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PROJECT	**SULFUR RECOVERY UNIT FOR DAKHNI EXPANSION**	
TITLE	**SPECIFICATION FOR PAINTING**	

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Section 1

1. SCOPE

This specification covers the requirements governing the selection and application of the painting system to be used on the external surfaces of piping, equipment and structures for production and processing facilities.

2. GENERAL

2.1 The following surfaces arc not required to be painted:

2.1.1 Non-ferrous materials (stainless steels, aluminum, etc) unless specifically required.

2.1.2 Plastic or plastic-painted materials not susceptible to ultra-violet deterioration.

2.2 Machined and threaded surfaces shall be protected with a temporary rust preventative.

2.3 Any deviation from this specification shall be approved in writing by authorized Owner's representative. Failure of applicator to consult with authorized Owner's representative to clarify and item in the specification will, in no way, relieve applicator of his responsibility of satisfactory compliance with these specifications.

2.4 The codes and rules to be taken into consideration are:

2.4.1 The SSPC (Steel Structures Painting Council)

Volume 1: good painting practice

Volume 2: systems and specifications

2.4.2 The SIS 05 59 00, pictorial surface preparation.

2.4.3 The RAL farbregister 840 HR for color identification. See also Appendix-I.

3. SURFACE PREPARATION

3.1

3.1.1 All rough welds, burrs, weld spatter, indentations and all other sharp surface projections shall be ground smooth prior to further surface preparation. Any grinding done after sandblasting shall be blast cleaned to obtain proper anchor pattern, grinding is forbidden on piping systems.

3.1.2 All bolt holes shall be drilled and smoothed before blast cleaning.

3.1.3 All surfaces to be painted shall be blast cleaned to:

SSPC-SP 10 “Near white blast cleaning” per Steel Structures Painting Council (SSPC) surface preparation specification SP-10-63T or

S.A. 2.5 of Swedish Standards Institution SIS 05 5900.

3.1.4 All surfaces shall be blast cleaned to achieve a minimum roughness of 40 to 90 microns.

3.2 Any oil, grease, dust or foreign matter deposited on the surface after the surface preparation is completed shall be removed prior to painting. In the event rusting occurs after completion of surface preparation, the surfaces shall again be cleaned in accordance with the specified method.

3.3 Cleaning shall be discontinued each day in sufficient time to permit the surfaces cleaned to be primed before the end of the working day.

3.4 Dry blast cleaning operations shall not he conducted on surfaces that will be wet after blasting and before painting. If relative humidity is greater than 80 percent, permission to blast shall be obtained from Owner’s Representative.

3.5 Extreme care shall be exercised to prevent damage when blasting near nameplates, machined surfaces and factory-painted items. These surfaces shall be adequately protected.

4. MIXING, THINNING AND STORAGE

4.1 Containers of painting material shall not be opened until required for use and shall be stored under cover.

4.2 Painting material, which has jelled or otherwise deteriorated during storage shall not be used.

4.3 All ingredients in any container shall be thoroughly mixed before use to a smooth and uniform consistency. Mechanical agitation during application shall he sufficient to keep pigment in solution.

4.4 Painting material mixed in the original container shall not be transferred until all settled pigment is incorporated in the vehicle. This does not imply that part of the vehicle may not be poured off temporarily to simplify the mixing.

4.5 Painting material shall not be mixed to keep in suspension by using a bubbling air stream.

4.6 Where a skin has formed in the container, the skin shall be cut loose and discarded. If such skins are sufficiently thick to have a practical effect on the composition and quality, the paint shall not be used.

4.7 All pigmented material shall be strained after mixing except where application equipment is provided with adequate strainers. Strainers shall be capable of passing the pigment and removing and skin.

4.8 Material, which does not have a limit to life or does not deteriorate on standing may be mixed any time before using, but, if settling has occurred, it shall be remixed immediately before using. Painting material shall not remain in spray pots or buckets overnight, but shall be gathered into a closed container and remixed before use.

4.9 No thinner shall be added unless necessary for proper application. Thinning shall not exceed limitations established by Manufacturer.

4.10 Type of thinner shall comply with Manufacture’s instructions.

4.11 When use of thinner is permissible, it shall be added during the mixing process. Painters shall not add thinner after it has been thinned to the proper consistency. All thinning shall be done under an expert’s supervision.

5. PROCEDURE

5.1. Painting Systems

5.1.1 The type, brand, number of Paints and thickness shall be as outlined in painting systems paras of this specification section.

Other brands of painting material shall be used only with Owner's approval.

Adequate time prior to application shall be allowed for Owner to investigate and approve such paintings to prevent delays in completion of facility.

5.1.2 Primers and finish Paints for any particular system shall be from the same manufacturer to ensure compatibility.

5.1.3 Manufacturer's instructions, including safety precautions, arc a part of this specification. In case of conflict, the Manufacturers mandatory instructions shall govern.

5.2. Application

5.2.1 Surfaces shall not be painted in rain, wind, snow, fog, and mist in areas where injurious airborne elements exist, when the steel surface temperature is less than 3°C above dew point, when the relative humidity is greater than 80% or when the temperature is below 5°C.

5.2.2 Blast cleaned surfaces shall be painted with one complete application of primer as soon as practical, but in no ease later than the same day as sandblasted.

5.2.3 To the maximum extent practical, each paint of material shall be applied as a continuous film of uniform thickness free of pores. Any thin spots or areas missed in the application shall be repainted and permitted to dry before the next paint is applied.

5.2.4 Each paint shall be in a proper state of cure or dryness before the application of the succeeding paint. Material shall he considered dry for re-painting when an additional paint can be applied without the development of any detrimental film irregularities such as lifting or loss of adhesion of the under paint.

5.2.5 When successive Paints of the same color have been specified, alternate Paints shall be tinted when practical, sufficiently to produce enough contrast to indicate complete coverage of the surface. When the material is the color of the steel or when the tinting of the final paint is objectionable, the first paint to be applied shall be tinted. The tinting material shall be compatible with the material and not detrimental to its service life.

5.2.6 Brush application of paint shall be in accordance with the following:

- Brushes shall be of a style and quality that will enable proper application of paint, round or oval brushes are most suitable for rivets,

bolts, irregular surfaces and rough or pitted steel, wide, flat brushes are suitable for large flat areas, but they shall not have a width over one hundred and twenty five (125) millimeters.

- The brushing shall be done so that a smooth paint as nearly uniform in thickness as possible is obtained.
- Paint shall be worked into all corners.
- Any runs or sags shall be brushed out.
- There shall be a minimum of brush marks left in the applied paint.
- Surfaces not accessible to brushes shall be painted by spray, daubers or sheepskin.

5.2.7 Air spray application shall be in accordance with the following:

- The equipment used shall be suitable for the intended purpose, shall be capable of properly atomizing the paint to be applied and shall be equipped with suitable pressure regulators and gauges. The air caps, nozzles and needles shall he those recommended by the Manufacturer of the equipment for the material being sprayed. The equipment shall be kept in satisfactory condition to permit proper paint application.
- Traps or separators shall be provided to remove oil and condensed water from the air. These traps or separators shall he of adequate size and shall be drained periodically during operations. The air from the spray gun impinging against the surface shall show no condensed water or oil.
- Ingredients shall be kept properly mixed in the spray pots or containers during application by continuous mechanical agitation.
- The pressure on the material in the pot and of the air at the gun shall be adjusted for optimum spraying effectiveness. The pressure on the material in the pot shall be adjusted when necessary for changes in elevation of the gun above the pot. The atomizing air pressure at the gun shall be high enough to properly atomize the paint, but not so high as to cause excessive fogging of paint, excessive evaporation of solvent or loss by overspray.
- Spray equipment shall be kept sufficiently clean so that dirt, dried paint and other foreign materials are not deposited in the paint film. Any solvents left in the equipment shall be completely removed before applying paint to the surfaces being painted.
- Paint shall be applied in a uniform layer with overlapping at the edge of the spray pattern. The spray pattern shall be adjusted so that the paint is deposited uniformly. During application, the gun shall be held perpendicular to the surface and at a distance which will ensure that a wet layer of paint is deposited on the surface.
  The trigger to the gun shall be released at the end of each stroke.

- All runs and sags shall be brushes out immediately or the paint shall be removed and the surfaces repainted.

- Areas inaccessible to the spray gun shall be painted by brush; if not accessible by brush, daubers or sheepskins shall be used. Brushes shall be used to work paint into cracks, crevices and blind spots which are not adequately painted by spray.

- Particular precautions are necessary in spraying inorganic zinc. These are listed in the Manufacture's instructions.

5.2.8 All nameplates, manufacturer's identification tags, machined surfaces; instrument glass, finished flange faces, control valve stems and similar items shall be masked to prohibit painting deposition. If these surfaces are painted, the component shall be cleaned and restored to its original condition.

5.2.9 Edges of structural shapes and irregular painted surfaces shall be painted first and an extra full pass made later.

5.2.10 Contact surfaces of all components (bottom of skids, mounting surfaces of equipment etc...) are included in the scope of work to be painted.

5.2.11 Wet paint shall be protected against contamination from dust or other foreign matter.

5.3. Drying of Painted Surfaces

5.3.1 No paint shall be applied until the preceding paint has dried. The material shall be considered dry for repainting when another paint can be applied without the development of any film irregularities such as a lifting or loss of adhesion to under paints and the drying time of the applied paint does not exceed the maximum specified for it as a first paint.

5.3.2 No paint shall be force dried under conditions which will cause checking wrinkling, blistering, formation of pores or detrimentally affect the condition of the paint.

5.3.3 No drier shall be added to paint on the job unless specifically called for in the manufacturer's specification for the paint.

5.3.4 Paint shall be protected from rain, condensation, contamination, snow and freezing until dry to the fullest extent practical.

5.4. Repair of Damaged Paint Surfaces

Where shop paint has been damaged in handling, all damaged and loosely adhering paint shall be removed and the surface thoroughly cleaned. Edges of the breaks shall be feathered and designated number of prime and finish Paints applied.

6. INSPECTION

6.1 All work and materials applied under this specification will be subject to inspection by the Owner's representative.

6.2 All parts of the work shall be readily accessible to the inspector.

6.3 Approval of each of the following shall be obtained before proceeding with any subsequent phase:

- Location of work
- Equipment
- Surface preparation
- First paint
- Each subsequent paint

6.4 Applicator shall meet the painting requirements which conform to this specification for overall painting and any painting found defective as per this specification.

6.5 The painting work Q.C. shall be undertaken in five (5) steps according to the hereunder sequence:

6.5.1 The sandblasting required grade shall be checked by means of a surface preparation tester, elcometer dial gauge model 123 or equivalent.

6.5.2 The surface cleanliness, result of the surface preparation step, will be checked by means of the elcometer model 153 "Surclean" or equivalent.

6.5.3 An in-process checking will be given to check the wet film thickness by means of the elcometer model 115 or model 120.

6.5.4 After painting, the dry film thickness shall be measured by means of an elcometer dial gauge model 126.

6.5.5 The painting integrity testing will be achieved by the use of a holiday detector "Pinhole Detector" model 104 or 169 according to the D.F.T. In ease of lack of paint detection, the inspector shall mark the holiday to indicate the location of repair work to be performed.

7. PAINTING SYSTEMS

7.1. PAINTING SYSTEM-1

For carbon steel, EXTERIOR SURFACE of vessels, structural piping, pumps, etc. operating up to 80°C.

	Prime Coat	Intermediate Coat	Finish Coat
Type	Inorganic Zinc	Amine or Polyimide Cured High Build Epoxy	Polyurethane Enamel
Number of coats	1	1	1
DFT, microns/coat	75	125	40
Supplier NAPKO CARBOLINE AMERON	 NAPKO 5Z CARBOLINE 11 AMERON 6	 NAPKO 5805 CARBOLINE 190HB AMERON 85	 NAPKO CARBOLINE B22 AMERON 450

7.2. PAINTING SYSTEM-2

For carbon steel EXTERIOR SURFACES of vessels, piping, pumps, etc. operating from 80°C to 150°C.

	Prime Coat	Intermediate Coat	Finish Coat
Type	Inorganic Zinc	Polyurethane	Polyurethane
Number of Coats	1	1	1
DFT, microns/Coat	75	40	40
Supplier NAPKO CARBOLINE AMERON	 NAPKO 5Z CARBOLINE 11 AMERON 6	 NAPKO 5900 CARBOLINE B22 AMERON 450	 NAPKO 5900 CARBOLINE B22 AMERON 450

7.3. PAINTING SYSTEM-3

For carbon steel, EXTERIOR SURFACE of vessels, piping, pumps, etc. operating from 150°C to 500°C.

	Prime Coat	**Intermediate and Finish Coat**
Type	Inorganic Zinc	Modified Silicon
Number of Coats	1*	1*
DFT, microns/paint	75	25 – 40
Supplier NAPKO CARBOLINE AMERON	 NAPKO 57-1375 RED ZINC CARBOLINE 11	 NAPKO 6003 thermal flex CARBOLINE 4631 AMERON 1778

* No Ameron Prime Paint but two 25-40 M topcoats.

8. PAINTING SYSTEMS FOR EXTERIOR SURFACES

For carbon steel surfaces of cabinets and control panels for instrument and electrical of cabinets, panels, etc.

	Prime Coat	**Intermediate and Finish Coat**
Type	Wash Prime	Aliphatic Polyurethane
Number of Paints	1	1
DFT, microns/paint	75	25 – 40
Supplier NAPKO CARBOLINE	 NAPKO 3326 CARBOLINE 1037 WP	 Napthane 5900 CARBOLINE B22

INTERIOR SURFACES of cabinets, panels, etc. same as EXTERIOR SURFACES, but with only one finish paint.

Painting for exterior surfaces of all ladder, grating, ladder cages, platforms, stairways and handrails.

	Prime Coat	**Finish Coat**
Type	Inorganic Zinc	Polyurethane Enamel
Number of Coats	1	1
DFT, Microns/Coat	100	75
Supplier NAPKO CARBOLINE	 NAPKO 5690 CARBOLINE 190 HB	 Napthane 5900 CARBOLINE B22

Note: The here above indicated trademarks are to be considered as indicative only. Other paints may be proposed provided they are previously approved in writing by the Owner.

Section – 2

1. LABOR

All steps pertaining to painting works shall only be performed by skilled personnel duly qualified to do so. The Contractor shall have its own supervision personnel working in relation with the Owner's quality control personnel.

2. PROTECTION OF WORKS

2.1. Works under Progress

All necessary protection steps shall be taken to protect works under progress from dust and a sufficient supply of clean drop clothes shall be foreseen. The Contractor shall lay such drop clothes in all areas where the painting works under progress are to be protected.

2.2. Other Works

For the same reasons and in the same manner, the Contractors shall lay drop clothes in all areas where painting is being done, to protect floors, machinery and equipment as well as other work, from damage during the prosecution of painting works.

As a general rule, spilled paint should be cleaned up immediately.

3. SAFETY AT WORK

3.1. Personnel Safety

The personnel safety at work is a very important point to be considered during painting works, as the hazards encountered are equal to working in chemical plants, i.e. particularly dangerous.

The personnel safety shall be granted by means of special personal equipment such as:

- Splash proof goggles to be worn during chipping, wire brushing, sandblasting, spraying, etc.
- Rubber gloves to be worn when using paint removers, acid treatment, cleaning compounds, etc.
- Safety belts when working inside tanks, on high equipment such as bridges, structural steel works, water towers, etc.
- Air line mask when sandblasting, spraying toxic products, etc.

3.2. Safety Equipment

3.2.1. Ladders

All extension and straight ladders should be equipped with safety shoes.

All ladders should be inspected once a month and the defectuous units discarded from the site.

No metal ladders are allowed to be used where electric cables or sources are installed.

It is reminded that neither piping nor equipment is to be used to support painters, ladders or scaffolding.

3.2.2. Swinging Stages and Scaffoldings

Swinging stages and scaffoldings shall always have a backrail.

They shall be tested with twice the load they will be expected to bear in service.

Provision shall be included on the back of the backrail for providing suitable support for all hand tools that may be used. All tools shall be kept in this support when not in use.

3.3. General Precautions

Other recommendations:

- When working around pulleys, gears, drive shafts, other moving parts, or inside tanks. Fuses should be pulled or drive belts removed. When working in any vessel, all lines coming to or leading from the vessel should be blanked or plugged.
- Overhead danger signs should be used when working near walkways, over doorways, platforms or roadways.
- Do not use paints containing a volatile solvent in enclosed areas where welders are at work.
- Use chemical type respirators when doing any spray painting except when in front of a proper spray booth.
- Face shields should be worn when using power cleaning tools and chipping hammers.
- Do not use Manila or hemp ropes for scaffolds in acid areas. Use nylon ropes or cables.
- Place equipment such as compressors, ladders or scaffolds more than 7 meters away from the centre of road tracks.
- Wear rubber gloves when using spark tester for locating breaks or pores in paintings.
- Do not seal paint cans of ready-to-mix paints after they have been mixed. These materials are not stable when mixed. For temporary storage punch a hole in the lid.

APPENDIX -1

COLOR SCHEDULE - MARKING

1. SCOPE

This appendix is intended to establish a common system to assist in identification of fluids conveyed in piping systems as well as painting of vessels, tanks, structural steel and miscellaneous other items included in the project.

2. DEFINITIONS

2.1. System

Piping system shall include pipes of any kinds and, in addition, fittings, valves and other miscellaneous devices involved in the piping field.

2.2. Tanks and Vessels

Tanks and vessels shall include all liquid containers, pressurized or not, vertical or horizontal, provided that they are not buried, and allowing storage of the different fluids handled for operational arid safety purposes.

2.3. Structural Steel

Structural steel works shall include all platforms gangways, ladders, safety cages, building structures, as well as skids, supports, etc foreseen for access and/or safety purposes and mechanical needs of the project.

2.4. Handling Devices

Handling devices shall include all necessary means of lifting, transportation and/or handling purposes.

It shall include all cranes, davits, overhead traveling cranes.

3. METHOD OF IDENTIFICATION

3.1. Marking

Positive identification of the content of a piping systems or vessel shall be by lettered and numbered legend. Arrows shall be used to indicate direction of flow. The identification of piping marking will refer to the line number shown in the P. and I.D.

The content of vessels and tanks shall be indicated in full (not abbreviated) and the tank or vessel identification number painted in a quiet visible location. Depending on the size of the tanks, several markings may be required, diametrically distributed, for example.

Marking shall be applied close to valves and adjacent to changes in direction, branches and where the pipes pass through walls or floors, and at frequent intervals on straight pipe runs. Not less than (5) five meters.

3.2. Color

See enclosed color schedule.

3.3. Visibility

Attention shall be given to visibility with reference to pipe markings. Where the pipes are located above or under the normal line of vision, the marking shall be placed above or under the pipe centre lines.

3.4. Type and Size of Markings

3.4.1. General

Maximum contrast shall be provided between color field and markings for readability.

The enclosed color schedule gives the requirements for piping and equipment painting. The color field is to be strictly adhered to.

The stripes or bands foreseen for the marking of piping systems shall not interfere with the pipe marking.

3.4.2. Size of Letter and Numbers

Unless specifically indicated by the material particular specification, the size of marking letters and numbers will be as follow:

Outside Diameter of Pipe or Equipment	Size of letters and numbers
¾” to 1 1/2 “ (19 – 32 mm)	15 mm
1 ½” to 2” (38 – 61 mm)	20 mm
3” to 6” (90 – 170 mm)	35 mm
8” to 10” (220 – 275 mm)	65 mm
12” to 16” (320 – 410 mm)	90 mm
18” to 24” (455 – 610 mm)	100 mm
Over 24” (Over 610 mm)	150 mm for piping 200 mm for equipment

COLOR SCHEDULE

1. PIPING

Items	Part	Color Field	Marking Color
1.1	Piping for all services	Grey RAL7031	White RAL 1013

2. EQUIPMENTS

Items	Part	Color Field	Marking Color
2.1	All Equipments	Grey RAL7031 (Note-1)	Black RAL 9005

Note 1- Vendor can use its own standards of painting.

3. STRUCTURAL STEEL

Item	Part	Color Field	Marking Color
3.1	All Structure	Grey RAL7031	No marking

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PROJECT	**SULFUR RECOVERY UNIT FOR DAKHNI EXPANSION**
TITLE	**SPECIFICATION FOR INSULATION**

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1 SCOPE

This specification covers the general requirements, acceptable materials, thickness of insulation and methods of application for insulation of vessels, heat exchangers, furnaces, piping and pumps for hot service inside and outside the process area with calcium silicate.

2 DEFINITIONS

2.1 **Hot service**: The hot service generally means operating temperatures, ambient and above.

2.2 Term "Indoors" shall be defined as any enclosure, which shelters the equipment and piping to be insulated from any contact with moisture of the outdoor weather.

A building with partial side walls (openings limited to 2.4 M above floor) comply with this definition of indoors.

2.3 The term cylindrical surfaces shall apply to equipment such as tanks, vessel shells, heat exchangers, etc. as well as piping.

2.4 The term seal for bands mean machine tightened bands.

3 REFERENCE DOCUMENTS

3.1 OEL Design Guide Lines-Insulation Hot Service Specification for hot insulation-hot Services (Spec No. 4908-PA-2012)

3.2 Applicable Codes/Standards

1) General Industry Standard

2) Materials, Relevant ASTM Specification (insulation, covering material etc.)

4 GENERAL REQUIREMENTS

4.1 All materials shall be protected from weather and damage during all stages of handling and application.

4.2 Insulation shall not be applied to any component (piping vessel or other equipment) unless it has been inspected, tested and approved for the service.

4.3 The surfaces to be insulated shall be coated with suitable primer in accordance with the painting specification (1029-95-05-SP-006) except stainless steel surface.

4.4 All surfaces to be insulated shall be hand cleaned to remove any loose rust, paint, dirt, grease or any other foreign matter prior to the application of insulation.

4.5 Materials shall be applied in a manner to reduce shrinkage to a minimum. Excessive cracks that develop in any material shall be repaired with a like material.

4.6 Materials shall follow ASTM standards, latest edition, substitute material will be considered only if the manufacturer guarantees that they are equal or superior than the specified.

4.7 All insulation materials, mastics etc. to be used on equipment or piping subject to stress, corrosion, cracking such as austenitic stainless steel, shall be guaranteed as these which do not contribute to stress corrosion cracking. For each one (1) ppm of bleachable chlorine in the materials the material shall contain a minimum of 20 ppm sodium silicate.

4.8 Insulation containing more than 800 ppm of chloride is not acceptable for use on Austenitic steel.

4.9 For austenitic stainless steels containing molybdenum (31 6 type etc.) and operating at or about 815°C (1500°F) insulation containing sodium silicate is not acceptable.

4.10 Materials composed of asbestos fibers shall not be used.

4.11 Aluminum covering, when used with insulations or materials which are chemically reactive with aluminum, shall be protected on the under side by asphalt, polyethylene, or equal protective barriers

4.12 Aluminum jacketing shall not be used on any equipment or piping whose maximum normal or short term operating temperature exceeds 1100 °F (500^0C).

4.13 Galvanized or zinc coated materials shall not be used on any equipment or piping whose maximum, normal or short term operating temperatures exceeds 700°F (370°C).

4.14 Name plates on hot equipment shall not be insulated. Insulation shall be tapered on a 45 degree angle to the name plate, covered with aluminum flashing and sealed with a caulking compound.

5 HOT SERVICE INSULATION INSTALLATION

Hot service insulation will be installed as described in the following paragraphs.

5.1 Hot service insulation with the exception of that specified in Paragraph 5.3 for sulfur recovery plants and insulation for personnel protection as specified in Paragraph 5.2 shall be applied in the following manner. Insulation shall be stopped short of nozzles, manways, flanges and unions to permit removing bolts or breaking unions without damaging the insulation. The insulation shall be tapered at these points on 45-degree angle and finished with a 45-degree aluminum terminus bevel.

5.2 Personnel protection insulation shall be provided only as shown on the piping drawings or models. Insulation required for "personnel protection" shall include all pipes up to a height of 7'-0" above grade at operating temperatures of 160°F or above that do not have hot service insulation, with the exception of compressors headers and lead lines.

5.3 In sulfur recovery plants, the hot service insulation specifications with the following additional requirements shall be applicable.

5.3.1 All vessel nozzles, vessel manways openings, flanges, and valve bodies, block or control, in sulfur vapor lines and in liquid sulfur handling lines shall be insulated and covered. Vessel manways insulation covers shall be removable. All flanges in sulfur pump discharge lines shall be insulated and covered.

5.3.2 The insulation for bolted connections shall be installed after the sulfur recovery plant is heated up and placed in operation. The sulfur leaks shall be detected and stopped prior to applying the insulation. "Hot-Bolting" shall be completed before bolted connections are covered with insulation. Surfaces, which are impractical to insulate, shall be primed and painted per Specification (1029-95-05-SP-006).

5.4 Circumferential insulation joints shall be staggered one-half a section or block length.

5.5 Circumferential and longitudinal joints in aluminum final coverings shall be arranged for good water drainage and lapped a minimum of 2" on piping and 3" on vessels and exchangers. The manufacturer's standard overlap for preformed and precut materials is acceptable.

5.6 Instrument insulation will be shown on the instrument detail drawings where ever applicable.

6 PROTECTION

6.1 The insulation shall be protected from moisture and weather effects before and during application.

6.2 All insulation shall be dry and fee from moisture prior to application of insulation finish.

6.3 If bare insulation cannot be finished before the end of the working day, it shall be protected to prevent the insulation from becoming wet.

6.4 The finish covering shall be applied as soon as possible after the insulation has been secured.

6.5 Sharp edges of insulation shall be well removed for protection.

7 THICKNESS OF INSULATION

7.1 The required nominal thickness of thermal insulation is indicated on equipment data sheets, P&IDs and Piping Drawings

7.2 If insulation is not available in thickness specified, the next larger commercially available thickness shall be used.

7.3 Exact extent of insulation is indicated on relevant piping and equipment drawing.

7.4 For "Hot Service" multilayered insulation shall only be used when required thickness is not available in single layer or exceeds 3" (75mm).

8 EXTENT OF INSULATION

8.1 INSULATION REQUIREMENT CODE

The insulation requirement code indicates what insulation is needed and is as follows for Hot Service.

Legend	Description
(H)	Heat Conservation Insulation
(P)	Personnel Protection Insulation
(EL)	Electric Heat Tracing
(T)	Steam Tracing insulation

8.2 LIMITATIONS

8.2.1 (P) Personnel Protection Insulation shall be applied to surfaces, which satisfy both of the following conditions:

Temperature of the surface shall be above 150°F (65°C)

The surface must be confined within normal working areas and be located where personnel inadvertently could contact the surface.

8.2.2 (P) Insulation shall extend as follows:

Insulated to a height of 7 feet (2.15m) above the floor or platform level

Within 2' (600mm) from the platform edges

Caps between items requiring (P) insulation shall be insulated when the un-insulated portion would be less than 10' (3m)

8.2.3 Pump cases, coolers and condensers shall normally not receive (P) insulation

8.2.4 The configuration of insulation for special considerations shall be determined for each specific case, e.g. protection against extremes of atmospheric temperatures in stagnant lines.

8.2.5 Vessels, piping and other equipment not insulated for heat conservation or personnel protection shall be insulated if required for process control. If process control insulation is required where operating temperatures are below 65^0C special consideration shall be given to weatherproofing, applications, and material selection to prevent corrosion and infiltration of atmospheric moisture.

9 MATERIALS

9.1 Insulation and finish materials for "Hot Service" shall use the materials and the application specified in this specification.

9.2 The insulation material selected for "Hot Service" shall be mineral Fiber.

9.3 Materials are described as under:

9.3.1 **BLANKET INSULATION:** stitched mats faced with galvanized wire mesh on one face for piping and ducts, and on both faces for vessels

and tanks. The material shall comply with ASTM specification and be suitable for use upto 1200°F.

9.3.2 **SHEET METAL SCREWS**: For sheet lap joints No.7, 5/32”x 3/8”Long (approx. 4mm x l0mm long), aluminum pan head self-tapping, type A (or AB), with neoprene washers under head.

9.3.3 **LAP SEALER**: A suitable flexible plastic sealing compound for all lap joints, except expansion joints shall be used.

9.3.4 **STAINLESS STEEL BANDS**: 3/4" x 0.02" (approx. 20mm x 0.5mm) with necessary seals.

9.3.5 **SELF TAPPING SCREWS**: For fastening Galvanized sheets to steel supports: 1/4" x 1/2" long (approx. 6mm x 12.5mm long) stainless steel, hexagon head, self tapping type, type B with neoprene washers under head.

9.3.6 **SEALING COMPOUND**: A heavy semi-viscous paste composed of inorganic fibres, non drying oils and pigment coloring agents, Stalastic high temperature grade of the Eagle Picher Co. or Equivalent.

9.3.7 **WELDED HOOKS (CLIPS**): 4-6 mm, dia.

9.3.8 **STEEL SPACER**: For weatherproofing holding.

9.3.9 **GALVANIZED STEEL SHEETS**: galvanized steel sheets complying with ASTM Specification A527. Sheet thickness to be as follows:

A- Equipment 24 BWG

B- Piping 26 BWG

9.3.10 **THERMAL INSULATING AND FINISHING CEMENT**: as per ASTM Specification C449, thickness of layer 10mm.

9.3.11 **MASTIC WEATHER-PROOFING COATING**: Fibrated mastic or vinyl suspension in ready mixed form, self-extinguishing, elastic and durable under extreme weather condition, thickness of layer 3mm when dry, finished to smooth surface. Or Equivalent

9.3.12 **MACHINE BOLTS:** hexagonal, H12 x 35mm under head, with hexagonal nut, stainless steel.

9.4 When tracing (EL) is indicated pipe insulation must be at least one size larger than noted pipe size.

10 INSULATION FOR CYLINDRICAL SURFACES

10.1 The open end of all insulation shall be neatly beveled either by leveling the insulation or by using finish or insulating cement.

10.2 Insulation adjoining un-insulated flanges shall be beveled down and terminated at a suitable distance from the flange to allow easy removal of

nuts and stud bolts without damage to the insulation [length of flange bolts plus 1 " (25mm)].

10.2.1 To seal the insulation to the pipe a conical flushing collar of the jacket material or high temperature sealing compound shall be installed over the beveled insulation termination, extending 1" (25mm) onto the pipe and pipe insulation.

10.2.2 A bead or fillet of heat resistant sealer shall be applied to flush the colar to the pipe.

10.3 Pipe resting directly on steel supports shall have the bottom section of insulation cut back a minimum of 6" (150mm) from either end of the supporting steel and for outdoor exposure shall be flushed with sheet metal of jacket material and sealed.

10.4 Vertical vessels will be provided with support angle rings attached by vessel fabricator.

10.5 Support rings shall be 1/2" (13mm) less than the insulation thickness.

11 INSULATION FOR HEADS AND SKIRTS

11.1 The heads of both vertical and horizontal equipment shall be insulted using blankets trimmed to ft the contour of the head.

11.2 Insulation on bottom heads only shall be held in place by wire bands attached to blank 3/" to 5/8" (9.5mm to 16mm) nuts which have been welded to the head on maximum 12" (300mmn) centers.

11.2.1 If blank nuts have not been provided, the insulation shall be secured by use of a floating ring of 3/" (9.5nun)-diameter carbon steel rod positioned in the center of the head and over the insulation as shown in detail.

11.2.2 The floating ring shall not contract nozzles or any other protruding metal.

11.2.3 One end of a band shall be fastened to the floating ring and the other end shall be anchored to a band(s) or ring welded around the cylindrical section of the vessel close to the head of the ring, if used, to be supplied and attached by the vessel fabricator.

11.2.4 Additional hold down bands 3/" (20mm) wide shall be similarly installed and shall be spaced on 12" (300mm) centers measured around the equipment's circumference.

11.2.5 On vessels that are skirt supported, the ring will be welded to the inside of the skirt.

11.3 Insulation on the outside of skirts below the shell insulation support ring and insulation on the inside of skirt shall be one half the shell insulation thickness or minimum 1" (25mm).

11.4 All equipment heads shall receive a layer of 1"(25mm) hex mesh No. 20 gage (0.89mm wire) galvanized or stainless (above 800°F (427°C) poultry netting and a 1/2" (13mm) thick layer of insulation cement troweled to a smooth finish.

12 ATTACHMENTS

12.1 Code inspection plates, stampings, name plates, data plates, etc., on equipment shall be left visible by cutting back the insulation and properly sealing openings against moisture penetration with high temperature flashing compound.

12.2 The insulation contractor shall furnish and install and clamp insulation supports on long vertical piping runs.

12.2.1 If vertical lines are steam or electric traced, these supports shall provide clearance provision for the tracer.

12.2.2 Insulation supports shall be in accordance with dimensions presented in details and shall be installed at 12'-1" (3680 mm) intervals (maximum).

12.3 Attachments beyond the insulation line on equipment such as stiffening rings shall be considered an integral part of the equipment and shall be insulated and finished in the same manner as the equipment proper.

12.4 Thickness of insulation on such attachments and projections shall be the same as the adjoining insulation.

13 VOIDS AND OPENINGS

13.1 All insulation sections shall be trimmed and tightly butted to eliminate voids.

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

13.3 Openings through the insulation finish shall be flashed "Moisture tight".

13.4 When standard flat blocks trimmed to ft are used in the field, all joints should be pointed up with insulating cement before applying jacketing or mastic finish.

14 FINISH - INDOORS

14.1 The covering for insulation on exposed piping and equipment located indoors shall be mastic reinforced with glass cloth plastic or aluminum jacketing.

14.1.1 Mastic shall be applied in two coats with the cloth in between and over-lapping by 3"(75mm) (minimum).

14.1.2 The completed reinforced mastic covering shall be 1/16" (1.6mm) thick minimum (dry).

15 FINISH OUTDOORS EXPOSURE

15.1 On all vertical lines, self-tapping sheet metal screws, 3/8" (9.5mm) long on maximum 12" (300min) circumferential centers shall be installed through every other circumferential lap to support the jacket.

15.2 On horizontal piping 30" (760mm) O.D. and smaller, the jacketing shall be secured with self tapping sheet metal screws installed on 10" (250mm) centers maximum, through the longitudinal lap.

15.3 On horizontal piping larger than 30" (760mm) O.D., the jacketing shall be secured with 3/4" x 0.020"(20mm x 0.5mm) thick stainless steel bands and seals placed over each circumferential overlap and on maximum 10" (250mm) centers.

15.4 Jacketing for cylindrical surfaces over 30" (760mm) O.D. shall be secured over each circumferential overlap and at the center of each course of jacketing.

15.5 Jacketing for cylindrical surfaces over 30" (760mm) insulation O.D. shall be secured with 3/4" (20mm) bands and seals [10" (250mm) centers maximum] placed over each circumferential overlap and at the center of each course of jacketing.

15.6 The finish covering for outdoor insulation shall be galvanized steel sheet for vessels and exchangers.

15.7 The finish covering or jacketing for the upper course shall overlap the lower course.

15.8 Jacketing for horizontal and vertical piping shall be applied with 3" circumferential and longitudinal laps.

15.9 Jacketing for horizontal and vertical cylindrical surfaces other than piping shall be applied with 3" (75mm) circumferential and longitudinal laps.

15.10 The finish longitudinal lap on horizontal equipment and piping shall be positioned to shed rain water and minimize dust collecting.

15.11 All longitudinal joints shall be secured with sheet metal screws or aluminum [upto 1100°F (600°C) pop rivets placed on 6" (150mm) centers].

15.12 The heads of vessels and exchangers, as well as irregular surfaces shall normally be finished with metal jacketing but reinforced mastic will be considered as an alternate.

16 FLANGE AND VALVE INSULATION

16.1 Flange and valve insulation shall consist of successively larger nesting sizes of pipe insulation to form a housing around the valve body.

16.2 The required thickness of insulation shall be equal to that of adjacent insulation.

16.3 Valve insulation shall be removable and replaceable.

APPENDIX-I

Material for Insulation Requirement Codes.

I. Mineral Wool

a) Mineral Fiber Blanket Type Ins. Compliance with ASTM C-592 or equal

Manufacturer	Brand Names	Temperature imitations
Eagle Picher	Mineral Fibre Blanket	1440 OF (760 °C)
Forty Eight	Metal Mesh Blanket 8 lb. Den	1200 °F (650 °C)

APPENDIX-II

JOINTING MATERIALS & MAN UFCTURERS

A-3 Finishing Cement, Hydraulic Setting, ASTM C-449:

a) Philip Carey - MW-One.

b) Johns-Manvile - No. 375 Cement.

c) Eagle-Picher Ind. Inc. -- One Cote

Above or equal

APPENDIX-III

FASTENING DEVICES & MANUFACTURERS

B-I Rod, 3/8" (9 min) Diameter Carbon Steel:

a) Bethelehem Steel.

b) United States Steel.

B-2 Sheet Metal Screws (pan Head "A" Type) - Stainless (Tyupe 304) or Aluminum

Self tapping:

a) Childers Products Co.

b) Premetco Intl.

Above or equal

APPENDIX-IV

COATING ACCESSORIES & MANUFACTURERS

C-1 Breather Mastic Vinyl Acrylic Emulsion:

a) Childers Prod. Co. - Vi-Cry! CP-10/11.

b) Foster Division Sealfaxs G-P-M 35-0

c) Insul-Coustic Co. I-C 551 VI-AC.

d) Virnasco-WC-1.

C-3 1" (25 mm) Galvanized Hex Mesh:

a) Galvanized Wire Mesh

C-6 Vapor Barrier Coating:

a) Foster Div. - 60-36.

b) Insul. Coustic-IC571 M-O-H Mastic.

c) Matrote -Dutyl Rubber

Above or equal

APPENDIX -V

JACKETING ACCESSORIES & MANUFACTURES

J-6 Galvanized Steel, Smooth Jacketing. Minimum thickness .010" (0.25 mm) for pipe, tanks and towers:

a) Childers Products Co

b) Insul-Coustic "TUF Jac".

Above or equal.

APPENDIX- VI

INSULATION & JACKETING SECUREMENTS & MANUFACTURERS

S-1 Bands and Seals (including expanding bands) stainless steel (Type 304):

a) Childers Products Co.

b) Premetco Intl.

c) Techalloy Incorporated (Breather Springs only).

S-2 Tie Wire-stainless steel (Type 304). Stainless wire shall be annealed. (16 gauge (1.57 mm) minimum):

a) Childers Products Co.

b) Premetco.

Above or equal.

APPENDIX- VII

Thickness Table (Equipment and Piping)

Nominal Pipe Size (NPS)	Temperature, Fahrenheit									
	70 to 300	301 to 400	401 to 600	601 to 800	801 to 1000	1001 to 1100	1101 to 1200	1201 to 1300	1301 to 1400	1401 to 1500
	Insulation Thickness in inches									
1-1/2" and smaller	1-1/2	1-1/2	2	3	3-1/2	3-1/2	4	4	4-1/2	4-1/2
2"	1-1/2	1-1/2	2	3	3-1/2	3-1/2	4	4	4-1/2	5
3"	1-1/2	2	2-1/2	3-1/2	3-1/2	4	4	4-1/2	5	5-1/2
4"	1-1/2	2	2-1/2	3-1/2	4	4	4-1/2	5	5-1/2	6
6"	2	2	3	3-1/2	4	4-1/2	4-1/2	5	5-1/2	6
8"	2	2-1/2	3	4	4-1/2	4-1/2	5	5-1/2	6	6-1/2
10"	2	2-1/2	3	4	4-1/2	5	5	5-1/2	6	7
12"	2	2-1/2	3-1/2	4	5	5-1/2	5-1/2	6	6-1/2	7
14"	2	2-1/2	3-1/2	4-1/2	5	5-1/2	6	6	6-1/2	7
16"	2	2-1/2	3-1/2	4-1/2	5	5-1/2	6	6	6-1/2	7-1/2
18"	2-1/2	3	3-1/2	4-1/2	5-1/2	5-1/2	6	6	7	7-1/2
20"	2-1/2	3	3-1/2	4-1/2	5-1/2	5-1/2	6	6	7	7-1/2
24"	2-1/2	3	3-1/2	4-1/2	5-1/2	6	6	6-1/2	7	8
30"	2-1/2	3	3-1/2	4-1/2	5-1/2	6	6	6-1/2	7	8
36"	2-1/2	3	3-1/2	4-1/2	5-1/2	6	6	6-1/2	7-1/2	8
Over 36" to Flat	2-1/2	3	4	5	6	6-1/2	7	7	8	8
Single Layer of Insulation				Multiple Layers of Insulation						

Note: Full Insulation thickness may be used in place of multiple layers

APPENDIX- VIII

Thickness Table (Personnel Protection)

Nominal Pipe Size (NPS)	Temperature, Fahrenheit									
	70 to 300	301 to 400	401 to 600	601 to 800	801 to 1000	1001 to 1100	1101 to 1200	1201 to 1300	1301 to 1400	1401 to 1500
	Insulation Thickness in inches									
1-1/2" and smaller	1	1	1-1/2	2-1/2	3	3-1/2	3-1/2	4	4-1/2	4-1/2
2"	1	1	2	2-1/2	3	3-1/2	4	4	4-1/2	5
3"	1	1	2	2-1/2	3-1/2	3-1/2	4	4-1/2	5	5-1/2
4"	1	1	2	2-1/2	3-1/2	4	4-1/2	5	5	5-1/2
6"	1	1-1/2	2	3	3-1/2	4	4-1/2	5	5-1/2	6
8"	1	1-1/2	2	3	4	4-1/2	5	5-1/2	6	6-1/2
10"	1	1-1/2	2	3	4	4-1/2	5	5-1/2	6	7
12"	1	1-1/2	2	3	4	4-1/2	5	6	6-1/2	7
14"	1	1-1/2	2	3	4	4-1/2	5-1/2	6	6-1/2	7
16"	1	1-1/2	2	3	4	5	5-1/2	6	6-1/2	7-1/2
18"	1	1-1/2	2-1/2	3	4-1/2	5	5-1/2	6	6-1/2	7-1/2
20"	1	1-1/2	2-1/2	3-1/2	4-1/2	5	5-1/2	6	7	7-1/2
24"	1	1-1/2	2-1/2	3-1/2	4-1/2	5	5-1/2	6-1/2	7	8
30"	1	1-1/2	2-1/2	3-1/2	4-1/2	5	6	6-1/2	7	8
36"	1	1-1/2	2-1/2	3-1/2	4-1/2	5-1/2	6	6-1/2	7-1/2	8
Over 36" to Flat	1	1-1/2	2-1/2	3-1/2	4-1/2	5-1/2	6	6-1/2	7-1/2	8
Single Layer of Insulation				Multiple Layers of Insulation						

Note: Full Insulation thickness may be used in place of multiple layers

APPENDIX- IX Sketches

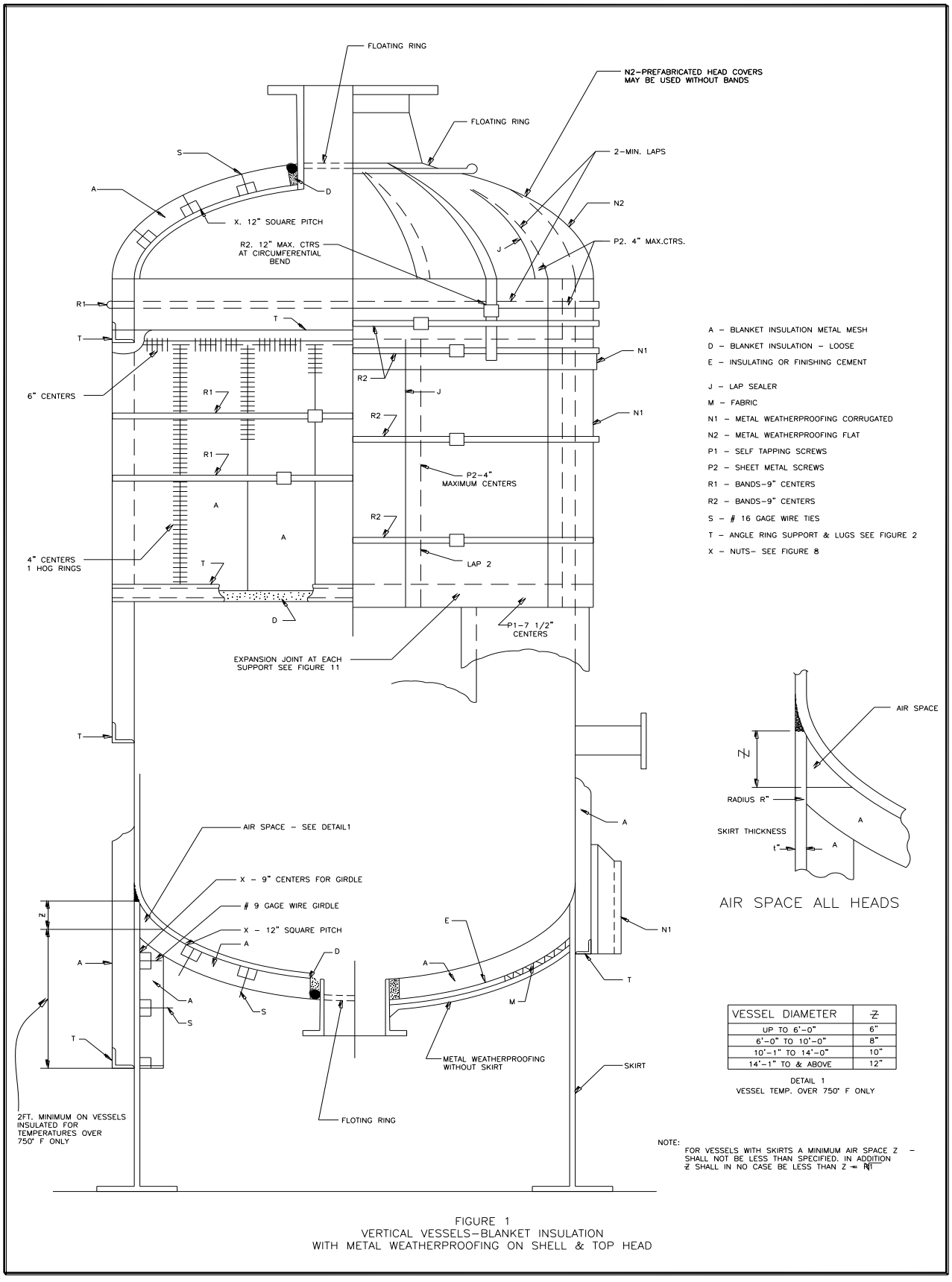
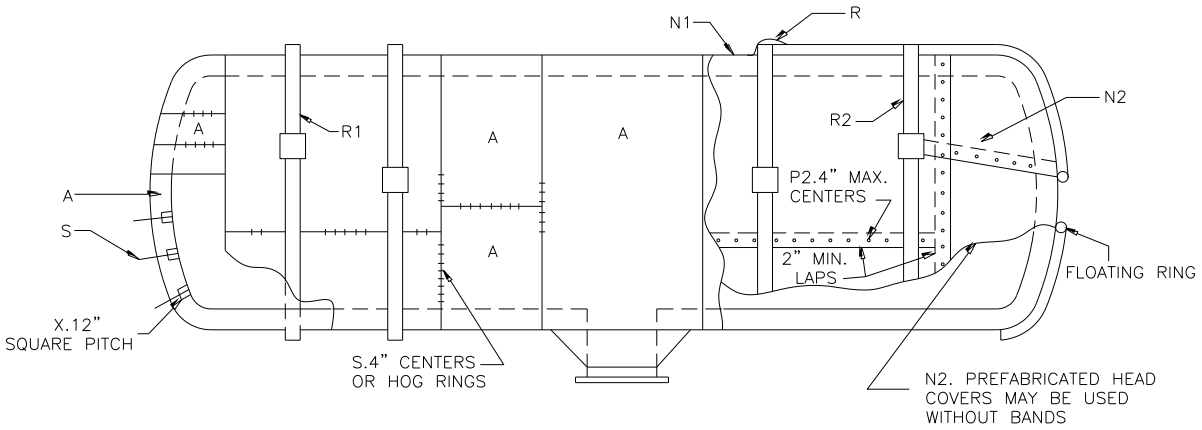


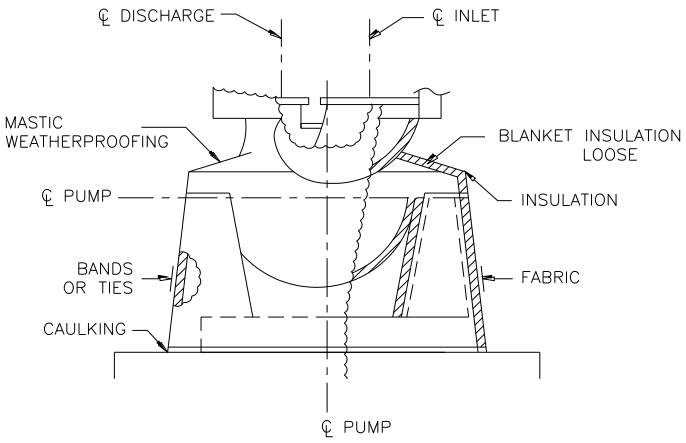
FIGURE 1
VERTICAL VESSELS–BLANKET INSULATION
WITH METAL WEATHERPROOFING ON SHELL & TOP HEAD



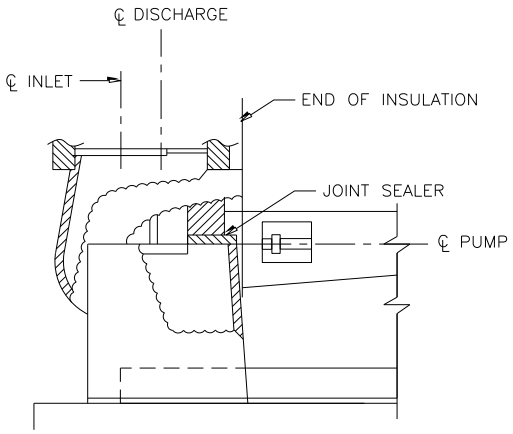
A– BLANKET INSULATION–METAL MESH
N1– METAL WEATHERPROOFING–CORRUGATED
N2– METAL WEATHERPROOFING–FLAT
P2– SHEET METAL SCREWS
R– BANDS . 12" CENTERS CIRCUMFERENTIAL BAND

R1– BANDS . 9" CENTERS
R2– BANDS . 9" CENTERS
S– #16 GAGE WIRE TIES
X– NUTS . SEE FIGURE 8

FIGURE 2
HORIZONTAL VESSELS AND EXCHANGERS WITH
BLANKET INSULATION AND METAL WEATHERPROOFING



CENTRIFUGUL



NOTE: COMPRESSOR INSULATION DETAILS SIMILAR

FIGURE 3
PUMP INSULATION DETAILS

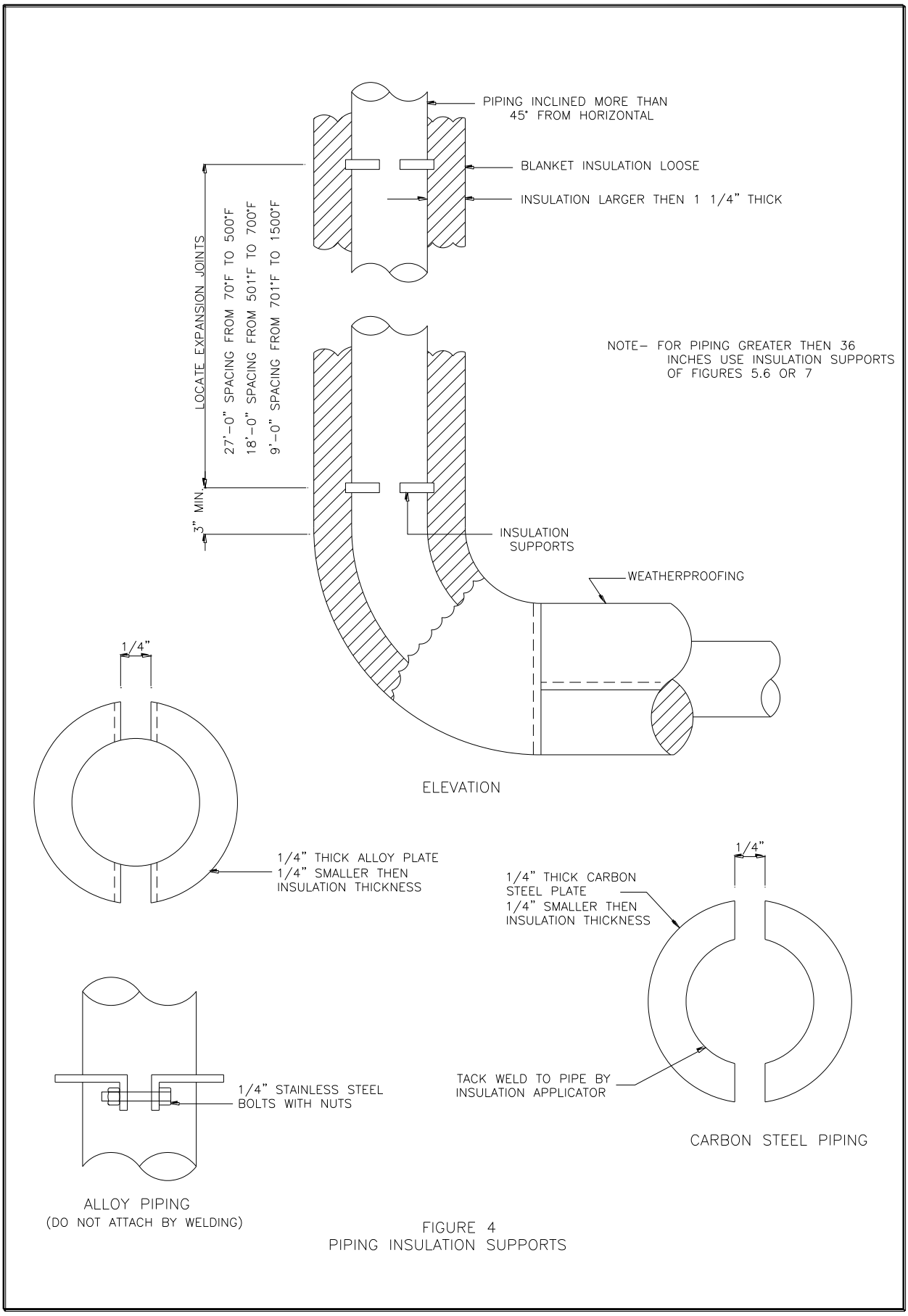
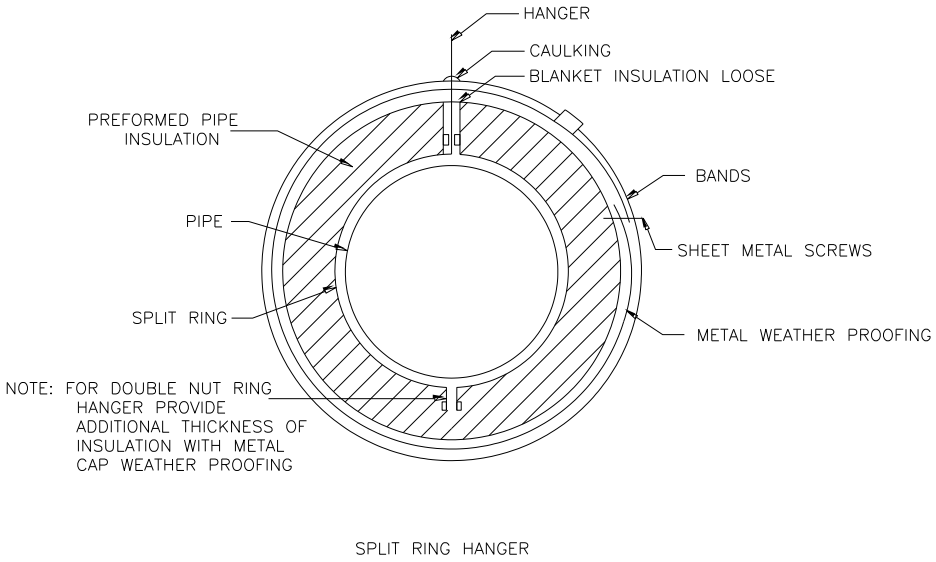


FIGURE 4
PIPING INSULATION SUPPORTS



SPLIT RING HANGER

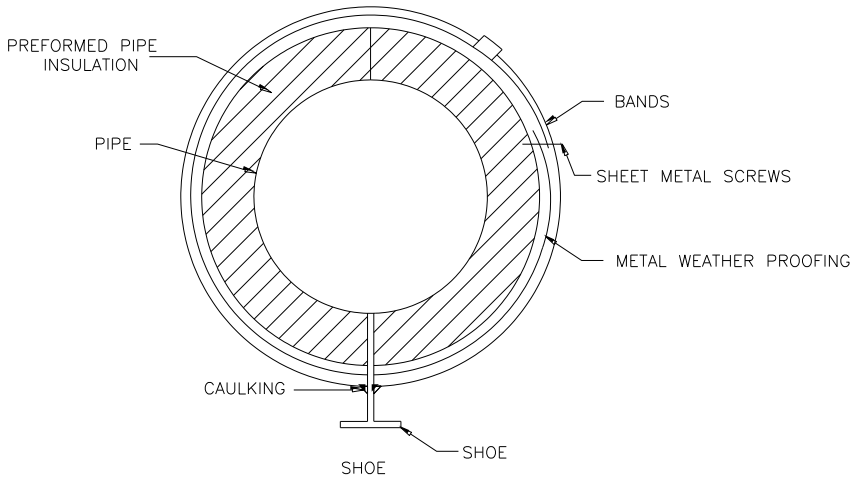
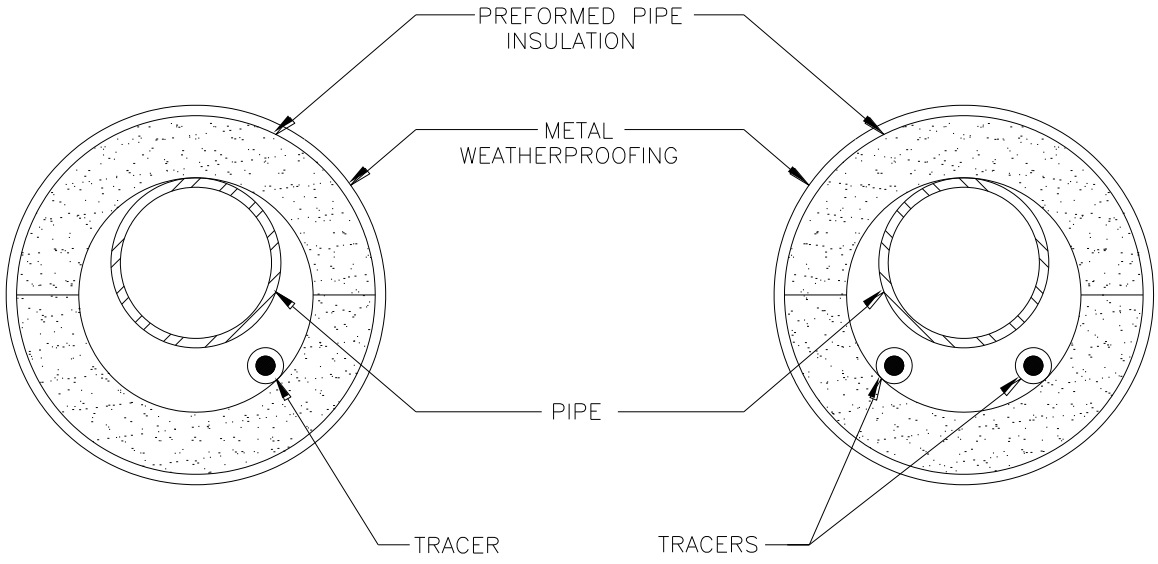
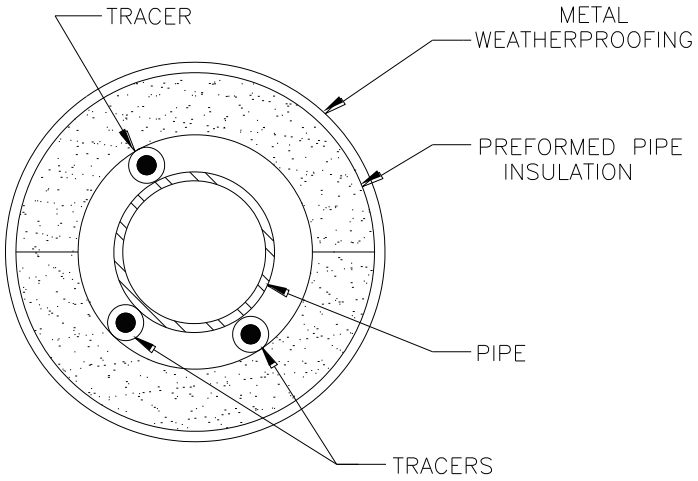


FIGURE 5
PIPING SUPPORTS



INSULATION FOR SINGLE TRACER

INSULATION FOR DOUBLE TRACER



INSULATION FOR 3 OR MORE TRACERS

FIGURE 6
PIPING INSULATION WITH ELECTRIC HEAT TRACING

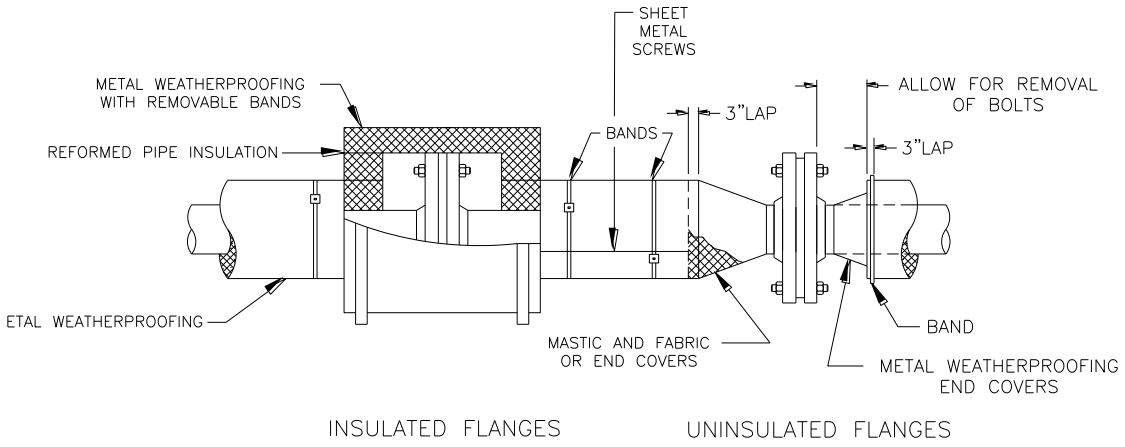
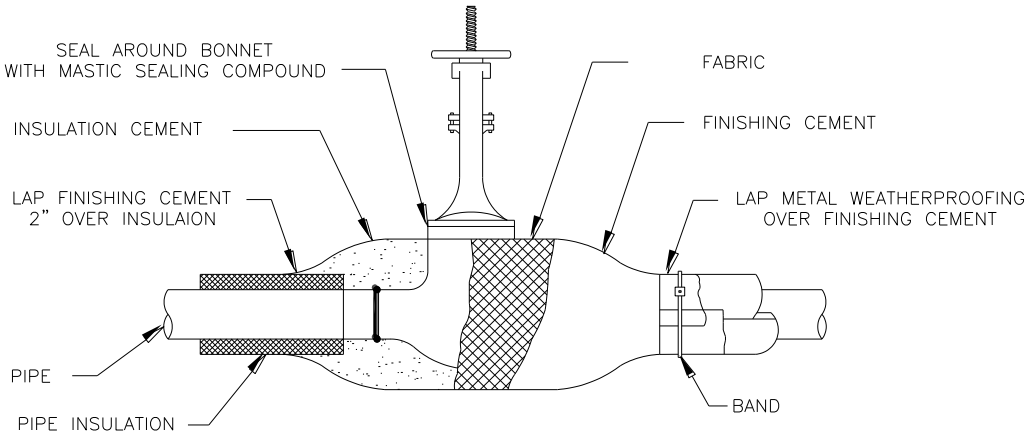
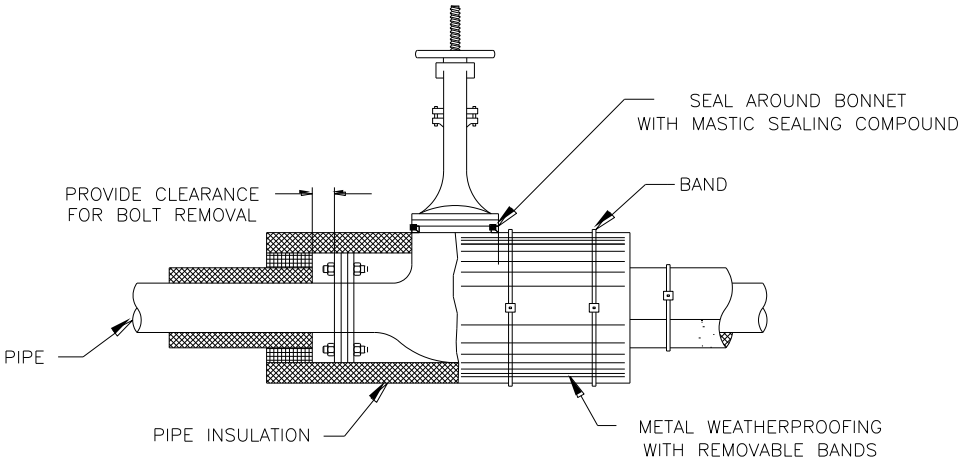


FIGURE 7
PIPING FLANGE INSULATION

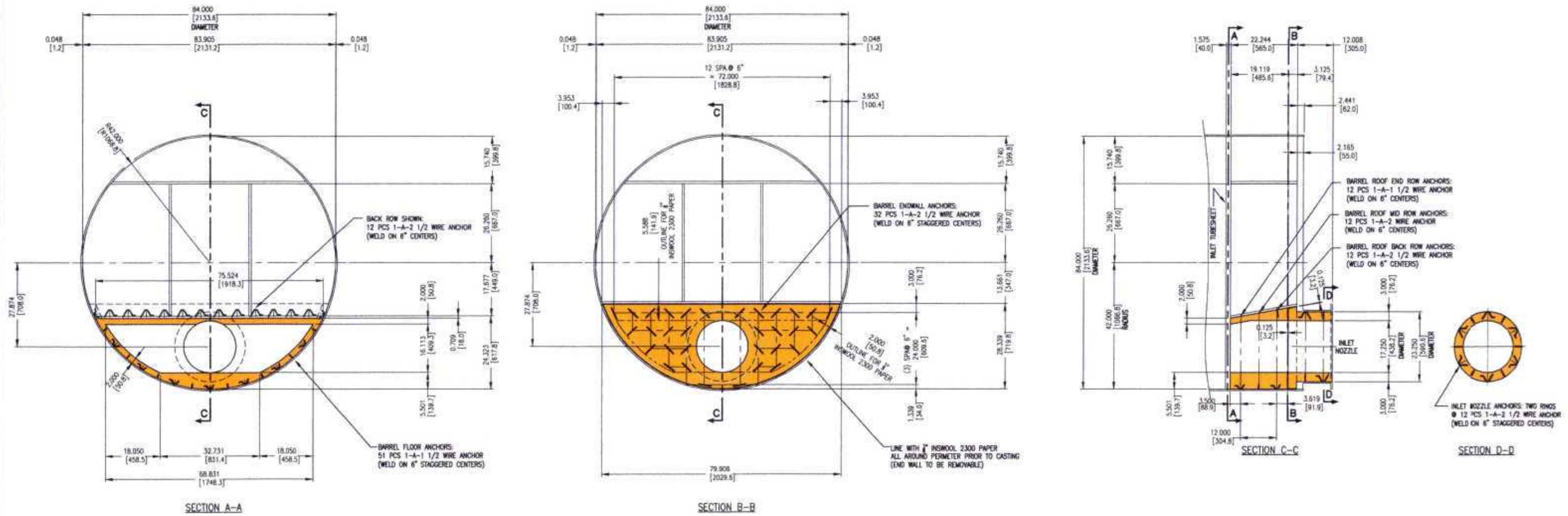


VALVES OTHER THAN FLANGED



FLANGED VALVES

FIGURE 8
PIPING VALVE INSULATION



REFERENCE NOTE: ORTLOFF ENGINEERS, LTD. REFRACTORY SPECIFICATION FOR SULFUR CONDENSER PACKAGE INCLUDED IN SALES ENGINEERING JOB FILE NUMBER: 2009-0012.

LEGEND

KS-4-GR PLUS

FINAL

FOR BILL OF MATERIALS SEE DRAWING NUMBER: PA005440

HARBISON-WALKER REFRACTORIES CO.
Cherrington Corporate Center
400 Fairway Drive
Moon Township, PA 15108

PRESSON DESLON INTERNATIONAL (PA) LIMITED

SULFUR CONDENSER
(E-1902)

USE COMMERCIAL TOLERANCE, SPEC CODE "DO"
UNLESS OTHERWISE SPECIFIED ON DWG. OR ORDER

*** REVISIONS ***

Scale: 3/4=1'-0"
Drawn by: WAR
Date: 01-21-09
1 of 1
PD005440-2

Bill of Material No. **PA005440-2.xls**

PRESSON DESCON INTERNATIONAL

PAKISTAN

Description

COUNT FOR ONE (1) SULFUR CONDENSER

Date Drawn: 1/20/2009
Estimated by: WAR
Checked by: ~

Reference
ORTLOFF ENGINEERS, LTD
REFRACTORY SPECIFICATION FOR REACTOR FURNACE AND WASTE HEAT RECLAIMER PACKAGE
INCLUDED IN SALES ENGINEERING JOB FILE NUMBER: 2009-0012

Revisions			
1	JOB No.2009-0257 SPLIT KS-4, ADD ANCHORS AND PAPER. CHANGE QUANTITIES.	MDP	4/22/2009
2	JOB No.2009-0327 REMOVE 1-A-1 ANCHORS, AND 51 PCS 1-A-1/12 NOW 63 WITH 56 PCS 1-A-2 1/2 NOW 68.	MDP	4/23/2009

Units	Net Qty.	Gross Qty.	Overage	Quality	Size or Description	Size/Shape Code	Lining Location	Comments	Cu. Ft. Req'd.	Brick 9" EQ or Total 9" EQ Mortar per unit
	-	1		Drawing Sheets @ $1500.00/sheet	17" x 22" or 22" x 34"	-	-	-	-	-
1	63	65	3%	304 SS	1-A-1 1/2 METALLIC ANCHOR	118128	BARREL	WELD ON 6" CENTERS	-	-
1	12	15	5%	304 SS	1-A-2 METALLIC ANCHOR	118130	BARREL	WELD ON 6" CENTERS	-	-
1	12	15	5%	304 SS	1-A-2 1/2 METALLIC ANCHOR	118131	BARREL	WELD ON 6" CENTERS	-	-
1	295 lb.	385 lb.	15%	KS-4 GR Plus (0% Rebound Built Into Net Qty)	Gun Mix @ 118 Lb.CU.FT.		BARREL	WORKING VARIES	2.5	-
1	68	70	3%	304 SS	1-A-2 1/2 METALLIC ANCHOR	118131	Nozzle & Endwall	WELD ON 6" CENTERS	-	-
1	448 lb.	550 lb.	15%	KS-4 GR Plus (0% Rebound Built Into Net Qty)	Gun Mix @ 118 Lb.CU.FT.		Nozzle & Endwall	3" WORKING VARIES	3.8	-
1	9 S.F.	10 S.F.	7%	INSWOOL 2300 PAPER	1/8" thick Ceramic Insulation		Nozzle & Endwall		-	-

KS-4® GR PLUS

Product Data

06/03: 5894

Description: 2500°F Gunning Castable for Low-Cost Service in Severe Abrasion Areas		
Features:	• Good strength and slag resistance.	
	• Low rebound, good setting characteristics, excellent flowability, and ideal moisture content.	
Uses:	• Excellent for large areas with relatively thin linings.	
	• Ideal as a general-purpose gunning castable.	
Chemical Analysis: Approximate (Calcined Basis)		
	Silica (SiO_2)	40.0% to 44.0%
	Alumina (Al_2O_3)	42.0% to 46.0%
	Iron Oxide (Fe_2O_3)	2.0% to 3.0%
	Titania (TiO_2)	2.0% to 3.0%
	Lime (CaO)	7.0% to 9.0%
	Magnesia (MgO)	0.2% to 0.7%
	Alkalies (Na_2O+K_2O)	0.5% to 1.5%
Physical Data (Typical)		Gunned
Maximum Service Temperature		2550°F (1400°C)
Material Required		118 lb/ft³ (1.89 g/cm³)
Bulk Density		lb/ft³ (g/cm³)
	After 220°F (105°C)	118 to 128 (1.89 to 2.05)
	After 1500°F (815°C)	114 to 122 (1.83 to 1.96)
Modulus of Rupture		lb/in.² (MPa)
	After 220°F (105°C)	600 to 1,000 (4.1 to 6.9)
	After 1000°F (540°C)	300 to 600 (2.1 to 4.1)
	After 1500°F (815°C)	300 to 600 (2.1 to 4.1)
	After 2000°F (1095°C)	250 to 550 (1.7 to 3.8)
Cold Crushing Strength		lb/in.² (MPa)
	After 220°F (105°C)	2,300 to 4,600 (15.9 to 31.7)
	After 1000°F (540°C)	1,500 to 3,000 (10.3 to 20.7)
	After 1500°F (815°C)	1,500 to 3,000 (10.3 to 20.7)
	After 2000°F (1095°C)	1,000 to 2,400 (6.9 to 16.5)
Permanent Linear Change		
	After 220°F (105°C)	None
	After 1000°F (540°C)	0% to -0.5%
	After 1500°F (815°C)	0% to -0.5%
	After 2000°F (1095°C)	0% to -0.6%
	After 2300°F (1260°C)	-0.5% to -1.5%
	After 2500°F (1370°C)	-0.7% to +2.0%
Thermal Conductivity		Btu·in/hr·ft²·°F (W/m·°C)
	At 400°F (205°C)	5.1 (0.74)
	At 800°F (425°C)	5.3 (0.76)
	At 1200°F (650°C)	5.5 (0.79)
	At 1600°F (870°C)	5.7 (0.82)
	At 2000°F (1095°C)	5.8 (0.84)

KS-4® GR PLUS

Product Data

Particle Size	
Maximum Grain Size 4 Mesh (Tyler)	Less than 4%

Note: The test data shown are based on average results on production samples and are subject to normal variation on individual tests. The test data cannot be taken as minimum or maximum values for specification purposes. ASTM test procedures used when applicable.

Mixing and Using Information (Water calculated at 8.337 lb/gallon)	55 lb bag	1000 lb bag	1500 lb bag
Water Required—Predampening for Gunning (Weight 3.0%)			
Pounds	1.7	30.0	45.0
Gallons	0.2	3.6	5.4
Liters	0.7	13.6	20.4

For detailed mixing and using instructions, contact your ANH representative or visit www.anhrefractories.com.

Working Time	15 minutes
Heatup/Dryout Schedule	
See ANH Dryout Schedule 2—PLUS Rated Castables and Gunning Castables.	
Installation Guidelines	
See ANH Installation Guidelines GC-1—Gunning Castables—Conventional.	
Shelf Life (Under Proper Storage Conditions)	365 days

Gunning Castables—Conventional (GC-1)

Installation Guidelines

4/30/08

Safety and Health

Review the Material Safety Data Sheet (MSDS) before using this product. The MSDS contains important information concerning potential health hazards and protective measures for these hazards. Contact your supervisor or safety director to obtain a copy.

Storage Requirements

- For best performance, store the product in a dry location at a temperature below 80°F.
- ANH packages its gunning castables in poly-lined paper bags or super sacks protected with plastic wrap to ensure dry product delivery. This packaging is not intended for outdoor storage. If no dry storage is available, contact your ANH sales and technical representative for alternate solutions.
- Always store gunning castables on a dry flooring surface to prevent ground moisture from condensing into the package.
- Avoid storage in direct sunlight to prevent the packaging from deteriorating over time.
- Ensure that your inventory is rotated on a regular basis. Gunning castables have an average shelf life of 12 months. Refer to the product data sheet for specific shelf life recommendations. If product usability is questionable due to age, consult your ANH sales and technical representative.
- Compaction during shipping and storage can cause soft lumps to form in the material. This is not detrimental to product performance if the lumps can easily be broken by hand.
- If the material becomes damp during shipping and storage, a partial reaction of the binders can occur causing hard lumps to form. If the lumps cannot easily be broken by hand, do not use the product without first consulting your ANH sales and technical representative.

Form and Backup Requirements

- Waterproof all porous forms, such as wood, and all porous backup linings before casting. Porous surfaces can reduce product properties, resulting in a substandard installation.
- If installing over existing refractory, remove all loose material, debris, or contaminants prior to installation.
- Remove wood forms prior to dryout and heatup. Allowing wood forms to catch on fire can cause localized overheating and possible spalling of the refractory.

Installation Equipment Requirements

- ANH gunning castables are designed to be installed using most feed-wheel type gunning equipment. They may not perform satisfactorily using simple pressure tank gravity feed systems.
- Always check with your equipment manufacturer or contact your ANH sales and technical representative to determine equipment suitability and proper setup for a specific product.
- Most products can be gunned with or without predampening. When applicable, predampening can lower rebound and improve material properties. Refer to the product data sheet or contact your ANH sales and technical representative for specific information on predampening.
- Clean all gunning and handling equipment prior to use. Residual material in the gunning and handling equipment may affect the set or properties of the product.

Environmental Conditions

- For best results, ensure that the temperature of the product is between 60°F and 80°F prior to mixing. Temperature extremes affect working time, final set time, and final product quality.

Water Quality

For best results, use drinkable water with a pH of 6 to 7.5 and a temperature of 60°F to 80°F.

Gunning Castables—Conventional (GC-1)

Installation Guidelines

Water Addition

Predampening

- Refer to the product data sheet for product predampening suitability and proper water requirements.
- Predampening water must be measured by weight or by volume.
- Predampen the material for 30 to 90 seconds.
- Excessive predampening can cause the material to clog the gunning equipment.
- Load material promptly into the gunning equipment. Under normal environmental conditions, no aging is required.
- For extremely cold conditions, aging can be used. As a general rule, age between 10 and 30 minutes.

Installation

- Adjust the water at the nozzle so that the gunned surface has a sheen and the coarse aggregate craters the surface on contact.
- A sandy surface indicates that the material is too dry; a rippled surface indicates that the material is too wet.
- Water adjustments are critical. Installing too dry or too wet will adversely affect rebound and material properties.
- Adequate and consistent nozzle water pressure is critical. A booster pump is recommended to ensure both.

Installation Methods

- Always begin an installation at the bottom to avoid trapping rebound.
- Installation should be done in small areas to ensure proper bonding of the layers.
- For large installations, a cold joint design is recommended.
- If a delay occurs during installation, score the installation surface while it is still wet to facilitate bonding of the layers.
- Remove excess material as soon as possible to facilitate easy trimming and to limit stresses on the installed material.

Curing

- Ideal curing temperatures are between 70°F and 100°F.
- For installations above 60°F, cure the product for a minimum of 24 hours.
- For installations below 60°F, longer times are required to reach a hard set. Apply heat (not exceeding 120°F) to accelerate curing in cold conditions.
- Dryout and heatup can begin after the recommended minimum cure time as long as a hard set has been achieved.
- A hard set can be determined by striking the installed surface with a metal bar. A distinctive ring indicates a hard set.
- During curing, keep the surface covered and damp to avoid drying and cracking. Avoid direct water spray on the surface during curing.
- Avoid allowing the material to freeze prior to reaching a hard set or preferably prior to dryout (complete water removal).
- During curing, avoid applying excessive weight, such as equipment, to the installed surface.

Dryout

Dryout and heatup can begin any time after a hard set has been achieved. Refer to the curing and dryout schedule specified on the product data sheet for more detailed information on the appropriate curing, dryout, and heatup procedures.

Tips

- When using metallic anchor systems, such as V-anchors, always use a coating on the tips to allow for anchor expansion during heatup.
- If your application requires weep holes, ensure that they are maintained before beginning installation.
- Wash out all equipment as soon as installation is complete. A power washer is recommended.
- Always ensure that the installation surface is free of oil, debris, and loose refractory.
- For large installations where visual contact is not possible, headset communication between the nozzle operator and the gun operator is recommended.
- Air pressure and volume are critical to a quality installation. Air pressure should be between 40 and 60 psi. Adequate air volume is necessary to ensure consistent pressure.
- Gunning hose inside diameter can range from 1½ to 2 in. depending on application requirements. Ensure that the gunning hose inside diameter is consistent from the gun to the nozzle.

INSWOOL® 2300 PAPER

Product Data

9/08: 5819

Description: 2300°F Alumina-Silica Ceramic Fiber Paper

INSWOOL PAPER is a lightweight, refractory material processed from washed, spun alumina-silica ceramic fibers formed into a flexible sheet. It is recommended for continuous use at temperatures to 2300°F. It is especially noted for having exceptional low thermal conductivity and good handling strength. Its highly uniform structure assures equal thermal conductivity throughout and its clean, smooth surface makes it ideal as a gasket, seal, and spacer material. INSWOOL PAPER contains an organic binder to provide increased handling strength. INSWOOL PAPER also resists oxidation and reduction. If it becomes wet due to water, steam, or oil, its thermal and physical properties will return as soon as the material is thoroughly dried. No water of combination is present.

Chemical Analysis: Approximate (Calcined Basis)	
Silica (SiO_2)	52.62%
Alumina (Al_2O_3)	47.00%
Iron Oxide (Fe_2O_3)	0.03%
Alkalies ($Na_2O + K_2O$)	0.35%

Physical Data (Typical)	
Maximum Service Temperature	
For Continuous Use	2300°F (1260°C)
Fiber Melting Point	3200°F (1760°C)
Color	White
Loss on Ignition	8.0%
Thermal Conductivity	Btu·in/hr·ft²·°F (W/m·°C)
At 800°F (427°C)	0.55 (0.079)
At 1300°F (704°C)	0.87 (0.126)
At 1600°F (871°C)	1.05 (0.152)

	"A"	"F"	"J"	"K"
Thickness Specifications (Nominal)	1/32 in. (0.8mm)	1/16 in. (1.6mm)	1/8 in. (3.2mm)	1/4 in. (6.4mm)
Uncompressed Thickness (in. @ 4 psi)	0.070	0.095	0.190	---
Tensile Strength				
Machine Direction - gms/in.	2400	3200	6000	---
Cross Direction - gms/in.	2200	2700	5200	---
Mullen Burst - lb/in² (kg/cm²)	7.0 (.49)	10.0 (.70)	24.0 (1.69)	40.0 (2.8)

Note: This product is manufactured for ANH Refractories Company by a third party. The results reported herein have been supplied by the third party manufacture. The above data are reported as typical properties and should not be taken as establishing maximum or minimum specifications. The above data is not intended as a warranty of any kind.

INSWOOL® -HP BLANKET

Product Data

8/05

Description: 2300°F Alumina-Silica Ceramic Fiber Blanket

INSWOOL-HP BLANKET was developed to meet the demand for a high temperature, flexible blanket insulation with a low iron content of less than 1%. INSWOOL-HP BLANKET has excellent strength, both hot and cold. It remains in place on the furnace anchors even at high temperatures and can resist damage even when subjected to normal mistreatment in shipment and handling. If INSWOOL-HP BLANKET becomes wet from water, steam, or oil, its thermal and physical properties are restored upon drying. Its sound absorption ability is greater than dense or insulating refractories and it stores some 95% less heat than dense firebrick and about 75% less than insulating brick.

Chemical Analysis: Approximate (Calcined Basis)	
Silica (SiO_2)	54.0%
Alumina (Al_2O_3)	45.0%
Iron Oxide (Fe_2O_3)	< 1.0%
Lime (CaO)	0.1%
Magnesia (MgO)	0.1%
Titania (TiO_2)	0.1%
Alkalies ($Na_2O + K_2O$)	0.2%

Physical Data (Typical)			
Maximum Service Temperature		2300°F (1260°C)	
Continuous Use Limit		2150°F (1177°C)	
Color		White	
Fiber Length (Average)		3 in. (7.6 cm.)	
Fiber Diameter		3 microns	
Tensile Strength 8 lb/ft³ (0.13 g/cm³) Blanket		lb/in² (MPa)	
Machine Direction		13 (0.09)	
Cross Direction		10 (0.07)	
Percent Shrinkage			
Heated for 24 hours at 2000°F (1093°C)		2.0%	
Heated for 24 hours at 2150°F (1176°C)		2.3%	
Thermal Conductivity	4 lb/ft³ (.06 g/cm³)	6 lb/ft³ (.10 g/cm³)	8 lb/ft³ (.13 g/cm³)
	Btu·in/hr·ft²·°F	Btu·in/hr·ft²·°F	Btu·in/hr·ft²·°F
	(W/m·°C)	(W/m·°C)	(W/m·°C)
At 600°F (316°C)	0.6 (.08)	0.5 (.07)	0.4 (.06)
At 1000°F (538°C)	1.16 (.17)	.95 (.14)	0.8 (.11)
At 1400°F (760°C)	1.8 (.26)	1.55 (.22)	1.2 (.17)
At 1600°F (871°C)	2.2 (.31)	1.85 (.26)	1.4 (.20)

Note: The test data shown are based on average results on production samples and are subject to normal variation on individual tests. The test data cannot be taken as minimum or maximum values for specification purposes. ASTM test procedures used when applicable.