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1.0 SCOPE

1.1 This specification, with accompanying project specifications and Cold Insulation Material Specification packets, covers specific fabrication and inspection requirements for insulation of piping, vessels, and equipment operating between the temperatures of -225°F (-143°C) and +70°F (+21°C) with intermittent operation up to 230°F (110°C).

1.2 The insulation described herein is limited to that required for economical reduction of heatgain, prevention of surface condensation, and maintenance of operating temperature.

1.3 Exceptions or variations shown in the project specifications shall take precedence over the requirements stated herein.

1.4 Cold Insulation Material Specification packets are available for use and recommended for specifying complete insulation, jacketing and coating/sealant systems; and can be found in COMPANY Engineering Specification.

2.0 REFERENCED PUBLICATIONS

Applicable sections of the latest edition of the following publications constitute part of this specification:

ASTM American Society for Testing and Materials

A-463 Specification for Steel Sheet, Cold-Rolled, Aluminum-Coated Type I and Type II
A-525 Specification for General Requirements for Steel Sheet, Zinc-Coated (Galvanized) by Hot-Dip Process
B-209 Specification for Aluminum and Aluminum-Alloy Sheet and Plate
C-547 Specification for Mineral Fiber Preformed Pipe Insulation
C-552 Specification for Cellular Glass Block and Pipe Thermal Insulation
C-591 Specification for Unfaced Preformed Rigid Cellular Polyurethane Thermal Insulation
C-612 Specification for Mineral Fiber Block and Board Thermal Insulation
D-1668 Specification for Glass Fabrics (Woven and Treated) for Roofing and Waterproofing
E-84 Test Method for Surface Burning Characteristics of Building Materials
E-96 Test Methods for Water Vapor Transmission of Materials
C-1126 Faced or Unfaced Rigid Cellular Phenolic Thermal Insulation
C-534 Preformed, Flexible Elastomeric Cellular Thermal Insulation in Sheet and Tubular Form

3.0 GENERAL CONDITIONS

* Denotes items which require further specification by COMPANY.

3.1 Vessels, equipment, tanks, and piping shall be insulated in accordance with the project specifications and this specification. The term "vessel" includes towers, drums, reactors, reboilers, exchangers, and similar items. The term "equipment" includes expanders, turbines, and pumps.

3.2 This specification requires compliance with all federal, state, and local laws and regulations which may be applicable.

3.3 Where materials are referred to by trade names within this specification, the use of such names is intended to describe the kind or quality of the material required, and any deviation must be submitted in writing to COMPANY for approval prior to use.
3.4 Insulation shall not be applied to any piping, vessels, or other process equipment until such items have been inspected, tested, and approved for the intended services unless prior COMPANY approval is obtained.

3.5 MANUFACTURER’S recommendation shall be followed in handling, storage, and application of insulation system components. Strict adherence to MANUFACTURER’S suggested operating limitations is required.

3.6 All pipelines found on the piping drawings are identified by a numbering system and are all listed on the Line List sheets. Line operating temperatures are shown on the Line List.

3.7 General Arrangement Drawings, Piping Plans, and Piping Isometrics show process and utility piping.

3.8 The vessel and equipment insulation list includes all vessels, reactors, exchangers, filters, pumps, jets, and other items of equipment to be insulated. The list shows insulation type and thickness and gives overall equipment dimensions or cites either VENDOR drawing or MANUFACTURER’S catalog identification.

3.9 All surfaces to be insulated shall be dry, free of dew and frost, and shall be cleaned to remove loose rust, loose paint, dirt, grease, or other foreign matter prior to application of insulation materials. Stainless steel items shall be brushed with stainless steel brushes only.

3.10 The insulation must be protected from moisture, sunlight, and weather before and during application. All insulation shall be dry prior to application of insulation finish.

3.11 Insulation shall be applied such that the blocks of insulation in any layer shall fit snugly over the surface beneath them and the surface of the outer layer shall have a smooth contour.

3.12 Outside sharp corners shall be beveled or rounded to prevent cracking or breakage which might promote damage to the vapor barrier.

3.13 All joints shall be carefully fitted. The edges of blocks shall be rubbed or cut to a bevel so that all joints are uniform.

3.14 Where single-layer insulation is used, the insulation shall be applied to piping and equipment with butt joints staggered and all joints tightly butted and buttered with joint sealer.

3.15 All systems operating below 0°F (-18°C) shall be multiple layer insulation where polyisocyanurate and phenolic foams are installed. Multiple layers are required for systems operating below -50°F (-46°C) where cellular glass is installed.

3.16 On multiple-layer insulation, the additional layer or layers shall be applied with butt and longitudinal joints staggered over joints of the preceding layer.

3.17 An intermediate vapor barrier membrane is required between the inner and outer layer of insulation.

3.18 Only the outer layer joints of multiple-layer applications shall be buttered with specified joint sealer before installation.

3.19 All terminated insulation such as valves and flanges shall be sealed with a reinforced mastic vapor barrier system.

3.20 All openings in the jacket for nozzles, brackets, etc., shall be cut as close as possible to achieve a tight fit.

3.21 Openings through the insulation finish shall have the vapor barrier applied so as to ensure a vaportight seal is made.

3.22 Outside the insulation a vapor barrier membrane shall be applied on regular shapes while a reinforced barrier mastic system shall be applied to the irregular shapes.
3.23 Removable insulation sections with easily repairable vapor barrier shall be installed on insulated piping joints and other flanged connections which are frequently serviced.

3.24 No field welding of insulation clips or supports, etc., is to be done except with specific written authorization of the COMPANY representative. Welding materials and procedures shall be reviewed and welders shall be tested and approved prior to receiving written authorization.

3.25 Location and details of insulation supports, if provided, will be shown on vessel and equipment drawings or piping isometrics. Where insulation supports have not been provided by the Fabricator, the insulation shall be supported by the insulation contractor in accordance with good practice and with the approval of the COMPANY representative.

4.0 MATERIALS

4.1 Insulation Requirements

4.1.1 The piping insulation code is included in the piping line designation. The type of insulation is indicated on the project specifications and drawings.

4.2.2 All insulation materials in this Specification shall have a flame spread and smoke density of 25/50 or less per ASTM E84.

4.2 Insulation Materials

4.2.1 Insulation materials, which may be used, shall be compatible with the surface on which they are applied, subject to the limitations stated in this specification and the project specifications, are:

a. Cellular glass: Block and preformed pipe covering.
b. Polyisocyanurate foam: Block, board and preformed pipe covering.
c. Mineral or Glass fiber: Block, board, and preformed pipe covering.
d. Flexible elastomeric foam: sheet and preformed pipe and tube covering.
e. Phenolic foam: Block, board and preformed pipe covering.

4.2.2 Cellular glass insulation shall conform to ASTM C-552 for temperatures from -450 F (-268 C) to +800 F (+427 C).

4.2.3 Polysiocyanurate foam shall conform to ASTM C-591, Grade 2, for temperature from -100 F (-73 C) to +250 F (+121 C). This specification is limited to preformed, rigid insulation.

4.2.4 Mineral or glass fiber materials:

a. Preformed pipe insulation shall conform to ASTM C-547.
b. Board or block shall conform to ASTM C-612.

4.2.5 Flexible elastomeric foam shall conform to ASTM C 534 for temperature from -20 F (-29 C) to +220 F (+104 C).

4.2.6 Phenolic foam shall conform to ASTM C 1126 for temperature from -290°F (-179°C) to +250°F (+121°C).

4.2.7 Weather Protective Jacketing

All metal jacketing shall have a factory-applied moisture barrier of a polyethylene or epoxy system containing no paper or cellulose filler. Exterior surface of jacketing shall be specified with a clear or color acrylic or PVF finish with an emissivity of at least 0.70. Color will be specified by COMPANY.

a. For pipe, vertical vessels 3 feet 0 inch (0.91m) diameter and smaller and all horizontal vessels jacketing shall conform to

the following:
1. 0.010 inch (0.25mm) thick, galvanized, copper-bearing sheet steel, meeting the requirements of ASTM A-525 with a minimum coating class of 1.5 ounces per square foot (0.46 kg/m²).
2. 0.010 inch (0.25mm) thick aluminized, copper-bearing sheet steel, meeting the requirements of ASTM A-463 with Ti-40 coating designation.
3. 0.016 inch (0.41mm) thick smooth aluminum roll form, with H14 through H19 temper in accordance with ASTM B-209.
4. 0.010 inch (0.25mm) thick stainless steel, Type 304 or 316.
5. 0.030-inch (0.76mm) thick PVC in roll form. Order precurl. Available in a variety of colors.

b. For tanks or vertical vessels larger than 3 feet 0 inch (0.91m) in diameter, jacketing shall conform to the following:

1. 0.020 inch (0.51mm) thick corrugated aluminum sheet, with H14 through H19 temper in accordance with ASTM B-209.
2. 0.032-inch (0.81mm) thick smooth aluminum roll, with H14 through H19 temper in accordance with ASTM B-209.
3. 0.010 inch (0.25mm) thick aluminized, copper-bearing sheet steel, meeting the requirements of ASTM A-463 with Ti-40 coating designation.
4. Corrugations for the above sheets shall be 1 1/4 inch by 1/4 inch (32mm by 6.4mm).

4.2.6 Joint Sealer

Flashing compounds, joint sealers, and bedding compounds shall be permanently flexible through a temperature range -225°F (-143°C) up to +230°F (+110°C). The ASTM E-96, Procedure B, water vapor permeability shall not exceed 0.02 per inch (0.03 ng/Pa/S/m). The ASTM E-84 flame spread index and smoke density rating in a cured state shall not exceed 25/50.

4.3 Accessories

4.3.1 All stainless steel accessories shall be 18-8 alloy, fully annealed.

4.3.2 Wire to secure pipe insulation up to 12 inch (305mm) O.D. shall be 18 gauge (1.2mm) stainless steel. Minimum 1/4 inch (6mm) diameter stainless wire or cable may be used for floating ring insulation on vessel heads. Do not use wire to secure foam type insulation.

4.3.3 Bands and seals for securing insulation and jacketing shall be of the following sizes and materials:

a. Piping and vertical or horizontal vessels with insulation 3 feet 0 inch (0.31m) OD and under:

1. For insulation and jacketing - use minimum 1/2 inch (13mm) by 0.015 inch (0.38mm) stainless steel bands.
2. 1 inch (25mm) fiberglass reinforced filament tape may be used to secure pipe insulation up to 12 inch (305mm) O.D. or as a temporary banding material to hold insulation in place for installation purposes.

b. Tanks and vertical or horizontal vessels with insulation indoors or 10 feet 0 inch (3m) O.D. or less outdoors: minimum 3/4 inch (19mm) by 0.015 inch (0.38mm) thick stainless steel.
c. Breather springs for bands shall be by Techalloy Company or COMPANY-approved equivalent. Breather springs shall be stainless steel, 4 inches (102mm) long and designed for banding up to 3/4 inch (19mm) wide.
d. Tanks and vertical or horizontal vessels with insulation outdoors over 10 feet 0 inch (3m) O.D.: minimum 1 1/4 inch (32mm) by 0.020 inch (.51mm) thick stainless steel.
e. Breather springs for 1 1/4 inch (32mm) wide bands shall be the Super Mity-Spring by Childers Products Co. or approved equivalent.

4.3.4 Material for "S" clips shall be identical to the material used for jacket bands.

4.3.5 Wood dowels shall be 1/4 inch (6.4mm) diameter, white birch, acid copper chromate treated.

4.3.6 Vapor barrier reinforcement for weatherproofing plastic shall be glass textile, open weave fabric conforming to ASTM D-1668, 10 x 10 mesh.

4.3.7 Anti-abrasion compound shall be vinyl base, retaining flexibility down to -300 F (-184 °C).

4.3.8 Wing-type band seals shall be stainless steel, 0.032 inch (0.81mm) thick, hardened and tempered.

4.3.9 Pipe supports shall be cellular glass, high-density, polyisocyanurate, phenolic foam or kiln dried, white or red oak, pressure treated with acid copper chromate. See Figure 1.

4.3.10 Vapor barrier coating shall be an elastomeric mastic system in accordance with the project specifications.

4.3.11 Pop rivets shall be stainless steel, 5/32 inch (4.0mm) minimum diameter.

4.3.12 Screw fasteners shall be stainless steel, self-tapping type, with slotted pan head, Type A, No.8, \( \frac{3}{16} \) inch (9.5mm) long.

5.0 APPLICATIONS

5.1 Piping, Vessels, and Equipment

5.1.1 Pipe diameter will be that of published nominal pipe sizes. Tolerances shall be in accordance with the applicable ASTM specification.

5.1.2 Cylindrical vessels with outside diameters of 30 inches (0.76m) and under, shall normally have "sectional pipe" insulation.

a. Insulation may be installed in single or multiple layers. No individual layer shall be more than 4 inches thick. In multiple-layer installations, layers should be limited to 3 inches (76mm) whenever possible. See 3.15 for multiple-layer requirements.

b. Sectional pipe insulation up to 12 inches (305mm) O.D. shall be secured with 18 gauge stainless steel wire or 1 inch (25mm) glass reinforced filament tape on 12 inch (0.31m) centers. Do not secure foam type insulation with wire. Secure pipe insulation 12 inches (0.31m) O.D. and above with \( \frac{3}{4} \) inch (13 mm) stainless steel bands.

c. The wire ends shall be bent and pressed into the insulation to avoid projections.

d. In all cases, at least four (4) attachments per 3 foot (0.91m) section of insulation shall be installed.

5.1.3 For cylindrical piping and vessels with outside diameters over 30 inches (0.76m), up to 10 feet (3m), preformed curved segments shall be used. For vessels with outside diameters greater than 10 feet (9m) where curved segments cannot be used, mitered logs cut from flat blocks may be used.
a. Block and curved segment insulation shall be applied with the length of block/segment parallel to greatest length of surface to be insulated. All successive end joints shall be staggered and the blocks scored or sized to eliminate gaps between surfaces and blocks. Block and curved segment insulation can be applied in multiple-layer construction, when required, with all joints in the adjacent layers staggered.

b. Each layer shall be secured with bands before the succeeding layer is applied.

5.1.4 Attachments on vessels beyond the insulation line, such as stiffening rings, shall be considered as an integral part of the vessel and shall be insulated and finished in the same manner as the vessel. Thickness of insulation on such attachments and projections shall be the same as the adjoining insulation.

5.1.5 Vents, drains, and uninsulated pipe branches shall be insulated for a minimum distance, beyond the first block valve, of 4 times the adjacent insulation thickness. The vapor seal coating shall be sealed to the uninsulated metal for a distance equal to the insulation thickness from the point the insulation stops. Exposed pipe threads on these branches shall be covered with the vapor seal coating.

5.2 Supports

5.2.1 Piping supports and anchors shall be cellular glass or high density polyisocyanurate and phenolic foam unless the temperature limitations are exceeded. Wooden supports may also be used for moderate temperatures.

5.2.2 On long vertical piping runs, the insulation contractor shall furnish and install all clamped insulation supports.

5.2.3 Where pipe hangers, platform brackets, etc., are not outside the insulation they shall be insulated for a distance of four times the insulation thickness measured from the junction of the uninsulated surface.

5.2.4 Welding pins may only be used to support inner layers of insulation on spherical vessels or on irregular, compound curved surfaces subject to COMPANY approval. In such applications, speed clips shall be used to hold insulation on pins that are cut flush above the clip. Split pins shall be spread and bent. The outer layer of insulation and all subsequent layers where pins are not applied shall be secured as indicated in Section 5.4.

5.3 Insulation Expansion/Contraction Joints

5.3.1 Vertical and horizontal vessels shall have insulation expansion/contraction joints at each support ring.

5.3.2 Insulation expansion/contraction joints for vertical equipment and vertical piping shall be provided at each insulation support or stiffener ring, 10 feet (3m) maximum spacing.

a. The expansion space between the underside of the ring and the insulation shall be packed with a resilient expansion joint filler.

b. The filler shall be sealed within the vapor barrier.

5.3.3 Insulation expansion/contraction joints are not required if the piping or equipment is less than 8 feet (2.5m) in length.

5.4 Insulation for Vessel Heads

5.4.1 The top heads of vertical vessels and both heads of horizontal vessels shall be insulated using shop fabricated, engineered vessel head segments, fitted to the contour of the head wherever possible.
5.4.2 For vertical equipment, insulation on bottom heads only shall be held in place by impaling the inner layers on weld studs or by wire bands attached to blank nuts 1/2 inch (13mm) to 5/8 inch (16mm) which have been welded to the vessel skirt or support ring on maximum 12 inch (0.31m) centers.

5.4.3 For the top head of vertical equipment and both ends of horizontal equipment, the insulation shall be secured by use of a floating ring fabricated from a minimum 1/4 inch (6.4mm) rod or six 18 gauge stainless steel tie wires twisted together, positioned in the center of the head and over the insulation. Where the head does not have a center nozzle, the bands can be crisscrossed over the center thus eliminating a floating ring. One end of a band shall be fastened to the floating ring and the other end shall be anchored to a band(s) or ring welded around the cylindrical section of the equipment close to the head.

5.4.4 Vessels and exchanger heads shall be insulated to the same thickness as the shells of the equipment. Blocks of insulation, neatly beveled to insure a close fit, shall be used.

5.4.5 Removable/reusable head insulation for exchangers, strainers, etc., shall be fabricated with the same materials as the equipment. Soft pad type covers are not acceptable for cold applications.

a. The head cover assembly may be split as required for ease of removal and installation.

b. Upon reassembly the head cover seams must be easily sealed with a vapor barrier caulking compound.

5.5 Vessels and Equipment Skirts and Supports

5.5.1 All supports shall be insulated for a length of at least 12 inches (0.31m) or 4 times the required thickness, whichever is greater.

5.6 Piping and Equipment Insulation Vapor Barriers

5.6.1 An inner vapor barrier shall be applied between the outer and inner layer of insulation where multi-layered systems are specified. The vapor barrier sheeting shall overlap by 2 inches (51mm) and be sealed with vinyl tape at all seams. For irregular shapes where the sheeting material cannot be applied use a coating of vapor barrier mastic 1/16 inch (.4mm) DFT.

5.6.2 The outer vapor barrier sheeting shall be applied by removing a release paper and exposing the adhesive. Firmly press the membrane sheeting against the insulation and overlap all seams by 3 inches (76mm). For irregular shapes where the sheeting material cannot be applied as a glass reinforced butyl or hypalon mastic system. The thickness shall be in accordance with the project specifications.

5.7 Jacketing

5.7.1 Where jacketing is specified, it shall not be applied until the insulation and vapor barrier have been fully inspected and approved by COMPANY.

5.7.2 Jacketing for cylindrical surfaces over 36 inch (0.91m) OD shall be secured with ⅛ inch (19mm) by 0.025 inch (0.64mm) bands and seals placed over each circumferential overlap and at least at the center of each course of jacketing.

5.7.3 Jacketing for cylindrical surfaces shall be applied with 3 inch (76mm) circumferential or longitudinal laps.

a. On vertical piping and vessels, the upper lap of jacketing shall overlap the lower lap by 3 inches (76mm)

1. On all vertical lines, S or Z clips shall be used on every circumferential lap to support the jacket.

2. All vertical piping and vessels where smooth jacketing is installed the longitudinal seam shall be sealed with a continuous bead of caulking compound.
3. Vertical vessels above 30 feet (9m) high shall have their jacketing secured with screws in addition to bands. The screw shall be applied to longitudinal seams only on the ridge of the corrugation on 6 inch (150mm) centers, and it shall not bind the upper course of jacketing to the lower course of jacketing at the circumferential lap. The screws shall not pierce the vapor barrier and are not permitted where smooth jacketing is used.

b. All horizontal piping and vessels shall have the jacketing circumferential seam caulked with a continuous bead of caulking compound.

5.7.4 On horizontal equipment and piping, the longitudinal finish lap shall be positioned to shed rain water and minimize dust collecting. Overlaps shall be positioned at the 4 o'clock or the 8 o'clock location.

5.7.5 The cylindrical surfaces greater than 30 inch (0.76m) OD and all longitudinal joints in corrugated jacketing shall be secured with bands and sheet metal screws, or pop rivets placed on 6 inch (150mm) centers on the ridge of the corrugation. Screws or pop rivets shall not pierce the vapor barrier and are not permitted where smooth jacketing is used.

5.7.6 Preformed metal elbows, tees, valve and flange covers shall be used to the largest commercially available size.

5.8 Inspection and Quality Control

5.8.1 Insulation will be judged defective and rejected for any of the following reasons:

a. If there are any cracks extending through the insulation.

b. If there are any cracks which would cause insulation to break upon sawing or gently flexing.

c. If there are broken or damaged pieces.

d. If any cold spots can be detected after start-up caused by failure to adhere to the specifications.

e. If there are any cracks or open spots in the vapor barrier.

f. If there is any other non-compliance with the specifications.

5.8.2 The insulation shall be inspected and approved by COMPANY prior to application of the vapor barrier. Where jacketing or other finish is specified, the vapor barrier shall be inspected and approved prior to application of the finish.
**Specifications for Cold Insulation**

**Figure 1a**

**TYPICAL DETAILS FOR PIPING**

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**Notes:**

1. Hardwood blocks shall be at least two inches longer than the steel bearing plate. The steel bearing plate for the split hanger type support shall be at least two inches longer than the width of the split hangar strap, and shall be determined by the expansion or contractor requirements on graphite slide type supports, use joint sealer between joints.
3. Graphite cradle and plate to be "UCAR" or approved equal.
4. Graphite is cemented to metal with "National" cement grade C-35 or approved equal.
5. Graphite slide surfaces must not be painted.
6. Minimum length of graphite cradle shall be 12 in.
7. For guide where large horizontal force is involved, graphite slide support may be added vertically to counteract the force as shown above in dotted lines. In this configuration metal cradle shall be banded to pipe insulation with 3/4" x 0.025" S.S. bands.
Figure 1b
TYPICAL DETAILS FOR PIPING

[Diagram of piping details with annotations]

GRAphite SLIDE SUPPORT

18-9180

Engineering Services, L.
Figure 2a
TYPICAL DETAILS FOR PIPING

Figure 2b
TYPICAL DETAILS FOR PIPING

NOTES:
1. If metallic cover is used, glass fabric and finishing mastic may not be required. Vapor seal mastic may be required at ends only as noted on detail.
2. Valve insulation may be in two sections for ease of removal. Joints must be staggered and completely vapor sealed.
Figure 2e
TYPICAL DETAILS FOR PIPING

FLANGES FITTINGS AND JOINTS
(CONTRACTION AND EXPANSION)
**Figure 3a**
**TYPICAL DETAILS FOR VESSELS**

**NOTES:**

1. The metal thickness may have to be increased for the lower courses of tall vessels to support the upper courses, spacing on the screw fasteners may have to be decreased also to provide the needed support.

2. Provide support rings for insulation every 12 feet maximum, 8 feet preferred.
Figure 3b
TYPICAL DETAILS FOR VESSELS

FLASHING DETAIL
DETAIL A

Figure 3c
TYPICAL DETAILS FOR VESSELS

INSULATION SUPPORT RING
AND CONSTRUCTION JOINT

DETAIL B
Figure 3d
TYPICAL DETAILS FOR VESSELS

Figure 3e
TYPICAL DETAILS FOR VESSELS

BOTTOM FLASHING DETAIL
DETAIL C
ID: 100030.DWG

BAND SUPPORT DETAIL
ID: 100035.DWG
Figure 3f
TYPICAL DETAILS FOR VESSELS

TYPICAL DETAILS FOR VESSELS

DETAIL OF CIRCUMFERENTIAL AND LONGITUDINAL LAP IN CORRUGATED JACKET
Figure 4a
TYPICAL DETAILS FOR VESSELS

Figure 4b
TYPICAL DETAILS FOR VESSELS

REMOVABLE COVER FOR MANWAY
Figure 5a

TYPICAL DETAILS FOR VESSELS

CONTRACTION JOINT
NON-METALLIC COVER