SECTION 230713 - DUCT INSULATION Updated 10/2019  
  
This Section may be edited and revised by inserting or deleting text to meet requirements specific to your project. The Document is provided in a modified format.

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

Indoor, concealed supply and outdoor air.

Indoor, exposed supply and outdoor air.

Indoor, concealed return located in unconditioned space.

Indoor, exposed return located in unconditioned space.

Indoor, concealed, Type I, commercial, kitchen hood exhaust.

Indoor, exposed, Type I, commercial, kitchen hood exhaust.

Indoor, concealed oven and ware wash exhaust.

Indoor, exposed oven and ware wash exhaust.

Indoor, concealed exhaust between isolation damper and penetration of building exterior.

Indoor, exposed exhaust between isolation damper and penetration of building exterior.

Outdoor, concealed supply and return.

Outdoor, exposed supply and return.

* + - * 1. Related Sections:

Section 230716 "HVAC Equipment Insulation."

Section 230719 "HVAC Piping Insulation."

Section 233113 "Metal Ducts" for duct liners.

* + - 1. REFERENCE STANDARDS
         1. ASTM International (ASTM).
         2. American Society of Heating, Refrigerating, and Air Conditioning Engineers, Inc. (ASHRAE).
         3. North American Insulation Manufacturers Association (NAIMA).
         4. NAIMA – "Guide to Insulating Chilled Water Piping Systems with Mineral Fiber Pipe Insulation".
         5. "National Commercial & Industrial Insulation Standards" – MICA Manual.
         6. Thermal Insulation Association of Canada (TIAC).
         7. National Fire Protection Association (NFPA).
         8. Sheet Metal and Air Conditioning Contractors National Association, Inc. (SMACNA).
         9. Underwriter's Laboratories (UL).
         10. Underwriter's Laboratories Environment (UL Environment).
         11. ASHRAE 189.1 – “Standard for the Design of High-Performance Green Buildings Except   
             Low-Rise Residential Buildings”.
         12. California Department of Public Health - "Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers". Formaldehyde emissions shall not exceed 16.5 mcg/cu. m or 13.5 ppb, whichever is less, except for insulation manufactured without formaldehyde.
      2. DEFINITIONS
         1. Thermal Conductivity (K value): Heat flow property of a homogeneous material; the lower the “k” the better the insulating value. Expressed in units of Btu-inch/hour per square foot per degree F.
         2. Underwriters Laboratories Environment (UL Environment): independent, third-party green claims validation, product assessment and certification.

1. Environmental Claim Validation (ECV): Independent third-party review to single attribute environmental claims.  
  
 a. Formaldehyde Free: Independent third-party validation of claim that a product does not contain formaldehyde (or formaldehyde precursors) using a combination of auditing raw material input and testing of chemical emission from the product.  
 b. Recycled Content:  
  
 1. Pre-Consumer - materials used or created from one manufacturing process which are collected as scrap and placed back into another manufacturing process rather than being placed in a landfill or incinerated.  
 2. Post-Consumer - materials such as bottled glass collected at curbside or other collection sites after consumer use.  
  
2. GREENGUARD Certification: Health based emission testing criteria for chemicals; requiring total VOC emission levels for products.  
  
  
  
  
  
3. GREENGUARD Gold: Emission testing criteria for chemicals requiring lower total VOC emission limit levels for products acceptable for use in environments such as schools and healthcare facilities. Complies with California’s Department of Public Health (CDPH) “Standard Method for the Testing and Evaluation of Volatile Organic Chemical Emissions from Indoor Sources Using Environmental Chambers”; Version 1.1 (2010), also known as California Section 01350 .   
4. Environmental Product Declaration (EPD): Independently verified and registered document providing information about the life-cycle impact of products.

* + - * 1. Health Product Declaration (HPD): Product disclosure document containing an inventory of the contents of a product for its end use and the associated health hazards.
        2. EPA: Environmental Protection Agency.
        3. WHO: World Health Organization.
        4. NIA – National Insulation Association - Thermal Insulation Certified Inspector Program: a recommended certified mechanical insulation inspector program that utilizes inspectors who maintain current certification by NIA to inspect and verify the materials used are, and the total insulation system has been, installed correctly in accordance with the Specifications; throughout the project.
        5. ILFI: International Living Institute; an international sustainable building certification program.

1. DECLARE: Ingredients label for Building Products  
  
 a. Red List Free: 100% ingredients disclosure to 100 ppm to not contain any Red List chemicals of concern.  
 b. LBC Red List Compliant: Ingredients disclosure to meet 99% of Red List chemicals at 100 ppm and may contain one or more exceptions for meeting Living Building Challenge (LBC) criteria.  
 c. Declared: 100% ingredients disclosure to 100 ppm, but contains one or more Red List chemicals that are covered by an existing exception.

* + - * 1. LEED: Leadership in Energy and Environmental Design, a voluntary rating system for high performance green buildings developed by the US Green Building Council (USGBC).
        2. Sustainable Minds (SM) Transparency Catalog: Designed as an educational marketing platform to provide access to products with environmental and material disclosures that qualify for Collaborative for High Performance Schools, LEED v4, Green Globes, the Well Building Standard and the Living Building Challenge ­– from all manufacturers, all program operators and all material disclosure rating systems. Available at: [**www.transparencycatalog.com/showroom/knauf-insulation**](http://www.transparencycatalog.com/company/knauf-insulation).
        3. EUCEB: The European Certification Board for Mineral Wool Products, a voluntary certification of the conformity to meet the bio-solubility criteria of mineral wool fibers.
        4. Polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE or Deca-BDE fire retardants: used in the manufacture of some insulation facings.
        5. UL Classified: Underwriters Laboratory product label of fire resistance testing that includes  
           on-going evaluation of the product to assure it continues to meet the Fire Hazard Classification (FHC) 25 Flame Spread; 50 Smoke Developed rating; unlike other FHC testing which is a one-time only test.
        6. ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film layer leaving no paper exposed.
        7. ASJ: All Service Jacket (no outer film).
        8. FSK: Foil Scrim Kraft; jacketing.
        9. PSK: Poly Scrim Kraft; jacketing.
        10. PVC: Poly Vinyl Chloride.
      1. ACTION SUBMITTALS
         1. Product Data: For each type of product indicated. Include thermal conductivity, water vapor permeance, thickness, and jackets (both factory and field-applied if any).
         2. EPD or HPD Submittals: Third Party Validated.
         3. Sustainable Design Submittals:

1. Product Data: For recycled content, indicating postconsumer and pre-consumer recycled content and cost.  
2. Product Data: For adhesives, indicating VOC content.  
3. Laboratory Certificates or Validations: For adhesives, indicating compliance with   
 requirements for low-emitting materials.  
4. Laboratory Certificates or Validations: For insulation, indicating compliance with   
 requirements for low-emitting materials.

* + - * 1. LEED v 4 Submittals:

Product Data for Credit Energy and Atmosphere (EA) – Minimum Energy Performance, Optimize Energy Performance.

Product Data for Credit Materials and Resources (MR) – Building Product Disclosure & Optimization – EPD, Building Product Disclosure & Optimization – Source of Raw Materials, Building Product Disclosure & Optimization – Material Ingredients.

Product Data for Credit Indoor Environmental Quality (EQ) – Minimum Indoor Quality Performance, Minimum Acoustic Performance, Low Emitting Materials.

* + - * 1. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

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

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

Detail application of field-applied jackets.

Detail application at linkages of control devices.

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

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

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

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

* + - 1. INFORMATIONAL SUBMITTALS
         1. Qualification Data: For qualified Installer.
         2. 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.
         3. Field quality control reports.
      2. QUALITY ASSURANCE
         1. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
         2. Knauf Insulation recommends the use of the NIA – National Insulation Association, Thermal Insulation Certified Inspector Program (as defined in 1.4 F – above).
         3. Bio-Based Binder: a plant based sustainable chemistry bond that holds the fiberglass product together; replacing the phenol/formaldehyde (PF) binder traditionally used in fiberglass products.
         4. Surface Burning Characteristics: For insulation and related materials, UL/ULC Classified per UL 723 or meeting 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.

Insulation Installed Indoors: Flame spread index of 25 or less, and smoke developed index of 50 or less.

Insulation Installed Outdoors: Flame spread index of 75 or less, and smoke developed index of 150 or less.

* + - * 1. Products shall not contain formaldehyde, asbestos, lead, mercury, or mercury compounds   
           **[if** **available]**. Products shall be Certified UL GREENGUARD Gold or Indoor Advantage Gold **[if** **available]**.
        2. Biosoluble Fiber: Certified by European Certification Board for Mineral Wool Products (EUCEB).
        3. Recycled Content: A minimum of 50 percent recycled glass content certified and UL Validated.
        4. Declare LBC Red List Compliant; minimum.
        5. Products shall contain no polybrominated diphenyl ethers (PBDE) such as Penta-BDE, Octa-BDE or Deca-BDE fire retardants; whenever available.
        6. Mockups: Before installing insulation, provide mockups for each type of insulation and finish listed below to demonstrate quality of insulation application and finishes. Mockups shall be labeled with the location indicated or, if not indicated, as directed by Architect. Use materials indicated for the completed Work.

Ductwork Mockups:

One 10 foot (3 m) section each of rectangular and round straight duct.

One each of a 90 degree mitered round and rectangular elbow, and one each of a 90 degree radius round and rectangular elbow.

One rectangular branch takeoff and one round branch takeoff from a rectangular duct. One round tee fitting.

One rectangular and round transition fitting.

Four support hangers for round and rectangular ductwork.

Each type of damper and specialty.

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

Notify Architect seven days in advance of dates and times when mockups will be constructed.

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

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

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

Demolish and remove mockups when directed.

* + - 1. DELIVERY, STORAGE, AND HANDLING
         1. Packaging: Insulation material containers shall be marked by manufacturer with appropriate ASTM standard designation, type and grade, and maximum use temperature.
      2. COORDINATION
         1. Coordinate sizes and locations of supports, hangers, and insulation shields specified in Section 230529 "Hangers and Supports for HVAC Piping and Equipment."
         2. 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.
         3. Coordinate installation and testing of heat tracing.
      3. SCHEDULING
         1. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
         2. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

1. PRODUCTS
   * + 1. INSULATION MATERIALS
          1. 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.
          2. Insulation materials applied to carbon steel shall be Mass Loss Corrosion Rate (MLCR) tested per ASTM 1617.
          3. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
          4. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
          5. Products shall comply with the standards in Section 1.7 – Quality Assurance.
          6. Fiberglass Blanket Insulation: Fiberglass bonded with a bio-based thermosetting resin. Comply with ASTM C 553, Types I, II, and III, ASTM C 1136 Type II, and ASTM C 1290, Type III. UL/ULC Classified per UL 723 for FSK, FHC 25/50 per ASTM E 84 for PSK only.   
             Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

Basis-of-Design Product: Subject to compliance with requirements, provide Knauf Insulation; Atmosphere Duct Wrap.

* + - * 1. Fiberglass Board Insulation: Fiberglass bonded with a bio-based thermosetting resin. UL/ULC Classified per UL 723 for unfaced, ASJ, ASJ+ and FSK; FHC 25/50 per ASTM E 84 for PSK only. 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 ASJ+ jacket**] [**with factory-applied FSK jacket**]. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

Basis-of-Design Product: Subject to compliance with requirements, provide Knauf Insulation; Earthwool Insulation Board.

* + - * 1. Fiberglass Pipe and Tank Insulation: Fiberglass bonded with a bio-based thermosetting resin. Semi-rigid board material with factory-applied [**ASJ**] [**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. Compressive Strength per ASTM C 165, not less than 102 PSF (5.75 kPa) at 10% deformation. Thermal conductivity (k-value) at 100 deg. F (38 deg. C) is 0.26 Btu x in. /h x sq. ft. x deg. F (0.037 W/m x C) or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

Basis-of-Design Product: Subject to compliance with requirements, provide Knauf Insulation; Earthwool Pipe and Tank Insulation.

I. Fiberglass Pipe and Tank Insulation: Fiberglass bonded with a thermosetting resin. Semi-rigid   
 blanket material with factory-applied [**ASJ**] [**FSK] [PSK]** jacket, complying with   
 ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612,   
 Type IB. Compressive Strength; per ASTM C 165, not less than 25 PSF (1.2 kPa) at 10%   
 deformation. Thermal conductivity (k value) at 100 deg. F (38 deg. C) is 0.25 Btu x in./h x   
 sq. ft. x deg. F (0.036 W/m x C). Factory-applied jacket requirements are specified in “Factory-  
 Applied Jackets” Article.

1. Basis-of-Design Product: Subject to compliance with requirements, provide Knauf  
 Insulation; Kwik-Flex Pipe and Tank Insulation.

* + - 1. FIRE RATED INSULATION SYSTEMS
         1. Fire Rated Board: Structural grade, press molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 1700 deg. F (927 deg. C). Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a [**1**] [**2**] hour fire rating by an NRTL acceptable to authorities having jurisdiction.
         2. Fire Rated Blanket: High temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a [**1**] [**2**] hour fire rating by an NRTL acceptable to authorities having jurisdiction.
      2. ADHESIVES
         1. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to itself and to surfaces to be insulated unless otherwise indicated.
         2. Mineral Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.

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).

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."

* + - * 1. ASJ Adhesive, and FSK Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.

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).

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."

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

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).

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."

* + - 1. MASTICS
         1. Materials shall be compatible with insulation materials, jackets, and substrates.

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).

* + - * 1. Vapor Barrier Mastic: Water based; suitable for indoor use on below ambient services.

Water Vapor Permeance: ASTM E 96/E 96M, Procedure B, 0.04 perm (0.026 metric perm) at 40 mil (1.016 mm) dry film thickness.

Service Temperature Range: Minus 20 to plus 180 deg. F (Minus 29 to plus 82 deg. C).

Solids Content: ASTM D 1644, 52 percent by volume and 62 percent by weight.

Color: White.

* + - * 1. Vapor Barrier Mastic: Solvent based; suitable for indoor use on below ambient services.

Water Vapor Permeance: ASTM F 1249, 0.05 perm (0.03 metric perm) at 35 mil   
(0.9 mm) dry film thickness.

Service Temperature Range: 0 to 180 deg. F (Minus 18 to plus 82 deg. C).

Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.

Color: White.

* + - * 1. Vapor Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.

Water Vapor Permeance: ASTM F 1249, 0.05 perm (0.033 metric perm) at 30 mil   
(0.8 mm) dry film thickness.

Service Temperature Range: Minus 50 to plus 220 deg. F (Minus 46 to plus 104 deg. C).

Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.

Color: White.

* + - * 1. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.

Water Vapor Permeance: ASTM F 1249, 1.8 perm (1.2 metric perm) at 0.0625 inch   
(1.6 mm) dry film thickness.

Service Temperature Range: Minus 20 to plus 180 deg. F (Minus 29 to plus 82 deg. C).

Solids Content: 50 percent by volume and 58 percent by weight.

Color: White.

* + - 1. LAGGING ADHESIVES
         1. Description: Comply with MIL-A-3316C, Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.

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).

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

Service Temperature Range: 0 to plus 180 deg. F (Minus 18 to plus 82 deg. C).

Color: White.

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

Materials shall be compatible with insulation materials, jackets, and substrates.

Fire and water resistant, flexible, elastomeric sealant.

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

Color: Aluminum.

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).

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."

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

Materials shall be compatible with insulation materials, jackets, and substrates.

Fire and water resistant, flexible, elastomeric sealant.

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

Color: White.

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).

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."

* + - 1. FACTORY-APPLIED JACKETS
         1. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:

ASJ+: All Service Jacket composed of aluminum foil reinforced with glass scrim bonded to a kraft paper interleaving with an outer film leaving no paper exposed; complying with ASTM C 1136 Type I, II, III, IV and VII.

ASJ: White, kraft paper, fiberglass reinforced scrim with aluminum foil backing; complying with ASTM C 1136, Type I.

FSK Jacket: Aluminum foil, fiberglass reinforced scrim with kraft paper backing; complying with ASTM C 1136, Type II.

PSK Jacket: Aluminum foil, fiberglass reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.

* + - 1. FIELD-APPLIED FABRIC-REINFORCING MESH
         1. 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 ducts.
         2. 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 ducts.
      2. FIELD-APPLIED CLOTHS
         1. Woven Glass Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz. /sq. yd. (271 g/sq. m).
      3. FIELD-APPLIED JACKETS
         1. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
         2. FSK Jacket: Aluminum foil face, fiberglass reinforced scrim with kraft paper backing.
         3. 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.

Adhesive: As recommended by jacket material manufacturer.

Color: [**White**] [**Color code jackets based on system. Color as selected by Architect**].

* + - * 1. Metal Jacket:

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

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

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

Moisture Barrier for Indoor Applications: [**1 mil (0.025 mm) thick, heat bonded polyethylene and kraft paper**] [**3 mil (0.075 mm) thick, heat bonded polyethylene and kraft paper**] [**2.5 mil (0.063 mm) thick polysurlyn**].

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

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

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

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

Moisture Barrier for Indoor Applications: [**1 mil (0.025 mm) thick, heat bonded polyethylene and kraft paper**] [**3 mil (0.075 mm) thick, heat bonded polyethylene and kraft paper**] [**2.5 mil (0.063 mm) thick polysurlyn**].

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

* + - * 1. Self-Adhesive Outdoor Jacket: 60 mil (1.5 mm) thick, laminated vapor barrier and waterproofing membrane for installation over insulation located aboveground outdoors; consisting of a rubberized bituminous resin on a cross laminated polyethylene film covered with [**white**] [**stucco embossed**] aluminum foil facing.
      1. TAPES
         1. ASJ Tape: White vapor retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.

Width: 3 inches (75 mm) or 4 inches (102 mm).

Thickness Total: [**11.5 mil (0.29 mm) for ASJ**] [**13.3 mil (0.34 mm) for ASJ+**].

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

Elongation: 2 percent.

Tensile Strength: 40 Lbf/inch (7.2 N/mm) in width.

ASJ Tape Disks and Squares: Precut disks or squares of ASJ tape.

* + - * 1. FSK Tape: Foil face, vapor retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.

Width: 3 inches (75 mm) or 4 inches (102 mm).

Thickness Total: 13.3 mil (0.34 mm).

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

Elongation: 2 percent.

Tensile Strength: 40 Lbf/inch (7.2 N/mm) in width.

FSK Tape Disks and Squares: Precut disks or squares of FSK tape.

* + - * 1. PVC Tape: White vapor retarder tape matching field-applied PVC jacket with acrylic adhesive; suitable for indoor and outdoor applications.

Width: 2 inches (50 mm).

Thickness: 6 mil (0.15 mm).

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

Elongation: 500 percent.

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

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

Width: 2 inches (50 mm), 3 inches (76 mm), or 4 inches (102 mm).

Thickness Total: 7.3 mil (0.19 mm).

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

Elongation: 5 percent.

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

* + - 1. SECUREMENTS
         1. Bands:

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**].

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**].

Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

* + - * 1. Insulation Pins and Hangers:

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

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.

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. Comply with the following requirements:

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

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

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

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

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

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

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

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

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

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

Adhesive backed base with a peel off protective cover.

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

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

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

* + - * 1. Staples: Outward clinching insulation staples, nominal ¾ inch (19 mm) wide, stainless steel or Monel.
        2. 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. CORNER ANGLES
         1. PVC Corner Angles: [**30 mil (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.
         2. 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.
         3. Stainless Steel Corner Angles: [**0.024 inch (0.61 mm)**] <**Insert dimension**> thick, minimum   
            1 by 1 inch (25 by 25 mm), stainless steel according to ASTM A 167 or ASTM A 240/A 240M, [**Type 304**] [**or**] [**Type 316**].

1. EXECUTION
   * + 1. EXAMINATION
          1. Examine substrates and conditions for compliance with requirements for installation tolerances and other conditions affecting performance of insulation application.

Verify that systems to be insulated have been tested and are free of defects.

Verify that surfaces to be insulated are clean and dry.

* + - * 1. Proceed with installation only after unsatisfactory conditions have been corrected.
      1. PREPARATION
         1. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application.
      2. GENERAL INSTALLATION REQUIREMENTS
         1. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of ducts and fittings.
         2. Install insulation materials, vapor barriers or retarders, jackets, and thicknesses required for each item of duct system as specified in insulation system schedules.
         3. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
         4. Install insulation with longitudinal seams at top and bottom of horizontal runs.
         5. Install multiple layers of insulation with longitudinal and end seams staggered.
         6. Keep insulation materials dry during application and finishing.
         7. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
         8. Install insulation with least number of joints practical.
         9. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers, supports, anchors, and other projections with vapor barrier mastic.

Install insulation continuously through hangers and around anchor attachments.

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

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

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

Draw jacket tight and smooth.

Cover circumferential joints with 3 inch (75 mm) wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches (100 mm) oc.

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)**] oc.

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

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

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

* + - * 1. Install insulation with self-sealing factory-applied jackets as follows:

Locate all longitudinal pipe insulation jacketing laps in least visible location.

Draw jacket tight and smooth.

For proper sealing, seal lap joints with reasonable pressure being applied with a plastic squeegee or sealing tool.

Vapor seal all circumferential joints with factory furnished matching pressure sensitive butt strips installed with reasonable pressure being applied with a plastic squeegee or sealing tool.

* + - * 1. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
        2. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
        3. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches (100 mm) beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
      1. PENETRATIONS
         1. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.

Seal penetrations with flashing sealant.

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

Extend jacket of outdoor insulation outside roof flashing at least 2 inches (50 mm) below top of roof flashing.

Seal jacket to roof flashing with flashing sealant.

* + - * 1. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.

Seal penetrations with flashing sealant.

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

Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches (50 mm).

Seal jacket to wall flashing with flashing sealant.

* + - * 1. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
        2. Insulation Installation at Fire Rated Wall and Partition Penetrations: 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 2 inches (50 mm).

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

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

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 2 inches (50 mm).

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

* + - 1. INSTALLATION OF FIBERGLASS INSULATION
         1. Blanket Insulation Installation on Ducts and Plenums: Secure with insulation pins.

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:

Install Duct Wrap using manufacturer’s stretch-out tables to obtain specified   
R-value using a **Maximum Compression of 25%.**

Minimum Installed R-value shall be per ASHRAE 90.1; UCC Code; or other design criteria.

Firmly butt all joints.

The longitudinal seam of the vapor retarder must be overlapped a minimum of 2 inches. A 2 inch tab is provided on Knauf Atmosphere Duct Wrap for the circumferential seam. Secure all seams and overlaps using outward clinch staples approximately 6” on center. It is neither necessary nor desirable to adhere duct wrap to the duct surfaces with adhesive.

Where vapor retarder performance is required, all penetrations and damage to the facing shall be repaired using pressure-sensitive tape matching the facing, or mastic prior to system startup. Pressure-sensitive tapes shall be a minimum 3 inches wide and shall be applied with moving pressure using a squeegee or other appropriate sealing tool. Closure shall have a 25/50 Flame Spread/Smoke Developed Rating per UL 723.

Duct Wrap shall be additionally secured to the bottom of rectangular ductwork over 24 inches wide using mechanical fasteners on 18 inch centers. Care should be exercised to avoid over-compression of the insulation during installation.

Unfaced Duct Wrap shall be overlapped a minimum of 2 inches and fastened using 4 inch to 6 inch nails or skewers spaced 4 inches apart, or secured with a wire/banding system. Care should be exercised to avoid damage to the Duct Wrap.

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 2 inches (50 mm) from one edge and one end of insulation segment. Secure laps to adjacent insulation section with ½ inch (13 mm) outward clinching staples, 1 inch (25 mm) oc. Install vapor barrier consisting of vapor barrier acrylic based tape; matching the facing, or factory or field-applied jacket, adhesive, vapor barrier mastic, and sealant at joints, seams, and protrusions. Follow NAIMA's "Guide to Insulating Chilled Water Piping Systems with Mineral Fiber Pipe Insulation" for additional details when installing Pipe and Tank Insulation.

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

Install vapor stops for ductwork and plenums operating below 50 deg. F   
(10 deg. C) at 18 foot (5.5 m) 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 times the insulation thickness, but not less than 3 inches   
(75 mm).

Where vapor retarder performance is required, all penetrations and damage to the facing shall be repaired using pressure sensitive foil tape or mastic prior to system startup.

Pressure sensitive foil tapes shall be a minimum 3” wide and shall be applied with moving pressure using a squeegee or other appropriate sealing tool.

Overlap unfaced blankets a minimum of 2 inches (50 mm) on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches (450 mm) oc.

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.

Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6 inch (150 mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) oc.

* + - * 1. Board Insulation Installation on Ducts and Plenums: Secure with insulation pins.

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:

Apply insulation with joints butted as close as possible to the duct surface.

On duct sides with dimensions 18 inches (450 mm) and smaller, place pins along longitudinal centerline of duct. Space 3 inches (75 mm) maximum from insulation end joints, and 16 inches (400 mm) oc.

On duct sides with dimensions larger than 18 inches (450 mm), space pins   
16 inches (400 mm) oc. each way, and 3 inches (75 mm) maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.

Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.

Do not over compress insulation during installation.

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.

All joints shall be sealed using minimum 3 inch wide pressure sensitive, acrylic based tape; matching the facing. Tape shall be firmly rubbed; using a plastic squeegee or sealing tool to assure complete bond.

For ducts and plenums with surface temperatures below ambient, install a continuous unbroken vapor barrier. Install vapor barrier consisting of vapor barrier acrylic based tape; matching the facing, or factory or field applied jacket, adhesive, vapor barrier mastic, and sealant at joints, seams, and protrusions.

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

Install vapor stops for ductwork and plenums operating below 50 deg. F   
(10 deg. C) at 18 foot (5.5 m) 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 times the insulation thickness, but not less than 3 inches   
(75 mm).

All joints shall be sealed using minimum 3 inch wide pressure sensitive, acrylic based vapor barrier tape; matching the facing. Tape shall be firmly rubbed; using a plastic squeegee or sealing tool to assure complete bond.

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.

Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6 inch (150 mm) wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches (150 mm) oc.

C. Pipe & Tank Insulation

1. Apply on clean, dry surfaces.

2. Cut to appropriate length using manufacturers’ stretch out guide for the specific pipe size. Add an additional 2 inches (51 mm) to 4 inches (102 mm) for a staple flap.

3. Install insulation around the duct circumference in a manner that ensures a firm fiber mesh at all joints. Fasten the longitudinal with outward clinching staples placed 3 inches on center (76 mm). As an alternative, individual sections may be fastened in place using continuous and overlapping strands of ¾” wide glass fiber filament tape around the insulation jacketing O.D. Longitudinal and circumferential joints shall be sealed with 4” wide matching pressure sensitive tape squeegeed along the entire length.

4. For duct exposed to the elements, jacketing shall be UV resistant PVC with a minimum thickness of 0.030 inches, or 0.016 inches (0.406) thick aluminum with factory applied moisture barrier or 0.010 inches (0.254mm) thick stainless steel with a factory applied moisture barrier or laminated self-adhesive water and weather seals. Fitting covers shall be of similar materials. The insulation and jacketing shall be held firmly in place with a friction type Z lock or a minimum 2″ overlap joint. For systems operating below ambient, all PVC joints shall be sealed completely along the longitudinal and circumferential seams and installed so as to shed water. When required, all PVC circumferential joints shall be sealed by use of preformed butt strips; minimum 2″ wide or a minimum 2″ overlap. Butt strips shall overlap the adjacent jacketing a minimum ½ inch and be completely weather sealed. PVC Jacketing shall be limited to a maximum 20 inch OD of the insulation when exposed to direct sunlight. For systems operating above ambient, circumferential joints should overlap a minimum of 2″ and not be sealed. Insulation thickness for duct covered by PVC Jacketing shall be such that the surface temperature of the PVC does not exceed 125°F (52°C).

5. On below ambient straight duct, vapor retarder mastic shall be applied to raw glass fiber ends at 12 foot to 21 foot intervals; at the Engineer’s discretion, and on either side of fittings, flanges or valves before taping. Mastic shall extend a minimum of 2 inches onto the bore of the pipe and 2 inches onto the jacketing.

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

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

Embed glass cloth between two 0.062 inch (1.6 mm) thick coats of lagging adhesive.

Completely encapsulate insulation with coating, leaving no exposed insulation.

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

Draw jacket material smooth and tight.

Install lap or joint strips with same material as jacket.

Secure jacket to insulation using manufacturer's recommended adhesive.

Install jacket with 1-1/2 inch (38 mm) laps at longitudinal seams and 3 inch (75 mm) wide joint strips at end joints.

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

* + - * 1. Where PVC jackets are indicated, install with 2 inch (50 mm) overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal using manufacturer's recommended adhesive.

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

* + - * 1. Where metal jackets are indicated, install with 2 inch (50 mm) overlap at longitudinal seams and end joints. Overlap longitudinal seams arranged to shed water. Seal end joints with weatherproof sealant recommended by insulation manufacturer. Secure jacket with stainless steel bands 12 inches (300 mm) oc. and at end joints.
        2. Where self-adhesive outdoor jackets are indicated, install in strict accordance with manufacturer's recommended installation procedures.
      1. FIRE RATED INSULATION SYSTEM INSTALLATION
         1. Where fire rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
         2. Insulate duct access panels and doors to achieve same fire rating as duct.
         3. Install fire-stopping at penetrations through fire rated assemblies. Fire-stop systems are specified in Section 078413 "Penetration Fire-stopping."
      2. FINISHES
         1. Insulation with ASJ+, 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." **NOTE: Painting jacket MAY affect the FHC Classification of the insulation.**

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

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

* + - * 1. Color: Final color as selected by Architect / Engineer. Vary first and second coats to allow visual inspection of the completed Work.
        2. Do not field paint aluminum or stainless steel jackets.
      1. FIELD QUALITY CONTROL
         1. Testing Agency: [**Owner will engage**] [**Engage**] a qualified testing agency to perform tests and inspections.
         2. Perform tests and inspections.
         3. Tests and Inspections:

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.

* + - * 1. All insulation applications will be considered defective Work if sample inspection reveals noncompliance with requirements.
      1. DUCT INSULATION SCHEDULE, GENERAL
         1. Plenums and Ducts Requiring Insulation:

Indoor, concealed supply and outdoor air.

Indoor, exposed supply and outdoor air.

Indoor, concealed return located in unconditioned space.

Indoor, exposed return located in unconditioned space.

Indoor, concealed, Type I, commercial, kitchen hood exhaust.

Indoor, exposed, Type I, commercial, kitchen hood exhaust.

Indoor, concealed oven and ware wash exhaust.

Indoor, exposed oven and ware wash exhaust.

Indoor, concealed exhaust between isolation damper and penetration of building exterior.

Indoor, exposed exhaust between isolation damper and penetration of building exterior.

Outdoor, concealed supply and return.

Outdoor, exposed supply and return.

* + - * 1. Items Not Insulated:

Fiberglass ducts.

Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.

Factory-insulated flexible ducts.

Factory-insulated plenums and casings.

Flexible connectors.

Vibration control devices.

Factory-insulated access panels and doors.

* + - 1. INDOOR DUCT AND PLENUM INSULATION SCHEDULE
         1. Concealed, round and flat oval, supply air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

Fiberglass Pipe and Tank Insulation: [**1-1/2 inches (38 mm)**]   
[**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Concealed, round and flat oval, return air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

Fiberglass Pipe and Tank Insulation: [**1-1/2 inches (38 mm)**]   
[**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Concealed, round and flat oval, outdoor air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)** [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

3. Fiberglass Pipe and Tank Insulation: [**1-1/2 inches (38 mm)**]   
 [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Concealed, round and flat oval, exhaust air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

3. Fiberglass Pipe and Tank Insulation: [**1-1/2 inches (38 mm)**]   
 [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Concealed, rectangular, supply air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, rectangular, return air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, rectangular, outdoor air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, rectangular, exhaust air duct insulation between isolation damper and penetration of building exterior shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire rated [**blanket**] [**or**] [**board**]; thickness as required to achieve 2 hour fire rating.
        2. Concealed, supply air plenum insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, return air plenum insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, outdoor air plenum insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, exhaust air plenum insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Exposed, round and flat oval, supply air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

Fiberglass Pipe and Tank: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Exposed, round and flat oval, return air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

Fiberglass Pipe and Tank: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Exposed, round and flat oval, outdoor air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

Fiberglass Pipe and Tank: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Exposed, round and flat oval, exhaust air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

Fiberglass Pipe and Tank: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Exposed, rectangular, supply air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Exposed, rectangular, return air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Exposed, rectangular, outdoor air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Exposed, rectangular, exhaust air duct insulation shall be [**one of**] the following:  
             
           1. Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
            [**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75-lb/cu. ft. (12-kg/cu. m)**]   
            [**1.0-lb/cu. ft. (16-kg/cu. m)**] [**1.5-lb/cu. ft. (24-kg/cu. m)**] nominal density.

2. Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
 [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3-lb/cu. ft. (48-kg/cu. m)**]   
 [**6-lb/cu. ft. (96-kg/cu. m)**] nominal density.

* + - * 1. Exposed, Type I, Commercial, Kitchen Hood Exhaust Duct and Plenum Insulation: Fire rated [**blanket**] [**or**] [**board**]; thickness as required to achieve 2 hour fire rating.
        2. Exposed, supply air plenum insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Exposed, return air plenum insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Exposed, outdoor air plenum insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Exposed, exhaust air plenum insulation shall be [**one of**] the following:

Fiberglass Blanket: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**0.75 lb. /cu. ft. (12 kg/cu. m)**]   
[**1.0 lb. /cu. ft. (16 kg/cu. m)**] [**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**]   
[**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - 1. ABOVEGROUND, OUTDOOR DUCT AND PLENUM INSULATION SCHEDULE
         1. Insulation materials and thicknesses are identified below. If more than one material is listed for a duct system, selection from materials listed is Contractor's option.
         2. Concealed, round and flat oval, supply air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> and [**0.75 lb. /cu. ft. (12 kg/cu. m)**] [**1.0 lb. /cu. ft. (16 kg/cu. m)**]   
[**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, round and flat oval, return air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> and [**0.75 lb. /cu. ft. (12 kg/cu. m)**] [**1.0 lb. /cu. ft. (16 kg/cu. m)**]   
[**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, round and flat oval, outdoor air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> and [**0.75 lb. /cu. ft. (12 kg/cu. m)**] [**1.0 lb. /cu. ft. (16 kg/cu. m)**]   
[**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, rectangular, supply air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> and [**0.75 lb. /cu. ft. (12 kg/cu. m)**] [**1.0 lb. /cu. ft. (16 kg/cu. m)**]   
[**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, rectangular, return air duct insulation shall be [**one of**] the following:

Fiberglass Blanket: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> and [**0.75 lb. /cu. ft. (12 kg/cu. m)**] [**1.0 lb. /cu. ft. (16 kg/cu. m)**]   
[**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, supply air plenum insulation shall be [**one of**] the following:

Fiberglass Blanket: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> and [**0.75 lb. /cu. ft. (12 kg/cu. m)**] [**1.0 lb. /cu. ft. (16 kg/cu. m)**]   
[**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Concealed, return air plenum insulation shall be [**one of**] the following:

Fiberglass Blanket: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> and [**0.75 lb. /cu. ft. (12 kg/cu. m)**] [**1.0 lb. /cu. ft. (16 kg/cu. m)**]   
[**1.5 lb. /cu. ft. (24 kg/cu. m)**] nominal density.

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Exposed, round and flat oval, supply air duct insulation shall be [**one of**] the following:

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

Fiberglass Pipe and Tank: [**1-1/2 inches (38 mm)**] [**2 inches (50 mm)**]   
[**3 inches (75 mm)**] <**Insert dimension**> thick.

* + - * 1. Exposed, round and flat oval, return air duct insulation shall be [**one of**] the following:

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

Fiberglass Pipe and Tank Insulation: [**1-1/2 inches (38 mm)**]   
[**2 inches (50 mm)**] [**3 inches (75 mm)**] <Insert dimension> thick.

* + - * 1. Exposed, rectangular, supply air duct insulation shall be:

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Exposed, rectangular, return air duct insulation shall be:

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Exposed, supply air plenum insulation shall be:

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - * 1. Exposed, return air plenum insulation shall be:

Fiberglass Board: [**2 inches (50 mm)**] [**3 inches (75 mm)**] <**Insert dimension**> thick and [**3 lb. /cu. ft. (48 kg/cu. m)**] [**6 lb. /cu. ft. (96 kg/cu. m)**] nominal density.

* + - 1. INDOOR, FIELD-APPLIED JACKET SCHEDULE
         1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
         2. If more than one material is listed, selection from materials listed is Contractor's option.
         3. Ducts and Plenums, Concealed:

None.

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

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

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

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 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.

Self-Adhesive Outdoor Jacket.

<**Insert jacket type**>.

* + - * 1. Ducts and Plenums, Exposed:

None.

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

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

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

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 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.

Self-Adhesive Outdoor Jacket.

<**Insert jacket type**>.

* + - 1. OUTDOOR, FIELD-APPLIED JACKET SCHEDULE
         1. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
         2. If more than one material is listed, selection from materials listed is Contractor's option.
         3. Ducts and Plenums, Concealed:

None.

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

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

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

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 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.

Self-Adhesive Outdoor Jacket.

<**Insert jacket type**>.

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

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

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

Stainless Steel, [**Type 304**] [**or**] [**Type 316**], [**Smooth 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.

Self-Adhesive Outdoor Jacket.

<**Insert jacket type**>.

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

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

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

Self-Adhesive Outdoor Jacket.

<**Insert jacket type**>.   
  
  
  
  
   
 END OF SECTION 230713