PLAINTIFF'S EXHIBIT

CHV-873

Memorandum

Engineering Department
San Francisco, California
April 24, 1974

Evaluation of Insulation Materials

MESSRS: R. C. ANDRESEN
J. E. HAYDEN
J. R. MASSON
R. F. MUELLER
W. B. SCARBOROUGH
R. L. SMITH

Attached is Drawing GT-D-25673-1 - "Standard Insulation Item Numbers." This revision reflects the results of recently completed Materials Laboratory tests. Two additional insulation brands, Keene Thermasil and Cary Temp 1500, have been added for intermediate and high temperature service, for both piping and equipment. Also, for very high temperature service, the "hold" has been removed from J-M Superex 2000 and B&W Kaowool for piping, and from B&W Kaowool for equipment. The specific notes on the drawing effecting these changes are tabulated on Attachment "B." All insulation materials shown on this drawing are asbestos free.

Detailed results of the Materials Laboratory tests are summarized in the report, Attachment "C." Our conclusions from these tests are:

1) Calcium Silicate and Perlite Insulation

Thermo-12, Kaylo-10, CalTemp N.A., and Thermasil are acceptable to 1200F. Carey Temp 1500, a perlite material, is an acceptable substitute to 1500F. Kaylo-10 had more shipping breakage than the other brands. A comparison of some of the properties important to selection and use is made in Attachment "D."

2) Mineral Wool Insulations

The Forty-Eight mineral wool for both piping and vessel insulation deteriorated badly in fire-resistance tests, and should be limited as described under fire resistance. Epitherm 1200 insulation was OK in the same fire tests.

For column and vessel insulation we believe calcium silicate is a better choice for long-term performance. We have only about 18 months' experience with mineral wool block and only on a few vessels. We are concerned that the mineral wools will compress and sag over the years under normal banding loads as the insulation binder deteriorates at high temperatures.

For piping, Company experience shows that mineral wool has adequate durability as long as lines are not walked on or otherwise abused. Additionally, the better "K-factor" of mineral wool reduces pipe spacing and eliminates the need to change our normal pipe spacing practices.

3) Fire Resistance

All the calcium silicates, the perlite, and Epitherm 1200 mineral wool have satisfactory fire resistance. The Forty-Eight insulation deteriorated badly in the tests and should be limited in use.

We recommend that Forty-Eight mineral wool should not be used on columns and vessels under fire conditions. We also recommend that Forty-Eight insulation should not be used on chrome-moly vessels, exchangers, and piping which can suffer serious metallurgical changes if exposed to a fire. For piping, we consider Forty-Eight insulation adequate except on lines which are so large that their volume must be considered in sizing relief valves on interconnected equipment.

4) Insulation for Stainless Steel

All the insulations listed are acceptable for use on stainless steel. After additional review, we concluded a primer is not justified under insulation on stainless. Instead we recommend that insulation for stainless should get extra attention to be certain that weatherproofing details are good and will keep the insulation dry.

D. R. LOPER

RDS/EHE:dps
Attachments A,B,C & D

cc: ETM w/1
DRL "
PGS "
EHE "
RDS "
RLP "
DMJ "
JGK/PEJ w/1

A

ITEM NO.	DESCRIPTION
01	1" THICK SECTIONAL TYPE MODERATE TEMPERATURE PIPE INSULATION
02	1½" THICK SECTIONAL TYPE MODERATE TEMPERATURE PIPE INSULATION
03	2" THICK SECTIONAL TYPE MODERATE TEMPERATURE PIPE INSULATION
06	1" THICK SECTIONAL TYPE INTERMEDIATE TEMPERATURE PIPE INSULATION
07	1½" THICK SECTIONAL TYPE INTERMEDIATE TEMPERATURE PIPE INSULATION
08	2" THICK SECTIONAL TYPE INTERMEDIATE TEMPERATURE PIPE INSULATION
09	2½" THICK SECTIONAL TYPE INTERMEDIATE TEMPERATURE PIPE INSULATION
010	3" THICK SECTIONAL TYPE INTERMEDIATE TEMPERATURE PIPE INSULATION
014	1" THICK SECTIONAL TYPE HIGH TEMPERATURE PIPE INSULATION
015	1½" THICK SECTIONAL TYPE HIGH TEMPERATURE PIPE INSULATION
016	2" THICK SECTIONAL TYPE HIGH TEMPERATURE PIPE INSULATION
017	2½" THICK SECTIONAL TYPE HIGH TEMPERATURE PIPE INSULATION
018	3" THICK SECTIONAL TYPE HIGH TEMPERATURE PIPE INSULATION
021	1" THICK SECTIONAL TYPE VERY HIGH TEMPERATURE PIPE INSULATION
022	1½" THICK SECTIONAL TYPE VERY HIGH TEMPERATURE PIPE INSULATION
023	2" THICK SECTIONAL TYPE VERY HIGH TEMPERATURE PIPE INSULATION
024	2½" THICK SECTIONAL TYPE VERY HIGH TEMPERATURE PIPE INSULATION
028	3" THICK SECTIONAL TYPE VERY HIGH TEMPERATURE PIPE INSULATION
029	3½" THICK SECTIONAL TYPE VERY HIGH TEMPERATURE PIPE INSULATION
034	1" THICK BLOCK TYPE MODERATE OR INTERMEDIATE TEMP INSULATION
035	1½" THICK BLOCK TYPE MODERATE OR INTERMEDIATE TEMP INSULATION
038	2" THICK BLOCK TYPE INTERMEDIATE TEMPERATURE INSULATION
039	2½" THICK BLOCK TYPE INTERMEDIATE TEMPERATURE INSULATION
043	1½" THICK BLOCK TYPE HIGH TEMPERATURE INSULATION
044	2" THICK BLOCK TYPE HIGH TEMPERATURE INSULATION
045	2½" THICK BLOCK TYPE HIGH TEMPERATURE INSULATION
046	3" THICK BLOCK TYPE HIGH TEMPERATURE INSULATION
050	1½" THICK BLOCK TYPE VERY HIGH TEMPERATURE INSULATION
051	2" THICK BLOCK TYPE VERY HIGH TEMPERATURE INSULATION
052	2½" THICK BLOCK TYPE VERY HIGH TEMPERATURE INSULATION
053	3" THICK BLOCK TYPE VERY HIGH TEMPERATURE INSULATION
054	3½" THICK BLOCK TYPE VERY HIGH TEMPERATURE INSULATION
060	1" THICK CELLULAR GLASS PIPE INSULATION
061	1½" THICK CELLULAR GLASS PIPE INSULATION
062	2" THICK CELLULAR GLASS PIPE INSULATION
063	2½" THICK CELLULAR GLASS PIPE INSULATION
064	3" THICK CELLULAR GLASS PIPE INSULATION, DOUBLE LAYER
065	3½" THICK CELLULAR GLASS PIPE INSULATION, DOUBLE LAYER
066	4" THICK CELLULAR GLASS PIPE INSULATION, DOUBLE LAYER
067	4½" THICK CELLULAR GLASS PIPE INSULATION, DOUBLE LAYER
068	5" THICK CELLULAR GLASS PIPE INSULATION, DOUBLE LAYER
069	5½" THICK CELLULAR GLASS PIPE INSULATION, DOUBLE LAYER
070	6" THICK CELLULAR GLASS PIPE INSULATION, TRIPLE LAYER
071	6½" THICK CELLULAR GLASS PIPE INSULATION, TRIPLE LAYER
072	7" THICK CELLULAR GLASS PIPE INSULATION, TRIPLE LAYER
073	7½" THICK CELLULAR GLASS PIPE INSULATION, TRIPLE LAYER

ITEM NO.	DESCRIPTION
080	PREFABRICATED CELLULAR GLASS VALVE COVER, THICKNESS TO MATCH PIPE INSULATION
087	PREFABRICATED CELLULAR GLASS ELBOW COVER, THICKNESS TO MATCH PIPE INSULATION
088	PREFABRICATED CELLULAR GLASS TEE COVER, THICKNESS TO MATCH PIPE INSULATION
090	PREFABRICATED CELLULAR GLASS FLANGE COVER, THICKNESS TO MATCH PIPE INSULATION
099	MINERAL WOOL FELT, 2" THICK - J-M "ZEROTEX"
0100	MODERATE TEMPERATURE INSULATING CEMENT FOR USE WITH SELECTED INSULATION BLOCK
0104	HIGH TEMPERATURE INSULATING CEMENT FOR USE WITH SELECTED INSULATION BLOCK
0102	HIGH TEMPERATURE WOOL INSULATING CEMENT - J-M NO. 400
0103	HIGH TEMPERATURE FINISHING CEMENT - J-M NO. 375
0104	HIGH TEMPERATURE HYDRAULIC SETTING CEMENT - EAGLE-PICHER "ONE-COTE"
0107	HIGH TEMPERATURE SEMI-FISCOUS WEATHERCOAT - E.P. "STALASTIC"
0108	ABRASION RESISTANT WEATHERCOAT - B.F. "SEALFAS" JD-36
0109	"LAYKOLD" WEATHERCOAT - CHEVRON ASPHALT COMPANY
0111	12 OZ. IMPREGNATED COTTON DUCK CLOTH - B.F. LAGGING CLOTH
0112	8 OZ. WHITE COTTON CANVAS
0113	6½ OZ. FIBERGLAS; CLOTH "TEXTOGLASS"
0114	GLASS FABRIC; ASPHALT IMPREGNATED, OPEN WEAVE
0117	95 LB. ASPHALT SATURATED ASBESTOS BASE FELT - J-M NO.450
0121	20 GAGE FLAT GALVANIZED STEEL SHEET
0122	22 GAGE FLAT GALVANIZED STEEL SHEET
0123	16 GAGE FLAT GALVANIZED STEEL SHEET
0124	20 GAGE SHEET ALUMINUM-ALLOY, WITH MOISTURE BARRIER BACKING
0125	20 GAGE SHEET ALUMINUM-ALLOY, WITH MOISTURE BARRIER BACKING
0126	16 GAGE SHEET ALUMINUM-ALLOY, WITH MOISTURE BARRIER BACKING
0127	0.010" THICK CORRUGATED ALUMINUM PIPE JACKET WITH MOISTURE BARRIER BACKING - CHILDERS MFG.
0130	1" MESH x 20 GAGE GALVANIZED POULTRY NETTING
0131	10 GAGE GALVANIZED IRON WIRE
0132	16 GAGE GALVANIZED IRON WIRE
0134	3/4" x 0.020" TYPE 302 STAINLESS STEEL STRAPPING - ACME
0135	TYPE 302 STAINLESS STEEL BUCKLE FOR 3/4" x 0.020" STRAPPING - ACME
0136	1" x 0.015" TYPE 302 STAINLESS STEEL STRAPPING - ACME
0137	TYPE 302 STAINLESS STEEL BUCKLE FOR 1" x 0.015" STRAPPING - ACME
0138	TYPE 304 STAINLESS STEEL BAND SPRING EXPANSION UNIT - WESTERN ASBESTOS CO.
0140	STAPLE, TINNED AND COPPERIZED

ITEM NO.	DESCRIPTION
0150	JOINT SEALER AND BEDDING COMPOUND, TEMPERATURE RANGE -50°F TO 300°F - BENJAMIN FOSTER "POWERSEAL" 30-46
0152	VINYL ASPHALT VAPORPROOFING MASTIC, TEMPERATURE RANGE -50°F TO 150°F - VIMASCO VIMASEAL 99
0153	COTTAGE ASPHALT VAPORSEAL, TEMPERATURE RANGE -50°F TO 150°F - L100 BOSOMONT SEAL-RITE
0154	VINYL BASE COATING, TEMPERATURE RANGE -300°F TO 300°F - VIMASCO CARLON 500
0155	HOT ERECTION ASPHALT, TEMPERATURE RANGE -50°F TO 150°F - CHEVRON PETROLASTIC NO.195
0160	ADHESIVE VAPORPROOFING TAPE - J.M. ZEROTAPE
0165	1" THICK CELLULAR INSULATING BLOCK
0166	1½" THICK CELLULAR INSULATING BLOCK
0167	2" THICK CELLULAR INSULATING BLOCK
0168	2½" THICK CELLULAR INSULATING BLOCK
0169	3" THICK CELLULAR INSULATING BLOCK
0170	3½" THICK CELLULAR INSULATING BLOCK, DOUBLE LAYER
0171	4" THICK CELLULAR INSULATING BLOCK, DOUBLE LAYER
0172	4½" THICK CELLULAR INSULATING BLOCK, DOUBLE LAYER
0173	5" THICK CELLULAR INSULATING BLOCK, DOUBLE LAYER
0174	5½" THICK CELLULAR INSULATING BLOCK, DOUBLE LAYER
0175	6" THICK CELLULAR INSULATING BLOCK, DOUBLE LAYER
0176	6½" THICK CELLULAR INSULATING BLOCK, TRIPLE LAYER
0177	7" THICK CELLULAR INSULATING BLOCK, TRIPLE LAYER
0178	7½" THICK CELLULAR INSULATING BLOCK, TRIPLE LAYER
0179	8" THICK CELLULAR INSULATING BLOCK, TRIPLE LAYER
0204	3/8" DIA STEEL BOB
0205	ANGLE 3 x 2 x 1/4 - 3" LONG, STEEL CLIPS
0206	3/4" MESH GALVANIZED EXPANDED FLAT METAL LATH

NOTES

1.

A. INSULATION-SECTIONAL FOR HOT PIPING (01-029)

I. MODERATE TEMPERATURES, 100°F - 350°F - SINGLE LAYER ONLY.

GLASS FIBER, PHENOLIC RESIN BONDED, "FIBERGLAS". 6-8 LB. DENSITY MAY BE USED ONLY ON SPECIFIC APPROVAL OF COMPANY

II. INTERMEDIATE TEMPERATURES, 100°F - 650°F (SINGLE LAYER) AND HIGH TEMPERATURES, 650°F - 1100°F (DOUBLE LAYER) (SEE NOTE II)

a. HYDROUS CALCIUM SILICATE

i. OWENS-CORNING - "KAYLO 10"
ii. J-M - "THERMO 12"
iii. PABCO - "SUPER CALTEMP H.A."
iv. NEESE - "THERMASIL"

b. MINERAL WOOL (SEE NOTE III)

i. EAGLE-PICHER -- "EPITHERM 1200 SUPERGLAS"

c. PERLITE

i. CANTEMP 1500

II.. VERY HIGH TEMPERATURES, 1100°F AND ABOVE - DOUBLE LAYER REQUIRED; USE HIGH TEMPERATURE MATERIAL FOR THE OUTER LAYER.

a. J-M - "SUPEREX 2000"

b. BBW - "KAOWOOL"

B.. INSULATION BLOCK FOR HOT EQUIPMENT (03-054)

I. MODERATE TEMPERATURES, 100°F - 350°F - SINGLE LAYER ONLY

GLASS FIBER, PHENOLIC RESIN BONDED, "FIBERGLAS". 6-8 LB. DENSITY MAY BE USED ONLY ON SPECIFIC APPROVAL OF COMPANY

II. INTERMEDIATE TEMPERATURES, 100°F - 650°F (SINGLE LAYER) AND HIGH TEMPERATURES, 650°F - 1100°F (DOUBLE LAYER)

a. HYDROUS CALCIUM SILICATE

i. OWENS-CORNING - "KAYLO 10"
ii. J-M - "THERMO - 12"
iii. PABCO - "SUPER CALTEMP H.A."
iv. NEESE - "THERMASIL"

b. MINERAL WOOL (SEE NOTE III)

i. EAGLE-PICHER -- "EPITHERM 1200 SUPERGLAS"

c. PERLITE

i. CANTEMP 1500

II.. VERY HIGH TEMPERATURES, 1100°F AND ABOVE, DOUBLE LAYER REQUIRED; USE HIGH TEMPERATURE MATERIAL FOR THE OUTER LAYER.

a. J-M - "SUPEREX 2000"

b. BBW - "KAOWOOL"

C. INSULATION - SECTIONAL FOR COLD PIPING (060-073)

I. CELLULAR GLASS, PIPE INSULATION, SECTIONAL AND SEGMENTAL WITHOUT JACKET -- PITTSBURG CORNING "FOAMGLASS"

D. INSULATING BLOCK FOR COLD EQUIPMENT (0165-0179)

I. CELLULAR GLASS FLAT BLOCKS, CURVED SEGMENTS BEVELED LAGS OR BEAD SEGMENTS -- PITTSBURG CORN OR "FOAMGLASS"

II. MANUFACTURERS "BRAND NAMES" OR "TRADE NAMES" SHOWN ON THIS DRAWING ARE PRODUCTS ACCEPTABLE TO COMPANY. COMPARABLE PRODUCTS BY OTHER MANUFACTURERS MAY BE PROPOSED BUT THE USE OF ANY SUBSTITUTE MUST HAVE COMPANY APPROVAL.

III. MINERAL WOOLS ARE LESS CAPABLE OF WITHSTANDING MECHANICAL ABUSE USE OF MINERAL WOOL INSULATION REQUIRES SPECIFIC APPROVAL BY COMPANY.

REFERENCE DRAWINGS

STANDARD INSULATION FOR HOT PIPING	CA-999793
STANDARD INSULATION FOR COLD PIPING	CA-999769
STANDARD INSULATION FOR HOT VESSELS	CA-999795
STANDARD INSULATION FOR COLD VESSELS	CA-999796
STANDARD STEAM TRACING DETAILS	50-L99868

REVISIONS

1	4-19-76	Added: KERNE, "THERMASIL" & CANTEMP 1500	RLP	DS

Standard Oil Company of California
Engineering Department, Los Angeles

SCALE: ABOVE — DATE: 9-7-73
DR. — CH. — DR. APP. — DWG. 246
DWG. DEPT. — APPROVED
ENG. DEPT.

STANDARD INSULATION ITEM NUMBERS

W.O.
S.O.

GT-D-25673-1

CHEV
BB 012147

ATTACHMENT B

LIST OF REVISIONS APPEARING IN DRAWING GT-D-25673-1
"STANDARD INSULATION ITEM NUMBERS"

Insulation - Sectional for Hot Piping

For Intermediate Temperatures 100F-650F (single layer) and High Temperature 650-1000F (double layer):

Note A2(a)-IV adds Keene Thermasil

Note A2(c)-1 adds Perlite Carey Temp 1500

For Very High Temperatures, 1100F and above:

Note A3(a) and A3(b) removes hold on J-M Superex 2000 and B&W Kaowool.

Insulation Block for Hot Equipment

For Intermediate Temperatures 100-650F (single layer) and High Temperatures 650F-1000F (double layer):

Note B2(a)-IV adds Kenne Thermasil

Note B2(c)-i adds Perlite, Carey Temp 1500

For Very High Temperatures, 1100F and above:

Note B3(b) removes hold on B&W Kaowool

ATTACHMENT C

MEMORANDUM

Richmond, California
January 17, 1974

EVALUATE PIPE AND VESSEL
INSULATION MATERIAL
Materials Lab File: M-283.02

MR. E. H. EDWARDS:

The attached report covers the evaluation of insulation materials for service from 450F to 1200F. Five calcium silicates and two mineral wool and one fiberglass materials were tested.

Our test results indicate that some mineral wool insulations, namely Epitherm 1200, will perform better in nearly every category than the calcium silicates except in the load carrying capabilities. All of the mineral wool and fiberglas materials compress when walked upon or put under pressure. They all soak up water when wet but regain their normal characteristics when dried out. All of the insulations were found to have a high percent of leachable chlorides. Accordingly, it is recommended that austenitic stainless steels be coated with a high temperature silicone paint (Mobile Chem 37J-1, Triangle Paint P-260 or equal) prior to insulating. Additional effort to insure a waterproof jacket would be desirable. All the insulations performed quite well in the fire test except for 40/8 which disintegrated quite rapidly. The calcium silicates and Epi-Therm 1200 glazed at the surface but the insulation appeared to be unaffected.

Based on the tests run and from visual examination of the materials, the Careytemp 1500 and Thermo-12 appear best of the calcium silicates. Eagle Picher mineral wool insulation appears a little easier to apply on pipe than the 40/8 Pipe Insulation; however, there is little, or no, difference between the Eagle Picher and 40/8 block insulation except in the fire test, and for this reason the Epi-Therm would be recommended over the 40/8. Owens-Corning Fiberglas is excellent for temperatures up to 450F, both for preformed pipe insulation and block.

J. G. KERR

PEJ/jhh
cc: RDS/RLP
File: M-283.02

MATERIALS LABORATORY - RICHMOND

EVALUATE PIPE AND VESSEL INSULATION MATERIAL

FILE: M-263.02
JANUARY 17, 1974

Five calcium silicate, two mineral wool and one fiberglass insulation materials were evaluated for service from 450F to 1200F. Factors considered in this test include weight loss at the test temperatures, thickness loss using a designated loading at test temperatures, chloride leaching and the effect of the pH factor when subjected to water immersion.

The following materials were tested:

a. **Johns-Manville Company - Thermo 12**

b. **Owens-Corning Company - Kaylo-10**

c. **Fiberboard Products - Caltemp N.A.**

d. Keene Building Products Corp. - Thermasil

e. Celotex Corporation - Careytemp 1500

f. Eagle Picher Company - Epi Therm 1200

g. 40/8 Insulation - 40/8 MF Pipe Insulation

h. Owens-Corning Company - Fiberglas 25 ASJ

All of these insulation materials, except Nos. f and h are block insulation. Nos. f and h are preformed pipe insulation. However, both Eagle Picher and Owens-Corning Company make block type insulation of the same material as the pipe insulation.

1. K-Factors

The "K" factors (in BTU-in/hr/sq.ft./°F) for the various materials tested, as obtained from the manufacturers are as follows:

ın Temp. °F	Thermo-12	Kaylo-10	Caltemp N.A.	Thermasil	Careytemp 1500	Epi Therm 1200	40/8 MF	Fiberglas 25 ASJ
100	.38	---	.288	.31	---	.215	---	.260
200	.41	.38	.343	---	---	.250	.275	.300
300	.44	.45	.400	.41	.42	.300	---	.340
400	.48	.50	.450	---	---	.365	.335	---
500	.52	.56	.505	.51	.51	.440	---	---
600	.57	.62	.560	---	---	.510	.44	---
700	.63	.70	.615	.61	.64	---	.53	---
800	---	---	.670	---	---	---	---	---

The above information indicates mineral wool has slightly better insulating qualties than the calcium silicate and all five of the calcium silicates have about the same insulating qualities.

CHEV
BB 012150

2. Physical Characteristics

2.1 JOHNS-MANVILLE THERMO-12 (Max. temperature application - 1500F)

A dense calcium silicate reinforced with fibers. Less pliable than some others, does not break easily in shipment, dusts when cut, but less than some others. Hard to indent with a stick.

2.2 OWENS-CORNING KAYLO-10 (Max. temperature application - 1200F)

A relatively hard calcium silicate with mineral fibers. Breaks easily in shipment. Ten percent or more of Kaylo-10 pieces examined were broken in shipment. Dusts badly when cut, moderately pliable, hard to indent with a stick.

2.3 FIBERBOARD PRODUCTS CO. (PABCO) CAL-TEMP N.A. (Max. temperature application - 1200F)

A calcium silicate with mineral fibers. Soft and easy to indent with a stick. Very pliable and dusts badly when cut. Appears to have a lower amount of fiber reinforcement than some others. Does not break easily in shipment.

2.4 KEENE COMPANY THERMASIL (Max. temperature application - 1200F)

This is Cal-Temp N.A. made under license from Pabco. The insulation is practically identical in every way to Cal-Temp N.A.

2.5 CELOTEX CARYTEMP 1500 (Max. temperature application - 1500F)

A low density pearlite and fiber insulation. Hard to indent with a stick. Very low dust when cut, moderately pliable but has good rigidity and resists cracking and breakage in shipment. Because of its low density it floats in water.

2.6 EAGLE PICHER CO. EPI-THERM 1200 - (Max. temperature application - 1200F)

A soft mineral wool material held together with a water repellant phenolic ester. It holds its shape well and has no tendency to break in shipment. It packs down when compressed. It wets rapidly in water, but when dried out, regains its original characteristics.

2.7 40/8 INSULATION CO. 40/8 MF PIPE INSULATION (Max. temperature application - 1200F)

A mineral wool material, softer than Eagle Picher. The blocks are glued to a thin resin impregnated fiberglas backing. The fibers are similar to Eagle Picher but the binder resin appears to be a phenolic type that burns out at a high temperature. This material packs down under compression and wets in water just like Epi Therm 1200.

2.8 OWENS-CORNING CO. FIBERGLAS 25ASJ (Max. temperature application - 450F)

This is a glass fibers mat held together with a phenolic binder. At temperatures above 450F, the binder appears to burn away leaving the fibers loose with no support.

3. Temperature Tests

All insulation materials were subjected to temperature tests at 450F, 900F and 1200F (if recommended for these temperatures) and the weight loss and deflection under a loading of 40.8 lbs. per sq. ft. were recorded except as indicated below.

BRAND	% Weight Loss			% Thickness Loss	
	30 days @ 450F	30 days @ 900F	10 days @ 1200F	30 days @ 450F	30 days @ 900F
Thermo-12	5.8	9.6	14.0	2.7	3.5
Kaylo-10	15.5	20.4	24.4	2.9	2.9
Caltemp N.A.	9.7	15.1	27.5	1.0	1.5
Thermasil	7.0	12.0	21.0	1.0	2.0
Careytemp 1500	8.0	10.0	11.0	1.0	1.6
Epi Therm 1200	(1)	-	3.4	(2)	-
40/8 MF	(1)	-	4.6	(2)	-
Fiberglas 25ASJ	(3)	-	-	(2)	-

(1) Material tested @ 1200F only due to expected low weight loss and lack of furnace space.

(2) Mineral wool and fiberglass should not be subjected to any loading conditions and therefore was not tested.

(3) Recommended only for 450F maximum - specimen not tested due to lack of furnace space.

4. PH Factor

2-inch square samples of each brand of insulation were submersed in a beaker of distilled water for 120 hours to determine the effect on the pH factor. The distilled water had an initial pH of 7.2.

BRAND	pH
Thermq-12	8.6
Kaylo-10	8.4
Caltemp N.A.	8.8
Themasil	8.9
Careytemp 1500	7.7
Epi Therm 1200	7.6
40/8 MF	7.8
Fiberglas 25ASJ	8.5

5. Chloride Leaching

The chloride content was investigated from samples of each insulation furnished. Test work was performed in the Materials Laboratory and at Chevron Research by the following methods:

Materials Laboratory

4 cu.in. of insulation were placed in 500 ml. of distilled water for a period of 30 days. The chloride content was analyzed by the Socal Chemical Laboratory by adding to the aqueous solution, HNO_3 (nitric acid) and titrated potentiometrically with $AgNO_3$ (silver nitrate).

Chevron Research

Test No. 1 Basic chloride content - Chloride is extracted from the insulation by stirring a one gram sample for 15 to 20 minutes in 50 ml of distilled water plus 1 to 1 HNO_3 at room temperature. 50 ml of isopropyl alcohol is added and the solution is filtrated potentiometrically with 0.02 $AgNO_3$.

Test No. 2 - Effect of hot water at 200F upon insulation. One gram sample, plus 30 ml distilled water stirred for five minutes at 200F. Water decanted and filtered through a five micron Millipore filter. The remaining asbestos in the beaker was washed three times with ten ml of distilled water each time and the washings filtered through the five micron Millipore filter. The combined filtrates were titrated for chloride by then adding 5 ml 1:1 HNO_3 plus 50 ml of isopropyl alcohol.

The chloride contents determined from the above tests were as follows:

Trade Name	Col. 1 Materials Lab chlorides extractable by water @ room temperature	Col. 2 Chev. Research chlorides in insulating material	Col. 3 Chev. Research chlorides extractable by water @ 200F
Thermo-12	3 ppm	646 ppm	556 ppm
Kaylo-10	2 ppm	< 100 ppm	< 100 ppm
Caltemp N.A.	15 ppm	333 ppm	360 ppm
Thermasil	11 ppm	185 ppm	291 ppm
Careytemp 1500	3 ppm	< 100 ppm	< 100 ppm
Epi Therm 1200	4 ppm	299 ppm	257 ppm
40/8 MF	-	360 ppm(1)	< 100 ppm
Fiberglass 25ASJ	2 ppm	< 100 ppm	< 100 ppm

(1) 40/8 mineral wool contains a considerable amount of sulfides which evolve as H_2S when acid is added to the sample. The amount, 360 ppm could include the H_2S which is also titratable with $AgNO_3$.

6. Flame Tests

Sample	PROPANE FLAME TEST Flame 6" from surface--one minute about 1500F	OXYGEN ACETYLENE FLAME Flame 3" from surface--30 sec. using #4 welding tip--about 2000F
1. Thermo-12	Insulation burns 1/16" deep, surface grayed but virtually unaffected except for slight chalk layer	1/16" layer of gray porcelain like glaze formed on the surface. Some shrink cracks formed during heating. Insulation under the glaze is unaffected
2. Kaylo-10	Insulation burns 1/8" deep, surface check cracked and is soft and chalky. Gray colored.	1/16" layer of glass beads formed on surface. A 1/16 inch layer of insulation under the glaze is burned, and chalky.
3. Caltemp N.A. *	Insulation burns 1/16" deep, surface unaffected except for slight chalk layer.	1/16" layer of green glass glaze formed on the surface. Insualtion under the glaze is unaffected.
4. Thermasil *	Insulation burns 1/8" deep, surface gray, chalky and checked.	1/16" layer of green glass glaze formed on the surface. Insulation under the glaze is unaffected.
5. Careytemp 1500	Insulation burns 1/4" deep, turns black and chalks. Appears more affected than any of the other calcium silicates tested.	1/16" layer of white ceramic glaze formed on the surface. Insulation under the glaze burned black 1/8".
6. Epi Therm 1200	Binder burns out 1/8" deep. Fiber darkens but does not appear affected.	Small area in center of sample burned 3/8" deep and a glass glaze formed on the surface. Insulation appears unaffected.
7. 40/8 mineral wool	Binder burns out 3/8" deep, fiber turns white but remains intact and appears unaffected.	50% of sample burned away. The fiber melted and formed some glass bead

* Note: Although Thermasil and Caltemp are reported to be identical formulas, Caltemp was much better in this low temp test than Thermasil.

Note: In all these tests as soon as the surface glaze of glass formed, the insulation appeared to be unaffected. Tests indicate flash

7. Conclusions

These test results indicate that the mineral wool insulations will perform better in nearly every category than the calcium silicates except in the load carrying capabilities. Where insulation can be readily damaged by personnel traffic or other mechanical impact conditions consideration should be given to adequately jacketing mineral wool installations or consider the calcium silicates with a suitable waterproof type jacket.

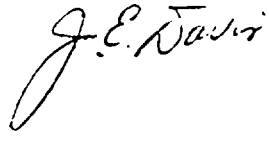
In reviewing the manufacturer's literature, mineral wool appears to have slightly better insulating qualities than the calcium silicates. All of the calcium silicates have about the same insulating qualities. The calcium silicates also have a larger weight loss at their rated maximum application temperature than the mineral wool but all will perform at the temperatures claimed by the manufacturer. The calcium silicates also tend to change the neutralization of water (towards alkalinity) to a greater degree than mineral wool although our tests do not show a disastrous trend with any of the materials tested.

All of the insulations were found to have a high percent of leachable chlorides. Hot water (200F) tended to release all of the available chlorides inherent in the insulation as noted in paragraph 5, columns 2 and 3. At ambient temperatures, the chlorides are released at a considerably slower rate (column No. 1) but are high enough to give concern with use on austenitic stainless steels.

Until insulations are provided chloride free, austenitic stainless steel piping should be coated with a high temperature silicone paint prior to insulating. Additional effort to insure a waterproof jacket would also be desirable.

All of the insulations performed quite well in the fire tests except 40/8 which disentegrated quite rapidly. The balance of the insulations glazed at the surface but appeared to be unaffected underneath.

J. E. DAVIS



PEJ/JED/jhh

ATTACHMENT D

COMPARISON OF CALCIUM SILICATE AND PERLITE INSULATIONS

BRAND	THERMO-12	KAYLO-10	CAL-TEMP N.A.	THERMASIL	CARYTEMP 1500
TYPE	CALCIUM SILICATE	CALCIUM SILICATE	CALCIUM SILICATE	CALCIUM SILICATE	PERLITE
BREAKAGE	OK	FRAGILE. 10% BREAKAGE IN SHIPMENT	OK	OK	OK
DUSTY ?	MODERATELY	BAD	BAD	BAD	BEST
TEMP. LIMIT	1200F	1200F	1200F	1200F	1500F
FIRE RESISTANCE	BEST	BEST	BEST	INTERMEDIATE	WORST OF GROUP BUT ACCEPTABLE
CHLORIDE CONTENT	WORST	BEST	INTERMEDIATE	INTERMEDIATE	BEST

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