PLAINTIFF'S EXHIBIT

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THERMAL INSULATION FOR HOT LINES, VESSELS, AND EQUIPMENT

SPECIFICATION IRM-EG-1381-J
THERMAL INSULATION FOR HOT LINES, VESSELS, AND EQUIPMENT

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THERMAL INSULATION FOR HOT LINES, VESSELS, AND EQUIPMENT

1.0 SCOPE

This specification covers the requirements for insulating hot surfaces on vessels, heat exchangers, piping, and equipment using conventional types of insulation such as calcium silicate, mineral wool, fiberglass, or cellular glass. This specification does not include storage tank insulation, polyurethane foam insulation, the insulation of equipment operating at temperatures below ambient, or the insulation of furnaces and buildings.

1.1 The equipment to be insulated and the insulation item number are listed on the attached Form IRM-EF-630.

2.0 MATERIALS

2.1 Acceptable Materials

Standard Drawing GD-N99993, Standard Insulation Item Numbers, shows materials acceptable to the Company. Other materials may be used only with the written approval of the Company. Materials referenced in this specification as "N" item numbers are found on Drawing GD-N99993.

2.2 Insulation

2.2.1 All insulation materials shall be asbestos-free. There shall be some indelible indicator, such as color, on the insulation that identifies it as asbestos-free, so that workers on subsequent repairs can readily identify insulation, at any location, as being asbestos-free.

2.2.2 All materials shall be new.

2.2.3 Insulation material for all applications shall be capable of meeting ASTM C-795 for leachable chloride ion content. All mastics, cements, and other material used with insulation for austenitic stainless steels shall contain less than 100 ppm leachable chlorides.

2.2.4 Insulation materials shall be used only within the temperature limits specified in Drawing GD-N99993.

2.3 Stainless Steel

Throughout this specification, the term "stainless steel" shall mean an austenitic stainless steel such as Type 304.

2.4 Weatherjacketing

2.4.1 Aluminum sheet with corrosion/moisture barrier of 40-pound Kraft paper and 1 mil polyethylene, Childers or Premetco process, or approved equal. Temper shall be 3/4 hard (H16) and copper content shall not exceed 0.40 weight %. Preformed aluminum weather jacket for pipe elbows shall be 1100 dead soft alloy with the corrosion/moisture barrier.

2.4.2 Mastic weathercoating shall be used only where metal weatherjacketing is not feasible and within the limitations of Section 3.5. Emulsion-type mastic coatings are preferred (N208). Solvent-base mastic coatings shall be used only with written approval of the Company, and shall be considered only when weather conditions at the time of application would not permit satisfactory curing of emulsion-type materials.

2.4.3 Stainless steel, galvanized steel, or coated carbon steel shall be used where fire-resistant weather jacket is specified.

2.5 Weather Jacket Attachment Fixtures

2.5.1 Fixtures shall be stainless steel, except that sheet metal screws, pop rivets and stud caps may be aluminum (0.40% maximum Cu). Clips used to support weather jacket panels and bands (S- and J-clips, Details 9 & 10 on GD-N99995) shall be 0.040-inch minimum thickness stainless steel. Pop rivets (N342) shall be of the type where the mandrel is retained after setting.

2.5.2 Threaded welding studs shall be 1/4-inch diameter, unless otherwise specified, and be of solid stainless steel, or composite with stainless steel at the exposed end and carbon steel at the welding end.

2.6 Storage of Materials

All insulation and necessary materials shall be protected from moisture during storage and installation. Wet insulation is unacceptable and must be replaced with dry materials.

3.0 GENERAL INSTALLATION REQUIREMENTS

3.1 Condition of Surfaces to Be Insulated

3.1.1 All surfaces to be insulated shall be clean and dry.

3.1.2 Contractor shall prime surfaces operating below 200°F with Coating System 1.4 per COM-EG-4743. No coating is required for surfaces operating at higher temperatures.

3.1.3 No insulation shall be installed until completion of any stress-relieving and chemical cleaning and after hydrotest inspection and release in writing.

3.2 Insulating Cement and Bore Coatings

All voids and cracks in insulation shall be filled with an insulating cement (N202). The side of cellular glass insulation exposed to the hot metal surface shall be coated with a bore coating (N454) in severe vibrating systems.

3.3 Valve Bodies, Flanges, and Manways

All carbon steel or low alloy valve bodies, pipe flanges, manways, and exchanger body flanges that operate at temperatures up to 750°F shall be insulated. Flanges operating above 750° will be insulated only if specified by the Company. Stainless steel flanges shall be insulated only if they won't get hotter than 400°F. Flexible, reusable insulation covers, as defined in Specification IRM-EG-4197, shall be used except for screwed and welded fitting/valves where permanent insulation is preferred.

3.4 Double-Layer Insulation

For metal temperatures above 650°F, double-layer insulation shall be used, except on piping 1 1/2 inches and smaller. Regardless of temperature, for insulation thickness greater than 3 inches, double-layer insulation shall be used. Insulating material used for both layers shall be capable of withstanding the maximum metal temperature, unless otherwise approved by the Company.

3.5 Weatherjacketing

3.5.1 Piping and equipment shall be weatherjacketed with aluminum sheet, except as indicated in Sections 3.5.2, 3.5.3 and 3.5.4.

3.5.2 Mastic weathercoat (N208) may be used on surfaces of complex shapes, where not prohibited by paragraph 3.5.3 of this specification. It shall be used only on calcium silicate, perlite and cellular glass insulation and where the surface temperature of the insulation will not exceed 180°F. Emulsion-type weathercoating shall not be applied when atmospheric precipitation or condensation may wet the finished surface within 24 hours after application.

3.5.2.1 The mastic weathercoat shall be constructed as follows for most applications:

a. Apply a layer of finishing cement (N203) over the insulation to provide a smooth, even surface.

b. Apply mastic (N208) to 1/8-inch wet thickness.

c. While still wet, wrap with glass fabric (N215). Lap joints 2 inches.

d. Apply finish coat of mastic (N208) to completely cover fabric. The total dry film thickness shall be a minimum of 1/8 inch.

On large fittings and equipment (insulation OD greater than 12 inches) or vessel heads, use poultry mesh (N330) in place of glass fabric. Poultry mesh shall be laced with wire (N332) and stapled (N340) to the insulation prior to the final coat of mastic.

3.5.3 Within 25 feet of furnaces, weather jacket shall be fire-resistant and insulation shall be calcium silicate, perlite or cellular glass. Weather jacket on piping and equipment shall be stainless steel, galvanized steel, or coated steel, rather than aluminum. Flammable weathercoating shall not be used. The Company will specify where fire-resistant weather jackets are required for other equipment.

3.5.4 For offshore facilities, stainless steel (N219) weather jacking shall be used in lieu of aluminum.

3.5.5 Weatherjacketing shall prevent entry of liquid water into the insulation under all normal weather conditions. The following are examples of unacceptable weatherjacketing techniques: upward-facing overlaps in aluminum weather jacket which collect rather than shed water run-off, unsealed or unflashed gaps where weather jacket is penetrated by structural members or nozzles, and lack of weathertight end-seals where the pipe insulation terminates.

4.0 SPECIFIC REQUIREMENTS FOR PIPING

4.1 Applicable Drawings and Forms

Piping shall be insulated in accordance with Form IRM-EF-630 and Drawing GD-N99783. Lines 36 inches in diameter and over shall be insulated as a vessel. The specific thickness of insulation does not include weatherjacketing.

4.2 Insulation Requirements

4.2.1 Insulation shall be calcium silicate, expanded perlite, or cellular glass preformed pipe insulation. Mineral wool and fiberglass insulation shall be used only when specified by the Company.

4.2.2 Insulation, 12 inches OD and less, shall be secured with 16-gage galvanized wire (N331). Larger diameters shall have 14-gage wire (N332). On double-layer insulation where insulation diameter exceeds 14 inches, the outer layer shall be secured with 1/2-inch x 0.015-inch stainless (N336) steel straps instead of wire. Regardless of diameter, cellular glass insulation shall be secured with straps (N336).

4.2.3 Insulation shall be secured on 9-inch centers.

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4.2.4 Longitudinal joints of single-layer insulation and longitudinal and circumferential joints of double-layer insulation shall be staggered (i.e., adjacent joints shall not align).

4.2.5 Insulation on vertical piping shall have ring supports (Detail 3, GD-N99783) installed at the bottom of the pipe run and above interruptions in the pipe run such as at flanges and valves. However, their maximum spacing shall be:

Pipe Operating Temperature (°F)	Maximum Ring Spacing (ft.)
0-360	21
361-400	18
401-480	15
481-560	12
461-1200	9

Support rings are not required for vertical rises less than six feet when measured from the bottom of a pipe run or from a support at an interruption.

4.2.6 Expansion joints (Detail 5, GD-N99783) shall be provided at the tangent points of elbows when the pipe temperature exceeds 425°F, and at the following spacing between tangent points:

Pipe Operating Temperature (°F)	Maximum Expansion Joint Spacing (ft.)
Below 300	None
300-424	50
425-459	36
460-650	24
651-799	18
800 and greater	12

4.3 Weather Jacket Requirements

4.3.1 Aluminum weather jacket shall be 0.016-inch cross-crimped (3/16-inch pitch) (N225), except for pipe elbows. They shall be weatherjacketed with 0.024-inch, smooth, preformed aluminum segments (N231) and fastened with #8 x 1/2-inch stainless screws (N344) on 9-inch centers. Use aluminum within the limitations of Section 3.5.4.

4.3.2 Weather jacket shall be overlapped 2 inches longitudinally and circumferentially. Longitudinal joints shall be staggered between the three o'clock and nine o'clock positions. Longitudinal seams on aluminum jacket shall have a 1/4-inch rolled hem.

4.3.3 For insulation larger than 12 inches OD, secure jacket with 3/4-inch x 0.020-inch, stainless steel straps (N334) with buckles (N335) on 9-inch maximum centers. For insulation 12 inches OD and smaller use 1/2-inch x .015-inch straps (N336) and buckles (N337).

4.3.4 Use end caps, (Detail 6, GD-N99783; and N232) wherever insulation terminates.

4.3.5 Joints in weather jacket shall be caulked with sealant (N206).

4.3.6 Weather jacket on vertical piping shall have S-clips to maintain it in position. Lines up to 18 inches in diameter shall have two S-clips spaced 180 degrees apart. Larger lines shall have four S-clips 90 degrees apart. Weather jacket straps shall be supported by J-clips of the same number and spacing as S-clips. J-clips and S-clips are as shown in Drawing GD-N99995, Details 9 and 10.

4.4 Insulation for Traced Lines

Traced lines shall be insulated with oversized insulation capable of withstanding maximum tracing temperature as well as stock temperature.

4.4.1 Tracer shields shall be used in all cases. Shields shall be constructed of 28-gage sheet steel (N221) and be secured with 14-gage wire (N332) on 12-inch centers. Shields are not required within two feet of a flange or fitting.

4.4.2 Distinctive weatherproof markers shall be applied to the outside of the weather jacket, at intervals of no more than ten feet, to mark the full length of the route of the tracing. The type of marker used shall be approved by the Company.

4.4.3 For small steam tracer supply lines and steam trap condensate return lines, pre-insulated tubing is preferred (N100).

5.0 SPECIFIC REQUIREMENTS FOR VESSELS, COLUMNS, AND HEAT EXCHANGERS

5.1 Applicable Drawings and Forms

Block insulation shall be applied in accordance with Form IRM-EF-630 and Drawing GD-N99785. The specified thickness of insulation does not include weatherjacketing.

5.2 Insulation Requirements

5.2.1 Heat exchanger shells less than 36 inches in diameter shall be insulated in the same manner as piping, Section 4.0. All other vessels, columns and heat exchangers shall be insulated according to Sections 5.2 and 5.3.

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5.2.2 Calcium silicate, perlite, or cellular glass block insulation shall be used for the top heads of vertical vessels and for the upper one-third of the circumference of horizontal vessels, to support foot traffic.

5.2.3 Block insulation shall be secured with 3/4-inch x 0.020-inch stainless steel straps (N334) on 12-inch centers. Each strap shall have one buckle (N335) per connection.

5.2.4 Circumferential joints shall be staggered on single-layer insulation. Circumferential joints shall not align between layers of double-layer insulation.

5.2.5 When insulating vessel heads, insulation straps shall be attached to a support ring (N501) centered on the head. Straps shall be spaced a maximum of 6 inches around the ring so that each block is well fastened. Intermediate rings may be necessary to prevent the straps from stacking. Straps shall not be carried completely around the vessel head.

5.2.6 On equipment 12'-0" diameter and greater operating above 800°F or 18'-0" diameter and greater operating above 600°F, insulation straps shall be provided with one expansion spring (N341) every 25 feet for both single- and double-layer construction. Folded straps, corrugated straps, and similar tensioning devices which tend to relax are not acceptable.

5.2.7 Expansion joints are required on horizontal vessels operating above 300°F or having a tangent length greater than 20 feet. An expansion joint shall be provided for each 10 feet of length and be equally spaced along the length.

5.3 Weather Jacket Requirements

5.3.1 Aluminum weather jacket shall have a thickness of 0.024 inch (N227). Stainless steel and galvanized steel sheeting shall be 0.010-inch thick (N219, N220). The shells of vertical equipment shall be weatherjacketed with 1 1/4-inch pitch corrugated sheet (N227). The shells of horizontal equipment shall use 3/16-inch cross-crimped sheets (N228). All weather jacket for exposed heads shall use flat sheet (N229).

5.3.2 Weather jacket shall be secured with 3/4-inch x 0.020-inch stainless steel straps (N334) on 18-inch maximum centers.

5.3.2.1 When specified by the Company for high wind areas, straps shall be on 12-inch maximum centers. Seams shall have rivets on 6-inch centers instead of 9-inch centers where specified in Sections 5.3.4. and 5.3.7.

5.3.3 The circumferential and longitudinal laps in the weather jacket shall be a minimum of 3 inches when using the cross-crimp corrugated or flat sheet. The lap in the 1 1/4-inch pitch corrugated sheet shall be two corrugations.

5.3.4 On vertical equipment, the circumferential lap of the weather jacket shall be supported by S-clips. Each sheet shall have at least one clip in the center of the sheet and one at the vertical lap. In addition, vertical laps shall be secured with pop rivets on 9-inch centers. However, at least two vertical laps 180 degrees apart shall not be riveted to allow for thermal expansion.

5.3.5 On vertical equipment, all straps shall be supported by J-clips on 4'-6" centers, except straps located at the circumferential laps. Circumferential lap straps shall be supported by S-clips located per Section 5.3.4.

5.3.6 On equipment 12'-0" diameter and greater operating above 800°F or 18'-0" diameter and greater operating above 600°F, weather jacket straps shall have an expansion unit (per Detail 6, Drawing GD-N99995) every 50 feet, but no fewer than one unit.

5.3.7 On horizontal vessels, the longitudinal lap shall be supported with S-clips on 12-inch centers. Circumferential laps shall be pop riveted on 9-inch centers.

5.3.8 Aluminum weather jacket for exposed heads shall be "gore and crown" with laps "beaded and crimped." Gores shall be overlapped a minimum of 3 inches. All laps shall be secured with pop rivets on 4-inch centers and caulked with sealant (N206).

5.3.9 When bottom head of vessel is fully enclosed by skirt (unexposed head), insulation shall be weathercoated with 1/4-inch wet thickness hydraulic insulating cement (N202) over poultry netting (N330) in place of metal weather jacket.

5.4 Manway flanges on insulated columns, vessels and heat exchanger flanges shall be insulated in accordance with Paragraph 3.4.

5.5 Nameplates and weep holes on reinforcing pads shall not be covered.

5.6 Each section of a double pipe exchanger shall be insulated as a single unit. Continuous insulation around a multi-sectional unit is permissible only with written approval by the Company.

6.0 SPECIFIC REQUIREMENTS FOR MISCELLANEOUS EQUIPMENT

6.1 Applicable Forms

Pumps, turbines and other miscellaneous equipment shall be insulated as indicated on Form IRM-EF-630. Access shall be provided to pump and turbine glands and other points requiring periodic maintenance.

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6.2 Protection of Mechanical Equipment

Working parts of turbines and other mechanical equipment shall be protected when insulation is applied. Until all insulation materials, including cement or mastic, have been removed from these parts, the scope of insulation work shall be considered incomplete.

6.3 Plastic Insulation

Plastic insulation (N202) shall be used on any surface which is not suited to block insulation. The use of plastic insulation shall be kept to a minimum. Insulation shall be applied on clean surfaces to recommended thicknesses. If a second layer is required, plastic insulation shall be allowed to set and 1-inch by 20-gage galvanized hexagonal mesh (N330) applied over the entire plastic insulation surface with butted joints laced together with No. 16-gage galvanized iron wire (N331) and secured to the insulation with copper wire staples (N340). The insulation, when dry, shall be weatherjacketed.

7.0 INSPECTION

The Company reserves the right to inspect the insulation prior to and after weatherjacketing. The Contractor shall replace or correct any materials or installation which do not meet the requirements of this specification and reference drawings.

8.0 FORMS AND DRAWINGS

The following forms and drawings are a part of this specification:

PPG-EF-565	Line Index
IRM-EF-630	Piping and Equipment Insulation Index
GD-N99783	Standard Insulation for Hot Piping
GD-N99785	Standard Insulation for Hot Vessels, Heat Exchangers and Hot Equipment
GD-N99993	Standard Insulation Item Numbers
GD-N99995	Standard Insulation and Aluminum Weatherproofing Details for Hot Tanks
IRM-EG-4197	Flexible Removable Insulation Covers

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