EVALUATION OF THE HIGH TEMPERATURE INSULATION MARKET AND DOW CERAMIC FOAM IN THAT MARKET

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SUMMARY

Manufactured or fabricated pipe insulation used in the pipe and vessel insulation market above 100°F amounts to approximately $80 M in sales per year. Dow manufactured products such as THORANEX and Dow Ceramic Foam should be able to compete in a $30 to $35 M segment of this market because of their physical properties and cost.

Calcium silicate the standard product used for most high temperature applications, and representing $25 M a year in sales is in trouble because of asbestosis, the lung disease caused by inhaling asbestos fibers. Manufacturers of this product are searching for a substitute for the asbestosis fibers, but as of this date no company has marketed an asbestos free calcium silicate.

The only product similar to the calcium silicates in properties and price is "Carey Temp 1500" an expanded perlite manufactured by Philip Carey Corporation (Panacon Corporation). This product represents a possible business opportunity for Dow. It is available for sale and would provide a companion product for Dow Ceramic Foam.

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INTRODUCTION

Within the next few months Dow Ceramic Foam will be introduced into the market place. This product, for the next few years, will be mainly utilized as pipe and vessel insulation material in the industrial insulation market.

This report will be mainly concerned with the high temperature industrial insulation market -- the specifiers, the end users, the competitive products, and the types of applicators in that market.

It is intended to provide the marketing department with as much information about the market as possible in order to assist in formulating marketing strategy and offer guidance in specification and pricing development.

A supplemental appendix which is not contained in every copy of this report will be maintained by the FP&S Market Research Department and is available upon request. This appendix contains the following.

1. Names and addresses of approximately 350 insulation contractors in the United States.

2. ASTM, Federal, and Military specification numbers and generic description of 70 products commonly used in the industrial insulation market.

3. How to select Mastics for thermal insulation (Benjamin Foster Company).

4. Simplified method to estimate insulation thickness (Hydrocarbon Processing).

5. Environmental exposures in the insulation trade (NICA Outlook).

6. Proceedings from Court of Appeals of Maryland, Babcock and Wilcox, Inc., vs. Francis Herman Steiner (Asbestosis Case).

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METHODOLOGY

Thirty in-depth personal interviews plus several telephone inverviews were held with owners, insulation contractors, fabricators-contractors, fabricators, design construction firms, industry associations, trade unions, and U.S. governmental agencies to investigate the industrial insulation market.

Information was obtained from industry magazines, government reports and by interviewing many Dow people who have been associated with the industrial market through TS&D or Production. Several studies have been conducted by Dow researchers in the past on related aspects of the industrial market. These reports were studied and were of value in making this report.

For persons interested in more background information on other segments of the industrial or commercial insulation market, these reports are listed in the Appendix.

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CONCLUSIONS

The high temperature insulation market is in a state of uneasiness today because of the asbestosis problem. Manufacturers are having their standard product banned for use by some firms and governmental agencies because of its asbestos content. The situation is getting worse for them, not better. It evidently is difficult for them to find a substitute for the asbestos fiber for two reasons. (1) Some firms such as Johns-Manville are basic in asbestos and change is difficult because of cost, and (2) products which might be considered a natural substitute such as glass fibers are not compatible with calcium silicate.

Asbestos workers also are very aware of the asbestosis problem and through the Asbestos Workers Union are spending thousands of dollars yearly on medical research. Industrial users, specifiers and applicators are searching for products to replace the asbestos containing calcium silicates. Dow Ceramic Foam will be entering the market at an opportune time to help fill the need for an asbestos free product.

The pricing of Dow Ceramic Foam within a cent or two over Foamglas should allow the product to be competitive and perhaps have an edge over Foamglas in the fabrication (larger pieces for DCF) and application (longer pieces - Foamglas 18" or 24" and DCF, 36" in length) of pipe insulation.

Ceramic Foam below 500° or 600°F can probably compete with Foamglas, calcium silicate and expanded perlite on an equal thickness and price basis. However, above this temperature the nature of Ceramic Foam's steeply increasing "k" factor will probably necessitate a greater thickness of insulation for the same temperatures. This greater thickness will result in higher cost which may or may not be overcome by (1) the contractor fabricator's ability to warehouse a much smaller

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amount of material to service his customers. Perhaps $25 M worth of DCF instead of $200 M worth of calcium silicate or expanded perlite. By not having to tie up large sums in inventory, he may be able to sell a greater thickness of DCF at a more favorable price against the "white goods." (2) Dow Ceramic Foam has a non-wicking property which no other product above 500° or 600°F has. This property,which means the prevention of auto ignition caused by solvents, etc., soaking into the insulation, is very important in chemical plants, refineries, power plants, and naval vessels. This property coupled with incombustibility should be worth more money to many owners.

In general, it appears that Dow Ceramic Foam is a good saleable product which has properties or physical characteristics which will enable it to compete in the market place successfully with existing products.

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RECOMMENDATIONS

1. Promote Dow Ceramic Foam by having industrial salesmen calling on design constructors, owner engineering departments, and engineering firms specializing in design work in the power industry and the chemical process industry.

2. For immediate business, seek out Foamglas projects first. Eighty to eighty five percent of Foamglas pipe and vessel covering is used at temperatures below 375°F. These jobs should require no change in thickness and Dow Ceramic Foam can be competitive with cost of Foamglas.

3. Develop a distributing arrangement with, or an interest in, one or more true pipe insulation fabricators. Offer the insulation contractor a choice of Styrofoam, Thurane, or Dow Ceramic Foam fabrication billets or finished pipe covering. The contractor can choose according to his ability to fabricate or the size of the job or both.

4. Sell to all insulation contractors at the same price. Do not have some contractors set up as distributors to sell to other contractors as Pittsburgh Corning does. This breeds unhappy contractors among those who are not distributors. Given a choice, they will use a substitute rather than be forced to buy from a competitor.

5. Investigate the possibilities of distributing or buying the manufacturing rights and patent for Carey Temp 1500°F. This would provide a more full line of insulating products for temperatures up to 1500°F and a choice for the customer who doesn't need the advantages of Dow Ceramic Foam above 500°F or 600°F.

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6. Do not sell end users direct, sell all material through contractors. If forced to sell an end user direct, sell at a price high enough to give the local friendly contractor a commission. This builds loyalty from the contractor.

7. Establish target accounts for industrial salesmen. These should be the top forty design constructors, large owner engineering departments, and engineering firms. Target accounts should be assigned by DSM's and market manager, and reviewed with salesmen at least once a year.

8. Develop an adhesive for bonding Ceramic Foam to Ceramic Foam which can withstand temperatures up to maximum use limit of the product.

9. Develop a product similar to Power House Cement as a companion product for Dow Ceramic Foam. This product is used to trowel over the foam where a smooth hard protective finish is desired in place of jacketing.

10. Market manager should become active in the National Insulation Contractors Association (NICA) of which Dow is presently an industry member. Local salesmen should be instructed to join regional insulation contractors associations, if they are not already members, and become active in those groups. Use these organizations to become closer to the insulation contractors and more knowledgeable about competition.

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BACKGROUND OF THERMAL INSULATIONS

The need for good thermal insulations, which may be described as products which either retain heat or excludes it from areas where it is not wanted, was not very demanding until after the turn of the century. Early materials used were mostly natural products such as felted vegetable fibers, eel grass, kelp, cottonseed hulls and similar materials formed into blankets with paper facings. At higher temperatures cementous type mixes were used, utilizing fibers of jute, straw, sheeps wool, or hair to serve as reinforcement. The cement was bound to the pipe or surface by wrapping it with cloth, like a bandage. Underground pipes were installed in hollow wood logs, utilized the insulating value of the wood.

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The first manufactured product was 85 percent magnesia. This material which was invented in 1885, became the mainstay of the high temp market for temperatures up to 550°F until calcium silicate came into being around 1940. During the past 30 years calcium silicate has, for practical purposes, eliminated 85 percent magnesia from the market place.[1]

Today, calcium silicate is the dominant high temperature pipe and vessel insulation, serving the industry at temperatures up to 1200°F.

Other products such as Foamglas and fiberous glass which came into being about the same time as calcium silicate, are also used in the industry, but at temperatures normally not over 350°F to 400°F.

There are several other products such as diatomaceous silica and alumina silica which withstand temperatures up to 1900°F and 2200°F respectively. These products are more expensive than the calcium silicates so, therefore, are only used in those few areas in industry where temperatures exceed 1200°F.

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[1] A. C. Wilson, Thermal Insulations

MARKET DESCRIPTION
INDUSTRIES

The market for high temperature pipe, tank and vessel covering is found in the Chemical Processing Industry and Power Industry. These two industries generate high temperatures in the manufacture of product or energy.

Although the end products of the CPI vary widely, it is unified by chemical engineering necessary for the processes involved. This industry is estimated to grow in output of product 145 percent between 1967 and 1982 by McGraw-Hill. Table I lists the 18 segments of this industry. Each of these industries represents many dollars of potential sales of high temperature insulation, both for new construction and rehabilitation. The major areas where high temperature insulation is used are the chemicals (including petrochemicals) and petroleum refining.

The other 16 segments represent potential business for high temperature also, but not in the same ratio of equipment to production. The higher the value of the processing equipment the more insulation will probably be needed. Table II illustrates the amount of money spent in the CPI for raw materials, energy and production contract work. This $80 billion does not include the more than $10 billion as shown in Table III. From Table III it becomes evident that the industriesl in Table I with the greatest output are also the industries which spend the most for new plant and equipment.

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TABLE I*

CPI SEGMENT	VALUE OF OUTPUT - BILLIONS 1967	1968	1982	% INCREASE 1967-1982
Chemicals (including petrochemicals)	$ 16.87	$ 17.72	$ 56	227
Drugs & Medicines	6.12	6.44	25	302
Explosives & Fireworks	3.77	3.95	9	133
Vegetable & Animal Oils	5.61	5.90	9	60
Fertilizers	2.71	2.85	6	85
Foods & Beverages	14.47	15.20	22	48
Leather Tanning	0.90	0.94	1	-28
Cement & Lime	1.45	1.52	3	70
Man-Made Fibers	3.43	3.60	14	290
Primary Nonferrous Metals	8.44	8.87	22	152
Paints & Allied Products	3.71	3.90	7	63
Petroleum Refining & Coal Products	21.82	22.92	38	72
Plastic Materials	3.85	4.04	26	568
Rubber Products	7.77	8.16	24	206
Soap & Related Products	3.83	4.03	8	96
Stone, Clay & Glass	8.23	8.64	16	87
Wood, Pulp, Paper & Board	10.96	11.51	22	97
Other Chemically Processed Products	10.09	10.60	19	85
TOTAL CPI	$134.03	$140.79	$327	145%

*U.S. Department of Commerce, McGraw-Hill, Chemical Engineering Research and Chemical Week research estimates.

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TABLE II*

CPI SEGMENT	1968 Estimated Spending For Raw Materials, Energy And Contract Work (Billions)
Chemicals (Including Petrochemicals)	$ 9.92
Drugs & Medicines	2.71
Explosives & Fireworks	2.01
Vegetables & Animal Oils	4.84
Fertilizers	1.97
Foods & Beverages	7.91
Leather Tanning	0.52
Cement & Lime	0.75
Man-Made Fibers	1.37
Primary Nonferrous Metals	4.57
Paints & Allied Products	2.07
Petroleum Refining & Coal Products	18.34
Plastic Materials	2.18
Rubber Products	4.08
Soap & Related Products	1.89
Stone, Clay, Glass & Ceramics	3.54
Wood, Pulp, Paper & Board	6.79
Other Chemically Processed Products	4.60
TOTAL CPI	$80.06

*U.S. Department of Commerce, McGraw-Hill, Chemical Engineering Research, and Chemical Week research estimates.

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TABLE III**

CPI SPENDING FOR NEW PLANT AND EQUIPMENT (BILLIONS OF DOLLARS)

CPI INDUSTRY SEGMENT	1966 ACTUAL	1967 ESTIMATED	1968 PLANNED*	1969 PLANNED*
Chemiclas (Including Petrochemicals)	$3.59	$3.66	$3.67	$3.64
Paper & Pulp	1.50	1.61	1.34	1.35
Rubber	0.42	0.51	0.59	0.58
Stone, Clay & Glass	0.91	0.73	0.72	0.75
Petroleum Refining	0.82	0.94	1.04	1.31
Coal Products	0.12	0.14	0.15	0.19
Nonferrous Metals	0.86	0.91	1.26	1.07
Food & Beverages	0.38	0.39	0.44	0.42
Atomic Energy	0.33	0.34	0.34	0.34
Other Chemically Processed Products	0.55	0.47	0.48	0.51
TOTAL	$9.48	$9.70	$10.03	$10.16

*Expenditures planned by manufacturers at the time they were surveyed.

**U.S. Department of Commerce, Atomic Energy Commission, McGraw-Hill, Chemical Engineering Research.

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These CPI plants are located throughout the United States with the major concentration in states bordering the Gulf Coast, Atlantic Coast, Pacific Coast, and those along the Ohio River. Table IV illustates the number of plants in the various states in 1966 and the total number of employees. States having more than 200 plants with 100 or more employees are California, Texas, Ohio, Illinois, New Jersey, New York, and Pennsylvania. The number of plants has perhaps changed but not enough to change the overall picture of where the major industries are located.

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The other large market for high temperature insulation is the electric power industry.

Electric power in the United States is supplied by a wide variety of electric supply systems. There are over 3,500 systems which vary in size, type of ownership, and range of power supply functions performed. Four distinct ownership segments make up the electric power industry-investor owned, state and local agencies, cooperatives, and Federal agencies. Details are shown in Table V.

Of the 1,098 systems engaged in generating power, 154 can produce over one billion kilowatt hours annually. This means that they produce over 90 percent of the output of the electric power industry.

TABLE IV

STATE AND REGION	CPI PLANTS WITH 20 OR MORE EMPLOYEES PLANTS	CPI PLANTS WITH 20 OR MORE EMPLOYEES EMPLOYEES	CPI PLANTS WITH 100 OR MORE EMPLOYEES PLANTS	CPI PLANTS WITH 100 OR MORE EMPLOYEES EMPLOYEES
Connecticut	220	42,611	84	36,557
Maine	76	24,729	41	23,127
Massachusetts	559	89,067	220	73,913
New Hampshire	66	11,962	29	10,427
Rhode Island	134	22,276	58	18,857
Vermont	36	5,304	14	4,334
NEW ENGLAND	1,091	195,949	446	167,215
New Jersey	1,025	199,469	435	172,657
New York	984	194,371	404	169,080
Pennsylvania	840	173,624	417	154,125
MIDDLE ATLANTIC	2,849	567,464	1,256	495,862
Delaware	43	12,640	23	11,757
District of Columbia	17	1,971	7	1,602
Florida	226	47,259	80	41,607
Georgia	284	45,244	113	37,204
Maryland	204	43,282	95	38,435
North Carolina	272	57,093	124	49,596
South Carolina	136	50,548	81	48,166
Virginia	193	69,640	106	65,648
West Virginia	124	44,808	87	43,009
SOUTH ATLANTIC	1,499	372,485	716	337,024
Illinois	970	159,285	363	132,546
Indiana	337	93,122	176	86,015
Michigan	472	93,550	192	81,219
Ohio	942	216,739	452	194,093
Wisconsin	306	61,459	128	53,392
EAST NORTH CENTRAL	3,027	624,155	1,311	547,265
Alabama	183	38,971	80	34,411
Kentucky	164	35,193	86	31,590
Mississippi	102	18,737	46	15,887
Tennessee	291	123,281	153	116,871
EAST SOUTH CENTRAL	740	216,182	365	198,759
Iowa	132	20,304	43	16,583
Kansas	104	17,434	56	15,303
Minnesota	191	34,558	61	29,080
Missouri	279	49,798	109	42,388
Nebraska	54	6,581	21	4,998
North Dakota	10	882	2	524
South Dakota	10	711	2	318
WEST NORTH CENTRAL	780	130,268	294	109,194
Arkansas	89	16,730	43	14,442
Louisiana	229	61,486	128	56,746
Oklahoma	89	18,777	46	16,758
Texas	661	146,115	289	130,422
WEST SOUTH CENTRAL	1,068	243,108	506	218,368

*Bureau of Census, Census of Manufacturers

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TABLE IV (continued)

STATE AND REGION	CPI PLANTS WITH 20 OR MORE EMPLOYEES PLANTS	CPI PLANTS WITH 20 OR MORE EMPLOYEES EMPLOYEES	CPI PLANTS WITH 100 OR MORE EMPLOYEES PLANTS	CPI PLANTS WITH 100 OR MORE EMPLOYEES EMPLOYEES
Arizona	43	8,929	23	8,156
Colorado	93	20,733	38	18,066
Idaho	24	9,288	14	8,798
Montana	25	7,340	16	6,866
Nevada	18	2,929	8	2,430
New Mexico	33	8,756	16	7,958
Utah	54	10,555	23	9,293
Wyoming	16	3,520	14	3,410
MOUNTAIN	306	72,050	152	64,977
California	1,702	157,301	395	127,998
Oregon	81	11,648	32	9,663
Washington	140	38,091	58	34,601
PACIFIC	1,293	207,040	485	172,262
GRAND TOTAL	12,653	2,628,701	5,531	2,310,962

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TABLE V

DISTRIBUTION OF ELECTRIC POWER SYSTEMS
IN THE UNITED STATES BY FUNCTION & OWNERSHIP

Ownership	Total	NUMBER OF SYSTEMS: Engaged in Generating and Transmission (Distribution)	NUMBER OF SYSTEMS: Engaged in Distribution Only
Investor owned*	437	262	175
Public (non-federal)	2,101	725	1,376
Cooperatives	971	72	899
Federal	41	39	2
	3,550	1,098	2,452

Source: Prevention of Power Failures, Vol. 1. Report of the Commission (Washington, D.C. Federal Power Commission July, 1967), page 31

*Includes twenty industrial concerns that supply energy to customers.

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The demand for electricity has grown on an average of 7 percent per annum since 1880. This growth has required continual addition to the supply of electric power production facilities. The Federal Power Commission in its National Power Survey of 1964 states that "The United States will probably require approximately 2.8 trillion kilowatt hours of electricity by 1980, or slightly more than three times the amount generated in 1960. To produce this energy a well interconnected and coordinated utility industry will require an installed capacity of about 525 million kilowatts, compared with about 200 million kilowatts of capacity in existence at the end of 1962."[1]

This expansion which is presently going on is in the form of steam generating plants, nuclear plants, gas turbines, and hydroelectric dams. With the exception of hydroelectric plants high temperature insulation is required for pipes and boilers in these plants. Maximum temperatures generated by these facilities usually does not exceed 1,100°F.

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[1] National Power Survey, Page 35 (Washington, D.C., United States Government Printing Office 1964), Volumes I and II.

SIZE OF THE MARKET

The insulation market can be divided into commercial and industrial applications.

Commercial work refers to the insulating of pipes and equipment in offices, schools, hospitals, hotels. Industrial insulation work refers to the insulation of piping, vessels, and equipment in manufacturing plants of some type.

Contractors usually specialize in one field with a minor interest in the other market. The degree of involvement in the industrial market will depend upon the location of the contractor. Commercial insulation contractors are in demand in every large city in the country, however, large successful industrial insulation contractors are only found in the areas of industry concentration.

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Ninety percent of the commercial market for pipe and vessel insulation is in the temperature range of 0° to 350°. The remaining 10 percent is above and below that range. The majority of this insulation is used on chilled or hot piping. Fibrous glass is the major product used and is estimated to account for 80 percent to 90 percent of the 35 million dollars of fibrous glass pipe insulation sold in the United States each year.

Other products such as Styrofoam, Foamglas, urethane, molded polystyrene, calcium silicate, and sponge tubing are utilized in this market as well, but due to price and/or combustibility, they are unable to capture a larger share of the market.

The industrial market has temperatures ranging from cyrogenic to 2200°F. However, for all practical purposes it starts at 350°F and stops at 1200°.

Eighty to eighty-five percent of high temperature insulation is less than 600°F. Ten percent is between 600 and 900, and concentrated mainly in the petrochemical industry. The remaining

five to ten percent above 900° and is mainly concentrated in the power industry. Table VI illustrates this breakdown and the major products utilized in the various temperature ranges.

According to information received from the Asbestos Workers Union and the National Insulation Contractors Association, the areas where most high temperature industrial insulation work is performed are; the Gulf Coast states, mainly Texas and Louisiana (25%), Ohio River Valley, Great Lakes states (25%), East Coast - Boston to Norfolk (25%), West Coast (10%), and remainder of the country, 15%.

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Asbestos containing pipe insulation products such as calcium silicate, diatomaceous silica, expanded silica, asbestos fiber, 85 percent; magnesia, cellular and laminated asbestos amount to approximately $20 M per year and increasing according to the U.S. Census of Manufacturers. Block insulation manufactured from the above named materials amounts to $5 M per year.

Fibrous glass pipe insulation manufactured in 1969 amounted to $35 M and it is estimated that about $12 M worth of Foamglas production probably goes into fabricated pieces for pipe and vessel covering. Another $8 M worth of other insulations such as plastic foams, rubber tubing, etc., is utilized in the temperature range from 100° to 350°F.

Total dollar volume for insulation used between 100°F and 2200°F is estimated to be $80 M annually, manufacturers selling price, and growing.

For comparison purposes, the industrial insulation market is approximately 2 1/2 to 3 times larger than the refrigerated warehouse market. This market which does not include small prefabricated walk-in coolers, uses in the neighborhood of 250 M to 275 M board feet of insulation yearly. Dollar volume for the low temperature space insulation is in the $20 M to $30 M range.

Walk-in coolers represent a dollar volume of $80 M to $90 M which is equal to the industrial insulations market.

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TABLE VI

Dollar Volume of Insulation For
Pipe and Vessel Insulation

100° to 350° 45% to 50%		350° to 600° 30% to 35%		600° to 900° 10% to 15%		Over 900° 5% to 10%	
Product	$M	Product	$M	Product	$M	Product	$M
Fiberglas	30	Cal Sil	15	Cal Sil	10	Diatomaceous Earth	5
Foamglas	8	Foamglas	4				
Urethane	5	Fiberglas	5				
TOTAL	41		24		10		5

Dollar volumes obtained from U.S. Dept. of Census
Cenus of Manufacturers; Balance Sheets:
Allied Chemical Marketing Facts Book

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PRODUCTS USED FOR INDUSTRIAL INSULATION

The insulation products used in the industrial market and their properties are listed in Table I. A more detailed description of these materials is as follows:

Calcium Silicate - This product is the most common product used between 400°F and 1200°F. It is manufactured from lime, silica, and asbestos fiber, and chemically converted by steam pressure into a molded shape of hydrous calcium silicate. Examples are Thermobestos (J.M.) and Thermasil (GAF).

Cellular Glass - Foamglas (P.C.) is the only product in this category. It is manufactured from a modified boro-silicate type of glass. By melting and heating, the glass is transformed by a chemical reaction to a closed cell foam glass.

Fibrous Glass - By combining glass fibers made by a drawn or spun process with binders, a molded fibrous glass insulation material can be formed. This product is inexpensive as compared to the other insulations and its usage exceeds any of the others by far. Owen Corning Fiberglas is an example of this product.

Diatomaceous Silicate - Sometimes called diatomaceous earth, this product made from calcined diatomaceous silica and molded with other materials such as asbestos and vermiculite to form an insulation which can be used up to 1900°F. Johns-Manville Superx-M is an example.

Asbestos - Amosite asbestos combined with diatomaceous silica and binders and molded into pipe sections. Pittsburg Corning's Unibestos is an example.

Eighty Five Percent Magnesia - Pipe and vessel insulation composed of magnesium carbonate reinforced with asbestos fiber. Available in molded shapes or powder form, it is almost obsolete today. Johns-Manville 85 percent magnesia is an example.

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Mineral Wool - This product is manufactured by melting siliceous rocks and slags and steam blowing or spinning the molten mass into fibers. By combining these fibers with binder blocks, pipe covering sections, blankets, and felts can be made. Examples are Mono-Block and Therma-K (Keene), and J. M. Banroc Blankets. Occasionally mineral wool is applied to vessels in a spray application. When this is performed, the spun mineral wool fibers, inorganic binders, and rust inhibitors are mixed and sprayed to give a monolithic coating of insulation to the vessel. Mono Spray from Keen is an example.

Expanded Perlite - Molded block and pipe covering sections manufactured with expanded perlite and inorganic fibers. Contains no asbestos. Carey Temp 1500 by Panacon is an example.

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COMPARISON OF INSULATION MATERIALS — HOT

TABLE I

THERMAL INSULATION MATERIALS	GENERAL FORM	COMPOSITION	TEMPERATURE LIMIT		THERMAL CONDUCTIVITY FOR MEAN TEMPERATURES	DENSITY	CHEMICAL RESISTANCE	LINEAR SHRINKAGE	CORROSION		ADVANTAGES	DISADVANTAGES
			CONTINUOUS	CYCLIC					RUSTING	STRESS		
UNIASBESTOS	BLOCK & PIPE COVERING	AMOSITE ASBESTOS FIBERS COMBINED WITH DIATOMACEOUS SILICATE AND SPRAYED WITH A SILICATE BINDER	1200°F	1200°F	100°F - 0.33 200°F - 0.38 300°F - 0.42 400°F - 0.47 500°F - 0.52	14.5#/CU. FT.	ACIDS - GOOD CAUSTICS - GOOD	0.81% @ 750°F 0.85% @ 1200°F	WILL NOT CONTRIBUTE	WILL NOT CONTRIBUTE	SINGLE LAYER MAY BE USED TO 1200°F., GOOD THERMAL SHOCK RESISTANCE, RELATIVELY HIGH STRENGTH	LOSES SOME STRENGTH WHEN WET.
FOAMGLAS	BLOCK, PIPE COVERING CURVED SEGMENTS & LAGS	INORGANIC PURE GLASS CONTAINING BILLIONS OF SEPARATE HERMETICALLY SEALED CELLS.	800°F	800°F	100°F - 0.42 200°F - 0.48 300°F - 0.55 400°F - 0.65 500°F - 0.75	9#/CU. FT.	ACIDS - GOOD CAUSTICS - GOOD SOLVENTS - GOOD	NONE	WILL NOT CONTRIBUTE	WILL NOT CONTRIBUTE	HIGH COMPRESSIVE STRENGTH, INCOMBUSTABLE, EASILY FABRICATED, VAPOR RESISTANT.	THE JOINTS SHOULD BE SEALED WITH A MASTIC TO MAKE THEM RESISTANT TO ABRASION AND WEAR.
GLASS, FIBROUS WITH BINDER	PIPE COVERING	FINE FIBROUS GLASS WITH PHENOLIC RESIN BINDER, AVAILABLE IN A VARIETY OF CANVAS, WATERPROOF FELT, DUAL TEMP AND FIRE-RETARDANT JACKETS.	450°F	500°F	70°F - 0.24 100°F - 0.25 200°F - 0.26	9#/CU. FT.	ACIDS - GOOD CAUSTICS - GOOD SOLVENTS - POOR	UNKNOWN	WILL NOT CONTRIBUTE	S.S. SHOULD BE PROTECTED	RESILIENT, AVAILABLE WITH A VARIETY OF FACINGS, LIGHTWEIGHT	LOW COMPRESSIVE STRENGTH
85% MAGNESIUM	BLOCK, PIPE COVERING	NOT LESS THAN 85% (BY VOL.) HYDRATED MAGNESIUM CARBONATE AND BALANCE ASBESTOS FIBERS	550°F	600°F	100°F - 0.31 TO 0.35 200°F - 0.33 TO 0.38 400°F - 0.43 TO 0.48	16 TO 18#/CU. FT.	ACIDS - POOR CAUSTICS - FAIR SOLVENTS - FAIR	0.05% @ 600°F 1.0% @ 800°F		S.S. MUST BE PROTECTED	HANDLES WELL, ASBESTOS FIBERS HOLD CURVED PIECES TOGETHER	SHARP CLEAN EDGES CANNOT BE MAINTAINED. LOSES MOST OF STRENGTH WHEN WET, DIFFICULT TO FABRICATE.
ALUMINUM SILICA FIBER & BINDER	BLOCK	ALUMINUM-SILICA FIBERS COMBINED WITH INORGANIC BINDER	2000°F	2300°F	400°F - 0.36 1000°F - 0.80 1600°F - 1.40 2000°F - 1.87	12 TO 20#/CU. FT.	ACIDS - GOOD CAUSTICS - FAIR TO POOR SOLVENTS - EXCELLENT	0.5% @ 1500°F 4.0% @ 2000°F			EXCELLENT THERMAL SHOCK RESISTANCE. WILL WITHSTAND FLAME IMPINGEMENT	
ASBESTOS FIBER IRONCORE FELTS	BLOCK, PIPE COVERING	ASBESTOS FIBER FELTS LAMINATED WITH CEMENT	350°F	700°F	100°F - 0.35 200°F - 0.42 300°F - 0.48 400°F - 0.54	35 TO 55#/Cu. FT.		4.3% @ 300°F			FAIRLY HIGH TENSILE STRENGTH RESILIENT	WILL NOT STAY IN TRUE ROUND OR HORIZONTAL LINES
CALCIUM SILICATE	BLOCK, PIPE COVERING	HYDROUS CALCIUM SILICATE REINFORCED WITH SMALL AMOUNT ASBESTOS FIBERS	1200°F	1000°F	100°F - 0.29 TO 0.33 200°F - 0.45 TO 0.51 300°F - 0.53 TO 0.63	10 TO 15#/CU. FT.	ACIDS - POOR CAUSTICS - FAIR SOLVENTS - GOOD	1.5% @ 1700°F 0.5% @ 1000°F	WILL NOT CONTRIBUTE	S.S. MUST BE PROTECTED	GOOD COMPRESSIVE STRENGTH, MAINTAINS SHAPE AND MOST OF STRENGTH WHEN WET. CAN BE PREFABRICATED	WHEN DRIED IN CITU FALL APART, NOT SUITABLE FOR HIGH VIBRATIONS. DOUBLE LAYER REQUIRED ABOVE 1500°F. BECAUSE OF HIGH SHRINKAGE.
DIATOMACEOUS SILICATE	BLOCK, PIPE COVERING	CALCINED DIATOMACEOUS SILICATE BLENDED WITH VERMICULITE, ASBESTOS AND HYDRAULIC BINDER	1900°F TO 1900°F	1000°F TO 1000°F	200°F - 0.58 TO 0.64 600°F - 0.67 TO 0.73 1000°F - 0.74 TO 0.78	21 TO 25#/CU. FT.	ACIDS - GOOD CAUSTICS - GOOD SOLVENTS - GOOD	2.0% @ 1900°F	WILL NOT CONTRIBUTE	S.S. MUST BE PROTECTED	HANDLES WELL RELATIVELY STRONG	LOSES MOST OF STRENGTH WHEN WET. UNSUITABLE TO DIFFICULT TO PREFABRICATE.
MINERAL WOOL	BLOCK, PIPE COVERING	MINERAL WOOL FIBERS WITH INORGANIC BINDER	1700°F TO 1900°F	1500°F TO 1900°F	100°F - 0.29 TO 0.34 400°F - 0.40 TO 0.46 800°F - 0.51 TO 0.64	14 TO 22#/CU. FT.	ACIDS - POOR CAUSTICS - POOR SOLVENTS - EXCELLENT	1.1% @ 1000°F 2.6% @ 1900°F		S.S. MUST BE PROTECTED	EASILY FITTED, FLEXIBLE TO A DEGREE, WITHSTANDS CONSIDERABLE EXPANSION AND CONTRACTION	WILL NOT WITHSTAND MECHANICAL ABUSE, NOT SUITABLE FOR FABRICATION OR FITTING COVERS
EXPANDED SILICA = FIBERS	BLOCK, PIPE COVERING	EXPANDED SILICA WITH SPECIAL BINDER AND REINFORCED WITH INORGANIC FIBER	1200°F	1000°F	100°F - 0.33 200°F - 0.51 600°F - 0.86 1000°F - 0.77	9 TO 10#/CU. FT.	ACIDS - EXCELLENT CAUSTICS - EXCELLENT SOLVENTS - GOOD	0.7% @ 1200°F 1.2% @ 1900°F	WILL NOT CONTRIBUTE	WILL NOT CONTRIBUTE	GOOD THERMAL SHOCK RESISTANCE LOW SHRINKAGE, LOW WATER ABSORPTION, CAN BE PREFABRICATED	WILL FRACTURE INTO PIECES

TABLE VII

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TABLE VIII

Thermal Insulation

Rigid and semi-rigid insulations

Material identification number	Generic type and class or description of insulation material	Form	Maximum temp limits °F		Density lbs/cu ft	Abrasion resistance % weight loss by tumbling/		Alkalinity pH	Capillarity
			Continuous	Short		1st 10 min run	2nd 10 min run		
1	Alumina-silica fibers combined with binders	Block	2200	2300	13 to 14				
2	Alumina-silica fibers combined with binders	Block	2000	2000	21				
3	Refractory fiber-molded Light Weight	Board	2300	2300	11				will wick
4	Amosite asbestos fibers with silicate binders	Pipe Covering	1200	1200	10 to 16			8 to 10.5	will wick
5	Asbestos sponge felts laminated together	Block and PC	550 to 700	550 to 700	26 to 33			9 to 10	will wick
6	Asbestos paper, plain and corrugated. Cemented together.	Pipe Covering	300	300	9 to 13			10 to 11	will wick
7	Calcium silicate, hydrous. Reinforced with asbestos fiber.	Block and PC	1200	1200	10 to 13	20 to 50	40 to 80	8 to 12.5	will wick
8	Calcium silicate, hydrous. (Same as 7)	Block and PC	1800	1800	10 to 14	7.5 to 20	16 to 40	8 to 12.5	will wick
9	Cork, vegetable compressed	Block	200	200	6 to 9			6.5 to 7.5	Neg.
10	Diatomaceous silica, blended and bonded Class I	Block and PC	1800	1800	21 to 24	30 to 55	50 to 80	7 to 9	will wick
11	Diatomaceous silica, blended and bonded Class II	Block and PC	1900	1900	24 to 26	30 to 55	50 to 80	7 to 9	will wick
12	Diatomaceous silica, asbestos fibers and inorganic binders.	Board	1200	1200	23			9 to 11	will wick
13	Diatomaceous silica, asbestos fibers and inorganic binders.	Board	1200	1200	36			9 to 11	will wick
14	Diatomaceous silica, asbestos fibers and inorganic binders	Board	1200	1200	65			9 to 11	will wick
15	Glass, cellular. Hermetically sealed cells.	Block and PC	800	800	7 to 9.5			7 to 8	Neg.
16	Glass, cellular. Hermetically sealed cells. Between layers of felt	Board	200	200	7 to 9.5			7 to 8	Neg.
*17	Glass, fiber, with organic binder	PC	370	370	3 to 4			7.5 to 9	Neg.
*18	Glass, fiber, with organic binder	PC	450	450	7.0			7.5 to 9	Neg.
*19	Glass, fiber, bonded, with organic binder.	PC	500	500	3.0 to 5			7.5 to 9	Neg.

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TABLE VIII (continued)

Properties of Thermal Insulation

Combustibility											
Flame spread/ flame spread index	Smoke density/ smoke density index	Non-combustible	Compressive strength/lbs/ sq. in. at % deformation	Hygroscopicity/ % volume after test	Linear shrinkage/ max % at max temp °F	Specific heat/ btu per lb per °F	Tensile strength/ lbs/sq in.	Thermal diffusivity/ sq ft/hr (calculated)	Water absorption/ % vol. 24 hr submersion	Water vapor transmission perm inch
		NC			1.0				91	
		NC			5.4				90	
		NC			2.2					
		NC	12.5 at 5%	2 to 5 at 70 F 90 RH	.25	.22 to .25	67	.009	84	
		NC			4 to 5.5	.25		.005	65	
		NC			3 to 7				85	
		NC	75 to 165 at 5%	10% by Wgt.	1.5 to 2	.20 to .21	10 to 30	.16	90	
		NC	110 to 130 at 5%	1.5	1.6 to 2.6	.25 to .28		.016	90	
			6 to 10 at 5%	1.0		.43		.006		2 to 7
		NC	50 to 120 at 5%	2 to 8 by Wgt.	2.0	.22 to .28	10 to 20	.008 to .01	85	
		NC	65 to 120 at 5%	2 to 8 by Wgt.	2.7 to 3.5	.22 to .28	15 to 20	.009 to .012	83	
		NC	800 at 10%	9	1 to 2	.25 to .34	18	.006 to .01		16
		NC	1800 at 10%	9	1 to 2	.25 to .34	460	.006 to .01		8
		NC	2800 at 10%	9	1 to 2	.25 to .34	750	.006 to .01		
		NC	100	0	.0000046 Exp. Co.	.20	50	.18		
			100	0	.0000046 Exp. Co.	.20	50	.18		
25 or less	50 or less			.2	Neg.	.20		.02	93	
25 or less	50 or less			.2	Neg.	.20		.015	92	
25 or less	50 or less			.2	Neg.	.20		.018	93	

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TABLE VIII (continued)

Thermal Insulation

Rigid and semi-rigid insulations (continued)

Material identification number	Generic type and class or description of insulation material	Form	Maximum temp limits °F		Density lbs/cu ft	Abrasion resistance % weight loss by tumbling/		Alkalinity pH	Capillarity
			Continuous	Short		1st 10 min run	2nd 10 min run		
*20	Glass, fiber, with organic binder. Available with various facings.	Board	450	450	4 to 5			7.5 to 9	Neg.
*21	Glass, fiber, with organic binder. Available with various facings.	Board	450	450	5 to 7			7.5 to 9	Neg.
*22	Glass, fiber, with organic binder. Available with various facings.	Board	450	450	7 to 9			7.5 to 9	Neg.
23	Glass, fiber, bonded with high temperature binder.	Board	1000	1000	3¼			8.5 to 9	Neg.
24	Glass, fiber, with organic binder. Asphalt attached foil facing. (Roof board)	Board	100	100	6			8.5 to 9.5	Neg.
25	Glass, fiber, coated one side to resist air erosion	Board (Duct Lining)	250	250	1.5 to 6			8.5 to 9.5	Neg.
26	Glass, fiber, bonded with organic resin, with vapor resistant facing. (Ducts)	Board & Round	250	250	3			8.5 to 9.5	Neg.
27	Glass, fiber, bonded with organic resin, with vapor resistant facing. (Ducts)	Board & Round	250	250	5			8.5 to 9.5	Neg.
28	Glass, fiber, bonded with organic binder, with factory applied aluminum facing.	4' x 8' Panels	450	450	Insul. only 3 to 5				
29	Magnesium carbonate, with asbestos fibers and binders	Block and PC	600	600	11 to 13	25 to 50	50 to 80	7 to 10.5	will wick
30	Mineral fiber with inorganic binder.	Block	1800	1800	15 to 18			7 to 9	will wick
31	Mineral fiber, with inorganic binder. Semi-rigid	Block	850 to 1000	850 to 1000	4 to 12			7 to 9	will wick
32	Perlite, expanded. Blended and bonded by binders. Water repellent	Block and PC	1500	1500	9.5 to 11.5	35 to 40	64 to 70	7 to 8	Neg
33	Polystyrene, expanded beads. Molded to shape	Block, Board, PC	180	180	1			6.5 to 7.5	None
34	Polystyrene, cellular foam. Molded to shape.	Block, Board, PC	185 to 175	185 to 175	1.5 to 3.3			6.5 to 7.5	None
35	Polystyrene, cellular foam	Block, Board, PC	165	165	1.5 to 2.5			6.5 to 7.5	None
36	Polystyrene, cellular foam. Self-extinguishing	Block, Board, PC	165	165	1.0 to 2.2			6.5 to 7.5	None

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TABLE VIII (continued)

Properties of Thermal Insulation

Combustibility										
Flame spread/ flame spread index	Smoke density/ smoke density index	Non-combustible	Compressive strength/lbs/ sq in. at % deformation	Hygroscopicity/ % volume after test	Linear shrinkage/ max % at max temp °F	Specific heat/ btu per lb per °F	Tensile strength/ lbs/sq in.	Thermal diffusivity/ sq ft/hr (calculated)	Water absorption/ % vol. 24 hr sub-mersion	Water vapor trans-mission perm inch
25 or less	50 or less		1.2 at 10%	.2	Neg.	.20		.018	93	
25 or less	50 or less		2.7 at 10%	.2	Neg.	.20		.02	92	
25 or less	50 or less		3.5 at 10%	.2	Neg.	.20		.03	91	
25 or less	50 or less			.2	Neg.	.20		.03	93	
25 or less	50 or less			.2	0	.20		.009	93	.01 to .05
25 or less	50 or less			.2	0	.20		.018	93	
25 or less	50 or less			.2	0	.20		.018	93	.01 to .10
25 or less	50 or less			.2	0	.20		.017	93	.01 to .10
		NC	50 at 10%	10 by Wgt.	2	.20		.008 to .012	90	
		NC	2 to 18 at 10%	.2	1.6	.22		.005 to .010	85	
			1 to 1.5 at 10%	.2	4	.22		.01 to .02	85 to 93	
		NC	80 at 5%	.5	1.25	.216	32	.014	3.5 to 4	18
less than 25	less than 350		6 to 8 at 5%		.000035 Exp. Co.	.27		.063	2.5	3.0
less than 25	less than 350		14 at 5%		.000035 Exp. Co.	.27	225	.017	0.1 to 1.25	1.0 to 2.0
Comb.	Comb.	Comb.	10 to 30 at 5%		.000035 Exp. Co.	.27	70	.017	0.1 to 1.25	1.0
less than 25	less than 400		8 to 30 at 5%		.000035 Exp. Co.	.27	70	.017	0.1 to 1.25	1.0

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SELLING IN THE INDUSTRIAL MARKET

Selling insulation for use in refineries, chemical plants, power plants and other industrial applications requires a somewhat different approach than the selling of insulation materials for use in office buildings and cold storage warehouses as Dow insulation materials have been sold in the past.

The majority of commercial or office buildings are designed for clients on a one-time basis, or at least several years apart for larger clients. These buildings will normally require no more than minimum maintenance to keep them in satisfactory condition.

The commercial client cannot afford to do his own design work because of the infrequent or one-time need for that ability. He, therefore, delegates or buys this function from an architect.

Industrial plants, on the other hand, are designed for a client who is producing a product with the designed facility. The industrial client requires that production equipment perform as long and economically as possible without breakdowns. This is the only way that he can stay in a competitive position in the market place.

An industrial owner of any size is also continually modifying or expanding new systems within his plants or building new facilities at another location.

Therefore, in order for the client or plant owner to achieve his goal of efficient equipment which will not break down, he must know as much as possible about his own processes. He does this by building up his internal staff of engineers and design people. This engineering department in many companies is large enough to handle new plant design for large expansions of the company as well as the modifications and designs for new systems

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within the existing plant. These engineering departments which exist in large corporations such as Dow, du Pont, Monsanto, Shell, Texaco, Gulf, Standard Oil, etc., require and should receive attention by the Dow industrial salesmen in order to sell them on the merits of Dow insulation products.

When new plants or large expansions are to be constructed, most companies including those with their own engineering departments, normally will go to the engineering design construction firms specializing in their segment of the industry and negotiate a contract on a lump sum contract. This means that the design construction firm agrees to erect an operating plant for a fixed number of dollars, subject to conditions agreed to in advance. Once the contract is signed "change orders" specified by the client are billed as "extras" over and above the agreed upon price. Under these circumstances, the contractor's engineers usually operate with more final authority. On vendor selection, for example, the contractor's engineers will select the vendors from lists of approved vendors that the client okayed in advance of the signing of the contract.

During periods of booming business and construction, many contracts are let on a cost plus basis. In this situation the client will usually participate more actively in project details such as vendor selection because the client is paying directly for any additional cost resulting from his comments or requests.

McGraw-Hill published a market research study entitled, "Buying Patterns in 20 Engineering/Construction Firms," in 1967, which contains some very pertinent information concerning the buying habits of these firms.

With the consent of their management, 3,540 questionnaires were distributed to personnel in the 20 largest design construction firms in the United States representing over three billion dollars annual business.

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A 43.8 percent response was received, which is considered an extremely high return in studies of the questionnaire type.

The section on Insulation Materials points out several interesting facts which are important to vendors selling in the industrial market. The survey shows that the engineering department which heavily influences the buying of insulation material is often ignored by the salesmen. Sixty-seven percent (67%) of 363 buyers of insulation reported that they are not called on by salesmen.

The other item of importance brought out in this study is the importance of client participation in vendor selection. A total of 312 respondents replied that 9 percent of the time the client always participates and 80 percent of the time the client sometimes participates. This emphasizes the importance of client contact as well as designer contact in the industrial insulation market.

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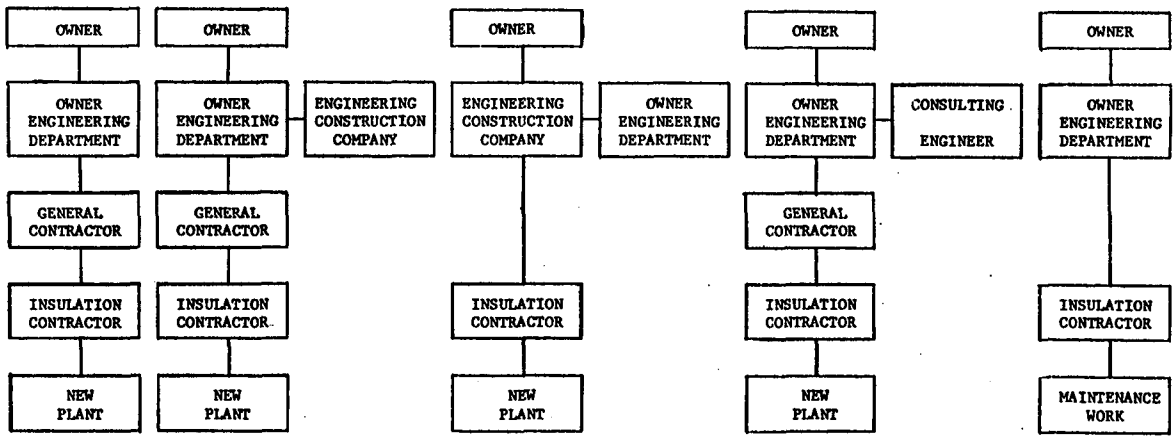
Diagram I illustrates the paths of responsibility in the building and design of new plants and maintenance work. In all cases the owner engineering departments exert all or partial influence on what product is specified. The next in importance would be the engineering construction company or consulting engineer and last as far as specifications go is the insulation contractor.

In many areas of the country, the insulation contractor has built up such a reputation that he acts as a consultant to the owner engineering department and keeps them advised as to the best insulation materials and specifications in vogue at the time.

DIAGRAM I

PATHS OF RESPONSIBILITY FOR INSULATION WORK



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IN ORDER TO PERFORM HIS JOB, AN INDUSTRIAL SALESMAN MUST:

A. Develop a relationship with the insulation specification people as well as the chief engineer in the engineering departments of chemical plants, refineries, power companies, etc.

B. Know the important personnel in engineering construction firms and other engineering firms engaged in industrial plant design.

C. Work closely with the insulation contractors. Many times the contractor is aware of projects which are not publicized, either because they are being negotiated, or because the project is in another area of the country.

D. Know his products and specifications.

E. Know competitive products and specifications.

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POTENTIAL INDUSTRIAL MARKET CUSTOMERS AND SPECIFIERS

During the year 1969, forty design contractors handled over $15 billion in contracts and the top 460 architectural engineering firms did $1.7 billion in billings.

By taking a figure of approximately 10 percent (which is approximately what an architectural firm would receive for design and supervision) and applying it to the $15 billion in contracts, it appears that the 40 design constructors are almost as important as the 460 leading architectural firms in the United States.

Due to the nature of most of the construction performed by the design constructors - manufacturing and process plants - they become very important to the sale of industrial products. It would be desirable for Dow industrial salesmen to maintain a close relationship with the engineering department of the firms listed in Table IX.* The market managers for industrial and low temperature space should look at these firms as target accounts and require a minimum contact of three to four times a year by the local salesman. Reports of call records on these accounts should be maintained by market managers and district sales managers.

Once a year Dow's relationship with each firm should be reviewed with the salesman involved in order to be sure that none are being neglected.

*Engineering News Record, May 21, 1970

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TABLE IX

THE TOP 40 DESIGN CONSTRUCTORS

	1969 contracts in $ millions: Design-&-construct + design-only** Total	Foreign	Construction specialty: Mfg., process plants	Gen'l building	Heavy	Highway
1. Bechtel Corp., San Francisco, Calif.	1,367.0	340.0	●	●	●	-
2. The Ralph M. Parsons Co., Los Angeles, Calif.	1,297.0	331.0	●	-	-	-
3. Ebasco Industries, Inc., New York, N.Y.	1,243.0	216.0	●	●	●	-
4. Kaiser Engineers Div., Kaiser Industries Corp., Oakland, Calif.	1,190.6	705.6	●	●	●	●
5. Brown & Root, Inc., Houston, Tex.	1,059.8	113.8	●	-	●	●
6. The Rust Engineering Co., Pittsburgh, Pa.	808.0	218.6	●	●	●	-
7. The M.W. Kellogg Co., New York, N.Y.-Houston, Tex.	620.0	206.0	●	-	●	-
8. Arthur McKee & Co., Cleveland, Ohio	572.2	343.8	●	-	-	-
9. The Lummus Co., New York, N.Y.	540.0	390.0	●	-	-	-
10. United Engineers & Constructors, Inc., Philadelphia, Pa.	482.0	0	●	●	●	-
11. C. F. Braun & Co., Alhambra, Calif.	466.0	70.3	●	-	-	-
12. Stone & Webster Engineering Corp., Boston, Mass.†	450.0*	200.0*	●	-	-	-
13. Fluor Corp., Los Angeles, Calif.	432.5	120.8	●	-	-	-
14. The Austin Co., Cleveland, Ohio	431.0	88.4	●	●	-	-
15. Procon, Inc., Des Plaines, Ill.	408.6	336.9	●	-	-	-
16. Stearns-Roger Corp., Denver, Colo.	398.4	109.3	●	-	-	-
17. Swindell-Dressler Co., Pittsburgh, Pa.	370.0	n.r.	●	●	●	●
18. Foster-Wheeler Corp., New York, N. Y.	337.0	200.0	●	-	●	-
19. Catalytic Const. Co., Philadelphia, Pa.	317.8	8.0	●	-	-	-
20. Burns & Roe, Inc., Oradell, N. J.	316.0	22.5	●	●	-	-
21. The Badger Co., Inc., Cambridge, Mass.†	227.0	79.0	●	-	-	-
22. The H. K. Ferguson Co., Inc., Cleveland, Ohio	179.6	29.6	●	●	-	-
23. J. Ray McDermott & Co., Inc., New Orleans, La.	176.0	n.r.	●	-	●	-
24. The Kuljian Corp., Philadelphia, Pa.	172.0	131.0	●	-	-	-
25. Jacobs Engineering Co., Pasadena, Calif.	162.0	80.0	●	-	-	-
26. The Edward J. DeBartolo Companies, Youngstown, Ohio	128.0	0	●	●	-	-
27. Day & Zimmermann, Inc., Philadelphia, Pa.	121.1	0	●	●	●	-
28. Dravo Corp., Pittsburgh, Pa.	98.2	46.3	●	●	●	-
29. Scientific Design Co., Inc., New York, N. Y.	98.0	n.r.	●	-	-	-
30. Daniel Const. Co., Inc., Greenville, S. C.	91.2	15.9	●	●	-	-
31. Blaw-Knox Chemical Plants, Inc., Pittsburgh, Pa.	85.0	4.7	●	-	-	-
32. S.I.P., Inc., Houston, Tex.	73.0	0	●	-	-	-
33. J. F. Pritchard & Co., Kansas City, Mo.	64.0	24.0	●	-	-	-
34. Fenix & Scisson, Inc., Tulsa, Okla.	61.7	9.8	-	-	●	-
35. Wigton-Abbott Corp., Plainfield, N. J.	59.1	0	●	●	-	-
36. Crawford & Russell, Inc., Stamford, Conn.	58.0	12.0	●	-	-	-
37. Cunningham-Limp Co., Birmingham, Mich.	53.6	6.0	●	●	-	-
38. The Litwin Corp., Houston, Tex.	53.3	0	●	-	-	-
39. Pittsburgh-Des Moines Steel Co., Pittsburgh, Pa.	53.0	0	-	●	●	-
40. H. P. Campbell Co., Detroit, Mich.	44.6	0	●	●	-	-

*Based on ENR-reported volume of projects awarded in the U.S. by erected value of plant. †Design-only contracts not reported

**Design-only contracts measured n.r. Not reported separately

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TABLE X

460 LARGEST DESIGNERS IN 1969

	Type of firm #	Dams	Heavy const.	Buildings	Architectural	Civil eng.	Structural	Mechanical	Electrical	City plan	Jobs started
Billings totaled $25 million or more											
1. Sargent & Lundy, Chicago, Ill.	E	–	●	●	●	●	●	●	●	–	●
Billings totaled $20 million to $24.9 million											
2. Howard, Needles, Tammen & Bergendoff, Kansas City, Mo. and New York, N.Y.	EAP	●	●	●	●	●	●	●	●	●	●
3. Ches. T. Main, Inc., Boston, Mass.	EA	●	●	●	●	●	●	●	●	●	●
4. Skidmore, Owings & Merrill, Chicago, New York, San Francisco, Portland, Ore. & Washington, D.C.*	AE	●	–	●	●	●	●	●	●	●	●
5. Michael Baker, Jr., Inc., Rochester, Pa.	EA	●	●	●	●	●	●	●	●	●	●
6. Gilbert Assoc., Inc., Reading, Pa.	AE	●	●	●	●	●	●	●	●	●	●
7. DeLeuw, Cather & Co., Chicago, Ill.	E	●	●	●	●	●	●	●	●	●	●
Billings totaled $15 million to $19.9 million											
8. Frederic R. Harris, Inc., New York, N. Y.	E	●	●	●	●	●	●	●	●	●	●
9. Louis Berger, Inc., East Orange, N. J.	EAP	●	●	●	●	●	●	●	●	●	●
10. A. Epstein & Sons, Inc., Chicago, Ill.	EA	●	–	●	●	●	●	●	●	●	●
11. Giffels & Rossetti, Inc., Detroit, Mich.	AEP	●	●	●	●	●	●	●	●	●	●
12. Tippetts-Abbett-McCarthy-Stratton, New York, N. Y.	EA	●	●	●	●	●	●	●	●	●	●
13. Sverdrup & Parcel and Assoc., Inc., St. Louis, Mo.	EAP	●	●	●	●	●	●	●	●	●	●
14. Gibbs & Hill, Inc., New York, N. Y.	EA	●	●	●	●	●	●	●	●	–	●
15. Black & Veatch, Kansas City, Mo.	E	●	●	●	●	●	●	●	●	●	●
16. Daniel, Mann, Johnson & Mendenhall, Los Angeles, Calif.	AEP	●	●	●	●	●	●	●	●	●	●
17. Lockwood Greene Engineers, Inc., New York, N. Y.	EA	●	●	●	●	●	●	●	●	–	●
18. Commonwealth Assoc., Inc., Jackson, Mich.	EA	●	●	●	●	●	●	●	●	●	●
Billings totaled $10 million to $14.9 million											
19. Parsons, Brinckerhoff, Quade & Douglas, New York, N. Y.	EAP	●	●	●	●	●	●	●	●	●	●
20. Ford Bacon & Davis, New York, Monroe (La.) & Dallas	EA	●	●	●	●	●	●	●	●	–	●
21. McIntire & Quiros, Inc., Monterey Park, Calif.	E	–	●	–	●	●	–	–	●	●	●
22. Harza Engineering Co., Chicago, Ill.	E	–	●	–	●	●	●	●	●	●	●
23. Henningson, Durham & Richardson, Inc., Omaha, Neb.	EA	●	●	●	●	●	●	●	●	●	●
24. The Perkins & Will Partnership, Chicago, Ill.	AE	●	–	●	●	–	–	●	●	●	●
25. Ammann & Whitney, New York, N. Y.*	E	●	●	●	●	●	●	●	●	●	●
26. Metcalf & Eddy, Inc., Boston, Mass.	EA	–	●	●	●	●	●	●	●	–	●
27. Dames & Moore, Los Angeles, Calif.	ESO	●	●	–	●	–	–	–	–	●	●
28. Sandwell International, Inc., Portland, Ore.	E	●	●	–	●	●	●	●	●	–	●
29. International Engineering Co., Inc., San Francisco, Calif.	E	●	●	●	●	●	●	●	●	–	●
30. Welton Becket & Assoc., Los Angeles, Calif.*	AE	●	●	●	–	●	●	●	●	–	●

*Billings estimated by ENR, based on company-reported size of staff.

#KEY TO TYPE OF FIRM: A = Architect; E = Consulting Engineer; AE = Architect-Engineer; EA = Engineer-Architect; SO = Soils Engineer; P = Planner; TC = Transportation Consultant. Firms classified themselves.

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Out of the top 460 designers in the United States there are many who are engineering firms only. Table X lists the top 30 design firms. Nine of these are engineering firms only and the remaining are engineering architectural or architectural engineering firms. Most of these firms are involved in the specification writing of industrial insulation, therefore, each should be evaluated by the market manager and district sales manager and classified as a target account for the industrial salesman. The remaining 430 designers listed by Engineering News Record are included in the appendix of this report.

The Petro/Chem Engineer magazine lists a firm directory of approximately 250 design constructors or engineer constructors, as they choose to call them, which includes the top 40 as mentioned previously. This directory covers the world with about 2/3 of the firms being located in the United States. A sample page of the directory is listed in Table XI.

Table XII lists the top 50 basic chemical makers and Table XIII lists the 46 largest power utilities in the United States in 1969. These firms will have engineering departments which will determine insulation specifications for their own facilities. Many times the modernization of old processes or the installation of new processes or equipment will require insulation. Contact by industrial salesmen should be maintained with these firms.

Another method of obtaining specifications for industrial insulation is to contact the licensors of the various processes used in the chemical process industry. For example, contact with the proper person at the Lummus Company in New Jersey could tell a salesman where ethylene and propylene processes licensed by Lummus are to be built throughout the country.

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well-Neal), G. P. O. Box 4092. ph (809) 783-5285. E. G. Kurkholder, mgr; W. L. McVeay, prod mgr; A. A. Martinez, sls mgr.

Sarnia, Ontario, Canada: (sub.) - Bagwell-Nesi Canada Ltd. 220 Vidal St. N., P. O. Box 245. ph (519) 344-8883. Robert J. Boychuk, mgr.

West Monroe, La. 71291. 1118 Natchitoches St., Harry Clark, mgr.

SALFOUR & CO. LTD. HENRY
Leven, Fife, Scotland, ph Leven (Fife) 3030. W. Wood, mgng dir; H. D. MacMurray, exp mgr; D. Traill, mktg mgr; J. C. Rochard, sls mgr.
- HP Industries Served: All
- Services Provided: Manuf & sell Friaudier glass lined vessels in the U. K., Europe & Commonwealth.

SARNARD AND BURR, INC.
Box 15648. Baton Rouge, La. zip 70815, ph (504) 926-0100. Jack S. Burr, pres; John D. Daniel, sr vp; Frank H. Koger, jr. vp-contracts; Harold Beard, vp-engrg; J. C. Hoffmaier, vp-const & maint; H. J. Boxill, bus dev mgr.
- HP Industries Served: All
- Services Provided: Process engr, equip specs & design, mtls procurement, constr/erection, maint.
- Branches:

Baton Rouge, La. 70821, Southeast Fabricators, P. O. Box 3095, 1050 W. McKinley St. ph (504) 343-5283. M. L. Sawyer, chf engr; D. Andrews, prod mgr; H. J. Boxill, bus dev mgr.; N. D. Anderson, sls rep.

Geismar, Louisiana, zip 70734, Heat Exchanger Service Division, P. O. Box 189-F. Rt. #2. Intersection State Hwys. 73 & 429, Geismar, ph (504) 342-1881. R. B. Gardner, mgr; E. Jeko, mgr engr; H. J. Boxill, bus dev mgr; N. D. Anderson, sls rep.

BARNES & CLICK, INC.
817 One Main Place, Dallas, Tex. 75250, ph (214) 741-7635. Brunner C. Barnes, consulting engr; Robert R. Click, consulting engr; Thomas H. King, consulting engr.
- HP Industries Served: Gas liquids proc.
- Services Provided: Process engrg, equip spec & design, economic eval & plng, pit testing & operational control.

BARRY & RICHARDSON
12600 Memorial Dr., Houston, Tex. 77024, ph (713) 465-4855, Charles B. Barry, partner; James A. Richardson, partner.
- HP Industries Served: Gas liquids proc, petrol rfy, petro chem mfg.
- Services Provided: Process engrg, equip specs & design.
- Branches:

Calgary, Alta., Canada: 816-7th Ave. S. W., ph 263-7714. Ronald H. Price, assoc; T. W. Field, assoc.; Alan H. Brook, jr. engr.

BECCO, INC.
16925 Main St., Houston, Tex. ph (713) 728-5400. Peter von Wiesenthal, pres; David G. Eller exec vp; A. L. Secrt, vp; C. E. Main, const mgr; Thomas M. McLean, engrg; Fred C. Dunn, purch; R. V. Symms, const supt; E. J. Pendergrass, const supt; W. A. Miller, const supt.
- HPIndustries Served: All
- Services Provided: Equip specs & design, materials procurement, const/erection, maint.

Branches:

New York, N. Y. 10022, 280 Third Ave., ph (212) 751-6262, William R. Baxter, regional mgr.

Pasadena, Calif. 91101, 301 East Colorado Blvd., Suite 220, ph (213) 681-1502, Lewis B. Paxton, dist sls mgr.

BECHTEL CORP.
Box 3965. 50 Beale St., San Francisco, Calif. 94119, ph (415) 764-5000. S. D. Bechtel Jr., pres; J. W. Komen, exec vp; J. R. Kiely, exec vp; J. F. O'Connell, exec vp.
- HP Industries Served: All
- Services Provided: Process engrg; equip specs & design, mtls procurement, constr/erection.
- Branches:

The Hague, Netherlands: Bechtel Inc. Laan van Nieuw Oost Indie 123-127. R. H. Darroch, mgr. Hague ofc. J. E. Flanders, res. mgr. (IR & C Div)

Houston, Tex. zip 77001: Box 2166. 3701 Kirby Dr., ph (713) 526-0611. (area office). R. C. Braunfield, area mgr.

London W1, England: Bechtel International Ltd., Bechtel House, Portman Sq., W. 1. Hanna, mgr. European res ut.; W. H. Thompson., resident a.e.

Melbourne, Victoria, Australia: Bechtel Pacific Corp. Ltd., West Tower, Princes Gate, 171 Flinders St., F. Moonna, res mgr; M. Farley, mgr bus dev; W. L. Kennedy, Jr., mgr, Australasian oper. (P & PS Div.)

Mexico 4, D. F. Mexico: Apartado Postal 30-532, Paseo de la Reforma 381, Mexico 5, D. F. Mexico, ph 33-29-05. R. F. Myers, mgr.

New York, N. Y.: Bechtel Associates, Box 1658, Grand Central Station, 485 Lexington, ph (212) 697-7100, (partnership and area office). D. R. Ferguson, vp and area mgr.

Paris 89, France: Bechtel France S. A. 37 Avenue Pierre 1 de Serbie. L. T. Crow, res mgr.

Toronto 116, Ontario, Canada: Canadian Bechtel Ltd. 25 King St. West. S. F. Wilson, pres.

CLYDE BERG & ASSOCIATES
5 Euclid Ave., Long Beach, Calif. zip 90803, ph (213) GE 8-7658. Dr. Clyde Berg, pres.
- HP Industries Served: All
- Services Provided: Synthetic crude, water pollution, proc licensing, proc engr.
- Processes Licensed: LNG composition control and oil shale retorting procedures.
- Branches:

San Francisco, Calif. 94111: D. F. Howard & Associates, 440 Davis Ct. 1901. ph (415) 433-1025. Donald F. Howard, associate.

Clyde Berg and Associates
Home Office
5 Euclid Avenue, Long Beach, California

Dr. Clyde Berg, President — Donald Howard, Associate

Specialized Services: Process Design, Engineering, and Economics; Refining and Petrochemicals; Major facilities for Industrial Waste Water Treatment; Synthetic Fuels.

Branch Office Affiliate
San Francisco — D. F. Howard & Associates

BLAW-KNOX CHEMICAL PLANTS, INC.
One Oliver Plaza, Pittsburgh, Penn. 15222, ph (412) 263-2200. E. P. Addison, pres; V. J. Hostler, vp sls; N. F. Boyd, vp engrg; G. F. Kline, tech mgr-petroleum & petrochemicals.
- HP Industries Served: Petroleum rfy, petrochemicals mfr.
- Services Provided: Process engrg, equip specs & design, mtls procurement, constr/erection.

BLOUNT BROTHERS CORP.
P. O. Box 949, Montgomery, Ala. ph (205) 264-8401. John A. Caddell, pres; Carl A. Farm, vp chem sls; C. R. Sweney, chf mech estimator.
- HP Industries Served: All
- Services Provided: Material procurement, const/erection.
- Branches:

Houston, Texas: 6810 Fannin St. ph (713) 748-0634. Walter D. Murphy, vp & mgr.

R. W. BOOKER & ASSOC. INC.
1138 Olive St., St. Louis, Mo. 63101. ph (314) GA 1-1476. C. C. Palmer, pres; E. E. Moulder, exec vp; Lee Carter, sr vp & dir proj studies; E. L. Fleischammer, 1st vp & dir design div.
- HP Industries Served: Gas liquids proc, petrol rfg, petrochem mfg.
- Services Provided: Process engrg, equip spec & design, economic analysis of processes & projects, mtls procurement.
- Branches:

Ft. Worth, Tex., 417 Baker Bldg., ph (817) 332-7638. Ronald G. Denton, mgr.

D. BONALDI & C. S. p. A.
Casella Postale 23, 26013 Crema, Cremona, Italy, ph 5151/52/53/54. Sig. Antonio Bonaldi, pres & consiglieare delegato: Ing Italo Artus-Martinelli, admin: Sig. Sandro Tagliaferri, admin: Sig. Edmondo Barbati, direttore vendite: Ing. Mario Pasponi, direttore acquisti: Ing. Lamberto Cosmi, direttore produzione.
- HP Industries Served: All
- Services Provided: Mtls procurement, constr.
- Branches:

Brewster, N. Y. zip 10509: Clubhouse Dr. Rd. 2, ph (914) 279-8823. Cable PHILSARA, BREWSTERY, (rep) F. Sabatini.

Kuwait: Abdulaziz Abdulmoshin Alrashed, Box 241, ph 51-7152. Cable ABDULAZIZ KUWAIT (rep).

London, W. C. 2, England: L. A. Poole Co. Ltd., Clun House, 17 Surrey St.-Strand, ph Covent Garden 0° 0021/2. Cable POOLECO, ESTRAND, Telex 261342 (rep).

Rome, Italy: Sig. Giacomo Porro 15, ph 877858. Cable: SABET, ROMA (rep.).

Siracusa, Italy: Stabilimeccanica Bonaldi S. p. A. PRIOLO (Siracusa) Contrada Vallone del Prado. Casella postale 29 ph 53.007. (affil).

BOVAY ENGINEERS, INC.
P. O. Box 8098, Houston, Tex. zip 77004, ph (713) 529-5500. Harry E. Bovay, Jr. pres; C. A. Lawler, exec vp; R. R. Robertson, exec vp; Guy Furgtuele, vp.
- HP Industries Served: All
- Services Provided: Equip specs & design, materials procurement.
- Branches:

Baton Rouge, La. P. O. Box 15728, 10205 Airline Hwy. zip 70815. ph (504) 924-3661. L. S. Curtis. vp.

Spokane, Wash., zip 99202, East 808 Sprague, ph (509) 838-4112. J. Byron Barber, vp.

C F BRAUN & CO
Alhambra, Calif. ph (213) CU 3-1131. J G Braun, pres; C Allan Braun, vp; W A Jack, vp; H A Braun, vp secy; C C Burton, vp; N Murphy vp NY; C M Sandland, vp; F A Thomas, treas.
- HPIndustries Served: Gas liquids proc., petrol rfg., petrochem mfg.
- Services Provided: Process licensing, process engrg, equip spec & design, mtls procurement, constr/erection.
- Branches:

Alhambra, Calif.: home office, ph CU 3-1131. J. A. Cortright, Pacific Sales.

Houston, Tex., 714 1st City Nat'l Bank Bldg. 227-1165. H. E. Dyer.

London SW1, England: C F Braun & Co. Ltd., Heathcoat House, 20 Savile Row, ph 01-734-5464. J. V. Whipp, mgr. London sales. Joe Vadas, tech sales mgr.

McLean, Va.: 1360 Old Chain Bridge Rd., ph 356-5141. L. E. Kennedy, Washington sales.

Murray Hill, N. J.: ph 464-9000. H. E. Rhoads, Murray Hill Div.

New York, N. Y.: 45 Rockefeller Plaza, ph (212) 765-6330. N. Murphy, vp New York sales.

The Netherlands, Braun Transworld Corp., Prinses Irenelaan 206, Rijswijk ZH, ph 99-78-70. Clint De Lancey, mgr European purchases.

BROWN, JAMES G. & ASSOCIATES, INC.
2505 W. Holcombe, Houston, Tex. 77025, ph (713) 667-9491. James G. Brown, pres; Wm. E. Nicholson, vp; T. W. Edwards, Jr. vp & chf engr; D. C. Lucas, assoc; R. H. Verner, assoc & chf str engr; John Wilson, chem engr; Art Guess, elect. engr.
- HP Industries Served: Petroleum refining, petrochemicals mfr.
- Services Provided: Proc engrg, equip. specs & design, materials procurement.
- Processes Licensed: Gas & oil sweetening.

BROWN & ROOT, INC.
Box 3, Houston, Tex., zip 77001, ph (713) 672-3011. George R. Brown chmn of the bd; Herbert J. Prensley, pres; L. E. Minor, sr exec vp; H. G. Austin, exec vp-constr; Foster Park er, exec vp-admin; G. A. Doolsman sr grp vp-engrg & sls; Louis C. Estes sr grp vp; J. Howard Payne, sr grp vp; Marvin L. Woodfin, sr grp vp Edwin M. Blaschke, sr vp & chief engr; L. L. Pettigrew, vp; Thomas J. Feehan, vp; W. E. Heffler, vp Harry F. Hutchins, vp; Charles T. Martin, vp; Joseph G. Muniatert, vp sls.
- HPIndustries Served: All
- Services Provided: Process engrg equip specs & design, mtls procurement, const/erection, maint, also complete engrg design & construction.
- Branches:

Edmonton, Alta., Canada: Brown & Root, Ltd., Box 6040, ph (403) 489-1341. Richard M. Venables, vp

London, S. W. 1, England: Brown & Root, (U.K.) Ltd., 82 Pall Mall, ph 01-836-6121. Telex 21367.

New York, N. Y. 10017: 330 Park Ave, ph PL 2-8338. H. J. Mercker

Washington, D. C.: 1730 Rhode Island Ave., N. W., ph (202) 223-0830. John P. Buecher.

BUCK-ROBINSON, INC.
5145 So. Peoria, Tulsa, Okla. zip 74105, ph 918-742-8275 & 742-6475. Loren L. Buck, pres; Wm. L. Robinson, jr., vp; James Boles, engr.
- HPIndustries Served: Gas liquid proc.
- Services Provided: Process engr, equip spec & design, mtls procurement, engr. supervision of constr erection, tech service-oper.

C & I GIRDLER INC.
Exec & sales office: 256 McCullough St., Cincinnati, Ohio, zip 45226, ph (513) 321-8285. H. H. Hamilton, pres; J. M. Burns, vp & gen mgr; C. Rowlings, vp; E. Pellitt, vp tech consulting; G. W. Stout, treas; W. E. Brown, vp, Louisville, Ky., zip 40200, C. & I Girdler Operations Div. Box 174, 1721 S. 7th St., ph (502) 637-8701. J. R. Hardin, vp; F. A. Hillin sls, vp.
- HPIndustries Served: Gas liquid proc, agricultural chem fertilizer.
- Services Provided: Process licensing process engr, equip specs & design, mtls procurement, constr/erection maint, feasibility studies, financial consulting.
- Branches:

Brussels 17, Belgium: C & I Girdle International S. A., 36, Bd du Souverain, ph 73.41.68 (SL) (foreign licensee).

Louisville, Ky, zip 40201: C & I Girdler Construction Co., Box 174, ph (502) 637-8701. (subsid) I. C. Reagle, vp cons.

Nassau, Bahamas: C & I Girdler International Ltd. Bag 37, Bernard Sunley Bldg., ph 94561 (foreign licensee).

C. I. M. I. - COMPAGNIA ITALIANA MONTAGGI INDUSTRIALI S. p. A.
Corso Europa, 13, Milano, Italy, p 700251. Rotterdam, Holland: Giovanni Giavazzi, chm; Renato Scotto, gr mgr; Reg. Armando Pitto, admin mgr; Walter Bonacina, comm mgr; Ing Ottilio Calenti, tech mgr.
- HPIndustries Served: All
- Services Provided: Constr/erection electrical & instruments installations.

CTIP-COMPAGNIA TECNICA INDUSTRIE PETROLI S. p. A.
(affil. of Arthur G. McKee & Co. (Cleveland, Ohio)
31, Piazzale G. Douhet. 00144 Rome, Italy, ph 5902. Pier Maria Pasolini Dall 'Onda, v chmn; Everett W. Vis Nes, mng dir & gnl mgr; Ing. Piero Angelini, asst gnl mgr; Lucio Lai asst gnl mgr; Roberto Alesandri, a mun mgr; Massimo Chiari, mgr proj dept; Francesco Giacobbe, m of process dept; Bruno Mavilio, m of tech dept.
- HPIndustries Served: All

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TABLE XII

TOP 50 BASIC CHEMICAL MAKERS IN 1969

Rank '69	Rank '68	Company	Chemical sales (Millions of dollars)	Total revenues[a]	Chemical sales as per cent of total revenues	Company SIC class.[b]
1	1	Du Pont[c]	$3220	$3,655	88%	281
2	3	Union Carbide	1815	2,933	62	281
3	2	Monsanto	1735	1,939	89	281
4	4	Dow Chemical	1570	1,876	84	281
5	7	Celanese	1028	1,250	82	281
6	5	W. R. Grace	1015	1,812	56	281
7	6	Standard Oil (N.J.)	1004	16,900	6	291
8	8	Allied Chemical	895	1,316	68	281
9	9	Hercules	642	746	86	281
10	11	Occidental Petroleum	625	2,059	30	909
11	10	FMC	620	1,409	44	281
12	12	American Cyanamid	576	1,067	53	281
13	13	Shell Oil	544	4,276	13	291
14	14	Eastman Kodak	522	2,747	19	383
15	16	Uniroyal	513*	1,554	33	301
16	15	Stauffer Chemical	499	499	100	281
17	17	Phillips Petroleum	471	2,227	21	291
18	18	Rohm and Haas	448	453	99	281
19	19	Mobil Oil	444	7,573	6	291
20	21	Borden	394	1,756	23	202
21	26	Ethyl Corp.	382	517	74	281
22	20	Cities Service	361	1,595	23	291
23	23	Ashland Oil	342	1,151	30	291
24	28	Diamond Shamrock	327	555	59	281
25	24	Continental Oil	325	2,607	13	291
26	29	Olin	322	1,167	28	281
27	27	Gulf Oil	315	6,238	5.6	291
28	32	PPG Industries	310	1,147	27	321
29	22	Standard Oil (Ind.)	308	4,322	7.1	291
30	25	ESSC	306	501	61	287
31	31	National Lead	296	938	32	285
32	40	Pfizer	293	818	36	283
33	34	U.S. Steel[c]	290	4,825	6	331
34	36	B. F. Goodrich	272	1,235	22	301
35	—	Standard Oil (Calif.)	268	4,674	6	291
36	33	Air Reduction	260	491	53	281
37	37	American Enka	257	257	100	281
38	35	Tenneco	251	2,493	11	291
39	44	Swift[c]	248	3,114	8	201
40	43	Chemetron	232	301	77	281
41	41	Koppers	221	536	41	281
42	—	Atlantic Richfield	215	3,162	6.8	291
43	42	Air Products	203	222	92	281
44	39	Pennwalt	200	410	49	281
45	—	Dart Industries[c]	184	707.5	26	283
46	45	Reichhold	181	181	100	281
47	46	Goodyear	175	3,236	5.5	301
48	50	National Distillers	168	1,082	16	208
49	47	GAF	164	606	27	281
50	38	Witco Chemical	154	237	65	281

SIC classifications are as follows

201 Meat products
202 Dairy products
208 Alcoholic beverages
281 Basic chemicals
283 Drugs
285 Allied products
287 Agricultural chemicals
291 Petroleum
301 Tires
321 Glass products
331 Steel
341 Metal cans
383 Photo equipment
909 Miscellaneous wholesaler

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TABLE XIII

THE 46 LARGEST POWER UTILITIES

(RANKED BY ASSETS)

CONSOLIDATED EDISON (NEW YORK)
PACIFIC GAS & ELECTRIC (SAN FRANCISCO)
SOUTHERN CALIFORNIA EDISON (LOS ANGELES)
COMMONWEALTH EDISON (CHICAGO)

AMERICAN ELECTRIC POWER (NEW YORK)
SOUTHERN COMPANY (ATLANTA)
PUBLIC SERVICE ELECTRIC & GAS (NEWARK)
EL PASO NATURAL GAS

GENERAL PUBLIC UTILITIES (NEW YORK)
CONSUMERS POWER (JACKSON, MICH.)
PHILADELPHIA ELECTRIC
TEXAS EASTERN TRANSMISSION (HOUSTON)
DETROIT EDISON

MIDDLE SOUTH UTILITIES (NEW YORK)
AMERICAN NATURAL GAS (NEW YORK)
NIAGARA MOHAWK POWER (SYRACUSE, N. Y.)
VIRGINIA ELECTRIC & POWER (RICHMOND)
TEXAS UTILITIES (DALLAS)

DUKE POWER (CHARLOTTE)
PENNZOIL UNITED (HOUSTON)
UNION ELECTRIC (ST. LOUIS)
FLORIDA POWER & LIGHT (MIAMI)

PEOPLES GAS (CHICAGO)
TRANSCONTINENTAL GAS PIPE LINE (HOUSTON)
CONSOLIDATED NATURAL GAS (NEW YORK)
NORTHERN NATURAL GAS (OMAHA)

NORTHERN STATES POWER (MINNEAPOLIS)
CENTRAL & SOUTH WEST (WILMINGTON)
ALLEGHENY POWER SYSTEM (NEW YORK)
NEW ENGLAND ELECTRIC SYSTEM (WESTBORO, MASS.)

PACIFIC LIGHTING (LOS ANGELES)
PANHANDLE EASTERN PIPE LINE (HOUSTON)
PENNSYLVANIA POWER & LIGHT (ALLENTOWN)
POTOMAC ELECTRIC POWER (WASHINGTON, D. C.)
BALTIMORE GAS & ELECTRIC

OHIO EDISON (AKRON)
LONG ISLAND LIGHTING (MINEOLA)
WISCONSIN ELECTRIC POWER (MILWAUKEE)
HOUSTON LIGHTING & POWER
PACIFIC POWER & LIGHT (PORTLAND)

GULF STATES UTILITIES (BEAUMONT, TEXAS)
CLEVELAND ELECTRIC ILLUMINATING
ILLINOIS POWER (DECATUR)
NORTHERN INDIANA PUBLIC SERVICE (HAMMOND)

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In the appendix is listed approximately 80 processes, the licensors, temperatures encountered, and comments regarding possible Foamglass applicators. This information was obtained from an insulation contractor and is supplied to contractors by the Pittsburg Corning Corporation.

Hydrocarbon Processing magazine publishes three times yearly a report titled "HP World Wide Boxscore." This report lists all the hydrocarbon processing plants being built throughout the world. The report lists the plant site, product to be manufactured, daily capacity estimated costs, status, probably completion date, licensor of the process, engineering firms, and contractors.

The Hydrocarbon Processing magazine also published a 1969 "Petrochemical Handbook" which diagrams and explains the processes for the manufacturing of over 125 different products. Many of these descriptions list items such as temperatures involved, licensors and cost of plant.

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TYPES OF CONTRACTORS

Although some of the large insulation manufacturers sometimes have contracting branches, the majority of contractors are independents.

These insulation contractors fall into four categories as follows:

1. Contractor
2. Contractor-Distributor
3. Contractor-Distributor-Fabricator
4. True Fabricator

1. Contractor - This is a firm which bids, negotiates or in some manner contracts to do insulation work. These firms buy some materials direct from manufacturers and some from contractor-distributors.

2. Contractor-Distributor - These firms bid or negotiate as regular contractors but in addition to their contract business, they also maintain a warehouse of materials for resale to other contractors and end users who have their own installation crews. Most manufacturers sell their products to one or more "appointed distributor" contractors in a given area. These in turn sell to the other contractors or distributor contractors who happen to need the product. Since there are several calcium silicates and fibrous glass products on the market, each manufacturer usually has a distributor in each city of any size. The only firm which has a distributorship for unique products has been Pittsburgh Corning with Foamglas and Unibestos. These two products are the only ones available and if a specification calls for either one, the contractor must buy it from a Pittsburg-Corning contractor-distributor. Some large contractors who are not Pittsburg-Corning distributors report that this has worked a hardship for them over the years. As a result many of them resent Pittsburg-Corning and will substitute something else whenever possible.

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The contractor-distributor most of the time will have salesmen who sell materials to the end users as previously mentioned, plus lumber dealers, general contractors, etc., depending on what products the firm handles.

3. Over the years contractors had to occasionally fabricate pipe and vessel insulation from such things as cork, 85 percent magnesia, calcium silica, etc. However, it was not until Foamglas was developed that the contractor-distributor-fabricator came into being as he is known today. The contractor-distributor-fabricator does all the things that a contractor-distributor does plus fabricating products into pipe and vessel covering for his own use and/or resell to other contractors and end users. Products commonly fabricated are Foamglas, urethanes, and polystyrenes.

4. The true fabricator is really not a contractor but is listed here because of his present and possible future importance in the sale of Dow insulation materials. The true fabricator in the industrial insulation market is a rare animal. Two examples are Styro Fabricators with plants in Kansas City, Sandusky, Ohio, and Conyers, Georgia, and Penn Valley Insulation in Lester, Pennsylvania.

   A true fabricator buys billets of foam direct from a manufacturer (Styrofoam - urethane - beadboard - Foamglas, etc.), and fabricator's pipe and vessel covering for resale to contractors. Styro Fabricators limits his sales to contractors. Penn Valley also sells to end users in the Philadelphia area.

   Around the United States there are also many fabricators of plastic foam such as the Styrofoam DB fabricators who also make some foam pipe covering. This firm's main interest is in the novelty and display or packaging field and they

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fabricate pipe covering only as a sideline. Tufflite Plastics in Ballston Spa, New York, is an example of this type firm. Purchases of Styrofoam DB exceeded five million board feet in 1969, while purchases of Styrofoam FB for pipe insulation fabrication was only 109,000 board feet. Styro Fabricators, a true fabricator purchased over two million board feet of Styrofoam FB for the fabrication of pipe and vessel covering in 1969.

The new selling company will have salesmen calling on specifiers, end users, and contractors in the low temperature space market and the industrial insulation market. These salesmen will be selling billets of Styrofoam FB, Thurane, and Dow Ceramic Foam to those contractors who have fabricating ability, such as the present Foamglas fabricators. The selling company will also sell the true fabricators of pipe insulation.

Since selling company personnel will be doing specification work for pipe and vessel insulation, it would be advantageous for the selling company to also have finished pipe and vessel insulation to sell as well as billets.

The advantages would be that a salesman could offer a choice to the contractor of billets and/or pipe insulation. The contractor, if he has fabricating equipment, could decide which product would be the most economical to him for a particular job at a given time. Perhaps on large jobs he would prefer billets and on smaller ones, the finished pipe insulation. On the other hand, the contractor who does not have fabricating ability could buy the finished pipe insulation from the national selling company and not be forced to buy from his competitor, which is now the case with Foamglas.

In order to have this ability to supply both billets and finished pipe insulation, it would become necessary for the national selling company to either fabricate pipe insulation itself or represent

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one or more true fabricators. Styro Fabricators is the logical choice to buy into or represent as an agent. They presently sell over $1,000,000 worth of pipe and vessel insulation (Styrofoam and urethane) and have an excellent reputation throughout the country.

Contractors such as Delaware Insulation in Wilmington, who supplies all of du Pont's needs, and Porter-Hayden in Newark, New Jersey, stated that they would prefer to be able to purchase finished pipe insulation and not have a worry about the fabricating end of the business. Other firms like McCarty Corporation in Baton Rouge, Brantors Insulation in New Orleans, and Fuller Austin in Houston, indicated that they would normally buy billets because they have the fabricating ability.

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DISTRIBUTION PATTERNS

The industrial insulation market today is supplied by many manufacturers with an array of products. The major firms are Johns-Manville, Owens-Corning, GAF (formerly Ruberoid), Panacon (formerly Philip A. Carey), Armstrong Cork, Keene Corporation (formerly Baldwin-Ehret-Hill), Pittsburg Corning, and Eagle-Pitcher.

Each of these firms has a distribution system of insulation contractors. Many times an insulation contractor will also represent several companies. Johns-Manville, Owens-Corning, Keene and Panacon also have contracting arms which compete with the independent contractor to whom they sell. Armstrong Cork's contracting arm is now an independent company and no longer tied to Armstrong. This firm is now known as AC&S, Inc.

In April, 1970, the Philip Carey Corporation was dissolved and various unreleated operations became separate divisions of the new firm, Panacon Corporation. The insulation contracting and sales corporating is now known as Carey Insulation Company, Division of Panacon Corporation. Carey Insulation has branches in Detroit, Indianapolis, Philadelphia, and Providence, Rhode Island. Offices in Washington, D.C., and west coast were closed last year.

Locations of the Johns-Manville, Owens Corning, Keene Corp., and AC&S, Inc., contract offices and/or contractor distributors are contained in the appendix.

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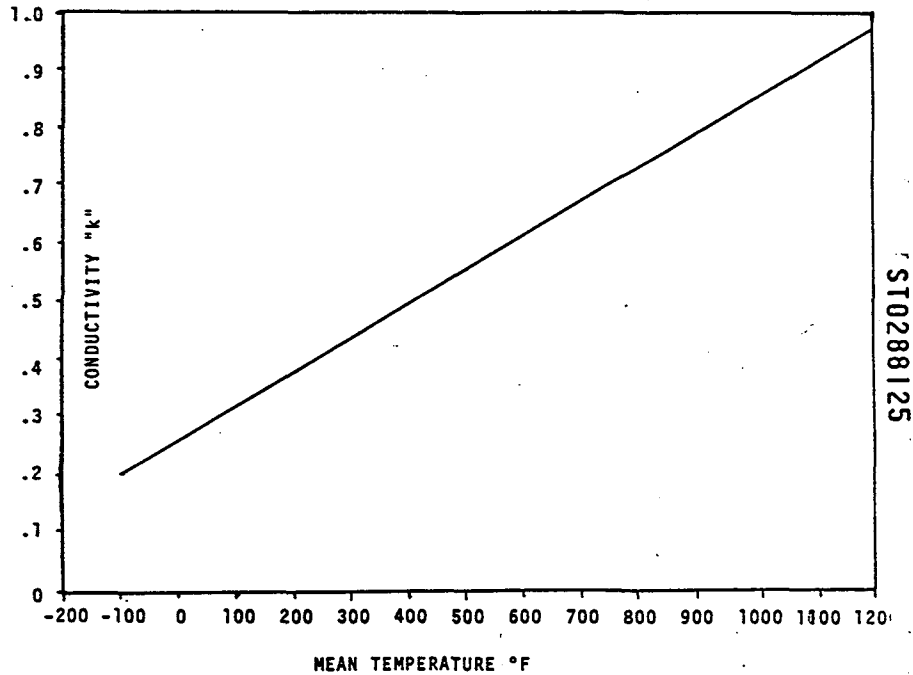
AVERAGE "k" VALUES
OF TEN COMMONLY USED INSULATIONS
(A. C. WILSON - THERMAL INSULATIONS - 1959)



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GRAPH I

THE RELATIONSHIP OF "k" FACTOR TO THICKNESSES IN PIPE INSULATIONS

One of the early problems encountered by designers of high temperature facilities was how to calculate the required thickness of pipe insulation since there were many products available, each with a different "k" factor.

This problem was overcome, according to A. C. Wilson in his book Industrial Thermal Insulation (published by McGraw-Hill in 1959), by using average conductivity factors for all insulations for general usage. Wilson states that this practice is followed by one of the largest refinery engineering companies in the United States. It was found that the errors involved in using average values for thickness determinations were negligible.

The average conductivities used are shown in Chart 1. These were selected according to Wilson "from curve layouts based on mean temperatures ranging from -100°F to 1000°F. Ten different commonly used insulations were used in arriving at the averages."

Wilson also pointed out that for general usage this averaging of insulation performs satisfactorily, however, for lines where exact heat loss must be calculated such as in some process line, the use of the "k" for the intended insulation must be used.

Apparently the "k" factor of high temperature insulation in general is not the most important property of the product. Mr. Paul Weaver of Dow E&CS in Houston states that Dow plants have used the same thickness of Foamglas and calcium silicate on lines for many years and have experienced no problems because of the difference in "k" factor. The difference in "k" factor for different materials at different temperatures is illustrated in Graph I. Since insulation is used for one or a combination of the following five reasons it becomes apparent why "k" factor is not always the governing factor (Table XIV).

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Apparently "k" factor is not the most important consideration in the selection of pipe insulation, except where accurate temperature control must be maintained.

Pipe and vessels are insulated for the following five reasons.

TABLE XIV

	Most Important Considerations		
	"k"	Incombustibility	Price
1. To conserve fuel or power	X		X
2. Accurate process control	X		
3. Protection of personnel from burns			X
4. To produce better working conditions			X
5. Fire protection		X	

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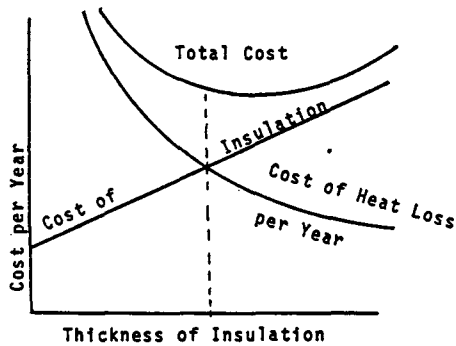
The insulation used in the conservation of fuel or power will be chosen on an economic basis which can be calculated for X number of years by determining the balance between cost of the material per thickness versus the cost of heat loss per year. The diagram below illustrates this theory.

DIAGRAM II



"k" Factor plays a role in the conservation of fuel or power, but must be coupled with durability and cost.

The only application where "k" factor is the number one concern is where accurate control of temperatures is required in order to insure the perfect or near perfect completion of the process involved.

In selecting insulation to provide for protection of personnel from burns by insulating pipes and vessels as well as improving working conditions, cost is probably the number one concern. Exactness as to heat loss is not critical in the selection of the insulation for these areas. Good ventilation will remove

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150 Btu per square foot per hour from a surface. Therefore, by utilizing an insulation thickness which will limit Btu to somewhere between 120 Btu's and 170 Btu's, satisfactory working conditions can be achieved. Workmen can be protected from burns by keeping the surface temperatures somewhere around 150°F. This too is usually accomplished with the thought of cost of material in mind, since this surface temperature can range up slightly.

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Fire protection for pipes and vessels: When fire protection is required, "k" factor is of the least importance after incombustibility durability, and cost. When a process line or vessel contains product which may cause a catastrophe if its temperature is elevated past a certain level, it becomes imperative that the chosen insulation remain whole and furnish the protection intended.

It is suggested that TS&D or Research should run tests on calcium silicate, Foamglas and DCF at 100° increments up to as far as the products will go using the same thickness of insulation and then measure the Btu heat loss. If DCF is in the range of the other two, then the thickness should be recommended for general usage.

One of the problems in trying to determine thickness based on "k" is the fact that smaller pipe with the same thickness of insulation as a large diameter pipe will have a lower ratio of inside insulation to outside insulation surface than the larger pipe insulation and, therefore, be more efficient. L. B. McMillan discussed this in December, 1926, in the ASME Journal.

An illustration of this problem is presented in Illustration I. The value of "k" to the thickness depends upon the ratio of inner surface to the outer surface of the segment. In the illustration, Figure 1, which is a flat block, is simple to calculate, double the thickness and cut the heat loss in half. The heated surface is the same size as the cooling surface.

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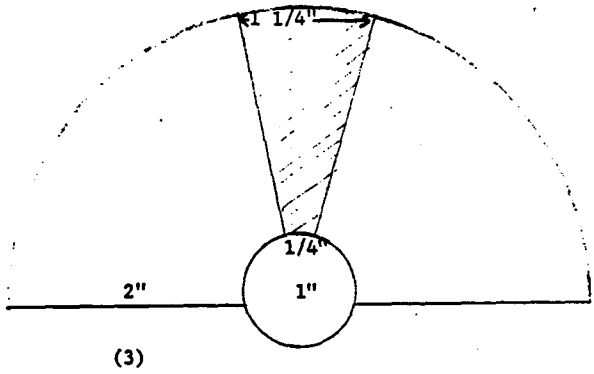
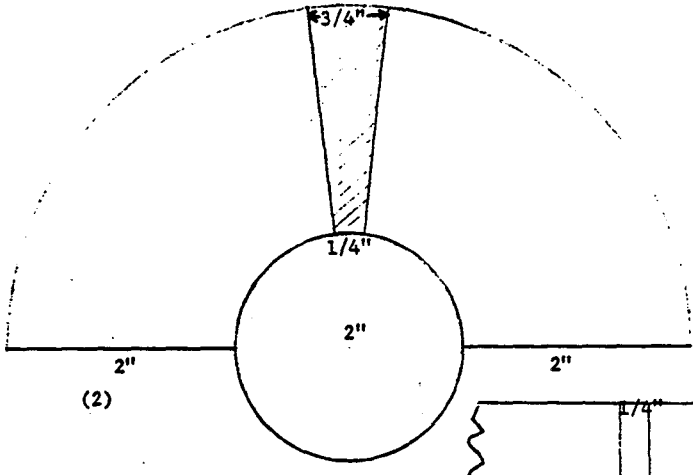
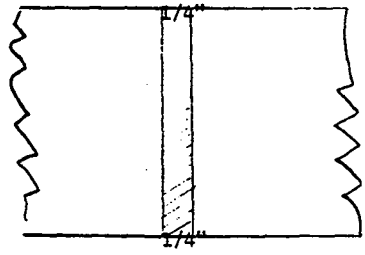


(3)



(2)



(1)

ILLUSTRATION I

It seems then that unless exact temperature control is necessary all high temperature insulations have been and can be used on average "k" factor equal thickness basis.

Although the "k" factor of Dow Ceramic Foam has not been determined on full production runs, indications from early plant short runs seems to say that it has a "k" factor similar to that of Foamglas up to around 500°F or 600°F, then increases to greater than Foamglas and double that of calcium silicate.

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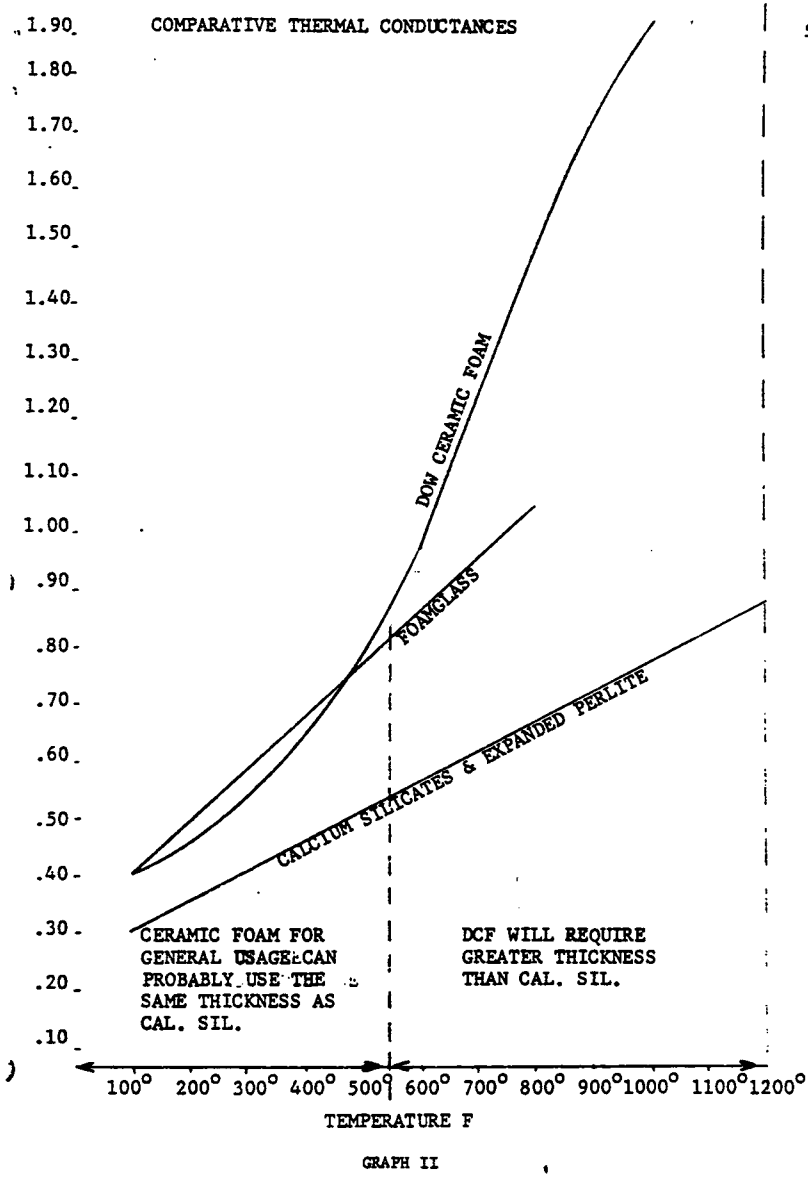
If this remains the case then perhaps TS&D or Research will be able to recommend the same thickness as cal sil up to 600°F, and have to increase the thickness over cal sil above 600°F. This would mean that DCF would be in a better competitive position in the area up to 600°F where 80 percent to 85 percent of all industrial insulation is used. On temperatures above 600°F, it would possibly become necessary to increase thickness over calcium silicate because of the increasing "k" factor curve of Dow Ceramic Foam at elevated temperatures. Graph II and Table XV on Comparative Thermal Conductance illustrates the situation.

Figure 2 in Illustration I is a 2" OD pipe and 2" covering, the outside surface is three times that of the inner surface of the pipe covering. Therefore, it can be said that the 2" pipe covering is more efficient than the 2" block. The heat has a greater mass to penetrate in order to escape. Figure 3 with a 1" pipe and 2" insulation is even more efficient. The outside is approximately five times greater than the inside.



GRAPH II

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TABLE XV

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COMPARATIVE THERMAL CONDUCTIVITIES

(BTU ---- In/Hr - Ft^2 - °F)

	°F										
	100	200	300	400	500	600	700	800	900	1000	1100
Unibestos	.32	.36	.40	.45	.49	.54	.59	.64	.66	.74	-
Calcium Silicate (Avg.)	.31	.36	.41	.46	.51	.56	.61	.66	.71	.76	-
Carey Temp 1500			.42		.51		.64				
Foamglas	.41	.48	.55	.64	.74	.84	.94	1.04	-	-	-
Ceramic Foam	.41	.46	.54	.66	.78	.96	1.18	1.48	1.72	1.92	

W. G. Phillips
September, 1970

DOW 04625

CAREY TEMP 1500

Panacon has the only product presently on the market which is similar to calcium silicate, but contains no asbestos fibers. "Carey Temp 1500" is manufactured by a patented process, which combines perlite and binders. As close as could be determined by discussions with people knowledgeable in the industry, sales are around $3 M for Carey Temp 1500.

Rumors are that Panacon is not overly interested in industrial insulations because of it being a minor part of their business and perhaps also they are not interested in expenditures to increase their business.

Due to the calcium silicates manufacturer's problems with asbestos fibers, and the fact that glass fibers cannot be substituted for asbestos fibers, companies like Johns-Manville and Owens-Corning are also rumored to be interested in buying the Carey Temp 1500 output or patent.

It would appear that the National Selling Company or Dow should also investigate the possibilities of selling Carey Temp 1500 as a companion item to Dow Ceramic Foam.

The reasoning is that Dow Ceramic Foam may be competitive with Foamglas and calcium silicates up to 500°F or 600°F for general usage on service piping because the "k" is fairly close to Foamglas and calcium silicate.

Since these products can be and are used with the same thickness for the same temperature, it can be assumed that DCF can be utilized in the same manner. However, at temperatures over 500°F to 600°F, the "k" factor on DCF climbs steeply away from calcium silicate. At 800°F, it is approximately double that of calcium

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silicate and the ratio continues to increase as the temperature elevates.

This means that at temperatures over 500°F to 600°F, thicker sections of DCF will have to be sold at a higher cost, on the merits of being incombustible and non-wicking. Calcium silicate or expanded perlite (Carey Temp 1500) will be less expensive and if wicking is not too great a problem, these products will have both a price advantage and thickness advantage. Many times the space allowed for pipe insulation is very confined, therefore, the thinner the cross section, the better.

The Carey Temp 1500 would be a companion product for Ceramic Foam. It would contribute to the industrial sales force by furnishing a product which has immediate sales and acceptance.

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COMPETITIVE PIPE INSULATION PRICING

Insulation products utilized in the market, except Foamglas, are sold from price sheets based on a sheet known as the "List Prices of August 1, 1907." This Price Sheet I was developed by the thermal insulation trade to facilitate easier pricing for the multiplicity of pipe sizes from 1/2" to 33" and insulation thickness of 1" to 5".[1]

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Discounts, or add-on percentages, are applied to each manufacturer's list price sheet for pricing to different buying levels in the market.

In the course of this study price sheets and discounts were obtained from contractors in the field on Owens Corning's "Fiberglas," Keen Corp's "Thermasil Calcium Silicate," and Pittsburgh Corning's "Foamglas." The pricing on fibrous glass and calcium silicate is representative of similar products in the market, although pricing will vary somewhat from manufacturer to manufacturer. Foamglas pricing is believed to be accurate as September, 1970.

It should be stated here that these price sheets were obtained freely from independent insulation contractors in the field. No contact was made at any time with Owens Corning, Pittsburgh-Corning, Keen Corporation, or their salesmen.

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[1] C. N. Williams, High Temperature Equipment Insulation Market, March 31, 1965, Dow Research Study

PIPE INSULATION — NET PRICES PER LINEAR FOOT

PIPE SIZE INCHES	1" THICK	1½" THICK	2" THICK	2½" THICK	3" THICK	3½" THICK	4" THICK	4½" THICK	5" THICK
½	.22	.46	.75	1.00	1.20	1.55	1.95	2.40	2.90
¾	.24	.49	.80	1.05	1.35	1.75	2.15	2.55	3.10
1	.27	.52	.85	1.10	1.40	1.80	2.20	2.60	3.15
1¼	.30	.56	.90	1.15	1.45	1.95	2.35	2.80	3.45
1½	.33	.60	.95	1.20	1.55	2.00	2.40	2.90	3.50
2	.36	.64	1.00	1.25	1.65	2.10	2.45	3.00	3.60
2½	.40	.70	1.05	1.35	1.75	2.25	2.70	3.25	3.90
3	.45	.76	1.15	1.50	1.90	2.35	2.85	3.40	4.00
3½	.50	.82	1.25	1.65	2.05	2.60	3.15	3.70	4.35
4	.60	.88	1.35	1.80	2.20	2.70	3.30	3.80	4.45
4½	.65	.94	1.45	1.95	2.35	2.95	3.50	4.10	4.80
5	.70	1.00	1.55	2.10	2.50	3.00	3.55	4.15	4.85
6	.80	1.10	1.70	2.25	2.70	3.30	3.90	4.50	5.30
7	1.00	1.20	1.85	2.40	2.90	3.60	4.25	4.85	5.75
8	1.10	1.35	2.00	2.55	3.15	3.85	4.55	5.25	6.10
9	1.20	1.50	2.20	2.80	3.40	4.20	4.90	5.60	6.65
10	1.30	1.65	2.40	3.05	3.65	4.65	5.40	6.15	7.10
11	1.40	1.75	2.55	3.20	3.90	4.90	5.70	6.50	7.50
12	1.50	1.85	2.70	3.40	4.10	5.15	6.00	6.85	7.90
14	1.70	2.10	3.00	3.80	4.60	5.55	6.50	7.45	8.55
15	1.85	2.25	3.15	4.00	4.85	5.85	6.85	7.85	8.95
16	2.00	2.35	3.30	4.20	5.10	6.15	7.15	8.15	9.30
17	2.10	2.50	3.45	4.40	5.35	6.45	7.50	8.50	9.70
18	2.20	2.60	3.60	4.60	5.60	6.70	7.80	8.85	10.10
19	2.35	2.75	3.80	4.80	5.80	7.00	8.10	9.25	10.55
20	2.45	2.85	4.00	5.00	6.00	7.25	8.45	9.55	10.85
21	2.60	3.00	4.15	5.20	6.25	7.50	8.75	9.90	11.25
22	2.70	3.10	4.30	5.40	6.50	7.85	9.05	10.25	11.65
23	2.85	3.20	4.40	5.60	6.75	8.05	9.35	10.70	12.05
24	3.00	3.30	4.50	5.75	7.00	8.25	9.65	11.00	12.45
26		3.55	4.85	6.20	7.50	8.85	10.35	11.80	13.25
27		3.65	5.05	6.40	7.70	9.15	10.60	12.05	13.65
28		3.75	5.15	6.65	7.95	9.45	11.05	12.45	14.05
30		4.00	5.50	6.95	8.40	10.00	11.55	13.00	14.70
32		4.30	5.90	7.40	9.10	10.50	12.10	13.85	15.45
33		4.40	6.05	7.60	9.20	10.70	12.45	13.95	15.75

BLOCKS — NET PRICES PER SQUARE FOOT

DOW 04629

¾" THICK	1" THICK	1½" THICK	2" THICK	2½" THICK	3" THICK	3½" THICK	4" THICK	4½" THICK	5" THICK
.27	.30	.45	.60	.75	.90	1.05	1.20	1.35	1.50

KEENE INDUSTRIAL INSULATION
KEENE CORPORATION — DIVISION

PRICE SCHEDULE

PAGE 534

DATE August 1, 1969

SUPERSEDES January 1, 1965

BDH

THERMASIL CALCIUM SILICATE

LIST PRICES (Still in effect September, 1970)

	Nom. Pipe Size Inches	Thicknesses 1"	1-1/2"	2"	2-1/2"	3"	3-1/2"	4"	4-1/2"	5"	5-1/2"	6"
Sectional Under 16" O.D.	1/2	$0.30	$0.48	$0.75	$1.00	$1.20	$1.55	$1.95	$2.40	$2.90	$3.45	$4.05
	3/4	.32	.52	.80	1.05	1.35	1.75	2.15	2.55	3.10	3.65	4.20
	1	.34	.55	.85	1.10	1.40	1.80	2.20	2.60	3.15	3.70	4.25
	1-1/4	.37	.59	.90	1.15	1.45	1.95	2.35	2.80	3.45	4.00	4.45
	1-1/2	.40	.63	.95	1.20	1.55	2.00	2.40	2.90	3.50	4.05	4.65
	2	.44	.67	1.00	1.25	1.65	2.10	2.45	3.00	3.60	4.10	4.75
	2-1/2	.48	.74	1.05	1.35	1.75	2.25	2.70	3.25	3.90	4.45	5.10
	3	.52	.80	1.15	1.50	1.90	2.35	2.85	3.40	4.00	4.60	5.25
	3-1/2	.56	.86	1.25	1.65	2.05	2.60	3.15	3.70	4.35	5.00	5.65
	4	.66	.93	1.35	1.80	2.20	2.70	3.30	3.80	4.45	5.10	5.75
	4-1/2	.72	.99	1.45	1.95	2.35	2.95	3.50	4.10	4.80	5.50	6.20
	5	.77	1.05	1.55	2.10	2.50	3.00	3.55	4.15	4.85	5.55	6.25
	6	.88	1.16	1.70	2.25	2.70	3.30	3.90	4.50	5.30	6.00	6.70
	7		1.20	1.85	2.40	2.90	3.60	4.25	4.85	5.75	6.50	7.35
	8		1.35	2.00	2.55	3.15	3.85	4.55	5.25	6.10	7.05	7.85
	9		1.50	2.20	2.80	3.40	4.20	4.90	5.60	6.65	7.50	8.35
	10		1.65	2.40	3.05	3.65	4.65	5.40	6.15	7.10	8.05	9.00
	11		1.75	2.55	3.20	3.90	4.90	5.70	6.50	7.50	8.50	9.50
	12		1.85	2.70	3.40	4.10	5.15	6.00	6.85	7.90	8.90	9.90
Sectional Over 16" O.D.	14		2.10	3.00	3.80	4.60	5.55	6.50	7.45	8.55	9.60	10.60
	15		2.25	3.15	4.00	4.85	5.85	6.85	7.85	8.95	10.00	11.10
	16		2.35	3.30	4.20	5.10	6.15	7.15	8.15	9.30	10.45	11.60
	17		2.50	3.45	4.40	5.35	6.45	7.50	8.50	9.70	10.90	12.05
	18		2.60	3.60	4.60	5.60	6.70	7.80	8.85	10.10	11.35	12.50
	19		2.75	3.80	4.80	5.80	7.00	8.10	9.25	10.55	11.75	13.00
Segmental	20		2.85	4.00	5.00	6.00	7.25	8.45	9.55	10.85	12.20	13.50
	21		3.00	4.15	5.20	6.25	7.50	8.75	9.90	11.25	12.65	13.90
	22		3.10	4.30	5.40	6.50	7.85	9.05	10.25	11.65	13.05	14.45
	23		3.20	4.40	5.60	6.75	8.05	9.35	10.70	12.05	13.55	15.00
	24		3.30	4.50	5.75	7.00	8.25	9.65	11.00	12.45	13.90	15.35
	26		3.55	4.85	6.20	7.50	8.85	10.35	11.80	13.25	14.85	16.40
	27		3.65	5.05	6.40	7.70	9.15	10.60	12.05	13.65	15.20	16.65
	28		3.75	5.15	6.65	7.95	9.45	11.05	12.45	14.05	15.65	17.15
	30		4.00	5.50	6.95	8.40	10.00	11.55	13.00	14.70	16.40	17.95
	32		4.30	5.90	7.40	9.10	10.50	12.10	13.85	15.45	17.15	19.00
	33		4.40	6.05	7.60	9.20	10.70	12.45	13.95	15.75	17.60	19.25

ST0288138

THERMASIL CALCIUM SILICATE BLOCKS

NET PRICES PER SQUARE FOOT

7/8"	1"	1-1/2"	2"	2-1/2"	3"	3-1/2"	4"	4-1/2"	5"
27	30	45	60	75	90	1.05	1.20	1.35	1.50

SUBJECT TO SAME TRADE DISCOUNTS AS PIPE INSULATION

ST0288139

The major products used in industrial insulation are calcium silicate, fibrous glass and cellular glass.

Calcium silicates are:

1.	Thermobestos	Johns-Manville
2.	Kaylo & Kaylo 20	Owens-Corning
3.	Thermasil	Keene-Corp. (B-E-H.)
4.	Calsilite & Calsilite SS	GAF Corp. (Ruberoid)
5.	Caltemp	Pabco
6.	Carey Temp 1500	Panacon (Philip Carey Co.)

This product is not a calcium silicate, but is an expanded perlite material with binders which competes in the same applications as calcium silicate.

These materials are very competitive and pricing to contractor distributors will be approximately the same in any given area.

1. Calcium Silicate - Price Sheet II is a list price sheet of the Keen Corp. The contractor-distributor price is list plus 18 percent for less than car load and list minus 2 percent for car load. Car load freight is allowed.

2. Fiberglas - Fibrous glass is manufactured by several companies and some private labeling does exist. Owens-Corning is the largest manufacturers with "Fiberglas." Johns-Manville, Certain-Teed Saint Gobain (formerly Gustin-Bacon Mfg. Co.) and PPG industries are also manufacturers of fibrous glass products.

   Price Sheet III is an Owens Corning list price sheet for 3-1/2 pound per cubic foot pipe insulation. Contractor-distributor buys at list plus 10 percent for less than car load and list minus 3 percent for car load. Car load freight allowed.

   This product is called "One-Piece" pipe covering by Owens-Corning and "Snap-On" by the Certain-Teed Saint Gobain.

ST0288140

PRICE SHEET III

Prices

FIBERGLAS

FIBERGLAS ONE-PIECE PIPE INSULATION

No. IN-2-20
Page 1 of 2
Date March 1, 1960
Supersedes

(List Prices Still In Effect September, 1970)

All sales are subject to Owens-Corning Fiberglas Corporation general terms and conditions of sale for warehouse sales.

PAYMENT TERMS: 1% 10th Prox., Net 30th Prox.

SHIPPING TERMS: Ex Warehouse: F.O.B. Warehouse
Ex Factory: F.O.B. Shipping Point, Freight Allowed on Seller's Routing; Additional Transportation Charges are extra.

Fiberglas® One-Piece Pipe Insulations are made of fine fiber insulating wool accurately molded to a predetermined shape and density. Thicknesses follow Simplified Dimensional Standards. All sizes are available in 3' lengths and, certain sizes are also available in 6' lengths upon request. 6' lengths are not available with jackets. Jackets available on 1/2" thickness are described on price sheet IN1.P6; jackets on other thicknesses are described on price sheet IN1.P1. See Page 2 for factory-applied limitations on Waterproof Jackets (WJ).

ONE-PIECE PIPE INSULATION

IRON PIPE SIZES (IPS)						COPPER TUBING (CT)					
Nominal Pipe Size	LIST PRICE PER LIN. FT. 1/2"	3/4"	1"	1-1/2"	2"	Actual O.D. of Tube	LIST PRICE PER LIN. FT. 1/2"	3/4"	1"	1-1/2"
1/2"	$.22	$.22	$.22	$.46	$.75	7/8"	$.24	$.24	$.24	$.49
3/4"	.24	.24	.24	.49	.80	1-1/8"	.27	.27	.27	.52
1"	.27	.27	.27	.52	.85	1-3/8"	.30	.30	.30	.56
1-1/4"	.30	.30	.30	.56	.90	1-5/8"	.33	.33	.33	.60
1-1/2"	.33	.33	.33	.60	.95	2-1/8"	.36	.36	.36	.64
2"	.36	.36	.36	.64	1.00	2-5/8"	.40	.40	.40	.70
2-1/2"	.40	.40	.40	.70	1.05	3-1/8"	.45	.45	.45	.76
3"	.45	.45	.45	.76	1.15	3-5/8"	.50	.50	.50	.82
3-1/2"	.50	.50	.50	.82	-	4-1/8"	.60	.60	.60	.88
4"	.60	.60	.60	.88	1.35	5-1/8"	.70	.70	.70	1.00
4-1/2"	.65	.65	.65	.94	1.45	6-1/8"	.80	.80	.80	1.10
5"	.70	.70	.70	1.00	1.55					
6"	.80	.80	.80	1.10	1.70					
7"	1.00		1.00	1.20	1.85					
8"	1.10		1.10	1.35	2.00					
9"	1.20		1.20	1.50	2.20					
10"	1.30		1.30	1.65	2.40					
11"	1.40		1.40	1.75	2.55					
12"	1.50		1.50	1.85						
14"			$1.70	$2.10	$3.00					
15"			1.85	2.25	3.15					
16"			2.00	2.35	3.30					
17"			2.10	2.50	3.45					
18"			2.20	2.60	3.60					
19"			2.35	2.75	3.80					
20"			2.45	2.85	4.00					
21"			2.60	3.00	4.15					
22"			2.70	3.10	4.30					
23"			2.85	3.20	4.40					
24"			3.00	3.30	4.50					
25"			3.10	3.45	4.70					
26"			3.20	3.55	4.85					
27"			3.30	3.65	5.05					
28"			3.40	3.75	5.15					
29"			3.50	3.90	5.35					
30"			3.60	4.00	5.50					
31"			3.70	4.15	5.70					
32"			3.80	4.30	5.90					
33"			3.90	4.40	6.05					
34"			4.00	4.50						
35"			4.10							

Information on IN-2-30 for 1/2" thick and IN-2-10 for 3/4", 1", 1-1/2", and 2" thicknesses regarding jackets available, Minimum Ordering Quantity, Carload Quantity, and Job-Site Shipments applies to One-Piece Pipe Insulation. Waterproof (WJ) jackets described on IN-2-10 are not available on 3/4" thick sizes.

OWENS-CORNING FIBERGLAS SUPPLY & CONTRACTING DIVISION

ST0288141

DOW 04633

PRICE SHEET III (continued)

(PS) PACKAGING DATA - PER CARTON - SECTIONS (3'LONG) AND APPROXIMATE GROSS WEIGHT (LBS.)

Nom. Pipe Size	1/2"		3/4"		1"		1-1/2"		2"	
	Sec.	Wt.	Sec.	Wt.	Sec.	Wt.	Sec.	Wt.	Sec.	Wt.
1/2"	48	21	48	21	35	22	20	24	12	24
3/4"	48	20	48	20	35	22	20	23	12	22
1"	48	18	35	20	24	22	14	20	9	20
1-1/4"	35	18	24	21	24	20	12	22	9	19
1-1/2"	35	16	24	17	20	21	12	21	9	19
2"	24	14	20	18	14	17	9	19	6	18
2-1/2"	20	15	14	16	12	17	9	18	6	17
3"	14	12	12	15	9	15	6	15	4	15
3-1/2"	12	12	9	14	6	15	6	14	-	-
4"	9	11	6	13	6	13	4	13	4	18
4-1/2"	6	11	6	11	4	12	4	12	4	19
5"	6	10	4	12	4	10	4	15	4	21
6"	4	8	4	18	4	12	4	18	2	13
7"	4	8			4	13	2	11	2	14
8"	4	11			2	9	2	12	2	17
9"	2	7			2	10	2	15	2	18
10"	2	7			2	11	2	16	2	18
11"	2	7			2	12	2	16	1	10
12"	2	11			2	13	1	9		
14"					3	20	3	27	2	26
16"					3	21	3	28	2	25
17"					3	22	2	21	2	26
18"					3	23	2	22	2	27
19"					2	18	2	23	2	32
20"					2	18	2	27	2	34
21"					3	29	2	30	2	34
22"					3	30	2	29	2	33
23"					2	24	2	30	2	36
24"					2	24	2	30	2	38
25"					2	25	2	31	2	39
26"					2	25	2	32	2	40
27"					2	26	2	33	2	41
28"					2	27	2	34	2	42
29"					2	28	2	35	2	43
30"					2	28	2	36	2	44
31"					2	28	2	36.5	1	27
32"					2	28.5	1	23	1	27
34"					2	29	1	24	1	28
36"					2	30	1	24	1	29
42"					1	23	1	24.5		
48"					1	21				

ACTUAL O.D. AND THICKNESS (INCHES) OF INSULATION

iron pipe size

Pipe Size Nominal	Actual O.D. (Inches)	1/2" O.D.	1/2" Thick	3/4" O.D.	3/4" Thick	1" O.D.	1" Thick	1-1/2" O.D.	1-1/2" Thick	2" O.D.	2" Thick
1/2"	.84	2.38	.76	2.38	.76	2.88 ②	1.01	4.00 ⑧	1.57	5.00	2.07
3/4"	1.05	2.38	.66	2.38	.66	2.88 ②	.91	4.00 ⑧	1.47	5.00	1.97
1"	1.32	2.38	.52	2.88	.77	3.50 ⑧	1.09	4.50 ⑧	1.59	5.56	2.10
1-1/4"	1.66	2.88	.60	3.50	.91	3.50 ⑧	.91	5.00	1.66	5.56	1.93
1-1/2"	1.90	2.88	.48	3.50	.79	4.00 ⑧	1.06	5.00	1.54	5.56	1.82
2"	2.38	3.50	.55	4.00	.80	4.50 ⑧	1.05	5.56	1.58	6.63	2.11
2-1/2"	2.88	4.00	.55	4.00	.80	5.00	1.05	5.56	1.33	6.63	1.86
3"	3.50	4.50	.48	5.00	.73	5.56	1.01	6.63	1.55	7.63	2.05
3-1/2"	4.00	5.00	.46	5.56	.76	6.63	1.29	6.63	1.29	-	-
4"	4.50	5.56	.51	6.63	1.04	6.63	1.04	7.63	1.54	8.63	2.04
4-1/2"	5.00	6.63	.79	6.63	.79	7.63	1.29	7.63	1.29	8.63	1.79
5"	5.56	6.63	.50	7.12	.75	7.63	1.00	8.63	1.50	9.63	2.00
6"	6.63	7.63	.47	8.19	.75	8.63	.97	9.63	1.47	10.75	2.03
7"	7.63	8.63	.46			9.63	.96	10.75	1.53	11.75	2.03
8"	8.63	9.63	.46			10.75	1.02	11.75	1.52	12.75	2.02
9"	9.63	10.75	.52			11.75	1.02	12.75	1.52	14.00	2.14
10"	10.75	11.75	.45			12.75	.95	14.00	1.57	15.00	2.07
11"	11.75	12.75	.44			14.00	1.07	15.00	1.57	16.00	2.07
12"	12.75	14.00	.56			15.00	1.06	16.00	1.56		

copper tubing

Tubing Size Actual O.D.	Nominal	1/2" O.D.	1/2" Thick	3/4" O.D.	3/4" Thick	1" O.D.	1" Thick	1-1/2" O.D.	1-1/2" Thick
7/8"	3/4"	2.38	.76	2.38	.76	2.88 ②	1.01	4.00 ⑧	1.57
1-1/8"	1"	2.38	.62	2.88	.87	3.50 ⑧	1.18	4.00 ⑧	1.43
1-3/8"	1-1/4"	2.38	.49	2.88	.74	3.50 ⑧	1.06	4.50 ⑧	1.56
1-5/8"	1-1/2"	2.88	.60	3.50	.91	4.00 ⑧	1.16	5.00	1.66
2-1/8"	2"	3.50	.68	4.00	.93	4.50 ⑧	1.18	5.56	1.71
2-5/8"	2-1/2"	4.00	.68	4.50	.93	4.50 ⑧	.93	5.56	1.46
3-1/8"	3"	4.50	.67	5.00	.92	5.56	1.20	6.63	1.74
3-5/8"	3-1/2"	5.00	.67	5.00	.67	5.56	.95	6.63	1.48
4-1/8"	4"	5.56	.67	5.56	.67	6.63	1.23	7.63	1.73
5-1/8"	5"	6.63	.73	6.63	.73	7.63	1.23	8.63	1.73
6-1/8"	6"	7.63	.72	7.63	.72	8.63	1.22	9.63	1.72

Waterproof Jackets are not available on 1/2" thick or 3/4" thick sizes. On 1" and 1-1/2" thicknesses, Jackets indicated are cut-to-size (and included in the carton) as noted:

* Not available with WJ-35, WJ-45, or WJ-55
⑧ Not available with WJ-45, or WJ-55
② Not available with WJ-55

ST028842

Price Sheet IV - The following pages are list price sheets, zone sheet, and discount sheets for Pittsburgh Corning's Foamglas pipe and vessel covering.

Discount sheets are for:

1. P.C. distributor contractor
2. Suggested resale to other insulation contractors
3. Suggested resale to national accounts
4. Suggested resale to consumers

Also included is a distributor-contractor price sheet, and zone sheet for Foamglas blocks.

1ST028143

PRICE SHEET IV7

CELLULAR, STAY-DRY INSULATION





FOAMGLAS Pipe Insulation



FOAMGLAS Fitting Covers



FOAMGLAS Curved Segments for Tanks & Equipment



FOAMGLAS Head Segments for Tanks & Equipment

PRICE LIST FGL
Effective March 22, 1963
(Subject to Trade Discounts)
for
REGULAR PIPE AND FITTING INSULATION
GLASS-FABRIC JACKETED PIPE INSULATION
ALUMINUM JACKETED PIPE INSULATION
STAY-DRY WHITE JACKET PIPE INSULATION
STAY-DRY ALUMINUM JACKET PIPE INSULATION
AND
STANDARD CURVED SIDEWALL SEGMENTS
SPECIAL SHAPED HEAD SEGMENTS
(Subject to Change Without Notice)

LIST PRICES STILL IN EFFECT Sept. 1967

ST0288144

PLAY SAFE WITH FOAMGLAS . . . .

It Stays Dry!

Six good reasons why FOAMGLAS can do any job for you so well, hot or cold . . . minus 300°F. to plus 800°F.

- **Acid Proof**
- **Non Combustible**
- **Is Rodent and Vermin-proof**
- **Has High Compressive Strength and Rigidity**
- **Is Easy to Handle and Cut**
- **Stays Dry**

When installed according to our specifications, FOAMGLAS assures years of trouble free performance and constant insulating efficiency on piping and equipment operating at high and low temperatures both indoors and outdoors.

DOW 04636

PITTSBURGH CORNING

GENERAL INFORMATION

1. FOAMGLAS PIPE INSULATION is supplied in 18" and 24" lengths as indicated in following schedules. All pipe coverings are made in simplified dimensional standard thicknesses. The outside diameter of the insulation corresponds to the O.D.'s of standard iron pipe. This allows nesting of layers and assures a proper fit for each pipe size.

2. FOAMGLAS PIPE INSULATION is supplied with or without a protective jacket.
   Insulation without a protective jacket is designated as:
   FOAMGLAS "Regular" Pipe Insulation (not available in 1" thickness)
   Insulation with a protective jacket is supplied in types as follows:
   FOAMGLAS Glass-Fabric Jacketed Pipe Insulation
   FOAMGLAS Aluminum Jacketed Pipe Insulation
   FOAMGLAS Stay-Dry White Jacket Pipe Insulation
   FOAMGLAS Stay-Dry Aluminum Jacket Pipe Insulation

3. FOAMGLAS FITTING INSULATION is supplied in two half sections whenever possible. Large sized fitting covers will be supplied in four or more sections. Fitting cover thicknesses are comparable to pipe insulation thicknesses; however, all fitting thicknesses are supplied in one layer. Fitting covers are supplied without protective jacket only.

4. TRANSVERSE JOINT STRIPS—FOAMGLAS JACKETED MATERIAL:
   Aluminum Jacketed Pipe Insulation—No Transverse Strips supplied.
   Glass-Fabric Jacketed Pipe Insulation—2" wide strip in rolls sufficient for transverse joints of order is included in one of the cartons of each shipment.
   Stay-Dry White Jacket and Stay-Dry Aluminum Jacket Pipe Insulation—3" wide strips cut to length are included in each carton for transverse joints of carton contents.

5. TOLERANCES—Maximum bore diameter of pipe insulation will be equivalent to outside diameter of pipe plus maximum A.S.A. tolerances for pipe. Nominal widths of curved segments are subject to plus 0" or minus ½" tolerance.

6. SHIPPING DESCRIPTION { Trucks Insulating Material, Cellular Vitreous.
   Rail: Insulating Material, Cellular Vitreous, in forms or shapes other than flat.

7. MINIMUM CARLOAD WEIGHT—12,000 lbs., except to points otherwise designated by freight tariffs, where minimum carloads of 24,000 lbs. can be shipped with lower rates per hundredweight.

ORDERING INFORMATION

1. PIPE AND FITTING INSULATION—Specify range of temperature to which material will be subjected. This information governs the proper bonding cement in the fabrication of large size pipe insulation and fitting covers.

2. PIPE INSULATION—Specify "Regular" (without protective jacket), Glass-Fabric Jacket, Aluminum Jacketed, Stay-Dry White Jacket, or Stay-Dry Aluminum Jacket, whichever is desired. Specify the nominal I.P.S. (iron pipe size), or the ACTUAL O.D. (outside diameter) of special piping or tubing. Insulation for specialties such as cast iron, drainage piping, nickel tubing, etc., must be specified by ACTUAL O.D. Specify thickness desired. (See wall thickness table, page 4.)

3. PIPE INSULATION—On all hot (over 212°F) lines, either Glass-Fabric Jacketed, Aluminum Jacketed, Stay-Dry White Jacket or Stay-Dry Aluminum Jacket pipe insulation should be used. "Regular" pipe insulation can be used providing it is to be wrapped in the field prior to being placed in service.

4. PIPE INSULATION—When thicknesses greater than 4" are required, indicate thickness and number of layers. Otherwise Pittsburgh Corning will supply pipe insulation with the minimum number of layers. Should multiple layers be desired for single layer thicknesses (4" or less), indicate number of layers opposite the thickness requirements.

5. FITTING INSULATION—Specify the following detailed information to avoid errors in fabrication: 1. Specify whether screwed, flanged, weld or sweat. 2. Specify type of valve, i.e., gate, globe, angle, etc., and if standard (125#, 150#), extra heavy (250#) or other. 3. Specify type of fitting, i.e., 90° or 45° ell (long or short radius), union, tee, flange, etc. 4. Special fittings specify manufacturer's name and catalog number of fitting. When this information is not available, include dimensioned prints with order.

6. CURVED SIDEWALL SEGMENTS—Specify outside diameter of vessel. Areas must be computed on the basis of vessel diameter plus insulation. If two or more layers are required, specify quantity and inside diameter of each layer along with thicknesses for each layer.

7. SPECIAL SHAPED HEAD SEGMENTS—Furnish drawing or description of vessel head, indicating outside diameter of vessel and spherical radius of head. If multiple layer application is desired, specify layers and thickness of each layer.

PRICING INFORMATION

1. 1" THICKNESS—1" Thickness of FOAMGLAS Pipe Insulation is not supplied in "Regular," without protective jacket. Available only in I.P.S. sizes shown, in jacketed material.

2. SPECIAL PIPE SIZES—Pipe insulation and fitting covers for other than standard I.P.S. or Standard Copper tubing sizes shown in price list will be priced at the next larger standard size.

3. SPECIAL FOAMGLAS THICKNESS—Where special thicknesses not shown in price list are required, pricing will be on the basis of next greater standard thickness.

4. MULTIPLE LAYER PIPE INSULATION—For convenience for pricing double layer pipe covering the table on Page 5 can be used. For other combinations of thickness or greater number of layers, see "Formula on Multiple Layer Pricing" on Page 5.

5. ACCESSORIES—Prices shown do not include bands, adhesives, etc.

6. See Page 8 for special pricing information on fitting covers. Prices for fittings not covered by Price Lists will be quoted on request.

ST0288145

DOW 04637

FOAMGLAS EQUIPMENT INSULATION

List prices subject to trade discounts

CURVED SIDEWALL SEGMENTS

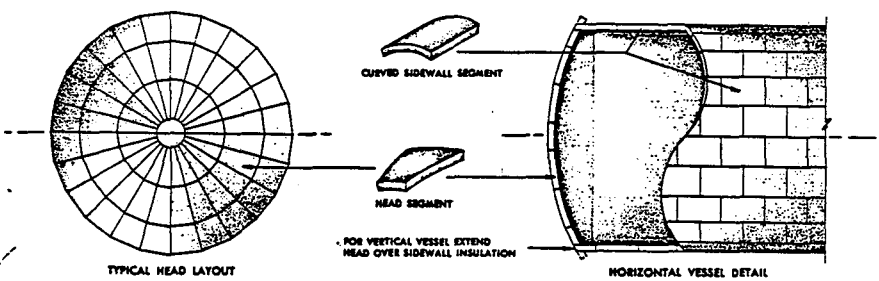
VESSEL DIAMETER (O.D.)	LIST PRICES PER SQUARE FOOT THICKNESS					
	1½"	2"	2½"	3"	3½"	4"
1'-0" up to and including 2'-0"	$1.50	$1.60	$1.90	$2.20	$2.60	$3.00
Over 2'-0" up to and including 8'-0"	1.00	1.10	1.40	1.65	1.90	2.15
Over 8'-0"	.90	1.00	1.25	1.55	1.80	2.10

1. FOAMGLAS curved sidewall segments are supplied only in 18" Long blocks with nominal chord width of 12".

SPECIAL SHAPED HEAD SEGMENTS

VESSEL DIAMETER (O.D.)	LIST PRICES PER HEAD SINGLE LAYER THICKNESS					
	1½"	2"	2½"	3"	3½"	4"
2'-0" up to and including 3'-0"	$37.20	$39.60	$42.00	$44.40	$47.40	$49.80
Over 3'-0" up to and including 4'-0"	59.40	64.20	69.60	74.40	77.40	80.40
Over 4'-0" up to and including 5'-0"	80.40	87.00	93.00	99.00	103.80	108.00
Over 5'-0" up to and including 6'-0"	96.00	104.40	114.60	123.60	133.20	142.80
Over 6'-0" up to and including 7'-0"	130.20	142.20	154.80	166.80	179.40	192.00
Over 7'-0" up to and including 8'-0"	170.40	186.00	201.60	217.20	232.80	248.40
Over 8'-0" up to and including 9'-0"	234.00	253.20	272.40	292.80	314.40	334.80
Over 9'-0" up to and including 10'-0"	266.40	290.40	315.60	340.80	367.20	390.00
Over 10'-0" up to and including 12'-0"	321.60	352.80	386.40	420.00	458.40	495.60

1. Supplied only for flanged and dished, or dished heads, with one radius.
2. Each head assembly of FOAMGLAS will include sufficient material to permit fitting with sidewall insulation (See sketch below).
3. Perimeter trimming of head segments in the field will be necessary.
4. Head material will not be shaped to fit knuckle radius.
5. Special prices on larger diameter heads available upon request.
6. Special prices on hemispherical and cone shaped heads available upon request.



OTHER SHAPES

1. FOAMGLAS EQUIPMENT INSULATION is also available in Flat and Bevelled Lags (See Lag Price Lists).
2. Prices for special shape segments for insulating Spheres, Hortonspheres, etc., are available on request.
3. Prices are available on request for FOAMGLAS Discs, Manhole Covers or other Special equipment.

DOW 04638

ST0288146

FOAMGLAS PIPE INSULATION

LIST PRICES PER LINEAL FOOT — SUBJECT TO TRADE DISCOUNTS

"REGULAR" (UNWRAPPED), AND JACKETED

STANDARD IRON PIPE SIZES * (INCHES)		DIMENSIONAL STANDARDS THICKNESSES (SEE TABLE BELOW FOR ACTUAL THICKNESSES)						COPPER TUBING SIZES * (INCHES)	
NOMINAL	ACTUAL O.D.	1"	1½"	2"	3½"	3"	3½"	4"	NOMINAL	ACTUAL O.D.
¼	.540	$ .62	$ 1.15	$ 1.90	$ 2.50	$ 3.00	$ 4.30	$ 5.30	¼	⅜
⅜	.675	.62	1.15	1.90	2.50	3.00	4.30	5.50	⅜	½
½	.840	.62	1.15	1.90	2.50	3.00	4.30	5.50	½	⅝
¾	1.050	.68	1.20	2.00	2.65	3.40	4.35	5.65	¾	⅞
1	1.315	.77	1.30	2.15	2.75	3.50	4.70	6.00	1	1⅛
1¼	1.660	.85	1.40	2.25	2.90	3.65	4.80	6.15	1¼	1⅜
1½	1.900	.93	1.50	2.40	3.00	3.90	5.15	6.25	1½	1⅝
2	2.375	1.02	1.60	2.50	3.20	4.15	5.50	6.75	2	2⅛
2½	2.875	1.13	1.75	2.65	3.50	4.40	5.65	6.90	2½	2⅝
3	3.500	1.39	1.90	2.90	3.75	4.75	6.15	7.50	3	3⅛
3½	4.000	1.54	2.05	3.20	4.15	5.30	6.70	8.15	3½	3⅝
4	4.500	1.65	2.20	3.50	4.50	5.60	6.85	8.40	4	4⅛
4½	5.000	2.00	2.46	3.90	5.10	6.40	7.35	9.15	4½	4⅝
5	5.563	2.16	2.86	4.40	5.25	6.90	7.50	9.40	5	5⅛
6	6.625	2.46	3.12	5.10	5.80	7.10	8.25	10.25	6	6⅛
7	7.625		3.90	5.70	6.15	7.30	9.00	11.00		
8	8.625		4.30	6.50	7.20	7.50	9.75	11.75		
9	9.625		4.60	7.70	8.30	8.80	10.70	13.00		
10	10.750		5.16	9.30	10.30	11.00	12.85	16.91		
11	11.750		5.40	9.80	10.70	11.30	13.07	17.27		
12	12.750		7.76	10.30	11.20	13.19	15.87	18.80		
14	14.000		7.59	9.03	11.44	12.80	16.35	19.84		
15	15.000		7.99	9.26	11.90	14.49	17.14	20.76		
16	16.000		8.40	9.43	12.36	15.18	17.94	21.68		
17	17.000		8.74	9.89	12.82	15.76	18.43	22.60		
18	18.000		9.32	10.24	13.28	16.33	19.38	23.52		
19	19.000		9.76	10.61	13.92	17.02	20.20	24.44		
20	20.000		10.24	11.27	14.49	17.71	20.99	25.30		
21	21.000		10.64	11.73	15.12	18.40	21.79	26.22		
22	22.000		11.04	12.25	15.70	19.15	22.60	27.08		
23	23.000		11.50	12.71	16.27	19.78	23.23	28.00		
24	24.000		11.96	13.17	16.79	20.41	24.04	28.92		
25	25.000		12.42	13.63	17.37	20.99	24.84	29.84		
26	26.000		12.88	14.09	17.88	21.62	25.65	30.71		
27	27.000		13.28	14.55	18.57	22.45	26.45	31.63		
28	28.000		13.74	15.07	19.15	23.23	27.26	32.55		
29	29.000		14.15	15.47	19.72	23.86	28.00	33.47		
30	30.000		14.61	15.99	20.34	24.50	28.75	34.39		
31	31.000		15.07	16.45	20.82	25.13	29.56	35.25		
32	32.000		15.53	16.96	21.39	25.82	30.30	36.11		
33	33.000		15.76	17.43	22.02	26.51	31.11	37.03		
34	34.000		15.99	17.94	22.60	27.26	31.91	37.95		
35	35.000		16.62	18.34	23.17	27.89	32.66	38.87		
36	36.000		17.51	18.80	23.69	28.52	33.41	39.79		

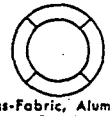
THIS THICKNESS FURNISHED ONLY WITH FACTORY APPLIED JACKET AND IN THE SIZES LISTED

For sizes above heavy black line, FOAMGLAS pipe insulation is furnished in sectional form.



Glass-Fabric, Aluminum Jacketed, Stay-Dry White Jacket and Stay-Dry Aluminum Jacket pipe insulation is furnished in these sizes only ▲

For sizes below heavy black line FOAMGLAS pipe insulation is furnished in segmental form. (Number of sections vary with pipe O.D.)



Glass-Fabric, Aluminum Jacketed, Stay-Dry White Jacket and Stay-Dry Aluminum Jacket pipe insulation not furnished in these sizes.

OUTSIDE DIAMETER AND WALL THICKNESSES OF FOAMGLAS *DIMENSIONAL STANDARDS* PIPE INSULATION

STANDARD IRON PIPE SIZES * (INCHES)		NOMINAL 1"		NOMINAL 1½"		NOMINAL 2"		NOMINAL 2½"		NOMINAL 3"		NOMINAL 3½"		NOMINAL 4"	
NOMINAL	ACTUAL	F.G. THICK.	OD OF COVERING	F.G. THICK.	OD OF COVERING	F.G. THICK.	OD OF COVERING	F.G. THICK.	OD OF COVERING	F.G. THICK.	OD OF COVERING	F.G. THICK.	OD OF COVERING	F.G. THICK.	OD OF COVERING
¼	.540	1.14	2.88	1.47	3.50	1.97	4.50	2.50	5.56	3.03	6.63	3.53	7.63	4.03	8.63
⅜	.675	1.10	2.88	1.66	4.00	2.16	5.00	2.44	5.56	2.97	6.63	3.47	7.63	3.97	8.63
½	.840	1.01	2.88	1.57	4.00	2.07	5.00	2.25	5.56	2.89	6.63	3.38	7.63	4.28	9.63
¾	1.050	0.90	2.88	1.47	4.00	1.97	5.00	2.25	5.56	2.78	6.63	3.78	8.63	4.28	9.63
1	1.315	1.08	3.50	1.58	4.50	2.12	5.56	2.67	6.63	3.15	7.63	3.65	8.63	4.15	9.63
1¼	1.660	0.90	3.50	1.40	4.50	1.96	5.56	2.49	6.63	2.97	7.63	3.47	8.63	3.97	9.63
1½	1.900	1.04	4.00	1.54	5.00	1.82	5.56	2.34	6.63	2.86	7.63	3.32	8.63	3.85	9.63
2	2.375	1.05	4.50	1.58	5.56	2.11	6.63	2.61	7.63	3.11	8.63	3.61	9.63	4.17	10.75
2½	2.875	1.02	5.00	1.30	5.56	1.83	6.63	2.33	7.63	2.83	8.63	3.33	9.63	3.89	10.75
3	3.500	1.02	5.56	1.56	6.63	2.05	7.63	2.55	8.63	3.05	9.63	3.61	10.75	4.11	11.75
3½	4.000	1.30	6.63	1.80	7.63	2.30	8.63	2.80	9.63	3.36	10.75	3.86	11.75	4.36	12.75
4	4.500	1.05	6.63	1.55	7.63	2.05	8.63	2.56	9.63	3.11	10.75	3.61	11.75	4.11	12.75
4½	5.000	1.28	7.63	1.78	8.63	2.28	9.63	2.84	10.75	3.34	11.75	3.84	12.75	4.49	14.00
5	5.563	0.99	7.63	1.49	8.63	1.99	9.63	2.56	10.75	3.06	11.75	3.56	12.75	4.18	14.00
6	6.625	0.97	8.63	1.47	9.63	2.03	10.75	2.53	11.75	3.03	12.75	3.66	14.00	4.16	15.00
7	7.625			1.53	10.75	2.03	11.75	2.53	12.75	3.16	14.00	3.66	15.00	4.16	16.00
8	8.625			1.53	11.75	2.03	12.75	2.66	14.00	3.16	15.00	3.66	16.00	4.16	17.00
9	9.625			1.53	12.75	2.16	14.00	2.66	15.00	3.06	16.00	3.66	17.00	4.16	18.00
10	10.750			1.58	14.00	2.08	15.00	2.58	16.00	3.08	17.00	3.58	18.00	4.08	19.00
11	11.750			1.58	15.00	2.08	16.00	2.58	17.00	3.08	18.00	3.58	19.00	4.08	20.00
12	12.750			1.58	16.00	2.08	17.00	2.58	18.00	3.08	19.00	3.58	20.00	4.08	21.00
14	14.000			1.50	17.00	2.00	18.00	2.50	19.00	3.00	20.00	3.50	21.00	4.00	22.00
15	15.000			1.50	18.00	2.00	19.00	2.50	20.00	3.00	21.00	3.50	22.00	4.00	23.00
16	16.000			1.50	19.00	2.00	20.00	2.50	21.00	3.00	22.00	3.50	23.00	4.00	24.00
17	17.000			1.50	20.00	2.00	21.00	2.50	22.00	3.00	23.00	3.50	24.00	4.00	25.00
18	18.000			1.50	21.00	2.00	22.00	2.50	23.00	3.00	24.00	3.50	25.00	4.00	26.00
19	19.000			1.50	22.00	2.00	23.00	2.50	24.00	3.00	25.00	3.50	26.00	4.00	27.00
20	20.000			1.50	23.00	2.00	24.00	2.50	25.00	3.00	26.00	3.50	27.00	4.00	28.00
21	21.000			1.50	24.00	2.00	25.00	2.50	26.00	3.00	27.00	3.50	28.00	4.00	29.00
22	22.000			1.50	25.00	2.00	26.00	2.50	27.00	3.00	28.00	3.50	29.00	4.00	30.00
23	23.000			1.50	26.00	2.00	27.00	2.50	28.00	3.00	29.00	3.50	30.00	4.00	31.00
24	24.000			1.50	27.00	2.00	28.00	2.50	29.00	3.00	30.00	3.50	31.00	4.00	32.00
25	25.000				28.00		29.00		30.00		31.00		32.00		33.00
to	to			1.50	to	2.00	to	2.50	to	3.00	to	3.50	to	4.00	to
36	36.000				39.00		40.00		41.00		42.00		43.00		44.00

THIS THICKNESS FURNISHED ONLY WITH FACTORY APPLIED JACKET AND IN THE SIZES LISTED

All pipe sizes and thicknesses in shaded area are made in 24" lengths. All others—in 18" lengths only.

ST0288147

DOW 04639

FOAMGLAS PIPE INSULATION

DOUBLE LAYER CONSTRUCTION

List Prices Per Lineal Foot — **Subject to Trade Discount**

Nominal Pipe Size Inches	NOMINAL THICKNESS OF INSULATION 4½" (1st Layer 2" / 2nd Layer 2½")	5" (1st Layer 2½" / 2nd Layer 2½")	5½" (1st Layer 2½" / 2nd Layer 3")	6" (1st Layer 3" / 2nd Layer 3")	6½" (1st Layer 3" / 2nd Layer 3½")	7" (1st Layer 3½" / 2nd Layer 3½")	7½" (1st Layer 3½" / 2nd Layer 4")	8" (1st Layer 4" / 2nd Layer 4")
¼	$ 6.30	$ 7.75	$ 9.40	$10.10	$11.25	$13.30	$15.30	$17.25
⅜	7.00	7.75	9.40	10.10	11.25	13.30	15.30	17.25
½	7.00	7.75	9.40	10.10	11.25	13.30	15.30	18.50
¾	7.10	7.90	9.55	10.50	11.65	14.10	16.10	18.65
1	7.40	8.55	9.85	10.80	12.50	14.45	16.45	19.00
1¼	7.50	8.70	10.00	10.95	12.65	14.55	16.55	19.15
1½	7.65	8.80	10.10	11.20	12.90	14.90	16.90	19.25
2	8.30	9.35	10.50	11.65	13.90	16.20	18.50	23.66
2½	8.45	9.45	10.80	11.90	14.15	16.35	18.65	23.81
3	9.05	10.95	11.25	13.55	15.45	19.00	23.06	25.27
3½	10.50	12.45	12.95	16.30	18.15	22.17	24.47	26.95
4	10.70	12.80	13.30	16.60	18.45	22.32	24.62	27.20
4½	12.20	15.30	16.10	17.90	21.87	23.22	26.15	28.99
5	12.70	15.45	16.25	18.40	22.37	23.57	26.30	29.24
6	15.30	16.50	17.30	19.29	22.97	24.58	28.09	31.01
7	16.40	17.35	18.34	21.10	23.63	26.14	29.76	32.68
8	17.70	18.64	21.00	21.99	24.66	27.49	31.43	34.35
9	19.14	20.20	22.79	23.98	26.74	29.33	33.30	36.52
10	21.20	22.56	25.38	26.76	29.63	32.23	36.37	41.35
11	22.16	23.52	26.46	27.83	30.88	33.77	39.91	43.07
12	23.13	24.48	27.53	29.21	32.49	36.86	41.17	45.02
14	22.31	25.36	28.46	31.51	34.79	38.12	42.58	46.92
15	23.18	26.39	29.61	32.89	36.28	39.74	44.22	48.76
16	23.92	27.48	30.76	34.33	37.78	41.17	45.94	50.60
17	25.01	28.52	31.97	35.54	38.99	42.67	47.55	52.44
18	25.94	29.55	33.06	36.74	40.37	44.22	49.22	54.23
19	27.08	30.71	34.33	38.01	41.86	45.95	51.01	56.07
20	28.06	31.86	35.48	39.33	43.36	47.44	52.62	57.85
21	29.10	33.00	36.74	40.83	44.85	49.05	54.34	59.69
22	30.13	34.27	38.13	42.38	46.41	50.60	56.07	61.47
23	31.28	37.42	39.50	43.64	47.78	52.48	57.62	63.25
24	32.32	36.51	40.65	44.91	49.16	53.60	59.29	65.03
25	33.35	37.61	41.87	46.12	50.55	55.14	60.95	66.87
26	34.53	38.70	43.01	47.44	51.92	56.76	62.68	68.66
27	35.27	39.96	44.39	48.94	53.54	58.36	64.40	70.50
28	36.46	41.17	45.66	50.49	55.14	59.92	66.13	72.34
29	37.49	42.32	46.98	51.75	56.52	61.41	67.79	
30	38.59	43.41	48.15	53.02	57.91			
31	39.62	44.51	49.34					
32	40.67							
33								
34	For total list price on these sizes use FGL Price List as follows:							
35	1st Layer: Use pipe insulation price for desired pipe size and thickness or calculate quantity of curved sidewall segments required.							
36	2nd Layer: Use curved sidewall segments as required.							

FORMS

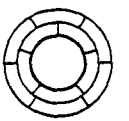
Both layers furnished in half sections.



First layer furnished in half sections. Second layer furnished in segmental form.*



Both layers furnished in segmental form.*



*Number of segments vary with pipe size.

NOTES 1. The above list prices are for two (2) layer construction only. If greater number of layers are required, use Formula Shown below.
2. Multiple Layer Pipe Insulation furnished in 18" lengths only.

ST0288148

MULTIPLE LAYER PRICING

Multiple layer prices are determined by adding the above list prices of individual layers required to obtain the desired total thickness.

FOAMGLAS pipe insulation is produced in dimensional standards thicknesses, i.e. the O.D.'s of the insulation correspond to the O.D.'s of standard pipes (see table page 4). Each layer of insulation is priced according to the pipe size of its inside diameter.

Example: Determine price of 4" pipe with 6" total thickness of insulation (two 3" thick layers)

1st layer: 4" IPS x 3" thick FOAMGLAS pipe insulation.....$ 5.60
(O.D. of 1st layer equals 10" IPS, see table page 4)

2nd layer: 10" IPS x 3" thick FOAMGLAS pipe insulation..... 11.00

Total List Price per L.F......$16.60

DOW 04640

FOAMGLAS FITTING INSULATION

List prices subject to trade discounts

SEE PAGE 8 FOR 1" THICK FITTINGS

1½" NOMINAL THICKNESS

Iron Pipe Size Inches	Standard (125 lb.) Screwed Fittings: Ells: 90° & 45°; Tees, Unions	Standard (125 lb.) Screwed Fittings: Globe, Angle, Gate Valves	Extra Heavy (250 lb.) and Ammonia Screwed Fittings: Ells: 90° & 45°; Tees, Unions	Extra Heavy (250 lb.) and Ammonia Screwed Fittings: Globe, Angle, Gate Valves	Standard, Extra Heavy, Ammonia Flanged Fittings: Ells: 90° & 45°; Tees, Globe, Angle, Gate Valves	Standard, Extra Heavy, Ammonia Flanged Fittings: Flanges	Weld and Sweat Fittings: Ells: 90° & 45°; Tees
¼	$ 1.75	$ 2.42	$ 2.31	$ 2.97	$ 6.96	$ 2.53	$ 1.75
⅜	1.75	2.42	2.31	2.97	6.96	2.53	1.75
½	1.75	2.42	2.31	2.97	6.96	2.53	1.75
¾	1.77	2.92	2.53	3.74	7.80	2.97	1.77
1	1.83	3.63	2.92	4.95	8.70	3.19	1.83
1¼	2.31	4.95	3.19	6.33	9.60	3.58	2.31
1½	2.42	6.33	3.96	8.64	10.92	3.80	2.42
2	3.06	8.58	4.84	10.78	12.96	4.29	3.06
2½	3.76	10.78	5.61	13.20	14.64	4.95	3.76
3	4.67	13.20	6.33	15.62	16.74	6.27	4.67
3½	5.48	15.62	7.15	17.88	19.08	6.71	5.48
4	6.26	17.88	8.69	22.66	21.12	7.26	6.26
5	7.76	22.66	10.67	27.28	24.96	7.98	7.76
6	10.50	27.28	14.30	36.85	29.40	9.02	10.50
8	15.55	36.85	26.07	45.93	65.08	22.00	15.55
10					78.50	26.75	19.31
12					93.16	31.86	25.11
14					107.82	35.88	42.79

2" NOMINAL THICKNESS

Iron Pipe Size Inches	Standard (125 lb.) Screwed Fittings: Ells: 90° & 45°; Tees, Unions	Standard (125 lb.) Screwed Fittings: Globe, Angle, Gate Valves	Extra Heavy (250 lb.) and Ammonia Screwed Fittings: Ells: 90° & 45°; Tees, Unions	Extra Heavy (250 lb.) and Ammonia Screwed Fittings: Globe, Angle, Gate Valves	Standard, Extra Heavy, Ammonia Flanged Fittings: Ells: 90° & 45°; Tees, Globe, Angle, Gate Valves	Standard, Extra Heavy, Ammonia Flanged Fittings: Flanges	Weld and Sweat Fittings: Ells: 90° & 45°; Tees
¼	$ 2.42	$ 3.19	$ 2.53	$ 3.52	$ 10.44	$ 3.74	$ 2.75
⅜	2.42	3.19	2.53	3.52	10.44	3.74	2.75
½	2.42	3.19	2.53	3.52	10.44	3.74	2.75
¾	2.64	3.52	3.19	4.84	12.12	4.29	3.19
1	3.08	4.84	3.80	6.71	12.96	4.95	3.74
1¼	3.41	5.83	3.96	7.48	14.52	5.06	3.96
1½	3.96	7.26	5.17	10.67	14.88	5.50	4.57
2	4.95	10.67	6.16	13.53	18.12	5.83	5.94
2½	6.05	13.53	7.37	16.06	21.12	6.82	7.15
3	7.81	16.06	8.69	19.58	24.36	7.37	8.91
3½	9.13	19.58	10.29	22.77	27.60	8.80	10.56
4	10.34	22.77	12.32	29.10	31.08	9.57	11.99
5	12.65	29.10	14.85	30.25	34.08	11.55	14.41
6	14.28	35.51	19.80	47.74	39.68	13.42	17.93
8	29.59	47.74	36.85	60.06	94.72	33.00	39.63
10					118.37	40.13	48.63
12					140.50	47.75	58.38
14					162.21	55.25	68.38

2½" NOMINAL THICKNESS

Iron Pipe Size Inches	Standard (125 lb.) Screwed Fittings: Ells: 90° & 45°; Tees, Unions	Standard (125 lb.) Screwed Fittings: Globe, Angle, Gate Valves	Extra Heavy (250 lb.) and Ammonia Screwed Fittings: Ells: 90° & 45°; Tees, Unions	Extra Heavy (250 lb.) and Ammonia Screwed Fittings: Globe, Angle, Gate Valves	Standard, Extra Heavy, Ammonia Flanged Fittings: Ells: 90° & 45°; Tees, Globe, Angle, Gate Valves	Standard, Extra Heavy, Ammonia Flanged Fittings: Flanges	Weld and Sweat Fittings: Ells: 90° & 45°; Tees
¼	$ 2.64	$ 4.57	$ 3.30	$ 5.45	$ 12.00	$ 4.73	$ 4.07
⅜	2.64	4.57	3.30	5.45	12.00	4.73	4.07
½	2.64	4.57	3.30	5.45	12.00	4.73	4.07
¾	3.08	4.84	3.74	6.71	12.96	4.95	4.73
1	3.52	6.16	4.18	8.14	15.60	5.28	4.95
1¼	3.96	6.71	4.57	8.69	16.44	5.61	5.39
1½	4.84	8.69	6.33	12.65	19.08	6.27	5.72
2	5.83	12.65	7.70	16.28	23.40	7.48	7.15
2½	7.48	16.28	9.24	18.98	27.60	8.69	8.80
3	9.35	19.69	11.88	23.43	29.88	10.34	11.99
3½	10.51	23.43	13.64	26.95	33.72	11.28	13.75
4	12.75	26.95	16.50	34.10	37.56	12.98	15.40
5	16.83	34.10	19.69	38.83	44.88	15.62	19.14
6	18.81	43.23	26.40	54.78	51.36	17.49	23.65
8	33.77	51.04	42.13	67.32	112.68	38.50	44.88
10					138.23	47.13	45.25
12					163.99	55.88	67.00
14					177.28	63.86	73.50

ST0288149

DOW 04641

	Iron Pipe Size Inches	Standard (125 lb.) Screwed Fittings		Extra Heavy (250 lb.) and Ammonia Screwed Fittings		Standard, Extra Heavy, Ammonia Flanged Fittings		Weld and Sweat Fittings
		Ells: 90° & 45°; Tees, Unions	Globe, Angle, Gate Valves	Ells: 90° & 45°; Tees, Unions	Globe, Angle, Gate Valves	Ells: 90° & 45°; Tees, Globe, Angle, Gate Valves	Flanges	Ells: 90° & 45°; Tees
3" NOMINAL THICKNESS	¼	$ 5.28	$ 7.15	$ 5.39	$ 7.37	$ 13.68	$ 5.72	$ 5.39
	⅜	5.28	7.15	5.39	7.37	13.68	5.72	5.39
	½	5.28	7.15	5.39	7.37	13.68	5.72	5.39
	¾	5.45	7.37	5.72	8.14	12.92	5.72	5.72
	1	5.72	7.48	6.71	9.46	18.12	7.04	6.16
	1¼	6.71	9.46	7.59	11.39	20.16	7.59	7.15
	1½	7.59	11.39	9.63	15.29	22.56	8.64	8.25
	2	9.63	15.29	11.39	19.36	26.76	10.12	10.34
	2½	11.39	19.36	13.20	23.32	31.08	11.77	12.65
	3	13.20	23.32	15.07	27.17	35.40	15.07	15.07
	3½	15.07	27.17	17.05	31.13	39.72	15.62	16.94
	4	17.05	31.13	20.68	39.05	44.04	16.50	19.03
	5	20.90	39.05	24.53	47.41	52.56	19.69	23.87
	6	27.06	44.88	31.13	61.88	58.08	23.43	29.48
	8	37.95	56.21	47.41	74.36	128.64	44.00	50.31
	10					158.24	50.13	62.00
	12					187.69	64.13	74.75
	14					192.35	72.63	78.75

	Iron Pipe Size Inches	Standard (125 lb.) Screwed Fittings		Extra Heavy (250 lb.) and Ammonia Screwed Fittings		Standard, Extra Heavy, Ammonia Flanged Fittings		Weld and Sweat Fittings
		Ells: 90° & 45°; Tees, Unions	Globe, Angle, Gate Valves	Ells: 90° & 45°; Tees, Unions	Globe, Angle, Gate Valves	Ells: 90° & 45°; Tees, Globe, Angle, Gate Valves	Flanges	Ells: 90° & 45°; Tees
3½" NOMINAL THICKNESS	¼	$ 9.63	$ 9.63	$ 9.90	$10.34	$ 15.25	$11.25	$ 9.68
	⅜	9.63	9.63	9.90	10.34	15.25	11.25	9.68
	½	9.63	9.63	9.90	10.34	15.25	11.25	9.68
	¾	10.01	10.01	10.29	10.78	15.38	11.25	10.01
	1	10.51	11.33	10.78	12.43	22.38	12.63	10.67
	1¼	11.66	13.09	12.65	14.08	24.63	13.75	11.88
	1½	12.65	14.52	13.64	16.50	26.69	14.88	12.98
	2	14.85	17.60	15.73	19.69	30.94	17.13	15.13
	2½	17.38	21.34	18.26	26.40	35.13	20.00	18.04
	3	19.25	24.20	20.13	30.36	39.88	22.88	20.13
	3½	21.34	29.48	23.76	33.28	44.13	24.75	22.33
	4	23.98	33.55	28.27	40.15	49.45	26.88	24.97
	5	28.71	41.25	33.55	48.07	58.50	31.94	30.14
	6	32.12	46.09	36.08	62.59	62.25	36.25	34.98
	8	43.56	61.38	53.35	76.67	138.07	57.70	56.76
	10					168.17	69.93	70.13
	12					199.06	79.65	84.13
	14					224.08	85.51	88.13

	Iron Pipe Size Inches	Standard (125 lb.) Screwed Fittings		Extra Heavy (250 lb.) and Ammonia Screwed Fittings		Standard, Extra Heavy, Ammonia Flanged Fittings		Weld and Sweat Fittings
		Ells: 90° & 45°; Tees, Unions	Globe, Angle, Gate Valves	Ells: 90° & 45°; Tees, Unions	Globe, Angle, Gate Valves	Ells: 90° & 45°; Tees, Globe, Angle, Gate Valves	Flanges	Ells: 90° & 45°; Tees
4" NOMINAL THICKNESS	¼	$14.30	$14.30	$14.30	$14.30	$ 16.25	$ 16.25	$ 14.30
	⅜	14.30	14.30	14.30	14.30	16.25	16.25	14.30
	½	14.30	14.30	14.30	14.30	16.25	16.25	14.30
	¾	14.30	14.30	14.30	14.30	16.25	16.25	14.30
	1	15.18	15.18	15.18	15.18	25.88	17.25	15.80
	1¼	16.61	16.61	16.61	16.61	28.28	18.88	16.61
	1½	17.60	17.60	17.60	17.60	29.88	20.00	17.60
	2	20.02	20.02	20.02	20.02	34.00	22.75	20.02
	2½	23.32	23.32	23.32	29.48	37.81	26.50	23.32
	3	25.19	25.19	25.19	33.55	42.88	28.63	25.19
	3½	27.61	30.47	30.47	36.74	46.88	31.38	27.61
	4	30.91	35.97	35.97	41.14	52.63	35.13	30.91
	5	36.52	42.68	42.68	48.72	62.25	41.63	36.63
	6	37.18	47.41	45.10	63.25	63.88	45.88	40.37
	8	49.06	63.25	54.29	79.09	141.93	64.99	63.00
	10					171.17	78.36	78.25
	12					202.20	92.66	92.50
	14					232.38	106.68	107.88

DOW 04642

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FOAMGLAS FITTING INSULATION

List prices subject to trade discounts

	Iron Pipe Size Inches	Screwed, Weld and Sweat Fittings Ells: 90° & 45°; Tees
1" NOMINAL THICKNESS	¼	$1.40
	⅜	1.40
	½	1.40
	¾	1.51
	1	1.57
	1¼	1.71
	1½	1.89
	2	2.09
	2½	2.46
	3	3.23
	3½	3.89
	4	4.60
	4½	5.31
	5	6.09
	6	7.31

SPECIAL FITTINGS — LIST PRICES

SPECIAL FITTINGS Use List Price in Corresponding Column of Fitting Insulation Price List (Pages 6 & 7), and add Percentage Indicated	SCREWED FITTINGS: STANDARD (125 lb.) VALVES GLOBE, ANGLE AND GATE	SCREWED FITTINGS: EXTRA HEAVY (250 lb.) AND AMMONIA ELLS (90° AND 45°), TEES AND UNIONS	SCREWED FITTINGS: EXTRA HEAVY (250 lb.) AND AMMONIA VALVES GLOBE, ANGLE AND GATE	FLANGED FITTINGS: STANDARD EXTRA HEAVY AND AMMONIA ELLS (90° AND 45°), TEES AND VALVES (GLOBE, ANGLE AND GATE)
Couplings		0%		
Crosses	25%		25%	25%
Ells:				
Ammonia (1 and screwed, T and flanged)		50%		
Drainage, Side Outlet, Street		0%		0%
Socket Weld (90° and 45°)				
Plug Cocks, Strainers	100%		100%	100%
Reducers		0%		
Tees:				
Drainage		0%		0%
Side Outlet	25%		25%	25%
Socket Weld				
Traps:				
Scale	100%		100%	100%
Valves:				
Butterfly, By-Pass, Clamp, Cross & Y's, Expansion	50%		50%	50%
Check	0%		0%	0%
Henry	0%			
Packless, Regulating & Control, Relief, Saddle Gate, Safety, Toe	50%		50%	50%

FOAMGLAS Fittings with Wall Thicknesses greater than 4 inches

Determine list price per foot of pipe covering (same thickness as desired for fitting) by Multiple Layer Pricing, page 5, and apply to appropriate category listed below:

1. **All screwed and weld fittings**
   a. Iron pipe sizes up to 8". Multiply multiple layer pipe insulation list price per lineal foot by 3.0.
   b. Iron pipe sizes 8" and over. Multiply multiple layer pipe insulation list price per lineal foot by 4.0.
2. **All flanged fittings**
   a. Iron pipe sizes up to 8". Multiply multiple layer pipe insulation list price per lineal foot by 4.0.
   b. Iron pipe sizes 8" and over. Multiply multiple layer pipe insulation list price per lineal foot by 8.0.
3. **All flanges**
   a. All iron pipe sizes. Multiply multiple layer pipe insulation list price per lineal foot by 3.0.
4. **Special fittings**
   Special Fittings such as those in table above will be quoted on request.

Example:

Determine price of 4" IPS, 90° Screwed Ell, 6" thick insulation.

L.F. list price of 4" IPS x 6" thick pipe covering	$16.60
multiply by	3.0
List price per Fitting	$49.80

PRICING INFORMATION

1. Prices apply to regular fittings having A.S.A. dimensions.
2. Fitting insulation with actual O.D.'s different from those shown will be priced on the basis of the nearest larger listed O.D.
3. Reducing and blanked fittings are priced on the size of the largest outlet.
4. Long turn, long sweep, and long radius fittings are priced the same as the respective std., heavy duty, ammonia, or weld fittings.
5. Weld and sweat valves are priced the same as std. scd. valves.

3-25M

DOW 04643

ST0288151

PRICE ZONES

State	Counties	Zone
ALABAMA		
	Baldwin	3
	Escambia	3
	Mobile	3
	All others	2
ARIZONA		
	Entire State	4
ARKANSAS		
	Entire State	2
CALIFORNIA		
	Entire State	4
COLORADO		
	Entire State	3
CONNECTICUT		
	Entire State	1
DELAWARE		
	Entire State	1
DIST. OF COLUMBIA		
	Entire Area	1
FLORIDA		
	Entire State	3
GEORGIA		
	Entire State	2
IDAHO		
	Entire State	4
ILLINOIS		
	Entire State	1
INDIANA		
	Entire State	1
IOWA		
	Cedar	1
	Clinton	1
	Delaware	1
	Des Moines	1
	Dubuque	1
	Henry	1
	Jackson	1
	Jones	1
	Louisa	1
	Muscatine	1
	Scott	1
	All others	2
KANSAS		
	Cheyenne	3
	Grant	3
	Greely	3
	Hamilton	3
	Kearney	3
	Logan	3
	Morton	3
	Rawlins	3
	Seward	3
	Sherman	3
	Stanton	3
	Stevens	3
	Thomas	3
	Wallace	3
	Wichita	3
	All others	2
KENTUCKY		
	Ballard	2
	Calloway	2
	Carlisle	2
	Fulton	2
	Graves	2
	Hickman	2
	Marshall	2
KENTUCKY - Cont'd.		
	McCracken	2
	All others	1
LOUISIANA		
	Bienville	2
	Bossier	2
	Caddo	2
	Catahoula	2
	Caudwell	2
	Claiborne	2
	Concordia	2
	De Soto	2
	E. Carroll	2
	Franklin	2
	Grant	2
	Jackson	2
	La Salle	2
	Lincoln	2
	Madison	2
	Morehouse	2
	Natchitoches	2
	Ouachita	2
	Rapides	2
	Red River	2
	Richland	2
	Sabine	2
	Tensas	2
	Union	2
	Vernon	2
	Webster	2
	W. Carroll	2
	Winn	2
	All others	3
MAINE		
	Entire State	1
MARYLAND		
	Entire State	1
MASSACHUSETTS		
	Entire State	1
MICHIGAN		
	Baraga	2
	Gogebic	2
	Houghton	2
	Iron	2
	Keweenaw	2
	Ontonagon	2
	All others	1
MINNESOTA		
	Entire State	2
MISSISSIPPI		
	Adams	3
	Amite	3
	Claiborne	3
	Clarke	3
	Copiah	3
	Covington	3
	Forrest	3
	Franklin	3
	George	3
	Greene	3
	Hancock	3
	Harrison	3
	Hinds	3
	Jackson	3
	Jasper	3
	Jefferson	3
	Jefferson Davis	3
	Jones	3
	Kemper	3
MISSISSIPPI - Cont'd.		
	Lamar	3
	Lauderdale	3
	Lawrence	3
	Leake	3
	Lincoln	3
	Madison	3
	Marion	3
	Neshoba	3
	Newton	3
	Pearl River	3
	Perry	3
	Pike	3
	Rankin	3
	Scott	3
	Simpson	3
	Smith	3
	Stone	3
	Walthall	3
	Warren	3
	Wayne	3
	Wilkinson	3
	All others	2
MISSOURI		
	Franklin	1
	Gasconade	1
	Jefferson	1
	Lincoln	1
	Montgomery	1
	Perry	1
	Pike	1
	St. Charles	1
	St. Francois	1
	St. Genevieve	1
	St. Louis	1
	Warren	1
	Washington	1
	All others	2
MONTANA		
	Entire State	3
NEBRASKA		
	Arthur	3
	Banner	3
	Box Butte	3
	Chase	3
	Cherry	3
	Cheyenne	3
	Dawes	3
	Deuel	3
	Dundy	3
	Frontier	3
	Garden	3
	Grant	3
	Hayes	3
	Hitchcock	3
	Hooker	3
	Keith	3
	Kimball	3
	Lincoln	3
	Logan	3
	Morrill	3
	McPherson	3
	Redwillow	3
	Perkins	3
	Scotts Bluff	3
	Sheridan	3
	Sioux	3
	Thomas	3
	All others	2
NEVADA		
	Entire State	4
NEW HAMPSHIRE		
	Entire State	1
NEW JERSEY		
	Entire State	1
NEW MEXICO		
	Entire State	3
NEW YORK		
	Entire State	1
NORTH CAROLINA		
	Entire State	2
NORTH DAKOTA		
	Barnes	2
	Cass	2
	Dickey	2
	Grand Forks	2
	Griggs	2
	Lamoure	2
	Nelson	2
	Pembina	2
	Ransom	2
	Richland	2
	Sargent	2
	Steele	2
	Traill	2
	Walsh	2
	All others	3
OHIO		
	Entire State	1
OKLAHOMA		
	Beaver	3
	Beckham	3
	Blaine	3
	Bryan	3
	Caddo	3
	Carter	3
	Choctaw	3
	Cimarron	3
	Coal	3
	Comanche	3
	Cotton	3
	Custer	3
	Dewey	3
	Ellis	3
	Garvin	3
	Greer	3
	Harper	3
	Harmon	3
	Jackson	3
	Jefferson	3
	Johnston	3
	Kiowa	3
	Love	3
	Major	3
	Marshall	3
	Murray	3
	Pontotoc	3
	Roger Mills	3
	Stephens	3
	Texas	3
	Tillman	3
	Washita	3
	Woodward	3
	All others	2
OREGON		
	Entire State	4
PENNSYLVANIA		
	Entire State	1
RHODE ISLAND		
	Entire State	1
SOUTH CAROLINA		
	Entire State	2
SOUTH DAKOTA		
	Armstrong	3
	Bennett	3
	Butte	3
	Campbell	3
	Corson	3
	Custer	3
	Dewey	3
	Fall River	3
	Gregory	3
	Haakon	3
	Harding	3
	Hughes	3
	Jackson	3
	Jones	3
	Lawrence	3
	Lyman	3
	Meade	3
	Mellette	3
	Pennington	3
	Perkins	3
	Potter	3
	Shannon	3
	Stanley	3
	Sully	3
	Todd	3
	Tripp	3
	Walworth	3
	Washabaugh	3
	Washington	3
	Ziebach	3
	All others	2
TENNESSEE		
	Entire State	2
TEXAS		
	Entire State	3
UTAH		
	Entire State	4
VERMONT		
	Entire State	1
VIRGINIA		
	Entire State	1
WASHINGTON		
	Entire State	4
WEST VIRGINIA		
	Entire State	1
WISCONSIN		
	Ashland	2
	Barron	2
	Bayfield	2
	Burnett	2
	Chippewa	2
	Douglas	2
	Dunn	2
	Eau Claire	2
	Iron	2
	Oneida	2
	Pepin	2
	Pierce	2
	Polk	2
	Price	2
	Rusk	2
	Sawyer	2
	St. Croix	2
	Vilas	2
	Washburn	2
	All others	1
WYOMING		
	Entire State	3

ST0288152

"FOAMGLAS"® INSULATION for PIPE, FITTINGS and VESSELS

Types Available are Shown in Table Below

DISCOUNT SHEET

99-L

Effective December 1, 1965
Applying to Price List FGL
Dated March 22, 1963

Any tax or other governmental charge upon the production, sale, use, or shipment of goods sold under this price list now imposed by Federal, State, or Municipal authorities, or hereafter becoming effective within the period that such price list remains in force, shall be added to each invoice, and shall be paid by Buyer. The amount of any tax or charge so added shall not be subject to any cash or other discount.

PERCENTAGES OFF LIST PRICE

TYPES AVAILABLE	FOR DELINEATION OF ZONES SEE REVERSE SIDE							
	ZONE 1		ZONE 2		ZONE 3		ZONE 4	
DISCOUNTS	CL	LCL	CL	LCL	CL	LCL	CL	LCL
REGULAR PIPE INSULATION -(Without Protective Jacket) FITTING COVERS	62%	56%	59%	52%	56%	50%	56%	44%
PIPE INSULATION STAY-DRY WHITE JACKET STAY-DRY ALUMINUM JACKET CURVED SIDEWALL SEGMENTS SPECIAL SHAPED HEAD SEGMENTS	57%	49%	52%	45%	49%	43%	49%	35%
PIPE INSULATION GLASS-FABRIC JACKETED ALUMINUM JACKETED	48%	42%	44%	38%	42%	36%	42%	30%

ST0288153

TERMS AND CONDITIONS OF SALE

All prices and discounts subject to change without notice

1. List prices include packing and are F.O.B. factory – rail freight allowed to nearest designated railroad siding or freight station. No rail freight allowance is made on shipments of less than 100 lbs.

2. Terms: 1%, 10th Prox.; Net, 30th Prox. Cash discounts are applicable to net delivered prices.

3. Carload discounts will apply to all FOAMGLAS products when total list value of order equals or exceeds $12,050.00. To determine total list value of FOAMGLAS standard flat blocks shipped in a combination carload, use a list price of $.20 per board foot.

4. Prepaid Transportation Policy:
   (a) All shipments to jobsite and to your customers' place of business will be prepaid, unless otherwise indicated on order.
   (b) Shipments to all other points will be collect.

5. (a) Orders are subject to acceptance upon receipt of specifications at our office at 277 Park Avenue, New York, New York 10017.
   (b) Orders will be invoiced at prices in effect on date of shipment, except as follows:
   In the case of any Pittsburgh Corning price advance, orders for material required to fulfill outstanding commitments on specified jobs will be invoiced at prices in effect immediately before such price advance, provided that within 10 days after the effective date of the price advance, we are furnished with the name and location of the job together with specifications of quantities required, and provided that complete shipment is made within 6 months after the effective date of the price increase.

6. (a) When shipments are made by other means than rail, any freight allowances made will be on the basis of actual transportation cost, but in no case to exceed rail rates.
   (b) Stopover shipments:
   (1) Where all destination points fall in one price zone, full rail freight allowance is made, with "stopover" charges to be for the account of the buyer.
   (2) Where destination points fall in more than one price zone the entire shipment will be billed at the zone price which is the highest, with full rail freight allowance made, and the "stopover" charges to be for the account of the buyer.

7. Changes or Cancellations of Orders:
   (a) Changes and cancellations may be made for any item which has not been fabricated by Pittsburgh Corning Corporation's factory, at the time they are notified of such changes or cancellations.
   (b) No changes or cancellations may be made for any of the materials listed under item b-1 below if they have been fabricated by our factory, except as listed under item (c).
   (1) 3½" and 4" thick pipe covering; all multiple layer pipe insulation; insulation for pipe larger than 12" I.P.S., add size pipe insulation not listed in our current Price List FGL; curved sidewall segments; shaped head segments; fitting insulation; and any other special fabricated items.
   (c) Materials other than those listed under item b-1 above may be changed or cancelled after they have been fabricated by our factory, provided they have not been loaded for shipment by the factory at the time they are notified.

8. We will not be responsible for delays occasioned by strikes, fires, accidents, transportation companies or other causes beyond our control.

9. No claims for shortages will be considered unless reported within 5 days after receipt of shipment. Claims for damaged materials should be entered by the consignee direct with the delivering carrier upon receipt of shipment.

PITTSBURGH CORNING

DOW 04645

77-L
Effective December 1, 1965
Applying to Price List FGL
Dated March 22, 1963

CONTRACTOR

PERCENTAGES OFF LIST PRICES

TYPES AVAILABLE	FOR DELINEATION OF ZONES SEE REVERSE SIDE							
	ZONE 1		ZONE 2		ZONE 3		ZONE 4	
DISCOUNTS	CL	LCL	CL	LCL	CL	LCL	CL	LCL
REGULAR PIPE INSULATION (Without Protective Jacket) FITTING COVERS	56%	49%	52%	46%	48%	43%	48%	36%
PIPE INSULATION STAY-DRY WHITE JACKET STAY-DRY ALUMINUM JACKET CURVED SIDEWALL SEGMENTS SPECIAL SHAPED HEAD SEGMENTS	47%	40%	43%	35%	37%	31%	37%	23%
PIPE INSULATION GLASS-FABRIC JACKETED ALUMINUM JACKETED	38%	33%	35%	30%	33%	27%	33%	21%

List prices include packing and are F.O.B. factory – rail freight allowed to nearest designated railroad siding or freight station. No rail freight allowance is made on shipments of less than 100 lbs.

Carload discounts will apply to all FOAMGLAS products when total list value of order equals or exceeds $12,000. To determine total list value of FOAMGLAS standard flat blocks shipped in a combination carload, use a list price of $.30 per board foot.

ST0288154

PITTSBURGH CORNING

DOW 04646

Types Available are Shown in Table Below

DISCOUNT SHEET
-33-L
Effective December 1, 1955
Applying to Price List FGL
Dated March 22, 1955

NATIONAL ACCOUNTS

PERCENTAGES OFF LIST PRICES

TYPES AVAILABLE	FOR DELINEATION OF ZONES SEE REVERSE SIDE							
	ZONE 1		ZONE 2		ZONE 3		ZONE 4	
DISCOUNTS	CL	LCL	CL	LCL	CL	LCL	CL	LCL
REGULAR PIPE INSULATION (Without Protective Jacket) FITTING COVERS	49%	43%	44%	38%	42%	36%	42%	36%
PIPE INSULATION STAY-DRY WHITE JACKET STAY-DRY ALUMINUM JACKET CURVED SEGMENTS SPECIAL SHAPED HEAD SEGMENTS	40%	31%	33%	27%	30%	23%	30%	16%
PIPE INSULATION GLASS-FABRIC JACKETED ALUMINUM JACKETED	30%	23%	27%	20%	23%	18%	23%	11%

List prices include packing and are F.O.B. factory – rail freight allowed to nearest designated railroad siding or freight station. No rail freight allowance is made on shipments of less than 100 lbs.

Carload discounts will apply to all FOAMGLAS products when total list value of order equals or exceeds $12,00 To determine total list value of FOAMGLAS standard flat blocks shipped in a combination carload, use a list pr of $.30 per board foot.

ST0288155

PITTSBURGH CORNING

DOW 04647

"FOAMGLAS"® INSULATION FOR PIPE, FITTINGS AND VESSELS

Types Available are Shown in Table Below

DISCOUNT SHEET
11-L
Effective December 1, 1965
Applying to Price List FGL
Dated March 22, 1963

CONSUMER

PERCENTAGES OFF LIST PRICES

TYPES AVAILABLE	FOR DELINEATION OF ZONES SEE REVERSE SIDE							
	ZONE 1		ZONE 2		ZONE 3		ZONE 4	
DISCOUNTS	CL	LCL	CL	LCL	CL	LCL	CL	LCL
REGULAR PIPE INSULATION (Without Protective Jacket) FITTING COVERS	43%	37%	38%	32%	35%	29%	35%	22%
PIPE INSULATION STAY-DRY WHITE JACKET STAY-DRY ALUMINUM JACKET CURVED SIDEWALL SEGMENTS SPECIAL SHAPED HEAD SEGMENTS	31%	24%	27%	18%	22%	15%	22%	7%
PIPE INSULATION GLASS-FABRIC JACKETED ALUMINUM JACKETED	21%	16%	18%	11%	16%	9%	16%	3%

List prices include packing and are F.O.B. factory – rail freight allowed to nearest designated railroad siding or freight station. No rail freight allowance is made on shipments of less than 100 lbs.

Carload discounts will apply to all FOAMGLAS products when total list value of order equals or exceeds $12,000. To determine total list value of FOAMGLAS standard flat blocks shipped in a combination carload, use a list price of $.30 per board foot.

ST0288156

PITTSBURGH CORNING

FOAMGLAS® BLOCKS
DISTRIBUTOR PRICE LIST
Effective December 1, 1968
(Net Prices)

TERMS AND CONDITIONS OF SALE
All Prices Subject to Change Without Notice

1. Prices are F.O.B. factory – rail freight allowed to nearest designated railroad siding or freight station. Allowances to and from points having restrictions on LCL shipments will be based on the applicable rail rates. Rail freight allowance on shipments of less than 100 lbs. is on basis of actual weight of shipment.
2. Carload prices will apply for any combination of less than carload quantities of any FOAMGLAS products provided the applicable minimum carload weight required is loaded in the car.
3. Terms: 1%, 10th Prox.; Net, 30th Prox. Cash discounts are applicable to listed prices.
4. Jobsite Delivery Charges:
   (a) When "jobsite" delivery is requested on orders this service will be provided at an additional cost of 4/10¢ ($.004) per board foot, subject to the following limitations:
      (1) Applicable only for carload shipments (30,000 bd. ft. or over) when job is *less* than 20 miles from rail siding.
      (2) Pittsburgh Corning reserves the right to ship by either:
         a. Rail to the nearest siding, then by truck to jobsite, or
         b. Truck straight to the jobsite.
5. Prepaid Transportation Policy:
   (a) All shipments to "jobsite" and to your customers' place of business will be prepaid, unless otherwise indicated on order.
   (b) Shipments to all other points will be collect.
6. (a) Orders are subject to acceptance upon receipt of specifications at our office at 277 Park Avenue, New York, New York 10017.
   (b) Orders will be invoiced at prices in effect on date of shipment, except as follows:
      In the case of any Pittsburgh Corning price advance, orders for material required to fulfill outstanding commitments on specified jobs will be invoiced at prices in effect immediately before such price advance, provided that within 10 days after the effective date of the price advance, we are furnished with the name and location of the job together with specifications of quantities required, and provided that complete shipment is made within 6 months after the effective date of the price increase.
7. (a) When shipments are made by other means than rail, any freight allowance made will be on the basis of actual transportation cost, but in no case to exceed rail rates.
   (b) Stopover Shipments:
      (1) Where all destination points fall in one price zone, full rail freight allowance is made, with "stopover" charges to be for the account of the buyer.
      (2) Where destination points fall in more than one price zone the entire shipment will be billed at the zone price which is the highest, with full rail freight allowance made, and the "stopover" charges to be for the account of the buyer.
8. Shipments made in full cartons or bundles only.
9. We will not be responsible for delays occasioned by strikes, fires, accidents, transportation companies or other causes beyond our control.
10. No claims for shortage will be considered unless reported within 5 days after receipt of shipment. Claims for damaged materials should be entered by the consignee direct with the delivering carrier upon receipt of shipment.
11. Any tax or other governmental charge upon the production, sale, use or shipment of goods sold under this price list now imposed by Federal, State, or Municipal authorities, or hereafter becoming effective within the period that such price list remains in force, shall be added to each invoice, and shall be paid by Buyer. The amount of any tax or charge so added shall not be subject to any cash or other discount.
12. Shipping Description: Rail – Insulating Material, Cellular Vitreous (In solid flat blocks or boards)
    Truck – Insulating Material, Cellular Vitreous

PITTSBURGH CORNING®

One Gateway Center Pittsburgh, Pa. 15222

Printed in U.S.A.

ST0288157

FOAMGLAS® BLOCKS DISTRIBUTOR PRICE LIST
EFFECTIVE DECEMBER 1, 1968
(NET PRICES)

FOR DELINEATION OF PRICE ZONES SEE BACK PAGE

QUANTITY BRACKETS	AVAILABLE SIZES AND THICKNESSES		PRICES PER SQUARE FOOT – F.O.B. FACTORY – RAIL FREIGHT ALLOWED													
			ZONE 1	ZONE 2	ZONE 3	ZONE 4	ZONE 5	ZONE 6	ZONE 7	ZONE 8	ZONE 9	ZONE 10	ZONE 11	ZONE 12	ZONE 13	Cal. ZONE 14
LESS THAN 30,000 BOARD FEET	12" x 18" ONLY	1½"	$.226	$.232	$.232	$.238	$.243	$.247	$.253	$.267	$.267	$.279	$.289	$.289	$.304	$.309
	12" x 18" ONLY	1¾"	.264	.271	.271	.278	.283	.289	.296	.311	.311	.325	.338	.338	.355	.360
	12" x 18" AND 18" x 24"	2"	.301	.309	.309	.317	.323	.329	.337	.355	.355	.371	.385	.385	.405	.411
		2½"	.378	.388	.388	.398	.406	.413	.423	.446	.446	.466	.483	.483	.508	.516
		3"	.452	.464	.464	.476	.485	.494	.506	.533	.533	.557	.578	.578	.608	.617
		3½"	.527	.541	.541	.555	.566	.576	.590	.622	.622	.650	.674	.674	.709	.720
		4"	.602	.618	.618	.634	.646	.658	.674	.710	.710	.742	.770	.770	.810	.822
		5"	.753	.773	.773	.793	.808	.820	.843	.888	.888	.928	.963	.963	1.013	1.028
30,000 BOARD FEET AND OVER	12" x 18" ONLY	1½"	.217	.219	.222	.225	.226	.229	.235	.238	.238	.244	.247	.247	.250	.250
	12" x 18" ONLY	1¾"	.254	.255	.259	.262	.264	.268	.275	.278	.278	.285	.289	.289	.292	.292
	12" x 18" AND 18" x 24"	2"	.289	.291	.295	.299	.301	.305	.313	.317	.317	.325	.329	.329	.333	.333
		2½"	.363	.366	.371	.376	.378	.383	.393	.398	.398	.408	.413	.413	.418	.418
		3"	.434	.437	.443	.449	.452	.458	.470	.476	.476	.488	.494	.494	.500	.500
		3½"	.506	.510	.517	.524	.527	.534	.548	.555	.555	.569	.576	.576	.583	.583
		4"	.578	.582	.590	.598	.602	.610	.626	.634	.634	.650	.658	.658	.666	.666
		5"	.723	.728	.738	.748	.753	.763	.783	.793	.793	.813	.823	.823	.833	.833

DOW 04650

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PRICE ZONES

State Counties Zone
ALABAMA
Entire State 7
ARIZONA
Entire State 14
ARKANSAS
Entire State 9
CALIFORNIA
Entire State 14
COLORADO
Entire State 13
CONNECTICUT
Entire State 2
DELAWARE
Kent 2
New Castle 1
Sussex 2
DIST. OF COLUMBIA
Entire Area 2
FLORIDA
Escam 6
Duval 6
All others 8
GEORGIA
Entire State 6
IDAHO
Entire State 13
ILLINOIS
Boone 3
Cook 1
DeKalb 5
DuPage 1
Ford 3
Grundy 3
Iroquois 3
Kane 1
Kankakee 3
Kendall 3
Lake 1
LaSalle 3
Livingston 3
McHenry 5
Will 3
All others 4
INDIANA
Entire State 5
IOWA
Clinton 6
Dubuque 6
Jackson 6
Scott 6
All others 7
KANSAS
Wyandotte 7
All others 9
KENTUCKY
Ballard 6
Boone 4
Calloway 6
Campbell 4
Carlisle 6
Fulton 6
Graves 6
Hickman 6
Hopkins 6
Livingston 6
Marshall 6
McCracken 6
All others 5
LOUISIANA
Beauregard 10
Bienville 10
Bossier 10
Caddo 10
Calcasieu 10
Cameron 10
Claiborne 10
De Soto 10
Natchitoches 10
Red River 10
Sabine 10
Vernon 10
Webster 10
All others 8
MAINE
Androscoggin 2
Cumberland 2
Oxford 2
Penobscot 2
York 2
All others 4
MARYLAND
Allegany 2
Anne Arundel 2
Baltimore 2
Calvert 2
Caroline 2
Carroll 2
Cecil 2
Charles 2

State Counties Zone
MARYLAND - Cont'd.
Dorchester 2
Frederick 2
Garrett 2
Harford 2
Howard 2
Kent 2
Montgomery 2
Prince Georges 2
Queen Annes 2
St. Marys 2
Somerset 2
Talbot 2
Washington 2
Wicomico 2
Worcester 2
MASSACHUSETTS
Entire State 2
MICHIGAN
Bay 4
Berrien 4
Hillsdale 4
Huron 4
Ingham 4
Jackson 4
Lapeer 4
Lenawee 4
Livingston 4
Macomb 4
Monroe 4
Oakland 4
Saginaw 4
St. Clair 4
Sanilac 4
Schiawassee 4
Tuscola 4
Washtenaw 4
Wayne 4
Balance of lower peninsula 5
All upper peninsula 4
MINNESOTA
Entire State 7
MISSISSIPPI
Entire State 8
MISSOURI
St.Louis City& Co. 6
All others 7
MONTANA
Entire State 13
NEBRASKA
Douglas 7
All others 9
NEVADA
Entire State 14
NEW HAMPSHIRE
Entire State 2
NEW JERSEY
Atlantic 2
Cape May 2
Cumberland 2
Sussex 2
All others 1
NEW MEXICO
Entire State 13
NEW YORK
Albany 2
Bronx 1
Broome 2
Chemung 2
Chenango 2
Columbia 2
Delaware 2
Dutchess 2
Greene 2
Kings 1
Nassau 1
New York 1
Orange 2
Otsego 2
Putnam 2
Queens 1
Rensselaer 2
Richmond 1
Rockland 1
Schenectady 2
Schoharie 2
Suffolk 1
Sullivan 2
Tioga 2
Ulster 2
Westchester 1
All others 3
NORTH CAROLINA
Entire State 8
NORTH DAKOTA
Entire State 9
OHIO
Ashtabula 3
Belmont 3
Carroll 3

State Counties Zone
OHIO - Cont'd.
Columbiana 3
Coshocton 3
Cuyahoga 3
Geauga 3
Guernsey 3
Harrison 3
Holmes 3
Jefferson 3
Lake 3
Mahoning 3
Medina 3
Monroe 3
Washington 3
Noble 3
Portage 3
Stark 3
Summit 3
Trumbull 3
Tuscarawas 3
Wayne 3
All others 4
OKLAHOMA
Entire State 9
OREGON
Entire State 14
PENNSYLVANIA
Adams 2
Bayhr 2
Bradford 1
Bucks 1
Carbon 2
Center 2
Chester 2
Clinton 2
Columbia 2
Cumberland 2
Dauphin 2
Delaware 2
Franklin 2
Huntingdon 2
Juniata 2
Lackawanna 2
Lancaster 2
Lebanon 2
Lehigh 2
Luzerne 2
Lycoming 2
Mifflin 2
Monroe 2
Montgomery 2
Montour 2
Northampton 2
Northumberland 2
Perry 2
Philadelphia 1
Pike 2
Schuylkill 2
Snyder 2
Sullivan 2
Susquehanna 2
Tioga 2
Union 2
Wayne 2
Wyoming 2
York 2
All others 3
RHODE ISLAND
Entire State 2
SOUTH CAROLINA
Entire State 8
SOUTH DAKOTA
Entire State 9
TENNESSEE
Anderson 6
Bledsoe 6
Blount 6
Bradley 6
Campbell 6
Carter 6
Claiborne 6
Coffee 6
Cumberland 6
Fentress 6
Grainger 6
Greene 6
Hamblen 6
Hamilton 6
Hancock 6
Hawkins 6
Jefferson 6
Johnson 6
Knox 6
Loudon 6
Marion 6
Meigs 6
Monroe 6
Morgan 6

State Counties Zone
TENNESSEE - Cont'd.
Pickett 6
Polk 6
Rhea 6
Roane 6
Scott 6
Sequatchie 6
Sevier 6
Smith 6
Unicoi 6
Union 6
Washington 6
All others 7
TEXAS
Anderson 10
Angelina 10
Aransas 10
Archer 10
Austin 10
Bastrop 10
Baylor 10
Bee 10
Bell 10
Bexar 10
Blanco 10
Bosque 10
Bowie 10
Brazoria 10
Brazos 10
Brewster 13
Brown 10
Burleson 10
Burnet 10
Caldwell 10
Calhoun 10
Camp 10
Cass 10
Chambers 10
Cherokee 10
Clay 10
Collin 10
Colorado 10
Comal 10
Comanche 10
Cooke 10
Coryell 10
Cottlerson 13
Dallas 10
Delta 10
Denton 10
De Witt 10
Eastland 10
Ellis 10
El Paso 13
Erath 10
Falls 10
Fannin 10
Fayette 10
Fort Bend 10
Franklin 10
Freestone 10
Galveston 10
Gillespie 10
Goliad 10
Gonzales 10
Grayson 10
Gregg 10
Grimes 10
Guadalupe 10
Hamilton 10
Hardin 10
Harris 10
Harrison 10
Hays 10
Henderson 10
Hill 10
Hood 10
Hopkins 10
Houston 10
Hudspeth 13
Hunt 10
Jack 10
Jackson 10
Jasper 10
Jeff Davis 13
Jefferson 10
Johnson 10
Kaufman 10
Kendall 10
Kerr 10
Kimble 10
Lamar 10
Lampasas 10
Lavaca 10
Lee 10
Leon 10
Liberty 10
Limestone 10
Llano 10
McLennan 10
Madison 10

State Counties Zone
TEXAS - Cont'd.
Marion 10
Matagorda 10
Milam 10
Mills 10
Montague 10
Montgomery 10
Morris 10
Nacogdoches 10
Navarro 10
Newton 10
Nueces 10
Orange 10
Palo Pinto 10
Panola 10
Parker 10
Parmer 13
Polk 10
Presidio 13
Rains 10
Red River 10
Reeves 13
Refugio 10
Robertson 10
Rockwall 10
Rusk 10
Sabine 10
San Augustine ... 10
San Jacinto 10
San Patricio 10
San Saba 10
Shelby 10
Smith 10
Somervell 10
Stephens 10
Terrant 10
Titus 13
Titus 10
Travis 10
Trinity 10
Tyler 10
Upshur 10
Van Zandt 10
Victoria 10
Walker 10
Waller 10
Washington 10
Wharton 10
Wichita 10
Williamson 10
Wilson 10
Wise 10
Wood 10
Young 10
All others 11
UTAH
Entire State 13
VERMONT
Entire State 3
VIRGINIA
Buchanan 2
Dickenson 2
Lee 2
Russell 2
Scott 2
Washington 2
Wise 2
All others 3
WASHINGTON
Entire State 14
WEST VIRGINIA
Entire State 2
WISCONSIN
Ashland 7
Barron 7
Bayfield 7
Buffalo 7
Burnett 7
Chippewa 7
Clark 7
Douglas 7
Dunn 7
Eau Claire 7
Iron 7
Jackson 7
Juneau 5
Milwaukee 5
Pepin 7
Pierce 7
Polk 7
Price 7
Racine 5
Rusk 7
St. Croix 7
Sawyer 7
Taylor 7
Trempealeau 7
Washburn 7
All others 6
WYOMING
Entire State 13

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DOW 04651

Table XVI illustrates the closeness of pricing among Foamglas, calcium silicate, and Fiberglas. Foamglas prices are for finished pipe insulation manufactured by Pittsburgh Corning. In areas such as the Gulf coast area, Foamglas fabricators supply their customers with Foamglas pipe covering fabricated by them at the same price as calcium silicate.

C. R. Richardson, of Styrothane, Inc., Freeport, Texas, a fabricator contractor, verified that he sells Foamglas to Dow at the same price as calcium silicate or expanded perlite. He says he has been forced into the situation by Anco in Baton Route and some of the other Foamglas distributors in the area. According to Richardson he is only breaking even when he does this. He says that the spread should be 10 percent to 20 percent greater than the calcium silicate pricing.

In most areas of the United States Foamglas pipe covering is more expensive than calcium silicate. In Midland Dow must pay 10 percent to 20 percent more for Foamglas depending on size, than for calcium silicate or perlite.

ST0288160

TABLE XVI

INSULATION CONTRACTOR'S COST FOR 3 COMMON PIPE SIZES AND 2" THICK INSULATION

PIPE SIZE		FOAMGLASS			CAL. C1L. AND PERLITE		FIBERGLAS	
		LIST	LESS 62% DISTRIBUTOR	LESS 56% CONTRACTOR	LIST	LESS 2% CONTRACTOR	LIST	LESS 3% CONTRACTOR
CARLOAD	2"	2.50	.95	1.10	1.00	.98	1.00	.97
	4"	3.50	1.30	1.50	1.35	1.32	1.35	1.31
	6"	5.10	1.94	2.24	1.70	1.66	1.70	1.65
		LIST	-56%	-49%	LIST	-18%	LIST	-10%
LESS THAN CARLOAD	2"	2.50	1.10	1.28	1.00	1.18	1.00	1.10
	4"	3.50	1.50	1.78	1.35	1.59	1.35	1.49
	6"	5.10	2.24	2.60	1.70	2.01	1.70	1.87

PRICES ARE F.O.B. PLANT FREIGHT ALLOWED ON CARLOADS

DOW 04653

STO28819

TWO INDUSTRY PROBLEMS

Asbestosis

The major problem confronting the high temperature industry today is asbestosis. This disease, which is caused by the inhaling of minute asbestos fibers, has been recognized during the past several years by government and private industry alike as being a hazard for the asbestos worker, and in the area of spray insulation, for the public in general.

As recently as July 20, 1970, the Daily Record of Baltimore, Maryland, a legal newspaper reported the proceedings in which the Court of Appeals of Maryland upheld a lower court's order for the Workman's Compensation Commission of Maryland to pay an asbestos worker of 36 years, $30,000 because of total disability attributable to asbestosis.[2]

John Pollock, Executive Director, of the National Insulation Contractors Association (NICA) stated that he expects in some states, asbestos workers will be excluded from coverage under workman's compensation as a result of the asbestosis problem.

Johns-Manville, a major producer of asbestos has launched a low key public relations campaign to refute the health hazard charges that have been leveled against asbestos containing products.[3] Johns-Manville issued a press release that included a paper by Dr. George Wright, Director of Medical Research at St. Lukes Hospital, in Cleveland. The release stated that the talk was delivered to the American Thoracic Society last year. The paper in essence stated that asbestos does not present a danger to the general public. According to the Air and Water News from which this information was obtained, Johns-Manville

[2] See copy in Appendix

[3] June 15, 1970, Air and Water News, Page 5.

ST0288162

neglected to mention that Dr. Wright was also chairman of the scientific committee of the Institute of Occupational and Environmental Health in Montreal, Canada. The group was formed five years ago by the Quebec Asbestos Mining Association. The implication was that Dr. Wright could not necessarily be unbiased in his findings.

The severity of the problem to the insulation industry might be illustrated by a couple of examples: Mike Katcher, head of insulation for the Naval Ship Engineering Department in Hyattsville, stated that the Navy has quietly placed a ban on the use of insulation materials containing more than 15 percent asbestos fibers aboard naval vessels. This eliminates the use of Unibestos manufactured by Pittsburgh-Corning. However, it does allow practically all calcium silicate on the market for the time being. According to Katcher, Johns-Manville and the other major producers of asbestos have been informed that the percentage of asbestos fibers allowable will continue to drop until no asbestos fiber content will be acceptable. No date has been named by the Navy for this elimination of asbestos fibers. Katcher emphasized, however, that they meant business and as a result the major companies are working hard to find substitutes. Another example closer to home is The Dow Chemical Company. The only product similar to calcium silicate being accepted for use in Dow plants today is Carey Temp 1500. This product contains no asbestos fibers as opposed to the approximate 15 percent asbestos content of the calcium silicate products. Carey Temp 1500 is a molded pipe covering consisting of expanded perlite and binders.

Basically asbestosis is caused by the unique physical characteristics of asbestos to subdivide longitudinally into fibrils of molecular diameter. Many of these fibrils are less than four or five microns in diameter and can be inhaled into the lung where they remain, creating scar tissue. This scar tissue impairs the lungs so severely that they cannot absorb sufficient oxygen. There is no cure. Death, a strangulating, coughing demise, is the only end.

ST0288163

Fibrous glass, although suspect by some researchers, probably can never be classified as big a hazard as asbestos. This is because fibrils of glass fiber range between 3 and 15 microns and the amount which is below 5 microns and respirable is very low. It would be assumed that since fiberglass is a manufactured product, the size of the fibrils could be increased if it is proven that fibrils or less than 5 microns are detrimental to the workmen's health.

The consensus among the people interviewed in this study, such as: the Navy Department, The Asbestos Workers Union, the National Insulation Contractors Association, end users such as Shell Chemical, du Pont, etc., is that asbestosis is the major problem in the industry. Practically all persons interviewed were enthusiastic about the prospect of Dow Ceramic Foam being the replacement for the asbestos containing calcium silicate.

ST0288164

INDUSTRY PROBLEMS

Auto Ignition as described in Dow Chemical Engineering Practices manual, Section MB-205, is a phenomenon of self-ignition due to heating or oxidation resulting in combustion which may occur in thermal insulations where leaking oil or organic fluids have been absorbed into the insulation. It is evidenced by smoking of the insulation, which, when uncovered may be found to be glowing or may burst into flame spontaneously. Although the exact mechanism is not known, it does appear that it is preceded by some kind of reaction resulting from heat retention and oxidation with a definite lowering of the apparent ignition temperature of the organic material which continues over a period of time. One incident occurred approximately 10 hours after start up of a cold process.

According to Les Engles of Dow Plant Engineering, Midland, auto ignition occurred 30 times in two years before they started using Foamglas around the areas where leaks could occur such as pumps, valves, etc. Present practices call for the use of Foamglas around these areas to about 6 or 8 inches on each side of the leak. A stop ring is installed between the Foamglas and other insulation. This stop ring is welded, or banded and caulked, to prevent the flow of any leakage to calcium silicate, fibrous glass, or perlite type insulation.

Auto ignition is a common problem throughout the industry. Chemical plants refineries, and the ship building industry are areas where the control or elimination of this phenomenon is a continuous battle because of the catastrophic conditions which unchecked fires can bring.

The specifiers, end users, and contractors interviewed in this study, felt that the non-wicking property of Dow Ceramic Foam coupled with its incombustibility could eliminate this problem.

ST0288165

PRODUCT INFORMATION REQUIRED BY SPECIFIERS AND APPLICATORS

An investigation as to the type of information required by the specifying influences was attempted in this study. Engineers, contractors and owners were questioned to determine what information should be presented in Dow sales or technical brochures.

The intent of this investigation was to ferret out the most important information required by the persons specifying pipe and vessel insulation, not to design the brochures in detail.

Information needed by specifiers in sales brochures:

1. "k" factor - a table illustrating the "k" factor at temperatures throughout the use range of the product.

2. Compressive strength - wet and dry at various temperatures as listed in ASTM #C533 Calcium Silicate Block and Pipe Thermal Insulation.

3. Perm Rating - emphasize the non-wicking properties of Dow Ceramic Foam.

4. Stress Corrosion Characteristics - list the amount of soluble chlorides PPM.

5. Thermal Shock Properties - For example, if DCF has good properties state "6" OD pipe covering with a 2 inch wall can withstand temperature changes of -20°F to +400°F in 30 minutes 500 times without failure. Or some similar expression illustrating Ceramic Foam's exceptional thermal shock properties.

6. Furnish Spec Compliances - Federal - Military - ASTM, etc.

ST0288166

7. Furnish thickness tables for various temperatures for pipe and vessel covering.

8. Incombustibility Information - State if can be used for fire protection.

9. Suggested application specifications naming accessory items required.

In determining the information needed for specification work the possible use of one layer of Ceramic Foam for pipe insulation up to 1,200°F was explored.

The standard practice in the industry is to use two layers when the temperature exceeds 600°F. The reason for this is that the old 85 percent magnesia, which was the major high temperature insulation for many years, would not withstand greater temperatures. Johns-Manville introduced a product called SUPEREX, a calcined diatomaceous silica, which would withstand temperatures up to 1,900°F. It then became common practice at temperatures over 600°F to use SUPEREX on the first layer and 85 percent magnesia as the outer layer. This combined the high heat resistance of the diatomaceous silica with the better "k" factor and lower price of the 85 percent magnesia.

ST0288167

During the past five to ten years this combination has been replaced by calcium silicate products. However, the use of two layers at 600°F has continued because of the shrinkage characteristics of calcium silicates coupled with the pipe expansion conditions experienced at elevated temperatures.

Table XVII was prepared by W. G. Phillips, Technical Service and Development for this study to illustrate the expansion characteristics of several types of metal piping as compared to Dow Ceramic Foam.

It appears that one layer of DCF could be used satisfactorily on wrought iron and soft steel up to 1,000°F without too much difficulty since the difference is about 2-1/2 to 3-1/2 inches per 100 lineal feet at that temperature. Assuming pipe insulation sections of three feet long, this would mean approximately 1/10 inch opening between each section.

The determination must be made by TS&D whether or not excessive heat loss would be experienced at the joints in one layer construction, which could produce scorched or burned jacketing. It should be considered also that two-layer construction minimizes thermal stresses in the insulation by reducing the temperature differential across each layer.

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TABLE XVII

THERMAL EXPANSION

(IN INCHES PER 100 LINEAR FEET)

TEMPERATURE TEMPERATURE (°F)	WROUGHT CRUCIBLE ALUMINUM ALUMINUM (12.8×10^{-6})	COPPER COPPER (9.3×10^{-6})	WROUGHT IRON (6.7×10^{-6})	SOFT STEEL (6.1×10^{-6})	STAINLESS STEEL, 18-8 (9.9×10^{-6})	CERAMIC FOAM (*)	FOAMGLAS (4.6×10^{-6})
75°	0	0	0	0	0	0	0
100°	0.384	0.279	0.205	0.183	0.297	0.088	0.138
150°	1.152	0.836	0.603	0.549	0.893	0.263	0.414
200°	1.192	1.395	1.015	0.914	1.488	0.472	0.692
250°	2.690	1.954	1.408	1.282	2.080	0.658	0.967
300°	3.460	2.563	1.820	1.650	2.678	0.848	1.245
350°	4.250	3.052	2.220	2.080	3.265	1.035	1.540
400°	5.000	3.622	2.618	2.380	3.862	1.225	1.800
450°	5.755	5.158	3.020	2.744	4.460	1.450	2.076
500°	6.505	4.704	3.420	3.112	5.060	1.642	2.352
550°	7.300	5.300	3.820	3.480	5.650	1.837	2.626
600°	8.055	5.860	4.220	3.842	6.245	2.026	2.904
650°	8.850	6.420	4.620	4.220	6.840	2.244	3.180
700°	9.600	6.970	5.030	4.580	7.435	2.438	3.455
750°	10.035	7.535	5.430	4.940	8.030	2.632	3.725
800°	11.505	8.090	5.830	5.320	8.625	2.940	.020
850°	11.905	8.650	6.240	5.670	9.220	3.142	-----
900°	12.675	9.200	6.640	6.040	9.815	3.345	-----
950°	13.450	9.760	7.040	6.420	10.281	3.546	-----
1,000°	14.375	10.035	7.440	6.775	11.000	4.060	-----

*Varies from ~ 2.9×10^{-6} to 3.4×10^{-6}

NOTE: Expansion coefficients for all materials except for D.C.F. are assumed to be constant over the indicated temperature range.

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