SECTION 15080 **Rev #0811**
MECHANICAL INSULATION

ISO-HT™ (POLYISO) RIGID FOAM PIPE, VESSEL, DUCT, AND EQUIPMENT INSULATION FOR HIGH TEMPERATURE APPLICATIONS UP TO 375F (190C), and up to 400F (204C) intermittent exposure.

In MS Word, display hidden notes to specifier by using Tools/Options/View/Hidden Text.

PART 1 GENERAL
1.1 SECTION INCLUDES
A. Section includes polyisocyanurate pipe and equipment insulation system for applications where temperatures are between -297F and +375F and where high thermal efficiency is desirable.
www.dyplastproducts.com
1.2 RELATED SECTIONS
A. Section 07210 - Building Insulation
B. Section 07260 - Vapor Retarders
C. Section 15180 - Heating and Cooling Piping
D. Section 15230 - Industrial Process Piping
E. Section 15600 - Refrigeration Equipment
F. Section 15700 - Heating, Ventilation, and Air Conditioning Equipment
1.3 REFERENCES
A. ASTM C 203 Test Methods for Breaking Load and Flexural Properties of Block-Type Thermal Insulation
B. ASTM C 209 Water Absorption (D 2842: 96-hour immersion; C272: 24-hour immersion)
C. ASTM C 272 Test Method for determining water absorption via 24 hour immersion
D. ASTM C 273 Test method for determining shear strength
E. ASTM C 355 Water Vapor Transmission
F. ASTM C 518 Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Heat Flow Meter Apparatus
G. ASTM C 591 Standard Specification for Unfaced Preformed Rigid Cellular Polyurethane Thermal Insulation. Covers unfaced, preformed rigid cellular polyisocyanurate plastic material intended for use at temperatures up to 300°F. Replaces federal specification HH-I-53
H. ASTM C 871-00 Test Methods for Chemical Analysis of Thermal Insulation Materials for Leachable Chloride, Fluoride, Silicate, and Sodium Ions
I. ASTM C 921 Standard Practice for Determining the Properties of Jacketing Material for Thermal Insulation
J. ASTM 1136 Standard for vapor retarders
K. ASTM D 1621 Test Method for Compressive Properties of Rigid Cellular Plastics
L. ASTM D 1622 Test Method for Apparent Density of Rigid Cellular Plastics
M. ASTM D 1623 Test Method for Tensile Strength
N. ASTM D 2126 Test Method for Response of Rigid Cellular Plastics to Thermal and Humid Aging
O. ASTM D 2842 Test Method for Water Absorption (96-hour immersion)
P. ASTM D 2856 Test Method for Open Cell Content of Rigid Cellular Plastics By the Air Pycnometer
Q. ASTM E 84 (UL 723) Test method for Surface Burning Characteristics of Building Materials
R. ASTM E 96 Test Method for Water Vapor Transmission of Materials
1.4 SYSTEM DESCRIPTION
A. Design requirements: Provide polyisocyanurate bunstock fabricated to specified dimensions and tolerances for application to pipe, fittings, and equipment, meeting the following additional criteria:

1. Surface burning characteristics (ASTM E84): Class 1 fire spread/smoke development [Note: Or specify other less conservative criteria]
2. Polyisocyanurate insulation shall not be produced with, or contain, any of the United States EPA regulated CFC compounds listed in the Montreal Protocol of the United Nations Environmental Program.
3. Compressive strength: 37 lb/in2 or greater development [Note: Or specify other less conservative criteria]
4. K-factor of polyiso (aged): 0.18 BTU*in/hr*ft2*F or less
8. Water absorption: < 0.1% by volume

9. Water vapor permeance: 2.23 perm-in or less
10. Service temperature: -297F to +375F (and up to 400F intermittent)
11. Fabrication tolerances: 1/16 inch
12. System R-value:
    a. As indicated on the drawings.
    b. System R-value:_____
13. Insulation thickness:
    a. As indicated on the drawings.
    b. Construction contractor calculate insulation thickness based on required R-values.
    c. Insulation thickness: _____

1.5 SUBMITTALS

A. Submit under provisions of Section 01300
B. Manufacturer's technical data, details, and specifications giving information on material composition and physical properties of the insulation, vapor retarders, and jacketing, if used. Also include:
   1. Preparation instructions and recommendations.
   2. Storage and handling requirements and recommendations.
   3. Manufacturer/supplier installation instructions or methods.
C. Manufacturer's Certificate: Certify stated R-values (aged) and flame spread/smoke development ratings are in accordance with laboratory testing from certified laboratories.

1.6 DELIVERY, STORAGE, AND HANDLING

A. Deliver materials in manufacturer's original, unopened, undamaged containers with shipping labels intact. The manufacturer's plastic wrapping is provided for protection during shipment only. Replace insulation that is damaged by physical abuse or water.
B. Store products off the ground, in dry conditions, under cover and in manufacturer's unopened packaging until ready for installation.

C. Consider flexural strength and friability characteristics of alternative polyiso manufacturers to minimize breakage during handling and to minimize dust while cutting and abrasion to hands when handling.

1.7 PROJECT CONDITIONS

A. Maintain environmental conditions within the limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.
B. Maintain ambient conditions required by manufacturers of adhesives, vapor retarders, sealants, etc.

PART 2 PRODUCTS

2.1 MATERIALS

A. Insulation: Rigid closed-cell polyisocyanurate thermal insulation bunstock, fabricated into shapes required to insulate pipe, valves, fittings, vessels, and/or special shapes. Density and physical properties are as specified in the Equipment Sections below. Polyiso material shall not be produced with, or contain, any of the United States EPA regulated CFC compounds listed in the Montreal Protocol of the United Nations Environmental Program.
B. Vapor Retarder: Even though polyisocyanurate has excellent water vapor permeance, an additional vapor retarder is recommended and can improve thermal efficiency, water penetration characteristics, and fire spread and smoke development attributes. Vapor retarders may consist of sheet-type film, such as cross-laminated high density polyethylene sheeting, polyvinylidene chloride polymer film, or similar materials. (Vapor retarder sheets may require matching tape if not self-adhering.)
C. Tape: Polyiso insulation is secured to the pipe with filament-reinforced tape, such as the synthetic filament-reinforced polyester film backing tape with non-thermosetting rubber adhesive, wrapped on a 3 inch paper core manufactured by 3M.
D. Outer surface finish: A finish with a high emissivity such as painted metal, PVC or All Service Jacket (ASJ) is recommended.
E Non-setting joint sealer.
F. Vapor retarder mastic: (use with an open weave glass fiber reinforcing cloth between the coats)
G. Smooth aluminum rolled jacketing, To ASTM B2089, 0.016 inch thick. Specify 2.5- mil poly/surlyn backing with plain, white acrylic or tedlar coated. Order 36 inch or 48 inch rolls.
   1. Childers 16-mil aluminum roll jacketing
   2. RPR 16-mil aluminum roll jacketing
   3. Pabco 16-mil aluminum roll jacketing
H. Deep Corrugated (1 ¼ inch) Aluminum Sheeting, To ASTM B209, 0.024 inch thick. Specify 2.5-mil poly/surlyn with plain or white acrylic coated.(Top)
   1. Childers, 24-mil Deep Corrugated Aluminum Sheets
   2. RPR, 24-mil Deep Corrugated Aluminum Sheets
   3. Pabco, 24-mil Deep Corrugated Aluminum Sheets
I. Smooth stainless steel rolled jacketing, To ASTM A-240, 0.010 inch thick with standard moisture barrier backing.
   1. Childers, 10-mil stainless steel rolled jacketing
   2. RPR, 10-mil stainless steel rolled jacketing
   3. Pabco, 10-mil stainless steel rolled jacketing
J. Smooth Stainless Steel Rolled Jacketing, To ASTM A-240, 0.016 inch thick with standard moisture barrier.
   1. Childers, 16-mil stainless steel rolled jacketing
   2. RPR, 16-mil stainless steel rolled jacketing
   3. Pabco, 16-mil stainless steel rolled jacketing

K. Deep Corrugated (1 ¼ inch) Stainless Steel Sheeting, To ASTM A-240, 0.010 inch thick with standard moisture barrier.
   1. Childers, 10-mil Corrugated Stainless Steel Sheeting
   2. RPR, 10-mil Deep Corrugated Stainless Steel Sheeting
   3. Pabco, 10-mil Deep Corrugated Stainless Steel Sheeting
L. Aluminum Covers For Vessel Heads, Fabricated Gores, 0.020 inch thick, Specify Plain or Acrylic Coated. Order 2.5-mil Poly/Surlyn Backing.
   1. Childers, Aluminum Gore Head-Jacs
   2. RPR, Aluminum Gore Head Jacket
M. Aluminum Two-piece Die-Formed 45 and 90 Ell Covers. Specify plain, acrylic or tedlar coated.
   1. Childers, Ell-Jac
   2. RPR, 2-Piece Aluminum Elbow Covers
   3. Pabco, Sure-Fit Elbow Covers
N. Stainless Steel Two-Piece Die-Formed 45 and 90 Ell Covers.
   1. Childers, Stainless Steel Univers Ell-Jacs
   2. RPR,2-Piece Stainless Steel Elbow Covers (Top)
O. Vapor Retarder Mastics and Coatings - Indoor
   1. Childers Chil-Perm CP-30, CP-32 (non-flammable)
   2. Marathon Lo Perm 590, 591
   3. Fosters Vapor-Fas 30-15
P. Vapor Retarder Mastics and Coatings – Indoor/Outdoor
   1. Childers Encacel V, X, Chil-Perm WB CP-35
   2. Fosters Monolar 60-39, 60-59
   3. Fosters Vapor-Safe Mastic 30-90
Q. Vapor Retarder Membrane
   1. Polyguard Products, inc. Insulrap 30, Insulrap 50
   2. Alpha Associates Inc. Alpha-Alaflex Style 13 MAM
   3. TGH-1000 VB
R. Insulation Joint Non-Setting Sealer
   1. Fosters Foamseal 30-45
   2. Childers CP-70
   3. Epolux Cadaseal 745
S. Insulation Adhesive For Adhesion To Itself and To The Substrate.
   1. Fosters Fire Resistant Adhesive 81-33 or Kold-Fas 82-08
   2. Childers Chil-Rene CP-96
T. Open-Weave Glass Cloth, 10x10/in.sq. min.
   1. J.P. Stevens, Glass Cloth, Style 1659/Geon
   2. Burlington , Resin Treated Style 1659
   3. Childers, No. 10 Chil-Glas
U. ASJ Kraft Aluminum Laminate-White
   1. Alpha, Alpha-Temp 10651 ASJ
   2. Compac, FB200 ASJ
V. Breather Acrylic Type Mastic
   1. L&L Coatings, L&L 300 Mastic-White
   2. Childers, Vi-Cryl CP-11
   3. Fosters, Weatherite Mastic 36-10, 46-10
W. Caulking Sealant, Silicone Rubber Compound
   1. Dow Corning, Silastic 732 RTV, 999 RTV
   2. Rhone-Poulene, Rhodorsil 3B-2542 (Aluminum)
   3. Pecora, 863 Silicone Sealant 345 (White) (Top)
X. Stainless Steel Bands and Seals. Type 430, 304 acceptable. ½ or ¾ inch widths x 0.020 inch thickness. Available from insulation distributors
Y. Stainless Steel Bands and Seals, 1 ¼ inch wide
   1. Childers, 1 ¼ inch Stainless Steel Bands and seals
   2. A.J.Gerrard, 1 ¼ inch Stainless Steel Bands and Seals
Z. Stainless Steel 4 inch Expansion Springs
   1. A.J. Gerrard, 4 in. Breather Spring
   2. Childers, Chil-Spring 4 in.
AA. Heavy Duty Stainless Steel Compression Springs
   1. Childers, Super-Mity-Springs
BB. Polyester Film Tape, Pressure-Sensitive Glass Reinforced, ½ inch wide
   1. 3M Co., Scotchbrand No.898 Polyester Tape
CC. ASJ Pressure Sensitive Tape, 3 inches wide
   1. Compac, Perm Tape ASJ Std 105-7
   2. Venture, 1540 CW ASJ
DD. Foil (2-mil) Pressure Sensitive Tape, 3 inches wide
   1. Compac, Perm Tape Foil Std 120-6
   2. Venture, 1520 CW Foil
EE. Tedlar Pressure Sensitive Tape, 2 inch wide
   1. Alpha, Avalock Style 209TG (Gray), Style 209 TW (White)

GG. Table of accessory materials:

Application	Finish	Remarks
Pipe	0.016 inch thick plain, smooth, rolled Aluminum jacket	Indoor/Outdoor, non-corrosive; Moderate mechanical abuse
Pipe	0.016 inch thick white acrylic coated, smooth, rolled aluminum jacket	Indoor/Outdoor, mild corrosion; Moderate mechanical abuse
Pipe	0.020 inch thick white, smooth, rolled PVC Jacket	Indoor, mild corrosion; Low mechanical abuse
Pipe	0.030 inch thick white, smooth, rolled PVC Jacket	Indoor/Outdoor, mild corrosion; Moderate mechanical abuse
Pipe	0.010 inch thick smooth, rolled stainless steel Jacket	Indoor/Outdoor, severe corrosion; High mechanical abuse
Pipe	0.010 inch thick tedlar, glass, hypalon rolled Laminate jacketing	Indoor/Outdoor, severe corrosion; High mechanical abuse
Pipe	0.016 inch thick white tedlar coated, smooth, Rolled aluminum jacket	Indoor/Outdoor, severe corrosion; Moderate mechanical abuse
Equipment	0.016 inch thick plain, smooth, rolled Aluminum jacket	Indoor, non-corrosive; Moderate mechanical abuse
Equipment	0.016 inch thick white acrylic coated, smooth, Rolled aluminum jacket	Indoor, mild corrosion; Moderate mechanical abuse
Equipment	0.030 inch thick white, smooth, rolled PVC Jacket	Indoor, mild corrosion; Moderate mechanical abuse
Equipment	0.024 inch thick deep corrugated, plain Aluminum sheets	Outdoor, non-corrosive; Moderate mechanical abuse
Equipment	0.024 inch thick white acrylic coated, deep Corrugated aluminum sheets	Outdoor, mild corrosion; Moderate mechanical abuse
Equipment	0.016 inch thick smooth, rolled stainless steel Jacket	Indoor/Outdoor, severe corrosion; High mechanical abuse
Equipment	0.010 inch thick deep corrugated, stainless Steel jacket	Outdoor, severe corrosion; High mechanical abuse
Ducts	Scrim reinforced, acrylic mastic system	Indoor, non-corrosive; Low mechanical abuse
Ducts	0.016 inch thick plain, smooth, rolled Aluminum jacket	Indoor/Outdoor, non-corrosive; Moderate mechanical abuse
Ducts	0.016 inch thick white acrylic coated, smooth, Rolled aluminum jacket	Indoor/Outdoor, mild corrosion; Moderate mechanical abuse
Irregular shapes	Scrim reinforced, acrylic mastic system	Indoor, non-corrosive; Low mechanical abuse
Irregular shapes	Scrim reinforced, hypalon-type mastic vapor Retarder system	Indoor/Outdoor, mild corrosion; Low mechanical abuse

2.2 MANUFACTURERS

A. Acceptable Manufacturer of Insulation: Polyisocyanurate pipe and equipment insulation shall be dP-ISO produced by Dyplast Products, LLC., 12501 NW 38th Avenue, Miami, Florida 33054. Phone: (800) 433-5551 or (305) 921-0100. Fax: (305) 687-8013. E-mail: info@dyplastproducts.com

B. Requests for substitutions will be considered in accordance with provisions of Section 01600.

C. Acceptable Manufacturers of Vapor Retarders: Cross-laminated high density polyethylene sheeting such as Polyguard Insulrap, or polyvinylidene chloride polymer film such as Dow Saran, or equivalent. All-service jackets (ASJ) provide a lower quality of vapor barrier and should be specified only in less demanding environments.

D. Acceptable Manufacturers of PVC Jackets: Proto Corporation, Johns Manville (Ceel-Co and Zeston), Childers Products Company Ltd., Sure-Fit System, Speedline, and Thermo-Cover Inc.
E. Requests for substitutions of PVC jacket manufacturers will be considered in accordance with provisions of Section 01600.
F. Acceptable Manufacturers of All Service Jackets (ASJ), Metal Jacketing and Fitting Covers: Any reputable manufacturer qualified by the engineer or specifier.
G Acceptable Manufacturers of Vapor Retarder Mastics include Foster Products' VAPOR-SAFE® Mastic, or equivalent.

2.3 PIPE INSULATION

A. 2.5 lb/ft3 Density Polyiso (ISO-HT/2.5®): Physical properties:
1. Compressive Strength: minimum 37 psi (255 kPa) Parallel to Rise (thickness)
2. Dimensional Stability: <0.1 percent linear change (7 days) at -30 degrees F and +158 degrees F (-34 degrees C and +70 degrees C, respectively)
3. Water Vapor Permeance: less than or equal to 2.23 perm-inch (3.25 ng/(Pa*s*m)).
4. Water Absorption: not to exceed 0.1 percent by volume; C272
5. Flame Spread: not to exceed 25 for thicknesses up to 4 inches
6. Smoke Development: not to exceed 160 for thicknesses up to 4 inches (100 mm)
7. Service Temperature: -297 degrees to 375 degrees F (-183 degrees C to +190 degrees C).
8. K-value: maximum 0.18 BTU*in/hr*ft2*F after 6 months aging at 75F

2.4 ACCESSORIES FOR PIPE INSULATION

A. Install a vapor retarder as specified in Materials Section over pipe insulation, rather than applying a mastic system. The sheet material usually has a better perm rating, improves continuity and is easier to apply. Install vapor retarders in accordance with instructions provided below and by manufacturer.
B. Finish insulation as required on drawings, and in exposed outdoor areas, in mechanical rooms and in high traffic areas with the following jacketing, unless otherwise indicated on drawings. Install metal jacketing in accordance with instructions provided below and by manufacturer.

2.5 EQUIPMENT INSULATION

A. 2.5 lb/ft3 Density Polyiso (ISO-HT/2.5®): Physical properties:
1. Compressive Strength: minimum 37 psi (255 kPa) Parallel to Rise (thickness)
2. Dimensional Stability: <0.1 percent linear change (7 days) at -30 degrees F and +158 degrees F (-34 degrees C and +70 degrees C, respectively)
3. Water Vapor Permeance: less than or equal to 2.23 perm-inch (3.25 ng/(Pa*s*m)).
4. Water Absorption: not to exceed 0.1 percent by volume; C272
5. Flame Spread: not to exceed 25 for thicknesses up to 4 inches
6. Smoke Development: not to exceed 160 for thicknesses up to 4 inches (100 mm)
7. Service Temperature: -297 degrees to 375 degrees F (-183 degrees C to +190 degrees C).
8. K-value: maximum 0.18 BTU*in/hr*ft2*F after 6 months aging at 75F

B. Insulation thickness:
1. As indicated on the drawings.
2. Construction contractor calculate insulation thickness based on required R-values.
3. Insulation thickness: _____
C. For equipment and vessels greater than 24 inches in diameter, operating below 30F (-2C), should have a double layer insulation system.
D. ISO-HT foam insulation is available in 4 feet by 8 feet sheets. With insulation thickness up to 1 ½ inch thick, the sheet is flexible enough to be wrapped around a vessel 12 feet in diameter or greater. This application will reduce the number of joints to be sealed and coverage is faster, thus savings in labor.
E. For vessels 24 inches in diameter and less pipe insulation sections should be used.

F. For vessels less than 12 feet in diameter, the longitudinal joints of the ISO-HT blocks shall be beveled to the radius of the vessel to ensure tight fitting joints.

2.6 ACCESSORIES FOR EQUIPMENT INSULATION

A. Non-setting sealers are used to butter all insulation joints.
B. Insulation adhesive is used on flat equipment surfaces to secure the insulation to the substrate.
C. Stainless steel bands and seals a minimum ½ inch wide stainless are used to secure the blocks of insulation on equipment (vessels) 12 feet in diameter and less. For equipment greater than 12 feet use ¾ inch wide stainless steel bands.
D. Reinforced vapor retarder mastic is applied to vessel heads and irregular shapes.
E. ASJ finish vapor retarder is an acceptable vapor retarder for equipment operating at 0F and above. All seams are sealed with appropriate tape.
F. A protective finish is recommended.

2.7 DUCT INSULATION

A. For square and rectangular ducts, the insulation shall be polyiso boards.
B. For cylindrical ducts up to 24 inches in diameter, use 2-piece pipe sectional polyiso insulation.

2.8 ACCESSORIES FOR DUCT INSULATION

A. Non-setting sealers are used to butter all insulation joints.
B. Insulation adhesive is used on flat equipment surfaces to secure the insulation to the substrate.
C. ASJ finish is recommended.
D. All seams are sealed with appropriate tape.

2.9 FABRICATION

A. Polyisocyanurate insulation for pipe and equipment applications is manufactured as bunstock. Dyplast Products utilizes the latest technologies and equipment to produce bunstock not only with different densities but also different dimensions, from 36' to 48' widths, heights to 36" and virtually any length (commonly 24'). The ability to vary bun sizes allows sizing the bun to closely fit final dimensions of pipe and equipment insulation components, reducing waste during fabrication. Buns are fabricated using only highly qualified fabrication facilities, ensuring close tolerances to reduce rework in the field as well as to ensure tight fit and improved thermal efficiencies. Dyplast Products' ISO line of polyiso has excellent workability characteristics, allowing for cutting to 1/16 inch tolerance or better.

PART 3 EXECUTION

3.1 EXAMINATION

A. Verify that all piping, equipment, and ductwork are tested and approved prior to insulation installation.

B. Verify that all surfaces are clean, dry, and free of foreign material before applying insulation materials.

3.2 INSTALLATION - GENERAL

A. Install in accordance with manufacturer's instructions and applicable building codes.

B. Where R-values are indicated, install in thickness required to achieve R-values; otherwise install to thicknesses required.

C. Install continuously on surfaces to be insulated without gaps to minimize losses in thermal efficiency, as follows:

1. Overlap layers of insulation so seams are not contiguous.
2. Use shiplap joints.
3. Butt sections firmly.

D. Locate seams in least visible location. Extend surface finishes to protect raw edges, ends and surfaces of insulation.

E Where vapor retarder facing or jacketing is specified, maintain continuous, unbroken moisture and vapor seal; insulate and vapor seal all hangers, supports, anchors, and other projections secured to cold surfaces to prevent condensation; repair penetrations and damage to vapor retarder using joint tape prior to system startup.

3.3 PIPE INSULATION

A. Install pipe insulation continuously through walls, ceiling and floor openings, and sleeves except where firestopping materials are required.

B. Vapor barriers: install vapor barriers as indicated on drawings and in accordance with manufacturer's instructions. Seal all joints, seams and fittings.

C. Insulate fittings and valves with insulation equivalent to that required for adjacent piping; finish with same materials unless otherwise specified.

D. Molded Pipe Insulation:

1. Install metal shields between hangers or supports and piping insulation and install rigid insulation inserts between pipe and the insulation shields.

E. Jacketing: Install jacketing as indicated on drawings and in accordance with manufacturer's instructions. Seal all joints, seams and fittings.

F. Contraction and expansion joints:

1. For cold piping and vessels, contraction joints are not normally required with ISO-HT for operating temperatures above –50F (-45C). For operating temperatures at – 50F (-45C) and below and over 48 lineal feet of pipe or vessels over 48 feet long, a contraction joint is recommended every 12 feet.
2. The contraction joints shall be in the inner layer of insulation only. The contraction joint space shall be 1 inch wide and packed with glass fiber insulation. The glass fibers shall be oriented perpendicular to the pipe or vessel length. Cover the contraction joint with a vapor retarder membrane sheet, overlapping the joint by 2 inches on both sides. Secure the membrane with reinforced tape on the pipe an stainless steel bands.
3. For hot piping and vessels, expansion joints are not normally required with ISO-HT. For the exception see ISO Specification and Installation Instructions at www.dyplastproducts.com.

3.4 EQUIPMENT INSULATION

A. Apply insulation with joints firmly butted as close as possible to the equipment surface. Secure insulation as specified in manufacturer's instructions with adhesive or banding material.

B. Overlap vapor retarders and tape as specified in manufacturer's instructions.

C. Equipment Insulation Exposed on Exterior: Position joints so as to shed water.

3.5 DUCT LINER

A. Cover internal duct areas with duct liner.

B. Apply duct lining in strict accordance with the latest edition of SMACNA HVAC Duct Construction Standards and manufacturer's instructions.

1. Butt transverse joints firmly with no gaps and coat with adhesive.
2. Overlap longitudinal corner joints.
3. When air velocity will be 4000 to 6000 feet per minute (1219 to 1829 meters per minute), apply metal nosing to upstream transverse edges to secure the insulation.

D. Adhesive:

1. Apply adhesive to the sheet metal with a 90 percent minimum coverage.
2. Coat exposed edges of the duct liner with the same adhesive.
3. Repair rips and tears using the same adhesive.

3.6 EXTERNAL DUCT INSULATION

A. Install duct insulation continuously through walls, ceiling and floor openings, and sleeves except where firestopping materials or fire or smoke dampers are required.

C. Board Insulation: Secure in place using adhesive and/or mechanical fasteners as indicated in manufacturer's instructions.

3.7 PROTECTION

A. Protect installed products until completion of project.

B. Touch-up, repair or replace damaged products before Substantial Completion.