 to 150 degrees F.

* + - * 1. TYPE P-4: ASTM C612 (Standard Specification for Mineral Fiber Block and Board Thermal Insulation); semi-rigid, fibrous glass board noncombustible. [**Conform to ASTM C795 for application on Austenitic stainless steel.**]

Thermal Conductivity: 0.27 at 75 degrees F.

Operating Temperature Range: 0 to 650 degrees F.

* + - * 1. TYPE P-5: ASTM C534 (Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form), Type I, flexible, closed cell elastomeric insulation, tubular.

Thermal Conductivity: 0.27 at 75 degrees F.

Operating Temperature Range: Range: Minus 70 to 180 degrees F.

* + - * 1. TYPE P-6: ASTM C534 (Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form), Type I, flexible, closed cell elastomeric insulation, tubular.

Thermal Conductivity: 0.30 at 75 degrees F.

Maximum Service Temperature: 300 degrees F.

Operating Temperature Range: Range: Minus 58 to 300 degrees F.

* + - * 1. TYPE P-7: ASTM C534 (Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form), Type I, flexible, nonhalogen, closed cell elastomeric insulation, tubular.

Thermal Conductivity: 0.27 at 75 degrees F.

Maximum Service Temperature: 250 degrees F.

Operating Temperature Range: Range: Minus 58 to 250 degrees F.

The following type of insulation is to be used in high temperature applications in lieu of calcium silicate. Specify it with bands for attaching to the pipe and with a field applied canvas jacket. Also consider specifying multiple layers with staggered joints to reduce heat loss.

For cold temperature applications, consider specifying vapor barrier.

* + - * 1. TYPE P-8: ASTM C547 (Standard Specification for Mineral Fiber Pipe Insulation), Type I or II, mineral fiber preformed pipe insulation, noncombustible.

Thermal Conductivity: 0.23 at 75 degrees F.

Maximum Service Temperature: 1200 degrees F.

Canvas Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric treated with fire retardant lagging adhesive.

* + - * 1. TYPE P-9: ASTM C591 (Standard Specification for Unfaced Preformed Rigid Cellular Polyisocyanurate Thermal Insulation), Type IV, polyisocyanurate foam insulation, formed into shapes for use as pipe insulation.

Density: [**2.0**] [**4.0**] [**6.0**] <**\_\_\_\_\_\_\_\_**> pounds per cubic foot.

Thermal Conductivity: 180 day aged value of [**0.19**] [**0.19**] [**0.20**] at 75 degrees F.

Operating Temperature Range: Range: Minus 297 to 300 degrees F.

Vapor Barrier Jacket: ASTM C1136 (Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation), Type I, factory applied film of [**4**] [**6**] mils thickness and water vapor permeance of [**0.02**] [**0.01**] perms.

* + - * 1. TYPE P-10: ASTM C578 (Standard Specification for Rigid, Cellular Polystyrene Thermal Insulation), Type XIII, extruded polystyrene insulation, formed into shapes for use as pipe insulation.

Thermal Conductivity: 180 day aged value of 0.259 at 75 degrees F.

Operating Temperature Range: Range: Minus 297 to 165 degrees F.

Vapor Barrier Jacket: ASTM C1136 (Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation), Type I, factory applied film of [**4**] [**6**] mils thickness and water vapor permeance of [**0.02**] [**0.01**] perms.

The following insulation type is usually finished by fastening with tie wire and covered with thermal insulating and finishing cement.

* + - * 1. TYPE P-11: ASTM C533 (Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation); Type I, hydrous calcium silicate pipe insulation, rigid molded white; asbestos free.

Thermal Conductivity: 0.45 at 200 degrees F.

Operating Temperature Range: 140 to 1200 degrees F.

* + - 1. PIPE INSULATION JACKETS

Where applicable piping insulation has been specified with factory applied jacket. Where other applications dictate another type of jacket, retain this article.

Use the following paragraph when insulation does not have factory furnished vapor barrier jacket.

* + - * 1. Vapor Retarder Jacket:

[**ASTM C921,**] white Kraft paper with glass fiber yarn, bonded to aluminized film.

Water Vapor Permeance: ASTM E96 (Standard Test Methods for Water Vapor Transmission of Materials); 0.02 perms.

Use the following for covering fittings and may be used to cover complete piping system.

* + - * 1. PVC Plastic Pipe Jacket:

Product Description: [**ASTM D1785,**] One piece molded type fitting covers and sheet material, off-white color.

Thickness: [**10**] [**15**] [**30**] mil.

Connections: [**Brush on welding adhesive**] [**Tacks**] [**Pressure sensitive color matching vinyl tape**].

The following jacket material meets USDA requirements for use in food processing plants but may not comply with ASTM E84 flame spread and smoke developed ratings.

* + - * 1. ABS Plastic Pipe Jacket:

Jacket: One piece molded type fitting covers and sheet material, off-white color.

Minimum service temperature: [**-40**] <**\_\_\_\_\_\_\_\_**>degrees F.

Maximum service temperature of [**180**] <**\_\_\_\_\_\_\_\_**> degrees F.

Water Vapor Permeance: ASTM E96 (Standard Test Methods for Water Vapor Transmission of Materials); 0.02 perms.

Thickness: [**30**] <**\_\_\_\_\_\_\_\_**> mil.

Connections: Brush on welding adhesive.

Retain one of the following two paragraphs when project includes piping located exterior to building or when insulation needs protection from damage.

* + - * 1. Aluminum Pipe Jacket:

[**ASTM B209**].

Thickness: [**0.016**] [**0.020**] [**0.025**] [**0.032**] [**0.040**] <**\_\_\_\_\_\_\_\_**> inch thick sheet.

Finish: [**Smooth**] [**Embossed**] <**\_\_\_\_\_\_\_\_**>.

Joining: Longitudinal slip joints and 2 inch laps.

Fittings: [**0.016**] <**\_\_\_\_\_\_\_\_**> inch thick die shaped fitting covers with factory attached protective liner.

Metal Jacket Bands: [**3/8 inch**] [**1/2 inch**] wide; [**[0.015] <\_\_\_\_\_\_\_\_> inch thick aluminum.**] [**[0.010] [0.020] <\_\_\_\_\_\_\_\_> inch thick stainless steel.**]

* + - * 1. Stainless Steel Pipe Jacket:

ASTM A240 (Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications) OR ASTM A666 (Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar) Type [**302**] [**304**] [**316**] stainless steel.

Thickness: [**0.010**] [**0.016**] [**0.018**] <**\_\_\_\_\_\_\_\_**>inch thick.

Finish: [**Smooth.**] [**Corrugated.**]

Metal Jacket Bands: [**3/8 inch**] [**1/2 inch**] wide; [**0.010**] [**0.020**] <**\_\_\_\_\_\_\_\_**> inch thick stainless steel.

* + - * 1. Field Applied Glass Fiber Fabric Jacket System:

Insulating Cement/Mastic: ASTM C195 (Standard Specification for Mineral Fiber Thermal Insulating Cement); hydraulic setting on mineral wool.

Glass Fiber Fabric:

Cloth: Untreated; 9 oz/sq yd weight.

Blanket: 1.0 lb/cu ft density.

Weave: [**5 x 5**] [**10 x 10**] [**10 x 20**].

Include the following paragraph for indoor vapor retarder finish used to finish over insulation.

Indoor Vapor Retarder Finish:

Cloth: Untreated; 9 oz/sq yd weight.

Vinyl emulsion type acrylic, compatible with insulation, [**black**] [**white**] <**\_\_\_\_\_\_\_\_**> color.

* + - 1. PIPE INSULATION ACCESSORIES

Include the following paragraph for vapor barrier lap adhesive used to seal laps and joints of vapor barrier jacket.

* + - * 1. Vapor Retarder Lap Adhesive: Compatible with insulation.

Include the following paragraph for PVC covering adhesive mastic used to seal laps and joints of PVC covers.

* + - * 1. Covering Adhesive Mastic: Compatible with insulation.
				2. Piping 1-1/2 inches diameter and smaller: Galvanized steel insulation protection shield. MSS SP-69, Type 40. Length: Based on pipe size and insulation thickness.
				3. Piping 2 inches diameter and larger: Wood insulation saddle, hard maple. Inserts length: not less than 6 inches long, matching thickness and contour of adjoining insulation.
				4. Closed Cell Elastomeric Insulation Pipe Hanger: Polyurethane insert with [**aluminum**] [**stainless steel jacket**] single piece construction with self-adhesive closure. Thickness to match pipe insulation.

Retain the following 2 paragraphs when calcium silicate type pipe insulation is used.

* + - * 1. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
				2. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449 (Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement).
				3. Insulating Cement: ASTM C195 (Standard Specification for Mineral Fiber Thermal Insulating Cement); hydraulic setting on mineral wool.
				4. Adhesives: Compatible with insulation.
			1. EQUIPMENT INSULATION
				1. TYPE E-1: ASTM C553 (Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications); glass fiber, flexible or semi-rigid, noncombustible.

Thermal Conductivity: [**0.24**] [**0.023**] at 75 degrees F.

Operating Temperature Range: 0 to 450 degrees F.

Density: [**1.5**] [**1.65**] [**2.3**] pound per cubic foot.

* + - * 1. TYPE E-2: ASTM C612 (Standard Specification for Mineral Fiber Block and Board Thermal Insulation); glass fiber, rigid board, noncombustible [**with factory applied [kraft] [reinforced] aluminum foil jacket**].

Thermal Conductivity: [**0.24**] [**0.023**] at 75 degrees F.

Operating Temperature Range: 0 to 450 degrees F.

Density: [**3.0**] [**4.2**] pound per cubic foot.

Jacket Temperature Limit: minus 20 to 150 degrees F.

* + - * 1. TYPE E-3: ASTM C612 (Standard Specification for Mineral Fiber Block and Board Thermal Insulation); semi-rigid, fibrous glass board noncombustible, end grain adhered to jacket.

Thermal Conductivity: 0.27 at 75 degrees F.

Operating Temperature Range: 0 to 650 degrees F.

Vapor Barrier Jacket: ASTM C1136 (Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation), Type II, factory applied reinforced foil kraft with self-sealing adhesive joints.

Jacket Temperature Limit: minus 20 to 150 degrees F.

* + - * 1. TYPE E-4: ASTM C612 (Standard Specification for Mineral Fiber Block and Board Thermal Insulation); semi-rigid, fibrous glass board noncombustible.

Thermal Conductivity: 0.27 at 75 degrees F.

Operating Temperature Range: 0 to 650 degrees F.

Generally, the following insulation requires finishing with facing of metal mesh and finishing cement.

* + - * 1. TYPE E-5: ASTM C612 (Standard Specification for Mineral Fiber Block and Board Thermal Insulation); glass fiber, semi-rigid board, noncombustible.

Thermal Conductivity: 0.23 at 75 degrees F.

Maximum Operating Temperature: 850 degrees F.

Density: 3.0 pound per cubic foot.

Generally, the following insulation requires attachment with welded pins and finished with facing of metal mesh and finishing cement.

* + - * 1. TYPE E-6: ASTM C553 (Standard Specification for Mineral Fiber Blanket Thermal Insulation for Commercial and Industrial Applications); mineral fiber blanket, Type I.

Thermal Conductivity: 0.27 at 75 degrees F.

Maximum Operating Temperature: 1000 degrees F.

Density: 1.0 pound per cubic foot.

The following insulation type is usually finished by fastening with tie wire and covered with thermal insulating and finishing cement.

* + - * 1. TYPE E-7: ASTM C533 (Standard Specification for Calcium Silicate Block and Pipe Thermal Insulation); Type II, hydrous calcium silicate block insulation, asbestos free.

Thermal Conductivity: 0.45 at 200 degrees F.

Operating Temperature Range: 140 to 1200 degrees F.

* + - * 1. TYPE E-8: ASTM C534 (Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form), Type II, flexible, closed cell elastomeric insulation, sheet.

Thermal Conductivity: 0.27 at 75 degrees F.

Operating Temperature Range: Range: Minus 70 to 220 degrees F.

Specify canvas jacket when using this type of insulation.

* + - * 1. TYPE E-9: ASTM C612 (Standard Specification for Mineral Fiber Block and Board Thermal Insulation), manmade mineral fiber, noncombustible, Classes 1-4.

Thermal Conductivity: 0.25 at 100 degrees F.

Maximum Service Temperature: 1200 degrees F.

Density: [**4**] [**6**] [**8**] [**10**] [**12**] pound per cubic foot.

* + - 1. EQUIPMENT INSULATION JACKETS
				1. PVC Plastic Equipment Jacket:

Product Description: ASTM D1785 (Standard Specification for Poly (Vinyl Chloride) (PVC) Plastic Pipe, Schedules 40, 80, and 120), sheet material, off-white color.

Minimum Service Temperature: [**-40**] <**\_\_\_\_\_\_\_\_**>degrees F.

Maximum Service Temperature: [**150**] <**\_\_\_\_\_\_\_\_**>degrees F.

Water Vapor Permeance: ASTM E96 (Standard Test Methods for Water Vapor Transmission of Materials); 0.02 perms.

Thickness: [**10**] [**15**] [**20**] [**30**] mil.

Connections: [**Brush on welding adhesive**] [**Tacks**] [**Pressure sensitive color matching vinyl tape**].

Retain one of the following two paragraphs when project includes equipment exterior to building or when insulation needs protection or insulation needs protection from damage.

* + - * 1. Aluminum Equipment Jacket:

[**ASTM B209**]Thickness: [**0.016**] [**0.020**] [**0.025**] [**0.032**] [**0.040**] <**\_\_\_\_\_\_\_\_**> inch thick sheet.

Finish: [**Smooth**] [**Embossed**] <**\_\_\_\_\_\_\_\_**>.

Joining: Longitudinal slip joints and 2 inch laps.

Fittings: [**0.016**] <**\_\_\_\_\_\_\_\_**> inch thick die shaped fitting covers with factory attached protective liner.

Metal Jacket Bands: 3/8 inch wide; [**[0.015] <\_\_\_\_\_\_\_\_> inch thick aluminum.**] [**[0.010] <\_\_\_\_\_\_\_\_> inch thick stainless steel.**]

* + - * 1. Stainless Steel Equipment Jacket:

ASTM A240 (Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications) OR ASTM A666 (Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar) Type [**302**] [**304**] [**316**] stainless steel.

Thickness: [**0.010**] [**0.016**] [**0.018**] <**\_\_\_\_\_\_\_\_**>inch thick.

Finish: [**Smooth.**] [**Corrugated.**]

Metal Jacket Bands: 3/8 inch wide; [**0.010**] <**\_\_\_\_\_\_\_\_**>inch thick stainless steel.

* + - * 1. Canvas Equipment Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.
				2. Vapor Retarder Jacket:

ASTM C921 (Standard Practice for Determining the Properties of Jacketing Materials for Thermal Insulation), white Kraft paper with glass fiber yarn, bonded to aluminized film.

Water Vapor Permeance: ASTM E96 (Standard Test Methods for Water Vapor Transmission of Materials ); 0.02 perms.

* + - * 1. Field Applied Glass Fiber Fabric Jacket System:

Insulating Cement/Mastic: ASTM C195 (Standard Specification for Mineral Fiber Thermal Insulating Cement); hydraulic setting on mineral wool.

Glass Fiber Fabric:

Cloth: Untreated; 9 oz/sq yd weight.

Blanket: 1.0 lb/cu ft density.

Weave: [**5 x 5**] [**10 x 10**] [**10 x 20**].

Include the following paragraph for indoor vapor retarder finish used to finish over insulation.

Indoor Vapor Retarder Finish:

Cloth: Untreated; 9 oz/sq yd weight.

Vinyl emulsion type acrylic, compatible with insulation, [**black**] [**white**] <**\_\_\_\_\_\_\_\_**> color.

* + - 1. EQUIPMENT INSULATION ACCESSORIES

Include the following paragraph for vapor barrier lap adhesive used to seal laps and joints of vapor barrier jacket.

* + - * 1. Vapor Retarder Lap Adhesive: Compatible with insulation.

Include the following paragraph for PVC covering adhesive mastic used to seal laps and joints of PVC covers.

* + - * 1. Covering Adhesive Mastic: Compatible with insulation.

Retain the following two paragraphs when using calcium silicate insulation on equipment.

* + - * 1. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
				2. Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement: ASTM C449 (Standard Specification for Mineral Fiber Hydraulic-Setting Thermal Insulating and Finishing Cement).
				3. Adhesives: Compatible with insulation.
			1. DUCTWORK INSULATION
				1. TYPE D-1: ASTM C1290 (Standard Specification for Flexible Fibrous Glass Blanket Insulation Used to Externally Insulate HVAC Ducts), Type III, flexible glass fiber, commercial grade with factory applied reinforced aluminum foil jacket meeting ASTM C1136 (Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation), Type II.

Thermal Conductivity: [**0.30**] [**0.27**] [**0.25**] at 75 degrees F.

Maximum Operating Temperature: 250 degrees F.

Density: [**0.75**] [**1.0**] [**1.5**] pound per cubic foot.

Insulation with density of 1.6 pound per cubic foot (26 kilogram per cubic meter). has thermal conductivity of 0.24 (0.035). Insulation with density of 2.25, 3.0, and 4.25 pound per cubic foot (36, 48, and 68 kilogram per cubic meter) has thermal conductivity of 0.23 (0.033). Insulation with density of 6.0 pound per cubic foot (96 kilogram per cubic meter) has thermal conductivity of 0.22 (0.032).

Available in thickness of 1 to 4 inches.

* + - * 1. TYPE D-2: ASTM C612 (Standard Specification for Mineral Fiber Block and Board Thermal Insulation), Type IA or IB, rigid glass fiber, with factory applied [**all service facing**] [**reinforced aluminum foil facing**] [**metalized polypropylene scrim kraft facing**] meeting ASTM C1136 (Standard Specification for Flexible, Low Permeance Vapor Retarders for Thermal Insulation), Type II.

Thermal Conductivity: [**0.24**] [**0.23**] [**0.22**] at 75 degrees F.

Density: [**1.6**] [**2.25**] [**3.0**] [**4.25**] [**6.0**] pound per cubic foot.

* + - * 1. TYPE D-3: ASTM C612 (Standard Specification for Mineral Fiber Block and Board Thermal Insulation), Type IA or IB, rigid glass fiber, no facing.

Thermal Conductivity: [**0.24**] [**0.23**] [**0.22**] at 75 degrees F.

Density: [**1.6**] [**2.25**] [**3.0**] [**4.25**] [**6.0**] pound per cubic foot.

This type of insulation is available in thicknesses of 1/2, 1, 1-1/2, and 2 inches.

* + - * 1. TYPE D-4: ASTM C1071 (Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)), Type I, flexible, glass fiber duct liner with coated air side.

Thermal Conductivity: [**0.28**] [**0.26**] [**0.25**] [**0.24**] at 75 degrees F.

Density: [**1.5**] [**2.0**] [**2.75**] [**3.0**] pound per cubic foot.

Maximum Operating Temperature: 250 degrees F.

Maximum Air Velocity: 6,000 feet per minute.

This type of insulation is available in thicknesses of 1, 1-1/2, and 2 inches

* + - * 1. TYPE D-5: ASTM C1071 (Standard Specification for Thermal and Acoustical Insulation (Glass Fiber, Duct Lining Material)), Type II, rigid, glass fiber duct liner with coated air side.

Thermal Conductivity: 0.23 at 75 degrees F.

Density: 3.0 pound per cubic foot.

Maximum Operating Temperature: 250 degrees F.

Maximum Air Velocity: 4,000 feet per minute.

* + - * 1. TYPE D-6: ASTM C534 (Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form), Type II, flexible, closed cell elastomeric insulation, sheet.

Thermal Conductivity: 0.27 at 75 degrees F.

Service Temperature Range: Range: Minus 58 to 180 degrees F.

* + - * 1. TYPE D-7: ASTM C534 (Standard Specification for Preformed Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form), Type II, flexible, closed cell elastomeric insulation, sheet laminated with [**white**] <**\_\_\_\_\_\_\_\_**> thermoplastic rubber membrane.

Thermal Conductivity: 0.27 at 75 degrees F.

Service Temperature Range: Range: Minus 58 to 180 degrees F.

The following insulation can be used for kitchen exhaust ductwork.

* + - * 1. TYPE D-8: Inorganic blanket encapsulated with scrim reinforced foil meeting UL 1978 (Standard for Safety for Grease Ducts).

Thermal Conductivity: 0.42 at 500 degrees F.

Weight: 1.4 pound per square foot.

Surface Burning Characteristics: Maximum 0/0 flame spread/smoke developed index when tested in accordance with ASTM E84.

* + - 1. DUCTWORK INSULATION JACKETS
				1. Aluminum Duct Jacket:

[**ASTM B209**].

Thickness: [**0.016**] [**0.020**] [**0.025**] [**0.032**] [**0.040**] <**\_\_\_\_\_\_\_\_**> inch thick sheet.

Finish: [**Smooth**] [**Embossed**] <**\_\_\_\_\_\_\_\_**>.

Joining: Longitudinal slip joints and 2 inch laps.

Fittings: [**0.016**] <**\_\_\_\_\_\_\_\_**> inch thick die shaped fitting covers with factory attached protective liner.

Metal Jacket Bands: 3/8 inch wide; [**[0.015] <\_\_\_\_\_\_\_\_> inch thick aluminum.**] [**[0.010] <\_\_\_\_\_\_\_\_> inch thick stainless steel.**]

The following jacket type is applicable when sheet metal ducts are used with exterior insulation.

* + - * 1. Vapor Retarder Jacket:

[**Kraft paper with glass fiber yarn and bonded to aluminized film**] [**0.0032 inch vinyl**].

Water Vapor Permeance: ASTM E96 (Standard Test Methods for Water Vapor Transmission of Materials); 0.02 perms.

Secure with pressure sensitive tape.

* + - * 1. Canvas Duct Jacket: UL listed, 6 oz/sq yd, plain weave cotton fabric with fire retardant lagging adhesive compatible with insulation.

Retain the following paragraph when ductwork is located exterior to the building.

* + - * 1. Outdoor Duct Jacket: Asphalt impregnated and coated sheet, [**50**] [**36**] lb/square.

In lieu of above, retain the following paragraph when ductwork is located exterior to the building. It is rubber roofing membrane material.

* + - * 1. Membrane Duct Jacket: ASTM D4637 (Standard Specification for EPDM Sheet Used in Single-Ply Roof Membrane); Type I, EPDM; non-reinforced, [**0.045**] [**0.060**] inch thick, [**48**] <**\_\_\_\_\_\_\_\_**> inch wide roll; [**white**] [**black**] <**\_\_\_\_\_\_\_\_**> color [**as selected**].
			1. DUCTWORK INSULATION ACCESSORIES
				1. Vapor Retarder Tape:

Kraft paper reinforced with glass fiber yarn and bonded to aluminized film, with pressure sensitive rubber based adhesive.

Include the following paragraph for vapor barrier lap adhesive used to seal laps and joints of vapor barrier jacket.

* + - * 1. Vapor Retarder Lap Adhesive: Compatible with insulation.

The following insulation type is used for interior lining of sheet metal ducts.

* + - * 1. Adhesive: Waterproof [**, ASTM E162 fire-retardant**] type.
				2. Liner Fasteners: Galvanized steel, [**self-adhesive pad**] [**impact applied**] [**welded**] with [**integral**] [**press-on**] head.
				3. Tie Wire: 0.048 inch stainless steel with twisted ends on maximum 12 inch centers.
				4. Lagging Adhesive: Fire retardant type with maximum 25/450 flame spread/smoke developed index when tested in accordance with ASTM E84.
				5. Impale Anchors: Galvanized steel, 12 gage self-adhesive pad.
				6. Adhesives: Compatible with insulation.

Include the following paragraph for adhesive used to seal laps and joints of rubber membrane jacket.

* + - * 1. Membrane Adhesives: As recommended by membrane manufacturer.
1. EXECUTION
	* + 1. EXAMINATION
				1. Section 013000 - Administrative Requirements: Coordination and project conditions.
				2. Verify [**piping,**] [**equipment**] [**and**] [**ductwork**] has been tested before applying insulation materials.
				3. Verify surfaces are clean and dry, with foreign material removed.
			2. INSTALLATION - PIPING SYSTEMS
				1. Piping Exposed to View in Finished Spaces: Locate insulation and cover seams in least visible locations.
				2. Continue insulation through penetrations of building assemblies or portions of assemblies having fire resistance rating of one hour or less. Provide intumescent firestopping when continuing insulation through assembly. Finish at supports, protrusions, and interruptions. Refer to Section 078400 for penetrations of assemblies with fire resistance rating greater than one hour.
				3. Piping Systems Conveying Fluids Below Ambient Temperature:

Insulate entire system including fittings, valves, unions, flanges, strainers, flexible connections, [**pump bodies,**] and expansion joints.

Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.

Insulate fittings, joints, and valves with molded insulation of like material and thickness as adjacent pipe. Finish with glass cloth and vapor retarder adhesive or PVC fitting covers.

* + - * 1. Glass Fiber Board Insulation:

Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.

Cover wire mesh or bands with cement to a thickness to remove surface irregularities.

* + - * 1. [**Polyisocyanurate Foam Insulation**] [**Extruded Polystyrene Insulation**]:

Wrap elbows and fitting with vapor retarder tape.

Seal butt joints with vapor retarder tape.

* + - * 1. Hot Piping Systems less than [**140**] <**\_\_\_\_\_\_\_\_**> degrees F:

Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.

Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

Do not insulate unions and flanges at equipment, but bevel and seal ends of insulation at such locations.

* + - * 1. Hot Piping Systems greater than [**140**] <**\_\_\_\_\_\_\_\_**> degrees F:

Furnish factory-applied or field-applied standard jackets. Secure with outward clinch expanding staples or pressure sensitive adhesive system on standard factory-applied jacket and butt strips or both.

Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe. Finish with glass cloth and adhesive or PVC fitting covers.

Insulate flanges and unions at equipment.

* + - * 1. Inserts and Shields:

Piping [**1-1/2**] <**\_\_\_\_\_\_\_\_**> inches Diameter and Smaller: Install [**galvanized**] steel shield between pipe hanger and insulation.

Piping [**2**] <**\_\_\_\_\_\_\_\_**> inches Diameter and Larger: Install insert between support shield and piping and under finish jacket.

Insert Configuration: Minimum 6 inches long, of thickness and contour matching adjoining insulation; may be factory fabricated.

Insert Material: Compression resistant insulating material suitable for planned temperature range and service.

Piping Supported by Roller Type Pipe Hangers: Install [**galvanized**] steel shield between roller and inserts.

* + - * 1. Insulation Terminating Points:

Coil Branch Piping 1 inch and Smaller: Terminate hot water piping at union upstream of the coil control valve.

Chilled Water Coil Branch Piping: Insulate chilled water piping and associated components up to coil connection.

Condensate Piping: Insulate entire piping system and components to prevent condensation.

* + - * 1. Closed Cell Elastomeric Insulation:

Push insulation on to piping.

Miter joints at elbows.

Seal seams and butt joints with manufacturer’s recommended adhesive.

When application requires multiple layers, apply with joints staggered.

Insulate fittings and valves with insulation of like material and thickness as adjacent pipe.

* + - * 1. High Temperature Pipe Insulation:

Install in multiple layers to meet thickness scheduled.

Attach each layer with bands. Secure first layer with bands before installing next layer.

Stagger joints between layers.

Finish with canvas jacket [**sized for finish painting**].

\*\*\*\*\*\* [OR] \*\*\*\*\*\*

Cover with [**aluminum jacket**] [**stainless steel jacket**] with seams located on bottom side of horizontal piping.

* + - * 1. Pipe Exposed in Mechanical Equipment Rooms or Finished Spaces [**(less than 10 feet above finished floor)**]: Finish with [**canvas jacket sized for finish painting**] [**PVC jacket and fitting covers**] [**ABS jacket and fitting covers**] [**aluminum jacket**] [**stainless steel jacket**].
				2. Piping Exterior to Building: [**Provide vapor retarder jacket.**] Insulate fittings, joints, and valves with insulation of like material and thickness as adjoining pipe, and finish with glass mesh reinforced vapor retarder cement. Cover with [**aluminum**] [**stainless steel**] jacket with seams located at 3 or 9 o’clock position on side of horizontal piping with overlap facing down to shed water or on bottom side of horizontal piping.
				3. Buried Piping: Insulate only where insulation manufacturer recommends insulation product may be installed in trench, tunnel or direct buried. Install factory fabricated assembly with inner all-purpose service jacket with self-sealing lap, and asphalt impregnated open mesh glass fabric, with 1 mil thick aluminum foil sandwiched between three layers of bituminous compound; outer surface faced with polyester film.
				4. Heat Traced Piping Interior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size large enough to enclose pipe and heat tracer.
				5. Heat Traced Piping Exterior to Building: Insulate fittings, joints, and valves with insulation of like material, thickness, and finish as adjoining pipe. Size insulation large enough to enclose pipe and heat tracer. Cover with [**aluminum**] [**stainless steel**] jacket with seams located at 3 or 9 o’clock position on side of horizontal piping with overlap facing down to shed water.

Edit specification sections referenced in paragraph below based on project requirements. Retain 099114 for exterior painting, retain 099123 for interior painting.

* + - * 1. Prepare pipe insulation for finish painting. Refer to Section[**s]** [**099114 and**][**099123**].
			1. INSTALLATION - EQUIPMENT
				1. Factory Insulated Equipment: Do not insulate.
				2. Exposed Equipment: Locate insulation and cover seams in least visible locations.
				3. Fill joints, cracks, seams, and depressions with bedding compound to form smooth surface. On cold equipment, use vapor retarder cement.
				4. Equipment Containing Fluids Below Ambient Temperature:

Insulate entire equipment surfaces.

Apply insulation close to equipment by grooving, scoring, and beveling insulation. Fasten insulation to equipment with studs, pins, clips, adhesive, wires, or bands.

Furnish factory-applied or field-applied vapor retarder jackets. Secure factory-applied jackets with pressure sensitive adhesive self-sealing longitudinal laps and butt strips. Secure field-applied jackets with outward clinch expanding staples and seal staple penetrations with vapor retarder mastic.

Finish insulation at supports, protrusions, and interruptions.

* + - * 1. Equipment Containing Fluids [**140**] <**\_\_\_\_\_\_\_\_**> degrees F Or Less:

Do not insulate flanges and unions, but bevel and seal ends of insulation.

Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.

Finish insulation at supports, protrusions, and interruptions.

* + - * 1. Equipment Containing Fluids Over [**140**] <**\_\_\_\_\_\_\_\_**> degrees F:

Insulate flanges and unions with removable sections and jackets.

Install insulation with factory-applied or field applied jackets, with or without vapor barrier. Finish with glass cloth and adhesive.

Finish insulation at supports, protrusions, and interruptions.

* + - * 1. Equipment in Mechanical Equipment Rooms or Finished Spaces: Finish with [**canvas jacket sized for finish painting**] [**PVC jacket and fitting covers**] [**aluminum jacket**] [**stainless steel jacket**].
				2. Equipment Located Exterior to Building: Install vapor barrier jacket or finish with glass mesh reinforced vapor barrier cement. Cover with [**aluminum**] [**stainless steel**] jacket with seams located on bottom side of horizontal equipment.
				3. Cover [**glass fiber**] [**cellular glass**] [**hydrous calcium silicate**] [**cellular foam**] insulation with [**metal mesh and finish with heavy coat of insulating cement**] [**aluminum jacket**] [**stainless steel jacket**].
				4. Nameplates and ASME Stamps: Bevel and seal insulation around; do not cover with insulation.
				5. Equipment Requiring Access for Maintenance, Repair, or Cleaning: Install insulation for easy removal and replacement without damage.

Edit specification sections referenced in paragraph below based on project requirements. Retain 099114 for exterior painting, retain 099123 for interior painting.

* + - * 1. Prepare equipment insulation for finish painting. Refer to Section[**s]** [**099114 and**][**099123**].
			1. INSTALLATION - DUCTWORK SYSTEMS

Either retain the following paragraph or include similar information on drawings.

* + - * 1. Duct dimensions indicated on Drawings are finished inside dimensions.
				2. Insulated ductwork conveying air below ambient temperature:

Provide insulation with vapor retarder jackets.

Finish with tape and vapor retarder jacket.

Continue insulation through walls, sleeves, hangers, and other duct penetrations.

Insulate entire system including fittings, joints, flanges, fire dampers, flexible connections, and expansion joints.

* + - * 1. Insulated ductwork conveying air above ambient temperature:

Provide with or without standard vapor retarder jacket.

Insulate fittings and joints. Where service access is required, bevel and seal ends of insulation.

* + - * 1. Ductwork Exposed in Mechanical Equipment Rooms or Finished Spaces [**(below 10 feet above finished floor)**]: Finish with [**canvas jacket sized for finish painting**] [**aluminum jacket**].
				2. External Glass Fiber Duct Insulation:

Secure insulation with vapor retarder with wires and seal jacket joints with vapor retarder adhesive or tape to match jacket.

Secure insulation without vapor retarder with staples, tape, or wires.

Install without sag on underside of ductwork. Use adhesive or mechanical fasteners where necessary to prevent sagging. Lift ductwork off trapeze hangers and insert spacers.

Seal vapor retarder penetrations by mechanical fasteners with vapor retarder adhesive.

Stop and point insulation around access doors and damper operators to allow operation without disturbing wrapping.

* + - * 1. External Elastomeric Duct Insulation:

Adhere to clean oil-free surfaces with full coverage of adhesive.

Seal seams and butt joints with manufacturer’s recommended adhesive.

When application requires multiple layers, apply with joints staggered.

Insulate standing metal duct seams with insulation of like material and thickness as adjacent duct surface. Apply adhesive at joints with flat duct surfaces.

Lift ductwork off trapeze hangers and insert spacers.

* + - * 1. Duct [**and Plenum**] Liner:

Adhere insulation with adhesive for [**90**] [**100**] percent coverage.

Secure insulation with mechanical liner fasteners. Comply with SMACNA (HVAC Duct Construction Standard - Metal and Flexible) Standards for spacing.

Seal and smooth joints. Seal and coat transverse joints.

Seal liner surface penetrations with adhesive.

Cut insulation for tight overlapped corner joints. Support top pieces of liner at edges with side pieces.

* + - * 1. Kitchen Exhaust Ductwork:

Cover duct by wrapping with insulation using [**overlap method**] [**checkerboard overlap method**] [**butt joint with collar method**].

Overlap seams of each method by 3 inches.

Attach insulation using steel banding or by welded pins and clips.

Install insulation without sag on underside of ductwork. Use additional fasteners to prevent sagging.

Use the following paragraph for externally insulated ductwork.

* + - * 1. Ducts Exterior to Building:

Install insulation according to [**external duct insulation**] [**duct liner**] paragraph above.

Provide external insulation with vapor retarder jacket. Cover with [**outdoor jacket finished as specified in Section <\_\_\_\_\_\_\_\_>**] [**with caulked aluminum jacket with seams located on bottom side of horizontal duct section**].

Finish with [**mineral fiber outdoor duct jacket**] [**aluminum duct jacket**] [**membrane duct jacket**].

Calk seams at flanges and joints. Located major longitudinal seams on bottom side of horizontal duct sections.

Edit specification sections referenced in paragraph below based on project requirements. Retain 099114 for exterior painting, retain 099123 for interior painting.

* + - * 1. Prepare duct insulation for finish painting. Refer to Section[**s]** [**099114 and**][**099123**].
			1. SCHEDULES

Include schedule listing services applicable to Project. Select type of insulation and indicate pipe size where insulation thickness varies with pipe size. Select appropriate types of equipment or devices to be insulated. List insulation materials permitted for each application. Indicate thickness for each permitted type of insulation. Since different insulation materials have different thermal resistance, services may be listed for several insulation materials.

Consider the following examples when developing Project schedule.

The following examples give insulation types and thicknesses. They are not meant to cover every possible application. In many cases various types of insulation can be used. Additionally insulation thickness should be verified with application, fluid temperatures, and space temperatures.

Consult ASHRAE 90.1 for pipe and duct insulation thickness to meet applicable energy code requirements.

* + - * 1. Cooling Services Piping Insulation Schedule:

Listing for glycol piping systems is mainly for use in cooling applications. When system temperatures vary greatly or are similar to hot water system, use thicknesses similar to those listed for that system.

Because of need to reject heat from system, condenser water piping is usually not insulated. When special cases require, an entry is included below.

Chilled Water Supply and Return [**, 40 to 60 Degrees F**]:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 1-1/4 Inches and Smaller: 0.5 inch

Pipe Size 1-1/2 Inches and Larger: 1.0 inch

Chilled Water Supply and Return [**, less than 40 Degrees F**]:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 3/4 Inch and Smaller: 0.5 inch

Pipe Size 1 to 6 Inches: 1.0 inch

Pipe Size 8 Inches and Larger: 1.5 inches

Glycol Supply and Return:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 1-1/4 Inches and Smaller: 0.5 inch

Pipe Size 1-1/2 Inches and Larger: 1.0 inch

Condenser Water:

Type: <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size <**\_\_\_\_\_\_\_\_**> Inches: <**\_\_\_\_\_\_\_\_**> inch

Condensate Piping from Cooling Coils:

Type: [**P-5**] <**\_\_\_\_\_\_\_\_**>.

Thickness: 0.5 inch

Refrigerant Suction:

Type: [**P-5**] <**\_\_\_\_\_\_\_\_**>.

Thickness: 0.5 inch

Refrigerant Hot Gas:

Type: [**P-5**] <**\_\_\_\_\_\_\_\_**>.

Thickness: 0.5 inch

* + - * 1. Heating Services Piping Insulation Schedule:

Due to pipe surface temperatures steam systems are usually insulated with glass fiber type pipe insulation. Verify steam system temperature with maximum temperature of pipe insulation.

Steam condensate return piping is usually insulation for personnel protection.

Heating Water Supply and Return [**, 105 to 140 degrees F**]:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 1-1/4 Inches and Smaller: 0.5 inch

Pipe Size 1-1/2 Inches and Larger: 1.0 inch

Heating Water Supply and Return [**, 141 to 200 degrees F**]:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 3 Inches and Smaller: 1.0 inch

Pipe Size 4 Inches and Larger: 1.5 inches

Heating Water Supply and Return [**, 201 to 250 degrees F**]:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 1-1/4 Inches and Smaller: 1.5 inches

Pipe Size 1-1/2 Inches and Larger: 2.0 inches

Low-Pressure Steam Supply to 15 psig [**, to 250 Degrees F**]:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 1-1/4 Inches and Smaller: 1.5 inches

Pipe Size 1-1/2 Inches and Larger: 2.0 inches

Medium-Pressure Steam Supply 16 to 119 psig [**, 251 to 350 Degrees F**]:

Type: [**P-1**] [**P-8**] [**P-11**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 3/4 Inch and Smaller: 1.5 inches

Pipe Size 1 to 1-1/4 Inches: 2.5 inches

Pipe Size 1-1/2 Inches and Larger: 3.0 inches

High-Pressure Steam Supply 120 psig [**, 350 Degrees F**]:

Type: [**P-8**] [**P-11**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 3/4 Inch and Smaller: 2.5 inches

Pipe Size 1 to 3 Inches: 3.0 inches

Pipe Size 4 Inches and Larger: 4.0 inches

Low-Pressure Steam Condensate Return:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 1-1/4 Inches and Smaller: 1.5 inches

Pipe Size 1-1/2 Inches and Larger: 2.0 inches

High-Pressure Steam Condensate Return:

Type: [**P-1**] [**P-8**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 3/4 Inch and Smaller: 1.5 inches

Pipe Size 1 to 1-1/4 Inches: 2.5 inches

Pipe Size 1-1/2 Inches and Larger: 3.0 inches

Gravity Steam Condensate Return:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 1-1/4 Inches: 1.5 inches

Pipe Size 1-1/2 Inches and Larger: 2.0 inches

Pumped Steam Condensate Return:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 1-1/4 Inches: 1.5 inches

Pipe Size 1-1/2 Inches and Larger: 2.0 inches

Boiler Feed Water:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 1-1/4 Inches: 1.5 inches

Pipe Size 1-1/2 Inches and Larger: 2.0 inches

Humidifier Supply Piping:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness:

Pipe Size 1-1/4 Inches: 1.5 inches

Pipe Size 1-1/2 Inches and Larger: 2.0 inches

Humidifier Drain Piping:

Type: [**P-1**] <**\_\_\_\_\_\_\_\_**>.

Thickness: 1.0 inch

* + - * 1. Equipment Insulation Schedule:

Complete the table based on project conditions. List only equipment here requiring field applied insulation. If equipment is furnished with insulation, delete from this list.

Based on diameter of heat exchanger, pipe insulation may be able to be used at lower cost.

Hot water pumps and system accessories have been deleted from this list. Generally, they are not insulated. However, be aware of special cases where insulation may be required.

For generator exhaust type piping, specify different insulation type for muffler and other accessories because their size may be larger than is available in sizes of piping insulation.

Steam-to-Water Heat Exchangers:

Type: [**E-2**] [**E-3**] [**E-7**].

Thickness: [**1.5**] <**\_\_\_\_\_\_\_\_**> inches

Water-to-Water Heat Exchangers:

Type: [**E-2**] [**E-3**] [**E-5**].

Thickness: [**1.5**] <**\_\_\_\_\_\_\_\_**> inches

Hot Thermal Storage Tanks:

Type: [**E-2**] [**E-3**] [**E-5**].

Thickness: [**1.5**] <**\_\_\_\_\_\_\_\_**> inches

Boiler and Feed Water Storage Tanks:

Type: [**E-2**] [**E-3**] [**E-5**].

Thickness: [**1.5**] <**\_\_\_\_\_\_\_\_**> inches

Steam Condensate Receivers:

Type: [**E-2**] [**E-3**] [**E-5**].

Thickness: [**1.5**] <**\_\_\_\_\_\_\_\_**> inches

Condensate Tanks:

Type: [**E-2**] [**E-3**] [**E-5**].

Thickness: [**1.5**] <**\_\_\_\_\_\_\_\_**> inches

Deaerators:

Type: [**E-2**] [**E-3**] [**E-5**].

Thickness: [**1.5**] <**\_\_\_\_\_\_\_\_**> inches

Boiler [**Flue**] [**Breeching**]:

Type: [**E-2**] [**E-3**] [**E-5**].

Thickness: [**1.0**] [**1.5**] inches

Chilled Water Pump Bodies:

Type: [**E-8**] <**\_\_\_\_\_\_\_\_**>.

Thickness: [**0.5**] [**1.0**] inch

Chilled Water Air Separators:

Type: [**E-8**] <**\_\_\_\_\_\_\_\_**>.

Thickness: [**0.5**] [**1.0**] inch

Chilled Water Expansion Tanks:

Type: [**E-8**] <**\_\_\_\_\_\_\_\_**>.

Thickness: [**0.5**] [**1.0**] inch

Chiller Cold Surfaces Not Factory Insulated:

Type: [**E-8**] <**\_\_\_\_\_\_\_\_**>.

Thickness: [**0.5**] [**1.0**] inch

Absorption Chiller Hot Surfaces Not Factory Insulated:

Type: [**E-2**] [**E-3**] [**E-5**] <**\_\_\_\_\_\_\_\_**>.

Thickness: [**1.0**] <**\_\_\_\_\_\_\_\_**> inch

Cold Thermal Storage Tanks:

Type: [**E-2**] [**E-8**] <**\_\_\_\_\_\_\_\_**>.

Thickness: [**0.5**] [**1.0**] inch

Generator Exhaust Piping:

Type: [**E-3**] [**E-4**] [**E-7**] [**E-9**].

Thickness: [**2.0**] [**4.0**] inch

Generator Exhaust Muffler:

Type: [**E-7**] [**E-9**].

Thickness: [**2.0**] [**4.0**] inch

* + - * 1. Ductwork Insulation Schedule:

Generally, TEC standard is to internally insulate ductwork for acoustical reasons. However, special applications may require external insulation. Hospital and health care facilities are one type of application where the ductwork should always be externally insulated.

Generally, for external duct insulation use flexible type insulation for supply and return air. Use with foil scrim facing.

For outside air applications or in areas where damage may occur, consider rigid board.

Use the following for internally insulated ducts located external to the building.

Use the following for externally insulated ducts located external to the building.

Combustion Air:

Type: [**D-2**].

Thickness: [**1.5**] [**2.0**] inch

Outside Air Intake:

Type: [**D-2**].

Thickness: [**1.5**] [**2.0**] inch

Equipment Casings:

Type: [**D-2**].

Thickness: [**1.0**] [**1.5**] inch

Supply Ducts - Internally Insulated:

Type: [**D-4**] [**D-5**].

Thickness: [**1.0**] [**1.5**] inch

Return Ducts - Internally Insulated:

Type: [**D-4**] [**D-5**].

Thickness: [**0.5**] [**1.0**] inch

Supply Ducts - Externally Insulated, Installed Thickness:

Type: [**D-1**] [**D-2**] [**D-6**].

Thickness: [**1.0**] [**1.5**] inches

Return Ducts - Externally Insulated, Installed Thickness:

Type: [**D-1**] [**D-2**] [**D-6**].

Thickness: [**1.0**] [**1.5**] inches

Duct Coils:

Type: D-1.

Thickness: [**1.0**] [**1.5**] inches

Kitchen Exhaust:

Type: D-8.

Thickness: 3.0 inches1.5 inches

[**Supply**] [**, Return**] [**, and**] [**Exhaust**] Air - Exterior to Building on Roof:

Type: [**D-2**] [**D-7**].

Thickness: [**2.0**] <**\_\_\_\_\_\_\_\_**> inches

Evaporative Condenser Intake and Exhaust, Installed Thickness:

Type: [**D-1**] [**D-2**].

Thickness: [**1.0**] [**1.5**] inches

Exhaust Ducts Within 10 feet of Exterior Openings, Installed Thickness:

Type: [**D-1**] [**D-2**].

Thickness: [**1.0**] [**1.5**] inches

Exhaust Ducts Exposed to Outdoor Air:

Type: D-2.

Thickness: 2.0 inches

Rectangular Supply Ducts Downstream of Variable Air Volume Boxes - Internally Insulated:

Type: [**D-4**] [**D-5**].

Thickness: [**0.5**] [**1.0**] inches

Rectangular Supply Ducts Downstream of Variable Air Volume Boxes - Externally Insulated:

Type: [**D-1**] [**D-2**].

Thickness: [**1.0**] [**1.5**] inches

Round Supply Ducts Downstream of Variable Air Volume Boxes - Externally Insulated:

Type: [**D-1**] [**D-2**].

Thickness: [**1.0**] [**1.5**] inches

Transfer Air Ducts - Internally Insulated:

Type: [**D-4**] [**D-5**].

Thickness: [**0.5**] [**1.0**] inches

END OF SECTION 230700