

VI. ENGINEERING AND INSPECTION

A. GENERAL

Engineering and inspection requirements for the work covered by these Specifications shall be as specified in the SWO's, applicable Alcoa Engineering Standard and/or as supplemented below.

The Owner will maintain continuous inspection of each phase of the installation throughout the course of the work. If at any time, discrepancies from these Specifications or drawings are discovered, all necessary corrective work shall be performed immediately by this Contractor and at no additional cost to the Owner. This Contractor shall at all times facilitate this inspection by the Owner's Engineer.

VII. GENERAL MATERIAL SPECIFICATIONS

A. GENERAL

All materials for the work covered by these Specifications shall be as specified in the SWO's, applicable Alcoa Engineering Standards, noted on the drawings and/or supplemented below.

B. OWNER-FURNISHED MATERIAL

The Owner will furnish materials for work covered by these Specifications as specified on each SWO.

C. CONTRACTOR-FURNISHED MATERIAL

This Contractor shall furnish all materials as specified in each SWO required to complete the work covered by these Specifications.



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ALUMINUM COMPANY OF AMERICA CONSTRUCTION DEPARTMENT

STANDARD SPECIFICATION FOR PIPING, VESSEL AND TANK INSULATION MATERIALS

1. GENERAL

- 1.1 This is a Standard Specification for piping, vessel and tank insulation materials, except for spray-on polyurethane foam insulation materials. It includes material specifications and testing responsibilities. See Engineering Standard 33.8.9 for engineering, inspection and workmanship requirements. See 33.7.38 and 33.8.38 for spray-on polyurethane foam insulation materials and workmanship specifications.
- 1.2 The following referenced standards of the issue in effect on date of invitation for bids or request for proposal form a part of this specification to the extent specified herein: ASTM A36, C533, C547, C610 and C612 available from American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19103; ANSI Standard B18.2.2 available from American National Standards Institute, 1430 Broadway, New York, NY 10018.
- 1.3 The operating temperatures of pipe lines, vessels and tanks will be specified in the Scope of Work along with the type, thickness and number of layers of insulation required and the type of jacketing to be used.
- 1.4 The materials and products specified herein shall be the basis of the bid and they shall be furnished under the contract, unless otherwise approved in writing by the Pittsburgh Construction Department. Where two or more products are named for the same application, the Contractor must name his choice in his proposal. Should the Contractor wish to use products other than those specified, the proposed substitution shall be submitted in writing with this Contractor's proposal, listing the trade name and manufacturer and the price difference (if none, so state) which shall be made in the bid price if the substitution is approved. For substitute insulation, the Contractor shall also state the thickness that is recommended by the manufacturer for the specified temperature and shall furnish reliable and sufficient data showing that the thermal efficiency of the proposed insulation is equivalent to the insulation specified. Similar information shall be provided for other proposed substitutions.

2. PIPE INSULATION MATERIALS

2.1 Molded Glass Fiber Pipe Insulation

- 2.1.1 The molded glass fiber pipe insulation for temperatures up to 450F shall be heavy density sectional pipe insulation conforming to ASTM Specification C547-74, or latest revision and having a nominal density of at least 5 pounds per cubic foot to better withstand mechanical damage such as "No-Wrap" as manufactured by Owens-Corning Fiberglas Corp., Fiberglas Tower, Toledo, OH 43643 or approved equal.

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- 2.1.2 Fiber glass pipe insulation with factory-applied vinyl jacket for use on hot (450F) or cold lines not subject to severe exposures or physical damage and in enclosed buildings shall be "Fiberglas 25 ASJ/SSL" consisting of heavy density sectional pipe insulation conforming to ASTM Specification C547-74, or latest revision, with a factory-applied, laminated jacket of vinyl and aluminum foil vapor barrier as manufactured by Owens-Corning Fiberglas Corp., or approved equal.

NOTE: "Fiberglas 25 ASJ/SSL" is suitable for insulating cold water lines, chilled lines and for anti-condensation insulation on downspout piping. On small jobs, No-Drip Coating (black) or No-Drip Tape (white) as manufactured by J. W. Mortell Co., 950 Hobbie Street, Kankakee, IL 60901, may be used to prevent condensation and dripping from cold lines. The No-Drip products shall be used in strict accordance with the manufacturers instructions.

- 2.1.3 Fiber glass pipe insulation with factory-applied aluminum jacket for interior or exterior pipe lines operating at temperatures up to 450F shall be "Metal-Lok" as manufactured by Johns-Manville, Ken-Caryl Ranch, Denver, CO 80217. The aluminum jacket shall be .016 in. thick, smooth finish and shall have a built-in moisture barrier. Butt joints shall be sealed with regular J-M snap-straps fastened with conventional aluminum straps and seals as recommended by Johns-Manville.

2.2 Molded Calcium Silicate Pipe Insulation

- 2.2.1 Molded calcium silicate pipe insulation, shall be a rigid hydrous calcium silicate, reinforced with asbestos or mineral wool fibers suitable for temperatures up to 1200 F, having a minimum density of 11 pounds per cu. ft. and conforming to ASTM Specification C533-72, or latest revision.
- 2.2.2 For overseas shipments, the calcium silicate insulation shall be crated because of excessive breakage when shipped in paper cartons.
- 2.2.3 Asbestos-free calcium silicate is available as follows: J-M Thermo-12 Pipe and Block Insulation, manufactured by Johns-Manville; Kaylo 10 Asbestos-Free Pipe and Block Insulation, manufactured by Owens-Corning Fiberglas Corp.; Pabco Super Caltemp, Pipe and Block Insulation, manufactured by Pabco, Industrial Products Division, Fiberboard Corp., 1710 59th Street, Emeryville, CA 94608.
- 2.2.4 Calcium silicate pipe insulation with factory-applied aluminum jacket for interior or exterior use shall be either "Metal-On" manufactured by Johns-Manville or "Alumi-Shield" manufactured by Pabco, each consisting of hydrous calcium silicate insulation with factory-applied .016 in. thick smooth aluminum jacket with a build-in moisture barrier and suitable for temperatures up to 1200F. Butt joints on "Metal-On" shall be sealed with special J-M one-piece snap straps having factory-applied sealing compound and available for "Metal-On" sizes up to 12 3/4" O.D. Butt joints on larger sizes of "Metal-On" shall be sealed with regular J-M snap straps. Butt joints on "Alumi-Shield" shall be sealed with Pabco sealer bands. Both the regular J-M snap straps and the Pabco sealer bands have a factory-applied sealing compound and shall be fastened with conventional stainless steel straps and seals as recommended by the insulation manufacturer.



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2.3 Expanded Perlite Pipe Insulation

Expanded perlite pipe insulation shall be asbestos free, suitable for up to 1500F, with minimum density 11 pounds per cu. ft. and conforming to ASTM Specification C610, latest revision, such as "Celotemp 1500" as manufactured by Celotex Corp., 1500 Dale Mabry, Tampa, FL 33622, or approved equal.

2.4 Valve and Fitting Insulation

- 2.4.1 Valve and fitting insulation shall be field fabricated with carefully mitered segments of the pipe insulation securely wired in place and with the joints pointed with insulating cement and the insulation finished with a minimum 1/8 in. coat of insulating-finishing cement.
- 2.4.2 Pre-formed fiber glass insulating elbows, "Insul-Sure", which are manufactured for pipe sizes up to 12 in. diameter by Insul-Coustic Division of Birma Products Corp., Jernee Mill Road, Sayreville, NJ 08872, may be used with fiber glass pipe insulation in lieu of field fabrication of the valve and fitting insulation, at the Contractor's option. Pre-molded PVC fitting covers with fiber glass insulation inserts as manufactured by Zeston Inc., may also be used. See Section 2.13 below.
- 2.4.3 Pre-formed calcium silicate insulation elbows marketed by the manufacturer of the calcium silicate pipe insulation being used, are acceptable in lieu of field fabrication, at the Contractor's option.
- 2.4.4 Pre-formed perlite insulation elbows manufactured by Celotex Corp., or approved equal, may be used with expanded perlite pipe insulation at the Contractor's option.
- 2.4.5 Calcium silicate pipe insulation with factory-applied aluminum jacket for pipe fittings may be either factory mitered or field mitered and used with miter seal bands furnished by the manufacturer.

2.5 Glass Fiber Blanket Insulation

The glass fiber blanket insulation for flexible steam lines or steam hose shall be Thermal Insulating Wool (TIW) Type I, 1 in. thick, suitable for temperatures up to 1000F, as manufactured by Owens-Corning Fiberglas Corp. and finished with Polyken plastic tape No. 900. (See Section 2.9 below)

2.6 Aluminum Jacketing And Accessories For Piping Insulation

2.6.1 Interior Only

- 2.6.1.1 Field fabricated, field-applied aluminum roll type jacketing for interior use only shall be .016 in. thick, in either plain or embossed finish as specified in the Scope of Work and with a factory-attached moisture barrier. Alcor-Jac with combination 1 mil polyethylene and 40 pound virgin kraft paper moisture barrier manufactured by Insul-Coustic and Childers' Aluminum Jacketing with Polycraft heat-laminated moisture barrier manufactured by Childers Products Co., Cleveland, OH 44122, meet this specification.

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NOTE: If specified in the Scope of Work, aluminum .006 in. thick instead of .016 in. thick may be used indoors on piping in areas where there is no possibility of mechanical damage.

- 2.6.1.2 Pre-fabricated, field applied aluminum jacketing for interior use only shall be "Strap-On" manufactured by Childers Co., .016 in. thick with factory applied Polykraft moisture barrier. Finish shall be either plain or embossed as specified in the Scope of Work. The "Strap-On" shall be installed with 2 in. circumferential laps and fastened with conventional stainless steel straps and seals.

2.6.2 Interior or Exterior

- 2.6.2.1 Field fabricated, field applied aluminum roll type jacketing shall be circumferentially corrugated "Corrolon" as manufactured by Childers Co., .016 in. thick with factory applied Polykraft moisture barrier. Finish shall be either plain or embossed as specified in the Scope of Work.
- 2.6.2.2 Pre-fabricated, field-applied aluminum jacketing for interior or exterior use shall be "Lock-On" manufactured by Childers, or "Metal-Clad" manufactured by Insul-Cooustic, each having a built-in, factory-attached moisture barrier. Aluminum shall be .016 in. thick in either plain or embossed finish as specified in the Scope of Work. "Metal-Clad" and "Lock-On" butt joints shall be sealed as recommended by the manufacturer using the special sealer bands which have a factory-applied sealing compound and are fastened with conventional stainless steel straps and seals.
- NOTE: "Corrolon" as specified in 2.6.2.1 above is also available as a pre-fabricated, field-applied jacketing.
- 2.6.2.3 Insulation with factory applied aluminum jacketing as specified in sections 2.1.3 and 2.2.4 above is also acceptable for interior or exterior use as applicable.
- 2.6.2.4 Aluminum jacketing for piping elbows shall be Childers Aluminum Ell-Jacs with a minimum thickness of .016 in. and with factory-applied epoxy moisture barrier.

2.7 Asphalt Coated Weatherproof Jacket

Asphalt coated weatherproof jacket shall be "Double-Coated Flextone" or "Glas-Kap" manufactured by Johns-Manville or "Fiberglas Perma-Kap" manufactured by Owens-Corning. The "Double-Coated Flextone" is a 50 pound asphalt-saturated and coated asbestos felt. "Glas-Kap" and "Fiberglas Perma-Kap" consists of a fiber glass mat saturated and coated with asphalt, into which is embedded mineral granules.

2.8 Stainless Steel Jacketing

In areas where the asphalt felt weatherproof jacket has not been satisfactory due to excessive caustic spillage or physical damage, use smooth stainless steel jacketing, 300 series alloy, 0.010 in. thick, such as Insul-Cooustic's I-C stainless or Childers T-304 with factory-applied moisture barrier. Stainless steel sheet, 300 series alloy, annealed, 0.015 thick, available from steel warehouses, may also be used.



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2.9 Plastic Tape Jacketing

Plastic tape jacketing shall be Polyken No. 900 Gray Protective Tape Coating, 2 in. wide, 12 mils thick, manufactured by Polyken Div., of the Kendall Co., 20 Walnut Street, Wellesley Hills, MA 02181.

2.10 Rubber Type Jacketing

Rubber type jacketing over pipe insulation shall be a combination of 10 mil thick Hypalon with flexible glass cloth backing such as Glas-Mesh 305H manufactured by the Glas-Mesh Co., P.O. Box 42, Westtown, PA 19395. Adhesive shall be as recommended by the jacketing manufacturer.

2.11 Reinforced Mastic Weatherproofing For Insulated Valves And Fittings For Which Aluminum Jacketing Is Not Specified - Outdoor Lines.

Weatherproofing mastic coating for valves and fittings on hot or cold outdoor lines where aluminum jacketing is not specified shall be Johns-Manville's J-M Insulkote vapor barrier coating type SG. The thickness of the coating shall be between 1/8 in. and 3/16 in. dry film thickness or between 3/16 in. and 1/4 in. wet film thickness.

The glass cloth reinforcing used with the weatherproofing mastic shall be 10 x 10 weave (10 x 10 threads per inch) woven glass cloth, with asphalt binder, Type 227 manufactured by Perma Glas-Mesh Corp., P.O. Box 39, Dover, OH 44622 or Micro Mesh 101A manufactured by Mineral Fiber Manufacturing Corp.

2.12 Reinforced Mastic Finishing For Insulated Valves And Fittings For Which Aluminum Jacketing Is Not Specified - Indoor Lines.

- 2.12.1 Hot Lines. Mastic for use on valves, fittings, etc. on hot lines indoors (in enclosed buildings) such as in powerhouses, fabricating buildings or other areas specified in the Scope of Work shall be Childers Products Co.'s special self-extinguishing type of Vi-Cryl-F mastic, metallic grey, either trowel or spray/brush grade, used with Childers' "Chilglas No. 10", open weave glass cloth membrane. Note that the regular "fire resistive" Vi-Cryl is not acceptable. The owner's Engineer will verify the self-extinguishing quality of a sample of dry Vi-Cryl-F mastic.

Also acceptable as reinforced mastic finishing for hot valves and fittings indoors is "Sealfas 30-36" used with 20 x 20 glass cloth or "Monolar 60-36" used with "Masta-Fab" membrane and "Lagfas 81-42W" primer, all manufactured by Foster Products Division, H. B. Fuller Co., 5220 Main St., N.E., Minneapolis, MN 55421.

- 2.12.2 Cold Lines. Mastic and glass cloth reinforcing for valves, fittings, etc. on cold indoor lines shall be "Vi-Cryl-F" as specified in 2.12.1 above, however, after the Vi-Cryl-F has dried completely, a coat of Childers' metallic grey color, Chil-Perm CP-32, nonflammable, fire resistive vapor barrier coating shall be applied to the entire surface at a rate of 50 sq. ft. per gallon.

Also acceptable as reinforced mastic finishing for cold valves and fittings indoors is "Monolar 60-36" used with "Masta-Fab" membrane and "Lagfas 81-42W" primer or "Tite-Fit 30-35" used with "Masta-Fab", all manufactured by Foster Products Division.

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2.13 PVC Fitting Covers

Pre-molded PVC fitting covers with fiber glass insulation inserts as manufactured by Zeston Inc., P.O. Box 46, Fords, NJ 08863 may be used as an alternate to reinforced mastic weatherproofing on hot (up to 450F) or cold lines, indoors or out where fiber glass insulation is specified for the piping. The covers shall be installed in strict accordance with the manufacturer's recommendations and with Section 3.8 of Engineering Standard 33.8.9, dated 1977 March.

2.14 Saddles

Where the pipe is supported on the insulation, as at rollers or at angles or beam brackets such points of support shall be provided with support segments and steel saddles, Insul-Shield Model 704 as manufactured by Insul-Coustic.

2.15 Stainless Steel Wire

Stainless Steel wire shall be Type 304 alloy stainless, insulation wire, soft, annealed. For fastening insulation to piping up to 4 in. in diameter, 18 U.S. Standard gage (.0475 in. diameter) shall be used. For fastening insulation to piping 6 in. in diameter and larger and for fastening asphalt coated weather-proof jacketing, 16 U.S. Standard gage (.0625 in. diameter) shall be used.

2.16 Aluminum Straps

Aluminum straps for fastening aluminum roll type jacketing shall be of alloy T3003-H14, 3/8 in. wide by .020 thick and used with wing-type seals of alloy T5005, .032 in. thick all as manufactured by Childers Co., or approved equal.

2.17 Stainless Steel Straps

Stainless steel straps for fastening prefabricated aluminum jacketing and stainless steel jacketing and when specified for fastening factory-applied jacketing systems, shall be of Type 304 alloy stainless, annealed, 1/2 in. wide by .015 in. thick and used with 300 series stainless, wing-type seals all as manufactured by A. J. Gerrard Co., 400 E. Touhy Ave., Des Plaines, IL 60018, or approved equal.

2.18 Polypropylene Straps

Polypropylene straps when specified for fastening insulation jacketing in extremely corrosive atmospheres, shall be 1/2 in. wide by .020 in. thick minimum tensile strength 600 pounds and used with Monel, wing-type seals, all as manufactured by A. J. Gerrard Co., or approved equal.

TANK AND VESSEL INSULATION

3.1 General

3.1.1 Refer to Section 1 above for general items.

3.1.2 The tops of tanks and vessels are defined as any flat, sloping or curved surface on which personnel could walk stand or climb.

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3.2 Glass Fiber Rigid Board Insulation

- 3.2.1 Glass fiber insulation may be used on the vertical sides and bottoms of vertical tanks and vessels; also on the ends of horizontal tanks and vessels. It shall not be used on the tops of vertical tanks or vessels, nor on the straight shells of horizontal tanks.
- 3.2.2 Glass fiber insulation shall be either Owens-Corning Fiberglas Industrial Insulation Type 703 (3 pounds per cu. ft. density) or Type 705 (6 pounds per cu. ft. density) as specified in the Scope of Work. Insulation shall be unfaced, suitable for temperatures up to 450F and shall conform to ASTM C612-70 or latest revision.

3.3 Calcium Silicate Block Insulation

- 3.3.1 The calcium silicate block insulation shall be rigid hydrous calcium silicate heat insulation, cut to lagging sizes, flat or curved as required, suitable for temperatures up to 1200F, conforming to ASTM Specification C533-72, or latest revision. The density of the block insulation shall be a minimum of 11 pounds per cu. ft.
- 3.3.2 Asbestos-free calcium silicate pipe and block insulation is available as listed in Section 2.2.3 above.

3.4 Expanded Perlite Block Insulation

Expanded perlite block insulation shall be suitable for temperatures up to 1500F, with minimum density at 11 pounds per cu. ft. and conforming to ASTM Specification C610, latest revision, such as "Celotemp 1500" as manufactured by the Celotex Corp.

3.5 Glass Fiber Blanket Insulation

Where specified for the vertical sides and bottoms only of indoor tanks and vessels or of outdoor tanks and vessels which will be jacketed with aluminum or stainless steel-jacketing and which have surface irregularities or projections, and surface temperatures up to 1000F, glass fiber blanket insulation may be Thermal Insulating Wool (TIW) Type II, 1 in. thick, as manufactured by Owens-Corning Fiberglas Corp.

3.6 High-Temperature Insulation Board

High-temperature insulation board shall be a homogeneous sheet material made of asbestos fiber with an inorganic binder, suitable for temperatures up to 1000F, such as J-M Marinite-36 (density 36 pounds per cu. ft.), manufactured by Johns-Manville. An asbestos-free board which may be substituted for the Marinite is Kaowool M Board, (density 12 to 16 pounds per cu. ft.) manufactured by The Babcock & Wilcox Co., Refractories Division, Savannah Road, P. O. Box 923, Augusta, GA.

3.7 Aluminum Jacketing And Accessories For Tanks And Vessels

- 3.7.1 The aluminum jacketing for tanks and vessels shall be deep corrugated, .024 in. thick, with factory-attached moisture barrier and 1 1/4 in. pitch corrugations. Insul-Coustic Alcor-Jac with combination 1 mil polyethylene and 40 pound virgin kraft paper moisture barrier, and Childers Products Co., aluminum jacketing with Polycraft moisture barrier, meet this specification.

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3.7.2 The stainless steel straps and seals for fastening aluminum jacketing for tanks and vessels shall be 311-SS, 3/4 in. wide by .020 in. thick, straps and 204-SS seals as manufactured by A. J. Gerrard & Co.

3.7.3 The laps in aluminum jacketing on tanks and vessels and aluminum elbows sections shall be fastened with aluminum sheet metal screws, Alcoa alloy 2024-T4, Type A, slotted head, bright finish No. 7, 5/8 in. long, or aluminum pop rivets, 1/8 in. diameter, natural finish, such as the AD-42-ABS manufactured by USM Corp., Pop-Rivet Div., 510 River Road, Shelton, CN 06484.

3.8 Reinforced Mastic Weatherproofing For Insulated Tanks And Vessels For Which Aluminum Jacketing Is Not Specified.

3.8.1 Hot Tanks. The "breathing" type of mastic for weatherproofing insulation at temperatures above ambient shall be "Nokorode Seal Perm," spray grade only, manufactured by Lion Oil Co. The applied thickness of the mastic shall be between 3/16 in. and 1/4 in. wet film thickness or between 1/8 in. and 3/16 in. dry film thickness.

NOTE: Any mastic containing clay, bentonite or diatomaceous earth must not be used around caustic exposures; further, the use of mastic emulsions is prohibited.

3.8.2 Cold Tanks. The "non-breathing" type vapor and weather-barrier mastic over insulation, for cold vessels (vessels whose contents are below ambient), shall be "Nokorode Seal Kote", spray grade only, manufactured by Lion Oil Co. The applied thickness of the mastic shall be between 3/16 in. and 1/4 in. wet film thickness or 1/8 in. and 3/16 in. dry film thickness.

3.9 Wire Reinforcing Mesh

Wire reinforcing mesh shall be Monel or a Type 300 Series stainless steel poultry netting, .028 in. wire diameter by 3/4 in. (preferred), or 1 in. maximum, hexagonal mesh. This wire reinforcing mesh is available from Newark Wire Cloth Co., 351 Verona Ave., NJ 07104; Edward J. Darby & Son Inc., 1517 Germantown Ave., Philadelphia, PA 19122; Estey Wire Works Co., 134 W. Central Blvd., Palisades Park, NJ 07650; J. M. Tull Metals, P.O. Box 767, Kenner, LA 70062.

3.10 Stainless Steel Wire

Wire for fastening insulation on tanks and vessels shall be Type 304 stainless steel insulation wire, soft annealed, 16 gauge, U.S. Standard (.0625 in. diameter).

3.11 Stainless Steel Bands

Stainless steel bands, when required for fastening insulation on tanks and vessels (See 33.8.9 Section 4.9.2) shall be 1/2 in. wide x .020 in. thick, Type 304 alloy, annealed and used with 300 series alloy stainless steel, wing-type seals, as manufactured by A. J. Gerrard Co., or approved equal.

3.12 Stainless Steel Rods

Stainless steel rods (used with the heavy hex nuts supplied by Others, see Section 5 below) shall be of Type 304 alloy stainless, 1/4 in. diameter.



3.13 Insulation Pins

Insulation pins shall be Nelson double pointed insulation pins, Type P2P, .134 in. diameter stainless steel Type 304 alloy, with stainless steel Speed Clips 2 in. minimum diameter, as manufactured by Nelson Stud Welding Co., 28th Street & Toledo Ave., Lorain, OH 44055. The length of the pins shall be 1/2 in. longer than the thickness of insulation before insulation and before cutting off the projection above the Speed Clip. These pins shall not be used on the tops of tanks or vessels.

4. MISCELLANEOUS INSULATION MATERIALS

4.1 Insulating Cement

The insulating cement (also known as wool cement) for filling voids and irregularities, shall be non-asbestos and suitable for 1700F such as "J-M No. 460" manufactured by Johns-Manville or "Super-Stik" manufactured by P. K. Insulation, Box 281, Joplin, MO 64801 or approved equal.

4.2 Lap Cement

4.2.1 Lap cement for felt jacketing shall be Laptite, a fibrated solvent lap cement, as manufactured by Johns-Manville.

4.2.2 Lap cement for sealing aluminum or stainless steel jacketing laps shall be Foster's 82-07 vapor barrier lap adhesive, as manufactured by the Foster Division, Amchem Products, Inc., P. O. Box 59, Ambler, PA 19002.

4.3 Insulating-Finishing Cement

The insulating-finishing cement for use with all insulation materials shall be J-M No. 375 cement, manufactured by Johns-Manville.

4.4 Heat Transfer Cement

4.4.1 Heat transfer cement, when specified or shown on the drawings, shall be an inorganic heat transfer cement such as: "Standard Thermon" for continuous temperatures to 600F and intermittent to 750F or "Thermon T-63" for continuous temperatures between 600F and 1200F as manufactured by Thermon Manufacturing Co., 100 Thermon Dr., San Marcos, TX 78666, or "Zeston Heat Transfer Cement," a non-metallic compound for continuous and maximum temperatures to 800F, manufactured by Zeston, Inc., P.O. Box 46, Fords, NJ 08863.

4.4.2 Thermon ALP dielectric primer, or an approved high dielectric aluminum primer, shall be used to coat aluminum or galvanized tubing when such tubing is used for tracing.

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5. TANK AND VESSEL INSULATION ANCHORAGES (By Others Unless Specified in the Scope of Work)

5.1 General

- 5.1.1 The anchorages specified below are required for securing insulation to the tanks and vessels.
- 5.1.2 Unless otherwise specified in the Scope of Work all anchorages specified below will be either shop-welded by the Tank Fabricator on tanks or vessels which are fabricated in the shop or will be field-welded by the Tank Erector on field assembled tanks or vessels.
- 5.1.3 Field-welding of the anchorages specified below to tanks or vessels fabricated in accordance with ASME code requirements is prohibited.
- 5.1.4 Heavy stainless steel nuts used for anchorage shall be Series 300 alloy stainless, heavy square nuts for 1/2 in. bolts, with dimensions conforming to ANSI B18.2.2 latest revision (7/8 in. on flat side and 1/2 in. thick). These nuts shall be punched but need not be threaded.
- 5.1.5 Steel angles used for anchorage shall conform to ASTM Specification A36, latest revision.

5.2 Insulation Anchorages for Calcium Silicate or Fiberglas Insulation on Sides of Round Vertical Tanks and Vessels

- 5.2.1 A bottom horizontal steel angle, with downstanding leg against the side, shall be welded to the sides. This angle shall be located as follows:
 - (a) Flat bottom (on Grade) - 6 in. above the bottom.
 - (b) Dished bottom (ellipsoidal) - at the top of the knuckle radius.
 - (c) Hopper or conical bottom - at or slightly above the bend line.
- 5.2.2 Intermediate horizontal steel angles, with legs turned down, shall be welded to the sides at 12 ft. 1/4 in. vertical intervals above the bottom horizontal angle.
- 5.2.3 Tanks and vessels with diameters greater than 12 ft. shall have vertical angles or bars (minimum of two required) spaced at intervals at approximately 30 ft. circumferentially. These angles shall be located between the bottom intermediate and top angles. Slotted holes 1/4 in. by 3/4 in. shall be spaced at 6 in. centers, with a distance of 3/16 in. from edge of slot to toe of angle. Length of slots shall be parallel to the vertical angles.
- 5.2.4 A continuous top, or weather, horizontal steel angle shall be welded to the sides. This angle shall have a downstanding leg away from the sides. The leg of the angle at 90 degrees to the sides shall be at least 1 1/2 in. longer than the thickness of the insulation. This angle shall be located as follows:
 - (a) Flat tops (1/4 in. to 1 1/2 in. slopes) at junction of top and sides.
 - (b) Dished tops (ellipsoidal) - at the bottom of the knuckle radius.



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5.2.5 All angles or bars shall be 1/4 in. thick. The outstanding legs of bottom and intermediate angles and vertical angles or bars shall be 1/2 in. less than the thickness of the insulation. Angles, except the top angle, need not be continuous, provided that the gap between ends of the angle segments is not more than 2 in.

5.2.6 Top angle shall be seal welded to the sides of the tank or vessel. Other angles may be intermittently welded. The downstanding leg of the top angles and the outstanding legs of the bottom and intermediate angles shall be punched or drilled with 5/16 in. diameter holes spaced approximately 12 in. centers.

5.3 Insulation Anchorages for Calcium Silicate Insulation on Tops and Bottoms of Round Vertical Tanks and Vessels

5.3.1 On tank tops, one-half inch, heavy stainless steel nuts will be welded on edge (by Others) to the top of the weather angle (see section 3.2.4) so that a 1/4 in. diameter rod can be threaded through the nut openings circumferentially around the tank or vessel.

5.3.1.1 On flat tops (1/4 to 1 1/2 in. slope) the nuts welded to the weather angle will be spaced on 36 in. centers and will be located 1/4 in. from outside edge of the angle.

5.3.1.2 On dished tops (ellipsoidal) the nuts welded to the weather angle will be spaced on 12 in. centers and will be located at the junction of the angle and the side of the tank or vessel.

5.3.2 On both tank tops and bottoms, nuts will be welded on edge in circumferential rows spaced at 36 1/4 in. intervals measuring from the first row to the center of the tank top or bottom. Nuts in these rows will be spaced on 36 in. centers. In addition, between these circumferential rows, intermediate circumferential rows will be installed at 12 in. intervals. Nuts in these intermediate circumferential rows will be spaced on 12 in. centers in each direction.

5.3.2.1 In all cases the first or outermost of the circumferential rows will be one with nuts spaced on 36 in. centers. This first row will be located as follows:

- (a) Flat tops - 36 1/4 in. from the row of nuts on the weather angle.
- (b) Dished tops - at the top of the knuckle radius on the dished bottom.
- (c) Dished bottoms - at the bottom of the knuckle radius on the dished bottom.
- (d) Conical bottoms - 36 1/4 in. below the bottom angle installed near the bend line. (see section 3.2.1)

5.4 Insulation Anchorages for Calcium Silicate Insulation on Straight Shell Portions of Horizontal Tanks and Vessels

Horizontal tanks and vessels having a diameter in excess of 4 ft. shall have two longitudinal angles or bars intermittently welded to the sides and located 60 degrees from the vertical center on the lower half of the tank or vessel. Angles or bars shall be 1/4 in. thick. The outstanding leg shall be 1/2 in. less

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than the insulation thickness and shall be punched with 1/4 in. by 3/4 in. slots spaced 6 in. centers with a distance of 3/16 in. from edge of slot to the toe of the angle. Length of slots shall be parallel with the longitudinal angles.

5.5 Insulation Anchorages for Rectangular Type Vessels

This section is applicable to such vessels as Electrostatic Precipitators and other rectangular units requiring insulation. It is impractical to outline in detail the anchorages required for insulation attachment. The general concept is that the following provisions must be made:

- (a) Provide weather angles at the top of the insulation.
- (b) Provide horizontal intermediate supports on the sides, spaced not more than 12 ft. apart.
- (c) Provide a support at the bottom of the insulation on the sides.
- (d) Provide a support at the bottom of the insulation on the hopper bottoms. This support shall be placed at a point above the bottom that will allow bolts to be removed from the bottom connection.
- (e) Provide horizontal intermediate supports on the hopper bottoms, spaced not more than 12 ft. apart.
- (f) Horizontal stiffeners on the sides and on the hopper bottoms may be considered as supports if they do not exceed a spacing of 12 ft.

TESTING RESPONSIBILITIES

This Contractor shall not be responsible for the costs of laboratory tests on any materials included under this Standard.

VIII. GENERAL WORKMANSHIP SPECIFICATIONS

A. GENERAL

The workmanship requirements for the work covered by these Specifications shall be as specified in the SWO's, applicable Alcoa Engineering Standards, and/or as noted on the drawings.



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, other than spray-on polyurethane foam insulation, on piping, vessels, and tanks; it includes engineering, inspection, and workmanship requirements. See Engineering Standard 33.7.9 for material specifications. See Engineering Standards 33.7.38 and 33.8.38 for material and workmanship specifications for spray-on polyurethane foam insulation.

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 The insulation type and thickness shall be as specified in the job specifications for the various pipe lines, vessels and tanks.
- 2.3 Insulation shall not be installed on any tanks, vessels or sections of pipe lines until they have been pressure tested, by Others, as required and have been released, in writing, for insulation by the Owner's Engineer.
- 2.4 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.
- 2.5 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.
- 2.6 This Contractor shall at all times facilitate inspection by the Owner's Engineer and shall proceed promptly to correct any deficiencies in his work which are brought to his attention.
- 2.7 The following is an index of the Owner's Standard Drawings for reference, all dated 8 May, 1974, or latest revision.

A-121774-PE Tank or Vessel Insulation - Vertical Tank Elevation and Details and Sections

A-121775-PE Tank or Vessel Insulation - Vertical Tank Details



- A-121776-PE Tank or Vessel Insulation - Vertical Tank Elevation Details and Sections
- A-121777-PE Tank or Vessel Insulation - Vertical Tank Details
- A-121778-PE Tank or Vessel Insulation - Dished Head of Vertical Tank and Details
- A-121779-PE Tank or Vessel Insulation - Dished Bottom of Vertical Tank and Details
- A-121780-PE Tank or Vessel Insulation - Horizontal Tank Elevation Sections and Details
- A-121801-PE Tank or Vessel Insulation - Flat Bottom Tank Elevation - Roof and Details - Pipe Riser Detail
- A-121802-PE Tank or Vessel Insulation - Special Details for Vertical and Horizontal Tanks

PIPING INSULATION 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 weatherproofing shall keep pace with the installation of insulation.
- 3.1.3 In no case shall weatherproof mastic, aluminum jacketing, or other type of jacketing 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 applying the weatherproof mastic or jacketing.
- 3.1.4 Molded insulation shall be used for all piping unless otherwise specified.
- 3.1.5 Calcium silicate insulation shall be used on any piping where mechanical damage can be expected.
- 3.1.6 Unless specified otherwise, condensate lines shall not be insulated, except where they are located closer than 7 ft. above walkways, platforms, floors, etc.; then they shall be insulated, as specified, for personnel protection.
- 3.1.7 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.
- 3.1.8 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 filed 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.

- 3.1.9 The job specifications 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. (See 33.7.9 Section 2.11.)
- 3.1.10 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. Where tack welding of an angle to the piping is not permitted by the Owner's Engineer, such as on coded piping, piping with special coatings or linings, etc., this Contractor shall provide positive intermediate support for the insulation by use of another method subject to the approval of the Owner's Engineer such as impaling the insulation on welded Nelson P2P pins, if permitted, or on vertically run finger or die cut strapping held in place with horizontally applied smooth banding or strapping.
- 3.1.11 No-Drip insulation (See 33.7.9 Section 2.1.2.) used on cold pipe, only where specified to prevent condensation shall be applied in accordance with the manufacturer's directions.
- 3.1.12 All flexible steam hose insulation shall be completely wrapped with plastic tape.

3.2 Molded Insulation - for Piping and Pipe Fittings

- 3.2.1 The sections of molded insulation without an integral jacket shall be tightly butted together and securely held in place with stainless steel wire loops, before the application of any specified jacketing. The ends of wire loops shall be tightly twisted together, bent over and pressed lightly into the insulation. Molded calcium silicate insulation shall be installed with four stainless steel wire loops per section, but spaced on no greater than 9 in. centers. Other molded pipe insulation shall be installed with three wire loops per section, but spaced on no greater than 12 in. centers for pipe sizes up to 12 in., and four loops per section but spaced on no greater than 9 in. centers., for larger diameter pipe.
- 3.2.2 Sections of molded insulation with a factory-applied fabric jacket shall have the laps pasted in accordance with the manufacturer's recommendations. The molded sections with an integral fabric jacket 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.
- 3.2.3 The sections of molded insulations with a factory-applied aluminum jacketing shall be installed in strict accordance with the manufacturer's recommendations.
- 3.2.4 Premolded fitting insulation shall be securely held in place with stainless steel wire loops.

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- 3.2.5 On piping, where the temperature exceeds 600 F or where specified in the Scope of Work, the insulation shall be installed in two layers. Each layer of the sectional or segmental insulation shall be separately secured in place with not less than four stainless steel wire loops per section but spaced on no greater than 9 in. centers. The second layer of insulation shall cover both the butt and lateral joints of the first layer. All joints between sections or segments shall be carefully filled with insulating cement.

3.3 Job-Fabricated Insulation For Fittings and Valves

- 3.3.1 Job-fabricated insulation for fittings on all pipe sizes for which premolded fittings are not available and for valves 4 in. and larger in diameter, shall consist of mitered segments of molded pipe or block insulation, neatly fitted together, and secured with stainless steel wire loops. All insulation joints shall be carefully filled with insulating cement and all of the insulation shall be covered with an 1/8 in. thick, smooth coat of insulating-finishing cement. The finished thickness shall be equal to that of the insulation of the adjoining pipe. Weatherproofing shall be as specified below in Section 3.7.
- 3.3.2 Job-fabricated insulation for valves 3 1/2 in. in diameter and smaller shall consist of insulating-finishing cement built up to the same thickness as that of the adjoining pipe insulation. Weatherproofing shall be as specified below in Section 3.7.

3.4 Aluminum Jacketing

- 3.4.1 Non-corrugated roll type jacketing, shall be cut to proper length, allowing an extra 3 in. for a 2 in. longitudinal lap with a 1 in. hem on the outside edge. Corrugated roll type jacketing shall be lapped 2 in. longitudinally, however, no hem shall be used. Circumferential laps on all aluminum roll type jacketing shall be 2 in.
- 3.4.2 Longitudinal jacketing joints on horizontal pipe lines shall be slightly offset and shall lap downward to shed water and shall be positioned slightly below the horizontal axis of the pipe (at approximately the 4 o'clock position).
- 3.4.3 At jacketing joints on vertical pipe lines the upper section shall lap over the lower section. To prevent slippage, one zee hook made of 3/8 in. stainless steel and of a size to permit a 2 in. overlap shall be used at each circumferential jacketing joint on vertical pipe lines when roll type jacketing or Childers "Strap-On" pre-fabricated, field-applied jacketing is used.
- 3.4.4 Where roll type jacketing is used, all laps on all cold water lines and the longitudinal laps on vertical lines of all outdoor exposed piping 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. With Childers "Strap-On" pre-fabricated, field-applied jacketing only the circumferential laps on cold water lines require this sealing. Indoor lines, except cold water lines, need not have the laps sealed.
- 3.4.5 All aluminum roll type jacketing shall be secured with 3/8 in. wide aluminum straps and seals on not more than 9 in. centers, with a strap at each circumferential lap.
- 3.4.6 Pre-fabricated and factory-applied aluminum jacketing shall be installed as recommended by the manufacturer.

3.4.7 Aluminum jacketing for elbows shall be secured with aluminum sheet metal screws or pop rivets on not more than 6 in. centers.

3.5 Asphalt Coated Fiber Glass Weatherproof Jacket

Asphalt coated weatherproof jacket shall be installed in one ply and fastened with stainless steel wire at all end laps, ends 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 lines of all outdoor exposed piping 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.

3.6 Stainless Steel Jacketing

Stainless steel jacketing used in lieu of asphalt coated fiber glass 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. Other installation details shall be as specified for aluminum jacketing in Section 3.4 above.

3.7 Weatherproofing and Finishing Insulated Valves and Fittings For Which Aluminum Jacketing Is Not Specified

3.7.1 Hot and Cold Outdoor Lines

3.7.1.1 Materials for weatherproofing insulated valves and fittings on hot and cold outdoor lines shall be as specified in 33.7.9, Section 2.11.

3.7.1.2 A primer shall first be applied to the insulation and allowed to dry. A brushed, trowelled or sprayed tack coat of the weatherproof mastic shall then be applied. 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 and embedded in the mastic, tightly drawn and smoothed out. The final coat of mastic shall then be applied to a wet film thickness of between 3/16 in. and 1/4 in. or between 1/8 in. and 3/16 in. dry film thickness. The weatherproofing system shall be applied only to totally dry insulation.

3.7.2 Hot Indoor Lines

3.7.2.1 Materials for finishing insulated valves and fittings on hot lines indoors (in enclosed buildings) shall be as specified in 33.7.9, Section 2.12.1

3.7.2.2 The finishing of valves and fittings with reinforced mastic shall be carried out as outlined below and in strict accordance with the recommendations of the manufacturer of the product used. When required below, a primer shall first be applied to the insulation and allowed to dry. Next a tack coat of mastic shall be applied at the rate specified. While the tack coat is still wet, a single layer of membrane shall be embedded in the tack coat

with all fabric seams overlapped a minimum of 2 inches. A finish coat of mastic shall then be applied at the rate specified to fully cover the membrane and obtain the total required dry film thickness. There shall be no voids or holidays, and the mastic shall be applied to a smooth, even finish. Finishing systems shall be applied only to totally dry insulation.

3.7.2.3 Required primers, application rates, membranes, etc. are as follows:

	<u>ViCryl-F</u>	<u>Monolar 60-36</u>	<u>Sealfas 30-36</u>
Primer	ViCryl-F diluted one part to 8 parts water	Lagfas 81-42W diluted one part to one part water.	None
Tack Coat	50 sq. ft. per gal.	50 sq. ft. per gal.	50 sq. ft. per gal.
Membrane	Chilglas No. 10	Masta-Fab	20 x 20 glass cloth
Finish Coat	25 sq. ft. per gal.	25 sq. ft. per gal.	50 sq. ft. per gal.
Total Min. DFT	1/16 in.	30 mils	31 mils

3.7.3 Cold Indoor Lines

3.7.3.1 Materials for finishing insulated valves and fittings on cold lines indoors (in enclosed buildings) shall be as specified in 33.7.9, Section 2.12.2.

3.7.3.2 The finishing of valves and fittings on cold lines indoors (in enclosed buildings) for which aluminum jacketing is not specified or available shall be as specified for hot lines in Section 3.7.2.2 above and as modified in Section 3.7.3.3 below. Finishing systems shall be applied only to totally dry insulation.

3.7.3.3 Required primer, application rates, membrane, etc. for "Monolar 60-36" are as indicated above in Section 3.7.2.3. Primer, application rates, membrane, etc. for ViCryl-F are also as indicated in Section 3.7.2.3; however, after the final coat of ViCryl-F has dried completely, a coat of Chil-Pern CP-32 grey color, vapor barrier coating shall be applied at a rate of 50 sq. ft. per gallon.

Requirements for "Tite-Fit 30-35" also acceptable as reinforced mastic finishing for valves, fittings, etc. on cold lines indoors are as follows:

	<u>Tite-Fit 30-35</u>
Tack Coat	50 sq. ft. per gal.
Membrane	Masta-Fab
Finish Coat	50 sq. ft. per gal.
Total Min. DFT	31 mils

3.8 PVC Fitting Insulation Cover

- 3.8.1 PVC fitting insulation covers shall be installed in strict accordance with the manufacturer's recommendations and the following.
- 3.8.2 The factory pre-cut fiberglass insulation furnished with the PVC fitting cover shall first be applied to the fitting. The ends of the insulation shall be tucked snugly into the throat of the fitting and the edges adjacent to the pipe covering tufted and tucked in, fully insulating the pipe fitting. The one piece PVC fitting cover is then secured by stapling, tack fastening, banding or taping the ends to the adjacent pipe covering.
- 3.8.3 Chilled water systems shall be insulated as indicated in 3.8.2 above, with the addition that all seam edges between the fitting cover and the pipe insulation as well as the overlap in the throat of the fitting cover shall be sealed with Zeston vapor mastic adhesive or equal. The circumferential edges of cover shall be wrapped with Zeston vapor-barrier pressure sensitive color matching Z Tape. The tape shall extend over the adjacent pipe insulation, and have an overlap on itself at least 2 inches on the downward side.
- 3.8.4 On fittings where temperature exceeds 250°F, 2 layers of the factory precut insulation inserts shall be applied with a few wrappings of twine on first layer, to be sure there are no voids or hot spots. The fitting cover shall then be applied over insulation as described in 3.8.2 above.
- 3.8.5 The same procedure for 2 layer insulation described in 3.8.4 above shall be followed on insulating fittings for pipe temperature 35°F and lower. In addition, the seam edges of the PVC fitting cover shall be sealed with Zeston vapor barrier mastic adhesive or equal. The circumferential edges shall be wrapped with Zeston vapor-barrier pressure sensitive color matching Z Tape. The tape shall extend over the adjacent pipe insulation, and have an overlap on itself at least 2 inches on the downward side.

4. TANK AND VESSEL INSULATION WORKMANSHIP

4.1 General

- 4.1.1 All insulation shall be stored in a dry place and kept dry prior to application.
- 4.1.2 The weatherproofing shall keep pace with the installation of the insulation.
- 4.1.3 In no case shall weatherproof mastic, aluminum jacketing or other type of jacketing 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 applying the weatherproof mastic or jacketing.
- 4.1.4 On tanks or vessels where the temperature may exceed 600F or where specified in the Scope of Work, insulation shall be installed in two equal or nearly equal layers with all vertical joints staggered in each layer and between layers.

4.1.5 The type and thickness of insulation shall be as specified in the Scope of Work.

4.1.6 The tops of tanks or vessels are defined as any surface, whether flat, sloping or curved, upon which personnel can walk, stand or climb.

4.2 Glass Fiber Rigid Board Insulation

4.2.1 General

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

4.2.1.2 The Type 705 glass fiber rigid board insulation, when applied to curved surfaces 8 ft. in diameter and less, shall be scored, with a saw, for stress-free application, 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.

4.2.2 Vertical Sides of Round Vertical Tanks and Vessels

4.2.2.1 Unless otherwise specified in the Scope of Work, the glass fiber rigid board insulation shall be supported by shelf angles, welded by Others, at the bottom of the vertical sides of tanks or vessels, and at vertical intervals of 12 ft. 1/4 in. (measured from back to back of angles).

4.2.2.2 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 or, if necessary, with insulating cement. Manhole covers and removable or hinged covers shall not be insulated unless specified in the Scope of Work.

4.2.2.3 The insulation board shall be banded with stainless steel bands spaced on 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.

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

4.2.3 Bottoms of Round and Rectangular Tanks and Vessels; Ends of Horizontal Tanks; and Sides of Rectangular Tanks.

4.2.3.1 This Contractor shall weld P2P pins at the location of each corner of each insulation board and at intermediate locations at not more than 12 in. centers in both directions.



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4.2.3.2 The insulation boards shall be fitted as specified in Section 4.2.1.2 above and impaled on the P2P pins.

4.2.3.3 After impalement of the insulation board, 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.

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

4.3 Blanket Insulation

4.3.1 Except for the tops of vertical tanks and the straight shell portion of horizontal tanks, blanket insulation may be used on all surfaces of indoor tanks and vessels with irregular surfaces and projections and with temperatures between 450F and 1000F. Blanket insulation may also be used on such surfaces of outdoor tanks where it will be covered with aluminum or stainless steel jacketing.

4.3.2 This Contractor shall weld P2P pins spaced at 12 in. centers in both directions on bottom and on 18 in. centers in both directions on sides and ends.

4.3.3 The insulation shall have all joints firmly butted together and shall be impaled over the P2P pins.

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

4.3.5 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.

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

4.3.7 A hard finish (Section 4.7 below) 1/2 in. thick is required over blanket insulation.

4.4 Calcium Silicate and Expanded Perlite Insulation

4.4.1 General

4.4.1.1 Calcium silicate or expanded perlite insulation shall be used on the tops (see Section 4.1.6) of all vertical tanks and on the straight shell portion of horizontal tanks unless a foam type of insulation is to be used.

4.4.1.2 Calcium silicate or expanded perlite insulation shall be used on other areas of tanks and vessels as specified in the Scope of Work.

4.4.1.3 The insulation on certain tanks and vessels, such as heaters, digesters, and flash tanks, will require expansion joints in the insulation to allow for the expansion and contraction of these vessels without damage to the insulation. The expansion joints shall be installed by this Contractor. The tanks that will require expansion joints will be specified in the Scope of Work.

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4.4.2 Tops and Bottoms of Round Vertical Tanks or Vessels

4.4.2.1 On tank tops, one-half inch, heavy stainless steel nuts will be welded on edge (by Others) to the top of the weather angle, so that a 1/4 in. diameter rod can be threaded through the nut openings circumferentially around the tank or vessel.

4.4.2.1.1 On flat tops (1/4 to 1 1/2 in. slope) the nuts welded to the weather angle will be spaced on 36 in. centers and will be located 1/4 in. from the outside edge of the angle.

4.4.2.1.2 On dished tops (ellipsoidal) the nuts welded to the weather angle will be spaced on 12 in. centers and will be located at the junction of the angle and the side of the tank or vessel.

4.4.2.2 On both tank tops and bottoms, nuts will be welded on edge in circumferential rows spaced at 36 1/4 in. intervals measuring from the first row to the center of the tank top or bottom. Nuts in these rows will be spaced on 36 in. centers. In addition, between these circumferential rows, intermediate circumferential rows will be installed at 12 in. intervals. Nuts in these intermediate circumferential rows will be spaced on 12 in. centers in each direction.

4.4.2.2.1 In all cases the first or outermost of the circumferential rows will be one with nuts spaced on 36 in. centers. This first row will be located as follows:

(a) Flat tops - 36 1/4 in. from the row of nuts on the weather angle.

(b) Dished tops - at the top of the knuckle radius on the dished top.

(c) Dished bottoms - at the bottom of the knuckle radius on the dished bottom.

(d) Conical bottoms - 36 1/4 in. below the bottom angle installed near the bend line.

4.4.2.3 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 on 36 in. centers in circumferential rings.

4.4.2.4 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 insulation and insulating cement. Manhole covers and removable or hinged covers shall not be insulated unless specified in the Scope of Work.

4.4.2.5 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 at not more than 12 in. centers.



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

4.4.3 Vertical Sides of Round Vertical Tanks and Vessels

Where calcium silicate or expanded perlite insulation is specified in the Scope of Work to be used on the vertical sides of round vertical tanks or vessels, it shall be installed in accordance with the specifications in section 4.2.2 above for glass fiber rigid board insulation. An insulating-finishing cement coat is not required over the insulation.

4.4.4 Straight Shell Portion of Round Horizontal Tanks or Vessels

4.4.4.1 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 insulation and insulating cement. Manhole covers and removable or hinged covers shall not be insulated unless specified in the Scope of Work.

4.4.4.2 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 will 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.

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

4.4.5 Sides and Bottoms of Rectangular Tanks and Ends of Round Horizontal Tanks or Vessels

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

4.4.5.2 The insulation shall be impaled on the P2P pins and 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 insulation and insulating cement. Manhole covers and removable or hinged covers shall not be insulated unless specified in the Scope of Work.

4.4.5.3 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.

4.4.5.4 Insulating-finishing cement coat is required over the insulation on the ends of horizontal tanks and vessels.

4.4.5.5 Insulating-finishing cement coat is not required on rectangular tanks.



4.5 Insulating-Finishing Cement Coat

4.5.1 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 tank or vessel.
- (c) Tanks and vessels weatherproofed with aluminum jacketing.

4.5.2 Insulating-finishing cement is required over calcium silicate or expanded perlite insulation on dished heads (tops and bottoms), flat or conical tops, and conical bottoms.

4.5.3 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 pigtailed which shall be attached 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.

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

4.6 Application of Weatherproof Mastic on Tanks and Vessels (Where Aluminum Jacketing Is Not Specified)

4.6.1 Weatherproofing materials shall be as specified in Engineering Standard 33.7.9 Section 3.8.

4.6.2 A layer of stainless steel or monel wire reinforcing mesh shall be installed as specified in Section 4.5.3 above.

4.6.3 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.

NOTE: Primer sealer is required over calcium silicate and expanded perlite insulation and over insulating-finishing cement coats, but is not required over fiber glass insulation.

4.6.4 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 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.



- 4.6.5 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 to a minimum.
- 4.6.6 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.

4.7 Hard Finish

- 4.7.1 A hard finish is required over blanket insulation and where specified in the Scope of Work, and is not weatherproof unless specified. A hard finish is not required where aluminum jacket covering is to be installed.
- 4.7.2 A layer of stainless steel or monel wire reinforcing mesh shall be installed as specified in section 4.5.3 above.
- 4.7.3 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.

4.8 Aluminum Jacketing for Insulated Tanks and Vessels

- 4.8.1 Aluminum jacketing shall be installed where specified using sheet metal screws or pop rivets spaced on not more than 6 in. centers on both the end and side laps.
- 4.8.2 To prevent slippage, zee hooks made of 3/4 in. stainless steel 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.
- 4.8.3 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.
- 4.8.4 All laps shall be not less than 3 in., and all side laps shall be staggered. The upper sheet of the circumferential lap on vertical tanks shall lap over the lower sheet to shed water. 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.
- 4.8.5 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.
- 4.8.6 On cold tanks and vessels, 32F 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 Section 4.8.3 above. All laps on cold tanks and vessels shall be sealed, in the laps, with lap cement.

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4.8.7 All outlets and all cut outs for brackets shall be flashed for water tightness.

4.9 Special Installation Conditions - Applicable Only to Coded Tanks or Vessels and Only Where Specified in Scope of Work - Refer to Alcoa Standard Drawing A-121802-PE

4.9.1 Vertical and Horizontal Steel Angles Omitted—Calcium Silicate or Fiber Glass on Sides of Round Vertical Tanks or Vessels

4.9.1.1 Where the vertical and horizontal steel angles have been omitted on tanks or vessels 15 ft. in diameter or smaller, this Contractor shall install two rows of P2P pins, on 6 in. centers both vertically and circumferentially, at the locations where the shelf angles would have been located. (See Engineering Standard 33.7.9, Section 5.2). Insulation shall then be impaled on the pins and banded as specified in Sections 4.2.2.2 and 4.2.2.3 above.

4.9.1.2 Where the vertical and horizontal angles have been omitted on tanks and vessels over 15 ft. in diameter and calcium silicate insulation is to be used, this Contractor shall install P2P pins spaced on not over 6 in. centers circumferentially and not over 12 in. vertically over the entire shell. Insulation shall then be impaled on the pins and fitted as specified in Section 4.2.2.2 above. Banding in this case shall be omitted.

4.9.1.3 Where the vertical and horizontal angles have been omitted on tanks and vessels over 15 ft. in diameter and fiber glass insulation is to be used, this Contractor shall weld P2P pins located in each corner of each insulation board and intermediate pins spaced 18 in. maximum in all directions. Insulation shall then be impaled on the pins and fitted as specified in Section 4.2.2.2 above. Banding in this case shall be omitted.

4.9.2 Top Angle and Heavy Stainless Steel Nuts Omitted - Calcium Silicate on Tops of Round Vertical Tanks or Vessels

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

4.9.2.2 The calcium silicate insulation shall be embedded in a still wet mixture of wool cement (see Engineering Standard 33.7.9 Section 4.1) mixed in accordance with the manufacturer's instructions and troweled onto the top to a thickness of 1/4 in. The insulation shall be installed on the top with ends and edges butted.

4.9.2.3 Install 1/2 in. wide stainless steel bands: connect one end to the circumferential bands, (installed under Section 4.2.9.1 above) 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 and shall be anchored at each end to the circumferential bands.



4.9.2.4 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.

4.9.2.5 Where nozzles or other projections interfere with the stainless steel 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.

4.9.3 Bottom Angles and Heavy Stainless Steel Nuts Omitted - Calcium Silicate on Bottoms of Round Vertical Tanks or Vessels

Where the bottom angles and the heavy stainless steel nuts have been omitted, the calcium silicate insulation shall be installed as specified above in Sections 4.9.2.1 and 4.9.2.3 thru 4.9.2.5 above. Rather than cementing the insulation to the tank as specified in Section 4.9.2.2 however, the insulation shall be impaled on P2P pins, welded by this Contractor in a circular pattern, with the pins in each row and the rows spaced on 6 in. centers.

5. PRECAUTIONS

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 the Contractor, and strict control of any welding or burning operations, or other sources of fire, shall be exercised at all times.



GENERAL CONDITIONS

ARTICLE 1. SITE AND OTHER EXAMINATIONS — OBSERVANCE OF LAWS.

A. Contractor represents that it has procured a license to do business, if required by law, and has complied with all other legal requirements before submitting a bid for the Work.

B. Contractor represents that it has carefully examined the Drawings and Specifications, governmental restrictions, permits and license requirements, and all other laws and rules applicable to the Work. Contractor further represents it has visited the Work site, has made all investigations essential to a full understanding of the difficulties which may be encountered, and has special qualifications for doing the Work.

C. Contractor shall before commencing Work obtain, at its own expense, all necessary permits (except building permits) and licenses, and shall, in the performance of the Work, observe and abide by all applicable laws, regulations, ordinances, governmental restrictions and other rules.

D. Contractor shall hold Owner harmless from any liability or penalty incurred or imposed by reason of an asserted violation by Contractor of any such laws, regulations, ordinances, governmental restrictions or other rules.

ARTICLE 2. SPECIFICATIONS AND DRAWINGS.

A. Contractor shall keep a copy of the Drawings and Specifications at the Work site at all times. Anything mentioned in the Specifications and not shown on the Drawings, or shown on the Drawings and not mentioned in the Specifications, shall be of like effect as if shown and mentioned in both. If there is any difference between the Drawings and the Specifications, the Specifications shall govern, but the matter shall be immediately submitted to Owner's representative without whose decision said difference shall not be resolved by Contractor, except at its own risk and expense. Contractor and Owner shall sign or initial each page of one copy of the Specifications and one print of each Drawing. The signed Specifications and Drawings shall be retained by Owner.

B. Contractor and its subcontractors shall furnish all shop drawings, properly identified, required by the Specifications. All shop drawings submitted by subcontractors shall be first checked by Contractor and corrected before being submitted to Owner. Approval of shop drawings by Owner shall not relieve Contractor from responsibility for errors or omissions therein, and Contractor, notwithstanding such approval, shall correct all errors and omissions.

C. All Drawings, Specifications, and shop drawings and all copies and all reproductions thereof: (1) are the property of Owner and must be delivered to Owner upon request, or at the completion of the Work; (2) are provided to Contractor, its subcontractors and material suppliers for the limited purpose of use in completing the Work, and may not be used for any other purpose whatsoever without the prior written consent of Owner; (3) are confidential and, except for the purpose specified above, may not be copied, exhibited or furnished to others without prior written consent of Owner, and no photographs may be taken of any article fabricated or assembled from the Drawings and/or Specifications without the prior written consent of Owner.

ARTICLE 3. MATERIALS AND WORKMANSHIP.

Where machinery, equipment, or material are referred to in the Contract as equal to any particular standard, Owner shall decide the question of equality. When required by the Contract, or requested by Owner, Contractor shall furnish Owner with the name of the manufacturer, the performance capabilities, and other pertinent information necessary to properly determine the quality and suitability of any machines, equipment and material to be incorporated in the Work. Material samples shall be submitted at Owner's request. When the Contract specifies machinery, equipment or material by manufacturer, model, or trade name, no substitution shall be made without Owner approval and, unless otherwise agreed, only those substitutions submitted prior to the signing of the Contract will be considered. Machinery, equipment or material installed in the Work without the approval required by this Article 3. shall be deemed to be defective material for purposes of Article 4..

ARTICLE 4. INSPECTIONS AND TESTS.

A. Owner and its representatives shall at all times have access to the Work wherever it is being performed, and Contractor shall provide proper facilities for such access and for inspection. When any item of Work is being executed away from the Work site, Contractor shall promptly notify Owner of the location and the schedule for completion.

B. Owner shall have the right to reject defective materials or workmanship and to require their correction. Rejected workmanship shall be satisfactorily corrected, and rejected materials shall be immediately removed from the Work site, without charge to Owner. If Contractor does not correct such defective workmanship within a reasonable time or remove rejected materials immediately, Owner may correct such defective workmanship or remove such rejected materials and charge the expense to Contractor. Should Owner at any time before final acceptance of the entire Work desire to make an examination of any items of Work already completed by removing or tearing out same,

Contractor shall, upon request, promptly furnish all necessary facilities, labor and materials therefore. If such items of Work are found to be defective in any material respect due to the fault of Contractor or its subcontractors, Contractor shall pay all the expenses of such examination and of satisfactory reconstruction. If, however, such items of Work are found to meet the requirements of the Contract, Contractor will be reimbursed by Owner for removal, examination and replacement, in accordance with Article 7.C..

C. Neither the failure of Owner to exercise the right of inspection nor the failure to discover defective workmanship or material during such inspection shall relieve Contractor of its obligation to provide material and workmanship strictly in accordance with the Contract.

D. All laboratory tests required by Owner shall be made in a laboratory approved by Owner, and Owner will, unless otherwise provided in the Contract, pay Contractor's actual costs of such tests and engineering services. Unless otherwise specified by Owner, all tests shall be made in accordance with the current standard methods of the American Society for Testing Materials governing the materials tested.

ARTICLE 5. SCHEDULE FOR COMPLETION — OVERTIME — DELAYS.

A. Contractor shall not be entitled to any damages or compensation for delays in the commencement, progress or completion of the Work resulting from any cause whatsoever, except as specifically provided for in this Article 5..

B. If a delay is not caused by or contributed to by any act or omission of Contractor, the time for completion shall be extended by Owner for a period of time determined by Owner to be equivalent to the time of such delay. If Owner requires Contractor to work overtime to make up any such delays, Owner will pay Contractor for such overtime in accordance with the provisions of Article 7.C..

C. If Owner directs Contractor to cease working, restrict its labor force or otherwise delay or suspend the Work, or if Owner causes a delay or suspension of the Work by its failure to provide for timely completion of work by others, timely delivery of machinery, material or equipment which Owner is required to provide, Owner will, if personnel, equipment and facilities are idled and cannot be productively employed elsewhere, grant an extension of time and reimburse Contractor or its subcontractors for the following: (1) Contractor's on-site salaries for supervisory, clerical and other office help; (2) the invoice cost of rental vehicles, equipment and facilities; (3) compensation for equipment, tools, vehicles and facilities owned by Contractor or its subcontractors at 60% of the agreed rental rate without operator; and (4) other similar expenses which Owner judges to be reasonable. The salaries of supervisors not located at the site, other overhead, other office expense, and profit will not be paid, nor will any Contractor markup of subcontractor billings be permitted. Contractor shall make every reasonable effort to utilize all manpower, equipment, and facilities and minimize the cost to Owner.

D. If any such delay is caused by or contributed to by any act or omission of Contractor, no extension of time will be granted by Owner, and Owner shall have the right to charge Contractor for any costs paid by Owner to others pursuant to Article 5.C.. Owner may require Contractor to work overtime at Contractor's expense to make up any time lost as a result of such delay.

E. Work shall be completed in accordance with the schedule set forth in the Contract. Contractor shall immediately notify Owner in writing any time the Work is behind schedule or may not be completed on schedule.

F. Any request for extension of time or compensation under this Article 5. must be made in writing within five working days from the date the delay commences.

ARTICLE 6. OTHER WORK.

A. It is understood that others may work in the same area occupied by Contractor. Contractor shall fully cooperate in scheduling the Work so that a minimum of interference will occur.

B. Owner will provide a baseline and elevation from which Contractor shall check all lines and grades previously established before proceeding with the Work, and make certain they are suitable for receiving the Work. If any fault exists, Contractor shall notify Owner in writing and shall not proceed until all faults are corrected. If Contractor proceeds without such notification and correction and it is then necessary to reconstruct any part of the Work because of such faults, Contractor shall reconstruct the Work without expense to Owner.

C. Before proceeding with the Work, and from time to time as the Work progresses, Contractor shall examine work installed by others which influences the Work, and shall promptly notify Owner in writing if any condition exists that will prevent Contractor from satisfactorily completing the Work. If Contractor proceeds without such notification and it is then necessary to reconstruct any part of the Work because of such condition, Contractor shall reconstruct such part without expense to Owner.

ARTICLE 7. CHANGES.

Owner, at any time, by a written order, and without notice to any surety, may make changes in the Drawings and the Specifications. If such changes affect the cost of the Work or time required for its performance, an equitable adjustment shall be made in the Contract price or time for performance or both. However, if specifically requested

in writing by Owner, Contractor shall proceed with the prosecution of the portion of the Work so changed without waiting for an agreement to be reached concerning such adjustment. Any change in the Contract price necessitated by such change shall be made in accordance with one or more of the following methods acceptable to Owner, and such change shall be authorized by a "Site Work Order" signed by Owner and accepted by Contractor:

A. By adding or deducting a lump sum (if requested by Owner, Contractor shall provide a detailed cost breakdown);

B. By adding or deducting unit prices;

C. By adding, with respect to additions to the Work:

(1) Actual straight time wage cost of all direct labor employed up to and including the first tier of foreman, including fringe benefits, subsistence and other contributions as determined by the applicable trade agreements, or prevailing wages and benefits established by Contractor in the absence of trade agreements, but shall not include indirect costs for other supervisory, administrative, clerical, office, or other overhead expense whether incurred at the Work site or elsewhere. Contractor shall furnish one copy of each current trade agreement to Owner;

(2) Average composite cost of payroll taxes including FICA, Federal and State Unemployment, and Contractor's average composite cost of workmen's compensation insurance and general liability insurance. An average composite rate for each tax and insurance element shall be submitted to Owner quarterly;

(3) 20% of Article 7.C. (1) and (2) to cover all required safety and personal protection equipment, equipment and small tools (under \$750 replacement value), transportation within the site of personnel and small items of material (except labor costs charged separately under paragraph 7.C.(1)), superintendence above the first tier of foreman, taxes (except on payroll or state sales tax), all administrative, clerical, office, and other overhead expense incurred at the site or elsewhere, and profit;

(4) Actual cost of the premium portion of approved overtime labor, including insurance, taxes, benefits, and other contributions required of Contractor;

(5) An amount for equipment, fueled, maintained but without operator, and tools used (over \$750 replacement value) at previously agreed rental rates;

(6) Actual cost of all materials furnished and expendable tools and supplies consumed (Contractor to obtain all available discounts);

(7) Actual cost of any items of Work performed by subcontractors. (Subcontractors on a cost plus basis shall be reimbursed by Contractor in accordance with this Article 7.C.);

(8) 5% of Article 7.C. (6) and (7); and

(9) Actual cost of any sales tax paid on materials, tools and supplies covered by Article 7.C. (6).

Separate records, subject to audit by Owner, shall be kept for any payments to be made pursuant to Article 7.C..

Contractor shall submit for Owner's approval a list of all wage costs determined pursuant to Article 7.C. (1), (2) and (4), and a list of all equipment and tools with the rental rates to be charged pursuant to Article 7.C. (5).

Any claim for adjustment under this Article 7. must be asserted in writing within ten days from the date the change was ordered. Owner may, without thereby waiving this provision, consider any such claim prior to completion and acceptance of the additions to the Work.

No claim for adjustment will be allowed unless the change was specifically ordered in writing by Owner.

ARTICLE 8. PAYMENTS.

A. Progress payments for lump sum and unit price items of the Work will be made by Owner upon proper application by Contractor during progress of the Work as follows:

(1) On or after the first day of each month, Contractor shall render a progress billing invoice, in duplicate, for Work completed through the last working day of the previous month. The term "Work completed" for progress payment purposes shall mean material or equipment actually installed in place. Contractor's progress billing invoice shall include progress payments due for lump sum and unit price Work applicable to Contract "Items for Payment" and for Article 7.A. and 7.B. changes authorized by issuance of a "Site Work Order". Format and support documents for these invoices shall be determined by Owner.

(2) Contractor's progress billing invoice shall be based upon the applicable percentages and/or units of Work completed as shown on Owner's engineering and financial certification acknowledgement. Ten percent (10%) retained percentage shall be deducted from the total value of Work completed.

B. A separate invoice shall be prepared and submitted in duplicate for each Site Work Order issued under the provision of Article 7.C., and these invoices shall not be subject to retained percentage. Payment for Work completed in accordance with Article 7.C. shall not be made until all of the Work required by that Site Work Order has been completed, unless the Site Work Order specifically provides otherwise. Format and support documentation for these invoices shall be determined by Owner. Contractor invoices shall show summary totals for each applicable reimbursable payment item listed in Article 7.C..

C. If required by Owner, Contractor shall submit with each progress billing subcontractor and materialmen receipts for payments made to them through the previous progress billing.

D. Payments otherwise due may be withheld by Owner on account of defective Work not remedied, liens or other claims filed, reasonable evidence indicating probable filing of liens or other claims, failure of Contractor to make payments properly to its subcontractors or for material or labor, reasonable doubt that the Contract can be completed for the balance then unpaid, the failure of Contractor to perform any of its other obligations under the Contract, or to protect Owner against any liability arising out of Contractor's failure to pay or discharge taxes or other obligations. If the causes for which payment is withheld are removed, the withheld payments will be made promptly. If the said causes are not removed within a reasonable period after written notice, Owner may remove them at Contractor's expense.

E. Payment of the retained percentage will be made by Owner upon: (1) submission of an invoice for the retained percentage after delivery of the Work, complete and undamaged; (2) written acceptance of the Work by Owner; (3) delivery of all Drawings and Specifications; (4) delivery of executed full releases of all liens arising out of the Contract or any agreement supplemental hereto, or any subcontract made pursuant to or in connection with the performance under the Contract or any agreement supplemental hereto, or receipts in full in lieu thereof; and (5) delivery of an affidavit listing all persons who might otherwise be entitled to file, claim, or maintain a lien of any kind or character whatsoever, and containing an averment that all of the said persons have been paid in full. If any person refuses to furnish an actual release or receipt in full, Contractor may furnish a bond satisfactory to Owner to indemnify Owner against any claim or lien.

F. Acceptance by Contractor of payment of the retained percentage pursuant to Article 8.E. shall constitute a waiver, release and discharge of any and all claims and demands of any kind or character whatsoever which Contractor then has, or can thereafter acquire against Owner, its successors and assigns, for or on account of any matter or thing whatsoever arising out of, or in any manner connected with, the performance of the Contract, or any agreement supplemental thereto. However, payment of the retained percentage by Owner shall not constitute a waiver, release, or discharge of any claims or demands which Owner then has, or can thereafter acquire, against Contractor, its successors and assigns, for or on account of any matter or thing whatsoever arising out of, or in any manner connected with, the performance of the Contract or any agreement supplemental thereto.

G. All invoices shall be mailed to Owner's location Accounting Manager and will be paid promptly after Owner's approval.

ARTICLE 9. TAXES.

A. Contractor shall, unless otherwise specified in the Contract, pay all applicable taxes including, but not limited to, sales, use, property, and taxes on income, and including all penalties and interest thereon.

B. Contractor and subcontractors shall pay all taxes measured by wages, salaries or other remunerations of its employees required by the Federal Insurance Contributory Act or the laws of the state in which the Work is done.

C. Contractor and subcontractors shall file such returns, reports or forms necessary for the payment of taxes.

D. Contractor shall, upon written request, submit to Owner written evidence of any filings or payments of all taxes, including government-furnished receipts and detailed documentation by the state. Owner reserves the right to contest, or cause Contractor to contest, any such tax, fee or assessment, and Contractor shall use its best efforts in cooperating with Owner in any such contest. The cost of any such contest will be paid by Owner.

ARTICLE 10. GUARANTEE.

A. In addition to specific guarantees required by the Contract, Contractor guarantees the Work to be free from defects in material and workmanship for a period of one year from the date of final written acceptance of the completed Work by Owner as required for final payment under Article 8.E. Contractor shall, within a reasonable time after receipt of written notice thereof, repair or replace such defective materials or workmanship and shall repair or replace other items of the Work which shall have been damaged by such defects or the repairing of the same, all at its own expense and without cost to Owner.

B. Contractor guarantees that any machinery, equipment, or process, the design of which is the responsibility of Contractor, shall meet the performance requirements specified in the Contract. Owner's inspection, testing, approval or acceptance of any such machinery, equipment, or process shall not relieve Contractor of its obligations under this Article 10.B. The guarantees contained in this Article 10.B. are in addition to those guarantees contained in Article 10.A. and Owner, in the event of a breach by Contractor of its obligations under this Article 10.B., shall not be limited to the remedies set forth in Article 10.A., but shall have all the rights and remedies permitted by the Contract and by law.

C. Owner's occupancy of the Work site, or any portion thereof, shall not constitute acceptance or approval of the Work or any such portion of the Work.

ARTICLE 11. INDEPENDENT CONTRACTOR.

Contractor shall be an independent contractor, and Owner will have no right to exercise supervision as to the manner or method of doing the Work.

ARTICLE 12. SUPERINTENDENCE.

Contractor shall have a competent superintendent, satisfactory to Owner, at the Work site at all times during progress of the Work with the authority to act for Contractor.

ARTICLE 13. SUBCONTRACTS.

Contractor shall obtain Owner's written permission before subcontracting any portion of the Work. All subcontracts and orders for the purchase or rental of supplies, materials, or equipment shall require that the subcontractor or materialman be bound by and subject to all terms and conditions of the Contract. No subcontract or order shall relieve Contractor from its obligations to Owner or shall purport to bind Owner, but each subcontract or order shall contain a provision permitting assignment to Owner.

ARTICLE 14. SAFETY.

A. Contractor shall take all necessary precautions for the safety of employees, shall comply with such regulations as Owner may from time to time establish, including, without limitation, *Alcoa Engineering Standard 33.052, Safety and Health, Fire Protection and Security Procedures for Outside Contractors and Subcontractors*, and Work site regulations, and shall comply with all federal, state and local safety laws and regulations, including without limitation, Occupational Safety and Health Act standards for the construction industry, and Mine Safety and Health Act standards.

B. Contractor shall not introduce to the Work site any hazardous chemicals without prior written approval of Owner.

ARTICLE 15. LABOR RELATIONS.

Good labor relations, coordination and cooperation with other contractors are essential to the successful completion of the Contract. Owner reserves the right to determine if Contractor's personnel policies and / or labor agreements adequately protect Owner's interests. *Alcoa Engineering Standard 33.042, Labor Relations Guide for Outside Contractors and Subcontractors* details Owner's requirements for labor relations.

ARTICLE 16. CLEANING.

Contractor shall at all times keep the Work site and the adjoining premises, driveways, and streets clean of rubbish caused by Contractor's operations and, at the completion of the Work, shall remove all rubbish and all of its tools, equipment, temporary work, and surplus material and shall have the Work clean and ready for use. If Contractor does not attend to such cleaning immediately upon request, Owner may cause such cleaning to be done by others and charge the cost to Contractor.

ARTICLE 17. TITLE AND RISK OF LOSS.

Owner shall have title to, and risk of loss of, all completed and partially completed portions of the Work and materials delivered to and stored at the Work site which are intended to become a part of the Work; provided, however, that Contractor shall be liable for any loss or damage caused by Contractor or its subcontractors, their agents, servants, or employees, and Contractor shall replace or repair said Work or materials at its own cost to the complete satisfaction of Owner. Contractor shall have risk of loss or damage to Contractor's property used in the construction of the Work but which does not become a part thereof.

ARTICLE 18. LIABILITY.

Contractor shall save and hold Owner harmless from and against all liability, claims and demands on account of personal injuries (including death), or property loss, or damage to others (including Contractor and employees and invitees of Owner and of Contractor) arising out of or in any manner connected with the performance of the Contract, and caused by the negligent or willful act or omission of Contractor, a subcontractor or materialman hereunder, or the employees or invitees of any of them, or notwithstanding any negligence of Owner, the failure of Contractor, its employees or invitees to comply with any of the terms and conditions of the Contract or to warn persons at the Work site of any unsafe condition or danger known to Contractor or which should have been known to Contractor; Contractor shall at its own expense defend any and all actions based thereon and shall pay all charges of attorneys and all costs and other expenses arising therefrom. Nothing contained herein shall obligate Contractor to save and hold Owner harmless from and against any liability, claim or demand which may arise from the sole negligence of Owner.

ARTICLE 19. INSURANCE.

A. Unless, otherwise specified in the Contract, Contractor shall, during the progress of the Work, maintain and, prior to starting the Work, provide Owner with written certification of:

(1) Worker's Compensation Insurance or qualification as a self-insurer to satisfy the laws of the State in which the Work is being done. Contractor's Worker's Compensation Insurer or Contractor, if self-insured, agrees to waive rights of subrogation against Owner except for claims caused by Owner's sole negligence;

(2) Employer's Liability Insurance with limits of not less than \$1,000,000 per occurrence;

(3) Comprehensive General Liability Insurance for personal injury and property damage, including contractual liability insurance, with combined limits of not less than \$5,000,000 per occurrence; and

(4) Automobile Liability Insurance for personal injury and property damage, with combined limits of not less than \$5,000,000 per occurrence.

B. Contractor shall name Owner as an additional insured on its Comprehensive General Liability and Automobile Liability policies.

ARTICLE 20. BONDS.

If required by Owner, Contractor shall furnish a performance and payment bond in form and amount and with such sureties as shall be approved by Owner. If such a bond is required, Owner will reimburse Contractor for its actual cost.

ARTICLE 21. LIENS.

A. Contractor, subcontractors, and materialmen shall not make, file or maintain a mechanic's or other lien or claim of any kind or character whatsoever against any building or other structure to which the Contract relates, the additions, improvements, alterations, or repairs made thereon, the ground on which said building or other structure is situated, or any other property or property interest owned, held, occupied or otherwise possessed by Owner, for or on account of any labor, materials, fixtures, tools, machinery, equipment or any other things furnished, or any other work done or performance given under, arising out of, or in any manner connected with the Contract, or any agreement supplemental thereto; (such liens or claims hereinafter referred to as "Claims") and Contractor, subcontractor, and materialmen hereby expressly waive and relinquish any and all rights which they now have, or may hereafter acquire, to file or maintain any Claim and Contractor, subcontractor, and materialmen agree that this provision waiving the right of Claims shall be an independent covenant.

B. Contractor shall save and hold Owner harmless from and against any and all Claims that may be filed by a subcontractor, materialman, or any other person and Contractor shall, at its own expense, defend any and all actions based upon such Claims and shall pay all charges of attorneys and all costs and other expenses arising therefrom.

ARTICLE 22. PATENTS.

Contractor shall defend all suits or claims and shall hold and save Owner harmless from liability of any nature or kind including costs and expenses for or on account of infringement of any United States Letters Patent by reason of the nature, form or condition of any material, article or machine supplied by Contractor in the performance of the Contract or by reason of use or sale by Owner of any such material, article or machine for a purpose intended or reasonably foreseeable by Contractor; provided that Owner shall not obtain any right under this Article 22. as to any claim or suit, unless Owner shall have given Contractor prompt written notice upon learning thereof and full opportunity to defend and dispose of such claim or suit.

ARTICLE 23. ASSIGNMENT.

Contractor shall not assign the Contract or any monies to become due hereunder without the prior written consent of Owner. No assignment shall relieve Contractor of any obligation hereunder.

ARTICLE 24. TERMINATION OF CONTRACT BY OWNER.

A. Should Contractor at any time refuse or fail to prosecute the Work with promptness and diligence, or to perform any of its other obligations under the Contract, Owner may terminate Contractor's right to proceed with the Work by written notice to Contractor. In such event Owner may enter upon the Work site and finish the Work by whatever method it may deem expedient, including the hiring of another contractor or other contractors and, for that purpose, may take possession of all materials, machinery, equipment, tools, and appliances thereon and exercise all rights, options and privileges of Contractor. In such case Contractor shall not be entitled to receive any further payments until the Work is finished. If the unpaid balance of the Contract price exceeds Owner's cost of finishing the Work, including compensation for additional managerial and administrative services, such excess will be paid to Contractor. If such Owner's cost shall exceed such unpaid balance, Contractor shall be liable for and shall pay the difference to Owner.

B. Owner may, for its own convenience, terminate Contractor's right to proceed with any portion or all of the Work by written notice to Contractor. Such termination shall be effective in the manner specified in such notice, shall be without prejudice to any claims which Owner may have against Contractor, and shall not affect the obligations and duties of Contractor hereunder with respect to portions of the Work not terminated.

C. On receipt of notice under Article 24.B., Contractor shall, with respect to the portion of the Work terminated, unless the notice states otherwise; (1) immediately discontinue such portion of the Work and the placing of orders for materials, facilities and supplies in connection with the performance thereof; (2) if requested, make every reasonable effort to procure cancellation of all existing orders or contracts upon terms satisfactory to Owner and; (3) thereafter complete only such portions of the Work as may be necessary to preserve and protect those portions of the Work already in progress and to protect material, plant and equipment at the Work site or in transit thereto.

D. Upon termination pursuant to Article 24.B., Contractor shall be paid a pro rata portion of the compensation in the Contract for any portion of the terminated Work already performed, including therein material and services for which it has made firm contracts which are not cancelled, it being understood that Owner shall be entitled to such material and services. Upon determination of the amount of said pro rata compensation, Owner will promptly pay such amount to Contractor upon delivery by Contractor of the releases or receipts and affidavit, pursuant to Article 8.E..

ARTICLE 25. COMPLIANCE WITH TERMS AND CONDITIONS.

Owner's failure at any time, or from time to time, to enforce or require the strict keeping and performance by Contractor of any of the terms and conditions of the Contract shall not constitute a waiver by Owner of such terms or conditions, and shall not affect or impair such terms or conditions in any way, or Owner's right at any time to avail itself of such remedies as it may have for any breaches of such terms or conditions.

ARTICLE 26. EXCLUSION OF CERTAIN PERSONS.

Contractor shall not, without the prior written consent of Owner, permit any person other than officers, employees or representatives of Owner, Contractor or its subcontractors to enter upon the premises of Owner at the Work site. Contractor shall not, without the consent of Owner, knowingly employ upon the premises of Owner, any person who is a member of or associated with any organization designated by the United States Attorney General as having interest in conflict with those of the United States, or any person whose character is such that his presence on Owner's premises might obviously be detrimental to Owner's interests. Owner shall have the right to bar or remove from its premises any such individual after appropriate notice has been given to Contractor.

ARTICLE 27. EXECUTIVE ORDER NO. 11246 — EQUAL EMPLOYMENT OPPORTUNITY.

A. For contracts exceeding \$10,000, unless exempt, Contractor agrees as follows:

(1) Contractor will not discriminate against any employee or applicant for employment because of race, color, religion, sex, or national origin. Contractor will take affirmative action to ensure that applicants are employed, and that employees are treated during employment, without regard to their race, color, religion, sex or national origin. Such action shall include, but not be limited to the following: employment, upgrading, demotion, or transfer; recruitment or recruitment advertising; layoff or termination; rates of pay or other forms of compensation; and selection for training, including apprenticeship. Contractor agrees to post in conspicuous places, available to employees and applicants for employment, notices to be provided by the government contracting officer setting forth the provisions of this nondiscrimination clause.

(2) Contractor will, in all solicitations or advertisements for employees placed by or on behalf of Contractor, state that all qualified applicants will receive consideration for employment without regard to race, color, religion, sex or national origin.

(3) Contractor will send to each labor union or representative of workers with which it has a collective bargaining agreement or other contract or understanding, a notice, to be provided by the agency contracting officer advising the labor union of workers representative of Contractor's commitments under Section 202 of Executive Order 11246 of September 24, 1965, and shall post copies of the notice in conspicuous places available to employees and applicants for employment.

(4) Contractor will comply with all provisions of Executive Order 11246 of September 24, 1965 and of the rules, regulations, and relevant orders of the Secretary of Labor.

(5) Contractor will furnish all information and reports required by Executive Order 11246 of September 24, 1965 and by the rules, regulations, and orders of the Secretary of Labor, and will permit access to its books, records and accounts by the contracting agency and the Secretary of Labor for purposes of investigation to ascertain compliance with such rules, regulations, and orders.

(6) In the event of Contractor's noncompliance with the nondiscrimination clauses of the Contract or with any of the said rules, regulations, or orders, the Contract may be cancelled, terminated, or suspended in whole or in

part, and Contractor may be declared ineligible for further Government contracts in accordance with procedures authorized in Executive Order 11246 of September 24, 1965 and such other sanctions may be imposed and remedies invoked as provided in Executive Order 11246 of September 24, 1965, or by rule, regulation or order of the Secretary of Labor on Equal Employment Opportunity, or as otherwise provided by law.

(7) Contractor will include the provisions of paragraphs (1) through (7) in every subcontract or contract unless exempted by rules, regulations or orders of the Secretary of Labor issued pursuant to Section 204 of Executive Order 11246 of September 24, 1965, so that such provisions will be binding upon each subcontractor or vendor. Contractor will take such action with respect to any subcontract or contract as the contracting agency may direct as a means of enforcing such provisions, including sanctions for noncompliance; provided, however, that in the event Contractor becomes involved in, or is threatened with, litigation with a subcontractor or vendor as a result of such direction by the contracting agency, Contractor may request the United States to enter into such litigation to protect the interests of the United States.

(8) **CERTIFICATION OF NONSEGREGATED FACILITIES (1970 AUG)** (Applicable to contract, subcontracts, and to agreements with applicants who are themselves performing Federally assisted construction contracts, exceeding \$10,000 which are not exempt from the provisions of the Equal Opportunity clause). Contractor certifies that it does not maintain or provide for its employees any segregated facilities at any of its establishments, and that it does not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. It certifies further that it will not maintain or provide for its employees any segregated facilities at any of its establishments, and that it will not permit its employees to perform their services at any location, under its control, where segregated facilities are maintained. The bidder, offeror, applicant, or subcontractor agrees that a breach of this certification is a violation of the Equal Opportunity clause in the Contract. As used in this certification, the term "segregated facilities" means any waiting rooms, work areas, rest rooms and wash rooms, restaurants and other eating areas, time clocks, locker rooms and other storage or dressing areas, parking lots, drinking fountains, recreation or entertainment areas, transportation, and housing facilities provided for employees which are segregated by explicit directive or are in fact segregated on the basis of race, color, religion, or national origin, because of habit, local custom or otherwise. It further agrees that (except where it has obtained identical certifications from proposed subcontractors for specific time periods) it will obtain identical certifications from proposed subcontractors prior to the award of subcontracts exceeding \$10,000 which are not exempt from the provisions of Equal Opportunity clause; that it will retain such certifications in its files; and that it will forward the following notice to such proposed subcontractors (except where the proposed subcontractors have submitted identical certifications for specific time periods):

NOTICE TO PROSPECTIVE SUBCONTRACTORS OF REQUIREMENT FOR CERTIFICATIONS OF NONSEGREGATED FACILITIES. A Certification of Nonsegregated Facilities must be submitted prior to the award of a subcontract exceeding \$10,000 which is not exempt from the provisions of the Equal Opportunity clause. The certification may be submitted either for each subcontract or for all subcontracts during a period (i.e., quarterly, semi-annually, or annually).

(NOTE: THE PENALTY FOR MAKING FALSE STATEMENTS IN OFFERS IS PRESCRIBED IN 18 U.S.C. 1001.)

B. For contracts exceeding \$50,000, unless exempt, Contractor agrees as follows:

(1) Contractor agrees to file with the appropriate federal agency a complete and accurate report on Standard Form 100 (EEO-1) within 30 days after the signing or the award of any such contract (unless such a report has been filed in the last 12 months), and agrees to continue to file such reports annually, on or before March 31st. Contractor agrees to develop and maintain a current written affirmative action compliance program for each of its establishments in accordance with the regulations of the Secretary of Labor promulgated under Executive Order 11246, as amended.

ARTICLE 28. EMPLOYMENT OF VETERANS AND HANDICAPPED.

The Contract incorporates by reference any currently applicable clauses relating to employment of the handicapped and the employment of veterans, inclusion of which are required by statutes such as Public Laws 93-112 and 93-508, regulations issued thereunder such as 41 CFR Part 60-741 and 41 CFR Part 60-250, and any additions, amendments or replacements thereto, including any limitations in such clauses as to dollar levels below which such clauses do not apply.

ARTICLE 29. NOTICES.

Any notice, order, certificate or writing provided for in the Contract shall be considered as having been given to Contractor, if delivered personally to its field representative at the Work site and to Owner, if delivered personally to Owner's representative at the Work site, and in either case a copy of any such notice, order, certificate or writing shall be mailed by registered mail, postage prepaid, to the recipient at the address provided.