

FOSTER



WHEELER

PROCESS PLANTS DIVISION

INSULATION STANDARD FOR

HOT PIPING AND EQUIPMENT

SPEC 3950-80A1

PAGE 3

REVISION 1

DATE February 23, 1965

I. SCOPETHIS STANDARD ALSO APPLIES FOR CONTRACT 15-3930

- A. This standard defines the extent of insulation, and the materials and methods to be used for insulating piping and equipment (including steam traced or jacketed piping and equipment) in hot service.
- B. The materials and methods described herein are suitable for use in outdoor service in normal process plant atmospheres for operating temperatures from 100°F to 1200°F. The project engineer shall specify other materials or methods for applications at higher temperatures or for cases where the atmosphere is corrosive to the materials specified.
- C. Cold service insulation is specified in Specification 3950-80A2.

II. EXTENT OF INSULATION

- A. The engineering flow sheets, line lists, vessel drawings, piping isometric drawings, and equipment insulation summary shall show the extent of insulation, based on the following criteria.
- B. Insulation shall be supplied for:
 - 1. Heat Conservation (HC) when the normal operating temperature exceeds 250°F and loss of heat is not desired;
 - 2. Process Stabilization (PS) when the normal operating temperature is 250°F or lower and loss of heat would adversely affect operation of the unit;
 - 3. Personnel Protection (PP) when the following conditions exist simultaneously:
 - a. The normal operating temperature exceeds 160°F.
 - b. Insulation is not otherwise required for heat conservation or process stabilization.
 - c. The equipment or piping is located within the confines of a space (operating area) bounded by distances of not more than seven (7) feet above or two (2) feet beyond access ways, ladders, and areas at platforms or ground level which may be used during the performance of the routine duties of operating (not maintenance only) personnel.

NOTE: The intent of line lists, flow diagrams, or piping drawings, which specify insulation for personnel protection (PP), is to indicate eligibility for such insulation only. The actual extent of such insulation shall be determined by the Foster Wheeler Project Superintendent using the above conditions as criteria.

- 4. Steam Traced (ST) and/or Steam Jacketed (SJ) piping or equipment, (including tracers where located outside the insulation) or electric heating used to maintain fluidity of process materials.



II. EXTENT OF INSULATION

C. Insulation shall NOT be applied to

1. Pumps, fans, compressors, blowers or other rotating equipment unless otherwise noted.
2. Unless otherwise noted, valves and flanges in piping system; except:
(a) valves and flanges in steam service and (b) valves and flanges in steam-traced and/or steam jacketed service.
3. Vessel manway covers or heat exchanger channel covers.
4. Unless otherwise noted, nozzle neck and flanges of all flanged connections on equipment. (Exception: DC 4101 and DA 4104)
5. Piping and equipment which becomes hot intermittently, such as relief valves; vents, steam-out and snuffing steam systems, flare and blowdown systems and bypasses at control valves or exchangers, except as may be required for personnel protection or to prevent freezing of process fluid.
6. Supports for piping or equipment.
7. Expansion joints, hinge joints, line filter access covers and mixers.
8. Internally insulated equipment.
9. Steam traps.

III. MATERIALSA. Basic Insulation Materials1. Pipe & Equipment - All Sizes

Calcium Silicate (Foster Wheeler Standard for Pipe and Vessel Covering) with asbestos and inorganic binders per ASTM Specification C344 and C345, for operating temperatures from 40°F to 1200°F.

This material shall be furnished in preformed half sections for pipe 24" dia. and smaller and in block form for larger size pipe and equipment. For piping, the insulation material may be furnished with a factory applied aluminum jacket with vapor barrier such as Johns-Manville "Metal-on" or Owens Corning "Kaylo-Clad."

For protection against chloride corrosion of stainless steel vessels in higher temperature service see Painting Specification 3950-83A1.

2. Piping 24" diameter and larger

Fiber glass in preformed half sections.

- a. 7-1/4 lb. density used for services up to 450°F.
- b. 10 lb. density to be used for services from 450°F to 1000°F.

III. MATERIALS (cont'd)

A. Basic Insulation Materials (Cont'd)

2. Piping 24" diameter & Smaller (Cont'd)

Fiber glass shall not be used for services over 1000°F.

Insulation may be furnished with a factory applied aluminum jacket as previously described in Section III-A-1

3. Piping & Equipment Larger than 24" diameter

Felted mineral wool or fiber glass blankets with 1" type 304 or 305 S.S. poultry netting on both sides for use with aluminum jacketing or with S.S. poultry netting on one side and 1/2" x 1-1/4" S.S. metal lathe on the other side for use with mastic weatherproofing.

Fiber glass shall not be used for services over 1000°F.

B. Other Materials

1. Tie Wire and Bands

a) Galvanized, annealed iron wire, #14 or 16 BWG.

b) 1/2" and 3/4" wide x 0.020" thick stainless steel bands and seals.

2. Cement and Mastic

a) Insulating cement - used for insulating pipe fittings and valves smaller than 3" in size and for filling cracks between formed sections or blocks of insulation.

b) Mastic (Breathing and Fire Resistant type) - used for weatherproofing of insulation not protected by aluminum jackets and for weatherproofing of joints in aluminum jacketing.

3. Glass Fabric

Used for reinforcement of mastic weatherproofing.

4. Aluminum Jackets

a) Pipe and Equipment

Alloy 3003, or equal; 0.010" and 0.016" thick; smooth and corrugated (3/4" & 1-1/4"), with factory applied vapor barrier bonded to one side.

III. MATERIALS (cont'd)B. Other Materials (cont'd)3. Glass FabricUse

Reinforcement of weatherproofing mastic on valves and fittings 3" size and larger and on irregular surfaces at equipment. Also with mastic for weatherproofing of heads at vessels, exchangers and cylindrical equipment.

4. Aluminum JacketsUse

a. Alloy 3003, or equal, .016" thick with 3/16" corrugation and with factory-applied moisture barrier bonded to one side.

a. Jacketing for straight pipe, vessels, and equipment. On vertical equipment use 1 1/4" corrugations. (2)

b. Aluminum elbows, alloy 3003 or equal, .020" minimum thickness, with 2" minimum straight section at each end for overlap with adjacent jacketing, and with factory applied moisture barrier bonded to inside surface. Elbows to be made in two halves with overlap at seams.

b. Jacketing for pipe elbows, 10" size and smaller. These jacket elbows may be substituted for mastic, or glass fabric and mastic, weatherproofing when the substitution results in a lower installed cost.

5. Miscellaneous MaterialsUse

a. No. 7 x 3/8" self-tapping aluminum screws, or approved aluminum alloy rivets.

a. Securing seams and joints of aluminum jacketing. Exploding rivets may be used as an alternate. (2)

b. Steel Angle Rings and 1/2" size square nuts.

b. Insulation supports for sides and bottom head of vertical vessels, furnished by vessel fabricator in accordance with Foster Wheeler Engineering Standards.

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V. APPLICATIONA. General

1. Care shall be taken to insure that all working parts of valves, turbines, or other mechanical equipment are protected when insulation is applied. Until all insulation materials, such as cement or mastic have been removed from parts such as valve stems or governor linkages, the performance of insulation work shall be considered incomplete.
2. Small turbines or other equipment having short radius curved surfaces may be insulated with insulating cement as for small fittings and valves.
3. For large irregular surfaces such as large turbine casings, block or blanket insulation material may be used as for heads of vessels. However, it is important that the materials used, methods of attachment, and extent of coverage have no effect upon the performance of equipment or the manufacturer's guarantee. For this reason it is preferred that insulation for large mechanical equipment be furnished complete with weather-proofing by the equipment vendor except when it is uneconomical or impractical.
4. All projections and attachments to insulated pipe, vessels and other equipment such as pipe nozzles or branches, shall be insulated at least six inches beyond the pipe or equipment insulation surfaces, unless this requirement is exempt under Paragraph II, c. of this standard or is superseded by specific job requirements.
5. At operating temperatures above 600°F differential expansion becomes a significant factor. To prevent opening of the joints and excessive heat loss two layer staggered joint construction shall be used.
6. Insulation shall be beveled and weatherproofed at all terminal points where it is required to remove bolts, studs, nuts, etc.
7. For straight run portions of pipe and equipment, methods of application of insulation and weatherproofing shall be as listed on Table "B" and as described in Sections V-B&C. The complete description of the materials specified in Table B shall be as indicated in Section III of the specification.

IV. INSULATION THICKNESS (cont'd)

B. Column "HC-1" (FW Standard) (cont'd)

Insulation Material: Calcium Silicate

Column "HC-2"

Purpose: Heat Conservation.

Cost of Heat: 50¢ per million BTU.

Other Conditions: Same as for Column "HC-1"

Column "HC-3"

Purpose: Heat Conservation

Cost of Heat: 75¢ per million BTU

Other Conditions: Same as for Column "HC-1"

C. Factors Governing Thickness

1. Columns "HC-1", "HC-2", and "HC-3" give the maximum operating temperatures which result in the most economical insulation thickness for the conditions.
2. Table "A" may be used for all insulation materials allowed by this standard. It is based on thermal conductivity values of 0.5, 0.6, and 0.7 at 400°F, 600°F and 800°F respectively. When the conductivity varies considerably adjustment of the required insulation thickness may be necessary.
3. Standard thicknesses and temperature limits for insulation are based on the ambient conditions of still air at 70°F. Adjustments to allow for wind velocity or surrounding air at any other temperature shall not be made except to satisfy process conditions.
4. Table "A" shows temperature limits which have been calculated for the lowest total of the annual cost of heat loss and material amortization. The calculations are further based on a surface emissivity factor equal to 0.9. This factor is suitable for most dull finish surfaces such as mastic or dark paint. For aluminum jacketing the emissivity factor is expected to be about 0.2 having the effect of slightly improving the operating temperature limit for the most economical thickness and raising the insulation surface temperature.

2) D. Insulation for Steam-Traced Equipment

The thickness of insulation for steam-traced equipment shall be dictated by the operating temperature of the traced equipment or the tracer-whichever is higher.

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V. APPLICATION (Cont'd)B. Piping, Vessels & Cylindrical Equipment, 24" O.D. and SmallerInsulation

1. It shall be the insulation contractor's responsibility to insure that the outside surface of all piping is to be dry and reasonably clean prior to the application of the insulation.
2. Apply half-sections of insulation material, starting, where possible, with a full length piece (usually 3 feet) and a half length piece so as to stagger the circumferential joints.
3. Secure the sections or segments of insulation to the pipe with loops of tie wire. Center to center spacing of the loops shall not exceed nine inches. The ends of the loops are to be twisted together, then imbedded into the surface of the insulation.
4. Butt the adjoining sections of insulation material firmly together and fill any cracks or voids with insulating cement.
5. When preformed sections are available for pipe elbows, these should be used and applied with tie wire as for pipe insulation.
6. Fittings and valves, smaller than 3" size, may be insulated by applying insulating cement in layers to the total thickness of the adjacent pipe insulation. The thickness of the individual layers and time allowed for drying shall be in accordance with the manufacturer's recommendations.
7. Insulation for weld tees or welded branch connections shall be field fabricated from preformed pipe insulation, mitered at the tee joints, and secured in place with tie wire as for pipe insulation.
8. Flanges, valves (where required) and fittings 3" size and larger shall be covered with field fabricated sections of pipe insulation or block of the same material and thickness. The blocks and segments of insulation are to be securely wired on the outside to hold the insulation against the metal surfaces. All voids and cracks shall then be filled with insulating cement leaving a smooth outside surface.

V. APPLICATION (Cont'd)B. Piping (24" O.D. and Smaller) (Cont'd)Weatherproofing1. Valves and Fittings

- a. Apply two (2) coats, each $1/8$ " minimum thickness (when dry) of mastic, to cover insulation on all valves and fittings smaller than 3" nominal size. Extend the mastic coats beyond the valve or fitting onto adjacent pipe covering so that aluminum jacketing, when installed, will overlap the mastic at least 3".
- b. For valves and fittings, 3" size and larger, apply a smooth layer of glass fabric when the first coat of mastic is still wet. Finish with a second coat of mastic as for smaller valves and fittings.

2. Straight Pipe

- a. Straight pipe shall have aluminum jacketing wrapped around with 2" minimum overlap on longitudinal seams.
- b. A 2" minimum overlap shall also be used on circumferential seams.
- c. All horizontal seams shall be installed with upper section overlapping the lower one to shed water.
- d. Vertical seams or circumferential seams on horizontal pipe shall be waterproof, or alternately shall be coated with mastic before assembly.
- e. Jacketing shall be held in place with metal bands and seals on 12" minimum centers, with a minimum of one band at each circumferential joint.
- f. Joints at pipe tees and branches should be fitted with aluminum flashing.
- g. Where a fitting at the top of a vertical line is weatherproofed with mastic, the mastic shall overlap the aluminum jacket by two (2) inches. Use masking tape to effect an even termination of the mastic.

V. APPLICATION (Cont'd)C. Vessels and Pipe Larger than 24" O.D. & Irregular SurfacesInsulation

1. For vessel heads and cylindrical sections of equipment larger than 24" O.D., curved blocks of calcium silicate shall be used as described below. Blanket insulation shall be used where pre-formed insulation is not available.
 - a. To secure block insulation to the heads of vertical vessels, attach tie wire on 12" minimum spacing to the insulation ring angle which is welded at the tangent line by the vessel fabricator. The other end of each tie wire may then be attached to loose ring made of 1/4" steel rod which is centered at the vessel head to hold the insulation block. The blocks are to be cut to fit firmly together and the wires tightened to hold the insulation material against the surface of the vessel.
 - b. For horizontal vessels without an attached ring angle at the tangent line, a ring angle may be tack welded near the vessel tangent line, or preferably use two loops of 3/8" diameter or larger steel wire rope around the vessel near each tangent, drawn tight, and then securely clamped. Before tightening, radial bands or tie wires on 12" centers shall be slipped under the 3/8" diameter ropes. They shall be looped over the inner ropes and under the outer rope. The free end of the radial bands shall be tied to a loose centering ring and drawn up tight once the insulation is in place.
 - c. For the bottom head under skirts of vertical vessels, the tie wire for supporting insulation block may be looped through nuts welded to the surface of the head by the vessel fabricator.
 - d. For cylindrical equipment sections the insulation blocks shall be held against the metal surface with 1/2" wide stainless steel bands (or 3/4" wide bands if the diameter is greater than 60") spaced on 9" centers. The blocks are to be firmly butted together. Vertical joints between blocks on vertical vessels and circumferential joints on horizontal vessels shall be staggered. Use the floating ring and radial pattern of tie wire as described in V c. 2. a.
 - e. The use of a fibrous adhesive equal to Eagle-Pitcher "Insula-Stic" is approved for temporary securing of block insulation until permanent attachments are in place. On vessel heads and irregular surfaces where an adhesive cannot be used, the blocks shall be held in place by impaling over #8 gauge welds and securing with speed clips.
 - f. Fill all voids and cracks with insulating cement.

V. APPLICATION (Cont'd)

C. Vessels (24" O.D. and Irregular) (Cont'd)

Insulation (Cont'd)

2. For blanket insulation the method of application shall be as follows:

- a. Number 12 gauge, or larger, weld pins shall be attached to the wall of steel equipment by means of a welding gun.
- b. Pins are normally spaced on 12" x 16" centers to suit a standard blanket width and length.
- c. Blankets are then impaled over the pins, pressed firmly against the metal surfaces, and the speed clips attached.
- d. Blanket edges shall be butted firmly together, then laced with tie wire at 6" intervals.
- e. Loose mineral wool shall be packed into all void spaces where the blanket has been cut to fit around equipment projections such as pipe nozzles.

Weatherproofing

1. Irregular Surfaces and Vessel Heads

- a. For the upper surfaces of small irregular equipment such as small turbines, mastic weatherproofing reinforced with glass fabric shall be used. One coat of mastic shall be applied. The glass fabric shall be embedded in this coat and covered with a second coat of mastic to give a final total thickness of $1/4$ " when dry.
- b. For heads of horizontal vessels, the bottom heads of vertical vessels when not protected by a skirt, and irregular bottom or vertical surfaces, poultry netting or wire lath shall be laced and fastened to the insulation support angles and wires. This netting or lath material shall provide support for a succeeding $1/4$ " minimum thick coat of insulating cement and two (2) $1/8$ " coats of mastic. Bottom heads of vertical vessels protected by a skirt do not require weatherproofing.
- c. For blanket insulation the stainless steel poultry netting or metal lath is an integral part of the blanket. Apply a $1/4$ " minimum thick coat of insulating cement and two (2) $1/8$ " thick coats of mastic.
- d. Smooth jacketing shall be used for weatherproofing the top heads of vertical vessels. The jacketing shall be applied directly over the block or block insulation.



V. APPLICATION (Cont'd)

C. Vessels (24" O.D. & Irregular) (Cont'd)

Weatherproofing (Cont'd)

2. Cylindrical Surfaces

- a. On vertical vessels the lower course of aluminum jacketing may be supported from the ring angle on the vessel, using stainless steel angle clips or rings designed to support the weight of the aluminum sheets.
- b. Aluminum shall not contact the steel surfaces of the vessel.
- c. Longitudinal seams should overlap as noted in Table "B".
- d. The aluminum sheets shall be held against the insulation by means of stainless steel bands drawn tight enough to prevent sagging but allowing for expansion of the vessel when heated to operating temperatures. A spacing as close as possible to 18" is required with a minimum of one band at each circumferential joint, plus one in the middle of each course.
- e. Succeeding courses of aluminum jacketing on vertical surfaces larger than 60" diameter shall be supported with suitable "Z" clips.
- f. Circumferential joints should overlap as noted in Table "B".
- g. All horizontal seams shall have the upper course overlapping the lower one to shed rain water.
- h. All longitudinal seams shall be joined together by means of sheet metal screws on 6" minimum centers.
- j. Mastic weatherproofing on horizontal vessel heads shall overlap the aluminum jacketing at least 6". Ring angle on vertical vessels precludes this construction.
- k. All equipment projections, such as pipe nozzles, shall have the jacketing sealed using aluminum flashing cut to fit the projection and extending under the jacket at least 3". The seal between flashing and jacket shall be made tight using sheet metal screws and mastic.

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VI. APPROVED MATERIALS AND MANUFACTURERS

<u>DESCRIPTION</u>	<u>TRADE NAME</u>	<u>MANUFACTURER</u>
1. Calcium Silicate Pipe Covering or Block	Calcium Silicate	Philip Carey Co. (Mfg'd. by Keasbey & Mattison Co.)
	Kaylo	Owens-Corning Fiberglass Corporation
	Thermobestos	Johns-Manville
2. Fiberglass 7½ lb. Density; 10 lb. Density	Fiberglas	Owens-Corning Fiberglass Corporation
3. Blanket Insulation	<u>TYPES</u>	
	With Poultry Mesh, Both Faces	With Metal Lath One Face & Poultry Mesh on Other
a. Mineral Wool Blanket	200 200 102	201 201-A 112
		Philip Carey Co. Eagle Pitcher Co. Johns-Manville
b. Fiberglass Blanket	*HH	*HL
		Owens-Corning Fiberglass Corp.

- * (Fiberglass material has 1,000° F. temperature limit.)
 ** 7½ lb. density fiberglass has a temperature limitation of 450° F.
 10 lb. density fiberglass has a temperature limitation of 1,000° F.

<u>TRADE NAME</u>	
No. 450	Johns-Manville
4. Insulating Cement	
5. Mastic	Vi-Ac(Vinyl-Acrylic)
	Insul-Cooustic
	Sealfas Mastic
	31-49
	(Aluminum Grey)
	Benjamin Foster Co.

Note: Sealfas Mastic also available in a variety of colors, consult
for Benjamin Foster Company Code Number.

6. Glass Fabric	Heat-A-Fab	Benjamin Foster Co.
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V. APPLICATION (contd)

C. Vessels and Pipe Larger than 24" O.D. & Irregular Surfaces (contd)

Weatherproofing (contd)

6. Cylindrical Surfaces (Over 30" O.D.)

- a. On vertical vessels the lower course of aluminum jacketing may be supported from the ring angle on the vessel, using stainless steel angle clips or rings designed to support the weight of the aluminum sheets.
- b. Aluminum shall not contact the steel surfaces of the vessel.
- c. Longitudinal seams should overlap at least 2".
- d. The aluminum sheets shall be held against the insulation by means of stainless steel bands drawn tight enough to prevent sagging but allowing for expansion of the vessel when heated to operating temperatures. A minimum of one band at each circumferential joint, plus one in the middle of each course is required.
- e. Succeeding courses of aluminum jacketing on vertical surfaces shall be supported with suitable "Z" clips.
- f. Circumferential joints should overlap at least 4" on vertical vessels and at least 3" on horizontal vessels.
- g. All horizontal seams shall have the upper course overlapping the lower one to shed rain water.
- h. All longitudinal seams shall be joined together by means of sheet metal screws on 6" minimum centers.
- j. Mastic weatherproofing on horizontal vessel heads shall overlap the aluminum jacketing at least 6". Ring angle on vertical vessels precludes this construction.
- k. All equipment projections, such as pipe nozzles, shall have the jacketing sealed using aluminum flashing cut to fit the projection and extending under the jacket at least 3". The seal between flashing and jacket shall be made tight using sheet metal screws and mastic.