

O517-14629

ADDENDUM NUMBER 7

MILWAUKEE COUNTY  
WAR MEMORIAL – ART MUSEUM  
HVAC IMPROVEMENTS  
Site #265, Bldg. #40  
750 North Lincoln Memorial Drive  
Milwaukee, WI 53202

Project Number: O517-14629

Notice Number: 6978

Date of Addendum: January 28, 2015

This Addendum to the Contract Documents is issued to modify, explain or correct the original documents, dated December 5, 2014, and is hereby made part of the Contract Documents. Acknowledge receipt of this Addendum in the space provided on the Bid Form, or bid may be rejected.

BIDDING, CONTRACT DOCUMENTS, AND ADDENDUM 1-6

Clarifications:

- Basis of Design for the extension of the existing building automation system is Johnson Controls, Inc. All components and software shall be manufactured or provided by Johnson Controls, Inc. Installation of building automation system shall be completed by mechanics, technicians, and software engineers and shall be direct employees of Johnson Controls, Inc. or a certified subcontractor under the direct supervision of Johnson Controls employees.
- The project schedule as outlined in the bidding documents is fixed. Contractor shall include all costs associated with off-shift work or overtime.
- Provide and install one (1) electric radiant heating system located in new East addition 200SF lobby. Basis of Design is Orbit Radiant Heating Nexans TXLP floor heating cables and RFWCK-16 control panel.
  - a. TXLP 0.13 custom heating cable
  - b. Two (2) cables at 464 feet each
  - c. 3136W each cable
  - d. 13.1A each cable
  - e. 18.4 Ohms each cable
  - f. 2.5" on center spacing
  - g. Imbedded in concrete, coordinate with Art Museum General Contractor
  - h. 10 foot standard cold lead
  - i. RFWCK-1-Air/Floor/Dual 50A max floor warming control kit
  - j. At 115-AF-120 Air/Floor/Dual sensing thermostat with terminal connection block

O517-14629

- Electrical contractor to provide smoke detectors in return air duct of all new air handling units. Temperature Control contractor to wire from smoke detector to TCP. Upon initiation of detector, fans shall be de-energized, dampers shut, and alarm indicated at BAS system panel. Fire alarms (by others) shall receive alarm via BAS or by direct wire from smoke alarm circuit.
- Provide two (2) 460V 20A circuits from panel MDP to new ½ HP motors on lake water cooling system filters, near new lake water cooling pumps.
- Temperature Control Contractor shall provide a minimum of one (1) methane detector in each bay or as directed by Art Museum Methane Mitigation Engineer. Whenever a methane alarm is initiated, an alarm shall be indicated at the BAS control panel, AHU NE and AHU SE will be de-energized and the dampers shut.
- Add attached specifications section 230700 "HVAC Insulation" to specification documents.
- Lower existing 1" electrical conduit in vicinity of new outside air louver located on north wall of War Memorial, approximately 50'0".

Refer to attached Bidding Questions and Responses dated January 28, 2015.

Section 01230 Alternatives:

ADD the following to Article 1.1 C.

5. Alternate Bid E:

- Provide the amount to add or deduct from the base bid to have Johnson Controls hardware and software installed by an independent control contractor not affiliated with Johnson Controls, Inc. as an employee or sub-contractor.

6. Alternate Bid F:

- Provide the amount to add or deduct from the base bid to provide temporary cooling for the Lower Level, First Floor, and Second Floor from May 15, 2015 through July 31, 2015. Cooling system shall maintain 70°F DB ±3°F and 50% RH ±5%. 42° supply chilled water is available from chilled water mains in Lower Level.

Bidding Forms:

ADD Bid Form page 00400-2a, attached to and issued as part of this addendum 7

End of Addendum No. 7

ALTERNATIVE E:

Provide the amount to add or deduct from the base bid to have Johnson Controls hardware and software installed by an independent control contractor not affiliated with Johnson Controls, Inc. as an employee or sub-contractor.

---

(In words)

---

Dollars \$ \_\_\_\_\_

(In figures)

ALTERNATIVE F:

Provide the amount to add or deduct from the base bid to provide temporary cooling for the Lower Level, First Floor, and Second Floor from May 15, 2015 through July 31, 2015. Cooling system shall maintain 70°F DB ±3°F and 50% RH ±5%. 42° supply chilled water is available from chilled water mains in Lower Level.

---

(In words)

---

Dollars \$ \_\_\_\_\_

(In figures)

O517-14629

January 28, 2015

ADDENDUM NUMBER 7

### BIDDING QUESTIONS AND RESPONSES

- 1) New hot water heating pumps P-3 and P-4 are scheduled as base mounted pumps. They are replacing two existing in-line pumps. Is this intent correct?
  - This is correct.
- 2) Sheet E200 Motor Schedule - confirm circuit breaker/conductor size for Motor's #5 & #6.
  - Conductor size shall be revised to #4 phase conductors and a #8 ground in 1-1/4" conduit.
- 3) Sheet E200 Motor Schedule - confirm panel source for Motor #6. (MDP or USS-2).
  - Source panel shall be "MDP."
- 4) Sheet E200 Motor Schedule - confirm circuit breaker/conductor size for Motor's #7 & #8.
  - Circuit breaker size shall be 125A, 3-pole. Conductor size shall be (3) #1 phase conductors and a #6 ground.
- 5) Quantity of humidifier control 120V terminations (2 or 10?).
  - Assume 10 at this point.
- 6) New RO system requires both 1 phase and 3 phase power. RO System wiring details per special purpose outlet schedule on sheet E200? No power requirement details or source shown for RO-P-1 & RO-P-2 per Addendum #4 (.75HP 480V 3PH pumps).
  - New motors shall be circuited to existing panel "P/1" located in the sub-basement level. Panel is located roughly at column line 5/B. Provide new 20A, 3-pole circuit breakers in newly created space. Provide (2) new feeders each consisting of (3) #12 phase conductors and (1) #12 ground in 1/2" conduit. Provide new disconnect switch near each motor.
- 7) Sheet M002 Note #37 reference radiant electric heating coils with no details. Is this part of Contract 1?
  - Addendum 7.
- 8) Per the information we received from the manufacturer's rep for the lake water filters, each unit requires 408 volt power. Currently this is not addressed on the electrical drawings.
  - Addendum 7.
- 9) Electrical specifications requires conduit 2.5" and larger to be rigid conduit. Will this be enforced or is 3" EMT acceptable for AHU-N & AHU-S?
  - EMT conduit is acceptable.

10) The existing doorways to the two mechanical rooms on the lower level are not large enough to accommodate the new AHU-N and AHU-S component sizes as shown on 5/M504 and 6/M504. What is the plan for creating access openings large enough to accommodate these pieces?

- Doors will be removed if possible. Other options will have to be evaluated at time of AHU selection/award.

11) Addendum 4 drawing M401A shows low pressure steam being piped to the sub-basement but there is no low pressure steam indicated to be run on sub-basement piping plan M400.

- The low pressure steam will be used for the Humidifiers near the units supply air duct.

12) The modified lake water piping identified on M003 is not addressed in the insulation specifications. Should it be treated as chilled water for the sake of insulating?

- Yes piping should be insulated.

13) We received a quote from Ryan Creagan of Polygon Group for temporary heating only. We were instructed to use this firm due to their experience in museums. Polygon is including a total of (4) steam heating modules that they tell us should maintain a minimum of 65° on the lower level, first and second floors of the Kahler building. They also require a minimum of 15 PSI steam to each steam heating module (1" supply and ¾" condensate) hard pipe is recommended.

PLEASE CONFIRM THAT 15 PSI IS AVAILABLE.

- Based on MAM staff 15psi is available.

PLEASE CONFIRM WHERE THE POINT OF CONNECTIONS WILL BE AND THE ROUTING OF FOR THE LPS AND LPC HARD PIPING THAT WILL BE REQUIRED AS WE ARE UNFAMILIAR WITH THE BUILDING MECHANICAL SYSTEMS OTHER THAN WHAT WE SAW DURING THE BID WALK.

- POC will be at Lower Level or Sub-basement in general vicinity of AHU's. There are several possible connection points. Condensate will need to drain to existing condensate pumps in sub-basement then pumped to drain.

PLEASE CONFIRM WHERE THESE UNITS ARE TO BE PLACED. POLYGON TOLD US THAT THEY DO NOT KNOW EXACTLY WHERE THEY SHOULD BE PLACED.

- Final locations are not available and will need to be coordinated with MAM architect and GC/CM.

PLEASE CONFIRM THE POINT OF CONNECTION OF THE TEMPORARY POWER FOR THESE UNITS. 120 V. 10 FLR REQUIRED FOR THE STEAM MODULE AND 460 V. 3 PH. 8 FLA REQUIRED FOR THE ASSOCIATED BLOWER MODULE.

- There are electrical panels on each floor that will be available. Actual availability will have to be coordinated with MAM GC/CM.

O517-14629

Additional Electrical Clarifications:

1. Motors #7 and #8 source panel shall be "MDP."
2. There are two hot water pumps being removed from Sub-Basement level to be replaced with Motors 5 & 6. Motors are fed from existing panel "P/1". E.C. shall disconnect motors and remove feeders, boxes, disconnect switches, and other associated equipment back to source panel. Remove circuit breakers and replace with (2) new 20A, 3-pole circuit breakers to serve new RO system pumps RO-P-1 and RO-P-2.

End of Bidding Questions and Responses

SECTION 230700  
HVAC INSULATION

PART 1 GENERAL

1.1 RELATED DOCUMENTS

- A. The conditions of the Contract (General, Supplementary, and other Conditions) are hereby made a part of the Division 23 (Mechanical) and apply to all sections within this Division. This Section is in conflict with Sections in the General Requirements, This Section shall apply.

1.2 INDEX OF SECTION 230700

A. Part 1 – General

- 1.1 Related Documents
- 1.2 Index of Section 230700
- 1.3 Submittals
- 1.4 Quality Assurance
- 1.5 Delivery, Storage, and Handling
- 1.6 Coordination
- 1.7 Scheduling

B. Part 2 – Products

- 2.1 Insulation Materials
- 2.2 Fire Rated Insulation Systems
- 2.3 Insulating Cements
- 2.4 Adhesives
- 2.5 Mastics
- 2.6 Lagging Adhesives
- 2.7 Sealants
- 2.8 Factory-Applied Jackets
- 2.9 Field-Applied Fabric-Reinforcing Mesh
- 2.10 Field-Applied Cloths
- 2.11 Field-Applied Jackets
- 2.12 Tapes
- 2.13 Securements
- 2.14 Corner Angles

C. Part 3 – Execution

- 3.1 Examination
- 3.2 Preparation
- 3.3 General Installation Requirements
- 3.4 Penetrations
- 3.5 Equipment, Tank, and Vessel Insulation Installation
- 3.6 General Pipe Insulation Installation
- 3.7 Calcium Silicate Insulation Installation
- 3.8 Cellular Glass Insulation Installation
- 3.9 Flexible Elastomeric Insulation Installation
- 3.10 Mineral Fiber Insulation Installation
- 3.11 Phenolic Insulation Installation
- 3.12 Polyisocyanurate Insulation Installation
- 3.13 Polyolefin Insulation Installation

- 3.14 Polystyrene Insulation Installation
- 3.15 Field-Applied Jacket Installation
- 3.16 Fire-Rated Insulation System Installation
- 3.17 Finishes
- 3.18 Field Quality Control
- 3.19 Generator Stack and Breeching Insulation Schedule
- 3.20 Duct Insulation Schedule, General
- 3.21 Indoor Duct and Plenum Insulation Schedule
- 3.22 Equipment Insulation Schedule
- 3.23 Piping Insulation Schedule, General
- 3.24 Indoor Piping Insulation Schedule
- 3.25 Outdoor, Aboveground Piping Insulation Schedule
- 3.26 Indoor, Field-Applied Jacket Schedule
- 3.27 Outdoor, Field-Applied Jacket Schedule

### 1.3 SUBMITTALS

- A. Product Data: For each type of product indicated. Include thermal conductivity, thickness, and jackets (both factory and field applied, if any).
- B. LEED Submittal (if applicable):
  - 1. Product Data for Credit EQ 4.1: For adhesives and sealants, including printed statement of VOC content.
- C. Shop Drawings:
  - 1. Detail application of protective shields, saddles, and inserts at hangers for each type of insulation and hanger.
  - 2. Detail attachment and covering of heat tracing inside insulation.
  - 3. Detail insulation application at pipe expansion joints for each type of insulation.
  - 4. Detail insulation application at elbows, fittings, flanges, valves, and specialties for each type of insulation.
  - 5. Detail removable insulation at piping specialties, equipment connections, and access panels.
  - 6. Detail application of field-applied jackets.
  - 7. Detail application at linkages of control devices.
  - 8. Detail field application for each equipment type.
- D. Samples: For each type of insulation and jacket indicated. Identify each sample, describing product and intended use.
  - 1. Sample Sizes:
    - a. Preformed Pipe Insulation Materials: 12 inches long by NPS 2.
    - b. Sheet Form Insulation Materials: 12 inches square.
    - c. Jacket Materials for Pipe: 12 inches long by NPS 2.
    - d. Sheet Jacket Materials: 12 inches square.
    - e. Manufacturer's Color Charts: For products where color is specified, show the full range of colors available for each type of finish material.

- E. Qualification Data: For qualified installer.
- F. 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.
- G. Field quality-control reports.

#### 1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Skilled mechanics who have successfully completed an apprenticeship program or another craft training program certified by the Department of Labor, Bureau of Apprenticeship and Training.
- B. All materials used will be UL and FM Global approved.
- C. Fire Test Response Characteristics: Insulation and related materials shall have fire test response characteristics indicated, as determined by testing identical products per ASTM E 84, by a testing and inspecting 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 and inspecting agency.
  - 1. Insulation Installed Indoors: Flame-spread index of 25 or less, and smoke-developed index of 50 or less.
  - 2. Insulation Installed Outdoors: Flame-spread index of 75 or less, and smoke-developed index of 150 or less.

#### 1.5 DELIVERY, STORAGE, AND HANDLING

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

#### 1.6 COORDINATION

- A. Coordinate size and location of supports, hangers, and insulation shields specified in "Hangers and Supports for HVAC Piping and Equipment" Section.
- B. Coordinate clearance requirements with piping installer for piping insulation application duct installer for duct insulation application, and equipment installer for equipment insulation application. Before preparing piping and ductwork shop drawings, establish and maintain clearance requirements for installation of insulation and field-applied jackets and finishes and for space required for maintenance.
- C. Coordinate installation and testing of heat tracing.

#### 1.7 SCHEDULING

- A. Schedule insulation application after pressure testing systems and, where required, after installing and testing heat tracing. Insulation application may begin on segments that have satisfactory test results.
- B. Complete installation and concealment of plastic materials as rapidly as possible in each area of construction.

## PART 2 PRODUCTS

### 2.1 INSULATION MATERIALS

- A. Comply with requirements in Part 3 schedule articles for where insulating materials shall be applied.
- B. Insulation materials (including fasteners and adhesives) will be UL and FM Global approved.
- C. Products shall not contain asbestos, lead, mercury, or mercury compounds.
- D. Products that come in contact with stainless steel shall have a leachable chloride content of less than 50 PPM when tested according to ASTM C 871.
- E. Insulation materials for use on austenitic stainless steel shall be qualified as acceptable according to ASTM C 795.
- F. Foam insulation materials shall not use CFC or HCFC blowing agents in the manufacturing process.
- G. Calcium Silicate:
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Industrial Insulation Group (The); Thermo-12 Gold.
  - 2. Preformed Pipe Sections: Flat-, curved-, and grooved-block sections of non-combustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
  - 3. Flat-, curved-, and grooved-block sections of non-combustible, inorganic, hydrous calcium silicate with a non-asbestos fibrous reinforcement. Comply with ASTM C 533, Type I.
  - 4. Prefabricated Fitting Covers: Comply with ASTM C 450 and ASTM C 585 for dimensions used in pre-forming insulation to cover valves, elbows, tees, and flanges.
- H. Cellular Glass: Inorganic, incombustible, foamed or cellulated glass with annealed, rigid, hermetically sealed cells. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 1. Products: Subject to compliance with requirements, provide the following
    - a. Cell-U-Foam Corporation; Ultra-CUF.
    - b. Pittsburgh Corning Corporation; Foamglas Super K.
    - c. Certain Teed.
    - d. DuPont.
  - 2. Block Insulation: ASTM C 552, Type I.
  - 3. Special-Shaped Insulation: ASTM C 552, Type III.
  - 4. Board Insulation: ASTM C 552, Type IV.

5. Preformed Pipe Insulation without Jacket: Comply with ASTM C 552, Type II, Class 1.
  6. Preformed Pipe Insulation with Factory-Applied ASJ-SSL: Comply with ASTM C 552, Type II, Class 2.
  7. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
- I. Flexible Elastomeric: Closed-cell, sponge- or expanded rubber materials. Comply with ASTM C 534, Type I for tubular materials and Type II for sheet materials.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Aeroflex USA Inc.; Aerocel.
    - b. Armacell LLC; AP Armaflex.
    - c. RBX Corporation; Insul-Sheet 1800 and Insul-Tube 180.
- J. Mineral Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type II and ASTM C 1290, Type II with factory-applied vinyl jacket, III with factory-applied FSK jacket or III with factory-applied FSP jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. CertainTeed Corp.; Duct Wrap.
    - b. Johns Manville; Microlite.
    - c. Knauf Insulation; Duct Wrap.
    - d. Manson Insulation Inc.; Alley Wrap.
    - e. Owens Corning; All-Service Duct Wrap.
- K. High Temperature, Mineral Fiber Blanket Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 553, Type V, without factory-applied jacket.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Johns Manville; HTB 23 Spin-Glas.
    - b. Owens Corning; High Temperature Flexible Batt Insulations.
- L. Mineral Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type IA or Type IB. For duct and plenum applications, provide insulation with factory-applied ASJ or with factory-applied FSK jacket. For equipment applications, provide insulation with factory-applied ASJ or with factory-applied FSK jacket. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. CertainTeed Corp.; Commercial Board.
    - b. Fibrex Insulations Inc.; FBX.
    - c. Johns Manville; 800 Series Spin-Glas.
    - d. Knauf Insulation; Insulation Board.

- e. Manson Insulation Inc.; AK Board.
  - f. Owens Corning; Fiberglas 700 Series.
- M. High Temperature, Mineral Fiber Board Insulation: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 612, Type III, without factory-applied jacket.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Fibrex Insulations Inc.; FBX.
    - b. Johns Manville; 1000 Series Spin-Glas.
    - c. Owens Corning; High Temperature Industrial Board Insulations.
    - d. Rock Wool Manufacturing Company; Delta Board.
    - e. Roxul Inc.; Roxul RW.
    - f. Thermafiber; Thermafiber Industrial Felt.
- N. Mineral Fiber, Preformed Pipe Insulation:
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Fibrex Insulations Inc.; Coreplus 1200.
    - b. Johns Manville; Micro-Lok.
    - c. Knauf Insulation; 1000 Pipe Insulation.
    - d. Manson Insulation Inc.; Alley-K.
    - e. Owens Corning; Fiberglas Pipe Insulation.
  - 2. Type I, 850°F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type I, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
  - 3. Type II, 1200°F Materials: Mineral or glass fibers bonded with a thermosetting resin. Comply with ASTM C 547, Type II, Grade A, with factory-applied ASJ or with factory-applied ASJ-SSL. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.
- O. Mineral Fiber, Pipe Insulation Wicking System: Preformed pipe insulation complying with ASTM C 547, Type I, Grade A, with absorbent cloth factory applied to the entire inside surface of preformed pipe insulation and extended through the longitudinal joint to outside surface of insulation under insulation jacket. Factory apply a white, polymer, vapor-retarder jacket with self-sealing adhesive tape seam and evaporation holes running continuously along the longitudinal seam, exposing the absorbent cloth.
- 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Knauf Insulation; Permawick Pipe Insulation.
    - b. Owens Corning; VaporWick Pipe Insulation.
- P. Mineral Fiber, Pipe and Tank Insulation: Mineral or glass fibers bonded with a thermosetting resin. Semi-rigid board material with factory-applied ASJ or FSK jacket complying with ASTM C 1393, Type II or Type IIIA Category 2, or with properties similar to ASTM C 612, Type IB. Nominal density is 2.5 lb/cu. ft. or more. Thermal conductivity (k-value) at 100°F is 0.29 Btu x in. /h x sq. ft. x°F or less. Factory-applied jacket requirements are specified in "Factory-Applied Jackets" Article.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
  - a. CertainTeed Corp.; CrimpWrap.
  - b. Johns Manville; MicroFlex.
  - c. Knauf Insulation; Pipe and Tank Insulation.
  - d. Manson Insulation Inc.; AK Flex.
  - e. Owens Corning; Fiberglas Pipe and Tank Insulation.

Q. Phenolic:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
  - a. Kingspan Corp.; Koolphen K.
2. Preformed pipe insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type III, Grade 1.
3. Block insulation of rigid, expanded, closed-cell structure. Comply with ASTM C 1126, Type II, Grade 1.
4. Factory fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
  - a. Preformed Pipe Insulation: ASJ.
  - b. Board for Duct and Plenum Applications: ASJ.
  - c. Board for Equipment Applications: ASJ.

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

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
  - a. Apache Products Company; ISO-25.
  - b. Dow Chemical Company (The); Trymer.
  - c. Duna USA Inc.; Corafoam.
  - d. Elliott Company; Elfoam.
2. Comply with ASTM C 591, Type I or Type IV, except thermal conductivity (k-value) shall not exceed 0.19 Btu x in. /h x sq. ft. x°F at 75°F after 180 days of aging.
3. Flame-spread index shall be 25 or less and smoke-developed index shall be 50 or less for thickness up to 1-1/2 inches as tested by ASTM E 84.
4. Fabricate shapes according to ASTM C 450 and ASTM C 585.
5. Factory-Applied Jacket: Requirements are specified in "Factory-Applied Jackets" Article.
  - a. Pipe Applications: ASJ-SSL or PVDC-SSL.
  - b. Equipment Applications: ASJ-SSL or PVDC-SSL.

- S. Polyolefin: Unicellular, polyethylene thermal plastic insulation. Comply with ASTM C 534 or ASTM C 1427, Type I, Grade 1 for tubular materials and Type II, Grade 1 for sheet materials.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Armacell LLC; Tubolit.
    - b. Nomaco Inc.; IMCOLOCK, IMCOSHEET, NOMALOCK, and NOMAPLY.
    - c. RBX Corporation; Therma-cell.
- T. Polystyrene: Rigid, extruded cellular polystyrene intended for use as thermal insulation. Comply with ASTM C 578, Type IV or Type XIII, except thermal conductivity (k-value) shall not exceed 0.26 Btu x in./h x sq. ft. x°F after 180 days of aging. Fabricate shapes according to ASTM C 450 and ASTM C 585.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Dow Chemical Company (The); Styrofoam.
    - b. Knauf Insulation; Knauf Polystyrene.

## 2.2 FIRE RATED INSULATION SYSTEMS

- A. Fire Rated Board: Structural-grade, press-molded, xonolite calcium silicate, fireproofing board suitable for operating temperatures up to 17000°F. Comply with ASTM C 656, Type II, Grade 6. Tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Johns Manville; Super Firetemp M.
- B. Fire Rated Blanket: High temperature, flexible, blanket insulation with FSK jacket that is tested and certified to provide a 2-hour fire rating by a NRTL acceptable to authority having jurisdiction.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. CertainTeed Corp.; FlameChek.
    - b. Johns Manville; Firetemp Wrap.
    - c. Nelson Firestop Products; Nelson FSB Flameshield Blanket.
    - d. Thermal Ceramics; FireMaster Duct Wrap.
    - e. 3M; Fire Barrier Wrap Products.
    - f. Unifrax Corporation; FryeWrap.
    - g. Vesuvius; PYROSCAT FP FASTR Duct Wrap.

## 2.3 INSULATING CEMENTS

- A. Mineral Fiber Insulation Cement: Comply with ASTM C 195.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Insulco, Division of MFS, Inc.; Triple I.

- b. P.K. Insulation Mfg. Co.; Super-Stik.
- B. Expanded or Exfoliated Vermiculite Insulating Cement: Comply with ASTM C 196.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. P.K. Insulation Mfg. Co., Inc.; Thermal-V-Kote.
- C. Mineral Fiber, Hydraulic-Setting Insulating and Finishing Cement: Comply with ASTM C 449/C 449M.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Insulco, Division of MFS, Inc.; SmoothKote.
    - b. P.K. Insulation Mfg. Co., Inc.; PK No. 127, and Quik-Cote.
    - c. Rock Wool Manufacturing Company; Delta One Shot.

#### 2.4 ADHESIVES

- A. Materials shall be compatible with insulation materials, jackets, and substrates and for bonding insulation to it and to surfaces to be insulated, unless otherwise indicated.
- B. Calcium Silicate Adhesive: Fibrous, sodium-silicate-based adhesive with a service temperature range of 50 to 800°F.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-97.
    - b. Foster Products Corporation, H.B. Fuller Company; 81-27/81-93.
    - c. Marathon Industries, Inc.; 290.
    - d. Mon-Eco Industries, Inc.; 22-30.
    - e. Vimasco Corporation; 760.
  - 2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- C. Cellular-Glass, Phenolic, Polyisocyanurate, and Polystyrene Adhesive: Solvent-based resin adhesive, with a service temperature range of minus 75 to plus 300°F.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-96.
    - b. Foster Products Corporation, H.B. Fuller Company; 81-33.
  - 2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- D. Flexible Elastomeric and Polyolefin Adhesive: Comply with MIL-A-24179A, Type II, Class I.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:

- a. Aeroflex USA Inc.; Aeroseal.
    - b. Armacell LCC; 520 Adhesive.
    - c. Foster Products Corporation, H.B. Fuller Company; 85-75.
    - d. RBX Corporation; Rubatex Contact Adhesive.
  2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- E. Mineral Fiber Adhesive: Comply with MIL-A-3316C, Class 2, Grade A.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H.B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
  2. For indoor applications, use adhesive that has a VOC content of 80 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- F. Polystyrene Adhesive: Solvent- or water-based, synthetic resin adhesive with a service temperature range of minus 20 to plus 140°F.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-96.
    - b. Foster Products Corporation, H.B. Fuller Company; 97-13.
- G. ASJ Adhesive and FSK and PVDC Jacket Adhesive: Comply with MIL-A-3316C, Class 2, Grade A for bonding insulation jacket lap seams and joints.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-82.
    - b. Foster Products Corporation, H.B. Fuller Company; 85-20.
    - c. ITW TACC, Division of Illinois Tool Works; S-90/80.
    - d. Marathon Industries, Inc.; 225.
    - e. Mon-Eco Industries, Inc.; 22-25.
  2. For indoor applications, use adhesive that has a VOC content of 50 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).
- H. PVC Jacket Adhesive: Compatible with PVC jacket.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Dow Chemical Company (The); 739, Dow Silicone.
    - b. Johns Manville; Zeston Perma-Weld, CEEL-TITE Solvent Welding Adhesive.
    - c. P.I.C. Plastics, Inc.; Welding Adhesive.
    - d. Speedline Corporation; Speedline Vinyl Adhesive.

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

## 2.5 MASTICS

- A. Materials shall be compatible with insulation materials, jackets, and substrates; comply with MIL-C-19565C, Type II.
- B. Vapor Barrier Mastic: Water based; suitable for indoor and outdoor use on below ambient services.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-35.
    - b. Foster Products Corporation, H.B. Fuller Company; 30-90.
    - c. ITW TACC, Division of Illinois Tool Works; CB-50.
    - d. Marathon Industries, Inc.; 590.
    - e. Mon-Eco Industries, Inc.; 55-40.
    - f. Vimasco Corporation; 749.
  2. Water Vapor Permeance: ASTM E 96, Procedure B, 0.013 perm at 43-mil dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 180°F.
  4. Solids Content: ASTM D 1644, 59 percent by volume and 71 percent by weight.
  5. Color: White.
- C. Vapor Barrier Mastic: Solvent based, suitable for indoor use on below ambient services.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-30.
    - b. Foster Products Corporation, H.B. Fuller Company; 30-35.
    - c. ITW TACC, Division of Illinois Tool Works; CB-25.
    - d. Marathon Industries, Inc.; 501.
    - e. Mon-Eco Industries, Inc.; 55-10.
  2. Water Vapor Permeance: ASTM F 1249, 0.05 perm at 35-mil dry film thickness.
  3. Service Temperature Range: 0 to 180°F.
  4. Solids Content: ASTM D 1644, 44 percent by volume and 62 percent by weight.
  5. Color: White.
- D. Vapor Barrier Mastic: Solvent based; suitable for outdoor use on below ambient services.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; Encacel.
    - b. Foster Products Corporation, H.B. Fuller Company; 60-95/60-96.
    - c. Marathon Industries, Inc.; 570.
    - d. Mon-Eco Industries, Inc.; 55-70.
  2. Water Vapor Permeance: ASTM F 1249, 0.05 perm at 30-mil dry film thickness.
  3. Service Temperature Range: Minus 50 to plus 220°F.

4. Solids Content: ASTM D 1644, 33 percent by volume and 46 percent by weight.
  5. Color: White.
- E. Breather Mastic: Water based; suitable for indoor and outdoor use on above ambient services.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-10.
    - b. Foster Products Corporation, H.B. Fuller Company; 35-00.
    - c. ITW TACC, Division of Illinois Tool Works; CB-05/15.
    - d. Marathon Industries, Inc.; 550.
    - e. Mon-Eco Industries, Inc.; 55-50.
    - f. Vimasco Corporation; WC-1/WC-5.
  2. Water Vapor Permeance: ASTM F 1249, 3 perms at 0.0625-inch dry film thickness.
  3. Service Temperature Range: Minus 20 to plus 200°F.
  4. Solids Content: 63 percent by volume and 73 percent by weight.
  5. Color: White.

## 2.6 LAGGING ADHESIVES

- A. Description: Comply with MIL-A-3316C Class I, Grade A and shall be compatible with insulation materials, jackets, and substrates.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-52.
    - b. Foster Products Corporation, H.B. Fuller Company; 81-42.
    - c. Marathon Industries, Inc.; 130.
    - d. Mon-Eco Industries, Inc.; 11-30.
    - e. Vimasco Corporation; 136.
  2. Fire resistant, water based lagging adhesive and coating for use indoors to adhere fire resistant lagging cloths over duct, equipment, and pipe insulation.
  3. Service Temperature Range: Minus 50 to plus 180°F.
  4. Color: White.

## 2.7 SEALANTS

- A. Joint Sealants:
1. Joint Sealants for Cellular-Glass, Phenolic, and Polyisocyanurate Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; CP-76.
    - b. Foster Products Corporation, H.B. Fuller Company; 30-45.
    - c. Marathon Industries, Inc.; 405.
    - d. Mon-Eco Industries, Inc.; 44-05.
    - e. Pittsburgh Corning Corporation, Pittseal 444.
    - f. Vimasco Corporation; 750.

2. Joint Sealants for Polystyrene Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
  - a. Childers Products, Division of ITW; CP-70.
  - b. Foster Products Corporation, H.B. Fuller Company; 30-45/30-46.
  - c. Marathon Industries, Inc.; 405.
  - d. Mon-Eco Industries, Inc.; 44-05.
  - e. Vimasco Corporation; 750.
3. Materials shall be compatible with insulation materials, jackets, and substrates.
4. Permanently flexible, elastomeric sealant.
5. Service Temperature Range: Minus 100 to plus 300°F.
6. Color: White or gray.
7. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

B. FSK and Metal Jacket Flashing Sealants:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
  - a. Childers Products, Division of ITW; CP-76-8.
  - b. Foster Products Corporation, H.B. Fuller Company; 95-44.
  - c. Marathon Industries, Inc.; 405.
  - d. Mon-Eco Industries, Inc.; 44-05.
  - e. Vimasco Corporation; 750.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire and water resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250°F.
5. Color: Aluminum.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

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

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
  - a. Childers Products, Division of ITW; CP-76.
2. Materials shall be compatible with insulation materials, jackets, and substrates.
3. Fire and water resistant, flexible, elastomeric sealant.
4. Service Temperature Range: Minus 40 to plus 250°F.
5. Color: White.
6. For indoor applications, use sealants that have a VOC content of 250 g/L or less when calculated according to 40 CFR 59, Subpart D (EPA Method 24).

## 2.8 FACTORY-APPLIED JACKETS

- A. Insulation system schedules indicate factory-applied jackets on various applications. When factory-applied jackets are indicated, comply with the following:
1. ASJ: White, kraft paper, fiberglass-reinforced scrim with aluminum foil backing; complying with ASTM C 1136, Type I.

2. ASJ-SSL: ASJ with self-sealing, pressure sensitive, acrylic-based adhesive covered by a removable protective strip; complying with ASTM C 1136, Type I.
3. FSK Jacket: Aluminum foil, fiberglass-reinforced scrim with kraft paper backing; complying with ASTM C 1136, Type II.
4. FSP Jacket: Aluminum foil, fiberglass-reinforced scrim with polyethylene backing; complying with ASTM C 1136, Type II.
5. PVDC Jacket for Indoor Applications: 4-mil thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
  - a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - i. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
6. PVDC Jacket for Outdoor Applications: 6-mil thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
  - a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - i. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
7. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure sensitive, acrylic-based adhesive covered by a removable protective strip.
  - a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - i. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.
8. Vinyl Jacket: White vinyl with a permeance of 1.3 perms when tested according to ASTM E 96, Procedure A, and complying with NFPA 90A and NFPA 90B.

## 2.9 FIELD-APPLIED FABRIC-REINFORCING MESH

- A. Woven Glass Fiber Fabric for Pipe Insulation: Approximately 2 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch for covering pipe and pipe fittings.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Vimasco Corporation; Elastafab 894.

- B. Woven Glass Fiber Fabric for Duct and Equipment Insulation: Approximately 6 oz./sq. yd. with a thread count of 5 strands by 5 strands/sq. inch for covering equipment.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; Chil-Glas No. 5.
- C. Woven Polyester Fabric: Approximately 1 oz./sq. yd. with a thread count of 10 strands by 10 strands/sq. inch, in a Leno weave, for duct, equipment, and pipe.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Foster Products Corporation, H.B. Fuller Company, Mast-A-Fab.
    - b. Vimasco Corporation, Elastafab 894.

#### 2.10 FIELD-APPLIED CLOTHS

- A. Woven Glass Fiber Fabric: Comply with MIL-C-20079H, Type I, plain weave, and pre-sized a minimum of 8 oz./sq. yd.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Alpha Associates, Inc.; Alpha-Maritex 84215 and 84217/9485RW, Luben 59.

#### 2.11 FIELD-APPLIED JACKETS

- A. Field-applied jackets shall comply with ASTM C 921, Type I, unless otherwise indicated.
- B. FSK Jacket: Aluminum foil face, fiberglass-reinforced scrim with kraft paper backing.
- C. PVC Jacket: High impact resistant, UV-resistant PVC complying with ASTM D 1784, Class 16354-C; thickness as scheduled; roll stock ready for shop or field cutting and forming. Thickness is indicated in field-applied jacket schedules.
  - 1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Johns Manville; Zeston.
    - b. P.I.C. Plastics, Inc.; FG Series.
    - c. Proto PVC Corporation; LoSmoke.
    - d. Speedline Corporation; SmokeSafe.
  - 2. Adhesive: As recommended by jacket material manufacturer.
  - 3. Color: White.
  - 4. Factory-fabricated fitting covers to match jacket if available; otherwise, field fabricate.
    - a. Shapes: 45- and 90-degree, short- and long-radius elbows, tees, valves, flanges, unions, reducers, end caps, soil-pipe hubs, traps, mechanical joints, and P-trap and supply covers for lavatories.

5. Factory-fabricated tank heads and tank side panels.
- D. Metal Jacket:
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Childers Products, Division of ITW; Metal Jacketing Systems.
    - b. PABCO Metals Corporation; Surefit.
    - c. RPR Products, Inc.; Insul-Mate.
  2. Aluminum Jacket: Comply with ASTM B 209, Alloy 3003, 3005, 3105, or 5005, Temper H-14.
    - a. Sheet and roll stock ready for shop or field sizing.
    - b. Finish and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Indoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
    - d. Moisture Barrier for Outdoor Applications: 2.5-mil thick polysurlyn.
    - e. Factory-Fabricated Fitting Covers:
      - i. Same material, finish, and thickness as jacket.
      - ii. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      - iii. Tee covers.
      - iv. Flange and union covers.
      - v. End caps.
      - vi. Beveled collars.
      - vii. Valve covers.
      - viii. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
  3. Stainless Steel Jacket: ASTM A 167 or ASTM A 240/A 240M.
    - a. Sheet and roll stock ready for shop or field sizing.
    - b. Material, finish, and thickness are indicated in field-applied jacket schedules.
    - c. Moisture Barrier for Indoor Applications: 3-mil thick, heat-bonded polyethylene and kraft paper.
    - d. Moisture Barrier for Outdoor Applications: 2.5-mil thick Polysurlyn.
    - e. Factory-Fabricated Fitting Covers:
      - i. Same material, finish, and thickness as jacket.
      - ii. Preformed 2-piece or gore, 45- and 90-degree, short- and long-radius elbows.
      - iii. Tee covers.
      - iv. Flange and union covers.
      - v. End caps.
      - vi. Beveled collars.
      - vii. Valve covers.
      - viii. Field fabricate fitting covers only if factory-fabricated fitting covers are not available.
- E. Underground Direct-Buried Jacket: 125-mil thick vapor barrier and waterproofing membrane consisting of a rubberized bituminous resin reinforced with a woven glass fiber or polyester scrim and laminated aluminum foil.

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
  - a. Pittsburgh Corning Corporation; Pittwrap.
  - b. Polyguard; Insulrap No Torch 125.
  - c. Perma-Pipe.
- F. Self-Adhesive Outdoor Jacket: 60-mil 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. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Polyguard; Alumaguard 60.
- G. PVDC Jacket for Indoor Applications: 4-mil thick, white PVDC biaxially oriented barrier film with a permeance at 0.02 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 20 when tested according to ASTM E 84.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Dow Chemical Company (The), Saran 540 Vapor Retarder Film.
- H. PVDC Jacket for Outdoor Applications: 6-mil thick, white PVDC biaxially oriented barrier film with a permeance at 0.01 perms when tested according to ASTM E 96 and with a flame-spread index of 5 and a smoke-developed index of 25 when tested according to ASTM E 84.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Dow Chemical Company (The), Saran 560 Vapor Retarder Film.
- I. PVDC-SSL Jacket: PVDC jacket with a self-sealing, pressure sensitive, acrylic-based adhesive covered by a removable protective strip.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Film and Saran 560 Vapor Retarder Film.

## 2.12 TAPES

- A. ASJ Tape: White vapor retarder tape matching factory-applied jacket with acrylic adhesive, complying with ASTM C 1136.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0835.
    - b. Compac Corp.; 104 and 105.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 428 AWF ASJ.

- d. Venture Tape; 1540 CW Plus, 1542 CW Plus, and 1542 CW Plus/SQ.
  2. Width: 3 inches.
  3. Thickness: 11.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. ASJ Tape Disks and Squares: Precut disks or square of ASJ tape.
- B. FSK Tape: Foil face, vapor retarder tape matching factory-applied jacket with acrylic adhesive; complying with ASTM C 1136.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0827.
    - b. Compac Corp.; 110 and 111.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 491 AWF FSK.
    - d. Venture Tape; 1525 CW, 1528 CW, and 1528 CW/SQ.
  2. Width: 3 inches.
  3. Thickness: 6.5 mils.
  4. Adhesion: 90 ounces force/inch in width.
  5. Elongation: 2 percent.
  6. Tensile Strength: 40 lbf/inch in width.
  7. FSK Tape Disks and Squares: Precut disks or square of FSK tape.
- C. PVC Tape: White vapor retarder tape matching field-applied PVC jacket with acrylic adhesive. Suitable for indoor and outdoor applications.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0555.
    - b. Compac Corp.; 130.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 370 White PVC tape.
    - d. Venture Tape; 1506 CW NS.
  2. Width: 2 inches.
  3. Thickness: 6 mils.
  4. Adhesion: 64 ounces force/inch in width.
  5. Elongation: 500 percent.
  6. Tensile Strength: 18 lbf/inch in width.
- D. Aluminum Foil Tape: Vapor retarder tape with acrylic adhesive.
  1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Avery Dennison Corporation, Specialty Tapes Division; Fasson 0800.
    - b. Compac Corp.; 120.
    - c. Ideal Tape Co., Inc., an American Biltrite Company; 488 AWF.
    - d. Venture Tape; 3520 CW.
  2. Width: 2 inches.
  3. Thickness: 3.7 mils.
  4. Adhesion: 100 ounces force/inch in width.
  5. Elongation: 5 percent.

6. Tensile Strength: 34 lbf/inch in width.
- E. PVDC Tape for Indoor Applications: White vapor retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Dow Chemical Company (The); Saran 540 Vapor Retarder Tape.
  2. Width: 3 inches.
  3. Film Thickness: 1.5 mils.
  4. Adhesive Thickness: 1.5 mils.
  5. Elongation at Break: 145 percent.
  6. Tensile Strength: 55 lbf/inch in width.
- F. PVDC Tape for Outdoor Applications: White vapor retarder PVDC tape with acrylic adhesive.
1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - a. Dow Chemical Company (The); Saran 560 Vapor Retarder Tape.
  2. Width: 3 inches.
  3. Film Thickness: 6 mils.
  4. Adhesive Thickness: 1.5 mils.
  5. Elongation at Break: 145 percent.
  6. Tensile Strength: 55 lbf/inch in width.

### 2.13 SECUREMENTS

A. Bands:

1. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
  - a. Childers Products; Bands.
  - b. PABCO Metals Corporation; Bands.
  - c. RPR Products, Inc.; Bands.
2. Stainless Steel: ASTM A 167 or ASTM A 240/A 240M, Type 304 or Type 316; 0.015 in ch thick, ½ inch, ¾ inch wide with wing or closed seal.
3. Aluminum: ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14, 0.020 inch thick, ½ inch wide with wing or closed seal.
4. Springs: Twin spring set constructed of stainless steel with ends flat and slotted to accept metal bands. Spring size determined by manufacturer for application.

B. Insulation Pins and Hangers:

1. Capacitor Discharge Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated.

- a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
  - i. AGM Industries, Inc.; CWP-1.
  - ii. GEMCO; CD.
  - iii. Midwest Fasteners, Inc.; CD.
  - iv. Nelson Stud Welding; TPA, TPC, and TPS.
2. Cupped Head, Capacitor Discharge Weld Pins: Copper- or zinc-coated steel pin, fully annealed for capacitor discharge welding, 0.135-inch diameter shank, length to suit depth of insulation indicated with integral 1-1/2 inch galvanized carbon steel washer.
  - a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - i. AGM Industries, Inc.; CWP-1.
    - ii. GEMCO; Cupped Head Weld Pin.
    - iii. Midwest Fasteners, Inc.; Cupped Head.
    - iv. Nelson Stud Welding: CHP.
  3. 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:
    - a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
      - i. AGM Industries, Inc.; Tactoo Insul-Hangers, Series T.
      - ii. GEMCO; Perforated Base.
      - iii. Midwest Fasteners, Inc.; Spindle.
    - b. Baseplate: Perforated, galvanized carbon steel sheet, 0.030 inch thick by 2 inches square.
    - c. Spindle: Stainless steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
    - d. Adhesive: Recommended by hanger manufacturer: Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
  4. Non-Metal, 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:
    - a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
      - i. GEMCO; Nylon Hangers.
      - ii. Midwest Fasteners, Inc.; Nylon Insulation Hangers.

- b. Baseplate: Perforated, nylon sheet, 0.030 inch thick by 1-1/2 inches in diameter.
  - c. Spindle: Nylon, 0.106-inch diameter shank, length to suit depth of insulation indicated, up to 2-1/2 inches.
  - d. Adhesive: Recommended by hanger manufacturer. Product with demonstrated capability to bond insulation hanger securely to substrates indicated without damaging insulation, hangers, and substrates.
5. 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:
- a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - i. AGM Industries, Inc.; Tactoo Insul-Hangers, Series TSA.
    - ii. GEMCO; Press and Peel.
    - iii. Midwest Fasteners, Inc.; Self Stick.
  - b. Baseplate: Galvanized carbon steel sheet, 0.030 inch thick by 2 inches square.
  - c. Spindle: Stainless steel, fully annealed, 0.106-inch diameter shank, length to suit depth of insulation indicated.
  - d. Adhesive-backed base with a peel-off protective cover.
6. Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick, stainless steel sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - i. AGM Industries, Inc.; RC-150.
    - ii. GEMCO; R-150.
    - iii. Midwest Fasteners, Inc.; WA-150.
    - iv. Nelson Stud Welding; Speed Clips.
  - b. Protect ends with capped self-locking washers incorporating a spring steel insert to ensure permanent retention of cap in exposed locations.
7. Non-Metal Insulation-Retaining Washers: Self-locking washers formed from 0.016-inch thick nylon sheet, with beveled edge sized as required to hold insulation securely in place but not less than 1-1/2 inches in diameter.
- a. Products: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following:
    - i. GEMCO.
    - ii. Midwest Fasteners, Inc.

- C. Staples: Outward-clinching insulation staples, nominal 3/4-inch wide, stainless steel or Monel.
- D. Wire: 0.062-inch soft-annealed, stainless steel.
  - 1. Manufacturers: Subject to compliance with requirements, available products that may be incorporated into the work include, but are not limited to, the following
    - a. C & F Wire.
    - b. Childers Products.
    - c. PABCO Metals Corporation.
    - d. RPR Products, Inc.

#### 2.14 CORNER ANGLES

- A. PVC Corner Angles: 30 mils thick, minimum 1 by 1 inch, PVC according to ASTM D 1784, Class 16354-C. White or color coded to match adjacent surface.
- B. Aluminum Corner Angles: 0.040 inch thick, minimum 1 by 1 inch, aluminum according to ASTM B 209, Alloy 3003, 3005, 3105, or 5005; Temper H-14.
- C. Stainless Steel Corner Angles: 0.024 inch thick, minimum 1 by 1 inch, stainless steel according to ASTM A 167 or ASTM A 240/A 240M, Type 304 or 316.

### PART 3 EXECUTION

#### 3.1 EXAMINATION

- A. Examine substrates and conditions for compliance with requirements for installation and other conditions affecting performance of insulation application.
  - 1. Verify that systems and equipment to be insulated have been tested and are free of defects.
  - 2. Verify that surfaces to be insulated are clean and dry.
  - 3. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 PREPARATION

- A. Surface Preparation: Clean and dry surfaces to receive insulation. Remove materials that will adversely affect insulation application. Before insulating, apply a corrosion coating to insulated surfaces as follows:
  - 1. Stainless Steel: Coat 300 series stainless steel with an epoxy primer 5 mils thick and an epoxy finish 5 mils thick if operating in a temperature range between 140 and 300°F. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
  - 2. Carbon Steel: Coat carbon steel operating at a service temperature between 32 and 300°F with an epoxy coating. Consult coating manufacturer for appropriate coating materials and application methods for operating temperature range.
- B. Coordinate insulation installation with the trade installing heat tracing. Comply with requirements for heat tracing that apply to insulation.

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

### 3.3 GENERAL INSTALLATION REQUIREMENTS

- A. Install insulation materials, accessories, and finishes with smooth, straight, and even surfaces; free of voids throughout the length of equipment, ducts and fittings, and piping including fittings, valves, and specialties.
- B. Install insulation materials, forms, vapor barriers or retarders, jackets, and thicknesses required for each item of equipment, duct system, and pipe system as specified in insulation system schedules.
- C. Install accessories compatible with insulation materials and suitable for the service. Install accessories that do not corrode, soften, or otherwise attack insulation or jacket in either wet or dry state.
- D. Install insulation with longitudinal seams at top and bottom of horizontal runs.
- E. Install multiple layers of insulation with longitudinal and end seams staggered.
- F. Do not weld brackets, clips, or other attachment devices to piping, fittings, and specialties.
- G. Keep insulation materials dry during application and finishing.
- H. Install insulation with tight longitudinal seams and end joints. Bond seams and joints with adhesive recommended by insulation material manufacturer.
- I. Install insulation with least number of joints practical.
- J. Where vapor barrier is indicated, seal joints, seams, and penetrations in insulation at hangers supports, anchors, and other projections with vapor barrier mastic.
  - 1. Install insulation continuously through hangers and around anchor attachments.
  - 2. For insulation application where vapor barriers are indicated, extend insulation on anchor legs from point of attachment to supported item to point of attachment to structure. Taper and seal ends at attachment to structure with vapor barrier mastic.
  - 3. Install insert materials and install insulation to tightly join the insert. Seal insulation to insulation inserts with adhesive or sealing compound recommended by insulation material manufacturer.
  - 4. Cover inserts with jacket material matching adjacent pipe insulation. Install shields over jacket, arranged to protect jacket from tear or puncture by hanger, support, and shield.
- K. Apply adhesives, mastics, and sealants at manufacturer's recommended coverage rate and wet and dry film thicknesses.
- L. Install insulation with factory-applied jackets as follows:
  - 1. Draw jacket tight and smooth.

2. Cover circumferential joints with 3-inch wide strips, of same material as insulation jacket. Secure strips with adhesive and outward clinching staples along both edges of strip, spaced 4 inches o.c.
  3. Overlap jacket longitudinal seams at least 1-1/2 inches. Install insulation with longitudinal seams at bottom of pipe. Clean and dry surface to receive self-sealing lap. Staple laps with outward clinching staples along edge at 4 inches o.c.
    - a. For below ambient services, apply vapor barrier mastic over staples.
  4. Cover joints and seams with tape as recommended by insulation material manufacturer to maintain vapor seal.
  5. Where vapor barriers are indicated, apply vapor barrier mastic on seams and joints and at ends adjacent to duct and pipe flanges and fittings.
- M. Cut insulation in a manner to avoid compressing insulation more than 75 percent of its nominal thickness.
- N. Finish installation with systems at operating conditions. Repair joint separations and cracking due to thermal movement.
- O. Repair damaged insulation facings by applying same facing material over damaged areas. Extend patches at least 4 inches beyond damaged areas. Adhere, staple, and seal patches similar to butt joints.
- P. For above ambient services, do not install insulation to the following:
1. Vibration control devices.
  2. Testing agency labels and stamps.
  3. Nameplates and data plates.
  4. Manholes.
  5. Handholes.
  6. Cleanouts.

### 3.4 PENETRATIONS

- A. Insulation Installation at Roof Penetrations: Install insulation continuously through roof penetrations.
1. Seal penetrations with flashing sealant.
  2. For applications requiring only indoor insulation, terminate insulation above roof surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  3. Extend jacket of outdoor insulation outside roof flashing at least 2 inches below top of roof flashing.
  4. Seal jacket to roof flashing with flashing sealant.
- B. Insulation Installation at Underground Exterior Wall Penetrations: Terminate insulation flush with sleeve seal. Seal terminations with flashing sealant.

- C. Insulation Installation at Aboveground Exterior Wall Penetrations: Install insulation continuously through wall penetrations.
  - 1. Seal penetrations with flashing sealant.
  - 2. For applications requiring only indoor insulation, terminate insulation inside wall surface and seal with joint sealant. For applications requiring indoor and outdoor insulation, install insulation for outdoor applications tightly joined to indoor insulation ends. Seal joint with joint sealant.
  - 3. Extend jacket of outdoor insulation outside wall flashing and overlap wall flashing at least 2 inches.
  - 4. Seal jacket to wall flashing with flashing sealant.
- D. Insulation Installation at Interior Wall and Partition Penetrations (That Are Not Fire Rated): Install insulation continuously through walls and partitions.
- E. Insulation Installation at Fire Rated Wall and Partition Penetrations: Install insulation continuously through penetrations of fire rated walls and partitions. 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.
  - 1. Comply with requirements for fire-resistive joint sealers.
- F. Insulation Installation at Floor Penetrations:
  - 1. Duct: Install insulation continuously through floor penetrations that are not fire rated. 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.
  - 2. Pipe: Install insulation continuously through floor penetrations.
  - 3. Seal penetrations through fire rated assemblies.

### 3.5 EQUIPMENT, TANK, AND VESSEL INSULATION INSTALLATION

- A. Mineral Fiber, Pipe, and Tank Insulation Installation for Tanks and Vessels: Secure insulation with adhesive and anchor pins and speed washers.
  - 1. Apply adhesive according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of tank and vessel surfaces. Access to tags and hatches will be maintained.
  - 2. Groove and score insulation materials to fit as closely as possible to equipment, including contours. Bevel insulation edges for cylindrical surfaces for tight joints. Stagger end joints.
  - 3. Protect exposed corners with secured corner angles.
  - 4. Install adhesively attached or self-sticking insulation hangers and speed washers on sides of tanks and vessels as follows:
    - a. Do not weld anchor pins to ASME-labeled pressure vessels.

- b. Select insulation hangers and adhesive that are compatible with service temperature and with substrate.
  - c. On tanks and vessels, maximum anchor-pin spacing is 3 inches from insulation end joints, and 16 inches o.c. in both directions.
  - d. Do not over-compress insulation during installation.
  - e. Cut and miter insulation segments to fit curved sides and domed heads of tanks and vessels.
  - f. Impale insulation over anchor pins and attach speed washers.
  - g. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
5. Secure each layer of insulation with stainless steel or aluminum bands. Select band material compatible with insulation materials.
  6. Where insulation hangers on equipment and vessels are not permitted or practical, and where insulation support rings are not provided, install a girdle network for securing insulation. Stretch pre-stressed aircraft cable around the diameter of vessel and make taut with clamps, turnbuckles, or breather springs. Place one circumferential girdle around equipment approximately 6 inches from each end. Install wire or cable between two circumferential girdles 12 inches o.c. Install a wire ring around each end and around outer periphery of center openings, and stretch pre-stressed aircraft cable radially from the wire ring to nearest circumferential girdle. Install additional circumferential girdles along the body of equipment or tank at a minimum spacing of 48 inches o.c. Use this network for securing insulation with tie wire or bands.
  7. Stagger joints between insulation layers at least 3 inches.
  8. Install insulation in removable segments on equipment access doors, manholes, handholes, and other elements that require frequent removal for service and inspection.
  9. Bevel and seal insulation ends around manholes, handholes, ASME stamps, and nameplates.
  10. For equipment with surface temperatures below ambient, apply mastic to open ends, joints, seams, breaks, and punctures in insulation.
- B. Flexible Elastomeric Thermal Insulation Installation for Tanks and Vessels: Install insulation over entire surface of tanks and vessels.
1. Apply 100 percent coverage of adhesive to surface with manufacturer's recommended adhesive.
  2. Seal longitudinal seams and end joints.
- C. Insulation Installation on Pumps:
1. Fabricate metal boxes lined with insulation. Fit boxes around pumps and coincide box joints with splits in pump casings. Fabricate joints with outward bolted flanges. Bolt flanges on 6-inch centers, starting at corners. Install 3/8-inch diameter fasteners with wing nuts. Alternatively, secure the box sections together using a latching mechanism.
  2. Fabricate boxes from galvanized steel, at least 0.050 inch thick.

3. For below ambient services, install a vapor barrier at seams, joints, and penetrations. Seal between flanges with replaceable gasket material to form a vapor barrier.

### 3.6 GENERAL PIPE INSULATION INSTALLATION

- A. Requirements in this article generally apply to all insulation materials except where more specific requirements are specified in various pipe insulation material installation articles.
- B. Insulation Installation on Fittings, Valves, Strainers, Flanges, and Unions:
  1. Install insulation over fittings, valves, strainers, flanges, unions, and other specialties with continuous thermal and vapor retarder integrity, unless otherwise indicated.
  2. Insulate pipe elbows using preformed fitting insulation or mitered fittings made from same material and density as adjacent pipe insulation. Each piece shall be butted tightly against adjoining piece and bonded with adhesive. Fill joints, seams, voids, and irregular surfaces with insulating cement finished to a smooth, hard, and uniform contour that is uniform with adjoining pipe insulation.
  3. Insulate tee fittings with preformed fitting insulation or sectional pipe insulation of same material and thickness as used for adjacent pipe. Cut sectional pipe insulation to fit. Butt each section closely to the next and hold in place with tie wire. Bond pieces with adhesive.
  4. Insulate valves using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. For valves, insulate up to and including the bonnets, valve stuffing-box studs, bolts, and nuts. Fill joints, seams, and irregular surfaces with insulating cement.
  5. Insulate strainers using preformed fitting insulation or sectional pipe insulation of same material, density, and thickness as used for adjacent pipe. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker. Fill joints, seams, and irregular surfaces with insulating cement. Insulate strainers so strainer basket flange or plug can be easily removed and replaced without damaging the insulation and jacket. Provide a removable reusable insulation cover. For below ambient services, provide a design that maintains vapor barrier.
  6. Insulate flanges and unions using a section of oversized preformed pipe insulation. Overlap adjoining pipe insulation by not less than two times the thickness of pipe insulation, or one pipe diameter, whichever is thicker.
  7. Cover segmented insulated surfaces with a layer of finishing cement and coat with a mastic. Install vapor barrier mastic for below ambient services and a breather mastic for above ambient services. Reinforce the mastic with fabric-reinforcing mesh. Trowel the mastic to a smooth and well-shaped contour.
  8. For services not specified to receive a field-applied jacket except for flexible elastomeric and polyolefin, install fitted PVC cover over elbows, tees, strainers, valves, flanges, and unions. Terminate ends with PVC end caps. Tape PVC covers to adjoining insulation facing using PVC tape.

9. Stencil or label the outside insulation jacket of each union with the word "UNION." Match size and color of pipe labels.
- C. Insulate instrument connections for thermometers, pressure gages, pressure temperature taps, test connections, flow meters, sensors, switches, and transmitters on insulated pipes, vessels, and equipment. Shape insulation at these connections by tapering it to and around the connection with insulating cement and finish with finishing cement, mastic, and flashing sealant.
  - D. Install removable insulation covers at locations indicated. Installation shall conform to the following:
    1. Make removable flange and union insulation from sectional pipe insulation of same thickness as that on adjoining pipe. Install same insulation jacket as adjoining pipe insulation.
    2. When flange and union covers are made from sectional pipe insulation, extend insulation from flanges or union long at least two times the insulation thickness over adjacent pipe insulation on each side of flange or union. Secure flange cover in place with stainless steel or aluminum bands. Select band material compatible with insulation and jacket.
    3. Construct removable valve insulation covers in same manner as for flanges except divide the two-part section on the vertical center line of valve body.
    4. When covers are made from block insulation, make two halves, each consisting of mitered blocks wired to stainless steel fabric. Secure this wire frame, with its attached insulation, to flanges with tie wire. Extend insulation at least 2 inches over adjacent pipe insulation on each side of valve. Fill space between flange or union cover and pipe insulation with insulating cement. Finish cover assembly with insulating cement applied in two coats. After first coat is dry, apply and trowel second coat to a smooth finish.
    5. Unless a PVC jacket is indicated in field-applied jacket schedules, finish exposed surfaces with a metal jacket.

### 3.7 CALCIUM SILICATE INSULATION INSTALLATION

- A. Insulation Installation on Boiler and Generator Breeching and Ducts:
  1. Secure single-layer insulation with stainless steel bands at 12-inch intervals and tighten bands without deforming insulation material.
  2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.
  3. On exposed applications without metal jacket, finish insulation surface with a skim coat of mineral fiber, hydraulic-setting cement. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth. Thin finish coat to achieve smooth, uniform finish.
- B. Insulation Installation on Straight Pipes and Tubes:
  1. Secure single-layer insulation with stainless steel bands at 12-inch intervals and tighten bands without deforming insulation materials.

2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.
  3. Apply a skim coat of mineral fiber, hydraulic-setting cement to insulation surface. When cement is dry, apply flood coat of lagging adhesive and press on one layer of glass cloth or tape. Overlap edges at least 1 inch. Apply finish coat of lagging adhesive over glass cloth or tape. Thin finish coat to achieve smooth, uniform finish.
- C. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of block insulation of same material and thickness as pipe insulation.
  4. Finish flange insulation same as pipe insulation.
- D. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed sections of same material as straight segments of pipe insulation when available. Secure according to manufacturer's written instructions.
  2. When preformed insulation sections of insulation are not available, install mitered sections of calcium silicate insulation. Secure insulation materials with wire or bands.
  3. Finish fittings insulation same as pipe insulation.
- E. Insulation Installation on Valves and Pipe Specialties:
1. Install mitered segments of calcium silicate insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  2. Install insulation to flanges as specified for flange insulation application.
  3. Finish valve and specialty insulation same as pipe insulation.

### 3.8 CELLULAR GLASS INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.

3. For insulation with factory-applied jackets on above ambient services, secure laps with outward clinched staples at 6 inches o.c.
4. For insulation with factory-applied jackets on below ambient services, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.

B. Insulation Installation on Pipe Flanges:

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

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

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

### 3.9 FLEXIBLE ELASTOMERIC INSULATION INSTALLATION

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

B. Insulation Installation on Pipe Flanges:

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

4. Secure insulation to flanges and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install mitered sections of pipe insulation.
  2. Secure insulation materials and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed valve covers manufactured of same material as pipe insulation when available.
  2. When preformed valve covers are not available, install cut sections of pipe and sheet insulation to valve body. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  3. Install insulation to flanges as specified for flange insulation application.
  4. Secure insulation to valves and specialties and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.10 MINERAL FIBER INSULATION INSTALLATION

- A. Insulation Installation on Straight Pipes and Tubes:
1. Secure each layer of preformed pipe insulation to pipe with wire or bands and tighten bands without deforming insulation materials.
  2. Where vapor barriers are indicated, seal longitudinal seams, end joints, and protrusions with vapor-barrier mastic and joint sealant.
  3. For insulation with factory-applied jackets on above ambient surfaces, secure laps with outward clinched staples at 6 inches o.c.
  4. For insulation with factory-applied jackets on below ambient surfaces, do not staple longitudinal tabs but secure tabs with additional adhesive as recommended by insulation material manufacturer and seal with vapor-barrier mastic and flashing sealant.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, plus twice the thickness of pipe insulation.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with mineral fiber blanket insulation.
  4. Install jacket material with manufacturer's recommended adhesive, overlap seams at least 1 inch, and seal joints with flashing sealant.

C. Insulation Installation on Pipe Fittings and Elbows:

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

D. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed sections of same material as straight segments of pipe insulation when available.
2. When preformed sections are not available, install mitered sections of pipe insulation to valve body.
3. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
4. Install insulation to flanges as specified for flange insulation application.

E. Blanket Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.

1. Apply adhesive according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces. Tags and access will be maintained.
2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
3. Install either capacitor discharge weld pins and speed washers or cupped-head, capacitor discharge weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
  - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
  - b. On duct sides with dimensions larger than 18 inches, place pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
  - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
  - d. Do not over compress insulation during installation.
  - e. Impale insulation over pins and attach speed washers.
  - f. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing.
4. 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 from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with ½-inch outward clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.

- a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.
    - b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
  5. Overlap unfaced blankets a minimum of 2 inches on longitudinal seams and end joints. At end joints, secure with steel bands spaced a maximum of 18 inches o.c.
  6. 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.
  7. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.
- F. Board Insulation Installation on Ducts and Plenums: Secure with adhesive and insulation pins.
1. Apply adhesive according to manufacturer's recommended coverage rates per unit area, for 100 percent coverage of duct and plenum surfaces. Tags and access will be maintained.
  2. Apply adhesive to entire circumference of ducts and to all surfaces of fittings and transitions.
  3. Install either capacitor discharge weld pins and speed washers or cupped-head, capacitor discharge weld pins on sides and bottom of horizontal ducts and sides of vertical ducts as follows:
    - a. On duct sides with dimensions 18 inches and smaller, place pins along longitudinal centerline of duct. Space 3 inches maximum from insulation end joints, and 16 inches o.c.
    - b. On duct sides with dimensions larger than 18 inches, space pins 16 inches o.c. each way, and 3 inches maximum from insulation joints. Install additional pins to hold insulation tightly against surface at cross bracing.
    - c. Pins may be omitted from top surface of horizontal, rectangular ducts and plenums.
    - d. Do not over compress insulation during installation.
    - e. Cut excess portion of pins extending beyond speed washers or bend parallel with insulation surface. Cover exposed pins and washers with tape matching insulation facing,
  4. 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 from 1 edge and 1 end of insulation segment. Secure laps to adjacent insulation section with 1/2-inch outward clinching staples, 1 inch o.c. Install vapor barrier consisting of factory- or field-applied jacket, adhesive, vapor-barrier mastic, and sealant at joints, seams, and protrusions.
    - a. Repair punctures, tears, and penetrations with tape or mastic to maintain vapor-barrier seal.

- b. Install vapor stops for ductwork and plenums operating below 50°F at 18-foot intervals. Vapor stops shall consist of vapor-barrier mastic applied in a Z-shaped pattern over insulation face, along butt end of insulation, and over the surface. Cover insulation face and surface to be insulated a width equal to 2 times the insulation thickness but not less than 3 inches.
5. 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.
6. Insulate duct stiffeners, hangers, and flanges that protrude beyond insulation surface with 6-inch wide strips of same material used to insulate duct. Secure on alternating sides of stiffener, hanger, and flange with pins spaced 6 inches o.c.

### 3.11 PHENOLIC INSULATION INSTALLATION

#### A. General Installation Requirements:

1. Secure single layer insulation with stainless steel bands at 12-inch intervals and tighten bands without deforming insulation materials.
2. Install 2-layer insulation with joints tightly butted and staggered at least 3 inches. Secure inner layer with 0.062-inch wire spaced at 12-inch intervals. Secure outer layer with stainless steel bands at 12-inch intervals.

#### B. Insulation Installation on Straight Pipes and Tubes:

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

#### C. Insulation Installation on Pipe Flanges:

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

#### D. Insulation Installation on Pipe Fittings and Elbows:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

E. Insulation Installation on Valves and Pipe Specialties:

1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.

### 3.12 POLYISOCYANURATE INSULATION INSTALLATION

A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation to pipe with tape or bands and tighten without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.
3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.

B. Insulation Installation on Pipe Flanges:

1. Install preformed pipe insulation to outer diameter of pipe flange.
2. Make width of insulation same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2 inch thickness.
3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polyisocyanurate block insulation of same thickness as pipe insulation/

C. Insulation Installation on Fittings and Elbows:

1. Install preformed sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.

D. Insulation Installation on Valves and Pipe Specialties:

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

### 3.13 POLYOLEFIN INSULATION INSTALLATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Seal split-tube longitudinal seams and end joints with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

#### B. Insulation Installation on Pipe Flanges:

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

#### C. Insulation Installation on Pipe Fittings and Elbows:

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

#### D. Insulation Installation on Valves and Pipe Specialties:

1. Install cut sections of polyolefin pipe and sheet insulation to valve body.
2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
3. Install insulation to flanges as specified for flange insulation application.
4. Secure insulation to valves and specialties, and seal seams with manufacturer's recommended adhesive to eliminate openings in insulation that allow passage of air to surface being insulated.

### 3.14 POLYSTYRENE INSULATION INSTALLATION

#### A. Insulation Installation on Straight Pipes and Tubes:

1. Secure each layer of insulation with tape or bands and tighten bands without deforming insulation materials. Orient longitudinal joints between half sections in 3 and 9 o'clock positions on the pipe.
2. For insulation with factory-applied jackets with vapor barriers, do not staple longitudinal tabs but secure tabs with additional adhesive or tape as recommended by insulation material manufacturer and seal with vapor-barrier mastic.

3. All insulation shall be tightly butted and free of voids and gaps at all joints. Vapor barrier must be continuous. Before installing jacket material, install vapor-barrier system.
- B. Insulation Installation on Pipe Flanges:
1. Install preformed pipe insulation to outer diameter of pipe flange.
  2. Make width of insulation section same as overall width of flange and bolts, same thickness of adjacent pipe insulation, not to exceed 1-1/2 inch thickness.
  3. Fill voids between inner circumference of flange insulation and outer circumference of adjacent straight pipe segments with cut sections of polystyrene block insulation of same thickness as pipe insulation.
- C. Insulation Installation on Pipe Fittings and Elbows:
1. Install preformed insulation sections of same material as straight segments of pipe insulation. Secure according to manufacturer's written instructions.
- D. Insulation Installation on Valves and Pipe Specialties:
1. Install preformed section of polystyrene insulation to valve body.
  2. Arrange insulation to permit access to packing and to allow valve operation without disturbing insulation.
  3. Install insulation to flanges as specified for flange insulation application.

### 3.15 FIELD-APPLIED JACKET INSTALLATION

- A. Where glass cloth jackets are indicated, install directly over bare insulation or insulation with factory-applied jackets.
1. Draw jacket smooth and tight to surface with 2-inch overlap at seams and joints.
  2. Embed glass cloth between two 0.062-inch thick coats of lagging adhesive.
  3. Completely encapsulate insulation with coating, leaving no exposed insulation.
- B. Where FSK jackets are indicated, install as follows:
1. Draw jacket material smooth and tight.
  2. Install lap or joint strips with same material as jacket.
  3. Secure jacket to insulation with manufacturer's recommended adhesive.
  4. Install jacket with 1-1/2 inch laps at longitudinal seams and 3-inch wide joint strips at end joints.
  5. Seal openings, punctures, and breaks in vapor-retarder jackets and exposed insulation with vapor-barrier mastic.
- C. Where PVC jackets are indicated, install with 1-inch overlap at longitudinal seams and end joints; for horizontal applications, install with longitudinal seams along top and bottom of tanks and vessels. Seal with manufacturer's recommended adhesive.

1. Apply two continuous beads of adhesive to seams and joints, one bead under lap and the finish bead along seam and joint edge.
- D. Where metal jackets are indicated, install with 2-inch 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 o.c. and at end joints.
- E. Where PVDC jackets are indicated, install as follows:
1. Apply three separate wraps of filament tape per insulation section to secure pipe insulation to pipe prior to installation of PVDC jacket.
  2. Wrap factory presized jackets around individual pipe insulation sections with one end overlapping the previously installed sheet. Install presized jacket with an approximate overlap at butt joint of 2 inches over the previous section. Adhere lap seal using adhesive or SSL, and then apply 1-1/4 circumferences of appropriate PVDC tape around overlapped butt joint.
  3. Continuous jacket can be spiral wrapped around a length of pipe insulation. Apply adhesive or PVDC tape at overlapped spiral edge. When electing to use adhesives, refer to manufacturer's written instructions for application of adhesives along this spiral edge to maintain a permanent bond.
  4. Jacket can be wrapped in cigarette fashion along length of roll for insulation systems with an outer circumference of 33-1/2 inches or less. The 33-1/2 inch circumference limit allows for 2-inch overlap seal. Using the length of roll allows for longer sections of jacket to be installed at one time. Use adhesive on the lap seal. Visually inspect lap seal for "fishmouthing," and use PVDC tape along lap seal to secure joint.
  5. Repair holes or tears in PVDC jacket by placing PVDC tape over the hole or tear and wrapping a minimum of 1-1/4 circumferences to avoid damage to tape edges.

### 3.16 FIRE-RATED INSULATION SYSTEM INSTALLATION

- A. Where fire-rated insulation system is indicated, secure system to ducts and duct hangers and supports to maintain a continuous fire rating.
- B. Insulate duct access panels and doors to achieve same fire rating as duct.
- C. Install firestopping at penetrations through fire-rated assemblies.

### 3.17 FINISHES

- A. Duct, Equipment, and Pipe Insulation with ASJ, Glass Cloth, or Other Paintable Jacket Material: Paint jacket with paint system identified below.
  1. Flat Acrylic Finish: Two finish coats over a primer that is compatible with jacket material and finish coat paint. Add fungicidal agent to render fabric mildew proof.
    - a. Finish Coat Material: Interior, flat, latex-emulsion size.
- B. Flexible Elastomeric Thermal Insulation: After adhesive has fully cured, apply two coats of insulation manufacturer's recommended protective coating.

- C. Color: Final color as selected by Architect. Vary first and second coats to allow visual inspection of the completed work.
- D. Do not field paint aluminum or stainless steel jackets.

### 3.18 FIELD QUALITY CONTROL

- A. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- B. Perform the following tests and inspections:
  - 1. Inspect ductwork, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations for each duct system defined in the "Duct Insulation Schedule, General" Article.
  - 2. Inspect field-insulated equipment, randomly selected by Architect, by removing field-applied jacket and insulation in layers in reverse order of their installation. Extent of inspection shall be limited to three locations for each type of equipment defined in the "Equipment Insulation Schedule" Article. For large equipment, remove only a portion adequate to determine compliance.
  - 3. Inspect pipe, fittings, strainers, and valves, 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 three locations of straight pipe, three locations of threaded fittings, three locations of welded fittings, two locations of threaded strainers, two locations of welded strainers, three locations of threaded valves, and three locations of flanged valves for each pipe service defined in the "Piping Insulation Schedule, General" Article.
- C. All insulation applications will be considered defective work if sample inspection reveals noncompliance with requirements.

### 3.19 GENERATOR STACK AND BREECHING INSULATION SCHEDULE

- A. Round, exposed breeching and connector insulation shall be one of the following:
  - 1. Calcium Silicate: 4 inches thick.
  - 2. High Temperature Mineral Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
  - 3. High Temperature Mineral Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.
- B. Round, concealed breeching and connector insulation shall be one of the following:
  - 1. Calcium Silicate: 4 inches thick.
  - 2. High Temperature Mineral Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
  - 3. High Temperature Mineral Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.
- C. Rectangular, exposed breeching and connector insulation shall be one of the following:
  - 1. Calcium Silicate: 4 inches thick.
  - 2. High Temperature Mineral Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.

3. High Temperature Mineral Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.
- D. Rectangular, concealed breeching and connector insulation shall be one of the following:
1. Calcium Silicate: 4 inches thick.
  2. High Temperature Mineral Fiber Blanket: 3 inches thick and 3-lb/cu. ft. nominal density.
  3. High Temperature Mineral Fiber Board: 3 inches thick and 6-lb/cu. ft. nominal density.

### 3.20 DUCT INSULATION SCHEDULE, GENERAL

- A. Plenums and Ducts Requiring Insulation:
1. Indoor, concealed supply and outdoor air.
  2. Indoor, exposed supply and outdoor air.
  3. Indoor, concealed return located in nonconditioned space.
  4. Indoor, exposed return located in nonconditioned space.
  5. Indoor, concealed exhaust between isolation damper and penetration of building exterior.
  6. Indoor, exposed exhaust between isolation damper and penetration of building exterior.
  7. Outdoor, concealed supply and return.
  8. Outdoor, exposed supply and return.
- B. Items Not Insulated:
1. Fibrous glass ducts.
  2. Metal ducts with duct liner of sufficient thickness to comply with energy code and ASHRAE/IESNA 90.1.
  3. Factory-insulated flexible ducts.
  4. Factory-insulated plenums and casings.
  5. Flexible connectors.
  6. Vibration control devices.
  7. Factory-insulated access panels and doors.

### 3.21 INDOOR DUCT AND PLENUM INSULATION SCHEDULE

- A. Concealed, round and flat-oval, supply air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 1-1/2 inches thick.
  4. Polyolefin: 1 inch thick.
- B. Concealed, round and flat-oval, return air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 1 inch thick.
  4. Polyolefin: 1 inch thick.

- C. Concealed, round and flat-oval, outdoor air duct insulation shall be one of the following:
1. Flexible Elastomeric: 1 inch thick.
  2. Mineral Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
  3. Mineral Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
  4. Phenolic: 2 inches thick.
  5. Polyolefin: 1 inch thick.
- D. Concealed, round and flat-oval, exhaust air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 1 inch thick.
  4. Polyolefin: 1 inch thick.
- E. Concealed, rectangular, supply air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
  3. Phenolic: 1-1/2 inches thick.
  4. Polyolefin: 1 inch thick.
- F. Concealed, rectangular, return air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 1 inch thick.
  4. Polyolefin: 1 inch thick.
- G. Concealed, rectangular, outdoor air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 2 inches thick.
  4. Polyolefin: 1 inch thick.
- H. Concealed, rectangular, exhaust air duct insulation between isolation damper and penetration of building exterior shall be one of the following:
1. Mineral Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 2 inches thick.
  4. Polyolefin: 1 inch thick.
- I. Concealed, return air plenum insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 1-1/2 inches thick.
  4. Polyolefin: 1 inch thick.
- J. Concealed, outdoor air plenum insulation shall be one of the following:
1. Mineral Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.

3. Phenolic: 2 inches thick.
- K. Concealed, exhaust air plenum insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 1-1/2 inches thick.
- L. Exposed, round and flat-oval, supply air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 6-lb/cu. ft. nominal density.
- M. Exposed, round and flat-oval, return air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 1-1/2 inches thick.
- N. Exposed, round and flat-oval, outdoor air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 1-1/2 inches thick.
- O. Exposed, round and flat-oval, exhaust air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 1-1/2 inches thick.
- P. Exposed, rectangular, supply air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 3-lb/cu. ft. nominal density.
  3. Phenolic: 1-1/2 inches thick.
- Q. Exposed, rectangular, return air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 1-1/2 inches thick.
- R. Exposed, rectangular, outdoor air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 2 inches thick and 1.5-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
  3. Phenolic: 1-1/2 inches thick.
- S. Exposed, rectangular, exhaust air duct insulation shall be one of the following:
1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  3. Phenolic: 1-1/2 inches thick.

- T. Exposed, supply air plenum insulation shall be one of the following:
  - 1. Mineral Fiber Blanket: 1-1/2 inches thick and 1.5-lb/cu. ft. nominal density.
  - 2. Mineral Fiber Board: 2 inches thick and 2-lb/cu. ft. nominal density.
  - 3. Phenolic: 2 inches thick.
- U. Exposed, return air plenum insulation shall be one of the following:
  - 1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  - 2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  - 3. Phenolic: 1-1/2 inches thick.
- V. Exposed, outdoor air plenum insulation shall be one of the following:
  - 1. Mineral Fiber Blanket: 2 inches thick and 3-lb/cu. ft. nominal density.
  - 2. Mineral Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
  - 3. Phenolic: 1-1/2 inches thick.
- W. Exposed, exhaust air plenum insulation shall be one of the following:
  - 1. Mineral Fiber Blanket: 1-1/2 inches thick and 0.75-lb/cu. ft. nominal density.
  - 2. Mineral Fiber Board: 1-1/2 inches thick and 2-lb/cu. ft. nominal density.
  - 3. Phenolic: 1-1/2 inches thick.

### 3.22 EQUIPMENT INSULATION SCHEDULE

- A. Insulation materials and thicknesses are identified below. If more than one material is listed for a type of equipment, selection from materials listed is Contractor's option.
- B. Insulate indoor and outdoor equipment in paragraphs below that is not factory insulated.
- C. Chillers: Insulate cold surfaces on chillers, including, but not limited to, evaporator bundles, condenser bundles, suction piping, compressor inlets, tube sheets, water boxes, and nozzles with one of the following:
  - 1. Cellular Glass: 2 inches thick.
  - 2. Flexible Elastomeric: 1 inch thick.
  - 3. Mineral Fiber Board: 1 inch thick and 3-lb/cu. ft., 6-lb/cu. ft. nominal density.
  - 4. Mineral Fiber Pipe and Tank: 1 inch thick.
  - 5. Phenolic: 1 inch thick.
  - 6. Polyisocyanurate: 1 inch thick.
  - 7. Polyolefin: 1 inch thick.
- D. Heat Exchanger (water-to-water for cooling service) insulation shall be one of the following:
  - 1. Cellular Glass: 2 inches thick.
  - 2. Flexible Elastomeric: 1 inch thick.
  - 3. Mineral Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
  - 4. Mineral Fiber Pipe and Tank: 1 inch thick.
  - 5. Phenolic: 1 inch thick.
  - 6. Polyisocyanurate: 1 inch thick.
  - 7. Polyolefin: 1 inch thick.

- E. Heat Exchanger (water-to-water for heating service) insulation shall be one of the following:
1. Calcium Silicate: 3 inches thick.
  2. Cellular Glass: 3 inches thick.
  3. Mineral Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
  4. Mineral Fiber Pipe and Tank: 2 inches thick.
- F. Chilled Water Pump insulation shall be one of the following:
1. Cellular Glass: 3 inches thick.
  2. Mineral Fiber Board: 2 inches thick and 3-lb/cu. ft. nominal density.
  3. Phenolic: 2 inches thick.
  4. Polyisocyanurate: 1-1/2 inches thick.
- G. Condenser Water Pump insulation shall be one of the following:
1. Cellular Glass: 2 inches thick.
  2. Mineral Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
  3. Phenolic: 1 inch thick.
  4. Polyisocyanurate: 1-1/2 inches thick.
- H. Chilled Water Expansion/Compression Tank insulation shall be one of the following:
1. Cellular Glass: 1-1/2 inches thick.
  2. Flexible Elastomeric: 1 inch thick.
  3. Mineral Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
  4. Mineral Fiber Pipe and Tank: 1 inch thick.
  5. Phenolic: 1 inch thick.
  6. Polyisocyanurate: 1 inch thick.
  7. Polyolefin: 1 inch thick.
- I. Condenser Water Expansion/Compression Tank insulation shall be one of the following:
1. Cellular Glass: 1-1/2 inches thick.
  2. Flexible Elastomeric: 1 inch thick.
  3. Mineral Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
  4. Mineral Fiber Pipe and Tank: 1 inch thick.
  5. Phenolic: 1 inch thick.
  6. Polyisocyanurate: 1 inch thick.
  7. Polyolefin: 1 inch thick.
- J. Chilled Water Air Separator insulation shall be one of the following:
1. Cellular Glass: 2 inches thick.
  2. Flexible Elastomeric: 1 inch thick.
  3. Mineral Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
  4. Mineral Fiber Pipe and Tank: 1 inch thick.
  5. Phenolic: 1 inch thick.
  6. Polyisocyanurate: 1 inch thick.
  7. Polyolefin: 1 inch thick.
- K. Condenser Water Air Separator insulation shall be one of the following:
1. Cellular Glass: 2 inches thick.
  2. Flexible Elastomeric: 1 inch thick.

3. Mineral Fiber Board: 1 inch thick and 3-lb/cu. ft. nominal density.
4. Mineral Fiber Pipe and Tank: 1 inch thick.
5. Phenolic: 1 inch thick.
6. Polyisocyanurate: 1 inch thick.
7. Polyolefin: 1 inch thick.

### 3.23 PIPING INSULATION SCHEDULE, GENERAL

- A. Acceptable preformed pipe and tubular insulation materials and thicknesses are identified for each piping system and pipe size range. If more than one material is listed for a piping system, selection from materials listed is Contractor's option.
- B. Items Not Insulated: Unless otherwise indicated, do not install insulation on the following:
  1. Drainage piping located in crawl spaces.
  2. Underground piping.
  3. Chrome-plated pipes and fittings unless there is a potential for personnel injury.

### 3.24 INDOOR PIPING INSULATION SCHEDULE

- A. Condensate and Equipment Drain Water below 60°F:
  1. All Pipe Sizes: Insulation shall be one of the following:
    - a. Cellular Glass: 1-1/2 inches thick.
    - b. Flexible Elastomeric: ¾ inch thick.
    - c. Mineral Fiber, Preformed Pipe Insulation, Type I: ½ inch thick.
    - d. Phenolic: 1 inch thick.
    - e. Polyisocyanurate: 1 inch thick.
    - f. Polyolefin: ¾ inch 1 inch thick.
- B. Chilled Water, Condenser Water (water-side economizer) and Brine, 40°F and below:
  1. NPS 3 and Smaller: Insulation shall be one of the following:
    - a. Cellular Glass: 2 inches thick.
    - b. Mineral Fiber, Preformed Pipe, Type I or Pipe Insulation Wicking System: 2 inches thick.
    - c. Phenolic: 2 inches thick.
  2. NPS 4 to NPS 12: Insulation shall be one of the following:
    - a. Cellular Glass: 2 inches thick.
    - b. Mineral Fiber, Preformed Pipe, Type I or Pipe Insulation Wicking System: 2 inches thick.
  3. NPS 14 and Larger: Insulation shall be one of the following:
    - a. Cellular Glass: 2 inches thick.
    - b. Mineral Fiber, Preformed Pipe, Type I or Pipe Insulation Wicking System: 2 inches thick.
    - c. Phenolic: 2 inches thick.
- C. Chilled Water and Brine, above 40°F:
  1. NPS 12 and Smaller: Insulation shall be one of the following:

- a. Cellular Glass: 2 inches thick.
  - b. Mineral Fiber, Preformed Pipe, Type I: 2 inches thick.
  - c. Phenolic: 2 inches thick.
2. NPS 14 and Larger: Insulation shall be one of the following:
- a. Cellular Glass: 2 inches thick.
  - b. Mineral Fiber Preformed Pipe, Type I or Pipe Insulation Wicking System: 2 inches thick.
  - c. Phenolic: 2 inches thick.
- D. Condenser Water Supply and Return:
1. NPS 12 and Smaller: Insulation shall be one of the following:
- a. Cellular Glass: 2 inches thick.
  - b. Mineral Fiber, Preformed Pipe, Type I: 2 inches thick.
2. NPS 14 and Larger: Insulation shall be one of the following:
- a. Cellular Glass: 2 inches thick.
  - b. Mineral Fiber, Preformed Pipe, Type I: 2 inches thick.
  - c. Phenolic: 2 inches thick.
- E. Refrigerant Suction and Hot Gas Piping:
1. All Pipe Sizes: Insulation shall be one of the following:
- a. Cellular Glass: 1-1/2 inches thick.
  - b. Flexible Elastomeric: 1 inch thick.
  - c. Mineral Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.
  - d. Phenolic: 1 inch thick.
  - e. Polyisocyanurate: 1 inch thick.
  - f. Polyolefin: 1 inch thick.
- F. Refrigerant Suction and Hot Gas Flexible Tubing:
1. All Pipe Sizes: Insulation shall be one of the following:
- a. Flexible Elastomeric: 1 inch thick.
  - b. Polyolefin: 1 inch thick.
- G. Hot Service Drains:
1. All Pipe Sizes: Insulation shall be one of the following:
- a. Calcium Silicate: 1-1/2 inches thick.
  - b. Cellular Glass: 1-1/2 inches thick.
  - c. Mineral Fiber, Preformed Pipe, Type I or II: 1 inch thick.
- H. Hot Service Vents:
1. All Pipe Sizes: Insulation shall be one of the following:
- a. Calcium Silicate: 1-1/2 inches thick.
  - b. Cellular Glass: 1-1/2 inches thick.
  - c. Mineral Fiber, Preformed Pipe, Type I or II: 1 inch thick.

### 3.25 OUTDOOR, ABOVEGROUND PIPING INSULATION SCHEDULE

#### A. Chilled Water and Brine:

1. All Pipe Sizes: Insulation shall be one of the following:
  - a. Cellular Glass: 3 inches thick.
  - b. Flexible Elastomeric: 3 inches thick.
  - c. Mineral Fiber, Preformed Pipe Insulation, Type I: 3 inches thick.
  - d. Phenolic: 2 inches thick.
  - e. Polyisocyanurate: 2 inches thick.
  - f. Polyolefin: 3 inches thick.
  - g. Polystyrene: 2 inches thick.

#### B. Condenser Water Supply and Return:

1. All Pipe Sizes: Insulation shall be one of the following:
  - a. Cellular Glass: 2 inches thick.
  - b. Flexible Elastomeric: 2 inches thick.
  - c. Mineral Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
  - d. Phenolic: 2 inches thick.
  - e. Polyisocyanurate: 2 inches thick.
  - f. Polyolefin: 2 inches thick.
  - g. Polystyrene: 2 inches thick.

#### C. Refrigerant Suction and Hot Gas Piping:

1. All Pipe Sizes: Insulation shall be one of the following:
  - a. Cellular Glass: 2 inches thick.
  - b. Flexible Elastomeric: 2 inches thick.
  - c. Mineral Fiber, Preformed Pipe Insulation, Type I: 2 inches thick.
  - d. Phenolic: 2 inches thick.
  - e. Polyisocyanurate: 2 inches thick.
  - f. Polyolefin: 2 inches thick.
  - g. Polystyrene: 2 inches thick.

#### D. Refrigerant Suction and Hot Gas Flexible Tubing:

1. All Pipe Sizes: Insulation shall be one of the following:
  - a. Flexible Elastomeric: 2 inches thick.
  - b. Polyolefin: 2 inches thick.

#### E. Hot Service Drains:

1. All Pipe Sizes: Insulation shall be one of the following:
  - a. Calcium Silicate: 1-1/2 inches thick.
  - b. Cellular Glass: 1-1/2 inches thick.
  - c. Mineral Fiber, Preformed Pipe Insulation, Type I: 1 inch thick.

#### F. Hot Service Vents:

1. All Pipe Sizes: Insulation shall be one of the following:

- a. Calcium Silicate: 1-1/2 inches thick.
- b. Cellular Glass: 1-1/2 inches thick.
- c. Mineral Fiber, Preformed Pipe Insulation, Type II: 1 inch thick.

### 3.26 INDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed: None.
- D. Ducts and Plenums, Exposed: None.
- E. Equipment, Concealed: None.
- F. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches: None.
- G. Equipment, Exposed, Larger Than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches: None.
- H. Piping, Concealed: None.
- I. Piping Exposed:
  1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.032 inch thick.
  2. Stainless steel, type 304 or 316, stucco embossed, with 1-1/4 inch deep corrugations thick.

### 3.27 OUTDOOR, FIELD-APPLIED JACKET SCHEDULE

- A. Install jacket over insulation material. For insulation with factory-applied jacket, install the field-applied jacket over the factory-applied jacket.
- B. If more than one material is listed, selection from materials listed is Contractor's option.
- C. Ducts and Plenums, Concealed:
  1. None.
  2. PVC: 20 mils thick.
  3. Aluminum, Stucco Embossed: 0.020 inch thick.
  4. Painted Aluminum, Stucco Embossed: 0.020 inch thick.
  5. Stainless Steel, Type 304 or 316, Stucco Embossed: 0.016 inch thick.
- D. Ducts and Plenums, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
  1. Aluminum, Stucco Embossed: 0.020 inch thick.
  2. Painted Aluminum, Stucco Embossed: 0.020 inch thick.
  3. Stainless Steel, Type 304 or 316, Stucco Embossed: 0.016 inch thick.
- E. Ducts and Plenums, Exposed, Larger than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:

1. Aluminum, stucco embossed, with 1-1/4 inch deep corrugations thick.
  2. Stainless steel, type 304 or 316, stucco embossed, with 1-1/4 inch deep corrugations thick.
- F. Equipment, Concealed:
1. None.
  2. PVC: 20 mils thick.
  3. Aluminum, Stucco Embossed: 0.016 inch 0.032 inch thick.
  4. Painted Aluminum, Stucco Embossed: 0.032 inch thick.
  5. Stainless Steel, Type 304 or 316, Stucco Embossed: 0.020 inch thick.
- G. Equipment, Exposed, up to 48 Inches in Diameter or with Flat Surfaces up to 72 Inches:
1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.032 inch thick.
  2. Stainless Steel, Type 304 or 316, Stucco Embossed with Z-Shaped Locking Seam: 0.024 inch thick.
- H. Equipment, Exposed, Larger than 48 Inches in Diameter or with Flat Surfaces Larger Than 72 Inches:
1. Aluminum, stucco embossed with 1-1/4 inch deep corrugations thick.
  2. Stainless steel, type 304 or 316, stucco embossed, with 1-1/4 inch deep corrugations thick.
- I. Piping, Concealed: None.
- J. Piping, Exposed:
1. Aluminum, Stucco Embossed with Z-Shaped Locking Seam: 0.032 inch thick.
  2. Stainless Steel, Type 304 or 316, Stucco Embossed with Z-Shaped Locking Seam: 0.020 inch thick.

END OF SECTION