

PLAINTIFF'S EXHIBIT

SH-3507

VOID

SHELL OIL COMPANY
ENGINEERING STANDARDS



DESIGN STANDARD 5-1
INSULATION

AUGUST 1959

ABS-061217

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CHART NO. 1 - Hot Service - Recommended Insulation Thicknesses

CHART NO. 2 - Cold Service - Recommended Insulation Thicknesses

5-1.1 GENERAL

5.1.1.1 SCOPE

This standard covers the Engineering design of insulation systems for piping, vessels, exchangers, tanks, pumps, compressors, and turbines in hot and cold services. It is intended to provide a basic guide for consideration of recurring insulation design problems and to inform engineers of preferred design procedures.

5-1.2 HOT SERVICE

5-1.2.1 INSULATION REQUIREMENTS

- .1 Hot service piping and equipment shall be insulated to conserve energy, maintain process stability, protect personnel, or for a combination of these reasons. In general, hot service insulation shall be applied on piping operating above 150°F and on equipment operating above 170°F. In addition, any hot surfaces of large area such as vessels and exchangers which operate below 170°F shall be considered to determine the need for insulation for process stability.
- .2 Valves, flanges and fittings, except unions, in steam and boiler feed water services shall be insulated. Valves, flanges and flanged fittings in other services shall not be insulated except where required for personnel protection, unless specified by Shell. Welded and screwed fittings, except unions, in insulated lines shall be insulated.

5-1.2.2 INSULATION THICKNESSES

- .1 Insulation thicknesses for hot service piping, vessels, exchangers, pumps, compressors, and turbines shall be in accord with appended chart No. 1. The recommended thicknesses are based upon personnel protection requirements. The need for additional thickness for energy conservation or process stability shall be considered.
- .2 Insulation thickness for hot service tanks 12 feet OD or less shall be 1 inch and shall be 1½ inches for tanks over 12 feet OD. The density of the insulation for tanks over 12 feet OD shall be dependent upon economic factors and specified by Shell for each installation.
- .3 Insulation thicknesses recommended in appended Chart No. 1 are based on an insulating material having approximate thermal conductivity values of 0.44 at 200°F and 0.58 at 600°F. Materials with other conductivity values may be substituted provided there is a corresponding adjustment in insulation thicknesses.

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5-1.2.3 PERSONNEL PROTECTION INSULATION

- .1 Insulation thicknesses for personnel protection shall be such that the external surface temperature of the insulation shall be a maximum of 150°F for piping and 170°F for other equipment. The effect of weatherproof coverings shall not be considered in establishing the insulation thicknesses.
- .2 Insulation for personnel protection shall generally be applied to hot surfaces which can be inadvertently contacted by personnel in normal performance of their duties. Such hot surfaces shall be insulated to a height 7 feet above normal walking or standing surfaces.
- .3 Unless specified by Shell internally insulated equipment such as cat cracker vessels and lines, reformer and desulphurizer reactors, etc., shall not be insulated for personnel protection by the insulation contractor even though their surface temperatures exceed 170°F. Personnel protection for these hot surfaces shall be applied, when required by Shell.
- .4 Personnel protection on equipment from which it is desirable to dissipate heat, such as steam condensate knockout drums and exchangers with cooling water on one side, shall be expanded metal guards instead of insulation.

5-1.2.4 STEAM TRAP INSULATION

Steam traps and their outlet piping shall not be insulated except for personnel protection or where the outlet piping is arranged so that a liquid head of condensate can collect. Inlet piping to traps shall be insulated.

5-1.2.5 STEAM TRACING INSULATION

- .1 Piping or equipment which is steam traced shall be covered with oversized insulation to include the Tracer Lines. Insulation thicknesses shall be selected from appended Chart No. 1 with the thickness for pipe insulation based on the size used.
- .2 Steam traced systems shall be completely insulated including equipment, valves, flanges fittings and tracer line loops.

5-1.3 COLD SERVICE

5-1.3.1 INSULATION REQUIREMENTS

Cold service equipment and piping shall be completely insulated to conserve energy, maintain process stability, protect personnel, prevent moisture condensation, or for a combination of these reasons. In general, cold service insulation shall be applied on equipment and piping operating at 50°F, or less which are part of a refrigeration system or contain fluids which are cooled by a refrigeration system.

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5-1.3.2 INSULATION THICKNESSES

- .1 Insulation thicknesses for cold service equipment shall be in accord with appended Chart No. 2. The recommended thicknesses, which are based upon prevention of moisture condensation, will in general be adequate for energy conservation, process stability, and personnel protection requirements. When additional thicknesses are necessary, the required insulation thicknesses shall be calculated.

Insulation thicknesses recommended in appended Chart No. 2 are based on an insulating material having approximate thermal conductivity values of 0.35 at 0°F and 0.39 at 70°F. Materials with other conductivity values may be substituted provided there is a corresponding adjustment in insulation thicknesses.

HOT SERVICE - RECOMMENDED INSULATION THICKNESSES

FOR COMBINATION OF ENERGY CONSERVATION, PERSONNEL PROTECTION, AND PROCESS STABILITY

VESSELS, EXCHANGERS, PUMPS, COMPRESSORS, AND TURBINES FOR INSULATION SURFACE TEMPERATURES OF 170°F.					
INSULATION THICKNESS, INCHES	1	1½	2	2½	3
MAXIMUM TEMPERATURE, °F	600	800	950	1100	1200

PIPING FOR INSULATION SURFACE TEMPERATURES OF 150°F.								
INSIDE UNIT AREAS								
PIPE SIZE INCHES	INSULATION THICKNESS, INCHES							
	1	1½	2	2½	3	3½	4	4½
	MAXIMUM TEMPERATURE, °F.							
1 Down	650	850	1100	1200				
1½	550	750	900	1200	1200			
2	550	750	900	1150	1200			
3	500	700	850	1150	1200	1200		
4	500	650	800	1000	1150	1200		
6	430	600	800	900	1050	1200		
8		600	750	900	1050	1200	1200	
10		600	750	900	1000	1150	1200	
12		600	750	850	1000	1100	1200	
14		550	700	800	950	1050	1150	1200
16		550	700	800	900	1050	1150	1200
18		550	700	800	900	1000	1150	1200
20		550	650	800	900	1000	1100	1200
22		550	650	800	900	1000	1100	1200
24		550	650	750	850	950	1100	1200
OUTSIDE UNIT AREAS								
Thicknesses shall be selected on individual basis for each refinery depending upon economic factors, personnel protection, and process stability.								

NOTES

- The above tables are based on 80°F. ambient still air and on an insulating material having approximate thermal conductivity values of 0.44 at 200°F. and 0.58 at 600°F.
- The above tables do not include the insulating effect of final coverings which can be expected to further reduce insulation surface temperatures.

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COLD SERVICE - RECOMMENDED INSULATION THICKNESSES
FOR COMBINATION OF ENERGY CONSERVATION, PROCESS STABILITY, PERSONNEL PROTECTION,
AND CONDENSATION PREVENTION

PIPING, VESSELS, EXCHANGERS, PUMPS, AND COMPRESSORS											
IRON PIPE SIZE INCHES	INSULATION THICKNESS, INCHES										
	1	1½	2	2½	3	3½	4	4½	5	5½	6
	MINIMUM TEMPERATURE, °F										
1 Down	50	25	-10	-25	-70						
1½	50	30	15	-15	-45						
2	50	30	15	-15	-45	-90					
3	50	30	15	-10	-35	-60					
4	50	30	20	0	-30	-55					
6	50	45	25	0	-25	-45	-70				
8		45	25	0	-15	-35	-60				
10		45	30	10	-10	-25	-50				
12		45	30	15	-5	-25	-45	-65			
14		45	30	15	0	-25	-40	-55			
16		45	30	20	0	-25	-35	-55			
18		45	30	20	0	-25	-35	-50			
20		50	30	20	0	-25	-35	-45	-65		
24		50	30	20	0	-25	-35	-45	-65		
30		50	30	20	5	-10	-25	-40	-60		
Vessel OD											
Inches											
36		50	30	20	10	-5	-25	-40	-55		
42		50	30	25	10	-5	-20	-35	-55		
48		50	30	25	10	-5	-20	-35	-50		
54		50	35	25	10	-5	-20	-35	-50		
60		50	40	25	10	-5	-20	-30	-50		
66		50	40	25	10	-5	-15	-30	-50		
72		50	40	25	10	0	-15	-30	-50		
78		50	40	25	10	0	-15	-30	-45	-65	
84		50	40	25	10	0	-15	-30	-45	-65	
96		50	40	25	10	0	-15	-30	-45	-65	
108		50	40	25	10	0	-15	-30	-45	-60	-75
120		50	40	25	10	0	-15	-30	-45	-60	-75
144		50	40	25	10	0	-15	-30	-45	-60	-75
Over 144 To Flat		50	40	25	15	0	-10	-25	-40	-55	-65

NOTES

1. The above tables are based on 90°F. ambient still air, 80% relative humidity, and on an insulating material having approximate thermal conductivity values of 0.35 at 0°F. and 0.39 at 70°F.
2. The above tables are based on the prevention of moisture condensation.
3. The above tables do not include the insulating effect of final covering.

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**SHELL OIL COMPANY
ENGINEERING STANDARDS**



**MATERIAL AND EQUIPMENT STANDARD 5-2
INSULATION**

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CHARTS APPENDED

CHART NO. 1 - Hot Service Insulation and Coating Materials

CHART NO. 2 - Cold Service Insulation and Coating Materials

5-2.1 GENERAL

5-2.1.1 SCOPE

This standard covers the selection of materials for the insulation of piping, vessels, exchangers, tanks, pumps, compressors, and turbines in hot and cold services. It is intended to establish a standard of quality applicable to all insulating materials.

5-2.1.2 MATERIAL REQUIREMENTS

- .1 Reference to a particular material or equal shall serve only as a precise identification of the type and quality of the material required. Alternate materials will be considered. Sufficient engineering data for evaluation of alternate materials shall accompany proposals. Shell shall be the sole judge of the equality, design, workmanship, and suitability of materials offered on an alternate basis.
- .2 All aluminum sheets and elbows used for final covering in hot services shall have an asphalt, polyethylene, or equal, protective barrier factory-applied to the under side when used with insulations which are chemically reactive with aluminum.

5-2.2 HOT SERVICE

5-2.2.1 PIPING

.1 INSULATION AND COATING MATERIALS

Insulations and coatings shall be in accord with appended Chart No. 1.

.2 FINAL COVERINGS

- .1 Final covering for piping insulation inside office buildings shall be 8-ounce canvas saturated with Aroclor Mfg. Co. Aroclor, or equal.
- .2 Final covering for straight piping insulation inside unit areas shall be flat aluminum sheets, 0.016 inch, utility grade, half hard, mill finished, in cut and machine rolled sections approximately 3 feet long. Final covering for welded elbow insulation inside unit areas shall be preformed aluminum elbows, Childers Mfg. Co., General Aluminum Supply Co., or equal.
- .3 Final covering for straight piping insulation outside unit areas shall be asbestos-asphalt felt in cut and rolled sections approximately 3 feet long, Johns-Manville Corp., Double-Coated Flexstone, or equal. Final covering for welded elbow insulation outside unit areas shall be weather-proofing compound, Philip Carey Mfg. Co. Thermotex B, or equal.

.3 BANDINGS

- .1 Banding shall not be applied on one-piece pipe insulation.
- .2 Banding on insulation under aluminum final covering shall be:
 - .1 Piping 10 inches and smaller - 0.051 inch diameter, soft, type 18-8, stainless steel wire;
 - .2 Piping 12 inches through 16 inches - 0.064 inch diameter, soft, type 18-8, stainless steel wire;
 - .3 Piping 18 inches and larger - 1/2 inch x 0.015 inch, soft, type 18-8, stainless steel bands and seals.
- .3 Banding on insulation under asbestos-asphalt felt final covering and on asbestos-asphalt felt final covering shall be:
 - .1 Piping 10 inches and smaller - 0.064 inch diameter, galvanized, soft, iron wire;
 - .2 Piping 12 inches through 16 inches - 0.083 inch diameter, galvanized, soft, iron wire;
 - .3 Piping 18 inches and larger - 1/2 inch x 0.020 inch, soft, aluminum bands and aluminum seals.
 - .4 Banding on aluminum final covering shall be 1/2 inch x 0.020 inch, soft aluminum bands and aluminum seals.

.4 ACCESSORIES

- .1 Glass fabric shall be Twinsburg - Miller Co. Glasfab, 20 x 20 mesh, asphalt treated, or equal.
- .2 Lacing wire shall be 0.051 inch diameter, soft, type 18-8, stainless steel wire.

5-2.2.2 VESSELS

.1 INSULATION AND COATING MATERIALS

Insulations and coatings shall be in accord with appended Chart No. 1.

.2 FINAL COVERINGS

- .1 Final covering for vertical vessel shell insulation shall be corrugated aluminum roofing sheets, 1-1/4 inches x 1/4 inch corrugations, 0.019 inch, standard grade, half hard, mill finished.

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- .2 Final covering for horizontal vessel shell insulation shall be flat aluminum sheets, 0.020 inch, utility grade, half hard, mill finished.
- .3 Final covering for vessel head insulation shall be weatherproofing compound, Philip Carey Mfg. Co. Thermotex B, or equal.

.3 BANDINGS

- .1 Banding on vessel shell insulation shall be:

- .1 Vessels 8 feet O.D. and smaller - 1/2 inch x 0.015 inch, soft, type 18-8, stainless steel bands.
- .2 Vessels larger than 8 feet O.D. - 3/4 inch x 0.020 inch, soft, type 18-8, stainless steel bands with A. J. Gerrard and Co. Expand-R-Strap, Techalloy Co. Breather Spring, or equal, expansion sections and stainless steel seals.

- .2 Banding on vessel head insulation shall be 1/2 inch x 0.015 inch, soft, type 18-8, stainless steel bands anchored with lacing wire hair pins to 1/2 inch nut blanks welded to heads.

- .3 Banding on vessel shell final covering shall be:

- .1 Vessels 8 feet O.D. and smaller - 3/4 inch x 0.025 inch, soft, aluminum bands with aluminum seals.
- .2 Vessels larger than 8 feet O.D. - 3/4 inch x 0.020 inch, soft, type 18-8, stainless steel bands with A. J. Gerrard and Co. Expand-R-Strap, Techalloy Co. Breather Spring, or equal, expansion sections and stainless steel seals.

.4 ACCESSORIES

- .1 Wire mesh shall be 1 inch hex mesh of 0.032 inch diameter, 3 twist, soft, type 18-8, stainless steel wire.
- .2 Lacing wire shall be 0.051 inch diameter, soft, type 18-8, stainless steel wire.

5-2.2.3 EXCHANGERS

.1 INSULATION AND COATING MATERIALS

Insulations and coatings shall be in accord with appended Chart No. 1.

.2 FINAL COVERINGS

- .1 Final covering for exchanger shell and channel insulation shall be flat aluminum sheets, 0.020 inch, utility grade, half hard, mill finished, in cut and machine rolled sections approximately 3 feet long.
- .2 Final covering for exchanger shell head and channel head insulation shall be weatherproofing compound, Philip Carey Mfg. Co. Thermotex B, or equal.

.3 BANDINGS

- .1 Banding on exchanger shell and channel insulation shall be 1/2 inch x 0.015 inch, soft, type 18-8, stainless steel bands with stainless steel seals.
- .2 Banding on exchanger shell and channel final covering shall be 3/4 inch x 0.025 inch, soft, aluminum bands with aluminum seals.

.4 ACCESSORIES

- .1 Wire mesh shall be 1 inch hex mesh of 0.032 inch diameter, 3 twist, soft, type 18-8, stainless steel wire.
- .2 Lacing wire shall be 0.051 inch diameter, soft, type 18-8, stainless steel wire.

5-2.2.4 TANKS

.1 INSULATION AND COATINGS MATERIALS

Insulations and coatings shall be in accord with the appended Chart No. 1.

.2 FINAL COVERINGS AND BANDING

- .1 Tanks 12 feet O.D. and smaller, - Final covering and banding for tank insulation shall be in accord with section 5-2.2.2 for hot service vessels.
- .2 Tanks larger than 12 feet O.D. - Final covering for tank insulation shall be flat asbestos-cement sheets, 4 feet x 8 feet x 3/16 inch thick, Johns-Manville Corp. Asbestocite, or equal.

.3 ACCESSORIES

- .1 Tanks 12 feet O.D. and smaller - Accessories shall be in accord with section 5-2.2.2. for hot service vessels.

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- .2 Tanks larger than 12 feet O.D. - Accessories shall be in accord with appended drawing No. B-1235.

5-2.2.5 PUMPS, COMPRESSORS AND TURBINES

.1 INSULATION AND COATING MATERIALS

Insulations and coatings shall be in accord with appended Chart No. 1.

.2 FINAL COVERINGS

Final covering for insulation shall be weatherproofing compound, Philip Carey Mfg. Co. Thermotex B, or equal.

.3 ACCESSORIES

- .1 Wire mesh shall be 1 inch hex mesh of 0.032 inch diameter, 3 twist, soft, type 18-8, stainless steel wire.
- .2 Lacing wire shall be 0.051 inch diameter, soft, type 18-8, stainless steel wire.

5-2.3 COLD SERVICE

5-2.3.1 PIPING

.1 INSULATION AND COATING MATERIALS

Insulation and coatings shall be in accord with appended Chart No. 2.

.2 FINAL COVERINGS

- .1 Final coverings for piping insulation inside office buildings shall be 8-ounce canvas saturated with Aroclor Mfg. Co. Aroclor, or equal.
- .2 Final covering for straight piping insulation inside unit areas shall be flat aluminum sheets, 0.016 inch, utility grade, half hard, mill finished, in cut and machine rolled sections approximately 3 feet long.
- .3 Final covering for straight piping insulation outside unit areas shall be asbestos-asphalt felt in cut and rolled sections approximately 3 feet long, Johns-Manville Corp. Double Coated Flexstone, or equal.
- .4 Final covering for welded elbow insulation inside unit areas shall be pre-formed aluminum elbows, Childers Mfg. Co., General Aluminum Supply Co., or equal.

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- .5 Final covering for welded elbows outside unit areas shall be weather-proofing compound, Pittsburgh Corning Corp. Pittcote 300, or equal.

.3 BANDINGS

- .1 Banding on insulation under aluminum final covering shall be:
 - .1 Piping 10 inches and smaller - 0.051 inch diameter, soft, type 18-8, stainless steel wire;
 - .2 Piping 12 inches through 16 inches - 0.064 inch diameter, soft, type 18-8, stainless steel wire.
 - .3 Piping 18 inches and larger - 1/2 inch x 0.015 inch, soft, type 18-8, stainless steel bands with stainless steel seals.
- .2 Banding on insulation under asbestos-asphalt felt final covering and on asbestos-asphalt felt final covering shall be:
 - .1 Piping 10 inches and smaller - 0.064 inch diameter, galvanized, soft, iron wire;
 - .2 Piping 12 inches through 16 inches - 0.083 inch diameter, galvanized, soft, iron wire.
 - .3 Piping 18 inches and larger - 1/2 inch x 0.020 inch, soft, aluminum bands and aluminum seals.
- .3 Banding on aluminum final covering shall be 1/2 inch x 0.020 inch, soft, aluminum bands and aluminum seals.

.4 ACCESSORIES

- .1 Glass fabric shall be Twinsburg-Miller Co. Glasfab, 20 x 20 mesh, asphalt treated, or equal.
- .2 Lacing wire shall be 0.051 inch diameter, soft, type 18-8, stainless steel wire.

5-2.3.2 VESSELS

.1 INSULATION AND COATING MATERIALS

Insulations and coatings shall be in accord with appended Chart No. 2.

2. FINAL COVERINGS

- .1 Final covering for vertical vessel shell insulation shall be corrugated aluminum roofing sheets, 1-1/4 inches x 1/4 inch corrugations, 0.019 inch, standard grade, half hard, mill finished.
- .2 Final covering for horizontal vessel shell insulation shall be flat aluminum sheets, 0.020 inch, utility grade, half hard, mill finished.
- .3 Final covering for vessel head insulation shall be weatherproofing compound, Pittsburgh Corning Corp. Pittcote 300, or equal.

.3 BANDINGS

- .1 Banding on vessel shell insulation shall be:
 - .1 Vessels 8 feet O.D. and smaller - 1/2 x 0.015 inch, soft, type 18-8, stainless steel bands with stainless steel seals;
 - .2 Vessels larger than 8 feet O.D. - 3/4 inch x 0.020 inch, soft, type 18-8, stainless steel bands with stainless steel seals.
- .2 Banding on vessel head insulation shall be 1/2 inch x 0.015 inch soft, type 18-8, stainless steel bands anchored with lacing wire hair pins to 1/2 nut blanks welded to heads.
- .3 Banding on vessel shell final covering shall be 3/4 inch x 0.025 inch, soft, aluminum bands with aluminum seals.

.4 ACCESSORIES

- .1 Glass fabric shall be Twinsburg-Miller Co. Glasfab, 20 x 20 mesh, asphalt treated, or equal.
- .2 Lacing wire shall be 0.051 inch diameter, soft, type 18-8, stainless steel wire.

5-2.3.3 EXCHANGERS

.1 INSULATION AND COATING MATERIALS

Insulations and coatings shall be in accord with appended Chart No. 2.

.2 FINAL COVERINGS

- .1 Final covering for exchanger shell and channel insulation shall be flat aluminum sheets, 0.020 inch, utility grade, half hard, mill finished, in cut and machine rolled sections approximately 3 feet long.

- .2 Final covering for exchanger shell head and channel head insulation shall be weatherproofing compound, Pittsburgh Corning Corp. Pittcote 300, or equal.

.3 BANDINGS

- .1 Banding on exchanger shell and channel insulation shall be 1/2 inch x 0.015 inch, soft, type 18-8, stainless steel bands with stainless steel seals.
- .2 Banding on exchanger shell and channel final covering shall be 3/4 inch x 0.025 inch, soft, aluminum bands with aluminum seals.

.4 ACCESSORIES

- .1 Glass fabric shall be Twinsburg-Miller Co. Glasfab 20 x 20 mesh, asphalt treated, or equal.

5-2.3.4 PUMPS AND COMPRESSORS

.1 INSULATION AND COATING MATERIALS

Insulation and coatings shall be in accord with appended Chart No. 2.

.2 FINAL COVERINGS

Final covering for insulation shall be weatherproofing compound, Pittsburgh Corning Corp. Pittcote 300, or equal.

.3 ACCESSORIES

Glass fabric shall be Twinsburg-Miller Co. Glasfab, 20 x 20 mesh, asphalt treated, or equal.

HOT SERVICE - INSULATION AND COATING MATERIALS

TYPE OF INSULATION	MANUFACTURER/DESCRIPTION	PIPING	VESSELS	EXCHANGERS	PUMPS, COMPRESSORS, AND TURBINES	TANKS
BLOCK INSULATION	JOHN-MANVILLE CORP. THERMOBESTOS, OWENS-CORNING FIBERGLAS CORP. KAYLO, PHILLIP CAREY CARRYTEMP, OR EQUAL	STRAIGHT SECTIONS LARGER THAN 24 INCHES O.D. AND HEADS			CASES - USED IN COMBINATION WITH MONOLITHIC INSULATION	SHELLS 12 FEET O.D. AND SMALLER
ONE PIECE INSULATION LIMITED TO 350°F	RUBEROD CO. IMPERIAL, GUSTIN-BACON MFG. CO. SNAP ON, OR EQUAL	STRAIGHT SECTIONS 24 INCHES O.D. AND SMALLER			NOZZLES	
SECTIONAL PIPE INSULATION	UNION ASBESTOS AND RUBBER CO. UNIBESTOS, JOHN-MANVILLE CORP. THERMOBESTOS, PHILLIP CAREY CARRYTEMP, OR EQUAL	STRAIGHT SECTIONS 24 INCHES O.D. AND SMALLER			NOZZLES	
PREFORMED VALVE, FLANGE, AND FITTING INSULATION	UNION ASBESTOS AND RUBBER CO. UNIBESTOS, JOHN-MANVILLE CORP. THERMOBESTOS, OR EQUAL	VALVES, FLANGES, AND FITTINGS 2 INCHES AND LARGER			AS REQUIRED	
MONOLITHIC INSULATION	EAGLE-PICHER CO. SUPER 66, OR EQUAL	VALVES, FLANGES, AND FITTINGS 1 1/2 INCHES AND SMALLER	HEADS	HEADS	CASES - USED IN COMBINATION WITH BLOCK INSULATION	
MINERAL WOOL INSULATION	EAGLE-PICHER CO. H-2, OR EQUAL		AS REQUIRED			
GLASS FIBER INSULATION	GUSTIN-BACON MFG. CO. ULTRALITE, 4 FEET x 150 FEET x 1 1/2 INCHES BLANKETS, OR EQUAL, DENSITY SPECIFIED BY SHELL					SHELLS LARGER THAN 12 FEET O.D.
FINISHING CEMENT	EAGLE-PICHER CO. ONE COTE, OR EQUAL		AS REQUIRED	AS REQUIRED		
SEALING COMPOUND	FLINTKOTE CO. PLASTIC CEMENT, OR EQUAL			AS REQUIRED		AS REQUIRED
WEATHER PROOFING COMPOUND	PHILLIP CAREY MFG. CO. THERMODEX B, OR EQUAL			AS REQUIRED		

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COLD SERVICE - INSULATION AND COATING MATERIALS

TYPE OF INSULATION	MANUFACTURER/DESCRIPTION	PIPING	VESSELS	EXCHANGERS	PUMPS AND COMPRESSORS		
BLOCK INSULATION	PITTSBURGH-CORNING CORP. FOAMGLAS, OR EQUAL	STRAIGHT SECTIONS LARGER THAN 24 INCHES O.D. AND HEADS			CASES		
SECTIONAL PIPE INSULATION	PITTSBURGH-CORNING CORP. FOAMGLAS, OR EQUAL				NOZZLES		
PREFORMED VALVE, FLANGE, AND FITTING INSULATION	PITTSBURGH-CORNING CORP. FOAMGLAS, OR EQUAL				AS REQUIRED		
MINERAL WOOL INSULATION	EAGLE-PICHER CO. H-2, OR EQUAL				AS REQUIRED		
SEALING COMPOUND	EAGLE-PICHER CO. STALASTIC, OR EQUAL				AS REQUIRED		
BORE COATING	PITTSBURGH CORNING CORP. ANTHABRASIVE COMPOUND 1A, OR EQUAL	AS REQUIRED					
JOINT ADHESIVE	PITTSBURGH CORNING CORP. PITTCOTE 300, OR EQUAL	AS REQUIRED					
WEATHERPROOFING COMPOUND	PITTSBURGH CORNING CORP. PITTCOTE 300, OR EQUAL	AS REQUIRED					

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VOID

**SHELL OIL COMPANY
ENGINEERING STANDARDS**



**INSTALLATION STANDARD 5-3
INSULATION**

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DRAWINGS APPENDED

DRAWING No. B-1235 - Hot Service - Details of Tank Insulation

5-3.1 GENERAL

5-3.1.1 SCOPE

This standard covers the installation of materials for the insulation of piping, vessels, exchangers, tanks, pumps, compressors, and turbines in hot and cold service. It is intended to establish a standard of quality for the installation of all insulating materials.

5-3.1.2 CONTRACTORS PROPOSALS

- .1 Proposals covering materials and installation shall be based on Shell drawings, data accompanying requests for quotations, thicknesses in accord with Engineering Standard 5-1, materials in accordance with Engineering Standard 5-2, and installation in accord with Engineering Standard 5-3.
- .2 Proposals shall include detailed information, for approval by Shell, of proposed insulation applications which are not covered by this Standard.

5-3.1.3 GUARANTEES AND INSPECTIONS

- .1 All work shall be subject to inspection and approval by Shell.
- .2 Contractor shall guarantee that design, materials and installation are in accord with Insulation Standards 5-1, 5-2 and 5-3.
- .3 Contractor shall guarantee that unsatisfactory materials or work which may be rejected by Shell shall be removed and replaced without charge to Shell.
- .4 Contractor shall guarantee that insulation which becomes defective as a result of faulty material or workmanship within one year from acceptance by Shell shall be replaced without charge to Shell.

5-3.1.4 REQUIREMENTS

- .1 Contractor shall execute job in accord with the best practices for insulation work with a minimum of waste and debris and work shall present a neat and workmanlike appearance.
- .2 Contractor shall observe Shell safety regulations for personnel and equipment.
- .3 Contractor shall plan, schedule, and coordinate his work as required.
- .4 Contractor shall be responsible for the unloading, handling, protection and storage of materials, including construction of the required warehouses.

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- .5 Contractor shall protect materials from damage and weather during all stages of handling and application until the final covering is applied.
- .6 Contractor shall provide, install and remove required scaffolding.
- .7 Contractor shall clean surfaces to be insulated of oil, grease, loose scale, dirt, insulation debris, etc. Cold service surfaces shall be dry before applying materials. Hot service surfaces which shall operate below 220°F or which shall not be in continuous operation and cold service surfaces shall be cleaned and prime coated with red lead, by others, before application of insulation in accord with protective coating Standard 19. Wounds in the coatings shall be repaired by others before application of insulation.
- .8 Contractor shall protect against and clean up splatter of insulating materials.
- .9 Contractor shall maintain a reasonably clean site; shall remove debris periodically; and upon completion of job shall remove materials, equipment, and debris to satisfaction of Shell.
- .10 Manufacturers' equipment and code name plates shall not be covered on hot service equipment. Insulation shall be cut on 45° angle from the nameplate edges and sealed off with a $\frac{1}{4}$ inch wet coat of finishing cement followed with a $\frac{1}{4}$ inch wet coat of weather-proofing compound. Name plates on cold service equipment shall be installed outside of insulation.
- .11 Contractor shall apply materials in a manner to reduce shrinkage to a minimum. Excessive cracks that develop in any materials shall be repaired with a like material.
- .12 Contractor shall not apply materials to surfaces which are to be pressure tested without prior approval of Shell.
- .13 Insulation supports, anchor nuts, etc., shall be welded to equipment and piping by the fabricators, prior to any required stress relieving operation.

5-3.2 HOT SERVICE

5-3.2.1 GENERAL

All insulation shall be applied with the joints tightly butted. Circumferential joints shall be staggered one half a section or block length. Ragged and open joints shall be neatly filled with finishing cement.

- .2 Insulation supports on vertical vessels, exchangers and piping shall be located at the bottom of the insulated area and on 12 feet 1 inch centers thereafter on piping and vessels. Supports shall be $\frac{1}{4}$ inch thick and $\frac{1}{2}$ the insulation thickness in width, minimum width shall be $\frac{1}{2}$ inch. Insulation supports on piping and exchangers shall be located a sufficient distance from the flanges to permit removing bolts without interference or damaging

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the insulation. The 1 inch voids between the top of supported insulation and the succeeding supports shall be filled with half compressed mineral wool insulation.

3. Insulation and final coverings around structural support attachments on vessels, exchangers and piping in hot service shall be closely fitted around such projections. Insulation voids in these areas shall be filled with monolithic insulation. The openings in the final coverings shall be sealed off with a fillet of sealing compound.

5-3.2.2 PIPING

.1 INSULATION

- .1 Straight piping 24 inches O.D. and smaller shall be insulated with one layer of one piece or sectional pipe insulation. Straight piping larger than 24 inches O.D. shall be insulated with one layer of block insulation. The blocks shall be either curved, flat or flat blocks cut into beveled lags to fit the piping contours.
- .2 When insulation is required, valves, flanges and fittings in piping $1\frac{1}{2}$ inches and smaller, shall be insulated with multi-layers of monolithic insulation. Valves, flanges, and fittings in piping 2 inches and larger, when insulation is required, shall be insulated with one layer of pre-formed or cut and fitted sectional pipe insulation.
- .3 Insulation shall be stopped short of uninsulated flanges and unions a sufficient distance to permit removing the bolts or breaking the union without damaging the insulation. The insulation shall be finished off at these points on a 45° bevel and back 2 inches under the adjacent final covering with a $\frac{1}{4}$ inch wet coat of finishing cement followed with a $\frac{1}{4}$ inch wet coat of weatherproofing compound.
- .4 Block or sectional insulation on straight piping shall be secured with bands on a maximum of 9-inch centers. Banding shall not be required on one-piece insulation. Where required, insulation on valves, flanges and fittings shall be secured with bands as required for adequate securement.

.2 FINAL COVERINGS

- .1 Piping insulation, except welded elbows inside unit areas, shall be covered with flat aluminum sheets. Piping insulation except welded elbows, outside unit areas shall be covered with asbestos-asphalt felt sheets. Piping insulation inside office buildings shall be covered with canvas saturated with Aroclor.
- .2 Welded elbow insulation inside unit areas shall be covered with pre-formed aluminum elbows. Welded elbow insulation outside unit areas shall be covered with weatherproofing compound.

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- .3 Aluminum and asbestos-asphalt felt final covering shall be fitted snugly over the insulation. Circumferential and longitudinal joints shall be lapped a minimum of 2 inches and arranged for good water drainage. Longitudinal joints on vertical piping shall be staggered.
- .4 Aluminum final covering shall be machine-rolled to the O.D. of the insulation and secured with bands on a maximum of 18-inch centers. One band shall be located on each circumferential lap. Each section of final covering on vertical piping larger than 10 inches shall be supported from the next lower section with two S clips made from the banding material. The bottom section of the final coverings shall be supported by extended insulation support clips.
- .5 Asbestos-asphalt felt final covering shall be secured with bands on a maximum of 9-inch centers. One band shall be installed on each circumferential lap.
- .6 Weatherproofing compound final covering shall be a two-coat installation. The first coat shall be a $\frac{1}{4}$ inch wet coat of finishing cement applied on top of insulation and allowed to dry thoroughly. The second coat shall be a $\frac{1}{4}$ inch wet coat of weatherproofing compound reinforced with glass fabric and troweled to a smooth finish. The glass fabric shall be secured as necessary with lacing wire. The glass fabric shall be omitted on piping 4 inches and smaller. The weatherproofing compound final covering and glass fabric shall lap 2 inches under the asbestos-asphalt felt final covering on the adjacent straight piping.

5-3.2.3 VESSELS

.1 INSULATION

- .1 The shells of vessels 24 inches O.D. and smaller shall be insulated with one layer of one piece or sectional pipe insulation. The shells of vessels larger than 24 inches O.D. shall be insulated with one layer of block insulation. The blocks shall be either curved, flat, or flat blocks cut into beveled lags to fit the shell contours. The insulation shall be secured with bands on 18-inch centers. Bands shall be machine stretched and sealed to remove slack only.
- .2 The heads of vessels shall be insulated with one layer of block insulation. The blocks shall be either curved, flat, or flat blocks cut into segmental beveled lags to fit the head contours. This insulation and that on vessel transition sections shall be secured with bands anchored with lacing wire hairpins to $\frac{1}{2}$ inch nut blanks welded to the vessel. Anchor on top heads shall be as required for good securement. Anchors on bottom heads, transition sections of vertical vessels, and heads of horizontal vessels shall be on 12-inch centers.
- .3 As an alternate to the above, the heads of vessels 3 feet O.D. and under may be insulated with broken block insulation imbedded in a coat of monolithic insulation. The voids between the broken blocks shall be filled level with finishing cement.

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- .4 Flanges, nozzles and manways shall not be insulated unless specified by Shell. When insulation is required, the insulation shall be that specified for shells and shall be contained in a two-piece, prefabricated aluminum removable housing. The design of the housing shall be submitted to Shell for approval.
- .5 Insulation shall be stopped short of uninsulated flanges a sufficient distance to permit removing the bolts without damaging the insulation. Insulation shall be stopped short of uninsulated nozzles and manways a sufficient distance to expose the nozzle to shell welds for inspection. Insulation shall be finished off at these points on a 45° bevel and back 2 inches under the adjacent final covering with a $\frac{1}{4}$ inch wet coat of finishing cement followed with a $\frac{1}{4}$ inch wet coat of weatherproofing compound.
- .6 The bottom insulation support on vertical vessels shall be a 2 inch x 2 inch x $\frac{1}{4}$ inch angle with one leg out and the other turned down to provide a flashing over the skirt fireproofing. On hot service vessels this support shall be located 12 inches below the skirt attachment weld seam.
- .7 Skirts shall be fireproofed by others.

2 FINAL COVERINGS

- .1 Vertical vessel shell insulation shall be covered with corrugated aluminum sheets. Horizontal vessel shell insulation and vertical vessel conical head and transition section insulation shall be covered with flat aluminum sheets.
- .2 Vessel head insulation other than on conical heads shall be covered with weatherproofing compound.
- .3 Aluminum final covering shall be fitted snugly over the insulation. Corrugated aluminum sheets shall be installed with the greater dimension in a vertical position. Circumferential and longitudinal joints shall be lapped a minimum of 3 inches and arranged for good water drainage. Longitudinal joints on vertical vessels shall be staggered. Longitudinal expansion joints in the insulation shall be covered continuously with the final covering.
- .4 Aluminum final covering shall be secured with bands on 18-inch centers. One band shall be located on each circumferential lap on horizontal vessels. The bands shall be machine stretched and sealed to remove slack only. Each section of final covering on vertical vessels shall be supported from the next lower section with two S clips made from $\frac{1}{2}$ inch stainless steel banding material. The bottom section of final coverings shall be supported by clips attached to the insulation support.
- .5 Weatherproofing compound final covering shall be a two-coat application. The first coat shall be a $\frac{1}{4}$ inch wet coat of finishing cement applied on top of the insulation and allowed to dry thoroughly. The second coat

shall be a $3/8$ inch wet coat of weatherproofing compound reinforced with wire mesh and troweled to a smooth finish. The wire mesh shall be secured together at the edges with lacing wire. On top heads the weatherproofing compound final covering and wire mesh shall lap 4 inches over the aluminum final covering on the adjacent shell. On bottom heads which are not confined within skirts and on heads on horizontal vessels, the weatherproofing compound final covering and wire mesh shall lap 4 inches under the aluminum final covering on the adjacent shell. The wire mesh shall be secured with two bands on the 4-inch lapped section on all heads.

5-3.2.4 EXCHANGERS

.1 INSULATION

- .1 The shells and channels of exchangers 24 inches O.D. and smaller shall be covered with one layer of one piece or sectional pipe insulation. The shells and channels of exchangers larger than 24 inches O.D. shall be covered with one layer of block insulation. The blocks shall be either curved, flat, or flat blocks cut into beveled lags to fit the shell or channel contours.
- .2 The shell heads of exchangers shall be covered with broken block insulation imbedded in a coat of monolithic insulation. The voids between broken blocks shall be filled level with finishing cement to the required thickness.
- .3 Exchangers, flanges and channel heads shall not be insulated unless specified by Shell. When insulation is required, it shall be the same as that specified for shells and shall be contained in a two-piece, prefabricated, removable aluminum housing to be secured in place with bands. The design of the housing shall be submitted to Shell for approval.
- .4 Insulation shall be stopped short of uninsulated flanges a sufficient distance to permit removing the bolts without damaging the insulation. Insulation shall be stopped short of uninsulated nozzles a sufficient distance to expose the nozzle to shell welds for inspection. Insulation shall be finished off at these points on a 45° bevel and back 2 inches under the adjacent final covering with a $1/4$ inch wet coat of finishing cement followed with a $1/4$ inch wet coat of weatherproofing compound.
- .5 Insulation on the shells of exchangers shall be secured with bands on 18-inch centers. Bands shall be machine stretched and sealed to remove slack only. Insulation on channels shall be secured with two bands.

.2 FINAL COVERINGS

- .1 Exchanger shell and channel insulation shall be covered with flat aluminum sheets.

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- .2 Exchanger shell head insulation shall be covered with weatherproofing compound.
- .3 Aluminum final covering shall be fitted snugly over the insulation. Circumferential and longitudinal joints shall be lapped a minimum of 3 inches and arranged for good water drainage. Longitudinal joints on vertical exchangers shall be staggered.
- .4 Aluminum final covering shall be machine rolled to the O.D. of the insulation and secured with bands on a maximum of 18-inch centers. One band shall be located on each circumferential lap. The bands shall be machine stretched and sealed to remove slack only. Each section of final covering on vertical exchangers shall be supported from the next lower section with two S clips made from the banding material. The bottom section of final coverings on vertical exchangers shall be supported by extended insulation support clips.
- .5 Weatherproofing compound final covering shall be a two-coat application. The first coat shall be a 1/4 inch wet coat of finishing cement applied on top of the insulation and allowed to dry thoroughly. The second coat shall be a 3/8 inch wet coat of weatherproofing compound reinforced with wire mesh and troweled to a smooth finish. The wire mesh shall be secured together at the edges with lacing wire. The weatherproofing compound final covering and wire mesh on integral shell heads shall lap 4 inches under the aluminum final covering on the adjacent shell. The wire mesh shall be secured with one band on the 4 inch lapped section on all shell heads. The wire mesh on flanged shell heads shall be laced to 1/2 inch nut blanks welded to the head.

5-3.2.5 TANKS

.1 INSULATIONS

- .1 Tanks 12 feet O.D. and smaller shall be insulated in accord with section 5-3.2.2 for hot service vessels.
- .2 Shells of tanks larger than 12 feet O.D. shall be insulated with one layer of blanket insulation. The insulation shall be installed in long vertical blankets which shall reach from top to bottom of the shell. Joints shall be snugly butted. The blankets shall be secured by carefully pressing them onto the final covering securement studs detailed on appended drawing B/1235. Circumferential bands shall not be used. Precautions shall be observed to install the blankets in full thick condition.
- .3 Nozzles, manways, and roofs shall not be insulated unless specified by Shell.

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.2 FINAL COVERINGS

- .1 Insulation on tanks 12 feet O.D. and smaller shall be covered in accord with section 5-3.2.2 for hot service vessels.
- .2 Insulation on tanks larger than 12 feet O.D. shall be covered with flat asbestos-cement sheets in accord with appended drawing B/1235. The top insulation flashing angle shall be provided by others. The final covering securement studs shall be provided and installed by the insulation contractor.
- .3 Cut outs for nozzles, manways, support attachments, etc., shall be carefully fitted, flashed and sealed with sealing compound to prevent water penetration.

5-3.2.6 PUMPS, COMPRESSORS AND TURBINES

.1 INSULATION

- .1 The cases of pumps, compressors, and turbines shall be covered with broken block insulation imbedded in a coat of monolithic insulation. The voids between broken blocks shall be filled level with finishing cement to the required thickness.
- .2 Flanges, bearing housings, threaded connections, and supports shall not be insulated unless specified by Shell.
- .3 The insulation shall be stopped short of uninsulated flanges a sufficient distance to permit removing the bolts without damaging the insulation. Insulation shall be finished off at these flanges on a 45° bevel.

.2 FINAL COVERINGS

Pump, compressor and turbine insulation shall be covered with a two-coat final covering. The first coat shall be a 1/4 inch wet coat of finishing cement applied on top of the insulation and allowed to dry thoroughly. The second coat shall be a 3/8 inch wet coat of weatherproofing compound reinforced with wire mesh and troweled to a smooth finish. The wire mesh shall be secured together at the edges with lacing wires.

5-3.3 COLD SERVICE

5-3.3.1 GENERAL

- .1 Insulation shall be applied with joints, including contraction slip joints, tightly butted and cemented with joint adhesive, in such a manner to provide one homogeneous mass of insulation with no ragged or open joints through which water vapor can penetrate. Circumferential joints shall be staggered one half a sectional or block length.

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- .2 All valves, flanges including manway blind flanges and fittings, shall be insulated with one layer of preformed insulation. The preformed insulation shall be either factory molded or fabricated from block or sectional pipe insulation and cemented with joint adhesive.
- .3 Small voids under insulation around valves, flanges, fittings and other irregular surfaces shall be filled with loose mineral wool insulation. Large voids under insulation shall be filled with cut and fitted block insulation and cemented with joint adhesive.
- .4 Support attachments and other non-operating protrusions shall be insulated a minimum of 18 inches beyond the finished insulation. In addition, after the unit has reached operating temperatures, insulation shall be extended beyond all points where frost or ice forms.
- .5 Insulation adjacent to insulation supports shall be fitted in such a manner that the support is completely covered and the insulation around the support can be sealed with joint adhesive.
- .6 Insulation, after being secured in place, shall be covered with a 1/8 inch wet coat of weatherproofing compound and allowed to dry.
- .7 Insulation on support attachments and other non-operating protrusions shall be covered with flat aluminum sheets. When it is impractical to cover insulation on irregular protrusions with aluminum final covering, the insulation shall be covered with weatherproofing compound.
- .8 Cut outs for nozzles, manways, support attachments, etc., shall be carefully fitted, flashed and sealed with sealing compound to prevent water penetration.

5-3.3.2 PIPING

5.1 INSULATION

- .1 Straight piping 24 inches O.D. and smaller shall be insulated with one layer of sectional pipe insulation. Straight piping larger than 24 inches O.D. shall be insulated with one layer of block insulation. The blocks shall be either curved, flat, or flat blocks cut into beveled lags to fit the piping contours.
- .2 Insulation on piping which shall be subjected to excessive vibration shall have the bore of the insulation coated with an application of bore coating. The bore coating shall be allowed to dry before the insulation is applied to the piping.
- .3 Longitudinal contraction joints shall be provided when the combination of straight run piping length and operating temperature require them to

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prevent damage to the insulation. Contraction joints shall consist of 1 inch space between adjacent lengths of insulation filled with loose mineral wool and covered with an 18 inches long section of oversize insulation. The oversize insulation section shall be cemented to the regular size insulation with joint adhesive. Contraction joints, when required, shall be at flanges wherever possible.

- .4 Insulation on straight piping shall be secured with bands on a maximum of 9-inch centers. Insulation on valves, flanges, and fittings shall be secured with bands as required for adequate securement.
- .5 Insulation supports shall be provided by others at the bottom of vertical piping 3 inches and larger when a vertical run is in excess of 12 feet long. Supports shall be 1/4 inch thick and shall be one half the insulation thickness in width.

.2 FINAL COVERINGS

- .1 Piping insulation, including valves, flanges, and fittings except welded elbows inside unit areas shall be covered with flat aluminum sheets. Piping insulation inside office buildings shall be covered with canvas sheets saturated with Aroclor.
- .2 Welded elbow insulation inside unit areas shall be covered with pre-formed aluminum elbows.
- .3 Aluminum final covering shall be fitted snugly over the insulation. Circumferential and longitudinal joints shall be lapped a minimum of 2 inches and arranged for good water drainage. Longitudinal joints on vertical piping shall be staggered. Longitudinal contraction joints in the insulation shall also be covered.
- .4 Aluminum final covering shall be machine rolled to the O.D. of the insulation and secured with bands on a maximum of 18-inch centers. One band shall be located on each circumferential lap. Each section of final covering on vertical piping larger than 10 inches shall be supported from the next lower section with two S clips made from the banding materials.
- .5 Weatherproofing compound final covering shall be 3/8 inch wet coat reinforced at the center with glass fabric and troweled to a smooth finish. The glass fabric shall be lapped 2 inches at the edges. The weatherproofing compound final covering and glass fabric shall lap 2 inches under the aluminum final covering on the adjacent piping.

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5-3.3.3 VESSELS

.1 INSULATION

- .1 The shells of vessels 24 inches O.D. and smaller shall be insulated with one layer of sectional pipe insulation. The shells of vessels larger than 24 inches O.D. and the heads of all vessels shall be insulated with one layer of block insulation. The blocks shall be either curved, flat or flat blocks cut into beveled lags to fit the shell or head contours.
- .2 The vessel shell insulation shall extend down to the bottom of the skirt. The top 24 inches of the inside of the skirt shall also be insulated.
- .3 Longitudinal contraction on vertical vessels shall be compensated for by providing an extra inch beyond the length of insulation between insulation supports. Insulation above and below supports shall be fitted to form a 3 inches long male and female slip joint which shall completely cover the support and the void below the support. The one-inch void shall be filled with loose mineral wool insulation.
- .4 Insulation on the shells of vessels shall be secured with bands on 9-inch centers. Bands shall be machine stretched and sealed to remove slack only. Insulation on heads and transition sections of vessels shall be secured with bands anchored with lacing wire hairpins to 1/2 inch nut blanks welded to the vessel. Anchors shall be on 12-inch centers. Insulation on the inside of vessel skirts shall be secured with joint adhesive.
- .5 Insulation supports shall be provided by others on vertical vessels. Supports shall be located on 12 feet 1 inch centers, starting 12 feet 1 inch above the bottom of the skirt. Supports shall be 1/4 inch thick and shall be one half the insulation thickness in width.

.2 FINAL COVERINGS

- .1 Vertical vessel shell and skirt insulation shall be covered with corrugated aluminum sheets. Horizontal vessel shell insulation, vertical vessel conical head and transition section insulation, and flange insulation shall be covered with flat aluminum sheets.
- .2 Vertical vessel top head insulation shall be covered with flat aluminum sheets. Other vessel head insulation except on conical heads and inside skirt insulation shall be covered with weatherproofing compound.
- .3 Aluminum final covering shall be fitted snugly over the insulation. Corrugated aluminum sheets shall be installed with the greater dimension in a vertical position. Circumferential and longitudinal joints shall be lapped a minimum of 3 inches and arranged for good water drainage. Longitudinal joints on vertical vessels shall be staggered. Longitudinal contraction joints in the insulation shall be covered continuously with the final covering.

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- .4 Aluminum final covering for vertical vessel top head insulation shall be prefabricated segmental sections flanged, flashed, and through bolted to form a water tight covering. The head final covering shall lap 4 inches over the aluminum final covering on the adjacent shell.
- .5 Aluminum final covering for manway flange insulation shall be a two-piece, prefabricated housing to be secured in place with bands. The design of the housing shall be submitted to Shell for approval.
- .6 Aluminum final covering shall be secured with bands on 18-inch centers. One band shall be located on each circumferential lap on horizontal vessels. The bands shall be machine stretched and sealed to remove slack only. Each section of final covering on vertical vessels shall be supported from the next lower section with two S clips made from 1/2 inch stainless steel banding materials.
- .7 Weatherproofing compound final covering shall be 3/8 inch thick wet coat reinforced at the center with glass fabric and troweled to a smooth finish. The glass fabric shall be lapped 3 inches at the edges. On bottom heads which are not confined within skirts and on heads on horizontal vessels the weatherproofing compound and glass fabric shall lap 4 inches under the aluminum final covering on the adjacent shell. The glass fabric shall be secured with two bands on the 4 inches lapped section.

5-3.3.4 EXCHANGERS

.1 INSULATION

- .1 The shells and channels of exchangers 24 inches O.D. and smaller shall be covered with one layer of sectional pipe insulation. The shells and channels of exchangers larger than 24 inches O.D. and all shell and channel heads shall be covered with one layer of block insulation. The blocks shall be either curved, flat or flat blocks cut into beveled lags to fit shell, channel, or head contours.
- .2 Insulation on the shells and channels of exchangers shall be secured with bands on 9-inch centers. Bands shall be machine stretched and sealed to remove slack only. Insulation on the heads of exchangers shall be secured with bands anchored with lacing wire hairpins to 1/2 inch nut blanks welded to the heads on 12-inch centers.
- .3 Insulation supports shall be provided by others at the bottom of insulation on vertical exchangers. Supports shall be 1/4 inch thick and shall be one half the insulation thickness in width.

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.2 FINAL COVERINGS

- .1 Exchanger shell, channel, channel head, and flange insulation shall be covered with flat aluminum sheets.
- .2 Exchanger shell head insulation shall be covered with weatherproofing compound.
- .3 Aluminum final covering shall be fitted snugly over the insulation. Circumferential and longitudinal joints shall be lapped a minimum of 3 inches and arranged for good water drainage. Longitudinal joints on vertical exchangers shall be staggered.
- .4 Aluminum final covering for flange and channel head insulation shall be a two-piece, prefabricated housing to be secured in place with bands. The design of the housing shall be submitted to Shell for approval.
- .5 Aluminum final covering shall be machine rolled to the O.D. of the insulation and secured with bands on a maximum of 18-inch centers. One band shall be located on each circumferential lap. The bands shall be machine stretched and sealed to remove slack only. Each section of final covering on vertical exchangers shall be supported from the next lower section with two S clips made from the banding material.
- .6 Weatherproofing compound final covering shall be a 3/8 inch thick wet coat reinforced at the center with glass fabric and troweled to a smooth finish. The glass fabric shall be lapped 3 inches at the edges. The weatherproofing compound final covering and glass fabric shall lap 4 inches under the aluminum final covering on the adjacent shell. The glass fabric shall be secured with one band on the 4 inches lapped section on all shell heads.

5-3.3.5 PUMPS AND COMPRESSORS

.1 INSULATION

- .1 The cases, flanges, and supports of pumps and compressors shall be insulated by boxing in with one layer of block insulation and filling the interior of the box with loose mineral wool insulation.
- .2 Packing glands shall be left exposed.
- .3 The insulation box shall be covered with a 1/8 inch wet coat of weatherproofing compound and allowed to dry.

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.2 FINAL COVERING

Pump and compressor insulation shall be covered with a 3/8 inch thick wet coat of weatherproofing compound reinforced at the center with glass fabric and troweled to a smooth finish. The glass fabric shall be lapped 3 inches at the edges.

