



Engineering Standard

Construction Department - Pittsburgh

PIPING, VESSEL AND TANK INSULATION
WORKMANSHIP

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ALUMINUM COMPANY OF AMERICA CONSTRUCTION DEPARTMENT

STANDARD SPECIFICATION FOR PIPING, VESSEL AND TANK INSULATION WORKMANSHIP

1. GENERAL

This is the Standard Specification for the installation of insulation on piping, vessels, and tanks; it includes engineering, inspection, and workmanship requirements. See Engineering Standard 33.7.9 for material specifications.

2. ENGINEERING AND INSPECTION

- 2.1 Many of the piping drawings for this work are diagrammatic. This Contractor shall carefully check all measurements. Complete building drawings are on file in the Owner's Engineer's office at the job site, and these drawings shall be inspected by this Contractor, prior to bidding, for any lack of necessary space, interferences, clearances, or support required to complete the installation. Any discrepancies shall be brought to the attention of the Owner's Engineer. Neglect to do so shall render this Contractor liable for any changes or additions required.
- 2.2 All insulated lines, vessels, and tanks must be inspected by the Owner's Engineer and approved in writing before the installation of separate jacketing or wrapping or any other covering material will be permitted.
- 2.3 This Contractor shall at all times facilitate inspection by the Owner's Engineer and shall proceed promptly to correct any deficiencies in his work that are brought to his attention.
- 2.4 The following is an index of the Owner's Standard Drawings for reference, dated as shown or latest revision.

(This space is reserved for listing drawings which are to be issued as they are completed.)

3. WORKMANSHIP

3.1 General

- 3.1.1 All insulation shall be stored in a dry place and kept dry prior to application.
- 3.1.2 The weatherproof coating of mastic, aluminum jacketing, or any other type of jacketing shall not be applied to wet insulation. If the insulation or insulating-finishing cement is not protected and becomes wet, it shall be replaced or allowed to dry thoroughly before

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applying the weatherproof coating of mastic, aluminum jacketing or any other type of jacketing.

- 3.1.3 The weatherproofing shall be kept up with the installation of insulating materials.
- 3.1.4 The insulation type and thickness shall be as specified in the Scope of Work for the various pipe lines, vessels, and tanks.
- 3.1.5 All piping, tanks and vessels for temperatures of 600 F and higher, or where specified in the Scope of Work, shall be insulated with the specified insulation in two equal or nearly equal layers.
- 3.1.6 The flexible steam hose insulation shall be completely wrapped with plastic tape.
- 3.1.7 Insulation shall not be installed on any sections of pipe lines until the sections have been tested under pressure by Others and have been released, in writing, for insulation by the Owner's Engineer.
- 3.1.8 Calcium silicate insulation shall be used on any piping where mechanical damage can be expected.
- 3.1.9 The Scope of Work and/or drawings will show the method of installing the pipe insulation in connection with the pipe hangers. Should the pipe hangers or saddles penetrate the pipe insulation jacketing or covering on cold water pipes or on exterior piping, such penetrations shall be sealed with J-M Insulkote weatherproof mastic.
- 3.1.10 The tops of tanks or vessels are defined as any flat, or sloping, or curved surface on which personnel could walk, stand or climb.
- 3.1.11 Expansion joints shall be installed in accordance with details shown on Owner's drawings; however, if such details are not shown, this Contractor shall prepare details of the expansion joints and submit them to the Owner's Engineer for approval before installation.

3.2 Pipe Insulation

- 3.2.1 Molded insulation shall be used for all piping, and when readily available, for all fittings. When molded insulation for fittings is not readily available, job-fabricated insulation shall be used.
- 3.2.2 The flanges and valves on low pressure steam lines (up to 15 psi) and on all process lines shall not be insulated, unless otherwise specified in the Scope of Work. Where the flanges and valves occur, a clear space of sufficient length shall be allowed to permit removal of flange bolts without interference. The ends of insulation shall be beveled and sealed with insulating-finishing cement.
- 3.2.3 The condensate lines shall not be insulated, except where they are located less than 7 ft. above walkways, platforms, floors, etc.; then they shall be insulated, as specified, for personnel protection.

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- 3.2.4 On all jacketed tar piping and high pressure steam lines, the valves, flanges, and fittings shall be insulated with the same material and the same thickness of insulation as on the adjoining pipe, using block or premolded insulation as required. The block insulation shall be wired in place, and all joints carefully filled with insulating cement, and finished with insulating-finishing cement. The premolded fitting insulation shall be installed as recommended by the manufacturer. The flange insulation shall be installed so as to be readily removable without damage to the adjacent pipe covering.
- 3.2.5 Vertical pipes over 15 ft. long (measured above the elbow) shall have 1/8 in. thick horizontal angles spaced and tack welded, by this Contractor, so that the pipe insulation will be supported at the bottom of the riser and at intervals of not more than 15 ft. The outstanding leg of these support angles shall be 1/2 in. less than the thickness of the insulation.
- 3.2.6 No-Drip insulation used on cold pipes, only where specified, to prevent condensation shall be applied in accordance with the manufacturer's directions.
- 3.2.7 Molded Insulation - for Piping and Pipe Fittings
- 3.2.7.1 The sections of molded insulation without an integral jacket shall be tightly butted together and securely held in place, before the application of any specified jacketing, with three stainless steel wire loops per section, but on no greater than 12 in. centers, on pipe up to 12 in. pipe size, and four loops per section, but on no greater than 9 in. centers, for larger diameter pipe. Calcium silicate insulation shall have four loops per section, but on no greater than 9 in. centers. The wire loop ends shall be tightly twisted together, bent over, and pressed lightly into the insulation.
- 3.2.7.2 The sections of molded insulation with a factory-applied jacket shall have the jacket laps pasted in accordance with the manufacturer's recommendations. The molded sections with an integral jacket other than aluminum need not be secured with wire loops, unless, in the judgment of the Owner's Engineer, the jacket will not properly hold the insulation in place until it is enclosed in aluminum jacketing.
- 3.2.7.3 The sections of molded insulation with a factory-applied aluminum jacketing shall be installed in strict accordance with the manufacturer's recommendations.
- 3.2.7.4 The premolded fitting insulation shall be securely held in place with stainless steel wire loops.
- 3.2.7.5 On high temperature piping, where the temperature exceeds 600 F or where specified in the Scope of Work, the insulation shall be installed in two layers. The first layer of the sectional or segmental insulation shall be securely wired in place with not less than four stainless steel wire loops per section, but on no greater than 9 in. centers. The second layer shall break both the butt and lateral joints and be secured in place with not less than four wire loops per section, but on no greater than 9 in. centers. All joints between sections or segments shall be carefully filled with insulating cement.

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3.2.8 Job-Fabricated Fitting Insulation

- 3.2.8.1 The job-fabricated insulation for fittings on all pipe sizes for which premolded fittings are not available shall consist of mitered segments of molded insulation neatly fitted together, secured with stainless steel wire loops, joints carefully filled with insulating cement, and covered with a 1/8 in. coat of insulating-finishing cement. The finished thickness shall be equal to that of the insulation on the adjoining pipe.
- 3.2.8.2 The job-fabricated insulation on valves to be insulated, 3 1/2 in. diameter and smaller, shall consist of insulating-finishing cement built up to the same thickness as that of the adjoining pipe insulation.
- 3.2.8.3 The job-fabricated insulation on valves to be insulated, 4 in. and larger in diameter, shall consist of mitered segments of molded pipe or block insulation properly cut and fitted together, secured with stainless steel wire loops, joints filled with insulating cement, and all of the insulation covered with a minimum 1/8 in. thick smooth coat of insulating-finishing cement. The finished thickness shall be equal to that of the insulation on the adjoining pipe.
- 3.2.8.4 In powerhouse areas or other areas specified in the Scope of Work, the finished field-fabricated insulation shall be coated with Foster 30-36 Sealfas coating and shall be wrapped with Glassbestos cloth, smoothed out and again coated with 30-36 Sealfas coating. After the coating has dried, the Glassbestos cloth will be painted by Others with an aluminum paint, Alcoa-A5, specification dated January 1972.

3.2.9 Aluminum Jacketing for Insulated Pipe Lines

- 3.2.9.1 The aluminum jacketing, where specified in the Scope of Work, for the insulated pipe lines shall be cut to proper length, allowing 3 in. for lap and hem, and applied to provide a 2 in. circumferential and a 2 in. longitudinal lap with a 1 in. hem on the outside edge.
- 3.2.9.2 The longitudinal joints on horizontal pipe lines shall be slightly offset and shall lap downward to shed water, and at joints on the vertical lines the upper section of jacketing shall lap over the lower section. The laps on all cold water lines and the longitudinal laps on vertical pipe lines of all outdoor exposed lines shall be properly sealed in the lap, not on top of it, with lap cement, being careful to keep the cement off the exposed aluminum jacketing. Indoor lines, except cold water lines, need not have the laps sealed.
- 3.2.9.3 The jacketing shall be secured with 3/8 in. wide aluminum strapping and seals on not more than 9 in. centers, with a strap at each circumferential lap.
- 3.2.9.4 The aluminum jacketing for elbows shall be secured with aluminum sheet metal screws or pop rivets on not more than 6 in. centers.

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- 3.2.9.5 The factory-applied aluminum jacketed insulation shall be secured with straps as



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3.2.10 Weatherproofing of Fittings and Valves

The weatherproofing of all fittings and insulated valves, both indoors and outdoors (except in powerhouse areas where they shall be finished as specified in section 3.2.8.4), for which aluminum jacketing is not specified or available, shall consist of two coats of weatherproof mastic and one thickness (unless otherwise specified) of glass cloth reinforcing applied as follows: A primer shall be applied to the surface of the insulating-finishing cement (calcium silicate if preformed), and the primer shall be allowed to dry. A brushed, troweled, or sprayed tack coat of the weatherproof mastic is then applied, into which, while the mastic is still tacky, 6 in. wide strips (4 in. wide for diameters up to 4 in.) of glass cloth shall be spirally wound around the fitting or valve, lapping half of the width of the strip, with the glass cloth embedded in the mastic, tightly drawn and smoothed out. The final coat of mastic is then applied to a total wet film thickness of between 3/16 in. and 1/4 in. or between 1/8 in. and 3/16 in. dry film thickness.

3.2.11 Asphalt Felt Weatherproof Jacket

The asphalt felt weatherproof jacket shall consist of one ply of the 50 pound asphalt-saturated asbestos felt jacket fastened with stainless steel wire at all laps, ends and sides, and at intermediate intervals of approximately 6 in. All laps shall be a minimum of 3 in. The laps on all cold water lines and the longitudinal laps on vertical pipe lines of all outdoor exposed lines shall be properly sealed in the lap, not on top of it, with lap cement. All other joints shall be left unsealed. All side laps on horizontal lines shall lap downward to shed water, and at the joints on the vertical lines the upper section of the felt jacket shall lap over the lower section. Indoor lines, except cold water lines, need not have the laps sealed.

3.2.12 Stainless Steel Jacketing

Stainless steel jacketing used in lieu of the asphalt felt jackets under special conditions shall be fastened with stainless steel wire or stainless steel bands at all laps, ends and sides, and at intermediate intervals of approximately 9 in. All laps shall be a minimum of 3 in. The laps on all cold water lines and the longitudinal laps on vertical pipe lines of all outdoor exposed lines shall be properly sealed in the lap, not on top of it, with lap cement. All other joints shall be left unsealed. All side laps on horizontal lines shall lap downward to shed water, and at the joints on the vertical lines the upper section of the felt jacket shall lap over the lower section. Indoor lines, except cold water lines, need not have the laps sealed.

3.3 Tank and Vessel Insulation

3.3.1 Glass Fiber Rigid Board Insulation - for Vertical Sides and Bottoms Only

Glass fiber rigid board insulation may be used on the vertical sides and bottoms of vertical tanks and vessels, and shall not be used on the tops. Glass fiber rigid board insulation may also be used on the ends only of horizontal tanks and shall not be used on the straight shell.

The Type 704 glass fiber rigid board insulation, when applied to curved surfaces 8 ft. in diameter and less, shall be scored, for stress-free application, with a saw with 1/4 in. of the material removed to a depth of one-half the insulation thickness on the side to be applied to the curved surface. The Type 703 insulation board need not be scored.

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3.3.1.1 Tank and Vessel Vertical Sides

- 3.3.1.1.1 Unless otherwise specified in the Scope of Work, the glass fiber rigid board insulation shall be supported at the bottom of the vertical sides of tanks or vessels, and at vertical intervals of 12 ft. 1/4 in. (back to back of angles), by shelf angles, welded by Others, to the tanks or vessels.
- 3.3.1.1.2 The insulation board shall have all joints tightly butted, vertical joints staggered, and neatly trimmed around fittings, manholes, and other projections. All open joints and open spaces around fittings and manholes shall be firmly packed with cut pieces of the insulation board used or insulating cement if necessary. Manhole covers and removable or hinged covers shall not be insulated unless specified in the Scope of Work.
- 3.3.1.1.3 The insulation board shall be banded with stainless steel bands spaced not more than 12 in. centers, vertically. On tanks or vessels 12 ft. diameter and smaller the bands shall span the entire circumference of the tanks or vessels. Tanks over 12 ft. diameter will have vertical angles or bars, welded by Others, to limit the circumferential span of the bands to approximately 30 ft.
- 3.3.1.1.4 Insulating-finishing cement coat is not required over the insulation.

3.3.1.2 Tank and Vessel Bottoms

This procedure for tank and vessel bottoms shall also apply to the ends of horizontal tanks and to the sides and hopper bottoms of rectangular tanks and vessels.

- 3.3.1.2.1 This Contractor shall install P2P pins as follows: A P2P pin shall be located in each corner of each insulation board with intermediate P2P pins spaced not more than 12 in. centers in both directions on the bottom of the tanks or vessels, and ends of horizontal tanks or vessels.
- 3.3.1.2.2 The insulation boards shall be installed as specified in section 3.3.1.1.2; impaled over P2P pins.
- 3.3.1.2.3 After impalement of the insulation board, the speed clips shall be forced over the pins, pressed into the insulation board and excess pin length above the clip cut off to provide a smooth surface.
- 3.3.1.2.4 Insulating-finishing cement coat is not required over the insulation.

3.3.2 Blanket Insulation

Blanket insulation may be used indoors only, on vertical sides, bottoms or ends only on vertical, or horizontal or rectangular vessels with irregular surfaces and projections, with temperatures above 450 F up to 1000 F.

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3.3.2.1 Blanket insulation shall be butted firmly together and impaled over P2P pins, welded by this Contractor, spaced 12 in. centers for bottoms and 18 in. centers for sides and ends, between pins both ways and held in place with speed clips forced over the pins, pressed into the insulation, and the excess pin cut off to provide a smooth surface.

3.3.2.2 After installation of insulation, stainless steel wire (#16 ga.) shall be pulled under the speed clips and tightly laced from each pin to all adjacent pins.

3.3.2.3 On large vessels insulated with blanket insulation when the temperature of the tanks is over 600 F, expansion joints in the insulation shall be provided every 16 ft. both ways.

3.3.2.4 A hard finish (section 3.3.6) 1/2 in. thick is required over blanket insulation.

3.3.3 Calcium Silicate and Expanded Perlite Insulation

The type of insulation and thickness shall be specified in the Scope of Work. This type of insulation shall be used on tops of all vertical tanks and vessels, and on the straight shells of horizontal tanks, unless a foam type of insulation is specified in the Scope of Work.

3.3.3.1 Vertical Tank and Vessel Sides

3.3.3.1.1 Unless otherwise specified in the Scope of Work, the calcium silicate and perlite block insulation shall be supported at the bottom of the sides of vertical tanks or vessels, and by shelf angles, welded by Others, to the tanks or vessels at vertical intervals of 12 ft. 1/4 in. (back to back of the angles).

3.3.3.1.2 The insulation shall have all joints tightly butted, staggered vertically, and neatly trimmed around fittings, manholes, and other projections. All open joints and open spaces around fittings and manholes shall be firmly packed with cut pieces of the insulation used and insulating cement. Manhole covers, removable or hinged covers shall not be insulated unless specified in the Scope of Work.

3.3.3.1.3 The insulation shall be banded with stainless steel bands spaced not more than 12 in. centers, vertically. On tanks or vessels 12 ft. diameter and smaller the bands shall span the entire circumference of the tanks or vessels. Tanks over 12 ft. diameter will have vertical angles or bars, welded by Others, to limit the circumferential span of the bands to approximately 30 ft.

3.3.3.1.4 Insulating-finishing cement coat is not required over this insulation.

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3.3.3.2 Horizontal Tanks or Vessels

This procedure shall only apply to the straight shell portions of the horizontal tanks or vessels.

3.3.3.2.1 The insulation shall have all joints tightly butted, staggered vertically, and neatly trimmed around fittings, manholes, and other projections. All open joints and open spaces around fittings and manholes shall be firmly packed with cut pieces of the insulation used and insulating cement. Manhole covers, removable or hinged covers shall not be insulated unless specified in the Scope of Work.

3.3.3.2.2 The insulation shall be banded with stainless steel bands spaced not more than 12 in. centers, horizontally. On tanks or vessels 4 ft. diameter and smaller the bands shall span the entire circumference of the tanks or vessels. Tanks over 4 ft. diameter shall have two longitudinal steel angles or bars, welded to the shell, by Others, and located 60 degrees from the vertical center on the lower half of the tank or vessel. Where longitudinal angles have been provided the straps shall span from angle to angle.

3.3.3.2.3 Insulating-finishing cement coat is not required over this insulation.

3.3.3.3 Horizontal Tanks or Vessels

This procedure shall apply only to the ends of horizontal tanks or vessels.

3.3.3.3.1 Install P2P pins 6 in. centers, in both directions, over the entire curved surface.

3.3.3.3.2 The insulation shall be installed as specified in section 3.3.3.2.1 impaled over P2P pins.

3.3.3.3.3 After impalement of the insulation, the speed clips shall be forced over the pins, pressed into the insulation and excess pin length above the clip cut off to provide a smooth surface.

3.3.3.3.4 Insulating-finishing cement coat is required over the insulation.

3.3.3.4 Vertical Tank or Vessel Tops and Bottoms

3.3.3.4.1 Heavy 1/2 in. stainless steel square nuts welded on edge (by Others) shall be located as follows:

- (a) Flat tops (1/4 in. to 1 1/2 in. slopes) - beginning 1/4 in. from the outside edge of the top or weather angle, nuts shall be placed in circumferential rings, spaced 36 1/4 in. centers up the top to the apex. Nuts shall be 36 in. centers in the circumferential rings.

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- (b) Dished tops (ellipsoidal) - the first row of nuts shall be located at the junction of the top or weather angle and the tank or vessel, spaced 12 in. centers. Beginning at the top of the knuckle radius on the dished top, nuts shall be placed in circumferential rings, spaced 36 1/4 in. centers up the top to the apex. Nuts shall be 36 in. centers in the circumferential rings..
- (c) Dished bottoms (ellipsoidal) - beginning at the bottom of the knuckle radius on the dished bottoms, nuts shall be placed in circumferential rings, spaced 36 1/4 in. centers down to the bottom. Nuts shall be 36 in. centers in the circumferential rings.
- (d) Conical bottoms - beginning at a distance of 36 1/4 in. below the bottom angle (located near the bend line), nuts shall be placed in circumferential rings, spaced 36 1/4 in. centers down to the bottom. Nuts shall be 36 in. centers in the circumferential rings.

3.3.3.4.2 This Contractor shall furnish and install stainless steel rods, 1/4 in. diameter, threaded circumferentially thru the 1/2 in. heavy square nuts which are spaced 36 in. centers in circumferential rings.

3.3.3.4.3 The insulation shall have all joints tightly butted, staggered vertically, and neatly trimmed around fittings, manholes, and other projections. All open joints and open spaces around fittings and manholes shall be firmly packed with cut pieces of the insulation used and insulating cement. Manhole covers, removable or hinged covers shall not be insulated unless specified in the Scope of Work.

3.3.3.4.4 After installation of insulation, stainless steel wire (#16 ga.) shall be tightly laced from each nut to all adjacent nuts and to the 1/4 in. diameter stainless steel rods with the wire on the rods spaced on not more than 12 in. centers.

3.3.3.4.5 Insulating-finishing cement coat is required over the insulation.

3.3.3.5 Rectangular Tanks and Vessels

3.3.3.5.1 Install P2P pins spaced 6 in. centers in both directions.

3.3.3.5.2 Insulation shall be installed as specified in section 3.3.3.3.2 impaled over the P2P pins.

3.3.3.5.3 Insulating-finishing cement coat is not required over the insulation.

3.3.3.6 The insulation on certain tanks and vessels, such as heaters, digesters, and flash tanks, will require expansion joints in the insulation to allow for expansion and contraction of these vessels without damage to the insulation. The expansion joints

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shall be installed by this Contractor. The tanks that will require expansion joints will be specified in the Scope of Work.

- 3.3.3.7 On tanks where the temperatures may be above 600 F, or where specified in the Scope of Work, the calcium silicate insulation shall be applied in two layers, with all vertical joints staggered in each layer and between layers.

3.3.4 Insulating-Finishing Cement Coat

- 3.3.4.1 All surfaces of calcium silicate or expanded perlite insulation over dished heads (tops and bottoms), flat tops, and conical bottoms shall have an insulating-finishing cement coat.

- 3.3.4.2 Insulating-finishing cement coat is not required on:

- (a) Calcium silicate or expanded perlite insulation on the sides of vertical tanks or vessels, nor on the straight shells of horizontal tanks, nor on the sides or hopper bottoms of rectangular type vessels.
- (b) Fiber glass rigid board insulation on any type of tanks or vessels.
- (c) Tanks and vessels weatherproofed with aluminum jacketing.

- 3.3.4.3 A layer of stainless steel or monel wire reinforcing mesh shall be installed, stretched tightly and securely fastened on all surfaces of the insulation. End and side laps of the wire mesh shall be securely laced together. Mesh shall be wired at intervals not exceeding 24 in. to the 1/4 in. diameter stainless steel rods, the stainless steel nuts, or the stainless steel bands or the P2P pins, and to the steel angles, welded by Others, to the tanks or vessels.

- 3.3.4.4 A coat of insulating-finishing cement shall be applied over the mesh to a minimum dry thickness of 1/4 in.

3.3.5 Application of Weatherproof Mastic on Tanks and Vessels

- 3.3.5.1 A layer of stainless steel or monel wire reinforcing mesh shall be installed, stretched tightly and securely fastened on all surfaces to which the waterproof mastic is to be applied. End and side laps of the wire mesh shall be securely laced together. Mesh shall be wired at intervals not exceeding 24 in., to pigtailed which shall be attached to the 1/4 in. diameter stainless steel rods, the stainless steel nuts, the stainless steel bands, P2P pins, and to the steel angles, welded by Others, to the tanks or vessels.

- 3.3.5.2 A primer sealer shall be spray or brush applied over the wire reinforcing mesh at the rate of approximately 150 sq. ft. per gallon, and allowed to dry so that the surface is black all over and dry to touch. Primer sealer is required over calcium silicate and expanded perlite insulation and insulating-finishing cement coats but is not required over fiber glass insulation.

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3.3.5.3 A tack coat of the mastic shall be spray applied, by airless spray, over the primer sealer and wire reinforcing. Excess tack coating shall be removed with the edge of a trowel using the wire reinforcing as a screed. As soon as the tack coat is sufficiently dry so that it can be touched without the mastic remaining on the hand, the final coat of mastic shall then be spray applied, by airless spray, to a total dry film thickness of $1/8$ in. minus 0 or plus $1/32$ in. for the two coats. The wire reinforcing shall be completely covered, but not necessarily embedded to the extent that the pattern of the mesh will not show. The pattern of the mesh is often quite distinct in a satisfactory installation.

3.3.5.4 After weatherproofing of the insulation, this Contractor will be required to remove any overspray of mastic from columns, stairs, handrails, ladders, valves, and electrical equipment. It will not be necessary to remove the mastic from the support beams of the vessels; however, this Contractor shall use caution in spraying mastic in order to keep the overspray at a minimum.

3.3.5.5 The mastic shall be applied in the "as received" condition. The use of solvents, driers, or any other additives will not be permitted. The manufacturer of the mastic should be contacted if any difficulty is encountered in the spray application of this material.

3.3.6 Hard Finish

3.3.6.1 A hard finish is required over blanket insulation and where specified in the Scope of Work, and not weatherproofed unless specified.

3.3.6.2 A layer of stainless steel or monel wire reinforcing mesh shall be installed, stretched tightly and securely fastened on all surfaces of the insulation. End and side laps of the wire mesh shall be securely laced together. Mesh shall be wired at intervals not exceeding 24 in. to the $1/4$ in. diameter stainless steel rods, the stainless steel nuts, the stainless steel bands, P2P pins and to the steel angles, welded by Others, to the tanks or vessels.

3.3.6.3 The insulating-finishing cement shall then be applied in two layers to a thickness of not less than $1/2$ in., with the surface troweled to a smooth finish.

3.3.6.4 This hard finish is not required where aluminum jacket covering is to be installed.

3.3.7 Aluminum Jacketing for Insulated Tanks and Vessels

3.3.7.1 The aluminum jacketing for the insulated tanks and vessels shall be cut to proper size and applied with sheet metal screws or pop rivets used on both the end and side laps placing them on not more than 6 in. centers. All laps shall be not less than 3 in., and all side laps shall be staggered. To prevent slippage, aluminum zee hooks made of $3/8$ in. aluminum strapping, of a size to permit the desired lap, shall be used at each circumferential lap, and the hooks shall be spaced on approximately 5 ft. centers. The upper sheet of the circumferential lap on vertical tanks shall lap over

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the lower sheet to shed water. On cold vessels, all laps shall be sealed in the laps with lap cement. On horizontal hot tanks or vessels, all end laps shall be sealed in the laps. Side laps shall be installed so that the lap will shed water.

3.3.7.2 Stainless steel straps and seals shall also be used to hold the aluminum jacketing in place. Not less than two straps per course of sheets shall be used, and the straps shall be equally spaced between the adjacent circumferential laps.

3.3.7.3 Screws shall be omitted from circumferential laps when necessary to provide expansion joints on vessels when the operating temperatures require expansion joints. The vessels that will require expansion joints will be specified in the Scope of Work.

3.3.7.4 All outlets and all cut outs for brackets shall be flashed for weather tightness.

3.3.7.5 On cold tanks and vessels, 32 F and lower, the screws in the lap shall not be used, unless the screws are installed, removed, coated with Insulkote SG, and reinstalled. The straps must be used as specified in 3.3.7.2. All laps on cold tanks and vessels shall be sealed with lap cement in the laps.

3.4 Special Installation Conditions

This section applies only to coded tanks or vessels and shall apply only when specified in the Scope of Work.

3.4.1 Calcium Silicate - on Sides

3.4.1.1 Where shelf angles, bottom or intermediate, have been omitted, this Contractor shall install two rows of P2P pins, 6 in. centers both vertically and circumferentially, at locations where the angles have been omitted. Banding shall then be installed as specified in section 3.3.3.1.3.

3.4.1.2 Where the vertical and horizontal angles have been omitted on tanks or vessels over 15 ft. diameter, Contractor shall disregard section 3.4.1.1 and install P2P pins spaced not over 6 in. centers circumferentially and not over 12 in. vertically over the entire shell. Banding will then be omitted.

3.4.2 Calcium Silicate - on Tops

3.4.2.1 Where the top angle has been omitted, install two stainless steel bands approximately 2 in. apart, on the straight steel shell as near the top as possible, pulled tight. Pigtailed shall be hung on the bands before tightening. The pigtailed shall be spaced 12 in. alternate centers (2 ft. apart on each band).

3.4.2.2 Where the heavy stainless steel nuts have been omitted, Eagle Picher Super 66 Cement ("wool cement" - Johns-Manville or Armstrong's equivalent may be used) shall be mixed with water in accordance with manufacturer's direction. Trowel on this mortar mix to 1/4 in. thickness and embed the calcium silicate insulation,



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butting edges and ends, while the mortar is still wet, to hold the calcium silicate until it is banded.

3.4.2.3 Install 1/2 in. wide stainless steel bands; connect one end to the circumferential bands installed under section 3.4.2.1 and carry the other end over the top of the tank and connect it also to the circumferential bands on the other side. All bands shall run over the top of the tank, be anchored at each end to the circumferential bands under 3.4.2.1 above.

3.4.2.4 Bands shall be spaced so that each piece of calcium silicate is covered by at least one band. These "over-the-top" bands shall be alternately connected to the circumferential bands so that each circumferential band is carrying 1/2 of the tie-down stress.

3.4.2.5 Where nozzles or other projections interfere with the stainless bands, 1/4 in. diameter stainless steel rods, or the equivalent diameter of twisted stainless steel wire, shall be used to form a floating ring around the projection, to which the ends of the stainless steel straps shall be anchored.

3.4.3 Calcium Silicate - Bottoms

This procedure shall also apply to the ends of horizontal tanks.

3.4.3.1 Where the bottom angle has been omitted, install two stainless steel bands approximately 2 in. apart, on the straight steel shell as near the bottom or ends as possible, pulled tight. Pigtails shall be hung on the bands before tightening. The pigtailed shall be spaced 12 in. alternate centers (2 ft. apart on each band).

3.4.3.2 Where the heavy stainless steel nuts have been omitted, this Contractor shall install circular patterns of P2P pins. Pins shall be 6 in. centers in circular rows also spaced 6 in. centers.

3.4.3.3 Install 1/2 in. wide stainless steel bands; connect one end to the circumferential bands installed under 3.4.3.1 and carry the other end over the bottom of the tank and connect it also to the circumferential bands on the other side. All bands shall run over the bottom of the tank (or ends of horizontal tank), be anchored at each end to the circumferential bands under 3.4.3.1 above. Bands shall be spaced so that each piece of calcium silicate is covered by at least one band. These "over-the-bottom" bands shall be alternately connected to the circumferential bands so that each circumferential band is carrying 1/2 of the tie-down stress.

3.4.3.4 Where nozzles or other projections interfere with the stainless bands, 1/4 in. diameter stainless steel rods, or the equivalent diameter of twisted stainless steel wire, shall be used to form a floating ring around the projection, to which the ends of the stainless straps shall be anchored.

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3.4.4 Fiber Glass on Sides

3.4.4.1 Where shelf angles, bottom or intermediate, have been omitted, this Contractor shall install two rows of P2P pins, 6 in. centers both vertically and circumferentially, at locations where the angles have been omitted. Banding shall then be installed as specified in section 3.3.1.1.3.

3.4.4.2 Where the vertical angles and shelf angles have been omitted on tanks and vessels over 15 ft. diameter, Contractor shall disregard the above section 3.4.4.1 and install P2P pins as follows: One pin shall be located in each corner of each board, with intermediate pins spaced 18 in. maximum in all directions. Banding shall then be omitted.

3.5 Polyurethane Sprayed-On Foam Installation (Max. Temp. 220 F)

When polyurethane sprayed-on foam insulation is specified for steel tanks or piping, it shall only be spray applied by applicators licensed or approved by the manufacturer of the specified foam materials in accordance with the manufacturer's recommendations and also in accordance with the following.

3.5.1 Surface Preparation - Near-White Metal Blast (by Others)

All steel surfaces to be insulated shall be given a No. 10 Near-White Blast Cleaning (Steel Structures Painting Council Surface Preparation Specification SSPC-SP10-63T) such that the steel surface has an appearance equal to, or cleaner than, Plate B Sa 2 1/2 as shown in the Swedish Standard SIS 05 59 00 - 1967 (also recognized as the Steel Structures Painting Council Visual Standard SSPC-Vis 1-67T and the American Society for Testing and Materials Designation D2200-1967), or has an appearance equal to, or cleaner than, the National Association of Corrosion Engineers Near-White Blast Cleaned Surface Finish Visual Standard of NACE Standard TM-01-70. The above standard may be seen at the office of the Owner's Engineer, or it may be purchased from the Steel Structures Painting Council, 4400 Fifth Ave., Pittsburgh, PA 15213; the American Society for Testing and Materials, 1916 Race St., Philadelphia, PA 19103; or Kenneth Tator Associates, 2020 Montour St., Coraopolis, PA 15108.

3.5.2 Steel Primer Application (by Others)

3.5.2.1 All sandblasted surfaces shall be swept free of sand and dust (using high pressure air and a natural bristle broom).

3.5.2.2 Steel primer, Carbo-Zinc 11, inorganic zinc rich paint, green color, manufactured by the Carboline Company, St. Louis, MO 63144, shall be applied by conventional air spray to a dry film thickness of 3.0 to 4.0 mils.

3.5.2.3 Extreme care must be taken to insure against contamination of the sandblasted area prior to the application of the inorganic zinc rich steel primer. In the event of rain, the near-white metal surface shall be protected. If the protection is not successful in maintaining a completely rust-free surface, a reblast must be undertaken prior to applying the inorganic zinc rich primer.

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- 3.5.3.1 As soon as possible after painting, not later than the following day, to minimize contamination and mechanical damage to the steel primer, the following steps shall be taken. The painted surface shall be thoroughly cleaned before applying the PAPI bond coat. Cleaning of the surface shall be done in accordance with the procedure outlined as follows: Blow off dust with high pressure air, and remove oil or grease with a mixture of 50 percent methyl ethyl ketone (MEK) and 50 percent isopropyl alcohol. Remove caustic, dust, sand, resin, or other foreign materials by scrubbing with clean, fresh water containing 3 percent by weight of an alkaline detergent soap cleaning compound such as "Tide." Workers shall be organized into a group of at least four scrubbers, two for handling water hoses, one to scatter detergent and one or two for air blow-off duties. One half of the tank top should first be blown off as thoroughly as possible with air in preparation for wash down. The workers must operate as a group moving from the center of the tank periphery washing pie-shaped sections and gradually moving circumferentially around the tank. The area to be washed must be kept wet and detergent sprinkled on and scrubbing commenced. The one water hose operator shall keep the area wet ahead of the scrubbers and shall keep the area around the scrubbers from drying with detergent on the surface. The second hoseman advances behind the whole group rinsing water repeatedly over the scrubbed area and ending up with rinsing over the edge of the tank. The process is repeated on the other half while thorough high pressure air drying of the first half prepares that surface to receive the second primer coat. Care shall be taken that all the water has been blown out of any plant air before using the air for drying prior to any coating or foam application.
- 3.5.3.2 If the steel primer is damaged to the extent that the steel surface is exposed, spot blast or wire brush exposed metal surface to near-white metal and reprime with Carbo-Zinc 11, green color, to a dry film thickness of between 3.0 to 4.0 mils. This Contractor shall notify the Owner's Engineer if any paint has been damaged; however, such paint repair will be done by Others.
- 3.5.3.3 Immediately following the cleaning operation, apply a bond coat consisting of one part of PAPI and three parts of methylene chloride, by volume. This PAPI bond coat shall be applied on the surface only by rubbing with soft rags to insure uniformity of the application. No localized areas of surface darkness indicating too heavy application shall be allowed. (Approximate coverage of the mixed solution of PAPI bond coat is 600 sq. ft. per gallon.) The PAPI bond coat shall be applied on a surface preheated to 150 F minimum to insure proper drying. Two to four hours drying time at 150 F should be adequate. A simple test for determining adequate dryness of PAPI bond coat is to lightly rub a clean white cloth over the surface. If no PAPI can be rubbed off on the cloth, then the surface is ready to receive foam. Temporary covering is recommended for heavy contamination areas since the PAPI is sticky while drying and will collect airborne contaminants on the surface. In the event the PAPI bond coat still becomes contaminated after best efforts to restrict airborne pickup, blow as much contamination off the primed surface as possible using high pressure air before proceeding to foam application. Because the PAPI bond coat will

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react with water, it should never be washed with water or blown dry with wet air. A schedule permitting enough time for PAPI bond coat drying and subsequent foaming within the same day is recommended for all areas but especially for heavy contamination areas.

NOTE: Rubber or plastic gloves must be used by all personnel involved with the handling of the PAPI bond coat solution.

3.5.4 Polyurethane Foam Application

- 3.5.4.1 The polyurethane foam shall not be applied where the metal surface temperature is less than 150 F. If the tank is not in operation, it shall be heated until the surfaces to be insulated reach the required temperature. The tank metal surface temperature shall remain at 150 F or over until all foam spraying is completed. In addition, foam shall not be applied when the temperature of components "A" (PAPI) and "B" (Resin) is less than 65 F, to prevent producing foam with excessively high density. If the tank surface should be exposed to dew or rain before the spraying is completed, it must be permitted to dry completely before the foam is again applied.
- 3.5.4.2 Protection against high winds must be provided at all times during the application of foam to prevent an increase in the foam density by cooling the mixture before the reaction is complete and also to insure against excessive cleanup by the increasing amount of overspray. Wind barriers are recommended to prevent this condition from existing.
- 3.5.4.3 The polyurethane foam shall be applied only by a skilled workman thoroughly trained and familiar with the application of Upjohn Rigid Urethane Foam System 367-2.
- 3.5.4.4 The Upjohn Rigid Urethane Foam System 367-2 shall be applied using a Gusmer Model "C" or Model "D" spray gun and a Gusmer Model "FF" or Model "H" Proportioner Machine equipped with proportioning pumps (#60) for supplying 1-1 ratio which is in this application delivering one part Component "A" (PAPI) to one part Component "B" (Resin) by weight. All of this equipment is manufactured by the Gusmer Corp., Route 18 and Spring Valley Rd., Old Bridge, NJ 08857.
- 3.5.4.5 The most important point in applying this spray foam system is the ratio. If the foam tends to be slightly soft to the feel or lacks proper adhesion, the ratio should be checked at once. Efforts should be made at all times to keep the ratio as near that called out in specification section 3.5.4.4. If it is impossible to get the two components exactly on ratio, the Component "A" (PAPI) should be the component in slight excess. This will guarantee the strongest and most serviceable foam. It will also have the best adhesion. Areas of a sprayed surface that tend to retain a high surface, gloss or remain tacky and uniform as compared to the adjacent area can be suspected of being to high in Component "B" (Resin).



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3.5.4.6 The urethane foam shall be applied to a thickness of 1/2 in. to 3/4 in. attained by spraying two successive overlapping layers. Each pass shall be 4 to 5 ft. wide and shall cover approximately one-half the width of the preceding pass, the rest covering new tank area. The length of each pass should be planned so that when returning to the beginning position to start a new pass, the foam from the preceding pass has completed its rise.

3.5.4.7 Avoid the foam application coming in contact with water. In the event of a possible rain storm, foam spraying must be stopped in sufficient time to permit covering the last pass applied with tarps, Visqueen, etc. If the foam application is to be continued within the same workday, it is recommended that all existing foam area surfaces to receive foam that have been wet from rain or heavy dew be blown off with high pressure air and manually wiped with a dry cloth then rewiped with MEK or methyl alcohol depending on the length of time the foam has had to cure. The methyl alcohol is the least aggressive drying solvent and should be used on any foam that has had only a matter of minutes to a few hours to cure. After longer periods of cure, MEK can be used and any foam dried the following day after application can be confidently swabbed with MEK in preparation for subsequent foaming.

3.5.4.8 In the event that rain falls on the fresh foam unexpectedly, a reaction will occur and small blisters will result. In this case the affected foam area shall be scraped off and treated in preparation for subsequent foaming. To continue application after a rain, the top surface of the foam shall be blown off with high pressure air and dried over an area several feet beyond the area that would ordinarily receive overspray when foaming is continued. This distance could be considerable on a windy day and allowances in judgment should be made for this fact. Remove the high density film surface from the dry foam in the area where a tie-in will be made. In addition, the area shall be feathered to the adjacent tank surface area to be insulated. A light application of 1:3 PAPI-methylene chloride solution shall be dusted over the surface where the high density film has been removed and along the feathered edge. (The PAPI application shall be applied lightly enough and shall dry long enough so that no PAPI is transferred to a cloth when it is lightly rubbed over the repair area.)

3.5.4.9 In the event patching areas in a foamed surface is required, the procedure is very similar to that mentioned in specification section 3.5.4.8. The area involved must be stripped back until all the circumferential area is soundly bonded foam insulation. A power circular wire brush shall be used to remove loosely adhering residues to the tank and to feather the edge over the adjacent good foam bond area for 4 to 6 ins. If the foam is sufficiently cured, then the surrounding area with intact high density skin shall be lightly swabbed with MEK on a rag. (Do not use MEK in a sloppy fashion at any time around foam.) This application will give a slight chemical activation, dry surface moisture and permit a permanent tie-in area for the foam deposited in the patch. As noted in specification section 3.5.4.8 for tying in foam after rain, lightly swab PAPI-methylene chloride mixture on the cleaned patch area and on the feathered edge in the periphery of the patch. Approximately 2

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hours drying time is required in the sun on a hot surface. Foam in the area when all these conditions have been met using circular spray pattern and as little overspray as possible.

3.5.5 Top Coating of Polyurethane Foam

3.5.5.1 The polyurethane foam insulation shall be allowed to cure a minimum of 12 hours, but no longer than 24 hours, unless prevented by adverse weather conditions. The surface of the polyurethane foam insulation shall then be dry and cleaned of all loose material and airborne contaminants with high pressure air.

3.5.5.2 Within the period of time and after cleaning as described in 3.5.5.1 above, spray apply one double pass coat of Alcoa-KK mastic, using airless spray, to a wet film thickness of 3/16 in. minimum and a dry film thickness of 1/8 in. minimum, using not less than 12 gallons per 100 sq. ft. on the top and from 10 to 12 gallons per 100 sq. ft. on the sides.

3.5.5.3 To obtain proper thickness, measured amounts of Alcoa-KK mastic must be applied over measured areas. One method of checking thickness of the Alcoa-KK mastic is to lay a small steel plate on the surface of the foam. Spray over the plate without changing the spraying movement. The thickness of the mastic on the steel plate can be checked by cutting off the point end of a double-headed nail to 3/16 in. beyond the second head and pressing the point into the freshly applied mastic.

3.6 Auxiliary Roof Foam

When polyurethane foam insulation is specified for a steel tank top which is to receive a steel cover over the insulation, the following surface preparation procedures and foam application procedures shall apply.

3.6.1 Surface Preparation Procedures for New Construction

Surface preparation shall consist of the following sequence of operations:

- (1) Oil and grease shall be removed by solvent.
- (2) The entire surface shall be cleaned by thorough "brush-off" sandblasting.
- (3) After brush-off blasting is completed, sand, dust and other loose matter shall be removed from the surface.
- (4) After the tank surface is cleaned as outlined above, immediately apply the PAPI foam insulation to avoid excessive accumulation of airborne contaminants.
- (5) No primer will be required.



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3.6.2 Surface Preparation Procedures for Previously Foam Insulated Surface

The amount of surface preparation required will vary depending on the conditions of the existing insulation and the previously primed steel surface. Surface preparation shall consist of the following sequence of operations:

- (1) The intact, firmly adhered insulation shall remain on the surface. Any intact, firmly adhered foam insulation which is higher than the 3/4 in. normal height of the new foam insulation shall be cut down not to exceed a height of 3/4 in.
- (2) A scraper similar to an ice scraper is recommended for the removal of the loose existing deteriorated insulation and also for the cutting down of existing intact, firmly adhered insulation.
- (3) The edges of the intact, firmly adhered insulation shall be "feathered" (beveled approximately 20 to 30 degrees), to receive the new foam.
- (4) Oil and grease deposits shall be removed by solvent.
- (5) Rust scale, loose paint, dirt and other foreign materials shall be removed by brush-off sandblasting.
- (6) After brush-off blasting is completed, sand, dust and loose matter shall be removed from the surface.
- (7) After the tank surface is cleaned as outlined above, immediately apply the PAPI foam insulation to avoid excessive accumulation of airborne contaminants.
- (8) No primer required.

3.6.3 The 1/8 in. thick steel cover shall be in accordance with Drawing B-107370-PE, revised 2/7/69.

3.6.4 The application of auxiliary roof foam shall be in accordance with the following subsections of Alcoa Engineering Standards 33.7.9 Piping, Vessel and Tank Insulation Materials, and 33.8.9 Piping, Vessel and Tank Insulation Workmanship:

Engineering Standard 33.7.9 - Piping, Vessel and Tank Insulation Materials

Subsection 2.27.2 Foam

Engineering Standard 33.8.9 - Piping, Vessel and Tank Insulation Workmanship

Subsection 3.5.4 Polyurethane Foam Application

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3.7 Precautions

3.7.1 Weatherproof Mastics

The weatherproof mastics such as Seal-Perm, Seal-Kote, and Alcoa-KK are flammable. All necessary safety precautions shall be taken during, and after, application to prevent fire. The tank or vessel area shall be roped off, by this Contractor, and strict control of any welding or burning operations, or other sources of fire, shall be exercised at all times.

3.7.2 Polyurethane Foam

3.7.2.1 The polyurethane components are flammable. All necessary safety precautions shall be taken during, and after, applications to prevent fire. The tank or vessel area shall be roped off, by this Contractor, and strict control of any welding or burning operations, or other sources of fire, shall be exercised at all times.

3.7.2.2 The spraying of urethane foams will release vapors and fine mist particles of the foam mixture, including the di-isocyanate component. Therefore, those who do the spraying or who are in the immediate vicinity observing the spraying operation will require adequate personal protective equipment. The foam manufacturers recommend, and we concur, that this consist of protective clothing, goggles, and as a minimum requirement for respiratory protection, a chemical cartridge respirator suitable for protection against organic vapors. Air supplied hoods are recommended where exposures are heavy or prolonged.

3.7.2.3 It is desirable that protective clothing completely cover all parts of the body. If this is not possible, a protective cream (water soluble type) may be of help. Materials splashed on the skin should be washed off as soon as possible with soap and water.

3.7.2.4 Rubber or plastic gloves must be used by all personnel involved with the handling of the PAPI bond coat solution.

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