SECTION 230700 – INSULATION FOR HVAC SYSTEMS AND EQUIPMENT

Latest Update: 09-12-2022 See Underlined Text for Edits

(Engineer shall edit specifications and blue text in header to meet project requirements. This includes but is not limited to updating Equipment and/or Material Model Numbers indicated in the specifications and adding any additional specifications that may be required by the project. Also turn off all "Underlines".)

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 01 Specification Sections, apply to this section and all other sections of Division 23.

1.2 SUMMARY

A. This section includes the insulation requirements for HAVC pipe and duct systems as follows:

1. Flexible elastomeric insulation.
2. Mineral fiber blanket insulation.
3. Mineral fiber board insulation.
4. Mineral fiber pipe and tank insulation.
5. Cellular glass insulation.
6. Calcium silicate insulation.
7. Adhesives.
8. Mastics.
9. Lagging adhesives.
10. Sealants.
11. Factory applied jackets.
12. Field applied cloths.
13. Field applied jackets.
14. Tapes.
15. Securements.
16. Corner angles.

1.3 ACTION SUBMITTALS

A. Product Data: For each specified product, include manufacturers cut sheets, dimensional data, thermal performance data, installation instructions, jackets, specified options, and warranty information.

B. LEED Submittals: <Delete if not a LEED project>

1. "Product Data for Credit IEQ 4.1" Subparagraph below applies to LEED-NC, LEED-CI, and LEED-CS; coordinate with requirements for adhesives and sealants.

2. Product Data for Credit IEQ 4.1: For adhesives and sealants, documentation including printed statement of VOC content.
3. "Laboratory Test Reports for Credit IEQ 4" Subparagraph below applies to LEED for Schools.
4. Laboratory Test Reports for Credit IEQ 4: For adhesives and sealants, documentation indicating that products comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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 insulation application at elbows, fittings, dampers, specialties and flanges for each type of insulation.
3. Detail application of field-applied jackets.
4. Detail application at linkages of control devices.

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

1. Sheet Form Insulation Materials: Twelve (12) inches square.
2. Sheet Jacket Materials: Twelve (12) inches square.
3. 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 CLOSEOUT SUBMITTAL

A. Operation and Maintenance Data: Include a copy of each approved submittal along with any applicable maintenance data in the project operation.

1.6 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 twenty five (25) or less, and smoke-developed index of fifty (50) or less.
2. Insulation Installed Outdoors: Flame-spread index of seventy five (75) or less, and smoke-developed index of one hundred fifty (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. Ductwork Mockups:

a. One (1), ten (10) foot section each of rectangular and round straight duct.
b. One (1) each of a 90° mitered round and rectangular elbow, and One (1) each of a 90° radius round and rectangular elbow.
c. One (1) rectangular branch takeoff and One (1) round branch takeoff from a rectangular duct. One (1) round tee fitting.
d. One (1) rectangular and round transition fitting.
e. Four (4) support hangers for round and rectangular ductwork.
f. Each type of damper and specialty.

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 (7) days in advance of dates and times when mockups will be constructed.
4. Obtain Architect's approval of mockups before starting insulation application.
5. Retain first subparagraph below if mockups are not only for establishing appearance factors.
6. Approval of mockups does not constitute approval of deviations from the Contract Documents contained in mockups unless Architect specifically approves such deviations in writing.
7. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed work.
8. Demolish and remove mockups when directed.

1.7 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.

1.8 COORDINATION

A. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Division 23 Specification Section "Hangers and Supports for HVAC Piping Systems."

B. Coordinate clearance requirements with duct Installer for duct insulation application. Before preparing ductwork Shop Drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.

C. Coordinate installation and testing of heat tracing.

1.9 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.

1.10 WARRANTY/GUARANTEE

A. See Division 23 Specification Section “Basic Mechanical Requirements – HVAC” for warranty and guarantee requirements.

PART 2 - PRODUCTS

2.1 GENERAL PRODUCT REQUIREMENTS

A. Equipment Design and Selection: Insulation and accessories shall be designed and selected, for the intended use, in accordance with the details on the drawings and the requirements of this specification.

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

1. Fiberglass, Fiber Board and Cellular Insulation: Subject to compliance with requirements, provide products by one (1) of the following:

a. Owings Corning Inc.
b. John Manville
c. Knauf Inc.
d. Pittsburgh Corning Corporation; Foamglas.

2. Elastromeric Insulation: Subject to compliance with requirements, provide products by one (1) of the following:

a. Armstrong.
b. Armcell
c. Knauf Inc.

3. Adhesives, Mastics, and Sealants: Provide adhesives, mastics and sealant products recommended by the insulation manufacturer or by one (1) of the following:

a. Foster Brand.
b. Fueller Company.
c. Eagle Bridge.

2.2 INSULATION MATERIALS <Delete types of insulation not required for particular project.>

A. Comply with requirements in "Duct Insulation Schedule, General," "Indoor Duct and Plenum Insulation Schedule," and "Aboveground, Outdoor Duct and Plenum 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.

2.3 FLEXIBLE ELASTOMERIC INSULATION

Paragraph below is unsuitable for temperatures lower than minus 40°F and higher than 200°F. <Do not specify materials at greater than 3/4 thickness, to comply with smoke development shall not exceed 50.>

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

2.4 MINERAL-FIBER BLANKET INSULATION:

A. 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.

B. Products: Subject to compliance with requirements, provide one (1) of the following:

1. Johns Manville; Microlite.
2. Knauf Insulation; Friendly Feel Duct Wrap.
3. Owens Corning; SOFTR All-Service Duct Wrap.

2.5 MINERAL-FIBER BOARD INSULATION

A. Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, TYPE IA or TYPE IB. For duct and plenum applications, provide insulation [without Factory-Applied Jacket] [with Factory-Applied ASJ] [with Factory-Applied FSK Jacket]. Factory-Applied Jacket Requirements are specified in "Factory-Applied Jackets" article.

B. Products: Subject to compliance with requirements, provide one (1) of the following:

1. Johns Manville; 800 Series Spin-Glas.
2. Knauf Insulation; Insulation Board.
3. Owens Corning; Fiberglas 700 Series.

2.6 MINERAL-FIBER, PIPE AND TANK INSULATION

A. Mineral or glass fibers bonded with a thermosetting resin. Semi rigid 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. or more. Thermal conductivity (k-value) at 100°F is 0.29 BTU X IN./H X SQ. FT. X °F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" article.

B. Products: Subject to compliance with requirements, provide one (1) of the following:

1. Johns Manville; MicroFlex.
2. Knauf Insulation; Pipe and Tank Insulation.
3. Owens Corning; Fiberglas Pipe and Tank Insulation.

2.7 CELLULAR GLASS

A. Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" article.

<MOST PROJECTS DO NOT REQUIRE CELLULAR GLASS. DELETE WHEN NOT APPLICABLE.>

B. Products: Subject to compliance with requirements, provide one (1) of the following:

1. Pittsburgh Corning Corporation; Foamglas.
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. <If retaining both types of insulation in first two (2) subparagraphs below, indicate where each type applies in insulation system schedules.>
6. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
7. Preformed Pipe Insulation with Factory-Applied [ASJ] [ASJ-SSL]: Comply with ASTM C 552, Type II, Class 2.
8. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.

2.8 CALCIUM SILICATE

<CALCIUM SILICATE IS FOR SURFACE TEMPERATURES TO 1600 DEG F.>

A. Products: Subject to compliance with requirements, provide one (1) of the following:

1. Industrial Insulation Group (IIG); Thermo-12 Gold.
2. Preformed Pipe Sections: 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.
3. 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.
4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in preforming insulation to cover valves, elbows, tees, and flanges

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

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Aeroflex USA, Inc.; Aeroseal.
b. Armacell LLC; Armaflex 520 Adhesive.
c. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-75.K-Flex USA; R-373 Contact Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 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 Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-127.Eagle Bridges - Marathon Industries; 225.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-60/85-70.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, 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 Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

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

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-82.Eagle Bridges - Marathon Industries; 225.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 85-50.Mon-Eco Industries, Inc.; 22-25.

2. For indoor applications, adhesive shall have a VOC content of 50 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 Health Services' "Standard Practice for the Testing of

Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

E. PVC Jacket Adhesive: Compatible with PVC jacket.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

   a. Dow Corning Corporation; 739, Dow Silicone.
   b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
   c. P.I.C. Plastics, Inc.; Welding Adhesive.
   d. Speedline Corporation; Polyco VP Adhesive.

2. For indoor applications, adhesive shall have a VOC content of 50 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 Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.10 MASTICS

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

1. For indoor applications, use mastics that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

1. Products: Subject to compliance with requirements, provide one (1) of the following**:**

   a. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-80/30-90.
   b. Vimasco Corporation; 749.

2. Water-Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.013 perm at 43-mil dry film thickness.
3. Service Temperature Range: -20°F to +180°F.
4. Solids Content: ASTM D 1644, 58% by volume and 70% by weight.
5. Color: White.

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

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-10.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 46-50.

2. Water-Vapor Permeance: ASTM F 1249, 1.8 perms at 0.0625-inch dry film thickness.
3. Service Temperature Range: -20°F to +180°F.
4. Solids Content: 60% by volume and 66% by weight.
5. Color: White.

2.11 LAGGING ADHESIVES

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

1. For indoor applications, use lagging adhesives that have a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
2. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-50 AHV2.Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 30-36.
b. Vimasco Corporation; 713 and 714.

3. Fire-resistant, water-based lagging adhesive and coating for use indoors to adhere fire-resistant lagging cloths over duct insulation.
4. Service Temperature Range: 0°F to +180°F.
5. Color: White.

2.12 SEALANTS

A. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.Eagle Bridges - Marathon Industries; 405.
b. Foster Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; 95-44.
c. Mon-Eco Industries, Inc.; 44-05.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40°F to +250°F.
5. Color: Aluminum.
6. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
7. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

B. ASJ Flashing Sealants, and Vinyl and PVC Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; CP-76.

2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire- and water-resistant, flexible, elastomeric sealant.
4. Service Temperature Range: -40°F to +250°F.
5. Color: White.
6. One or both subparagraphs below may be required to comply with Project requirements or authorities having jurisdiction. Retain first subparagraph below if required for LEED-NC, LEED-CI, or LEED-CS Credit IEQ 4.1.
7. For indoor applications, sealants shall have a VOC content of 420 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
8. Retain subparagraph below if required for LEED for Schools Credit IEQ 4.
9. Sealants shall comply with the testing and product requirements of the California Department of Health Services' "Standard Practice for the Testing of Volatile Organic Emissions from Various Sources Using Small-Scale Environmental Chambers."

2.13 FACTORY-APPLIED JACKETS <Delete types of jackets not used for particular project>

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

1. ASJ: White, kraft-paper, fiberglass-reinforced scrim with aluminum-foil backing; complying with ASTM C 1136, Type I.
2. ASJ-SSL: ASJ with self-sealing, pressure-sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum-foil, fiberglass-reinforced scrim with kraft-paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum-foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96/E 96M, Procedure A, and complying with NFPA 90A and NFPA 90B.

2.14 FIELD-APPLIED CLOTHS <Delete types of jackets not used for particular project>

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

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

2.15 FIELD-APPLIED JACKETS

A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.

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

C. PVC Jacket: High-impact-resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop cutting and forming. Thickness twenty (20) mil-thick.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. Johns Manville; Zeston.
b. P.I.C. Plastics, Inc.; FG Series.
c. Proto Corporation; LoSmoke.
d. Speedline Corporation; SmokeSafe.

2. Adhesive: As recommended by jacket material manufacturer.
3. Color: White.

D. Metal Jacket:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

   a. Childers Brand, Specialty Construction Brands, Inc., a business of H. B. Fuller Company; Metal Jacketing Systems.
   b. ITW Insulation Systems; Aluminum and Stainless Steel Jacketing.
   c. RPR Products, Inc.; Insul-Mate.

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

   a. Factory cut and rolled to size.
   b. Finish and thickness: Smooth finish, 0.016 inch thick.
   c. Moisture Barrier for Indoor Applications: 1-mil thick, heat-bonded polyethylene and kraft paper.

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

   a. Factory cut and rolled to size.
   b. Material316, 0.10-inch thick, No 2B finish.
   c. Moisture Barrier for Indoor Applications: 1-mil-thick, heat-bonded polyethylene and kraft paper.

2.16 TAPES

A. ASJ Tape: White vapor-retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one of the following:
   a. ABI, Ideal Tape Division; 428 AWF ASJ.
   b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0836.
   c. Compac Corporation; 104 and 105.
   d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.

2. Width: Four (4) inches.

B. FSK Tape: Foil-face, vapor-retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. ABI, Ideal Tape Division; 491 AWF FSK.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
c. Compac Corporation; 110 and 111.
d. Venture Tape; 1525 CW NT, 1528 CW, and 1528 CW/SQ.

2. Width: Four (4) inches.

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

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. ABI, Ideal Tape Division; 370 White PVC tape.
b. Compac Corporation; 130.
c. Venture Tape; 1506 CW NS.

2. Width: Four (4) inches (50 mm).

D. Aluminum-Foil Tape: Vapor-retarder tape with acrylic adhesive.

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. ABI, Ideal Tape Division; 488 AWF.
b. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
c. Compac Corporation; 120.
d. Venture Tape; 3520 CW.

2. Width: Four (4) inches (50 mm).

2.17 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, provide one (1) of the following:

a. ITW Insulation Systems; Gerrard Strapping and Seals.
b. RPR Products, Inc.; Insul-Mate Strapping, Seals, and Springs.

2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304; 0.015 inch thick, three quarter (3/4) inch wide with wing seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, three quarter (3/4) inch wide with wing seal.

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 diameter shank, length to suit depth of insulation indicated.

   a. Products: Subject to compliance with requirements, provide one (1) of the following:

      1) AGM Industries, Inc.; CWP-1.
      2) GEMCO; CD.
      3) Midwest Fasteners, Inc.; CD.
      4) Nelson Stud Welding; TPA, TPC, and TPS.

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

   a. Products: Subject to compliance with requirements, provide one (1) of the following:

      1) AGM Industries, Inc.; Tactoo Perforated Base Insul-Hangers.
      2) GEMCO; Perforated Base.
      3) Midwest Fasteners, Inc.; Spindle.

   b. Baseplate: Perforated, galvanized carbon-steel sheet, 0.030 inch thick by two (2) inches square.
   c. Spindle: Copper- or zinc-coated, low-carbon steel, fully annealed, 0.106-inch-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, and securely in position indicated when self-locking washer is in place. Comply with the following requirements:

   a. Products: Subject to compliance with requirements, provide one (1) of the following:

      1) GEMCO; Nylon Hangers.
      2) Midwest Fasteners, Inc.; Nylon Insulation Hangers.

b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by one and one half (1-1/2) inches in diameter.
c. Spindle: Nylon, 0.106-inch-diameter shank, length to suit depth of insulation indicated, up to two and one half (2-1/2) inches.
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. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch-thick, galvanized-steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than one and one half (1-1/2) inches in diameter.

a. Products: Subject to compliance with requirements, provide one (1) of the following:

1) AGM Industries, Inc.; RC-150.
2) GEMCO; R-150.
3) Midwest Fasteners, Inc.; WA-150.
4) Nelson Stud Welding; Speed Clips.

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

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

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

D. Wire: 0.062-inch soft-annealed, stainless steel.

2.18 CORNER ANGLES

A. Material and thickness shall be same as jacket.

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 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.

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 ducts and fittings.

B. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system 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.

J. 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.

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

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

1. Draw jacket tight and smooth.
2. Cover circumferential joints with three (3) inch-wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced four (4) inches o.c.
3. Overlap jacket longitudinal seams at least one and one half (1-1/2) inches. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at two (2) inches 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 and at ends adjacent to duct flanges and fittings.

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

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

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

3.4 PENETRATIONS

A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside roof flashing at least two (2) inches (50 mm) below top of roof flashing.
4. Seal jacket to roof flashing with flashing sealant.

B. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

1. Seal penetrations with flashing sealant.
2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least two (2) inches.
4. Seal jacket to wall flashing with flashing sealant.

C. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.

D. Insulation Installation at Fire-Rated Wall and Partition Penetrations: Terminate insulation at fire damper sleeves for fire-rated wall and partition penetrations. Externally insulate damper sleeves to match adjacent insulation and overlap duct insulation at least two (2) inches.

1. Comply with requirements in Section "Penetration Firestopping" Firestopping and fire-resistive joint sealers.

E. Insulation Installation at Floor Penetrations:

1. Duct: For penetrations through fire-rated assemblies, terminate insulation at fire damper sleeves and externally insulate damper sleeve beyond floor to match adjacent duct insulation. Overlap damper sleeve and duct insulation at least two (2) inches.
2. Seal penetrations through fire-rated assemblies. Comply with requirements in Architectural Specification Section "Penetration Fire Stopping."

3.5 GENERAL PIPE INSULATION INSTALLATION

A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.

B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:

1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor-retarder integrity unless otherwise indicated.
2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be

butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.

3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below-ambient services, provide a design that maintains vapor barrier.
6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor-barrier mastic for below-ambient services and a breather mastic for above-ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.
9. Stencil or label the outside insulation jacket of each union with the word "union." Match size and color of pipe labels.

C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.

D. Install removable insulation covers at locations indicated. Installation shall conform to the following:

1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless-steel or aluminum bands. Select band material compatible with insulation and jacket.
3. Construct removable valve insulation covers in same manner as for flanges, except divide the two-part section on the vertical center line of valve body.
4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless-steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least two (2) inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

3.6 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

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

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
4. Finish flange insulation same as pipe insulation.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
3. Finish fittings insulation same as pipe insulation.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
2. Install insulation to flanges as specified for flange insulation application.
3. Finish valve and specialty insulation same as pipe insulation.

3.7 INSTALLATION OF CELLULAR-GLASS INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient services, secure laps with outward-clinched staples at six (6) inches o.c.
4. For insulation with factory-applied jackets on below-ambient services, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of cellular-glass block insulation of same thickness as pipe insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least one (1) inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
2. When preformed sections of insulation are not available, install mitered sections of cellular-glass insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of cellular-glass insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

3.8 INSTALLATION OF FLEXIBLE ELASTOMERIC INSULATION

A. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Insulation Installation on Pipe Flanges:

1. Install pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of sheet insulation of same thickness as pipe insulation.
4. Secure insulation to flanges and seal seams with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed valve covers manufactured of same material as pipe insulation when available.
2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.

3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

3.9 INSTALLATION OF MINERAL-FIBER INSULATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
3. For insulation with factory-applied jackets on above-ambient surfaces, secure laps with outward-clinched staples at six (6) inches o.c.
4. For insulation with factory-applied jackets on below-ambient surfaces, do not staple longitudinal tabs. Instead, secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral-fiber blanket insulation.
4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least one (1) inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed insulation elbows and fittings are not available, install mitered sections of pipe insulation, to a thickness equal to adjoining pipe insulation. Secure insulation materials with wire or bands.

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.

3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

3.10 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% 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 adhesives that are compatible with service temperature and with substrate.
    c. On tanks and vessels, maximum anchor-pin spacing is three (3) inches (75 mm) from insulation end joints, and sixteen (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 six (6) inches from each end. Install wire or cable between two circumferential girdles twelve (12) inches o.c. Install a wire ring around each end and around outer periphery of center openings and stretch prestressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of forty eight (48) inches o.c. Use this network for securing insulation with tie wire or bands.

7. Stagger joints between insulation layers at least three (3) inches.
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% 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 six (6) inch centers, starting at corners. Install 3/8-inch-diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
2. Fabricate boxes from galvanized steel, at least 0.040 inch 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.

3.11 INSTALLATION OF CALCIUM SILICATE INSULATION

A. Insulation Installation on Boiler Breechings:

1. Secure single-layer insulation with stainless-steel bands at twelve (12) inch intervals and tighten bands without deforming insulation material.
2. Install two (2) layer insulation with joints tightly butted and staggered at least three (3) inches. Secure inner layer with wire spaced at twelve (12) inch intervals. Secure outer layer with stainless-steel bands at twelve (12) inch 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 (1) layer of glass cloth. Overlap edges at least one (1) inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.

3.12 DUCT INSULATION

A. Installation Of Flexible Elastomeric Insulation:

1. Seal longitudinal seams and end joints with manufacturers recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

B. Installation Of Mineral-Fiber Insulation:

1. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
2. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50% coverage of duct and plenum surfaces.
3. Revise first subparagraph below to allow adhesive to be omitted from top surface of horizontal rectangular ducts.
4. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
5. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

    a. On duct sides with dimensions eighteen (18) inches and smaller, place pins along longitudinal centerline of duct. Space three (3) inches maximum from insulation end joints, and sixteen (16) inches o.c.
    b. On duct sides with dimensions larger than eighteen (18) inches, place pins sixteen (16) inches o.c. each way, and three (3) inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    d. Do not overcompress insulation during installation.
    e. Impale insulation over pins and attach speed washers.
    f. 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.

6. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams and end joints with insulation by removing two (2) inches from one (1) edge and one (1) end of insulation segment. Secure laps to adjacent insulation section with one half (1/2) inch outward-clinching staples, one (1) inch (25 mm) o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

    a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

b. Install vapor stops for ductwork and plenums operating below 50°F at eighteen (18) foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness, but not less than three (3) inches.

7. Overlap unfaced blankets a minimum of two (2) inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of eighteen (18) inches o.c.
8. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
9. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with six (6) inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced six (6) inches o.c.

C. Board Insulation Installation on Ducts and Plenums:

1. Secure with adhesive and insulation pins.
2. Apply adhesives according to manufacturer's recommended coverage rates per unit area, for 50% coverage of duct and plenum surfaces.
3. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
4. Install either capacitor-discharge-weld pins and speed washers or cupped-head, capacitor-discharge-weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:

   a. On duct sides with dimensions eighteen (18) inches and smaller, place pins along longitudinal centerline of duct. Space three (3) inches maximum from insulation end joints, and sixteen (16) inches o.c.
   b. On duct sides with dimensions larger than eighteen (18) inches, space pins sixteen (16) inches o.c. each way, and three (3) inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
   c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
   d. Do not overcompress insulation during installation.
   e. 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. For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Create a facing lap for longitudinal seams

and end joints with insulation by removing two (2) inches from one edge and one end of insulation segment. Secure laps to adjacent insulation section with one half (1/2) inch outward-clinching staples, one (1) inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
b. Install vapor stops for ductwork and plenums operating below 50°F at eighteen (18) foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to two (2) times the insulation thickness, but not less than three (3) inches.

6. Install insulation on rectangular duct elbows and transitions with a full insulation section for each surface. Groove and score insulation to fit as closely as possible to outside and inside radius of elbows. Install insulation on round and flat-oval duct elbows with individually mitered gores cut to fit the elbow.
7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with six (6) inch-wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced six (6) inches o.c.

3.13 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 two (2) inch overlap at seams and joints.
2. Embed glass cloth between two 0.062-inch-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 one half (1-1/2) inch laps at longitudinal seams and three (3) inch 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 one (1) inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturers recommended adhesive.

1. Apply two (2) 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 two (2) inch overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless-steel bands twelve (12) inches o.c. and at end joints.

3.14 FINISHES

A. Insulation with ASJ, Glass-Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below and as specified in Architectural Specification Sections for "Exterior Painting" and/or "Interior Painting."

1. Flat Acrylic Finish: Two (2) 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 (2) 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.

3.15 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:

1. Inspect ductwork, 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 duct system defined in the "Duct Insulation Schedule, General" Article.

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

3.16 INSULATION SCHEDULES

A. General: Mechanical System Descriptions for Plumbing, HVAC and Abbreviations used in the following schedules include:

1. Pipe System Descriptions for HVAC Systems:
   a. Cold HVAC Hydronic Piping Systems: Includes Chilled Water, Glycol Chilled Water, and Condenser Water Piping.
   b. Hot HVAC Piping Systems: Includes Heating Hot Water, and Heating Glycol (Energy Recovery) Piping.
   c. High Temperature Heating Piping Systems: Includes Steam Supply Piping, Steam Condensate, Piping, Steam Drain Piping, and Steam Vent Piping for HP, MP, LP Steam Systems.
   d. HVAC Refrigerant Piping Systems: Includes Refrigerant Piping serving the following types of systems:
      1) Split System Dx System: Split system with air cooled condensing unit with compressor and indoor A/C Unit.
      2) Water Cooled Split System: Split system with air cooled condensing units without compressor and indoor A/C Unit with compressor.

2. Duct System Descriptions for HVAC:
   a) Concealed Interior Duct Systems include: Supply Air Duct Systems, and Return Air Duct Systems.
   b) Exposed Interior Duct Systems include: Supply Air Duct Systems, and Return Air Duct Systems, and Fresh Air Intake Ducts and Plenums.
   c) Exposed Exterior Duct Systems include: Supply Air Duct Systems, and Return Air Duct Systems.
   d) Concealed Interior Sound Lined Duct Systems include: Low Pressure (LP) Supply Air Duct Systems, and LP Return Air and Exhaust Duct Systems between the Terminal Unit and the first elbow or branch duct to the Air Device.

3. Abbreviations:

   a. Field-Applied Jackets:

      1) P: PVC.
      2) GC: Glass Cloth.
      3) A: Aluminum.
      4) SS: Stainless Steel.
      5) ASJ: All Service Jacket.

   b. Pipe Sizes - NPS: Nominal Pipe Size.

c. N/A: Not Applicable.
d. MER: Mechanical Equipment Room.
e. WP: Weather Proof Covering.

B. Insulation Schedules:

HVAC SYSTEMS – HYDRONIC PIPING						
Pipe System	**Pipe Size in Inches (NPS)**	**Materials**	**Thickness in Inches**	**Vaper Barrier Required**	**Field Applied Jacket - MER**	**Field Applied Jacket - NON MER**
A/C Condensate Drain Piping - 40ºF - 110ºF	1/2 to 1, Branch Run – outs	Fiberglass Flexible Elastomeric	1/2 1/2	Yes Yes	G C G C	P P
	1/2 to 1-1/2	Fiberglass	1	Yes	G C	P
	2 to 36	Fiberglass	1-1/2	Yes	N / A	P
Concealed Interior Cold HVAC Piping Systems, 0ºF - 100ºF	1/2 to 2	Fiberglass Cellular Glass Flexible Elastomeric	1 1 3/4	Yes Yes Yes	None None None	None None None
	2-1/2 to 8	Fiberglass Cellular Glass	1- 1/2 1 -1/2	Yes Yes	None None	None None
	10 to 36	Fiberglass Cellular Glass	2 2	Yes Yes	None None	None None
Exposed Interior Cold HVAC Piping Systems, 0ºF - 100ºF	1/2 to 2	Fiberglass Cellular Glass Flexible Elastomeric	1 1 3/4	Yes Yes Yes	GC GC GC	P P P
	2 -1/2 to 8	Fiberglass Cellular Glass	1-1/2 1-1/2	Yes Yes	GC GC	P P
	10 to 36	Fiberglass Cellular Glass	2 2	Yes Yes	GC GC	P P

HVAC SYSTEMS – HYDRONIC PIPING						
Pipe System	**Pipe Size in Inches (NPS)**	**Materials**	**Thickness in Inches**	**Vaper Barrier Required**	**Field Applied Jacket -MER**	**Field Applied Jacket - NON MER**
Concealed Interior Hot HVAC Piping Systems, 100ºF - 250ºF	1/2 to 2	Fiberglass	1	N / A	None	None
	2 -1/2 to 8	Fiberglass	2	N / A	None	None
	10 to 36	Fiberglass	2 -1/2	N / A	None	None
Exposed Interior Hot HVAC Piping Systems, 100ºF - 250ºF	1/2 to 2	Fiberglass	1	N / A	None	None
	2 -1/2 to 8	Fiberglass	2	N / A	None	None
	10 to 36	Fiberglass	2 -1/2	N / A	None	None
Concealed Interior HVAC Steam and Condensate Piping Systems * 220ºF - 450ºF	1/2 to 2	Mineral Fiber or Calcium Silicate	2	N/A	None	None
	2-1/2 to 8	Mineral Fiber or Calcium Silicate	3	N/A	None	None
	* Steam Systems include Low (0 – 20 psig), Medium (60 psig) and High (125 psig) Pressure Systems.					
Exposed Interior HVAC Steam and Condensate Piping Systems ** 220ºF - 450ºF	1/2 to 2	Mineral Fiber or Calcium Silicate	2	N/A	Yes *	None
	2-1/2 to 8	Mineral Fiber or Calcium Silicate	3	N/A	Yes *	None
	* Field Applied Jacket shall be Aluminum or Stainless Steel. ** Steam Systems include Low (0 – 20 psig), Medium (60 psig) and High (125 psig) Pressure Systems.					

HVAC SYSTEMS – HYDRONIC PIPING						
Pipe System	**Pipe Size in Inches (NPS)**	**Materials**	**Thickness in Inches**	**Vaper Barrier Required**	**Field Applied Jacket - MER**	**Field Applied Jacket - NON MER**
Exposed Exterior Cold HVAC Piping Systems, 0ºF - 100ºF	1/2 to 2	Fiberglass Cellular Glass Flexible Elastomeric,	2 2 3/4	Yes Yes Yes	N / A N / A A,SS,GC*	A,SS,GC* A,SS,GC* A,SS,GC*
	2 -1/2 to 8	Fiberglass Cellular Glass Flexible Elastomeric	2 -1/2 2 -1/2 3/4	Yes Yes Yes	N / A	A,SS,GC* A,SS,GC* A,SS,GC*
	10 to 36	Fiberglass Cellular Glass	2 -1/2 3	Yes Yes	N / A	A,SS,GC* A,SS,GC*
	* Install Insulation and Field Applied Jacket over Freeze Protection Heat Tracing where indicated on the construction documents. Choose Jacket Option					
Exposed Exterior Hot HVAC Piping Systems, 100ºF - 250ºF	1/2 to 1-1/4	Fiberglass Cellular Glass Calcium Silicate	3 3 -1/2 3	N / A	GC A	GC A
	1-1/2 to 4	Fiberglass Cellular Glass Calcium Silicate	3 -1/2 4 3 -1/2	N / A	GC A	GC A
	5 to 10	Fiberglass Cellular Glass Calcium Silicate	4 -1/2 5 4 -1/2	N / A	GC A	GC A
	* Install Insulation and Field Applied Jacket over Freeze Protection Heat Tracing where indicated on the construction documents. Choose Jacket Option					

HVAC SYSTEMS – REFRIGERANT PIPING						
Pipe System	**Pipe Size in Inches (NPS)**	**Materials**	**Thickness in Inches**	**Vaper Barrier Required**	**Field Applied Jacket - MER**	**Field Applied Jacket - NON MER**
Exposed & Concealed Interior Refrigerant Piping	1/2 to 2	Fiberglass Cellular Glass Flexible Elastomeric,	2 2 3/4	Yes Yes Yes	N / A N / A A,SS,GC	A,SS,GC A,SS,GC A,SS,GC
Exposed Exterior Refrigerant Piping	1/2 to 2	Fiberglass Cellular Glass Calcium Silicate	3 3 -1/2 3	N / A	GC A	GC A
	* Install Insulation and Field Applied Jacket over Freeze Protection Heat Tracing where indicated on the construction documents. Choose Jacket Option					

HVAC SYSTEMS - EQUIPMENT						
System Equipment	**Materials**	**Form**	**Thickness in Inches**	**Vaper Barrier Required**	**Field Applied Jacket - MER**	**Field Applied Jacket - NON MER**
Exposed Interior Cold HVAC Equipment, Tanks and Pumps, 40ºF - 110ºF	Fiberglass Cellular Glass Flexible Elastomeric	Block or Board Block Sheet	2 1-1/2 1	Yes Yes Yes	GC GC None	GC GC None
Exposed Interior Hot HVAC Equipment, Tanks and Pumps, 100ºF - 250ºF	Fiberglass Cellular Glass	Block or Board Block	3 3	No No	GC GC	GC GC
Exposed Interior Steam Equipment, Tanks and Pumps, 250ºF - 450ºF	Fiberglass Cellular Glass	Block or Board Block	3 3	No No	GC GC	GC GC

HVAC SYSTEMS - DUCTWORK						
Duct System	**Materials**	**Form**	**Thickness in Inches**	**Vaper Barrier Required**	**Field Applied Jacket - MER**	**Field Applied Jacket - NON MER**
Concealed Interior HVAC Supply and Return Ducts and Plenums	Fiberglass	Blanket	1-1/2	Yes	None	None
Exposed Interior HVAC Supply and Return Ducts and Plenums	Fiberglass Fiberglass	Board - Rectangular or Square Pipe - Round	1-1/2 1-1/2	Yes Yes	None None	None None
Concealed Interior HVAC Fresh Air Ducts and Plenums	Fiberglass	Blanket	1-1/2	Yes	None	None
Exposed Interior HVAC Fresh Air Ducts and Plenums	Fiberglass	Board - Rectangular or Square	1-1/2	Yes	None	None
Exterior HVAC Supply and Return Ducts	Fiberglass	Rigid Board	3	Yes	None	WP Covering
Lined Interior Supply, Return, Exhaust Ducts	Fiberglass	Board - Rectangular or Square	1-1/2	No	None	None

END OF SECTION 230700