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CEL-946

**ENGINEERING
STANDARD**

**THERMAL INSULATION FOR VESSELS
-50°F to 0°F**

CELANESE CORPORATION OF AMERICA

Central Engineering

Charlotte Office

HNA 14340

Approved March 7, 1962

INSULATION AND PROTECTIVE COATINGS

E8-3.1

THERMAL INSULATION FOR VESSELS (-50°F. to 0°F.)

Issued

Rev. No.

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Sponsor - Celriver

3/7/62

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CELANESE CORPORATION OF AMERICA INSULATION AND PROTECTIVE COATINGS THERMAL INSULATION FOR VESSELS (-50°F. to 0°F.) Sponsor - Celriver		ENGINEERING STANDARD E8-3.1	
		Issued	Rev. No.
		3/7/62	01

1. Scope

This standard is intended to specify type, thickness, calculation method and application procedures for insulation used on vessels operating in the temperature range of -50°F. to 0°F. where corrosive conditions are present. It also specifies a suitable protective coating to withstand physical abuse where required.

2. General

The purpose of this standard is to provide a practical procedure for insulating cold vessels such as brine storage and head tanks, brine cooled jacketed vessels, and tube and shell heat exchangers (refrigeration equipment). The material specified is impervious to the external elements including weather and chemical spills, and to internal elements when leaks allow process chemicals to be trapped between the insulation and the vessel. The materials used and method of application represents the most economical way to insulate vessels operating in the above temperature range and to satisfy process requirements.

The criteria for insulating these vessels are:

- 1) Maintain required process temperatures
- 2) Reduce heat gain of brine or cooling agent
- 3) Prevent ice formation on vessel
- 4) Prevent sweating on either vessel or insulation surfaces.

3. Specifications

3.1 Materials. All cold vessels operating in the temperature range of -50°F. to 0°F. and under corrosive conditions (except where extreme vibration is present) should be insulated with multiple layers of cellular glass insulation.

3.1.1 Comparison of Materials. There are five types of insulation materials that can be used for cold applications. Three of these, mineral wool, expanded polystyrene, and hairfelt, are not suitable for the conditions of this standard. The other two, vegetable cork and cellular glass, are most

commonly used. Cork is clean to work with and offers fair resistance to impact due to its resilience. However, it is difficult to cut and shape in the field for fitting around various obstacles as compared to cellular glass which can be trimmed, cut, or notched very quickly and easily. Cellular glass dust created by cutting operations can result in a minor clean up problem unless care is taken to contain it. Labor time can be reduced on most installations by about one third when using cellular glass.

Cellular glass is more readily available and can be supplied on short notice, shaped to various contours. Material cost is comparable to cork although cork is slightly higher on the basis of total job cost, irregardless of thicknesses required.

The primary advantage of cellular glass over cork is that due to its composition and cellular structure it is unaffected by chemical leaks and spills. The absorption of water or chemicals by cork will result in cracks because its low tensile strength will not withstand the additional weight. However, cellular glass is a practical insulation to use in either environment, whether liquid absorption is a problem or not.

3.1.2 Thickness Requirements. The first consideration in making a selection of insulation thickness is to determine the process temperature requirements. This is usually done by holding to a minimum the allowable heat gain of the brine or cooling agent. In most cases, sweating is the biggest problem to overcome in insulating vessels in the -50°F to 0°F temperature range. Therefore, if the insulation is designed to prevent condensation, the heat gain of the brine will probably be minimum and the process temperature requirements met. Equally important, along with the thickness of insulation, is the positive seal to eliminate air from penetrating through the joints of the insulation, resulting in ice build up on the vessel surfaces. This is the reason for using a good combination cement and sealing compound and staggering all joints. Recommended thicknesses of cellular glass insulation on flat surfaces is shown below for the following conditions:

90 $^{\circ}\text{F}$. outside ambient air temperature
80% relative humidity
.9 emissivity factor (uncoated cellular glass)
10.50 BTU/hr./sq. ft. average heat gain
0 MPH wind velocity

Temperature range 0° to -20°F - 4" thick
Temperature range -20° to -40°F - 4-1/2" thick
Temperature range -40° to -50°F - 5" thick

The above thicknesses are minimum. For borderline cases use an additional 1/2" thickness.

3.1.3 Calculations. The above atmospheric and heat transfer conditions will cover most applications. However, since temperature and humidity vary considerably from one locality to another, required thicknesses can be calculated and verified as follows:

Using the formula $q = \frac{T_2 - T_1}{\frac{X}{K}}$ where:

q = BTU/hr./sq. ft. insulation surface

T_2 = Ambient outside temperature °F. (dry bulb)

T_1 = Lowest inside temperature °F. (process or cooling agent temperature)

X = Insulation thickness

K = BTU/hr./sq. ft./ °F/in. thickness (see conductivity nomograph)

Example:

A brine circulating tank is to be insulated to prevent condensation and maintain a -30°F. brine temperature with an outside temperature of 80°F. (still air) and a relative humidity of 75%.

q = 13.23 allowable heat gain, BTU/hr./sq. ft. of insulation surface. This is found by first determining the dew point from Psychrometric chart or attached dew point graph. (Fig. 1) To use graph follow 80°F. line from bottom of sheet to intersection point of diagonal 75% relative humidity line. Read to left of sheet for dew point which is 71°. Subtracting this from 80° (dry bulb temperature) we have 9°F. difference between air and surface temperatures. Using attached table of values, (Table 1) which gives allowable BTU gain or loss/°F. (difference between air and surface temperature), find 80°F. on left side of sheet (0 MPH). Read across to column under 9° and find 1.47. Since this is BTU/°F. multiply 1.47×9 (° difference) for an allowable BTU gain/hr./sq. ft. of 13.23.

The values given in the table are for .9 emissivity and represents heat transmitted by convection plus heat transmitted by radiation. If difference between air and surface temperature is more than 10°, additional graphs can be obtained from Pittsburgh Corning* so that an allowable q can be found for almost any condition. There are a number of these graphs and a detailed explanation of their use would be lengthy. Since the attached table covers a wide variety of conditions, the additional graphs are not included in the standard.

$$T_2 = 80^\circ\text{F.}$$

$$T_1 = -30^\circ\text{F.}$$

$$K = .365 \text{ from attached conductivity nomograph (Fig. 2)}$$

Solving for X we have:

$$X = \frac{(T_2 - T_1) (K)}{q}$$

$$X = \frac{(80 - (-30)) (.365)}{13.23}$$

$$X = \frac{(110) (.365)}{13.23}$$

$$X = 3.05 \text{ use } 3\frac{1}{2}'' \text{ thick insulation}$$

The calculations shown are for flat surfaces; however, for all practical purposes

* Or use alternate data

the same calculations would hold true for vessels 3 ft. or more in diameter. If exact calculations are desired so that vessel diameter is considered, then $r_2 \log e \frac{r_2}{r_1}$ can be substituted for X to find equivalent thickness. (r_1 =

radius of vessel and r_2 = radius to outside surface of insulation). Graphs and charts showing equivalent thicknesses for pipe up to 24" diameter, where equivalent thickness is important, can be obtained from Pittsburgh Corning.

3.2 Method of Application. Manufacturers recommendations should be followed whenever possible. Reference Pittsburgh Corning Specification FI-104A revised, (refer to Appendix A).

3.3 Protective Coatings. Several types of coatings can be used and the one chosen depends entirely on conditions. Some examples are shown below.

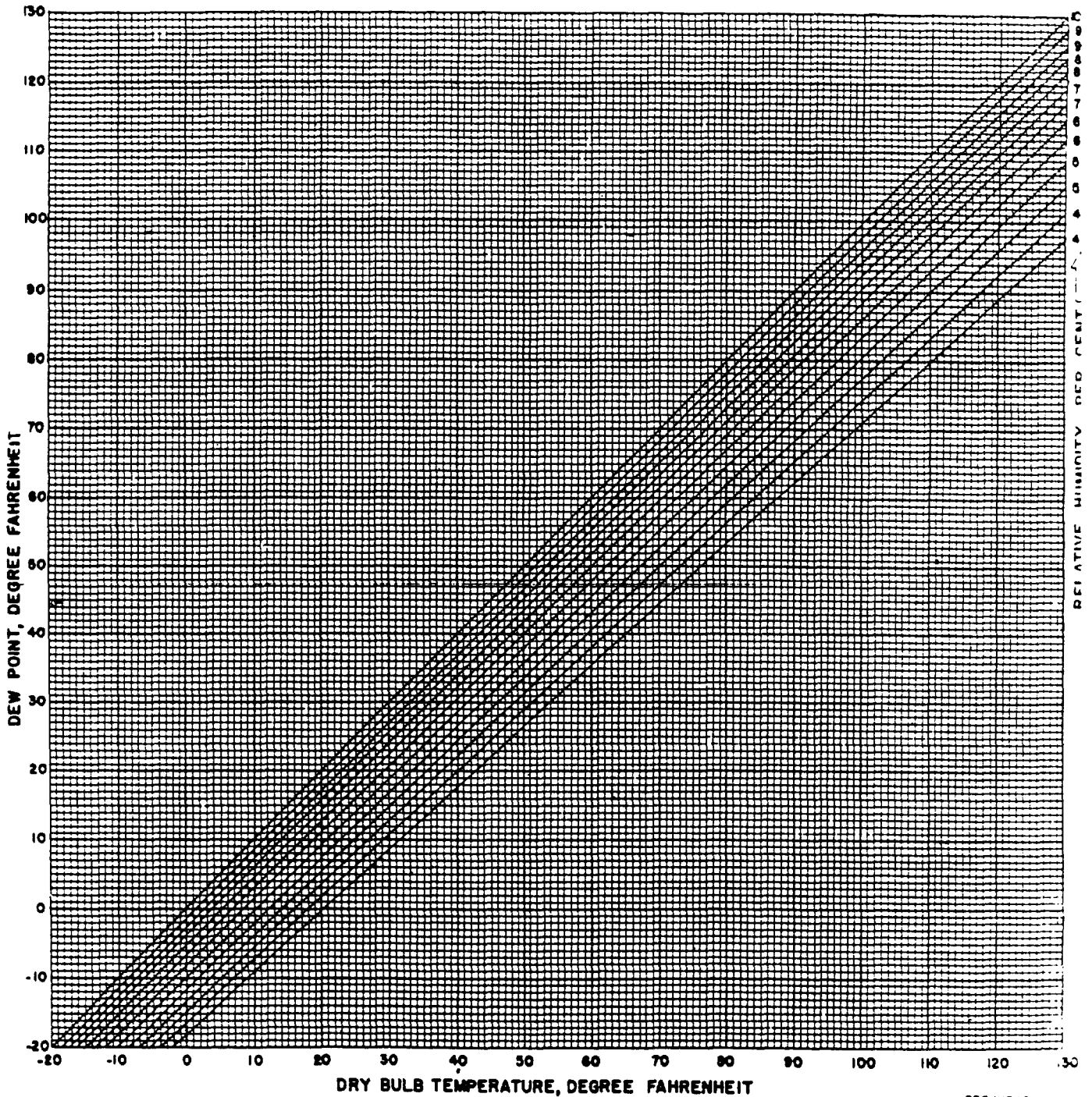
<u>Condition</u>	<u>Type Coating</u>	<u>Reference</u>
No vibration, physical abuse, or chemical spills	1. Paint (type to suit conditions). 2. Filler (concrete type) to seal pores, then paint. 3. Heavy, filled paint to seal and paint in one coat.	"Re-Nu-It", mfg. by Re-Nu-It Corp., N.Y., N.Y.
Light vibration, average physical abuse, and chemical spills	1. Asphalt base - cork filled coating 1/8" to 1/2" thick, depending on degree of protection required. Leaves rough surface, hard to keep clean. Can be sealed and painted. 2. Asphalt cut back, with layer of glass cloth & more asphalt cut back	"Insul-Mastic" - Pittsburgh Chemical and Coke Co., Pittsburgh, Pa. Detailed in Pittsburgh Corning FI-104A specification.
Subject to heavy physical abuse and direct acid spills.	1. Combination coatings of asphalt base - cork filled mastic, epoxy mastic, and epoxy or urethane paint coat.	Refer to Appendix B



PITTSBURGH CORNING CORPORATION

FOAMGLAS INSULATION

DEW POINT TEMPERATURES FOR VARIOUS AIR
TEMPERATURES AND RELATIVE HUMIDITIES

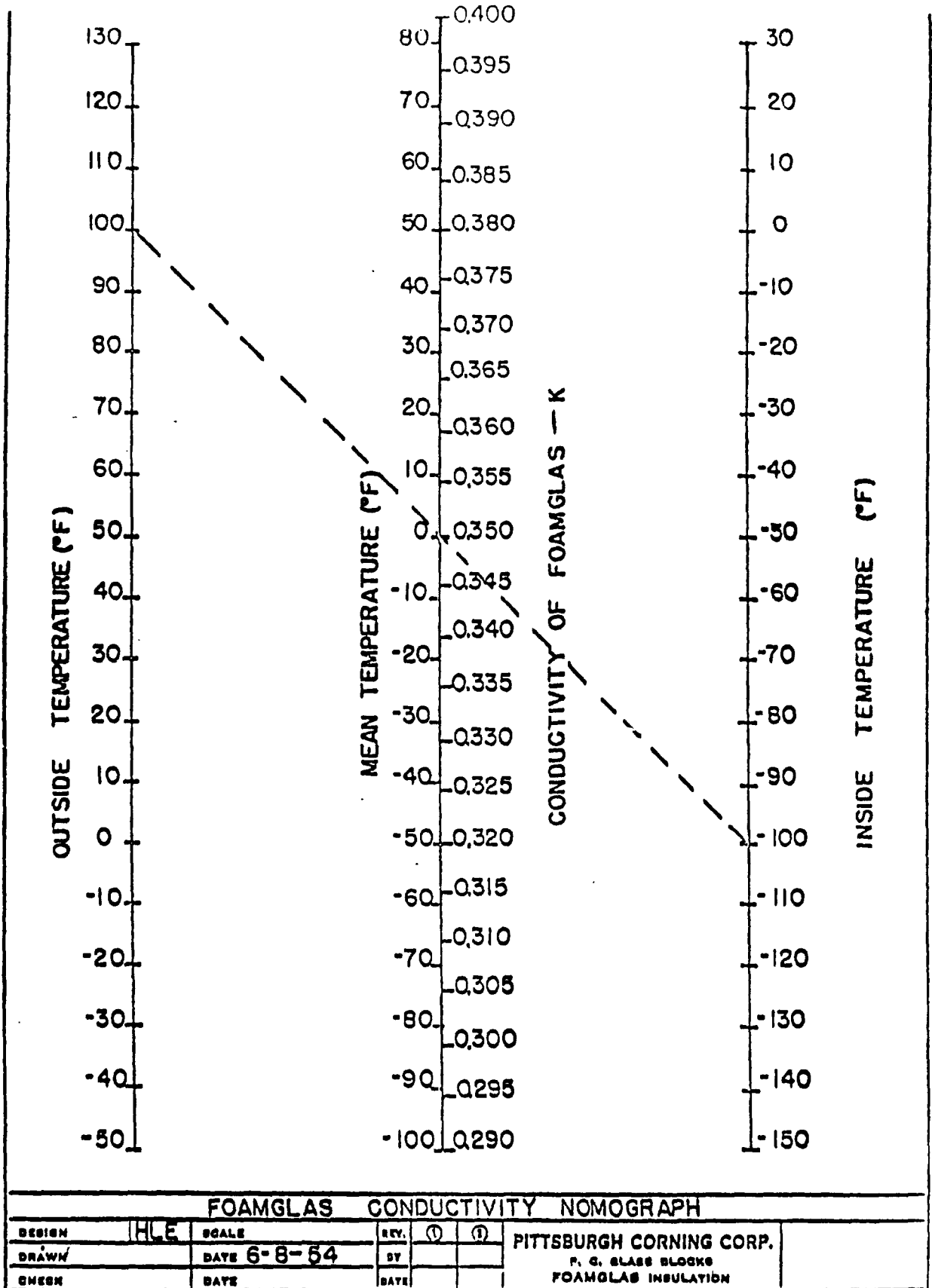


DEC. 1, 1949

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HNA 14346

Fig. 1



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FORM 8108 REV. 7-1-55

VALUES OF ϵ_p : EMISSIVITY - 0.9
HEAT TRANSFER FROM AIR TO LOWER TEMPERATURE SURFACE

Air Temp.	Air Velocity	1°	2°	3°	4°	5°	6°	7°	8°	9°	10°
0	0 MPH	.092	0.96	0.99	1.02	1.04	1.07	1.08	1.09	1.10	1.11
	15 MPH	1.94	2.19	2.36	2.48	2.57	2.67	2.75	2.83	2.89	2.95
10	0 MPH	0.96	1.00	1.03	1.06	1.08	1.11	1.12	1.13	1.14	1.16
	15 MPH	1.98	2.22	2.40	2.52	2.62	2.72	2.79	2.85	2.93	2.99
20	0 MPH	0.99	1.04	1.08	1.10	1.12	1.15	1.16	1.17	1.18	1.19
	15 MPH	2.02	2.27	2.44	2.56	2.65	2.77	2.85	2.91	2.97	3.03
30	0 MPH	1.03	1.09	1.12	1.15	1.17	1.19	1.20	1.21	1.22	1.23
	15 MPH	2.06	2.31	2.48	2.61	2.71	2.80	2.88	2.95	3.01	3.07
40	0 MPH	1.07	1.12	1.17	1.20	1.22	1.23	1.25	1.26	1.27	1.28
	15 MPH	2.11	2.35	2.53	2.66	2.75	2.87	2.93	3.00	3.06	3.12
50	0 MPH	1.13	1.16	1.20	1.23	1.25	1.27	1.28	1.30	1.31	1.33
	15 MPH	2.16	2.39	2.57	2.67	2.79	2.89	2.97	3.04	3.13	3.16
60	0 MPH	1.18	1.24	1.26	1.28	1.30	1.32	1.34	1.35	1.37	1.38
	15 MPH	2.21	2.47	2.59	2.75	2.85	2.94	3.02	3.09	3.18	3.24
70	0 MPH	1.23	1.27	1.30	1.34	1.36	1.38	1.39	1.40	1.43	1.44
	15 MPH	2.26	2.50	2.67	2.80	2.89	2.99	3.06	3.12	3.20	3.26
80	0 MPH	1.28	1.33	1.36	1.39	1.41	1.42	1.44	1.46	1.47	1.48
	15 MPH	2.31	2.56	2.72	2.85	2.95	3.04	3.12	3.20	3.25	3.31
90	0 MPH	1.34	1.38	1.40	1.45	1.48	1.49	1.50	1.51	1.52	1.53
	15 MPH	2.35	2.54	2.74	2.91	3.01	3.10	3.18	3.25	3.33	3.37
100	0 MPH	1.39	1.44	1.47	1.50	1.53	1.54	1.56	1.57	1.58	1.59
	15 MPH	2.43	2.67	2.84	2.98	3.06	3.17	3.23	3.31	3.36	3.43

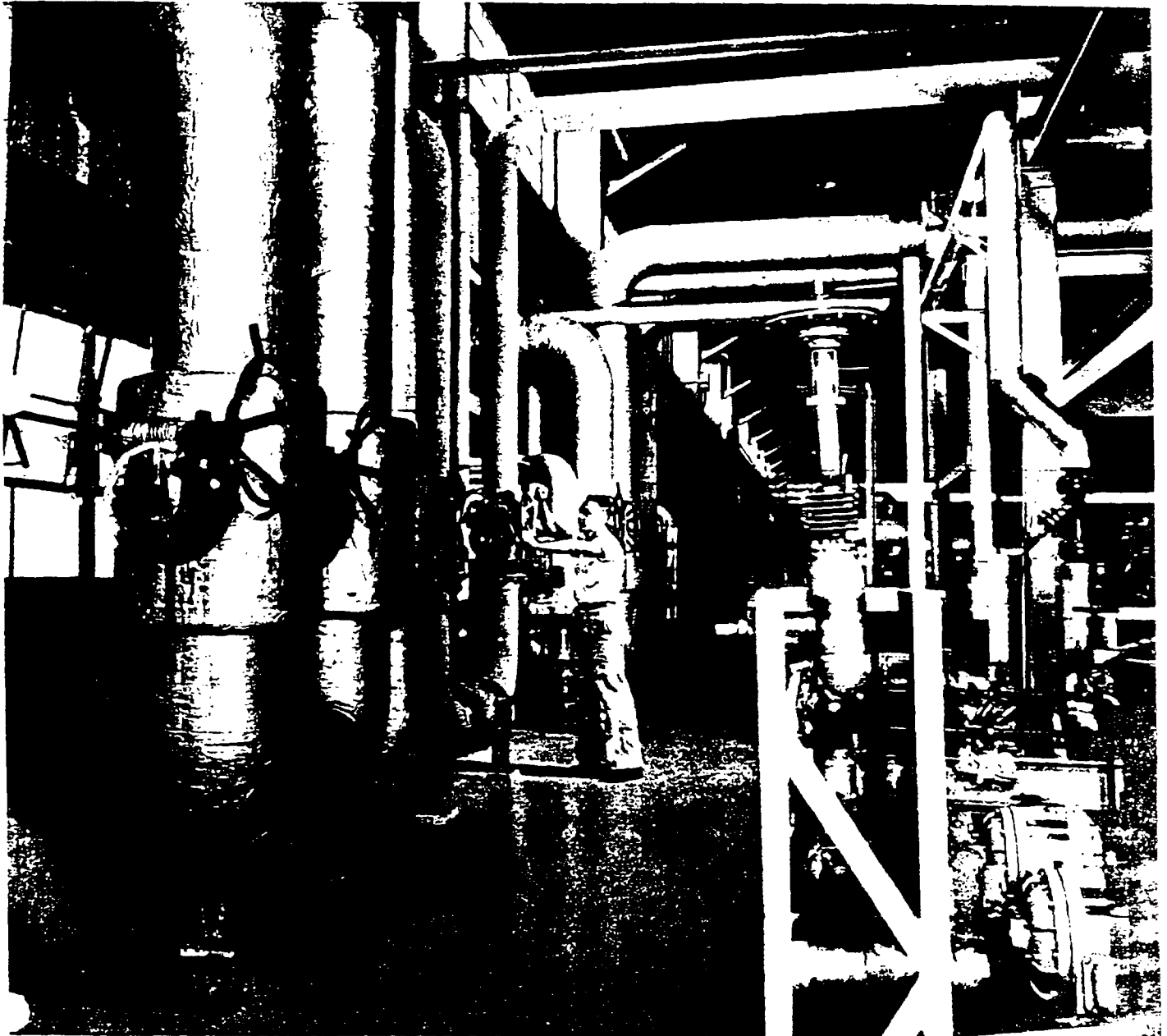
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FOAMGLAS[®] APPLICATION SPECIFICATIONS

...for LOW TEMPERATURE Equipment and Piping

(Below 70°F)

This specification covers the application of FOAMGLAS insulation for use on equipment and piping normally operating at temperatures below 70°F. It is applicable to either indoor or outdoor service.



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P I T T S B U R G H

(9)



C O R N I N G

HNA 14349

Appendix A

Table I

MINIMUM SUGGESTED THICKNESSES FOR SPECIFIED TEMPERATURES

Figures in table are degrees Fahrenheit and are minimum temperatures for use with thickness and design conditions stated. When design temperature falls between two thickness columns, use the greater thickness. Table is based on thickness required to pre-

vent condensation on surfaces with .9 emissivity, in 90° F still air at 80% relative humidity. Heat gains average 8.9 Btu/Hr/S.F. insulation surface. Where other design conditions are used, thicknesses should be adapted to meet job requirements

Iron Pipe Size	Nominal FOAMGLAS Thickness																						
	1"	1½"	2"	2½"	3"	3½"	4"	4½"	5"	5½"	6"	6½"	7"	7½"	8"	8½"	9"	9½"	10"	10½"	11"	11½"	12"
½"	45	10	-25	-45	-95	-140	-275	-300	-335	-390	-450												
¾"	50	25	-10	-25	-70	-135	-225	-255	-300	-340	-415	-450											
1"	50	25	-10	-25	-70	-130	-180	-255	-300	-340	-415	-450											
1¼"	50	30	5	-25	-60	-105	-145	-200	-265	-315	-375	-425	-450										
1½"	50	30	15	-15	-45	-100	-120	-185	-230	-290	-345	-390	-440	-450									
2"	50	30	15	-15	-45	-90	-120	-175	-225	-290	-340	-385	-430	-450									
2½"	50	30	15	-10	-35	-60	-105	-130	-175	-235	-290	-330	-375	-415	-450								
3"	50	30	15	-10	-35	-60	-105	-135	-175	-235	-290	-330	-370	-415	-450								
3½"	50	30	15	-10	-35	-60	-105	-135	-175	-235	-290	-330	-355	-410	-450								
4"	50	30	20	0	-30	-55	-85	-135	-160	-205	-255	-300	-340	-375	-420	-450							
4½"	50	30	20	0	-30	-55	-85	-135	-160	-205	-255	-300	-340	-380	-420	-450							
5"	50	45	25	0	-25	-45	-80	-110	-140	-175	-220	-270	-305	-345	-380	-415	-450						
6"	50	45	25	0	-25	-45	-70	-105	-125	-160	-195	-240	-290	-325	-360	-395	-430	-450					
7"		45	25	0	-25	-40	-65	-95	-120	-150	-185	-220	-275	-305	-340	-375	-410	-450					
8"		45	25	0	-15	-35	-60	-85	-115	-145	-175	-215	-255	-295	-325	-360	-395	-425	-450				
9"		45	25	5	-10	-35	-55	-80	-105	-135	-170	-200	-240	-265	-315	-345	-380	-415	-445	-450			
10"		45	30	10	-10	-25	-50	-70	-105	-125	-150	-185	-225	-265	-300	-330	-360	-410	-420	-440	-450		
11"		45	30	10	-5	-25	-45	-70	-105	-120	-145	-175	-210	-255	-290	-320	-350	-380	-410	-435	-450		
12"		45	30	15	-5	-25	-45	-65	-95	-115	-140	-170	-205	-245	-285	-325	-340	-370	-400	-425	-450		
14"		45	30	15	0	-25	-40	-55	-80	-105	-130	-160	-190	-225	-265	-295	-325	-355	-380	-410	-430	-450	
16"		45	30	20	0	-25	-35	-55	-75	-105	-125	-150	-180	-210	-250	-285	-310	-340	-365	-395	-425	-450	
18"		45	30	20	0	-25	-35	-50	-70	-105	-115	-145	-175	-200	-235	-275	-295	-325	-355	-380	-410	-435	-450
20"		50	30	20	0	-25	-35	-45	-65	-95	-110	-135	-165	-190	-225	-260	-290	-315	-345	-370	-395	-425	-450
24"		50	30	20	0	-25	-35	-45	-65	-85	-105	-130	-155	-180	-205	-240	-270	-300	-330	-355	-380	-405	-430
28"		50	30	20	5	-10	-25	-45	-60	-80	-105	-125	-145	-170	-200	-235	-260	-295	-315	-340	-365	-390	-415
32"		50	30	20	5	-10	-25	-40	-60	-75	-105	-120	-140	-170	-190	-225	-250	-285	-305	-330	-350	-375	-400
36"		50	30	20	10	-5	-25	-40	-55	-75	-105	-115	-135	-160	-185	-215	-240	-280	-300	-320	-345	-365	-390
Vessel O. D.																							
42"		50	30	25	10	-5	-20	-35	-55	-70	-95	-110	-130	-155	-175	-195	-230	-260	-290	-310	-330	-355	-375
48"		50	30	25	10	-5	-20	-35	-50	-70	-90	-105	-125	-145	-170	-190	-225	-245	-280	-305	-325	-345	-365
54"		50	35	25	10	-5	-20	-35	-50	-65	-85	-105	-125	-145	-165	-190	-215	-240	-270	-295	-315	-340	-360
60"		50	40	25	10	-5	-20	-30	-50	-65	-85	-105	-125	-140	-165	-185	-210	-230	-260	-290	-310	-330	-350
66"		50	40	25	10	-5	-15	-30	-50	-65	-80	-105	-120	-140	-160	-180	-205	-230	-260	-285	-305	-325	-345
72"		50	40	25	10	0	-15	-30	-50	-65	-80	-105	-115	-135	-155	-180	-200	-230	-255	-285	-305	-320	-340
78"		50	40	25	10	0	-15	-30	-45	-65	-80	-105	-115	-135	-155	-175	-200	-225	-250	-280	-300	-315	-340
96"		50	40	25	10	0	-15	-30	-45	-65	-80	-105	-115	-130	-150	-170	-190	-220	-240	-270	-290	-310	-330
108"		50	40	25	10	0	-15	-30	-45	-60	-75	-105	-110	-130	-150	-170	-190	-215	-240	-265	-290	-305	-325
120"		50	40	25	10	0	-15	-30	-45	-60	-75	-105	-110	-130	-145	-170	-190	-210	-230	-260	-290	-305	-320
144"		50	40	25	10	0	-15	-30	-45	-60	-75	-95	-110	-125	-145	-165	-185	-205	-230	-255	-280	-300	-305
Over 144" to Flat		50	40	25	15	0	-10	-25	-40	-55	-65	-80	-105	-115	-130	-145	-165	-180	-200	-220	-240	-265	-290

Prior to the application of any insulation, all metal surfaces shall be thoroughly cleaned. The metal should then be primed with either a rust inhibiting paint or an asphalt mastic depending upon the temperatures involved.

I. EQUIPMENT

A. Thickness

Equipment shall be insulated with thickness of FOAMGLAS insulation as shown in Table I. Insulation thickness shall be determined by lowest temperature at which the equipment normally operates.

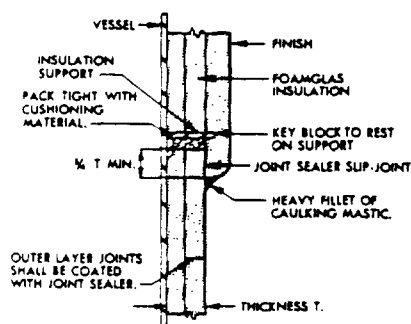
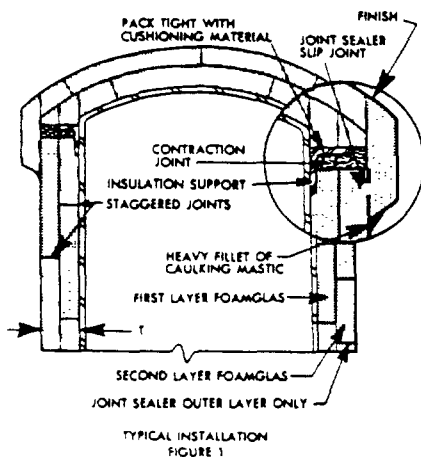
B. Insulation Supports

1. Vertical Equipment

- Angle or plate supports shall be welded around the shell at top and bottom.
- On equipment requiring multiple-layer insulation, horizontal leg of support shall be of such length as to support $1/2$ the thickness of the outer layer of insulation. Horizontal leg of insulation supports for single layer application shall be of such length as to support $1/2$ the thickness of the insulation.

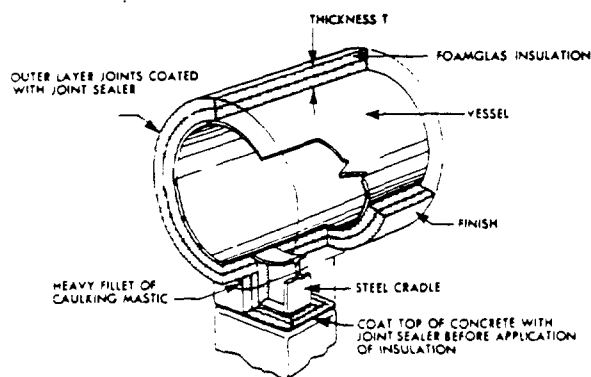
C. Application

- FOAMGLAS insulation shall be curved sidewall segments or beveled lags fabricated to fit the diameter of the equipment to which it is applied. Insulation shall be applied in staggered position with all joints tightly butted and secured with specified strap in sufficient tension to hold insulation in place.
 - Additional layer or layers of FOAMGLAS insulation, where specified, shall be applied in the same manner as the first layer, with side and end joints staggered over joints of preceding layer, so that no two joints coincide.
 - All butt edges and ends of outermost layer (or single layer) shall be sealed with a buttered coat of joint sealer.
 - An additional layer of FOAMGLAS insulation shall be applied over the outside layer where insulation supports are located.
 - Typical installation shown in Figure 1.
- Each layer of FOAMGLAS insulation shall be secured in place with stainless steel strapping, on 9 inch centers, where contour of equipment permits firm and effective attachment.
 - On irregular surfaces, where use of insulation strap is impractical, FOAMGLAS insulation shall be secured with stainless steel wire.

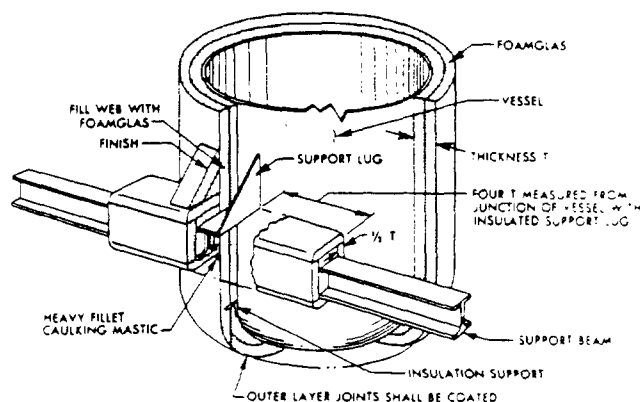


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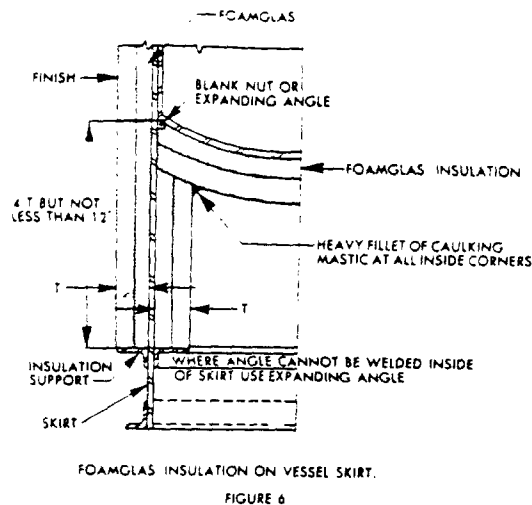
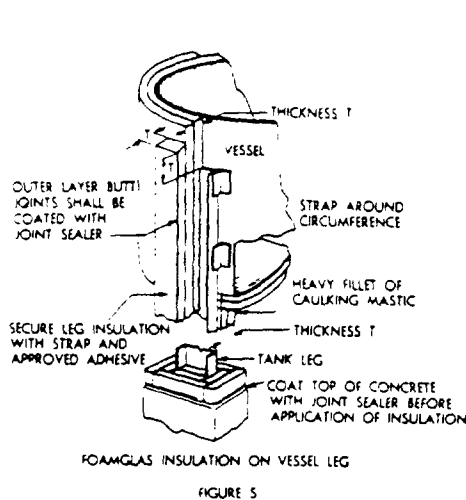
- b. Head insulation, as well as insulation around manholes and other connections, may be fastened in place using a floating ring of steel rod or stranded cable. One end of the band is fastened to the floating ring and the other is anchored to an extra band or bands placed around the sidewall insulation. Bands shall be spaced on 12 inch centers around the perimeter of the extra band or bands.
3. Contraction joints shall be provided below insulation support as shown in Figure 1. Where more than one thickness is specified for the equipment, an insulation support shall be provided at the junction of two different thicknesses and insulated in similar manner shown in Figure 2.
4. Where equipment is supported on metal cradles, FOAMGLAS insulation shall be carried down over cradles and shall be installed as shown in Figure 3.
5. Where equipment is supported by structural steel members, FOAMGLAS insulation shall be extended not less than four times the specified insulation thickness in each direction, measured from junction of equipment with insulated support lug. Thickness of insulation over steel supports shall be one-half that specified for body of equipment. Thickness of insulation over support lugs to be the same as body insulation. Installation shall be as shown in Figure 4.
6. Equipment legs shall be insulated with FOAMGLAS block as part of equipment area. FOAMGLAS insulation to extend over structural legs and down legs a distance of four times insulation thickness. Thickness shall be as specified for body of equipment. Body insulation shall be brought up to and butted firmly against tank leg flange. Spaces between flanges and webs of structural members shall be filled with FOAMGLAS block cemented in place with an approved adhesive. Installation shall be as shown in Figure 5.
7. Skirts supporting vertical equipment shall be insulated inside and outside as part of equipment area, FOAMGLAS to extend downward from junction of inside of skirt with insulated bottom head a distance of not less than four times the thickness of insulation, but in no case less than one foot. Thickness shall be as specified for body of equipment. FOAMGLAS insulation shall be secured to inside of skirt with an approved adhesive. FOAMGLAS insulation inside skirt shall be supported on angle or plate support. Blank nuts on 12 inch centers shall be provided on inside of skirt for securement of bottom head insulation. Where welding is prohibited, a punched, expanding split ring type angle shall be used. Installation shall be as shown in Figure 6.



FOAMGLAS INSULATION OF VESSEL CRADLES & SUPPORTS
 FIGURE 3



FOAMGLAS INSULATION ON VESSEL LUGS AND SUPPORTING STEEL
 FIGURE 4



D. Finish

1. After specified thickness of equipment insulation has been installed, an approved coating shall be sprayed, brushed, or troweled on to a minimum thickness. While coat is still tacky, an open weave (10 x 10 mesh) glass membrane shall be laid smooth and thoroughly embedded in coating. Care must be exercised that weave does not rupture and that cloth is overlapped approximately three inches (3") to provide strength at joint equal to that maintained elsewhere.
2. Before surface becomes dry to the touch, a second coating shall be sprayed, brushed, or troweled over the reinforcing cloth to a uniform thickness not less than 1/8 inch thick, with a smooth, unbroken surface and allowed to dry.
3. Application of coating shall be built up in a uniform manner to prevent uneven contraction and tendency toward surface cracks. When spraying, care should be taken that air is directed at sufficient pressure to obtain maximum atomization without pock-marking of surface owing to excessive velocity. Slugs shall be removed from surface immediately.

Da. Finish (Alternate Application Method)

An open weave 10 x 10 mesh glass membrane may be spot tacked to the insulation and the finish coating applied through membrane as a single application. Coating should be applied in accordance with manufacturer's recommendations.

E. Flashing

On equipment located outdoors, it is imperative that proper flashing materials and methods be used at nozzles, manholes and other projections, as well as at the junction of horizontal and vertical installations.

F. Painting

When asphaltic materials are specified for the weathercoat and paint is desired, it may be done as follows (usually by separate contract):

1. As soon as asphalt surface has dried, the surface shall be painted with an asphalt base aluminum paint.
2. If aluminum finish is not desired, the asphalt surface shall be sealed with asphalt sealer and painted to desired color.

HNA 14353

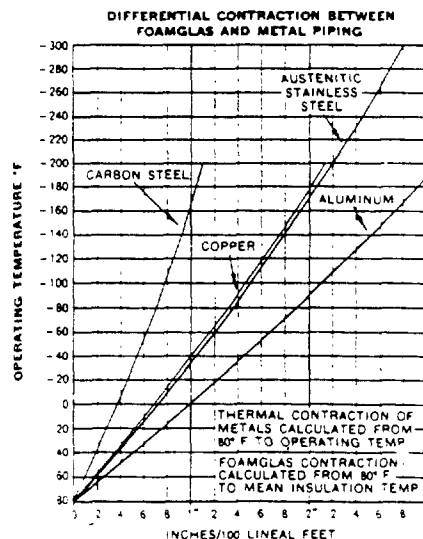
II. PIPING

A. Thickness

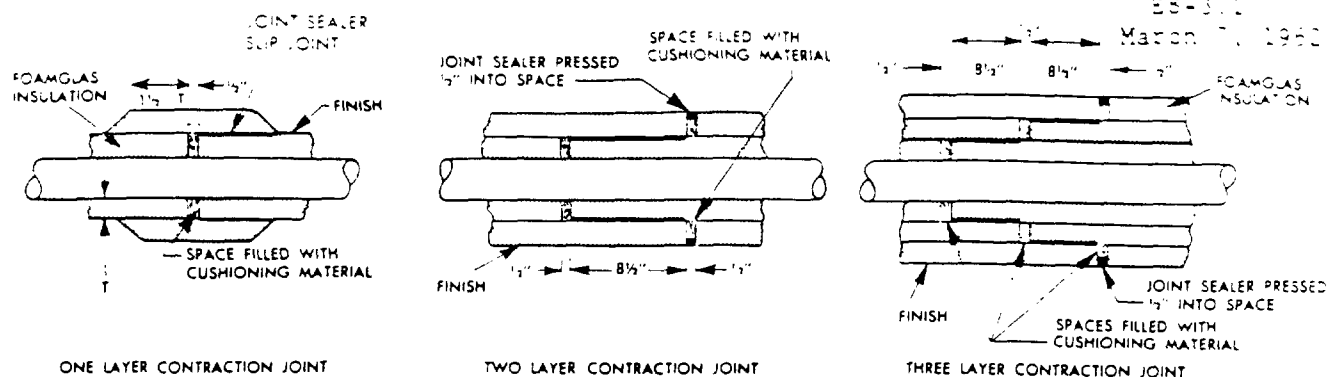
All piping shall be insulated with the proper thickness of FOAMGLAS insulation as shown in Table I. Insulation thickness shall be determined by lowest temperature at which the piping normally operates.

B. Application

1. Where single layer "Factory-wrapped" insulation is used, application shall be made as received, with joints tightly butted and sufficiently buttered with specified joint sealer. Wrapping laps shall be brushed with asphalt cut back and pressed firmly in place.
2. Where single layer "Regular" insulation is used, the FOAMGLAS insulation will be applied to piping with butt joints staggered and all joints tightly butted and buttered with joint sealer. A finish shall then be applied in similar manner as called for under "Equipment" in these specifications.
3. On multiple-layer insulation, where specified, the additional layer or layers shall be applied with side and end joints staggered over joints of preceding layer.
4. Only outer layer joints of multiple-layer applications shall be buttered with specified joint sealer before installation. The joints shall be drawn together when FOAMGLAS insulation is applied so that only a very thin vapor seal separates the section of insulation.
5. FOAMGLAS insulation shall be applied with all joints fitted to eliminate voids. Large voids shall not be filled with vapor seal coating, but eliminated by refitting or replacing insulation.
6. Where piping is subject to excessive vibration, the bore of the inner layer shall be coated with a thin application (to fill surface cells only) of specified bore coating, and allowed to dry before application of insulation to piping.
7. Single and outermost layers of pipe insulation shall be secured in place with stainless steel insulation strap on 9" centers.
8. After specified thickness of insulation has been installed, a finish shall be applied as called for under "Equipment" in these specifications.
9. Contraction joints shall be installed in both horizontal and vertical straight run piping when piping will be subjected to temperatures which dictate the necessity of such joints. Chart at right may be used as a guide for determining number of joints required.
 - a. Joints shall be loosely filled with cushioning material.
 - b. When contraction joints are required, contraction should be provided by and in the flange cover of flanged joints when they occur in the line.
 - c. Typical installations shown in Figure 7A, B, C.



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FOAMGLAS INSULATION CONTRACTION JOINTS FOR HORIZONTAL PIPING.
NOTE: ALL OUTER LAYER JOINTS COATED WITH JOINT SEALER.

FIGURE 7A

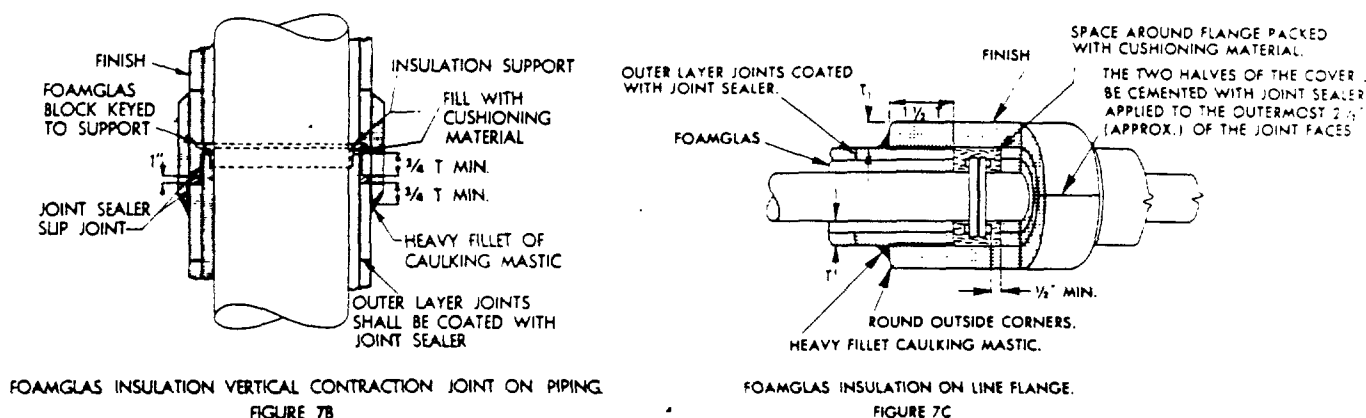


FIGURE 7B

FIGURE 7C

10. FOAMGLAS insulation on flanges, valves and other fittings shall consist of prefabricated fitting covers of the same material and thickness specified for pipe insulation.

- Fitting covers shall be applied in same manner as pipe insulation. Stainless steel insulation strap will be so located that maximum strength and securement shall be obtained. Fitting fillers are not necessary, provided all joints are properly sealed.
- Protruding metal parts (such as valve stems) shall be thoroughly sealed.
- Hangers shall be on the outside of the insulation and shall not be in contact with the pipe. Curved metal shields shall be used between the hangers and the bottom of the insulation. Shield and hanger spacing shall be designed to limit the compressive stress between hanger and insulation to 35 psi.
- Outer surface of fitting covers shall be reinforced and finished in the same manner as specified for pipe insulation. Care shall be exercised that reinforcing cloth overlaps connecting pipe insulation a distance of not less than six inches.

C. Painting

When asphaltic materials are specified for the weathercoat, and painting is desired, it may be done as follows (usually by separate contract):

- As soon as asphalt surface has dried, the surface shall be painted with an asphalt base aluminum paint.
- If aluminum finish is not desired, the asphalt surface shall be sealed with asphalt sealer and painted to desired color.

HNA 14355

RECOMMENDED ACCESSORY MATERIALS FOAMGLAS PIPING AND EQUIPMENT

MATERIALS	USE	TEMP. RANGE	SOURCE
Regular Hot Erection Asphalts	Adhesive & Sealer	- 50°F. to 150°F.	Refineries
RR-1950 (Erection Asphalt) RB-2813 (Erection Asphalt)	Adhesive & Sealer Adhesive & Sealer	- 100°F. to 150°F. - 25°F. to 200°F.	H.H. Robertson Co. Farmers Bank Bldg. Pittsburgh, Pa.
Pittcote 300 Fibrated Asphalt Cutback	Coating & Sealer	- 40°F. to 250°F.	Pittsburgh Corning Corporation
Pittcote 400 Vinyl Emulsion Mastic	Coating	- 50°F. to 180°F.	Pittsburgh Corning Corporation
Pittseal 111	Sealer & Slipjoint	- 100°F. to 300°F.	Pittsburgh Corning Corporation
PC Mastic 100	Sealer & Slipjoint	- 50°F. to 125°F.	Pittsburgh Corning Corporation
Anti-Abrasive Compound 1A	Bore Coating	- 300°F. to 150°F.	Pittsburgh Corning Corporation
Keenes Cement	Bore Coating	- 25°F. to 500°F.	Local Builders' Supply Firms
CS Paint	White insulation coating Lagging adhesive for light-weight fabrics	- 10°F. to 125°F.	Pittsburgh Corning Corporation
Primer Sealer 3A	Asphaltic Primer	- 50°F. to 150°F.	Pittsburgh Corning Corporation
Glass Fabrics 10 x 10 asphalt treated 10 x 10 plain	Membrane for asphaltic coatings Membrane for vinyl coatings	(determined by coating used)	Pittsburgh Corning Corporation

These specifications are necessarily general in nature and do not cover all possible methods of application. Application procedure is at the discretion and responsibility of the design engineer to meet specific job requirements.

General Offices

Pittsburgh Corning Corporation
One Gateway Center
Pittsburgh 2, Pennsylvania

District Offices

Atlanta 9, Georgia
968 Peachtree Street, N.E.
TRinity 2-4402

Philadelphia 2, Pennsylvania
Lewis Tower Building
225 South Fifteenth Street
KIngsley 6-3510

New York 17, New York
579 Fifth Avenue
Murray Hill 8-8350

Houston 2, Texas
1607 Jefferson Avenue
CApitol 7-1619

Chicago 6, Illinois
The Engineering Building
205 West Wacker Drive
FI-nancial 6-2376

Montreal, Quebec, Canada
3333 Cavendish Boulevard
HUnter 1-7038

HNA 14356

P I T T S B U R G H

(16)



C O R N I N G

March 7, 1962

CELANESE FIBERS COMPANY
Celriver Plant

REPAIR

General Instructions for Insulating
Crystallizers and Acetylizers

Maintenance Dept. Procedure

VM3-0041

Date

10-30-61

Supersedes Procedure

I. Crystallizer Insulation Procedure.

1. All surfaces are to be clean and free of rust and scale. Jacket, nozzle, and supporting beam repairs are to be complete. Acid drain lines, etc., are to be complete. Retaining ring, pan around stuffing box, any other anticipated mechanical repairs should be completed if possible to avoid later damage to insulation. All mild steel parts should be thoroughly primed and painted before insulation is applied.

2. Material specifications - See B.M., Page 2.

II. Acetylyzer Insulation Procedure

1. All surfaces are to be clean and free of rust and scale. Jacket, nozzle, and supporting beam repairs are to be complete. Sheet metal boxes (s/s) are to be installed around four stationary arm bolt locations. Any other mechanical repairs should be completed if possible to avoid later damage to insulation. All mild steel parts should be thoroughly primed and painted before insulation is applied.

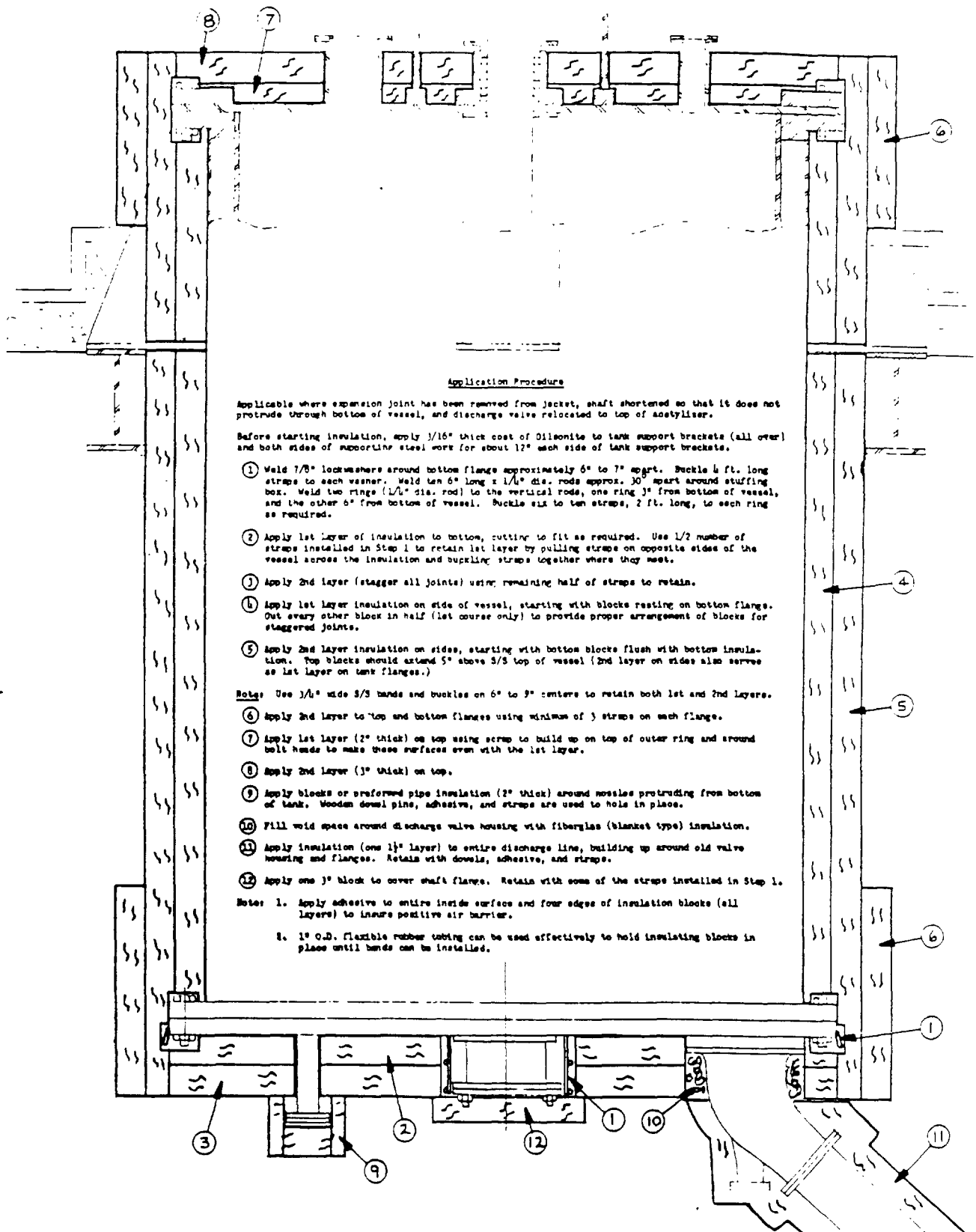
2. Material specifications - See B.M., Page 5.

Appendix B

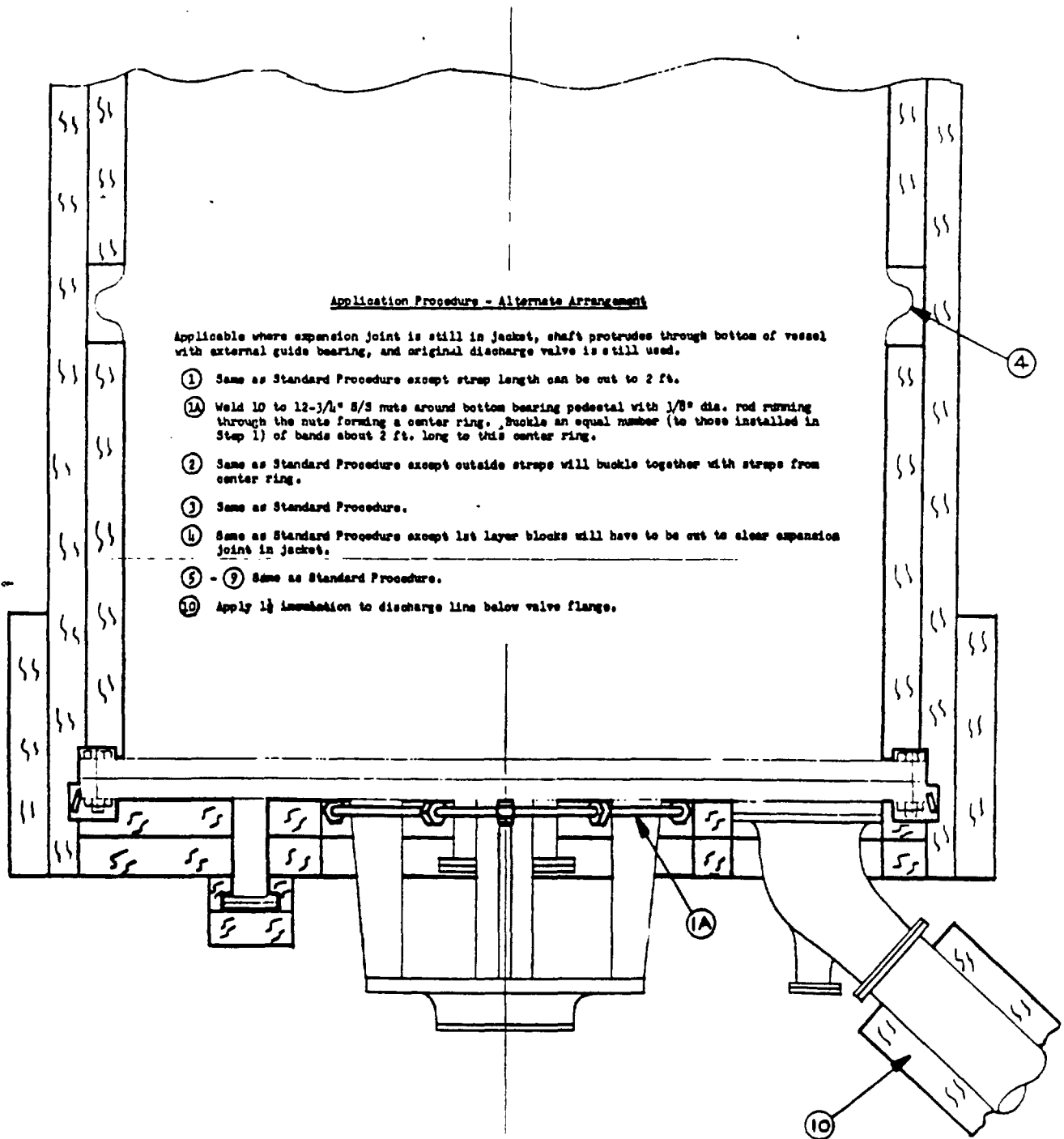
PLANT		Celriver		CELANESE CORPORATION OF AMERICA			REF. DWG(S).		MATERIAL BILL NO.	
EST				ENGINEERING DEPT.			VM3-0043		VM3-0042	
REQ. NO.							VM3-0044			
NO. REQ	MARK	SIZE	NAME	DESCRIPTION	REQ NO.	ORDER NO.	STORE REMARKS			
150 sq.ft.		12" x 18" x 3"	Insulation	Foamglas blocks, preformed to fit 5'-0" O.D. (1st layer on tank sides)						
240 sq.ft.		12" x 18" x 3"	Insulation	Foamglas blocks, preformed to fit 5'-6" O.D. (2nd layer over above insulation; and, top and bottom flange.)						
60 sq.ft.		12" x 18" x 3"	Insulation	Foamglas blocks, preformed to fit 6'-0" O.D. (2nd layer over above flanges).						
90 sq.ft.		18" x 24" x 3"	Insulation	Foamglas blocks, flat (2nd layer - top; and both layers - bottom).						
30 sq.ft.		18" x 24" x 2"	Insulation	Foamglas blocks, flat (1st layer - top).						
15 sq.ft.		12" x 18" x 1 1/2"	Insulation	Foamglas blocks, preformed to fit 6" O.D. tubing or 6" IPS pipe; whichever size is used for the crystallizer discharge line.						
24 gals.			Insul.adhesive	Foster C.I. mastic 60-25, trowelling grade			40388-424			
5 gals.			Anti-sweat coat.	Pittsburg Chemical and Coke Co. Gilonite			42560-119			
600 ft.	3/4"		Strapping	S/S			42561-070			
200	3/4"		Buckles	S/S						
35	7/8"		Lockwashers	S/S (May be fabricated from flat bar)			06513-386			
12	3/4"		Hex nuts	S/S			42510-309			
8 ft.	3/8" dia.		Rod	S/S			42510-156			
12 ft.	1/4" dia.		Rod	S/S						
TITLE								Crystallizer Insulation - Material for one Vessel		
DEPT BLDG		8 C. A.	USE	LISTED DATE	CHK'D DATE	APPR DATE	APPR DATE	SHEET OF SHEET(S) -		

* Used only when guide bearing and housing remain on bottom of crystallizer.

1278-00-3



VM3-0044



Appendix B

PLANT		C. L. Driver		CELANESE CORPORATION OF AMERICA		ENGINEERING DEPT.		REF. DWG(S).		VM3-0046		VM3-0045	
EST													
REQ. NO.													
NO. REQD.	MARK	SIZE	NAME	DESCRIPTION	REQ. NO.	ORDER NO.	STORE REMARKS						
80 sq. ft.	3" thick	Insulation		Foamglas blocks, preformed to fit dished bottom of 8'-6" O.D. vessel (1st layer). Radius of dished head 8'-0".									
100 sq. ft.	3" thick	Insulation		Foamglas blocks, preformed to fit over above insulation (2nd layer).									
150 sq. ft.	12" x 18" x 3"	Insulation		Foamglas blocks, preformed to fit 8'-6" O.D. (1st layer on sides of vessel).									
200 sq. ft.	12" x 18" x 3"	Insulation		Foamglas blocks, preformed to fit 9'-0" O.D. (2nd layer over above insulation and also used for top flange).									
40 sq. ft.	12" x 18" x 3"	Insulation		Foamglas blocks, preformed to fit 2'-6" O.D. (1st layer on discharge chutes).									
60 sq. ft.	12" x 18" x 3"	Insulation		Foamglas blocks, preformed to fit 3'-0" O.D. (2nd layer over above insulation).									
50 sq. ft.	18" x 24" x 3"	Insulation		Foamglas blocks, flat, (1st layer - top).									
50 sq. ft.	18" x 24" x 1 1/2"	Insulation		Foamglas blocks, flat, (2nd layer - top).									
120 sq. ft.	18" x 24" x 2"	Insulation		Foamglas blocks, flat, (2nd & 4th layer - top).									
35 gals.		Insul Adhesive		Foster C.I. mastic 60-25 trowelling grade.									
4 gals.		Anti-sweat coat		Pittsburg Chemical and Coke Co. Gilsonite			40388-424						
600 ft.	3/4" wide	Strapping		S/S			42560-119						
200	3/4"	Buckles		S/S			42561-070						
15 ft.	1 1/2 x 1 1/2 x 1/2	Angle		S/S			42500-176						
75 ft.	3/8" dia.	Rod		S/S			42510-309						
TITLE								Acetylyzer Insulation - Material for One Vessel					
DEPT. 8		USE		LISTED		CH'K'D		APPR		SHEET		OF	
BLDG		C		A									

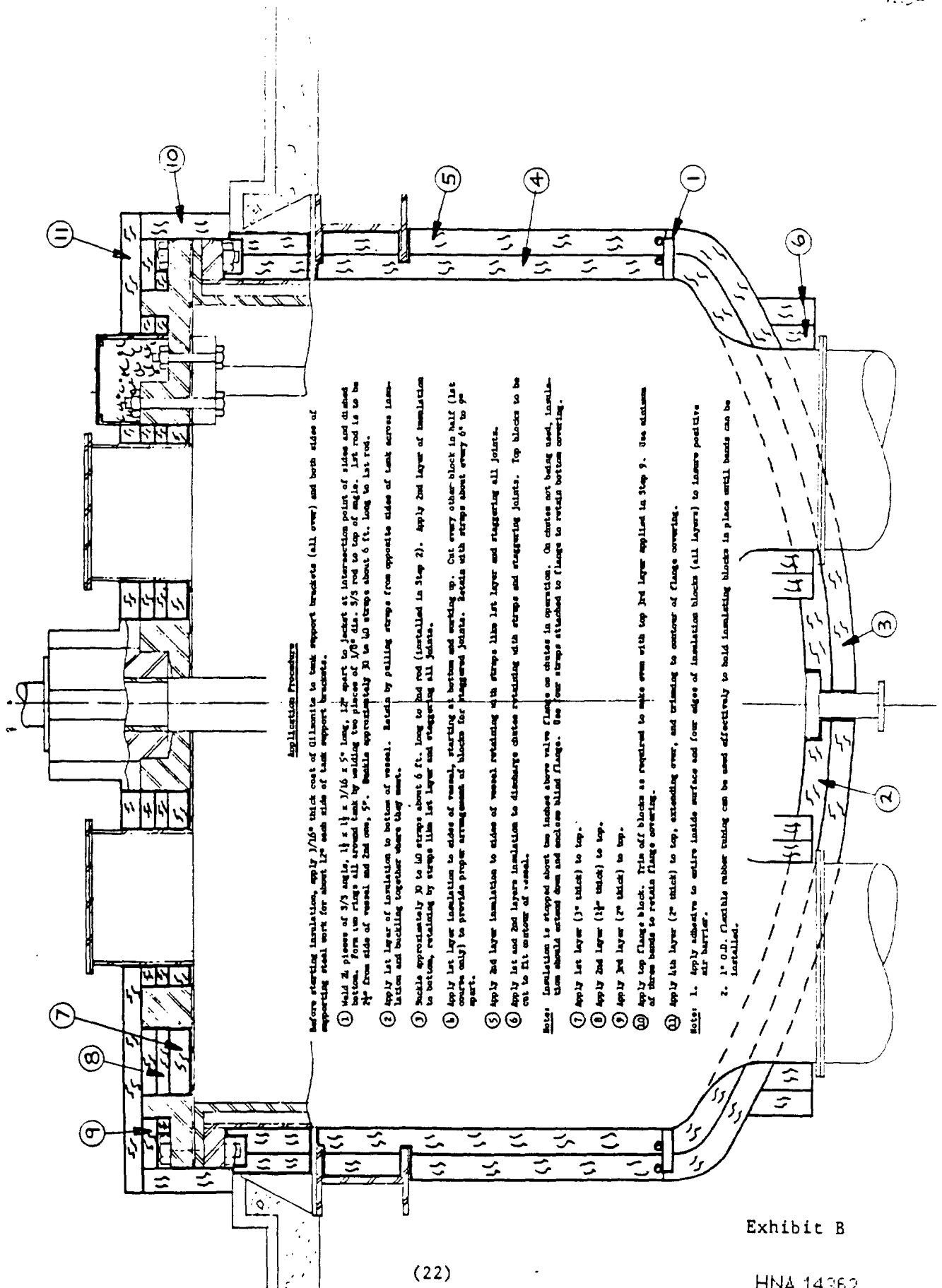


Exhibit B

March 7, 1962

Maintenance Department Procedure

WM3-0047

III. Protective Coating for crystallizers and acetylizers insulation.

1. Material requirements - See B.M., Page 8.

2. Application procedure (both vessels).

a. Insul-Mastic (Gilsomite)

Trowel on directly over smooth Foamglas approximately 1/16" to 1/8" thick and thick as required to fill in holes, cracks, and cover metal bands. Allow to dry thoroughly. Hot air, infra-red lights, etc., will reduce drying time.

b. Carboline Hardtop #3

Mix according to instructions (reduce amount of water if sand is wet) and trowel on top of vessel. Thickness should vary from about 1/2" in center of vessel to 1/8" at outer perimeter. This will provide a slight slope which will drain off water or acid spilled on top. Pea gravel can be used as an aggregate to fill and strengthen mix. Allow to dry at least 8 hours.

c. Carboline X2200-21 Mastic

Mix equal parts of Component A and Component B to make one part ($\frac{1}{2}$ qt. A and $\frac{1}{2}$ qt. B = 1 qt. mixture), 3 to $3\frac{1}{2}$ parts special silica sand, and 1/2 to 1 part ground asbestos. It is extremely important that Components A and B be mixed properly. Due to the fast set-up time and unless more than two men are working, not more than 1 qt. of each component plus 8 parts of sand and asbestos should be mixed at a time. Mixing can best be done using a slow speed 1, drill motor and 1/2" rod about 3 ft. long with blades welded on the end. Two men applying and a third mixing gives most efficient procedure.

This material is not easy to apply and some experience is required to do a smooth, good-looking job. Upward strokes should be used on vertical surfaces and minimum number of strokes should be used as the material will tend to stick to the trowel. A good, heavy pressure on the trowel on each stroke will minimize this sticking and provide a smoother finish. Tools can be kept clean and moist with special trowelling solvent or MEK. The trowelling solvent is used with a brush and trowel to provide the final smooth slick finish. Allow to dry 12 to 24 hours.

d. Carboline X1301-2 (Gray 724) Polyurethane build coat

Wipe down surface of mastic coat with Solox (denatured alcohol) and brush one coat X1301-2 build coat. This helps to seal pores of mastic and provides a still smoother surface for the final coat. (This step is more for appearance and can be eliminated if desired.)

e. Carboline X1301-66 Polyurethane (any color) finish coat

This coat should be applied 8 to 48 hours after build coat. If more than four days elapse, surface of build coat should be washed down with Solox before applying final coat.

Appendix B

Handwritten signature/initials

PLANT CeIrIver		CELANESE CORPORATION OF AMERICA ENGINEERING DEPT.				REF. DOC(S).		MATERIAL BILL NO. VM3-0048	
EST									
REQ. NO.									
NO. REQD	QTY	SIZE	NAME	DESCRIPTION	REQ. NO.	ORDER NO.	STORE	REMARKS	
				PROTECTIVE COATING MATERIAL FOR ONE CRST.					
10 gals.			Mastic	Pittsburg-Chemical Coke-Gilsonite.					
2 gals.			Mastic	Carboline Hardtop #3.					
10 gals.			Mastic	Carboline X2200-21 Epoxy.					
500 lbs.			Sand	Silica					
25 lbs.			Asbestos	Johns Mansville Shorts #352.					
2 gals.			Solvent	Carboline trowelling solvent.					
1/2 gal.			Paint	Carboline XI301-2 Polyurethane build coat (gray 724 standard).					
1/2 gal.			Paint	Carboline XI301-66 Polyurethane finish coat.					
				PROTECTIVE COATING MATERIAL FOR ONE ACETY.					
15 gals.			Mastic	Pittsburg-Chemical Coke Gilsonite.					
3 gals.			Mastic	Carboline Hardtop #3.					
20 gals.			Mastic	Carboline X2200-21 Epoxy.					
750 lbs.			Sand	Silica					
10 lbs.			Asbestos	Johns Mansville Shorts #352.					
5 gals.			Solvent	Carboline trowelling solvent.					
1 gal.			Paint	Carboline XI301-2 Polyurethane build coat (gray 724 standard).					
1 gal.			Paint	Carboline XI301-66 Polyurethane finish coat.					
TITLE									
DEPT. 8		USE		LISTED		CHK'D		APPR	
BLDG C.A.				DATE		DATE		DATE	
								SHEET OF	
								SHEET(S) -	