SECTION 230716 - HVAC EQUIPMENT INSULATION

TIPS:

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

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

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this Section.

1.2 SUMMARY

A. Section includes insulating the following HVAC equipment that is not factory insulated:

1. Chillers.
2. Heat exchangers.
3. Converters.
4. Chilled-water pumps.
5. Condenser-water pumps.
6. Dual-service heating and cooling pumps.
7. Heating, hot-water pumps.
8. Heat-recovery pumps.
9. Steam condensate pumps.
10. Expansion/compression tanks.

11. Air separators.
12. Thermal storage tanks.
13. Deaerators.
14. Steam condensate tanks.
15. Steam flash tanks, flash separators, moisture separators, and blow-off tanks.
16. Piping system filtration unit housings.
17. Outdoor, aboveground, heated, fuel-oil storage tanks.

B. Related Sections:

1. Section 230713 "Duct Insulation."
2. Section 230719 "HVAC Piping Insulation."

1.3 ACTION SUBMITTALS

A. Product Data: For each type of product indicated. Include thermal conductivity, water-vapor permeance thickness, and jackets (both factory- and field-applied if any).

B. Sustainable Design Submittals:

1. Product Data: For adhesives, indicating VOC content.
2. Laboratory Test Reports: For adhesives, indicating compliance with requirements for low-emitting materials.
3. Product Data: For coatings, indicating VOC content.
4. Laboratory Test Reports: For coatings, indicating compliance with requirements for low-emitting materials.
5. Product Data: For sealants, indicating VOC content.
6. Laboratory Test Reports: For sealants, indicating compliance with requirements for low-emitting materials.

C. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
2. Detail attachment and covering of heat tracing inside insulation.
3. Detail removable insulation at equipment connections.
4. Detail application of field-applied jackets.
5. Detail application at linkages of control devices.
6. Detail field application for each equipment type.

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

1. Preformed Pipe Insulation Materials: 12 inches (300 mm) long by NPS 2 (DN 50).
2. Sheet Form Insulation Materials: 12 inches (300 mm) square.
3. Sheet Jacket Materials: 12 inches (300 mm) square.
4. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

1.4 INFORMATIONAL SUBMITTALS

A. Qualification Data: For qualified Installer.

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

C. Field quality-control reports.

1.5 QUALITY ASSURANCE

A. 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.

B. Surface-Burning Characteristics: For insulation and related materials, as determined by testing identical products according to ASTM E 84, by a testing agency acceptable to authorities having jurisdiction. Factory label insulation and jacket materials and adhesive, mastic, tapes, and cement material containers, with appropriate markings of applicable testing agency.

1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

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

1. Equipment Mockups:

a. One chilled-water pump and one heating-hot-water pump.
b. One tank or vessel.
c. <**Add equipment**>.

2. For each mockup, fabricate cutaway sections to allow observation of application details for insulation materials, adhesives, mastics, attachments, and jackets.
3. Notify Architect [**seven**] <**Insert number**> days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
6. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
7. Demolish and remove mockups when directed.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.

1.7 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."

B. Coordinate clearance requirements with equipment Installer for equipment insulation application.

C. Coordinate installation and testing of heat tracing.

1.8 SCHEDULING

A. 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.

B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

PART 2 - PRODUCTS

2.1 INSULATION MATERIALS

A. Comply with requirements in "Breeching Insulation Schedule" and "Equipment Insulation Schedule" articles for where insulating materials shall be applied.

B. Products shall not contain asbestos, lead, mercury, or mercury compounds.

C. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 ppm when tested according to ASTM C 871.

D. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.

E. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.

F. Calcium Silicate:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Industrial Insulation Group, LLC (IIG-LLC).

b. <**Insert manufacturer's name**>.

2. Flat-, curved-, and grooved-block sections of noncombustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.

G. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Pittsburgh Corning Corporation.
b. <**Insert manufacturer's name**>.

2. Block Insulation: ASTM C 552, Type I.
3. Special-Shaped Insulation: ASTM C 552, Type III.
4. Board Insulation: ASTM C 552, Type IV.
5. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

H. Flexible Elastomeric Insulation: Closed-cell, sponge- or expanded-rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Aeroflex USA, Inc.
b. Armacell LLC.
c. K-Flex USA.
d. <**Insert manufacturer's name**>.

I. Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, [**Type I**] [**Type II with factory-applied vinyl jacket**] [**Type III with factory-applied FSK jacket**] [**Type III with factory-applied FSP jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. CertainTeed Corporation.
b. Johns Manville; a Berkshire Hathaway company.
c. Knauf Insulation.
d. Manson Insulation Inc.
e. Owens Corning.
f. <**Insert manufacturer's name**>.

J. High-Temperature, Mineral-Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Industrial Insulation Group, LLC (IIG-LLC).
    b. Johns Manville; a Berkshire Hathaway company.
    c. Knauf Insulation.
    d. Roxul Inc.
    e. <**Insert manufacturer's name**>.

K. Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. Provide insulation [**without factory-applied jacket**] [**with factory-applied ASJ**] [**with factory-applied FSK jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. CertainTeed Corporation.
    b. Johns Manville; a Berkshire Hathaway company.
    c. Knauf Insulation.
    d. Manson Insulation Inc.
    e. Owens Corning.
    f. <**Insert manufacturer's name**>.

L. High-Temperature, Mineral-Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Industrial Insulation Group, LLC (IIG-LLC).
    b. Knauf Insulation.
    c. Rock Wool.
    d. Roxul Inc.
    e. Thermafiber, Inc.; an Owens Corning company.
    f. <**Insert manufacturer's name**>.

M. Mineral-Fiber, Preformed Pipe Insulation:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Johns Manville; a Berkshire Hathaway company.
    b. Knauf Insulation.
    c. Manson Insulation Inc.
    d. Owens Corning.
    e. <**Insert manufacturer's name**>.

2. Type I, 850 Deg F (454 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, [**without factory-**

applied jacket] [**with factory-applied ASJ**] [**with factory-applied ASJ-SSL**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

3. Type II, 1200 Deg F (649 Deg C) Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, [**without factory-applied jacket**] [**with factory-applied ASJ**] [**with factory-applied ASJ-SSL**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

N. Mineral-Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semirigid board material with factory-applied [**ASJ**] [**FSK jacket**] complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. (40 kg/cu. m) or more. Thermal conductivity (k-value) at 100 deg F (55 deg C) is 0.29 Btu x in./h x sq. ft. x deg F (0.042 W/m x K) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. CertainTeed Corporation.
    b. Johns Manville; a Berkshire Hathaway company.
    c. Knauf Insulation.
    d. Manson Insulation Inc.
    e. Owens Corning.
    f. <**Insert manufacturer's name**>.

O. Phenolic:

1. Basis-of-Design Product: Subject to compliance with requirements, provide Polyguard Products, Inc.; PolyPhen Phenolic insulation or comparable product by one of the following:

    a. ITW Insulation Systems.
    b. Resolco International BV.
    c. <**Insert manufacturer's name**>.

2. Preformed pipe insulation of rigid, expanded, closed cell structure. Comply with ASTM C 1136, Type III, Grade 1.
3. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
4. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

    a. Preformed Pipe Insulation: Jacket to have a maximum perm rating of 2 perms (1.32 metric perms) when tested according to ASTM E 96, Procedure A.

P. Polyisocyanurate: Unfaced, preformed, rigid cellular polyisocyanurate material intended for use as thermal insulation.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Duna USA Inc.
    b. Dyplast Products.
    c. Elliott Company of Indianapolis.

d. ITW Insulation Systems; Illinois Tool Works, Inc.
e. <**Insert manufacturer's name**>.

2. Comply with ASTM C 591, 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 (0.027 W/m x K) at 75 deg F (24 deg C) after 180 days of aging.
3. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1 inch (25 mm) as tested by ASTM E 84.
4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.

a. Equipment Applications: [**None**] [**ASJ**] [**ASJ-SSL**] [**PVDC**] [**PVDC-SSL**].

Q. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Armacell LLC.
b. Nomaco Insulation.
c. <**Insert manufacturer's name**>.

R. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x deg F (0.038 W/m x K) after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Polyguard Products, Inc.; Dow Styrofoam XPS PIB or comparable product by one of the following:

a. ITW Insulation Systems; Illinois Tool Works, Inc.
b. <**Insert manufacturer's name**>.

2.2 INSULATING CEMENTS

A. Mineral-Fiber Insulating Cement: Comply with ASTM C 195.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ramco Insulation, Inc.
b. <**Insert manufacturer's name**>.

B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ramco Insulation, Inc.

b. <**Insert manufacturer's name**>.

C. Mineral-Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Ramco Insulation, Inc.
b. <**Insert manufacturer's name**>.

2.3 ADHESIVES

A. 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.

B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800 deg F (10 to 427 deg C).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. Eagle Bridges - Marathon Industries.
c. Foster Brand; H. B. Fuller Construction Products.
d. Mon-Eco Industries, Inc.
e. Vimasco Corporation.
f. <**Insert manufacturer's name**>.

2. Adhesives shall have a VOC content of [**50**] <**Insert value**> g/L or less.
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. Cellular-Glass Adhesive: Two-component, thermosetting urethane adhesive containing no flammable solvents, with a service temperature range of minus 100 to plus 200 deg F (minus 73 to plus 93 deg C).

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Foster Brand; H. B. Fuller Construction Products.
b. <**Insert manufacturer's name**>.

2. Adhesives shall have a VOC content of [**50**] <**Insert value**> g/L or less.
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. <**Insert manufacturer's name**>.

2. Adhesives shall have a VOC content of [**50**] <**Insert value**> g/L or less.
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

E. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Aeroflex USA, Inc.
   b. Armacell LLC.
   c. Foster Brand; H. B. Fuller Construction Products.
   d. K-Flex USA.
   e. <**Insert manufacturer's name**>.

2. Adhesives shall have a VOC content of [**50**] <**Insert value**> g/L or less.
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.
   d. Mon-Eco Industries, Inc.
   e. <**Insert manufacturer's name**>.

2. Fiberglass adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Foster Brand; H. B. Fuller Construction Products.
   c. <**Insert manufacturer's name**>.

2. Adhesives shall have a VOC content of [**50**] <**Insert value**> g/L or less.
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. Eagle Bridges - Marathon Industries.
   c. Foster Brand; H. B. Fuller Construction Products.
   d. Mon-Eco Industries, Inc.
   e. <**Insert manufacturer's name**>.

2. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

I. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Dow Corning Corporation.
   b. Johns Manville; a Berkshire Hathaway company.
   c. P.I.C. Plastics, Inc.
   d. Speedline Corporation.
   e. <**Insert manufacturer's name**>.

2. Adhesive shall have a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of

Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.4 MASTICS

A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-PRF-19565C, Type II.

1. VOC Content: [**300**] <**Insert value**> g/L or less.
2. Low-Emitting Materials: Mastic coatings shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. Vapor-Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Foster Brand; H. B. Fuller Construction Products.
    b. Knauf Insulation.
    c. Vimasco Corporation.
    d. <**Insert manufacturer's name**>.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm (0.009 metric perm) at 43-mil (1.09-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 58 percent by volume and 70 percent by weight.
5. Color: White.

C. Vapor-Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges - Marathon Industries.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. Mon-Eco Industries, Inc.
    e. <**Insert manufacturer's name**>.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35-mil (0.9-mm) dry film thickness.
3. Service Temperature Range: 0 to 180 deg F (Minus 18 to plus 82 deg C).
4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
5. Color: White.

D. Vapor-Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges - Marathon Industries.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. <**Insert manufacturer's name**>.

2. Water-Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30-mil (0.8-mm) dry film thickness.
3. Service Temperature Range: Minus 50 to plus 220 deg F (Minus 46 to plus 104 deg C).
4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
5. Color: White.

E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges - Marathon Industries.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. Knauf Insulation.
    e. Mon-Eco Industries, Inc.
    f. Vimasco Corporation.
    g. <**Insert manufacturer's name**>.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms (1.2 metric perms) at 0.0625-inch (1.6-mm) dry film thickness.
3. Service Temperature Range: Minus 20 to plus 180 deg F (Minus 29 to plus 82 deg C).
4. Solids Content: 60 percent by volume and 66 percent by weight.
5. Color: White.

2.5 LAGGING ADHESIVES

A. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Foster Brand; H. B. Fuller Construction Products.
    c. Vimasco Corporation.
    d. <**Insert manufacturer's name**>.

2. Adhesives shall have a VOC content of [50] <Insert value> g/L or less.
3. Adhesive shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of

Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

4. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over equipment insulation.
5. Service Temperature Range: 0 to plus 180 deg F (Minus 18 to plus 82 deg C).
6. Color: White.

2.6 SEALANTS

A. Joint Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges - Marathon Industries.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. Mon-Eco Industries, Inc.
    e. Pittsburgh Corning Corporation.
    f. <**Insert manufacturer's name**>.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Permanently flexible, elastomeric sealant.
4. Service Temperature Range: Minus 100 to plus 300 deg F (Minus 73 to plus 149 deg C).
5. Color: White or gray.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

B. FSK and Metal Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. Childers Brand; H. B. Fuller Construction Products.
    b. Eagle Bridges - Marathon Industries.
    c. Foster Brand; H. B. Fuller Construction Products.
    d. Mon-Eco Industries, Inc.
    e. <**Insert manufacturer's name**>.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: Aluminum.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of

Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

C. ASJ Flashing Sealants, and Vinyl, PVDC, and PVC Jacket Flashing Sealants:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Childers Brand; H. B. Fuller Construction Products.
   b. <**Insert manufacturer's name**>.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250 deg F (Minus 40 to plus 121 deg C).
5. Color: White.
6. Sealant shall have a VOC content of 420 g/L or less.
7. Sealant shall comply with the testing and product requirements of the California Department of Public Health's "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers."

2.7 FACTORY-APPLIED JACKETS

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

1. Vapor Barrier: Vapor barrier meeting ASTM C 1136, Type IX. Provide a field-applied metal or PVC jacket as described in the "Field-Applied Jacket" Article.

   a. Basis-of-Design Product: Subject to compliance with requirements, provide Polyguard Products, Inc.; Zero-Perm vapor barrier or comparable product by one of the following:

      1) 3M.
      2) <**Insert manufacturer name**>.

   b. Laminate Thickness: Polymer/foil/polymer laminate, 0.5 mils (0.013 mm)/1 mil (0.025 mm)/0.5 mils (0.013 mm).
   c. Permeance: 0 perms (0 metric perms) when tested according to ASTM E 96, Procedure A, and meeting ASTM E 84 25/50 requirements.

2. Flexible Waterproof Cladding: Flexible waterproof cladding for use either indoors or outdoors to meet ASTM 25/50 requirements, provide permeance of 0 perms (0 metric perms) when tested according to ASTM E 96, Procedure A; serves as a final permanent jacket, no additional field-applied jacket required.

   a. Basis-of-Design Product: Subject to compliance with requirements, provide Polyguard Products; Alumaguard Lite White or comparable product by one of the following:

1) 3M.
2) <**Insert manufacturer name**>.

3. Self-Adhering Membrane: Self-adhering membrane for use either indoors or outdoors, providing a permeance of 0 perms (0 metric perms) when tested according to ASTM E 96, Procedure A. Use on below-ambient surfaces as a vapor barrier; covered by field-applied permanent metal or PVC jacket.

   a. Basis-of-Design Product: Subject to compliance with requirements, provide Polyguard Products, Inc.; [**Insulrap 30 NG**] [**or**] [**Insulrap 30 SJ NG**] or comparable product by one of the following:

      1) Foster Brand; H. B. Fuller Construction Products.
      2) Pittsburgh Corning.
      3) <**Insert manufacturer name**>.

4. WMP-ASJ: WMP-ASJ polypropylene foil fiberglass scrim composite that meets ASTM C 1136, Types I-IV with permeance of 0.02 perm (0.013 metric perm) when tested according to ASTM E 96, Procedure A; can be left exposed indoors or covered with permanent PVC or metal jacket.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Avery Dennison.
      2) Lamtec Corporation.
      3) <**Insert manufacturer name**>.

5. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) Avery Dennison.
      2) 3M.
      3) <**Insert manufacturer name**>.

6. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

   a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

      1) ITW Insulation Systems; Illinois Tool Works, Inc.
      2) <**Insert manufacturer's name**>.

7. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested

according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ITW Insulation Systems; Illinois Tool Works, Inc.
2) <**Insert manufacturer's name**>.

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

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) ITW Insulation Systems; Illinois Tool Works, Inc.
2) <**Insert manufacturer's name**>.

9. Vinyl Jacket: White vinyl with a permeance of 1.3 perms (0.86 metric perm) when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Johns Manville; a Berkshire Hathaway company.
2) P.I.C. Plastics, Inc.
3) Proto Corporation.
4) Speedline Corporation.
5) <**Insert manufacturer name**>.

2.8 FIELD-APPLIED FABRIC-REINFORCING MESH

A. Woven Glass-Fiber Fabric: Approximately 6 oz./sq. yd. (203 g/sq. m) with a thread count of 5 strands by 5 strands/sq. in. (2 strands by 2 strands/sq. mm) for covering equipment.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Childers Brand; H. B. Fuller Construction Products.
b. <**Insert manufacturer's name**>.

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Foster Brand; H. B. Fuller Construction Products.
b. Vimasco Corporation.

c. <**Insert manufacturer's name**>.

2.9 FIELD-APPLIED CLOTHS

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Alpha Associates, Inc.
b. <**Insert manufacturer's name**>.

2.10 FIELD-APPLIED JACKETS

A. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. Johns Manville; a Berkshire Hathaway company.
b. P.I.C. Plastics, Inc.
c. Proto Corporation.
d. Speedline Corporation.
e. <**Insert manufacturer's name**>.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: [**White**] [**Color-code jackets based on system. Color as selected by Architect**].
4. Factory-fabricated tank heads and tank side panels.

B. Metal Jacket:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ITW Insulation Systems; Illinois Tool Works, Inc.
b. RPR Products, Inc.
c. <**Insert manufacturer's name**>.

2. Aluminum Jacket: Comply with ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005, Temper H-14.

a. [**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].
b. Finish and thickness are indicated in field-applied jacket schedules.

c. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**] [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil- (0.063-mm-) thick polysurlyn**].
d. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil- (0.063-mm-) thick polysurlyn**].
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

3. Stainless-Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.

a. [**Sheet and roll stock ready for shop or field sizing**] [**Factory cut and rolled to size**].
b. Material, finish, and thickness are indicated in field-applied jacket schedules.
c. Moisture Barrier for Indoor Applications: [**1-mil- (0.025-mm-) thick, heat-bonded polyethylene and kraft paper**] [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil- (0.063-mm-) thick polysurlyn**].
d. Moisture Barrier for Outdoor Applications: [**3-mil- (0.075-mm-) thick, heat-bonded polyethylene and kraft paper**] [**2.5-mil- (0.063-mm-) thick polysurlyn**].
e. Factory-Fabricated Fitting Covers:

1) Same material, finish, and thickness as jacket.
2) Preformed two-piece or gore, 45- and 90-degree, short- and long-radius elbows.
3) Tee covers.
4) Flange and union covers.
5) End caps.
6) Beveled collars.
7) Valve covers.
8) Field fabricate fitting covers only if factory-fabricated fitting covers are not available.

C. Underground Direct-Buried Jacket: thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven-glass fiber or polyester scrim and laminated aluminum foil.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Polyguard Products, Inc.; [**Insulrap 50 NG**] [**or**] [**Insulrap 50 SJ NG**] or comparable product by the following:

a. Pittsburgh Corning Corporation.
b. <**Insert manufacturer's name**>.

D. Self-Adhesive Field-Applied Jacket: Composite membrane consisting of a multi-ply embossed UV resistant aluminum foil/polymer laminate to which is applied a layer of rubberized asphalt.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Polyguard Products, Inc.; Alumaguard or comparable product by one of the following:

   a. 3M.
   b. MFM Building Products Corp.
   c. <**Insert manufacturer name**>.

2. Perm Rating: 0 perms (0 metric perms), when tested according to ASTM E 96/E 96M.
3. Membrane Thickness: 56 mils (1.42 mm).
4. Membrane Thickness, with Surface Finish: 59 mils (1.50 mm).

   a. Solar reflectance, CRRC Initial Rating: 0.86.
   b. Solar Reflectance, CRRC 3-Year Rating: 077.
   c. Thermal Emittance, CRRC Initial Rating: 0.82.
   d. Thermal Emittance, CRRC 3-Year Rating: 0.86.

E. Self-Adhesive Field-Applied Jacket: Multi-ply aluminum foil/polymer composite film coated with a low-temperature acrylic adhesive.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Polyguard Products, Inc.; Alumaguard Lite or comparable product by one of the following:

   a. 3M.
   b. MFM Building Products Corp.
   c. <**Insert manufacturer name**>.

2. Perm Rating: 0 perms (0 metric perms), when tested according to ASTM E 96/E 96M.
3. Membrane Thickness, Smooth Silver: 7 mils (0.18 mm).
4. Membrane Thickness, Stucco Embossed Silver: 9 mils (0.23 mm).
5. Membrane Thickness, White Surface Finish: 9 mils (0.23 mm).

   a. Solar reflectance, CRRC Initial Rating: 0.86.
   b. Solar Reflectance, CRRC 3-Year Rating: 077.
   c. Thermal Emittance, CRRC Initial Rating: 0.82.
   d. Thermal Emittance, CRRC 3-Year Rating: 0.86.

F. Self-Adhesive Field-Applied Jacket: Hybrid product combining UV-resistant aluminum foil/polymer laminate and rubberized asphalt with a metalized film coated with low temperature acrylic adhesive.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Polyguard Products, Inc.; Alumaguard All-Weather or comparable product by one of the following:

   a. 3M.
   b. MFM Building Products Corp.
   c. <**Insert manufacturer name**>.

2. Perm Rating: 0 perms (0 metric perms), when tested according to ASTM E 96/E 96M.

3. Membrane Thickness: 35 mils (0.89 mm).
4. Membrane Thickness, with Surface Finish: 38 mils (0.96 mm).

    a. Solar reflectance, CRRC Initial Rating: 0.86.
    b. Solar Reflectance, CRRC 3-Year Rating: 077.
    c. Thermal Emittance, CRRC Initial Rating: 0.82.
    d. Thermal Emittance, CRRC 3-Year Rating: 0.86.

G. PVDC Jacket for Indoor Applications: 4-mil- (0.10-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perm (0.013 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ITW Insulation Systems; Illinois Tool Works, Inc.
    b. <**Insert manufacturer's name**>.

H. PVDC Jacket for Outdoor Applications: 6-mil- (0.15-mm-) thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perm (0.007 metric perm) when tested according to ASTM E 96/E 96M and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ITW Insulation Systems; Illinois Tool Works, Inc.
    b. <**Insert manufacturer's name**>.

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    a. ITW Insulation Systems; Illinois Tool Works, Inc.
    b. <**Insert manufacturer's name**>.

2.11 TAPES

A. Zero Perm Vapor Barrier Tape: Complying with ASTM C 1136.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Polyguard Products, Inc.; Zero-Perm or comparable product by one of the following:

    a. 3M.
    b. <**Insert manufacturer name**>.

2. Laminate Thickness: Polymer/foil/polymer laminate, 0.5 mils (0.013 mm)/1 mil (0.025 mm)/0.5 mils (0.013 mm).
3. Permeance: 0 perms (0 metric perms) when tested according to ASTM E 96, Procedure A, and meeting ASTM E 84 25/50 requirements.
4. Release Liner Thickness: [**2 inches (51 mm)**] [**3 inches (76 mm)**].
5. Self-Wound Thickness: [**2 inches (51 mm)**] [**3 inches (76 mm)**].
6. Elongation: 2 percent.
7. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.

B. WMP-ASJ Tape: WMP-ASJ polypropylene foil fiberglass scrim composite that meets ASTM C 1136, Types I-IV. Available in various widths with kraft release paper.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. 3M.
   b. Avery Dennison Corporation, Specialty Tapes Division.
   c. Ideal Tape Co., Inc., an American Biltrite Company.
   d. Knauf Insulation.
   e. <**Insert manufacturer's name**>.

2. Width: [**3 inches (75 mm)**] <**Insert width**>.
3. Permeance: 0.02 perms (0.013 metric perms) when tested according to ASTM E 96.
4. Thickness: 11.5 mils (0.29 mm).
5. Adhesion: 90 ounces force/inch (1.0 N/mm) in width.
6. Elongation: 2 percent.
7. Tensile Strength: 40 lbf/inch (7.2 N/mm) in width.
8. WMP-ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

   a. Avery Dennison.
   b. Ideal Tape Co., Inc., an American Biltrite Company.
   c. 3M.
   d. <**Insert manufacturer's name**>.

2. Width: 2 inches (50 mm).
3. Thickness: 6 mils (0.15 mm).
4. Adhesion: 64 ounces force/inch (0.7 N/mm) in width.
5. Elongation: 500 percent.
6. Tensile Strength: 18 lbf/inch (3.3 N/mm) in width.

D. PVDC Tape for Indoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ITW Insulation Systems; Illinois Tool Works, Inc.
b. <**Insert manufacturer's name**>.

2. Width: 3 inches (75 mm).
3. Film Thickness: 4 mils (0.10 mm).
4. Adhesive Thickness: 1.5 mils (0.04 mm).
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

E. PVDC Tape for Outdoor Applications: White vapor-retarder PVDC tape with acrylic adhesive.

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ITW Insulation Systems; Illinois Tool Works, Inc.
b. <**Insert manufacturer's name**>.

2. Width: 3 inches (75 mm).
3. Film Thickness: 6 mils (0.15 mm).
4. Adhesive Thickness: 1.5 mils (0.04 mm).
5. Elongation at Break: 145 percent.
6. Tensile Strength: 55 lbf/inch (10.1 N/mm) in width.

2.12 SECUREMENTS

A. Bands:

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. ITW Insulation Systems; Illinois Tool Works, Inc.
b. RPR Products, Inc.
c. <**Insert manufacturer's name**>.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, [**Type 304**] [**or**] [**Type 316**]; 0.015 inch (0.38 mm) thick, [**1/2 inch (13 mm)**] [**3/4 inch (19 mm)**] wide with [**wing seal**] [**or**] [**closed seal**].
3. Aluminum: ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch (0.51 mm) thick, [**1/2 inch (13 mm)**] [**3/4 inch (19 mm)**] wide with [**wing seal**] [**or**] [**closed seal**].
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

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

2. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    1) AGM Industries, Inc.
    2) Gemco.
    3) Midwest Fasteners, Inc.
    4) Nelson Stud Welding.
    5) <**Insert manufacturer's name**>.

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

    1) AGM Industries, Inc.
    2) CL WARD & Family Inc.
    3) Gemco.
    4) Midwest Fasteners, Inc.
    5) Nelson Stud Welding.
    6) <**Insert manufacturer's name**>.

2. 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.

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

        1) AGM Industries, Inc.
        2) Gemco.
        3) Midwest Fasteners, Inc.
        4) <**Insert manufacturer's name**>.

    b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
    c. Spindle: [**Copper- or zinc-coated, low-carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
    d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

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

    a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Gemco.
2) Midwest Fasteners, Inc.
3) <**Insert manufacturer's name**>.

b. Baseplate: Perforated, nylon sheet, 0.030 inch (0.76 mm) thick by 1-1/2 inches (38 mm) in diameter.
c. Spindle: Nylon, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches (63 mm).
d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.

4. 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.

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) AGM Industries, Inc.
2) Gemco.
3) Midwest Fasteners, Inc.
4) <**Insert manufacturer's name**>.

b. Baseplate: Galvanized carbon-steel sheet, 0.030 inch (0.76 mm) thick by 2 inches (50 mm) square.
c. Spindle: [**Copper- or zinc-coated, low-carbon steel**] [**Aluminum**] [**Stainless steel**], fully annealed, 0.106-inch- (2.6-mm-) diameter shank, length to suit depth of insulation indicated.
d. Adhesive-backed base with a peel-off protective cover.

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

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) AGM Industries, Inc.
2) Gemco.
3) Midwest Fasteners, Inc.
4) Nelson Stud Welding.
5) <**Insert manufacturer's name**>.

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

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

a. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1) Gemco.
2) Midwest Fasteners, Inc.
3) <**Insert manufacturer's name**>.

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

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

1. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

a. C & F Wire.
b. <**Insert manufacturer's name**>.

2.13 CORNER ANGLES

A. PVC Corner Angles: [**30 mils (0.8 mm)**] <**Insert dimension**> thick, minimum 1 by 1 inch (25 by 25 mm), PVC according to ASTM D 1784, Class 16354-C. White or color-coded to match adjacent surface.

B. Aluminum Corner Angles: [**0.040 inch (1.0 mm)**] <**Insert dimension**> thick, minimum 1 by 1 inch (25 by 25 mm), aluminum according to ASTM B 209 (ASTM B 209M), Alloy 3003, 3005, 3105, or 5005; Temper H-14.

C. Stainless-Steel Corner Angles: [**0.024 inch (0.61 mm)**] <**Insert dimension**> thick, minimum 1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, [**Type 304**] [**or**] [**Type 316**].

PART 3 - EXECUTION

3.1 EXAMINATION

A. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

1. Verify that systems and equipment to be insulated have been tested and are free of defects.
2. Verify that surfaces to be insulated are clean and dry.

B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.

B. Surface Preparation: Clean and prepare surfaces to be insulated. Before insulating, apply a corrosion coating to insulated surfaces as follows:

1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils (0.127 mm) thick and an epoxy finish 5 mils (0.127 mm) thick if operating in a temperature range between 140 and 300 deg F (60 and 149 deg C). Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300 deg F (0 and 149 deg C) with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.

C. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

D. Mix insulating cements with clean potable water; if insulating cements are to be in contact with stainless-steel surfaces, use demineralized water.

3.3 GENERAL INSTALLATION REQUIREMENTS

A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment.

B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment as specified in insulation system schedules.

C. 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.

D. Install insulation with longitudinal seams at top and bottom of horizontal runs.

E. Install multiple layers of insulation with longitudinal and end seams staggered.

F. Keep insulation materials dry during application and finishing.

G. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.

H. Install insulation with least number of joints practical.

I. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor-barrier mastic.

1. Install insulation continuously through hangers and around anchor attachments.

2. 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 at attachment to structure with vapor-barrier mastic.
3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
4. Cover inserts with jacket material matching adjacent insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.

J. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.

K. Install insulation with factory-applied jackets as follows:

1. Draw jacket tight and smooth.
2. Cover circumferential joints with 3-inch- (75-mm-) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) o.c.
3. Overlap jacket longitudinal seams at least 1-1/2 inches (38 mm). Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at [**2 inches (50 mm)**] [**4 inches (100 mm)**] o.c.

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

4. Cover joints and seams with tape, according to insulation material manufacturer's written instructions, to maintain vapor seal.
5. Where vapor barriers are indicated, apply vapor-barrier mastic on seams and joints.

L. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.

M. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.

N. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.

O. For above ambient services, do not install insulation to the following:

1. Vibration-control devices.
2. Testing agency labels and stamps.
3. Nameplates and data plates.
4. Manholes.
5. Handholes.
6. Cleanouts.

3.4 INSTALLATION OF EQUIPMENT, TANK, AND VESSEL INSULATION

A. Mineral-Fiber, Pipe and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.

1. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for [**100**] [**50**] <**Insert number**> percent coverage of tank and vessel surfaces.
2. 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.
3. Protect exposed corners with secured corner angles.
4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:

    a. Do not weld anchor pins to ASME-labeled pressure vessels.
    b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is 3 inches (75 mm) from insulation end joints, and 16 inches (400 mm) o.c. in both directions.
    d. Do not overcompress insulation during installation.
    e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
    f. Impale insulation over anchor pins and attach speed washers.
    g. 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.

5. Secure each layer of insulation with stainless-steel or aluminum bands. Select band material compatible with insulation materials.
6. Where insulation hangers on equipment and vessels are not permitted or practical and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch prestressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches (150 mm) from each end. Install wire or cable between two circumferential girdles 12 inches (300 mm) o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches (1200 mm) o.c. Use this network for securing insulation with tie wire or bands.
7. Stagger joints between insulation layers at least 3 inches (75 mm).
8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.

B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.

1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
2. Seal longitudinal seams and end joints.

C. Insulation Installation on Pumps:

1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch (150-mm) centers, starting at corners. Install 3/8-inch- (10-mm-) diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from [**galvanized steel**] [**aluminum**] [**stainless steel**], at least [**0.040 inch (1.0 mm)**] [**0.050 inch (1.3 mm)**] [**0.060 inch (1.6 mm)**] thick.
3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

3.5 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Boiler Breechings:

1. Secure single-layer insulation with stainless-steel bands at 12-inch (300-mm) intervals and tighten bands without deforming insulation material.
2. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.
3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral-fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch (25 mm). Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.6 INSTALLATION OF PHENOLIC INSULATION

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

B. Install two-layer insulation with joints tightly butted and staggered at least 3 inches (75 mm). Secure inner layer with 0.062-inch (1.6-mm) wire spaced at 12-inch (300-mm) intervals. Secure outer layer with stainless-steel bands at 12-inch (300-mm) intervals.

3.7 FIELD-APPLIED JACKET INSTALLATION

A. Where glass-cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.

1. Draw jacket smooth and tight to surface with 2-inch (50-mm) overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch- (1.6-mm-) thick coats of lagging adhesive.
3. Completely encapsulate insulation with coating, leaving no exposed insulation.

B. Where FSK jackets are indicated, install as follows:

1. Draw jacket material smooth and tight.
2. Install lap or joint strips with same material as jacket.
3. Secure jacket to insulation with manufacturer's recommended adhesive.
4. Install jacket with 1-1/2-inch (38-mm) laps at longitudinal seams and 3-inch- (75-mm-) wide joint strips at end joints.
5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.

C. Where PVC jackets are indicated, install with 1-inch (25-mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

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

D. Where metal jackets are indicated, install with 2-inch (50-mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands 12 inches (300 mm) o.c. and at end joints.

E. Where PVDC jackets are indicated, install as follows:

1. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches (850 mm) or less. 33-1/2-inch- (850-mm-) circumference limit allows for 2-inch- (50-mm-) overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
2. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

3.8 FINISHES

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

1. 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.

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

B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed Work.

D. Do not field paint aluminum or stainless-steel jackets.

3.9 FIELD QUALITY CONTROL

A. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.

B. Perform tests and inspections.

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

D. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.

3.10 BREECHING INSULATION SCHEDULE

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

1. Calcium Silicate: 4 inches (100 mm) thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

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

1. Calcium Silicate: 4 inches (100 mm) thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

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

1. Calcium Silicate: 4 inches (100 mm) thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.
3. High-Temperature Mineral-Fiber Board: 3 inches (75 mm) thick and [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

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

1. Calcium Silicate: 4 inches (100 mm) thick.
2. High-Temperature Mineral-Fiber Blanket: 3 inches (75 mm) thick and 3-lb/cu. ft. (48-kg/cu. m) nominal density.

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

3.11 EQUIPMENT INSULATION SCHEDULE

A. 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.

B. Insulate indoor and outdoor equipment that is not factory insulated.

C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, [**condenser bundles,**] [**heat-recovery bundles,**] suction piping, compressor inlets, tube sheets, water boxes, and nozzles with[**one of**] the following:

1. Cellular Glass: [**2 inches (50 mm)**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch (25 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.
5. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.
6. Polyisocyanurate: [**1 inch (25 mm)**] <**Insert dimension**> thick.
7. Polyolefin: [**1 inch (25 mm)**] <**Insert dimension**> thick.

D. Heat-exchanger (water-to-water for cooling service) insulation shall be[**one of**] the following:

1. Cellular Glass: [**2 inches (50 mm)**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch (25 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.
5. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.
6. Polyisocyanurate: [**1 inch (25 mm)**] <**Insert dimension**> thick.
7. Polyolefin: [**1 inch (25 mm)**] <**Insert dimension**> thick.

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

1. Calcium Silicate: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.

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

1. Calcium Silicate: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.

G. Hot-water-to-steam converter insulation shall be[**one of**] the following:

1. Calcium Silicate: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.

H. Chilled-water pump insulation shall be[**one of**] the following:

1. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
3. Phenolic: [**2 inches (50 mm)**] <**Insert dimension**> thick.

I. Condenser-water pump insulation shall be[**one of**] the following:

1. Cellular Glass: [**2 inches (50 mm)**] <**Insert dimension**> thick.
2. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
3. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.

J. Dual-service heating and cooling pump insulation shall be[**one of**] the following:

1. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
3. Phenolic: [**2 inches (50 mm)**] <**Insert dimension**> thick.
4. Polyisocyanurate: [**1 inch (25 mm)**] <**Insert dimension**> thick.

K. Heating-hot-water pump insulation shall be[**one of**] the following:

1. Calcium Silicate: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

L. Heat-recovery pump insulation shall be[**one of**] the following:

1. Cellular Glass: [**2 inches (50 mm)**] <**Insert dimension**> thick.
2. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
3. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.

M. Steam condensate pump and boiler feedwater pump insulation shall be[**one of**] the following:

1. Calcium Silicate: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.

N. Chilled-water expansion/compression tank insulation shall be[**one of**] the following:

1. Cellular Glass: [**1-1/2 inches (38 mm)**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch (25 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.
5. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.
6. Polyisocyanurate: [**1 inch (25 mm)**] <**Insert dimension**> thick.
7. Polyolefin: [**1 inch (25 mm)**] <**Insert dimension**> thick.

O. Condenser-water expansion/compression tank insulation shall be[**one of**] the following:

1. Cellular Glass: [**1-1/2 inches (38 mm)**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch (25 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.
5. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.
6. Polyisocyanurate: [**1 inch (25 mm)**] <**Insert dimension**> thick.
7. Polyolefin: [**1 inch (25 mm)**] <**Insert dimension**> thick.

P. Dual-service heating and cooling expansion/compression tank insulation shall be[**one of**] the following:

1. Cellular Glass: [**1-1/2 inches (38 mm)**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch (25 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.
5. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.
6. Polyisocyanurate: [**1 inch (25 mm)**] <**Insert dimension**> thick.
7. Polyolefin: [**1 inch (25 mm)**] <**Insert dimension**> thick.

Q. Heating-hot-water expansion/compression tank insulation shall be[**one of**] the following:

1. Calcium Silicate: [**2 inches (50 mm)**] <**Insert dimension**> thick.
2. Cellular Glass: [**1-1/2 inches (38 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.

R. Heat-recovery expansion/compression tank insulation shall be[**one of**] the following:

1. Cellular Glass: [**1-1/2 inches (38 mm)**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch (25 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.
5. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.
6. Polyisocyanurate: [**1 inch (25 mm)**] <**Insert dimension**> thick.

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

S. Chilled-water air-separator insulation shall be[**one of**] the following:

1. Cellular Glass: [**2 inches (50 mm)**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch (25 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.
5. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.
6. Polyisocyanurate: [**1 inch (25 mm)**] <**Insert dimension**> thick.
7. Polyolefin: [**1 inch (25 mm)**] <**Insert dimension**> thick.

T. Condenser-water air-separator insulation shall be[**one of**] the following:

1. Cellular Glass: [**2 inches (50 mm)**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch (25 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.
5. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.
6. Polyisocyanurate: [**1 inch (25 mm)**] <**Insert dimension**> thick.
7. Polyolefin: [**1 inch (25 mm)**] <**Insert dimension**> thick.

U. Dual-service heating and cooling air-separator insulation shall be[**one of**] the following:

1. Cellular Glass: [**2 inches (50 mm)**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch (25 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.
5. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.
6. Polyisocyanurate: [**1 inch (25 mm)**] <**Insert dimension**> thick.
7. Polyolefin: [**1 inch (25 mm)**] <**Insert dimension**> thick.

V. Heating-hot-water air-separator insulation shall be[**one of**] the following:

1. Calcium Silicate: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.

W. Heat-recovery air-separator insulation shall be[**one of**] the following:

1. Cellular Glass: [**2 inches (50 mm)**] <**Insert dimension**> thick.
2. Flexible Elastomeric: [**1 inch (25 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**1 inch (25 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**1 inch (25 mm)**] <**Insert dimension**> thick.
5. Phenolic: [**1 inch (25 mm)**] <**Insert dimension**> thick.

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

X. Thermal storage tank (brine, water, ice) insulation shall be[**one of**] the following:

1. Cellular Glass: [**4 inches (100 mm)**] <**Insert dimension**> thick.
2. Mineral-Fiber Board: [**3 inches (75 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
3. Mineral-Fiber Pipe and Tank: [**3 inches (75 mm)**] <**Insert dimension**> thick.
4. Phenolic: [**3 inches (75 mm)**] <**Insert dimension**> thick.
5. Polyisocyanurate (Outdoor Application Only): [**3 inches (75 mm)**] <**Insert dimension**> thick.
6. Polystyrene (Outdoor Application Only): [**3 inches (75 mm)**] <**Insert dimension**> thick.

Y. Deaerator insulation shall be[**one of**] the following:

1. Calcium Silicate: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.

Z. Steam condensate tank and receiver insulation shall be[**one of**] the following:

1. Calcium Silicate: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.

AA. Steam flash-tank, flash-separator, moisture-separator, and blow-off-tank insulation shall be[**one of**] the following:

1. Calcium Silicate: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
3. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
4. Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.

BB. Piping system filter-housing insulation shall be[**one of**] the following:

1. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.
3. Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.

CC. Outdoor, aboveground, heated, fuel-oil storage tank insulation shall be[**one of**] the following:

1. Cellular Glass: [**3 inches (75 mm)**] <**Insert dimension**> thick.
2. Mineral-Fiber Board: [**2 inches (50 mm)**] <**Insert dimension**> thick and [**2-lb/cu. ft. (32-kg/cu. m)**] [**3-lb/cu. ft. (48-kg/cu. m)**] [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

3. Mineral-Fiber Pipe and Tank: [**2 inches (50 mm)**] <**Insert dimension**> thick.
4. Polyisocyanurate: [**1-1/2 inches (38 mm)**] <**Insert dimension**> thick.

3.12 INDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. Self-Adhesive, Field-Applied Jacket Schedule: [**Alumaguard Lite Silver Smooth or Embossed**] [**or**] [**Alumaguard Lite White**].
3. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils (0.5 mm)**] [**30 mils (0.8 mm)**] thick.
4. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] [**0.032 inch (0.81 mm)**] [**0.040 inch (1.0 mm)**] thick.
5. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] [**0.032 inch (0.81 mm)**] thick.
6. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch (0.25 mm)**] [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] thick.
7. <**Insert jacket type**>.

D. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):

1. None.
2. Self-Adhesive, Field-Applied Jacket Schedule: [**Alumaguard Lite Silver Smooth or Embossed**] [**or**] [**Alumaguard Lite White**].
3. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils (0.5 mm)**] [**30 mils (0.8 mm)**] thick.
4. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] [**0.032 inch (0.81 mm)**] [**0.040 inch (1.0 mm)**] thick.
5. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] [**0.032 inch (0.81 mm)**] thick.
6. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch (0.25 mm)**] [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] thick.
7. <**Insert jacket type**>.

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

1. None.
2. Self-Adhesive, Field-Applied Jacket Schedule: [**Alumaguard Lite Silver Smooth or Embossed**] [**or**] [**Alumaguard Lite White**].

3. [**Painted**]Aluminum, [**Smooth**] [**Stucco Embossed**] with [**1-1/4-Inch- (32-mm-) Deep Corrugations**] [**2-1/2-Inch- (65-mm-) Deep Corrugations**] [**4-by-1-Inch (100-by-25-mm) Box Ribs**]: [**0.032 inch (0.81 mm)**] [**0.040 inch (1.0 mm)**] thick.
4. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth**] [**Stucco Embossed**], with [**1-1/4-Inch- (32-mm-) Deep Corrugations**] [**2-1/2-Inch- (65-mm-) Deep Corrugations**] [**4-by-1-Inch (100-by-25-mm) Box Ribs**]: [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] thick.
5. <**Insert jacket type**>.

3.13 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.

B. If more than one material is listed, selection from materials listed is Contractor's option.

C. Equipment, Concealed:

1. None.
2. Self-Adhesive, Field-Applied Jacket Schedule: [**Alumaguard or Alumaguard Cool Wrap,**] [**Alumaguard All-Weather or Alumaguard All-Weather Cool Wrap,**] [**and**] [**Alumaguard Lite Smooth or Embossed or Alumaguard Lite Cool Wrap or White**].
3. [**PVC**] [**PVC, Color-Coded by System**]: [**20 mils (0.5 mm)**] [**30 mils (0.8 mm)**] thick.
4. Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] [**0.032 inch (0.81 mm)**] [**0.040 inch (1.0 mm)**] thick.
5. Painted Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**]: [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] [**0.032 inch (0.81 mm)**] thick.
6. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**]: [**0.010 inch (0.25 mm)**] [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] thick.
7. <**Insert jacket type**>.

D. Equipment, Exposed, up to 48 Inches (1200 mm) in Diameter or with Flat Surfaces up to 72 Inches (1800 mm):

1. Self-Adhesive, Field-Applied Jacket Schedule: [**Alumaguard or Alumaguard Cool Wrap,**] [**Alumaguard All-Weather or Alumaguard All-Weather Cool Wrap,**] [**and**] [**Alumaguard Lite Smooth or Embossed or Alumaguard Lite Cool Wrap or White**].
2. [**Painted**]Aluminum, [**Smooth**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] [**0.032 inch (0.81 mm)**] [**0.040 inch (1.0 mm)**] thick.
3. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 2B Finish**] [**Corrugated**] [**Stucco Embossed**] [**with Z-Shaped Locking Seam**]: [**0.010 inch (0.25 mm)**] [**0.016 inch (0.41 mm)**] [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] thick.
4. <**Insert jacket type**>.

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

1. Self-Adhesive, Field-Applied Jacket Schedule: [**Alumaguard or Alumaguard Cool Wrap,**] [**Alumaguard All-Weather or Alumaguard All-Weather Cool Wrap,**] [**and**] [**Alumaguard Lite Smooth or Embossed or Alumaguard Lite Cool Wrap or White**].
2. [**Painted**]Aluminum, [**Smooth**] [**Stucco Embossed**] with [**1-1/4-Inch- (32-mm-) Deep Corrugations**] [**2-1/2-Inch- (65-mm-) Deep Corrugations**] [**4-by-1-Inch (100-by-25-mm) Box Ribs**]: [**0.032 inch (0.81 mm)**] [**0.040 inch (1.0 mm)**] thick.
3. Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth**] [**Stucco Embossed**], with [**1-1/4-Inch- (32-mm-) Deep Corrugations**] [**2-1/2-Inch- (65-mm-) Deep Corrugations**] [**4-by-1-Inch (100-by-25-mm) Box Ribs**]: [**0.020 inch (0.51 mm)**] [**0.024 inch (0.61 mm)**] thick.
4. <**Insert jacket type**>.

END OF SECTION 230716