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DOW-231

D. M. Greason

THE HIGH TEMPERATURE EQUIPMENT INSULATION MARKET

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C. N. Williams
March 31, 1965

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MARKETING RESEARCH DEPARTMENT
THE DOW CHEMICAL COMPANY

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THE HIGH TEMPERATURE EQUIPMENT INSULATION MARKET

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SUMMARY

This study describes the nature, scope and marketing procedures of the high temperature (200°F to 2000°F) insulation industry. The total value is estimated to be about $200 million annually. About 80% of the industry is in pipe and vessel insulation, the other 20% is in board or slab form. The industry is growing at an annual rate of about 8%.

Approximately 60% of the industry's products are [illegible] made from [illegible] materials. The remainder consists of [illegible] products. [illegible] insulation products are used in temperatures above 1200°F. [illegible] 1200°F to 1600°F. [illegible] 1600°F to 2000°F. [illegible] 2000°F. [illegible] 1200°F. [illegible] 1600

Summary - [illegible]

Of [illegible] interest are the economics of the rib or bolt stock vs. the economics of the molded shapes (i.e. pipe) [illegible]. Raw material costs play a much more critical part in the cost of [illegible] stock [illegible] than [illegible] of specific shapes. Thus, [illegible] economic advantage over wide goods for rib stock [illegible] extensively used for pipe [illegible].

[illegible]

[illegible]

[illegible]

Summary - [illegible]

The Dow foamed glass development in research does not fit well into the picture which was developed. This situation is based on three primary factors:

1. Economics. The raw material costs [illegible] them are high. While they may be lowered [illegible] siderably, our incomplete knowledge of the economics of manufacture of molded shapes out of Dow [illegible] glass is a distinct drawback. Molded shapes constitute the bulk of the market.

2. The properties of Dow [illegible] offer no significant advantages [illegible] tions would indicate that [illegible] ment of the market totaling $20 [illegible] very best. This would have to be shared [illegible] several other companies [illegible] market.

3. [illegible]

[illegible]

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HIGH TEMPERATURE EQUIPMENT INSULATION MARKET

I. PURPOSE AND METHODOLOGY

The purpose of this study was to describe the scope of the high temperature insulation industry, its products and its marketing procedures. Specifically, the study was undertaken to furnish information in support of a decision whether or not to continue effort on a research project concerned with foamed glass. It was felt that this product may have possibilities as a high temperature insulation. This product is referred to as Dow cellular glass in this report.

The information was obtained from reference manuals, brochures, articles in journals, questionnaires and personal communication with insulation manufacturers, distributors, contractors, labor and consumers. The various contacts and bibliography are given in Exhibit I of the Appendix. The dollar value was estimated by cross-referencing and comparing localized and individual estimates and figures. The scope of this study encompassed insulation used in the temperature ranges roughly from 200°F. to 2000°F.

The information was gathered while the author was on special assignment to the Marketing Research Department from the Physical Research Laboratory. G. E. Olson assisted in the preparation of the summary.

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II. PRODUCT DESCRIPTION

The various types of thermal insulation are listed in Table I along with their most important physical properties. Figure 1 is provided as a quick reference to the temperature usage of the various types.

Thermal insulation made from the materials listed on Table I are supplied in various forms to do different jobs. They are molded or cut into cylinders, half cylinders or curved segments for application to piping, and into flat or curved blocks for vessels and large equipment. Insulating cements come in dry form to be mixed with water, for application by trowel to irregular surfaces, or as a final finish on other types. Fibrous materials, in addition to the above forms, also come in flexible blankets, semi-rigid felts, and loose and granulated forms.

Pipe insulations are made in "simplified thicknesses", in which the outside insulation diameter is approximately the same as the diameter of standard iron pipe, so that building up the thickness of insulation in layers is possible. Actual thicknesses are related to but vary above and below nominal thicknesses. All pipe insulations are furnished in 1/2, 1, 1-1/2, 2, 2-1/2 inch, etc., nominal thicknesses and in specifying and ordering, pipe insulation is referred to by pipe size and nominal thickness only.

The various types of high temperature thermal insulations are discussed below. The manufacturing processes for each important type of insulation are described in Exhibit II of the Appendix.

Fiber Glass

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Fiber glass insulations are manufactured from specific proportions of silica and other glass-forming compounds. These are fused and drawn, flame-blasted or spun into boro-silicate glass fibers of consistent chemical composition. The fibers are combined with binders and molded into self-contained boards and cylindrical pipe insulation, with or without binders they are formed into flexible blankets and semi-rigid felts. They also come in the loose form in containers.

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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		
UNIBESTOS	BLOCK & PIPE COVERING	AMOSITE ASBESTOS FIBERS COMBINED WITH DIATOMACEOUS SILICATE AND SPRAYED WITH A SILICATE BINDER	1200°F	1200°F	100°F – 0.32 200°F – 0.37 300°F – 0.42 400°F – 0.47 500°F – 0.52	14-20#/Cu. FT.	ACIDS – GOOD CAUSTICS – GOOD	0.01% @ 750°F 0.05% @ 1200°F	WILL NOT CONTRIBUTE	WILL NOT CONTRIBUTE	SINGLE LAYER MAY BE USED TO 1200°F. GOOD THERMAL SHOCK RESISTANCE RELATIVELY HIGH STRENGTH	LOSSES SOME STRENGTH WHEN WET.
FOAMGLAS	BLOCK, PIPE COVERING CURVED SEGMENTS & LAGS	INORGANIC PURE GLASS CONTAINING MULTI-SEPARATE HERMETICALLY SEALED CELLS.	800°F	800°F	100°F – 0.42 200°F – 0.48 300°F – 0.56 400°F – 0.66 500°F – 0.78	9#/Cu. FT.	ACIDS – GOOD CAUSTICS – GOOD SOLVENTS – GOOD	NONE	WILL NOT CONTRIBUTE	WILL NOT CONTRIBUTE	HIGH COMPRESSIVE STRENGTH. INCOMBUSTABLE. EASILY FABRICATED. VAPOR RESISTANT.	REQUIRES CLOSE FITTING. LOW RESISTANCE TO ABRASION AND IMPACT.
GLASS, FIBROUS WITH BINDER	PIPE COVERING	FINE FIBROUS GLASS WITH PHENOLIC RESIN BINDER. AVAILABLE IN A VARIETY OF CANVAS, WATER-PROOF FELT, DUAL TEMP AND FIRE-RETARDANT JACKETS.	450°F	550°F	75°F – 0.24 100°F – 0.25 200°F – 0.35	7 1/2#/Cu. FT.	ACIDS – GOOD CAUSTICS – GOOD SOLVENTS – POOR	UNKNOWN	WILL NOT CONTRIBUTE	S.S. SHOULD BE PROTECTED	RESILIENT, AVAILABLE WITH A VARIETY OF FACINGS. LIGHT-WEIGHT	LOW COMPRESSIVE STRENGTH
85% MAGNESIUM	BLOCK, PIPE COVERING	NOT LESS THAN 85% (BY VOL.) HYDRATED MAGNESIUM CARBONATE AND BALANCE ASBESTOS FIBERS	600°F	600°F	100°F – 0.31 TO 0.35 200°F – 0.36 TO 0.39 300°F – 0.43 TO 0.48	10 TO 15#/Cu. FT.	ACIDS – POOR CAUSTICS – FAIR SOLVENTS – FAIR	0.05% @ 500°F 1.0% @ 600°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	2300°F	2300°F	400°F – 0.38 1000°F – 0.88 1800°F – 1.48 2300°F – 1.87	10 TO 20#/Cu. FT.	ACIDS – GOOD CAUSTICS – FAIR TO POOR SOLVENTS – EXCELLENT	0.5% @ 1800°F 4.0% @ 2300°F			EXCELLENT THERMAL SHOCK RESISTANCE. WILL WITHSTAND FLAME IMPINGEMENT	
ASBESTOS FIBER (SPONGE FELT)	BLOCK, PIPE COVERING	ASBESTOS FIBER FELTS LAMINATED WITH CEMENT	700°F	550°F	100°F – 0.38 200°F – 0.42 300°F – 0.48 400°F – 0.54	25 TO 33#/Cu. FT.		4.3% @ 550°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	1200°F	100°F – 0.30 TO 0.33 400°F – 0.46 TO 0.51 800°F – 0.63 TO 0.69	10 TO 13#/Cu. FT.	ACIDS – POOR CAUSTICS – FAIR SOLVENTS – GOOD	1.5% @ 1200°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 BROKEN PIECES FALL APART, NOT SUITABLE FOR BRIDGING GAPS. DOUBLE LAYER REQUIRED ABOVE 600°F BECAUSE OF HIGH SHRINKAGE.
DIATOMACEOUS SILICATE	BLOCK, PIPE COVERING	CALCINED DIATOMACEOUS SILICATE BLENDED WITH VERMICULITE, ASBESTOS AND HYDRAULIC BINDER	1600°F TO 1800°F	1600°F TO 1600°F	200°F – 0.50 TO 0.64 600°F – 0.67 TO 0.73 1000°F – 0.74 TO 0.75	21 TO 25#/Cu. FT.	ACIDS – GOOD CAUSTICS – GOOD SOLVENTS – GOOD	2.0% @ 1600°F	WILL NOT CONTRIBUTE	S.S. MUST BE PROTECTED	HANDLES WELL RELATIVELY STRONG	LOSES MOST OF STRENGTH WHEN WET. UNSUITABLE TO BRIDGE GAPS. DIFFICULT TO PREFABRICATE.
MINERAL WOOL	BLOCK, PIPE COVERING	MINERAL WOOL FIBERS WITH INORGANIC BINDER	1700°F TO 1900°F	1700°F TO 1900°F	100°F – 0.29 TO 0.34 200°F – 0.40 TO 0.46 300°F – 0.51 TO 0.64	14 TO 22#/Cu. FT.	ACIDS – POOR CAUSTICS – POOR SOLVENTS – EXCELLENT	1.1% @ 1200°F 2.0% @ 1900°F		S.S. MUST BE PROTECTED	EASILY FITTED, FLEXIBLE TO A DEGREE. WITHSTANDS CONSIDERABLE EXPANSION AND CONTRACTION	WILL NOT RESIST MECHANICAL ABUSE. SOFT. UNSUITABLE FOR FABRICATION OR FITTING COVERS
EXPANDED SILICA — FIBERS	BLOCK, PIPE COVERING	EXPANDED SILICA WITH SPECIAL BINDER AND REINFORCED WITH INORGANIC FIBER	1600°F	1600°F	100°F – 0.33 500°F – 0.51 800°F – 0.66 1000°F – 0.77	8 TO 10#/Cu. FT.	ACIDS – EXCELLENT CAUSTICS – EXCELLENT SOLVENTS – GOOD	0.7% @ 1200°F 1.2% @ 1600°F	WILL NOT CONTRIBUTE	WILL NOT CONTRIBUTE	GOOD THERMAL SHOCK RESISTANCE. LOW SHRINKAGE. LOW WATER ABSORPTION. CAN BE PREFABRICATED	WILL FRACTURE INTO PIECES

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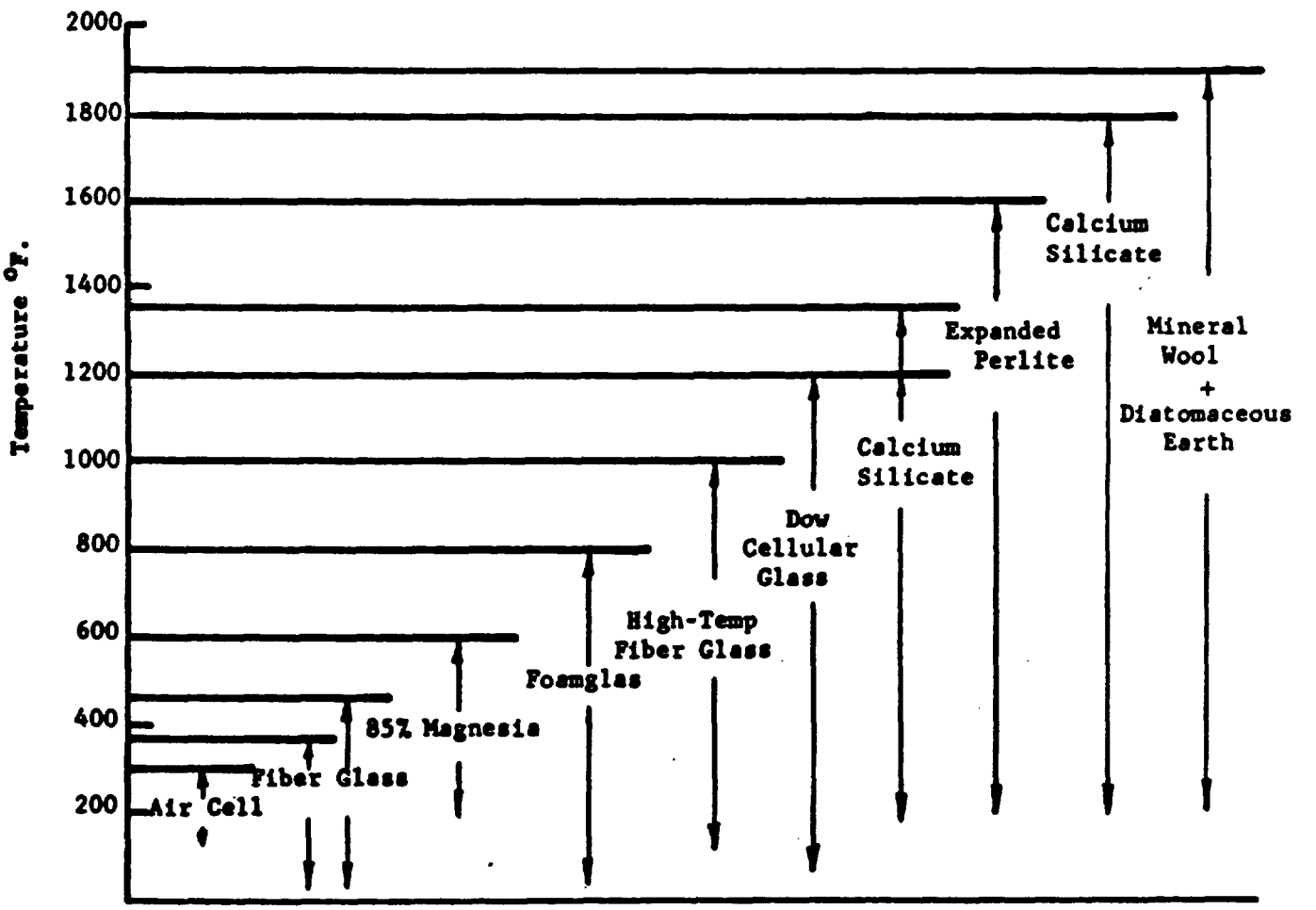
Figure 1. Insulation Products vs. Temperature



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Fiber glass is making rapid inroads into the insulating field temperature range 200-400°F. where 85% magnesia was once king. The 85% magnesia portion of the market has dropped from about 50% of the market to less than 2% in the last ten years. Calcium silicate also has captured some of the 85% magnesia market at the upper temperature range of 300-600°F. Owens-Corning Fiberglas has aimed at this and other market segments also with new fiber glass products using higher temperature binders. Because the glass itself will withstand better than 1000°F. the temperature resistance of the binder is the current limiting factor to broader usage.

Two Owens-Corning Fiberglass products, called "IS" and "High Temp" are bonded with an inorganic system with suggested use temperatures of 700°F. and 1000°F. respectively. Experimental quantities are priced at $.26-.28 per board foot for a density of 10.75 pcf and k factor of .321 at 70°F. Pipe insulation will be available about mid 1965 at a price competitive with calcium silicate.

Fiber glass insulation has the advantage of lower k factor, lighter weight, flexibility, a multitude of factory applied coverings, and one-piece snap-on construction, which add up to less breakage, easier handling and lower installation costs. Despite these advantages, fiber glass is not the ultimate product. Besides its low elevated temperature limit, it has a poor compressive strength, will absorb liquids, and causes some itching discomfort during handling due to the needle-like fibers. There is some reported lung trouble due to glass fiber dust.

The greatest drawback for the low density fiber glass (three pounds or below) is that it is very difficult to secure desirable seals at the joints. A poor appearance is produced by the compression of the insulation and the crimping of the vapor jacket. An installation of this type would have a sausage-like appearance. A second drawback also related to the low compressive strength is the damage done to the vapor seal, appearance, and loss of insulation value due to the internal compression of the fibers on crimping. Further, when ladders

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or scaffolding are placed against or on the insulation, similar damage results. Locations of known physical abuse like this are usually insulated with calcium silicate type insulation.

The differentiation between fiber glass and mineral wool has been narrowed by additions to and further refining of mineral wool producing slag glass by some of the former mineral wool producers. The product is claimed to be a finer fiber and shot free compared with the old mineral wool but is not as yet as fine or resilient as regular fiber glass.

Calcium Silicate

Calcium silicate is made from silica and lime, molded with a small amount of asbestos fiber, and chemically converted by steam pressure autoclaving into a hydrous calcium silicate called tobermorite with a formula $4CaO \cdot 5SiO_2 \cdot 5H_2O$. It is furnished in pipe sections and in flat and curved blocks, to be applied on heated surfaces up to approximately 1200°F.

A second type of calcium silicate of slightly higher density called xonotlite with a formula $5CaO \cdot 5SiO_2 \cdot H_2O$ is suitable for temperatures up to 1800°F.

85% Magnesia

Eighty-five percent magnesia is a molded material composed principally of basic magnesium carbonate reinforced with asbestos fiber. It is used on heated surfaces at temperatures up to 600°F., and comes in semi-cylindrical sections and segments for pipes, and in flat and curved blocks for other surfaces. It also comes in dry cement form to be mixed with water and applied in a plastic state to pipe fittings and other irregular surfaces. Where temperatures exceed 600°F. it is often used as the outer layer over a diatomaceous silica inner layer.

Use of 85% magnesia has dropped to less than 2% of the present market and will soon be gone entirely. There are presently only one

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or two manufacturers producing 85% magnesia according to the Baldwin-Ehret-Hill Detroit office. Baldwin-Ehret-Hill ceased production in September 1964.

Diatomaceous Silica

Diatomaceous earth insulation is made from the siliceous remains of microscopic diatoms, using clay, lime and asbestos for bonding and reinforcing. It is molded into pipe sections and segments, and into flat and curved blocks for large surfaces. One type is suitable for temperatures to approximately 1600°F. and a second type to 1900°F. It is often used as the inner layer of two-layer insulation construction so as to permit use of a lower temperature, density, and thermal conductivity product as the outer layer. The 1600°F. type has a density of 21-22 pcf, and the 1900°F. type 23-25 pcf. Diatomaceous silica also is available in aggregate form for fill and as an ingredient for cements.

Expanded Perlite (Silica)

Perlite is an inert siliceous volcanic rock containing some combined water. When crude perlite particles are heated above 1600°F., the water vaporizes and perlite expands 10 to 20 times its original volume. Expanded perlite contains countless tiny, glass-sealed air cells or bubbles. For molded insulation products the perlite is combined with binders and reinforced with inorganic fibers. It is suitable for temperatures to 1600°F.

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Mineral Fibers (Rock and Slag)

Rock and slag fibers are made by melting siliceous rocks and slags and steam-blowing or spinning the molten mass into fibers. These are combined with binders and formed into boards, blocks and cylindrical pipe sections; blankets or felts are sometimes encased in wire mesh. Fibers in loose or granulated form are used for packing into spaces. Combined with high-temperature bonding clay or other binders to form cements, they are applied by troweling to form a monolithic insulation.

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Blocks and boards with inorganic binders, such as bonding clay and asbestos fiber, are used up to 1800°F., in densities from 16-24 pcf.

One type of blanket, with felted fibers held between wire mesh and with or without binders, is used on flat and cylindrical surfaces at temperatures up to 1200°F. Density ranges from 6-15 pcf. One type of cement used with mineral wool, applied in several heavy coats to build the required thickness, has a density of 24-30 pcf and is used at temperatures up to 1800°F. A second type, a hydraulic-setting finishing cement, is quick hardening, has a density of 30-35 pcf, and is used up to 1200°F.

Glass (Cellular)

Foamglas, the only cellular glass now on the market and made by Pittsburgh Corning, is made from a modified boro-silicate type of glass, melted and foamed by a heating and chemical process. The resulting rigid glassy material contains sealed cells and weighs approximately 8-10 pcf. It is used for insulating piping and equipment operating at temperatures up to 800°F. The material is furnished in pipe sections and in flat and curved blocks.

Foamglas was first placed on the market in 1942. Several factors contribute to the production of this new material, but most important were:

1. An idea that there was a need for a waterproof, fireproof, inorganic material for a low density and low thermal conductivity material to serve industry as an insulant.
2. The Navy's need for a buoyancy material which would stand up well in salt water, be buoyant enough to float anti-submarine nets, and withstand the action of enemy bullets.

Since the United States was at war during 1942, the larger part of the development of Foamglas was pointed toward the production of a buoyancy item. From Foamglas a cube was formed approximately 8' on a side. These were protected on the outside

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by heavy planking. They were floated out into the mouths of harbors and rivers by the thousands and there used to hold up steel anti-submarine nets. During the war years, the vast quantity of Foamglas produced was used for this purpose; however, some Foamglas was available and was used as an insulant for roofs, cold storage and wall insulation for humidity controlled buildings such as exist in the textile industry.

Because the availability of Foamglas was somewhat limited during the war years, the development of commercial markets had to be restricted and, as a consequence, Foamglas was first well known in certain parts of the country while in other areas promotional efforts and selling were delayed. Immediately after the war, however, it was thought that a full-fledged country-wide campaign would be started. This did not take place, it developed, because the increasing popularity of Foamglas placed a strain upon production facilities. Improvements were installed at Pittsburgh Corning, Port Allegany, Pennsylvania plant which increased its capacity well over 50% but even this was not sufficient to satisfy growing needs. Late in 1951 a new plant at Sedalia, Missouri was placed in operation, virtually doubling the capacity and in 1952 additional improvements increased it still further. In 1960 Mr. Lovett of the Pittsburgh Corning Corporation stated that they made approximately 100 million board feet per year or a little less.

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Asbestos

In the insulation industry, asbestos is used primarily as a reinforcement for the rigid calcium silicate type insulation. Normally up to 15% by weight is used, however; much higher percentages are used in Pittsburgh Corning Unibestos and the various sprayed-on insulations. The medium length asbestos fibers that sell in the range of $120-250 per ton are used for the reinforcement.

A recent investigation and report has shown that workers in the asbestos and asbestos associated industries have a much higher incidence of a rare form of cancer known as Mesothelioma. Previous work had found that lung cancer and possibly gastrointestinal cancer were markedly increased also.

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Sprayed Insulation

Sprayed-on thermal insulations are being introduced by an increasing number of manufacturers or suppliers. The insulations are composed of asbestos and asbestos-mineral wool fibers suspended in a slurry and sprayed-in-place on large tanks, ducts and boilers. The manufacturers or suppliers trade names and temperature lists are listed in the Appendix, Exhibit III, Table VI-F. A page of notes on a particular installation follows Table VI-F in the Appendix.

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Jacketing

Jacketing of high temperature thermal insulation has been undergoing major transformation for some time. It has progressed from the on-the-job application of cotton canvas and paint to factory applied canvas to factory applied fiber glass mesh reinforced foil coatings to the use of present day aluminum and stainless steel jackets applied both at the factory and on-the-job. Some canvas is still applied on-the-job to insulation used by maintenance personnel. The usage of aluminum and stainless steel jackets will not completely eliminate the canvas, asphalt, and fiber glass coverings However, in areas of extreme physical abuse, extreme weather, chemical, heat or fire exposure the metal jackets are always used.

Plain cotton canvas jacket cloth is available in 4, 6 and 8 ounce weights. Owens-Corning is introducing a new close weave Fiberglas jacket which looks like the cotton canvas but will have higher strength, longer life, rot and fire resistance. The weather and chemical exposure on the Gulf Coast is extremely hard on the canvas and asphalt type jackets.

Aluminum jacketing is available as plain or corrugated in eight different thicknesses ranging from .006" to .025" with the most common two thicknesses being .016" and .020". Aluminum elbows are processed from .025" and .032" stock. The trade union which has jurisdiction for applying the on-the-job aluminum jacket varies in different parts of the country. Generally, however, the Asbestos Workers can apply up to .019" while the Sheet Metal Workers are

required for the heavier gauge aluminum. Dow Metal Products Company has supplied several jacket fabricators with aluminum coil for processing.

Stainless steel jacketing has within the last year become somewhat competitive with aluminum. Generally the 300 series stainless steel is used, is .010" thick, and used only in areas of chemical or physical exposure too severe for aluminum. It is felt that in a year or two the price will be directly competitive with aluminum and that both metals will be used at an accelerated rate. At present if factory applied metal jacket is used, asbestos workers would install it regardless of thickness or type. It is not clear yet as to who would apply on-the-job stainless steel as few contractors have had experience with this material. No mention of stainless steel jacketing as such is made in the present labor agreements. U. S. Steel is one large supplier of stainless steel coils to the manufacturers of jackets.

A listing of metal jacket suppliers is given below:

Stainless	Aluminum
Insul-Coustic, Inc.	Asefco
Johns-Manville	Childers
Midwestern Metals, Inc.	Fleet Marking
Mirror Insulation	General Aluminum Supply
Owens-Corning	Johns-Manville
Pabco	Midwestern Metals, Inc.
Philip Carey	Mirror Insulation
Pittsburgh Corning	Pabco
Smith Products, Inc.	Philip Carey
	Pittsburgh Corning
	Preformed Metal Products Co.
	Smith Products, Inc.

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III. PRODUCT SYSTEM

Pipe insulations are made in "simplified thickness" in which the outside insulation diameter is approximately the same as the diameter of standard iron pipe, so that building up the thickness of insulation in layers is possible. Actual thicknesses are related to but vary above and below nominal thicknesses so that every size will exactly fit over or into another standard size and thickness. "Simplified thickness" was introduced in 1954 to reduce the number of standard sizes and thicknesses of covering required. All pipe covering insulations are furnished as nominal thickness and pipe size when specifying and ordering as listed in the Appendix, Exhibit III, Table VII.

Factory molded insulation fittings have not been universally accepted. On the surface they appear to be a boon to cost savings, however, many adverse conditions come forward on close analysis. The first is the extra time and details required to estimate by establishing degree of angle, clearance, flanges, pipe diameter, and welded or threaded joints for the molded fittings required. Compound this with the additional ordering, lead time, invoicing, warehousing, breakage, labor's reluctance, and availability, it becomes quite apparent that the economics are unfavorable. Molded insulation fittings are made and used but only to the extent that the consumer specifies. Several companies that manufacture them are listed below:

Fibrous Glass Products, Inc.
Insul-Coustic Corp.
Johns-Manville
Philip Carey Mfg. Co.

Labor has also been reluctant, but is beginning to accept the two-piece factory molded fittings, however, it has not accepted the shop fabricated mitered fittings. Mitered fittings must be made on the job, however, special jigs are available for this resulting in little time difference. Another critical point to be considered is the measured fit required to lay up the fitting with a tight joint with the straight run on either side. This exact measurement is not

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required with the built-up asbestos cement systems. Labor defends this built-up system as a skill of their trade which is cheaper and as good or better appearing than the molded fitting. A change in fitting design, etc., may subject the premolded insulation pieces to obsolescence. A premolded fitting may have to be trimmed or cut on the job if too close pipe or wall tolerances are encountered. The built-up system would be made to order for this application, that is if two hands can get to the work.

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IV. MARKET SIZE AND DESCRIPTION

The total high temperature insulation market is valued at about $200 million to the manufacturer. About 75% or $150 million of this is of fibrous glass type products including mineral wool. The remaining $50 million is made up of what is known in the trade as white goods. White goods are the silicates, perlite and diatomaceous earth products. Of this group, the largest volume is enjoyed by the calcium silicate type products. Foamglas is not a very significant factor at all in high temperature insulation. Figure 2 depicts the market breakdown for 1964 by temperature usage and type based on a percent of the total market on a dollar basis. Figure 3 further describes the market breakdown for 1964 by establishing the temperature limits as well as the percent market volume as indicated by the blocked off areas. The high temperature insulations are not used much below 1000°F. because of their higher cost, higher k factor, and greater density. The 1200°F. class insulation is 180°F. to 1200°F. inclusive because of the cyclic nature of much equipment in this temperature range.

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Table II gives the usage breakdown by area and by type of customer. It will be quickly seen that the market is concentrated in the north east U. S. and along the Gulf Coast. Further, it will be noticed that the chemical,refining and electric power industries account for almost all of the white goods segment of the market. It is significant that the fibrous glass is largely consumed by the category which may be called general construction. Owens-Corning's new high temperature fibrous glass products are undoubtedly an effort on their part to capture more of the white goods market segment. The basic reasons the "white goods" can't compete with fibrous glass in the lower temperatures are primarily because of unfavorable economics and k factor. Exhibit IV in the Appendix gives background material used to develop market size.

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Figure 2. % Material Dollar vs. % Temperature Usage, 1964

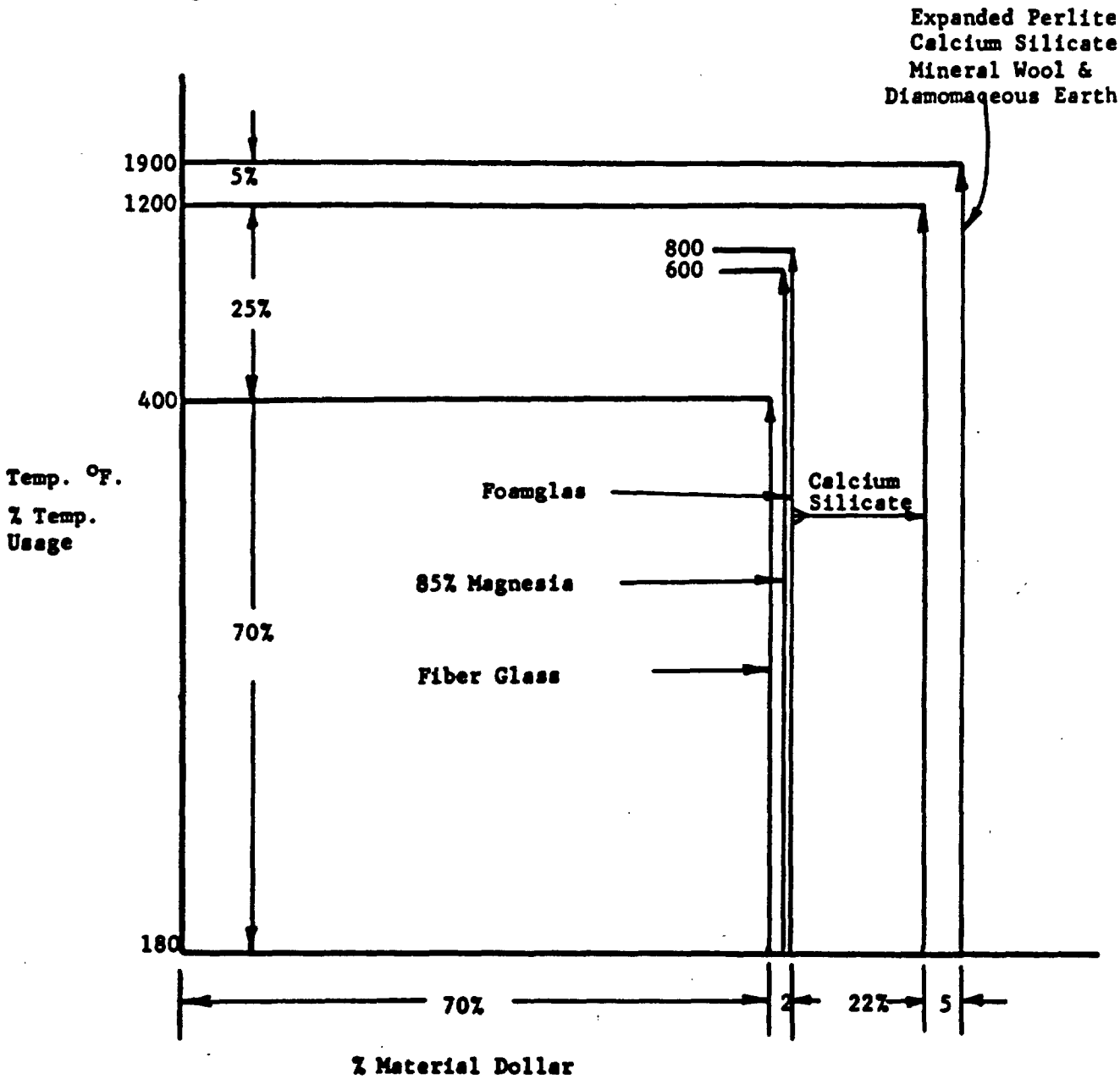

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Figure 3. High Temperature Insulation Use Temperature as Percent of Market Designated by the Area Blocks

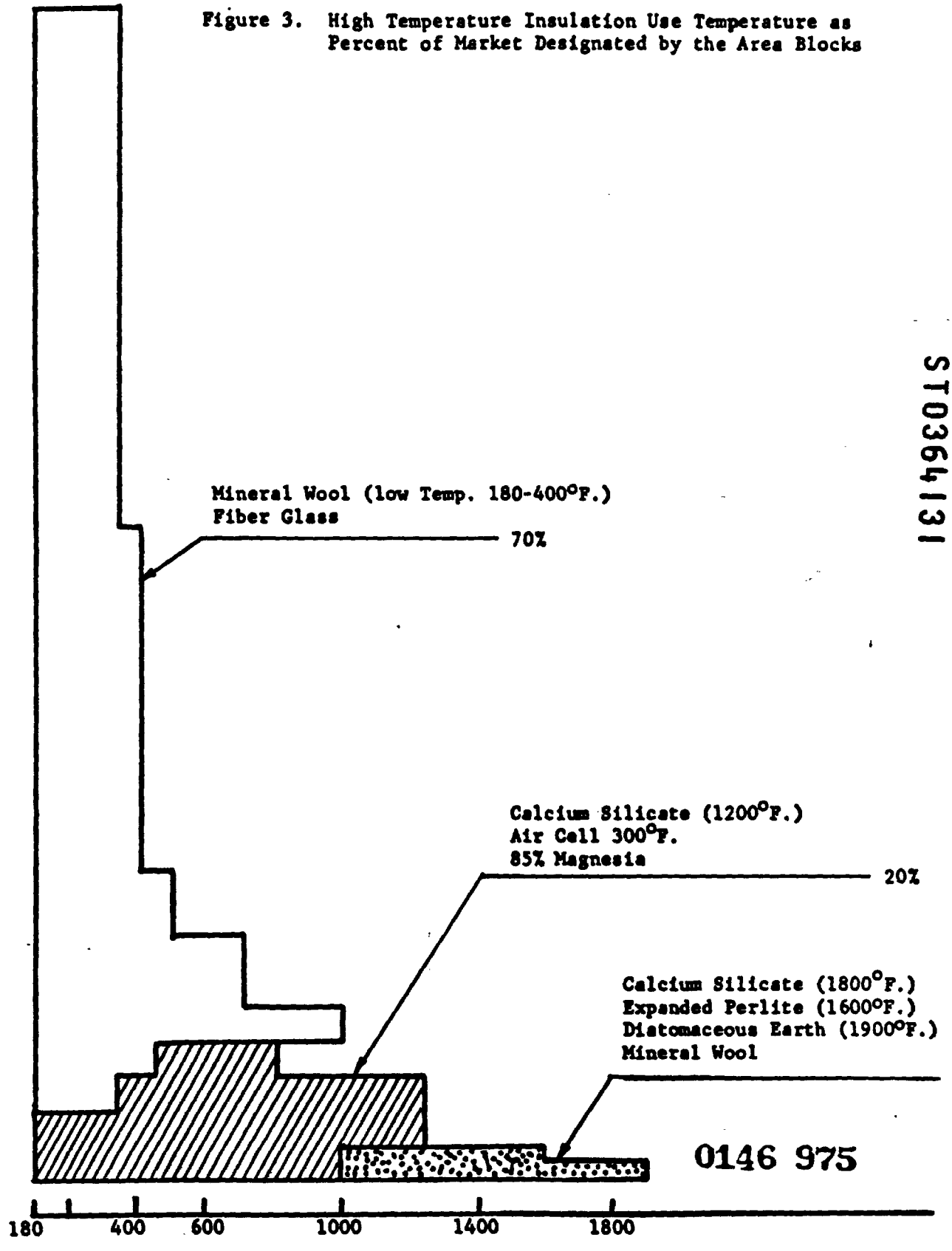

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Table II

Market Breakdown by Area & Type of Customer

Consumer	% Total Market	% Insulation Usage			
		Fibrous		White Goods	
		%	$ x 10^6	%	$ x 10^6
Chemical) Petro-Chem.) - Refinery)	10	10	2	90	18
Power (steam)	10	10	4	80	16
Other construction					
Industrial)		(85)		(15)	
Commercial) -	80	-(90)-	144	- (10)-	16
Schools &)		(95)		(5)	
Hospitals)					
			$150		$50

Geographic	% Total Insulation	% White Goods
East Coast	25	25
Gulf Coast	25	35
West Coast	10	10
Great Lakes-Ohio River Valley	25	20
Remainder U.S.	15	10

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A percent of the market consumption trend for 1954 to 1975 for fiber glass, 85% magnesia, and calcium silicate is shown in Figure 4. It is readily apparent that 85% magnesia is being replaced nearly completely by fiber glass and calcium silicate. Baldwin-Ehret-Hill ceased production of 85% magnesia in September of 1964. Foamglas is included since it does serve as a dual temperature pipe covering insulation and as block on heated tanks. Its usage is limited because of its sensitivity to thermal shock.

Fiber glass growth is expected to continue at 10-12 % a year and control up to 80% of the high temperature insulation market by 1970. At present fiber glass is placed at 70-75% of the material dollar.

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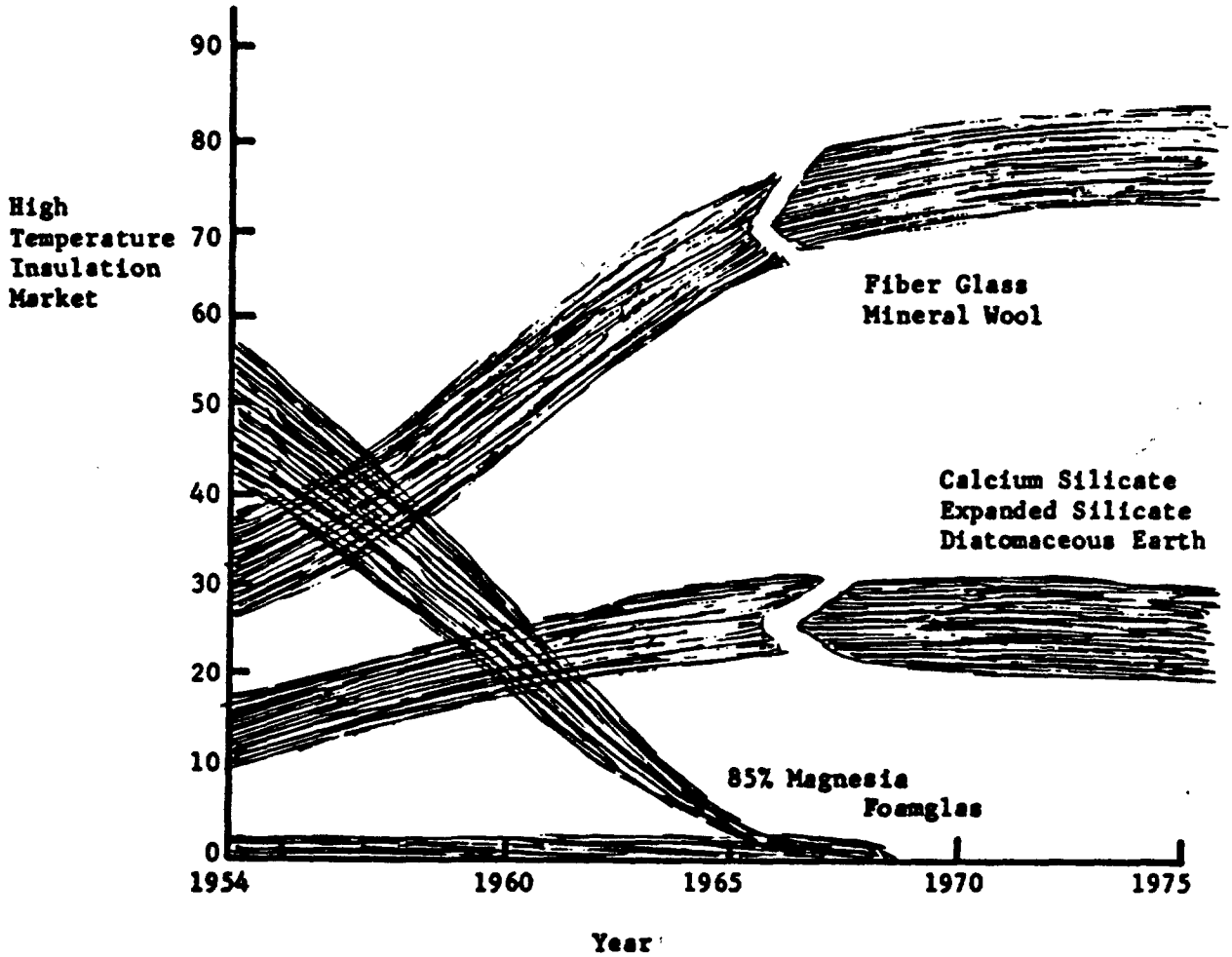
Figure 4. Consumption Trend of High Temperature Insulations as a Percent of the High Temperature Insulation Market (180-1200°F.) for the Period 1954-1975



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V. PRICE STRUCTURE

A convenient tool used by the thermal insulation trade to facilitate easier price quoting for the multiplicity of insulation sizes was developed and is known as the "List Prices of August 1, 1907" It now includes prices for all pipe sizes from 1/2" through 33" and for insulation thicknesses from 1" through 5" and has been further enlarged to a reference book with prices for each percent from -99 to +99 from the basic price index, known as "List Net". Each percent is known as its corresponding table where the discounts or negative percents have the minus sign dropped (-20% = Table 20), however, on the positive side, the plus sign is retained (+20% = Table +20). The "List Net" price index page is reproduced in the Appendix, Exhibit III, Table VII.

Nearly all distribution and using levels that sell or buy thermal insulation use these tables as a very effective time saver and means of eliminating typographical errors when one considers the vast variety of insulations required, especially by chemical and refinery operations. As an example Dow, Midland in 1964 used four different thicknesses of calcium silicate type insulation on 17 different pipe sizes.

It is normal procedure to have the same table quoted for a given type and thickness of insulation foam 1/2" to 12" pipe as illustrated below.

Average Price for One-Piece Glass Fiber Pipe Covering

Truckloads	Table	
1/2" thick*	44	(-44% from List Net)
3/4" thick	27	
1" & thicker	5	
LCL		
1/2" thick	38	
3/4" thick	17	
1" & thicker	+5	

*Note: For insulation thickness less than 1" thick the 1" column is used from the desired table.

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VI. COMPARATIVE ECONOMICS

Table III gives a quick economic comparison of the various high temperature insulations of the k value at 100°F. The relative economics at k values for higher temperatures are not greatly different and hence have been omitted. Calcium silicate has been used as a base for comparison because of its dominance of the market at higher temperature ranges. Three prices have been listed for Dow cellular glass. It will be noted that only at the 17¢/board foot price is it competitive with the going price for calcium silicate insulation. Because of current interest in foamed clay it has also been included in this table. The data show it to be very competitive at the price of 9.5¢/board foot.

The above data are based on board stock and not on unusual shapes such as for pipe and vessel covering. Because 80% of the dollar volume of the high temperature insulation market is in pipe covering some attempt to relate the above economics to unusual shapes is necessary. The cost of fiber glass and calcium silicate pipe covering expressed as board foot costs for several different sizes are given in Table IV. The figures were developed from costs obtained from the Dow Material Center.

For each material, the lineal foot price reduced to a board foot price does not appear to vary a great deal with the various pipe sizes. However, a comparison of Tables III and IV is in order. The price of fiber glass is in the vicinity of 10¢/board foot in Table III and calcium silicate in the vicinity of 22¢/board foot. In Table IV the board foot price of fiber glass pipe insulation is reduced to an average price in the vicinity of 40¢/board foot. This is an increase of four times while calcium silicate under similar scrutiny does not even double in price. Thus, the costs of converting fiber glass into pipe insulation must be considerably greater than that for calcium silicate.

The relation of board stock economics to pipe shape economics needs to be explored further in view of our interest in foamed clay and its potential as a high temperature insulation. Firstly, it is

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Table III

Board: Comparative Economics

Material	Upper Temp. Limit °F.	Density	Price*	k 100°F.	Equiv.*** Price
Calcium Silicate	1200	11.50	.22	.31	.22
Fiber Glass	400	3	.07	.24	.0541
Fiber Glass	400	7.25	.10	.25	.0806
Foamglas	800	9	.14	.42	.19
O-C High Temp	1000	10.75	.28	.30	.271
Dow Cellular Glass	1200	12	.17 .22 .25	.4 - .41	.225 .290 .330
Mineral Wool	1900	12	.10	.29	.0935
Foamed Clay	-	10 - 12	.095	.46**	.138

*Price per board foot to distributor

**75°F.

***Equiv.: Calcium silicate 1200°F. is taken as a base and the insulation equivalent is calculated by $\frac{k_2}{k_1} \times \text{price}_2$ where

k_1 = calcium silicate 1200°F.; k_2 = other material;

price_2 = price other insulation.

questionable validity in view of changing k with mean temp.

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Table IV

Pipe Covering Costs Expressed as Board Foot Costs

(Dow Material Center Price)

A Fiber Glass Pipe Covering - 3/4" Thickness (Nominal)

insulation I.D. — price/BF based on nominal thk.

List	Price Per Linear Foot		Table From List	Pipe Size Nominal	Pipe Size Actual	Actual Thickness			Cubic Inch Per Linear Foot		Board Foot		Price Per Board Foot Equivalent	
.22	$.204	.2046	-7	½	.84	.86	.76	.442	68.2	67.6	.474	.469	$.431	.436
.27	.250	.2511	-7	1	1.32	1.33	.77	.448	83.6	83.0	.580	.576	.431	.436
.36	.334	.3348	-7	2	2.38	2.41	.80	.429	120.7	120.0	.837	.833	.399	.402
.40	.366	.3660	-8½	2½	2.88	2.91	.80	.416	136.0	135.0	.945	.938	.346	.390
.50	.465	.4650	-7	3½	4.00	4.03	.76	.429	159.0	158.1	1.105	1.098	.421	.424
.65	.601	.6013	-7½	4½	5.00	5.03	.79	.466	197.0	195.9	1.370	1.360	.440	.442

Volume - Circum. x 12" x thickness
Assumes fiber glass is compressed to higher density on inside circumference.

B. Calcium Silicate Pipe Covering - 1" Thickness (Nominal)

List						I.D.								
.22	$.209	.2090-5	$.4227	½	.84	.86	1.01 1.00		58.0	69.33	.483	.481	$.433	.435
.27	.256	.2565-5	.3740	1	1.32	1.33	1.08 1.06		79.5	95.1	.661	.660	.387	.389
.36	.342	.3420-5		2	2.38	2.41	1.04 1.03		107.0	132.3	.890	.919	.384	.372
.40	.380	.3800-5		2½	2.88	2.91	1.04 1.03		152.0	151.8	1.06	1.054	.359	.361
.50	.530	.5300+6		3½	4.00	4.03	1.30 1.28		212.2	254.8	1.77	1.769	.299	.300
.65	.689	.6890+6		4½	5.00	5.03	1.30 1.28		301.8	303.0	2.12	2.104	.325	.327
.80	.764	.7600-5		6	6.63	6.70	.96 .97		232.0	217.9	1.93	1.930	.396	.394

Volume of Calcium Silicate per linear foot = $V_1 - V_2$ where V_2 is the volume of the cylinderical hole for the pipe and V_1 is the volume of the whole cylinder including the hole.

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to be noted that here foamed clay presents an attractive competitive situation in board form. Further, it cannot be predicted that these same favorable economics would exist for foamed clay in pipe form because the manufacturing process for this conversion has not been investigated. In view of this, it seems reasonable to regard foamed clay similar to Foamglas and have fabricators make pipe insulation as they do with Foamglas for chilled water lines.

In one case, a rough comparison of Foamglas and Carey Temp pipe insulation was given by a fabricator even though Foamglas cannot technically compete with Carey Temp in the high temperature ranges. The data are presented below. The basis is 1-1/2" thick insulation for a 1-1/2" pipe.

	Foamglas	Carey Temp
Materials	46¢/lineal ft.*	56¢/lineal ft.
Labor to install	30¢/ft.	30¢/ft.
Labor to cover	25¢/ft.	-
Material to cover	12¢/ft.	
	$1.13 /ft.	86¢/ft.

*Foamglas cost and cost to fabricate into proper shape.

B. 60 list

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At first glance this would not appear to be a very favorable position for foamed clay if it were substituted for the Foamglas. In actuality, this probably is the case. However, because of foamed clay's favorable board form economics and with fabricating and installing costs staying fairly constant, the picture should become more favorable in the greater thicknesses and larger sizes where the materials assume a larger portion of the cost.

It is not felt necessary to delve into this situation any further at this point. It has been mentioned because of foamed clay's potentially strong position with respect to competing with Foamglas in the low temperature pipe insulation market. A marketing effort on foamed clay in this area would most likely include fabricators to form the foamed clay into proper shapes. A logical sequence would be to expect these fabricators to use fabricated foamed clay where it would compete with factory formed calcium

silicate shapes. Further, if foamed clay is in their hands the potential exists of using the block form in place of other materials on the basis of the assumed favorable economics.

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VII. INDUSTRY STRUCTURE

The manufacturer-distributor-contractor system mode and size of operation varies by company and with the volume of business in a given market area. It is also in a state of change. This is discussed in the Appendix in Exhibit III. Johns-Manville is the only major basic manufacturer of the three basic insulation raw materials: mineral wool, fiber glass and white goods. The other firms are basic producers of but one or two material lines and are supplied by others using either their own or the original producers trade names. This is especially true in the sundry material line where Flintkote, Benjamin Foster and Insul-Coustic are the major suppliers. A sample listing of sundry insulation materials is given in the Appendix in Exhibit III, Table I.

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Two basic manufacturer-supplier systems are encountered. Type 1 is headed by the manufacturer-supplier that owns or controls a distributor-contractor outlet (captive) while the Type 2 manufacturer sells directly to an independent contractor. Generally, the captive operations are found in market areas with sales of "white goods" type insulation of over two million dollars per year.

The big five with captive distributor-contractor operations are Johns-Manville, Owens-Corning, Armstrong, Baldwin-Ehret-Hill and Philip Carey. Johns-Manville and Owens-Corning control over half of the business directly and an additional 25% through independent contractors. Baldwin-Ehret-Hill purchased the insulating contracting division of Mundet in 1964 to compete in the contractor phase. Philip Carey does not publicize the fact that they are in the contracting phase, but feel they must maintain these units in the larger market areas. They have closed some of their contracting units where the power struggle between Johns-Manville and Owens-Corning has built up.

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Some insulation manufacturing companies that do not have captive distributor-contractor are Pittsburgh Corning, Pittsburgh Plate Glass, Ruberoid, Pabco, Eagle-Picher and Nicolet Industries. These, others like them, and the big five mentioned above have only

a few franchised and many well established independent insulation contractors whom they supply a complete line of insulation products. A block diagram of the insulation industry complex is given in Table V and the insulation lines manufactured or supplied by the various insulation firms are shown in the Appendix, Exhibit III, Table II. The home office and manufacturing plants are also listed in the Appendix, Exhibit III, Table III.

The economic life of the independent contractor is somewhat established by an unwritten mutual agreement with the large distributor-contractor system. The agreement pertains to the size of each job. In Buffalo a $10,000 contract is good, while in New York City a $60,000 contract is considered good for an independent contractor.

The additional asbestos workers required on a large contract that the smaller independent contractor would need are recognized as a make or break factor in regard to extra cost and quality of workmanship. The ASTM, Military and Federal Specifications for industrial insulation are given in the Appendix, Exhibit III, Table IV.

The several materials described in the Materials System section are grouped in Figure 1 on an increasing temperature capability scale and as such make up an over-lapping complete line of insulating materials. The insulation product line is described in general blanket, board, and pipe covering categories in the Appendix, Exhibit III, Table V by type of insulating material and temperature. A more specific breakdown by type of insulation products by manufacturer, trade name, density, and temperature is also shown in the Appendix, Exhibit III, Table VI.

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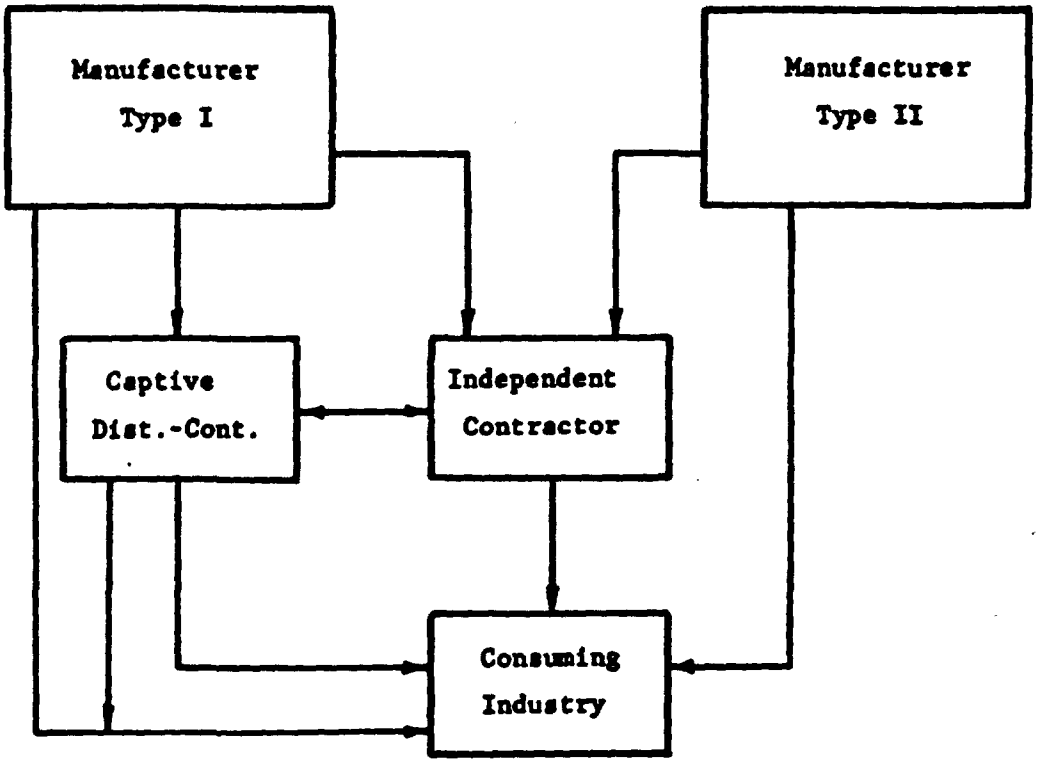
Table V. The Insulation Industry Complex
Manufacturer-Distributor-Contractor System



Type I
Johns-Manville
Owens-Corning
Armstrong
Baldwin-Ehret-Hill
Philip Carey

Type II
Pittsburgh Corning
Pittsburgh Plate Glass
Ruberoid
Eagle-Picher
Pabco
Nicolet

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VIII. DOW CELLULAR GLASS PERSPECTIVE

For Dow cellular glass to be competitive in the high temperature thermal insulation field its properties must match or exceed those of both Pittsburgh Corning Foamglas, Unibestos and standard calcium silicates. These properties are outlined in Table VI.

In addition to the above properties, the various advantages and disadvantages of cellular glass insulation must be weighed as to conditions met in the field. The advantages and disadvantages are outlined in Table VII.

General tests that must be conducted with satisfactory performance for the industry to even consider using Dow cellular glass as a high temperature thermal insulation are listed below:

1. hot asphalt dip
2. maximum temperature heat distortion
3. hot-cold pipe thermal shock cycle
4. thermal conductivity
5. vibration
6. "steam line banging" (with and without various jackets)

A U. S. government accelerated life test and results for Unibestos pipe covering are described in the Appendix, Exhibit V.

If the foregoing properties and tests prove themselves, a formidable task yet remains: The Market Entry. Entry methods for this product are (1) sell know-how, (2) license process and know-how, (3) established distributor-contractor system, and (4) the recommended way - through the independent selling company and the insulation contractor.

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Table VI

Physical Properties of High Temperature Thermal Insulation

Property	Other Insulation	Dow Cellular Glass
Density	9 - 12#	8 - 12#
Thermal conductivity	.40 @ 70°F. .55-.65 @ 600°F.	?
Temperature, maximum	1250°F.	1250°F.
Compressive strength	100 psi	125 psi
Closed cell	0-100%	55+%
Thermal shock	yes	?
Vibration & steam line	yes	?
Size	All pipe & board to 36" length and 4" thick	All pipe & board to 36" length and 4" thick
Jacket	Cloth-plastic-metal	None to date
Price	$.14-.22 per bd.ft.	?

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Table VII

Cellular Glass - Advantages and Disadvantages

A. Advantages

1. Fireproof (non smoke contribution)
2. Waterproof (chemical proof)
3. High strength (rigid)
4. Dual temperature operation
5. Long life
6. Inert (non corrosive)
7. Odorless

B. Disadvantages

1. Abrasiveness (hands, gloves, tools)
2. Glass dust and particles (eyes, lungs and skin)
3. Vulnerable to damage in shipping and handling (fragile)
4. Vulnerable to vibration and abrasion
5. Vulnerable to thermal shock
6. Foamglas: expensive in pipe covering form
   Dow cellular glass: expensive in board form

} based on the fabrication technique unique to each

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Before any of the above entry methods will succeed, a complete information and selling program must be undertaken with the following groups:

1. Architects
2. Consulting engineers
3. Consumer engineering and maintenance
4. Insulation contractor
5. Labor
6. Purchasing agents
7. Safety and hazard committees

Target

Some required properties are presently in the equal to or exceeding category, however, some not tested yet are the critical ones. Four of these that must be realized are (1) thermal conductivity, (2) thermal shock, (3) vibration and (4) the price. Without these our market potential is nil. The least important of these four is thermal conductivity, however, our values should not be much higher than the competitive white goods at any rate. It is thought that we are an order of magnitude better than P-C Foamglas in respect to thermal shock but have not established relationship with calcium silicate type insulations. Vibration, thermal shock and abrasion are problems with a fragile material eventhough it has high strength.

The main obstacle lies with the economics. A poor economic situation is caused by a relatively high raw material cost and further it is known that the high temperature mold forming operation to make pipe insulation will not be inexpensive. The glass powder raw material @ $195 per ton is for bagged ton quantities of a highly fined glass ground to 95% - 200 mesh. At twelve pound density, we presently have 10¢ of raw material per board foot of cellular glass foam. It is foreseen that this glass powder, since our end product does not require a highly refined raw material, could be produced from cheaper impure raw materials at a greatly increased glass tank throughput and shipped in bulk carload quantities. Another saving

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could be made if the glass was produced and ground at the same plant where the final product is molded.

The total market potential with all properties listed in Table VI on the positive side would be possibly 10-15% or $20-30 million. This is assuming extensive inroads into the present fiber glass area and based on better selling effort to architects, etc., than is presently done by the industry. This would require the availability of a line of sundry products as listed in the Appendix, Exhibit III, Table I. A line of other insulation materials such as fiber glass and diatomaceous earth to supplement and complete the temperature and use range are also recommended to compete with a "complete line".

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IX. DISCUSSION

With the data presented as a vantage point, a clear focus can be obtained of the environment which we can expect for Dow cellular glass. The environment matched with the technical and economic characteristics of Dow cellular glass do not present a bright picture.

Three salient factors seem to be the largest obstacle to success of this project.

1. Economics -

   Dow cellular glass appears in an unfavorable position here. If added value were provided along with the higher cost, this may not be a serious deterrent. As it is, however, the product appears to have very little in the way of superiority.

2. Resistance to thermal shock and breakage -

   These two physical factors are very important and failure to have the strength to resist thermal shock and rough handling can severely limit the market.

3. Lack of specific know-how on molding -

   About 80% of the high temperature insulation market is for pipe insulation. If economics on the raw materials are unfavorable, considerable savings must be obtained in the molding process for Dow cellular glass to compete. Knowledge in this area is critical if the project is to be continued much further in view of the major portion of the market where this consideration is critical.

   Critical analysis on the future course of the cellular glass project seems very desirable at this point. The probability of improving on the outlook from the standpoint of economics, properties and processing it would seem, would have to be high to warrant continuing the effort much further.

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APPENDIX

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Exhibit I

A. Contacts

Buffalo, New York

- Alfred University, Alfred, New York
- Armstrong Contracting and Supply Company
- Baldwin-Ehret-Hill
- C. S. Behler, Inc., Kenmore
- Buffalo Insulation Distributors
- Claxton Asbestos Company
- Construction Industries
- Dow Chemical Company - Sales Office
- Frontier Insulation & Asbestos
- Niagara Asbestos

Chicago, Illinois

- Ace Insulators
- Commonwealth Edison
- Illinois Insulation & Construction Company
- Industrial Publications, Inc.
- Insulation Board Institute
- Keeney Publishing Company
- Luse-Stevenson Company, Melrose Park
- Pabco Construction (Fibreboard Paper Products)
- Sargent & Lundy

Detroit, Michigan

- American Insulation Company
- R. H. Anderson, Inc.
- Armstrong Cork Company
- Baldwin-Ehret-Hill
- Builders Exchange of Detroit and Michigan
- Building Material Suppliers Association
- Brown Insulation
- Philip Carey Manufacturing Company
- M. H. Detrick Company
- Ennico Fermi Nuclear Power Plant, Monroe, Michigan
- Fiberglas Supply and Contracting Div., Oak Park

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Detroit, Michigan - Continued
- Hansen Wholesale Lumber Company
- C. Holmes Insulation Company
- Johnson Insulation, Madison Heights
- Oberson Insulatim Company, Royal Oak
- U. S. Thermo Insulation Company
- Zonolite Company, Dearborn

New York, New York
- ASHRAE
- ASME
- Consolidated Edison
- EBASCO
- Edison Electric Institute
- McGraw Hill
  - Chemical Week
  - F. W. Dodge
  - Power
- Myer & Strong & Jones Heating Company
- National Insulation Manufacturers Association
  - Magnesia-Silica Insulation Manufacturers Assoc.
  - Industrial Mineral Insulation Manufacturers Institute
  - Magnesia Insulation Manufacturers Assoc.
- Perlite Institute, Inc.
- York and Sawyer, Architects

Philadelphia, Pennsylvania
- Armstrong Cork
- du Pont
- IDCNA
- Johns-Manville
- Mechanical Insulation Association
- Owens-Corning
- Secretarial Service - Asbestos
- Sun Oil Company

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Texas

American Oil Company, Texas City
Dow Chemical Company, Freeport
Dow Chemical Company, Houston
Gulf Oil Company, Port Arthur
Houston Lighting & Power Company, Houston
Humble Oil & Refining Company, Baytown
Marathon Oil Company, Texas City
Monsanto Chemical, Texas City, Texas; St. Louis, Missouri
Texaco Refinery Company, Port Arthyr

Washington, D. C.

Walter E. Campbell Company, Inc.
U. S. Census Bureau - Industry, Suitland, Maryland
International Association of Heat & Frost Insulators & Asbestos Workers (AFL-CIO)

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36. "Underground Insulated Piping Systems (Excluding Walk-In Tunnels)", NAS-NRC Publication 1073, FCC Tech. Report No. 27, 1963

ST0364155

37. U. S. Patents

2,547,127	Kalousek;	Calcium Silicate of Microcrystalline Lathlike Structure
2,665,996	Kalousek;	Hydrous Calcium Silicates and Method of Preparation
2,674,775	Willson;	Making Molded Panels
2,698,256	Shea;	Siliceous Composition and Method for Manufacturing the Same
2,699,097	Binkley;	Method of Manufacture of Heat Insulating Shapes
2,716,070	Seipt;	Lime-Silica Insulation and Method of Making
2,754,547	Allen;	Heat Insulation Composition and Preparation Thereof
2,748,008	Kalousek;	Method of Making Porous Calcium Silicate Products
2,766,131	Seipt;	Method for the Manufacture of Calcium Silicate Type Insulation
2,888,377	Allen;	Calcium Silicate and Method of Producing Same
2,915,409	Taylor;	Process for Producing Cellular Insulating Materials
3,001,882	Taylor;	Thermal Insulating Material and Method of Making Same
3,025,176	Herrington;	Thermal Insulation Composition and Preformed Fittings Made Therefrom
3,033,648	Linden;	Hydrothermal Process for the Manufacture of Hydrated Calcium Silicates
3,042,536	Bishop;	Vinculum for Porous Alkaline Earch Metal Silicate Insulating Materials
3,116,158	Taylor;	Thermal Insulating Materials and Method for Making
3,148,996	Vukasovich;	Foamed Ceramic

ST0364156

DOW 05467

C. References

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23. Time, November 20, 1964
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26. U. S. Patent 3,116,158 (O-C 1963)
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28. Willman, Saginaw; Industrial Insulation, Bay City; Hollinger & Co., Midland

ST0364157

DOW 05468

Exhibit II

Insulation Manufacturing Process

The processing steps required to produce pipe covering insulation of fiber glass, calcium silicate and Dow cellular glass are shown as block diagrams in Figure I. Schematic drawings for processing various fiber glass products are shown in Figure II. A schematic drawing of a calcium silicate process as described in U. S. patent 2,716,070 is shown in Figure III. A schematic drawing of the Dow cellular glass proposed process is shown in Figure IV.

ST0364158

Figure I

High Temperature Insulation Processes - Block Diagram

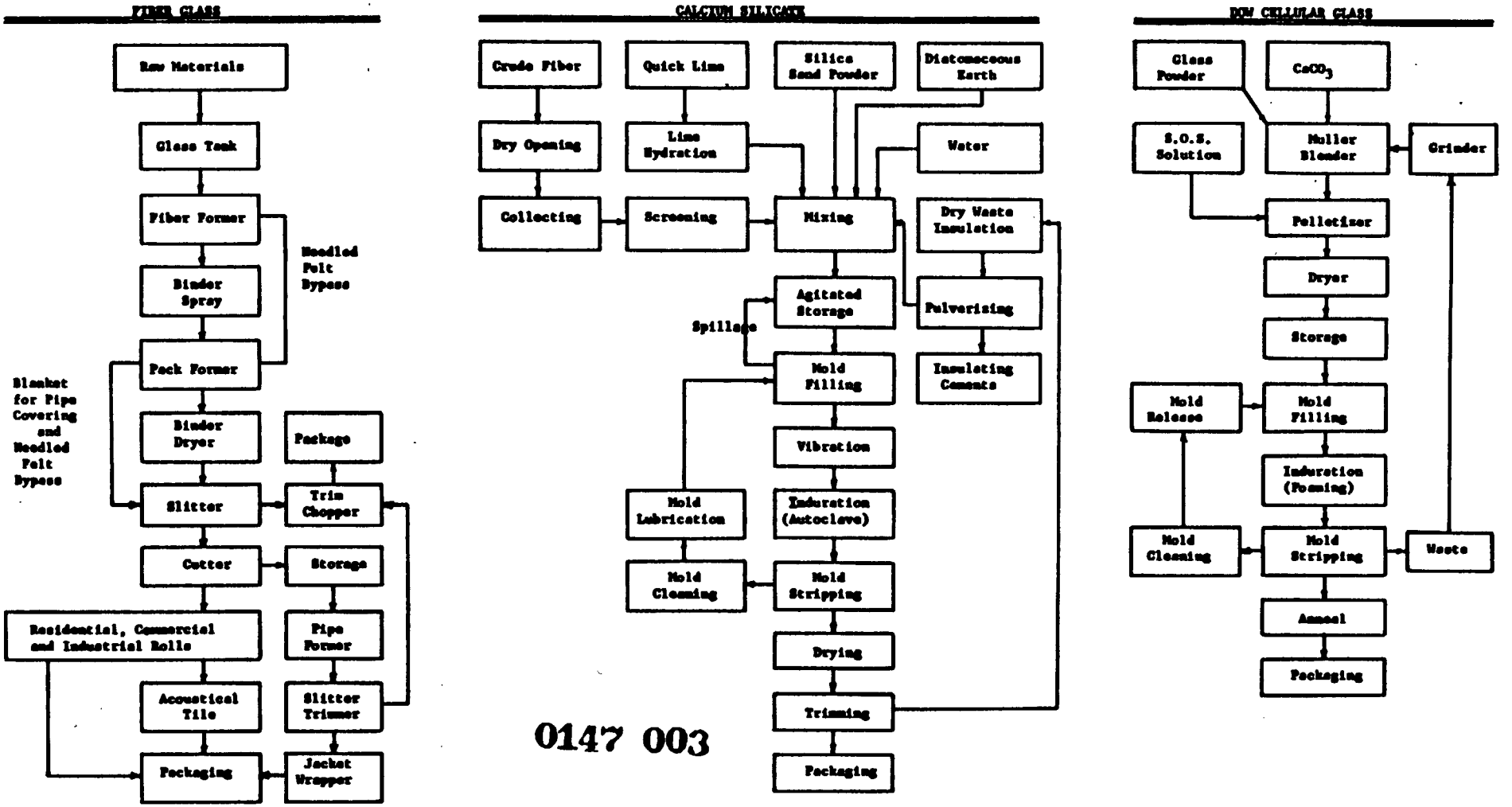

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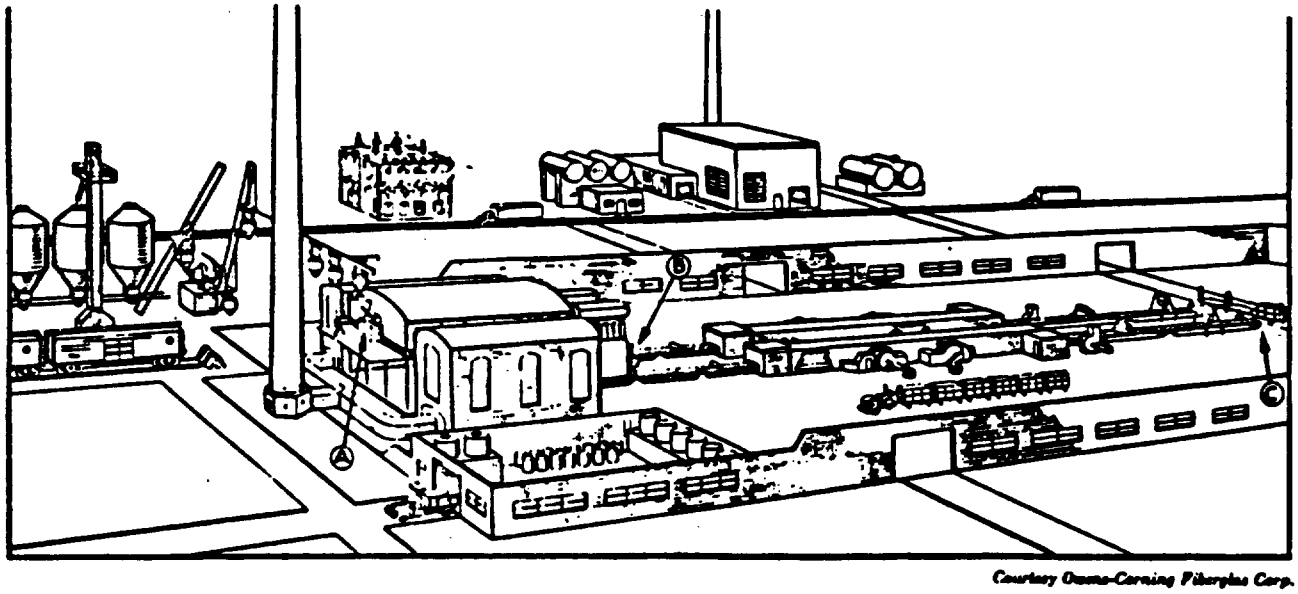
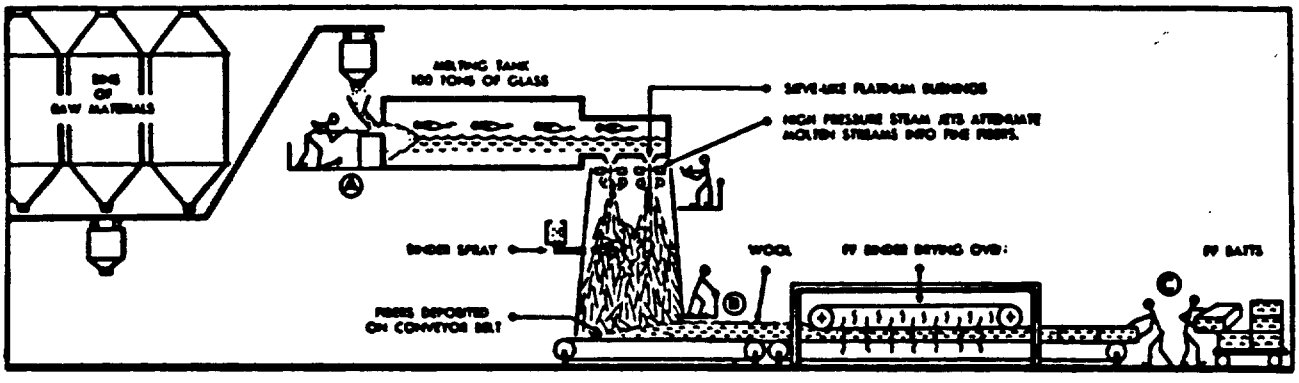
Figure II

Process for Manufacturing Fiber Glass Products

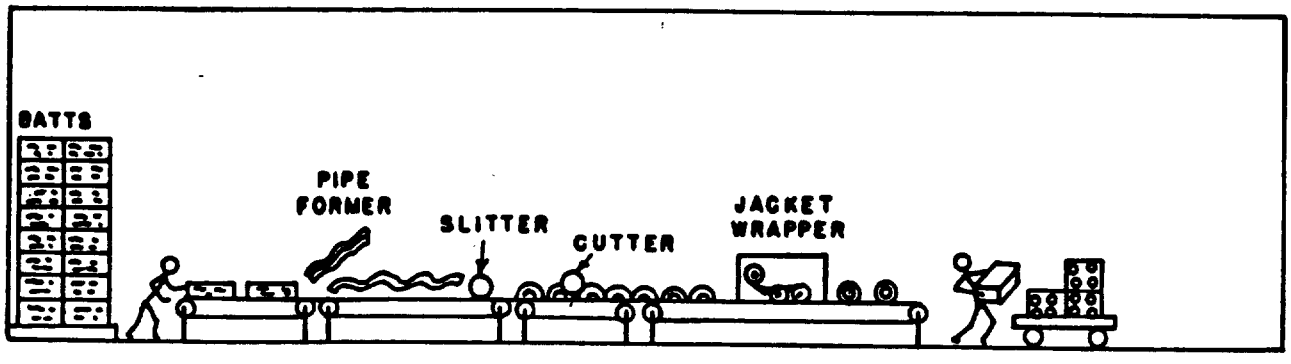


Courtesy Owens-Corning Fiberglas Corp.

A. Simplified bird's-eye view of wool forming line.



B. Process for Manufacturing Batts



C. Process for Manufacturing Pipe Covering from Batts

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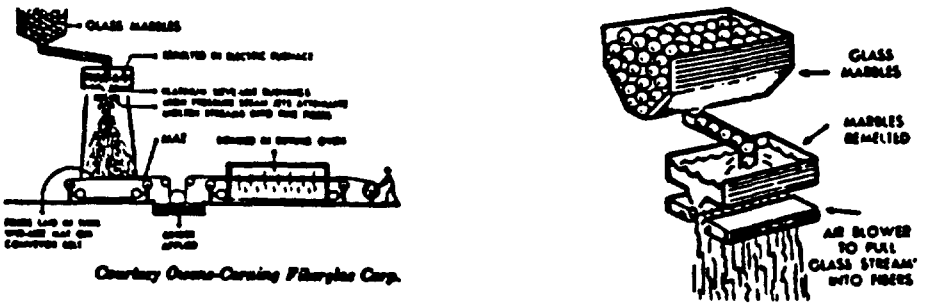
Figure II - Continued



Courtesy Owens-Corning Fiberglas Corp.

D. Process for Manufacturing Bonded Mat

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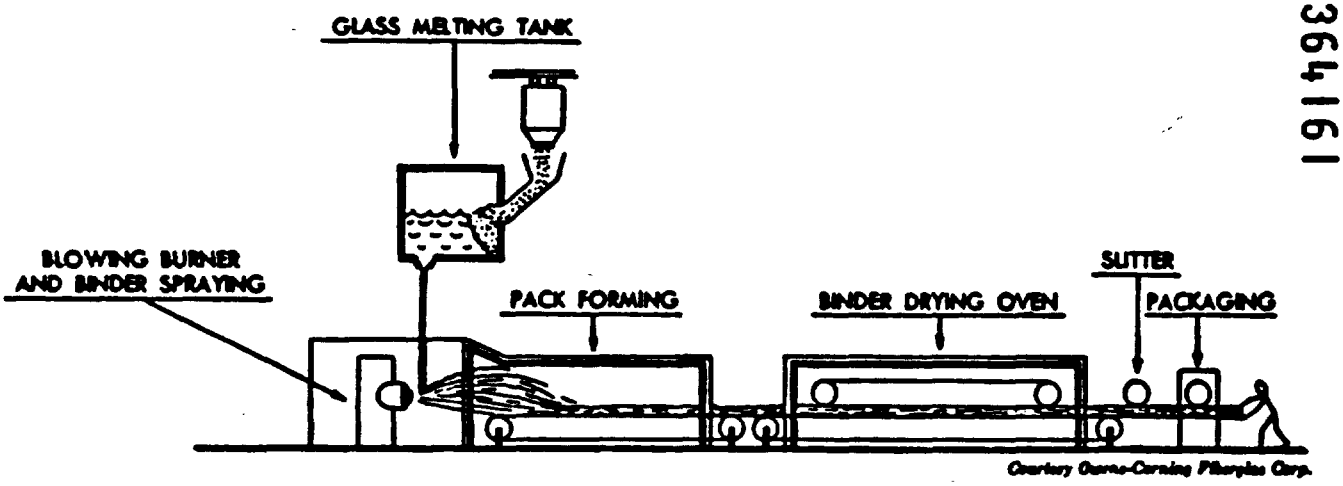
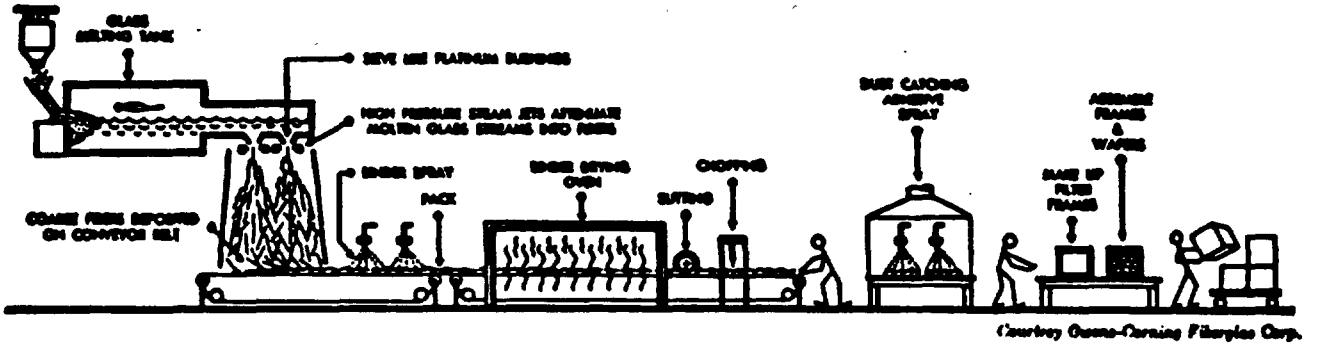


Courtesy Owens-Corning Fiberglas Corp.

E. Process for Manufacturing Superfine Wool



Courtesy Owens-Corning Fiberglas Corp.

F. Process for Manufacturing Air Filters

Figure III

Lime-Silica Insulation and Method of Making
U. S. Patent 2,716,070, W. R. Seipt, August 23, 1955

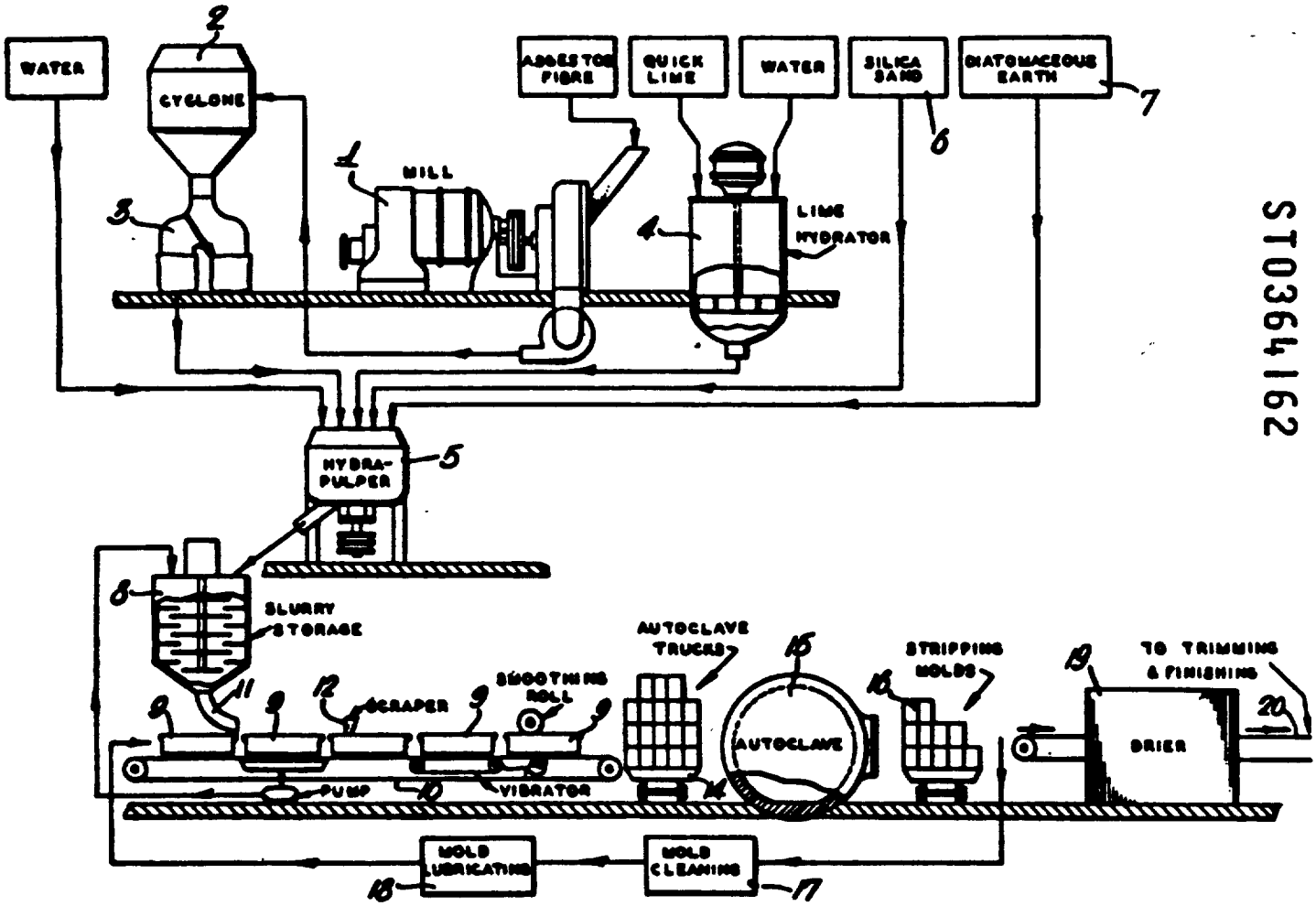


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Figure IV

Process for Manufacturing Dow Cellular Glass

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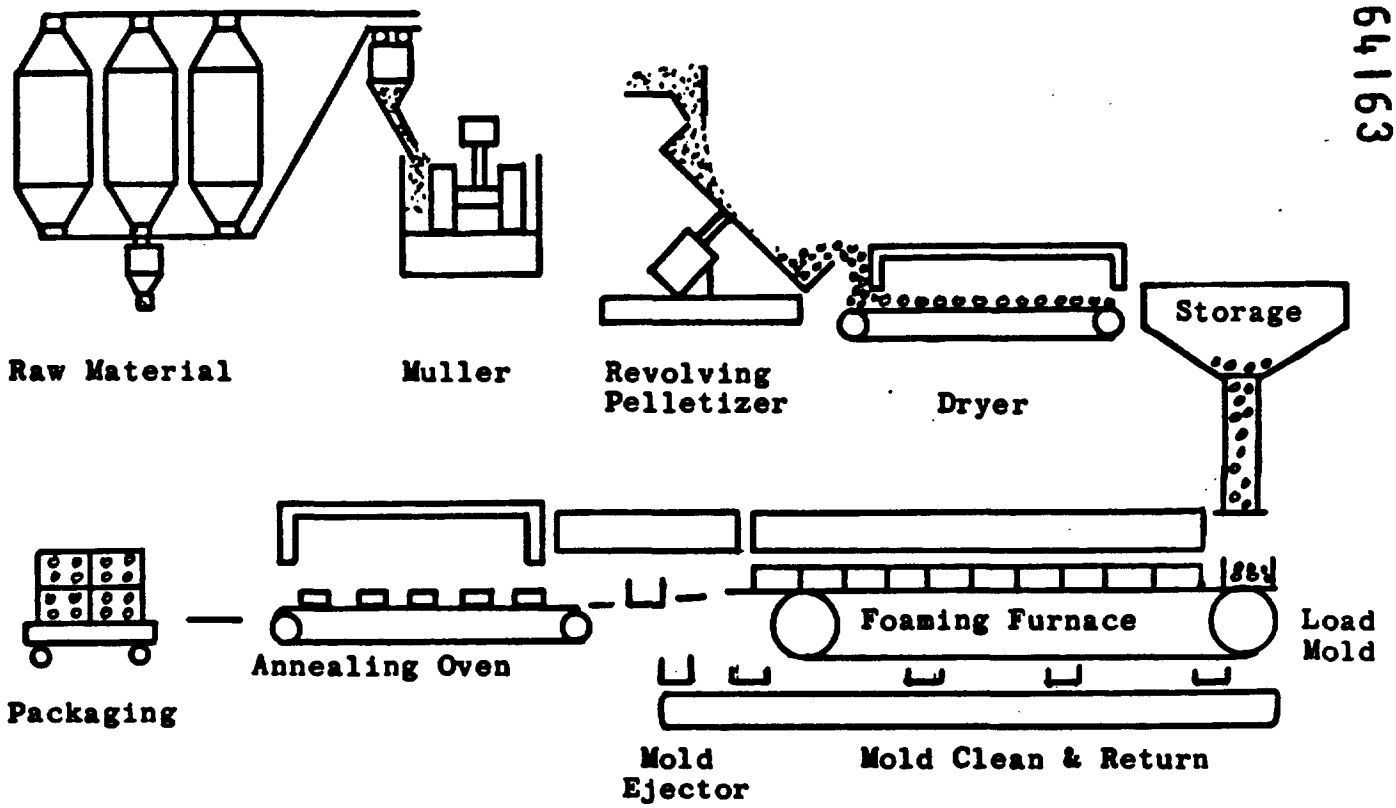

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Exhibit III

Industry Structure - Background

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Table I - Insulation Sundry Materials

Prices

No. IN-1-20
Page 1 of
Date April 9, 1962
Supersedes 3/8/62

BENJAMIN FOSTER PRODUCTS

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. Philadelphia, Pa. except as noted.

A service charge of 75¢ per item, per order, on split case quantities will be added to all invoices.

Star (★) indicates product not stocked. Available only on special order. Prices quoted on inquiry.

CODE No.	PRODUCT NAME	PRICES PER GALLON 55—DRUM	5—PAIL	3—PAIL	1—CAN	QUART EACH
30-01	Protection Kote	$4.05	$ 4.15	★	$ 4.35	★
30-30	Fire Resistive Vapor Barrier (Brushing)	4.05	4.15	★	4.35	★
30-42	Vinyl Vapor Barrier, White	5.70	5.80	★	6.00	★
30-420T	Vinyl Vapor Barrier, Orange Tint	6.05	6.15	★	6.35	★
30-43	Heat Resistant Sealer	3.65 per lb. — all sizes (3#, 12#, 60#)				
30-79	Cold Sealer, White	4.65	4.75	★	4.95	★
50-56	Vitect Vinyl Coating, Medium Gray	4.65	4.75	★	4.95	★
51-06	Stackfas® Concrete Curing Agent	2.65	2.75	★	2.95	★
51-12	Fire Resistive Mastic Primer	3.55	3.65	★	3.85	★
51-20	Vinyl Wash Primer	5.55	5.6[illegible]	★	5.85	★
55-11	Vitect Vinyl Thinner	2.70	2.80	★	3.00	★
55-13	Vitect Epoxy Thinner	4.70	4.80	★	5.00	★
55-17	Fire Resistive Mastic Reducer	4.95	5.05	★	5.25	★
55-24	Non-Flammable Fire Resistive Reducer	5.15	5.25	★	5.45	★
57-15	Vitect Vinyl Coating, White	4.95	5.05	★	5.25	★
57-16	Vitect Vinyl Coating, Aluminum	5.40	5.50	★	5.70	★
57X50	Heat Resistant Coating, Dark Gray	★	29.40	★	29.60	★
57-57	Vitect Epoxy Coating, Medium Gray	★	9.20	★	9.40	2.65
57-61	Vitect Epoxy Coating, White	★	10.10	★	10.30	2.80
60-30(N)	Fire Resistive Mastic (Trowel)	3.45	3.55	★	3.75	★
60X41	Fire Resistive Intumescent Mastic	4.10	4.20	★	4.40	★
60-44	Stackfas® (Spray)	4.00	4.10	★	4.30	★
60-45	Stackfas® (Trowel)	4.00	4.10	★	4.30	★
60-46	High Solids Stackfas®	4.40	4.50	★	4.70	★
60X48	Heat Resistant Metal Coating	4.15	4.25	★	4.45	★
60-60(N)	Fire Resistive Mastic (Spray)	3.45	3.55	★	3.75	★
60-65	Fire Resistive Mastic, Aluminum	4.30	4.40	★	4.60	★
60-80	Safetee Mastic®	.80	.90	★	1.10	★
81-13	Adhesive A-90	3.70	3.80	★	4.00	★
81-20	Fire Resistive Adhesive	5.80	5.90	★	6.10	1.75
81-33	Fire Resistive Adhesive	4.55	4.65	★	4.85	★
81-59	White Adhesive	4.55	4.65	★	4.85	★
81-60	Fire Resistive Insulation Adhesive	4.70	4.80	★	5.00	★
81-99	Safetee Duct-fas®	4.90	5.00	★	5.20	1.55
82-01	Epoxy Adhesive	★	13.35	★	13.55	3.60
82-17	Insulation Adhesive	★	17.10	★	17.30	4.60
90-10	Low-Temperature H.I. Mastic	1.10	1.20	★	1.40	★
90-30	Fire Resistive Mastic (Knife Grade)	3.85	3.95	★	4.15	★

STACKFAB

$0.22 per lineal foot, f.o.b. Phila., Pa.
100 lineal feet per roll
4 rolls per package. Minimum order one pkg.

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Table I - Continued

IN-1-20
Page 2
4/9/62

A service charge of 75¢ per item, per order, on split case quantities will be added to all invoices.

Star (★) indicates product not stocked. Available only on special order. Prices quoted on inquiry.

GROUP II

CODE No.	PRODUCT NAME	55-GRN	PRICES PER GALLON 5-PAIL	3-PAIL	1-GAL	QUART PACK
30-02	Fire Resistive High Velocity Duct Sealer ..	★	$5.95	★	$6.15	$1.80
30-02	.85 per cartridge—8/100 gal. per cartridge—Minimum Order 12 cartridges per carton					
30-16	Fire Resistive Anti-Abrasion Coating	3.85	3.95	★	4.15	1.25
30-36	Sealfas®	3.20	3.30	★	3.50	★
30-45	Foamseal®	3.95	4.05	★	4.25	★
30-45	.75 per cartridge—8/100 gal. per cartridge—Minimum Order 12 cartridges per carton					
30-46	Insulation Sealer	3.95	4.05	★	4.25	★
30-46	.75 per cartridge—8/100 gal. per cartridge—Minimum Order 12 cartridges per carton					
30-70	Lagtone®	4.80	4.90	★	5.10	★
30-76	White Insulation Coating	4.65	4.75	★	4.95	★
30-97	Sealfas®, Black	3.35	3.45	★	3.65	★
31-02	Sealfas®, Mermaid Green	3.70	3.80	★	4.00	★
31-03	Sealfas®, Pearl Gray	3.70	3.80	★	4.00	★
31-40	Lagtone®, Light Blue	5.15	5.25	★	5.45	★
31-45	Lagtone®, Dark Blue	5.15	5.25	★	5.45	★
31-52	Lagtone®, Orange	9.20	9.30	★	9.50	★
31-55	Lagtone®, Fire Engine Red	5.70	5.80	★	6.00	★
31-60	Lagtone®, Light Green	5.15	5.25	★	5.45	★
31-65	Lagtone®, Dark Green	5.15	5.25	★	5.45	★
31-70	Lagtone®, Yellow	5.15	5.25	★	5.45	★
31-80	Lagtone®, Buff	5.15	5.25	★	5.45	★
31-90	Lagtone®, Gray	5.15	5.25	★	5.45	★
31-95	Lagtone®, Black	5.15	5.25	★	5.45	★
50-08	Superleaf Asphalt Aluminum Paint.....	3.05	3.15	★	3.35	★
60-32	Asphalt Aluminum Mastic (Spray)	3.90	4.00	★	4.20	★
60-42	Asphalt Aluminum Mastic (Trowel).....	3.90	4.00	★	4.20	★

CODE No.	PRODUCT NAME	55-GRN	PRICES PER GALLON 5-PAIL	3-PAIL	1-GAL	QUART PACK
60-99	HiLastic®	$ .92*	$1.05	★	★	★
81-42	Fire Resistive Lagging Adhesive..	3.70	3.80	★	$4.00	★
81-88	Lagfas®	2.75	2.85	★	3.05	★
81-94	Lagfas®, Blue	2.95	3.05	★	3.25	★
82-10	Flexfas®	.20 per lb. — (54 lbs. per unit)				
82X11	Clipfas®	4.85	4.95	★	5.15	1.50
82-16	Clear Vinyl Adhesive.....	★	5.00	★	5.20	1.55
	Sealfas® Mastic — Standard Grade					
31-04	Mediterranean Blue	4.15	4.25	★	4.45	★
31-16	Sand (Low Temp. Grade)....	4.40	4.50	★	4.70	★
31-17	Mediterranean Blue (Low Temp. Grade).....	4.60	4.70	★	4.90	★
31-22	Gull Gray	4.70	4.80	★	5.00	★
31-24	Sand	4.15	4.25	★	4.45	★
31-25	Blue Gray	4.15	4.25	★	4.45	★
31-27	Sea Gray	4.15	4.25	★	4.45	★
31-49	Aluminum Gray	4.15	4.25	★	4.45	★
31-87	Battleship Gray	4.15	4.25	★	4.45	★
31-96	Black	4.15	4.25	★	4.45	★
31-97	Green Gray	4.15	4.25	★	4.45	★

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IN-1-20
Page 3
4/9/62

Table I - Continued

GROUP II CONT.

CODE No.	PRODUCT NAME	55-GAL. DRUM	PRICES PER GALLON 5-PAIL	3-PAIL	1-GAL	QUART CANS
	Sealfas® Mastic — Heavy Trowel Grade					
41-04	Mediterranean Blue	4.15	4.25	★	4.45	★
41-16	Sand (Low Temp. Grade)....	4.40	4.50	★	4.70	★
41-17	Mediterranean Blue (Low Temp. Grade).....	4.60	4.70	★	4.90	★
41-22	Gull Gray	4.70	4.80	★	5.00	★
41-24	Sand	4.15	4.25	★	4.45	★
41-25	Blue Gray	4.15	4.25	★	4.45	★
41-27	Sea Gray	4.15	4.25	★	4.45	★
41-49	Aluminum Gray	4.15	4.25	★	4.45	★
41-87	Battleship Gray	4.15	4.25	★	4.45	★
41-96	Black	4.15	4.25	★	4.45	★
41-97	Green Gray	4.15	4.25	★	4.45	★
41-98	Stone Gray	4.50	4.60	★	4.80	★
41-99	White	4.50	4.60	★	4.80	★

HI LASTIC® REINFORCING MAT†
55¢ per sq. yard, f.o.b. Phila., Pa.
25 sq. yards per Roll, 4 Rolls per Package (32" Wide)

* 53 gallons

A service charge of 75¢ per item, per order, on split case quantities will be added to all invoices.

GROUP III

CODE No.	PRODUCT NAME	55-GAL. DRUM	PRICES PER GALLON 5-PAIL	3-PAIL	1-GAL	QUART CANS
10-16	Liquid Asphalt Emulsion	$ .75	$ .85	★	$1.05	★
10-17	Asphalt Emulsion (Heavy)	.75	.85	★	1.05	★
51-03	Block Insulation Primer	.85	.95	★	1.15	★
51-11	Industrial Oxide Chromate Primer	3.85	3.95	★	4.15	★
56-22	Rubber Adhesive Thinner.....	1.40	1.50	★	1.70	★
60-24	Cork-Filled Mastic	.88*	1.00	★	1.20	★
60-25	C. I. Mastic® (Trowel).....	.65	.75	★	.95	★
60-26	C. I. Mastic® (Spray)	.65	.75	★	.95	★
60-28	Lo-Temp V B Coating.....	★	★	★	★	★
81-02	Black Spot Adhesive	.80	.90	★	1.10	★
81-27	Fibrous Adhesive	1.10	1.20	★	1.50	★
81-28	Facing Machine Adhesive	3.25	3.35	★	3.55	★
81-36	C. C. Adhesive	1.35	1.45	★	1.65	★
81-38	Lagfas® Type I (Special).....	3.20	3.30	★	3.50	★
81-42W	Lagfas®	2.75	2.85	★	3.05	★
81-71	Duct-fas® Clear Rubber Adhesive	2.15	2.25	★	2.45	.85
81-81	Duct-fas® Red Rubber Adhesive..	2.15	2.25	★	2.45	.85
81-91	Duct-fas® White Rubber Adhesive	2.50	2.60	★	2.80	.90
81-93	Fibrous Adhesive (Trowel)	1.05	1.15	★	1.35	★
82X08	Insulation Adhesive	1.40	1.50	★	1.70	★
82-18	Duct-fas® Quick-Tack®	2.20	2.30	★	2.50	.90
90-07	H. I. Mastic®	.58	.70	★	.90	★

SEALFAS OPEN WEAVE GLASS CLOTH
#18—$0.35 per lineal yard, 50 sq. yds. per roll
#28—$0.27 per lineal yard, 50 sq. yds. per roll
(36" wide by 50 yards long)
} F.O.B. PHILA., PENNA.

SEALFAS LAGGING CLOTH (Cotton Brattice Cloth)
$.90 per sq. yard, F.O.B. Phila., Penna.
$.80 per sq. yard, F.O.B. Warsaw, Indiana
(133-1/3 square yards per 32" wide roll)

SEALFAS 8 oz. P & M DUCK
$.75 per sq. yard, F.O.B. Phila., Penna.

SEALFAS GLASS LAGGING TAPE
Rolls 15 yards long by:
1" wide $.09 per lineal yard
2" wide 0.135 per lineal yard
4" wide 0.24 per lineal yard
6" wide 0.345 per lineal yard
8" wide 0.45 per lineal yard
} F.O.B. PHILA., PENNA.

POSTER GOOPHES®
$0.10 EA. — 120 per carton — F.O.B. Phila., Penna.

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DOW 05478

Table I - Continued

Prices

OWENS-CORNING FIBERGLAS

INSULATION SUNDRY MATERIALS

No. IN-1-15
Page 1 of 2
Date July 18, 1960
Supersedes Original

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

SHIPPING TERMS: Ex Warehouse: F.O.B. Warehouse

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

	NET PRICE
ADHESIVES:	
Wheat Paste - 2# Bag	$ .46
-5# Bag	1.05
St. Clair 48-47 - 1 Gal. Pail	3.00
- 5 Gal. Pail	14.00
Miracle Adhesive, Type AA - 1 Gal. Pail	4.98
Tuft Bond - Quick Set - 1 Quart	2.17
Permalastic PL 440 - 5 Gal. Pail	11.70
Permalastic PL 5122 - 5 Gal. Pail	14.85
O-C 500 - Pint	1.00
CANVAS:	Per Lin. Yd.
2 oz. - 40" Wide	$ .15
4 oz. - 40" Wide	.24
6 oz. - 60" Wide	.45
7.2 oz. - 72" Wide	.72
FELT:	Per Sq. Ft.
Hair Felt, 3' x 50' x 1/2"	$ .13
Hair Felt, 3' x 50' x 1"	.20
TWINE:	Per Tube
Jute - 1/2#	$ .31
Sewing - 1/2#	.70

	Price per Roll		
ALUMINUM JACKETS:	1 - 9 Rolls	10 - 99 Rolls	100 or More Rolls
.006" x 4' x 100' with paper	$45.00	$42.00	$39.00
.006" x 4' x 200' without paper	72.00	67.00	61.00
.016" x 3' x 100' with paper	51.50	49.50	47.50
.016" x 3' x 100' without paper	44.50	42.50	40.50
.019" x 4' x 100' with paper	69.00	66.00	63.00
.019" x 4' x 100' without paper	60.00	57.00	54.00

INDUSTRIAL PAPERS:	Per Roll
12# & 16# Asbestos Paper (50# Roll)	$8.30
30# Roofing Felt (400 sq. ft. per Roll)	4.00
45# Roofing Paper (36" x 36')	3.08
55# Roofing Paper (36" x 36')	3.86
30# Red Rosin Paper (36" x 167')	3.90
40# Red Rosin Paper (36" x 167')	5.80
Dual Temp Paper (White one Side 36" x 300')	40.30
Universal Jacket (39-1/4" x 600')	45.00
Fibreen 200# Sisalkraft (72" x 37')	26.05
	MSF
RFFFRK Paper	50.00
TAPES:	Per Roll
Permacel #703 Masking Tape (1" x 60 Yards)	$1.00
Permacel #691 Silvercloth (3" x 60 Yards)	6.45
B & A Friction (2" x 60 yards)	.95
P.H.D. Alum. Paper Tape (3" x 60 Yards)	4.50
Fiberglas Alum. Foil Reinforced (4" x 1000')	14.55
Embossed Joint Sealing Tape (4" x 600')	24.00

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OWENS-CORNING FIBERGLAS

DOW 05479

Table I - Continued

IN-1-15
Page 2
July 18, 1960

MEMBRANE REINFORCED:		Per Roll
Glasfab	3" x 150'	$1.16
	18" x 150'	6.98
	36" x 150'	13.30
STRAPPING & SEALS:		Per Lb.
Galv. Strapping	1/2" x 3/4"	.32
Alum. Strapping	1/2" x 3/8"	1.08
		Per Piece
Gerrard Galv. Seals	1/2"	$.04
Aluminum Seals	3/8"	.02
MISCELLANEOUS:		Per Roll
Chicken Mesh	24" x 150' x 1"	$7.32
	36" x 150' x 1"	11.19
	48" x 150' x 1"	14.64
		Per Lb.
Wire	18 Ga. Copper Coated	$.19
	16 Ga. Black Enameled	.17
Staples	Copper 3/4" x 3/4"	.36
	Copper 5/16' x 2" Hairpin	.36
		Per Box
	Galv. Bostitch - 5000 per Box	$2.10
		Per Lin.Ft.
Corner Bead (Plain)		$.06
		Per Piece
Welding Nails 2-1/2" (KSM)		$.03
Speed Clips B-110 (KSM)		.02
Spindle Anchors 2-1/2"		.05
	1-1/2"	.05
Washers W4-D		.03

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Mergers and Acquisitions in the Industry

The growth and structure of the insulation industry is reflected from the mergers and acquisitions that have occurred in the last three years. Many of these mergers are shown on the following page.

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DOW 05481

Table II - Continued

Mergers and Acquisitions

1962 (1) Certain-Teed Products Corp. acquired Keasbey & Mattison Co. (asbestos cement pipe products)

(2) Nicolet Industries purchased Keasbey & Mattison Co. (insulation, paper, millboard facilities)

(3) Pittsburgh Plate Glass bought The Rubber & Asbestos Corp., Bloomfield, N. J. (industrial adhesive products)

(4) Pittsburgh-Corning bought "Unibestos" line from Union Asbestos & Rubber Co. (manufacturer of Unibestos at Tyler, Texas)

1963 (1) Baldwin-Ehret-Hill acquired Standard Asbestos Mfg. Co. to operate as Division (Chicago, Illinois)

(2) Union Asbestos & Rubber became UNARCO Industries, Inc., April 17, 1963

(3) Combustion Engineering purchased Refractory & Insulations

(4) Combustion Engineering owns 70% of Loomis Engineering

(5) W. R. Grace Co. purchased Zonolite

1964 (1) Mineral Fiber Products Bureau - new name of reorganized association: Asbestos Cement Products Association

(2) Nicolet Industries - Keasbey & Mattison Division has been merged into parent company

(3) Baldwin-Ehret-Hill purchased Mundet thermal insulation contracting division, March 1964

(4) Refractory & Insulations purchased Detrick insulation plant, Chicago, Illinois, April 1964

(5) Nicolet Industries acquired the physical assets of Protective Papers

(6) Victor Manufacturing & Gasket Co. purchased Smith & Kanzler

(7) Smith & Kanzler signed agreement on Spray Craft asbestos mineral fiber with Nippon Asbestos of Tokyo

(8) Certain-Teed Products Corp. acquired the rights to Pall Corp.'s Technical Developments & Advances in Glass Wool Manufacture together with its glass fiber production facilities at Mountain Top, Pennsylvania

(9) Basic Carbon Corp. became a subsidiary of The Carborundum Co.

1965 Forecast: Agreement between Carey and Gustin-Bacon on white goods line exchange

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Associations and Institutes

The past few years have seen the closing, merging or name changing of several insulation associations or institutes. The present insulation and associated associations and institutes are listed on the following page. The IDCNA has a circulation of 725 for their monthly 18 page newsletter with 45 advertisers. It is mailed to all known insulation contractors, suppliers of the industry, interested people and publications.

The NIMA members are listed on page xxiv. Philip Carey is the one large insulation manufacturer that does not care to join this association.

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Table II - Continued

Associations and Institutes

1. Insulation Distributor - Contractor National Association, Inc. (IDCNA)
   1425 Chestnut Street
   Philadelphia, Pennsylvania 19102
   Ellwood F. Jones, Executive Secretary LO3-9088

2. National Insulation Manufacturers Association
   441 Lexington Avenue
   New York, New York 10017
   J. M. Barnhart, Executive Secretary

3. Thermal Insulation Association of Canada
   5435 Engers Street
   Montreal 20, Quebec
   Albert Fryes, Secretary - Treasurer
   Ian Dewar, President
      Dewar Insulations Limited
      759 Warden Avenue
      Scarborough, Ontario

4. "Asbestos" Secretarial Service
   S. E. Corner Broad & Chestnut Street
   Philadelphia, Pennsylvania 19107
   Miss E. E. Cox, Editor

5. Asbestos Textile Institute
   P. O. Box 239
   75 Center Street
   Pompton Lakes, New Jersey
   H. E. Sundbury, Executive Secretary
   80 Members (Publish "Handbood of Asbestos Textiles")

6. Asbestos Workers National Union
   1300 Connecticut Avenue N.W.
   Washington, D. C.
   C. W. Sickles, President
   124 Locals 12,000 members

7. "Pipe Fabrication Institute"
   992 Perry Highway
   Pittsburgh 37, Pennsylvania
   Noah F. Young, Executive Secretary
   15 Members

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Table II - Continued

National Insulation Manufacturers Association
NIMA
441 Lexington Avenue - New York, N. Y. 10017

Membership List

Baldwin-Ehret-Hill Inc.
500 Breunig Avenue
Trenton 2, N. J.
609 Export 6-4571
Principal: M. M. Wilson, V.P.

The Eagle-Picher Co.
American Bldg.
Cincinnati 1, Ohio
513 Parkway 1-7101
Principal: J. P. Harrington

Fibreboard Paper Products Corp.
(Pabco)
475 Brannan Street
San Francisco 19, Calif.
415 Exbrook 2-3657
Principal: D. M. Nelson

Forty-Eight Insulations, Inc.
Box 472
Aurora, Ill.
312 Aurora 6-8578
Principal: T. S. Clousing

Gustin-Bacon Mfg. Co.
210 West 10th Street
Kansas City 5, Mo.
816 Harrison 1-7788
Principal: F. W. Muller, V.P.

Johns-Manville Sales Corp.
22 East 40th Street
New York 16, N. Y.
212 Lexington 2-7600
Principal: M. W. Burleson, V.P.

N. L. Morell
402 Union Bank Bldg.
Bethlehem, Pa.
215 University 6-5057
Principa: N. L. Morell

Owens-Corning Fiberglas Corp.
717 Fifth Avenue
New York 22, N. Y.
212 Plaza 9-3810
Principal: J. F. Vyverberg

Pittsburgh Corning Corp.
One Gateway Center
Pittsburgh 22, Pa.
412 Court 1-2900
Principal: R. E. Buckley, V.P.

Pittsburgh Plate Glass Co.
One Gateway Center
Pittsburgh 22, Pa.
412 - 281-5100
Principal: P. D. Kaley

The Ruberoid Company
733 Third Avenue
New York 17, N. Y.
212 Yukon 6-2500
Principal: H. B. Hutten

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Table III

B. Office and Plant Locations

Company & Main Office	Plant Class	Plant Locations
Armstrong Cork Lancaster, Pa.	Mineral Wool	Beaver Falls, Pa.
Baldwin-Ehret-Hill Trenton, N. J.	Mineral Wool Calcium Silicate-85% Magnesia	Kalamazoo, Mich.; Trenton, N.J Valley Forge, Pa.;Temple, Tex. Huntington, Ind.;Chicago, Ill.
The Carborundum Co. Niagara Falls, N. Y.	Ceramic Fiber	Niagara Falls, N. Y.
Philip Carey Cincinnati, O.	Industrial Insulation	Cincinnati, O.; Plymouth Meeting, Pa.
Celotex Chicago, Ill.	Industrial Insulation	Largo, Ind.; Pittston, Pa.
Certain-Teed Products Ardmore, Pa.	Glass Fiber	Mountain Top, Pa.
Eagle-Picher Cincinnati, O.	Diatomaceous Earth Insulation	Clark, Nev.; Colado, Nev.; Joplin, Mo.; Newark, N.J.
Fibreboard Paper Prod. (Pabco) San Francisco, Calif.	Asbestos	Emeryville, Calif.
Gustin-Bacon Mfg. Co. Kansas City, Mo.	Glass Fiber	
Inter. Mineral & Chem. Skokie, Ill.	Mineral & Earth Perlite Ore	Big Pine, Calif.
Johns-Manville New York, N. Y.	Asbestos Insulation Mineral Wool Glass Fiber Perlite Minerals & Earth	Manville, N. J. Corona, Calif.; Alexander, Ind. Waterville, O.; Joliet, Ill.; Natches, Miss.; Richmond, Ind. Long Beach, Calif. Antonito, Calif. Joliet, Ill.; Lompoc, Calif.
National Gypsum Buffalo, N. Y.	Mineral Wool	Alexandria, Ind.; Dover, N. J.
Nicolet Industries Florham Park, N.J.		

Continued

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Company & Main Office	Product Class	Plant Locations
Owens-Corning Toledo, O.	Mineral Wool	Santa Clara, Calif.; Barrington N.J.; Kansas City, Kan.; Newark, O.
	Calcium Silicate	Berlin, N.J.
	Glass Fiber	Aiken. S.C.; Anderson, S.C.; Ashton, R.I.; Huntington, Pa.
Pittsburgh-Corning Pittsburgh, Pa.	Foamglas Unibestos	Sedalia, Mo.; Port Allegany,Pa Tyler, Tex.
Pittsburgh Plate Glass Pittsburgh, Pa.	Glass Fiber	Shelby, N.C.; Shelbyville,Ind.
Ric-Wil Inc. Barberton, O.	Jacketed Pipe Insulation	Barberton, O.; Niles, Mich.; Newark, Calif.; Salt Lake City Utah; Charleston, S.C.
Ruberoid Co. New York, N.Y.	Asbestos Industrial Insulation	Erie, Pa. Gloucester City, N. J.
	Calcium Silicate	Gloucester City, N. J.
H. I. Thompson Gardena, Calif.	Ceramic Fiber	
UNARCO Bloomington, Ill..	Mineral Wool	
U. S. Gypsum Chicago, Ill.	Perlite Rock Wool	Grants, N.M.; Lovelock, N.M. Tacoma, Wash.; Torrance,Calif. Red Wing, Minn.; So. Plainfiel N.J.; Corsicana, Tex.; Wabash, Ind.; Birmingham, Ala.

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INDEX TO ASTM AND GOVERNMENT SPECIFICATIONS FOR INDUSTRIAL INSULATIONS

Table IV

PRODUCT FORM	REFERENCE NAME AND GENERAL DESCRIPTION	ACCEPTED MAX. TEMP.[a] DEGREES F	ASTM SPECIFICATIONS[a]	MILITARY (MIL) and MARITIME (MA) SPECIFICATIONS[a]	FEDERAL SPECIFICATIONS[a]
PIPE INSULATION	ASBESTOS (Molded Amosite and Binder)	1200		MIL-I-2781 Grade II, Class c Grade III, Class f	HH-I-561, Type IV
	CALCIUM SILICATE (Calcium Silicate and Asbestos)	1200	C-345	MIL-I-2781 Grade I, Class b Grade II, Class d Grade III, Class e, Type I	HH-I-523, Class 2
	CELLULAR GLASS (Foamed, Fabricated from Block)	800	C-381		HH-I-551
	CELLULAR SILICA (Foamed, Fabricated from Block)	1600 (cyclic) 2200 (cont.)			
	DIATOMACEOUS SILICA (Diatomaceous Silica and Asbestos)	1600 1900	C-334 C-334	MIL-I-2781 Grade III, Class e, Type II	
	85% MAGNESIA (Basic Magnesium Carbonate and Asbestos)	600	C-320	MIL-I-2781 Grade I, Class b	HH-I-554, Type II
	MINERAL FIBER (Rock, Slag or Glass) Low Temp (Organic Binder)	250	C-300		HH-I-562, Type II HH-I-552, Type I
	Low and Medium Temp (Fine Fiber, Organic Binder)	370	C-281 C-300	MIL-I-22344	HH-I-562, Type II HH-I-552, Type I
	High Temp (Blanket-Type Metal Reinforced)	1200	C-280		HH-I-552, Type II
BLOCKS and BOARDS	CALCIUM SILICATE (Calcium Silicate and Asbestos)	1200	C-344	MIL-I-2819, Classes a & b MIL-I-002819, Classes 1 & 2	HH-I-523, Class 1
	CELLULAR GLASS (Foamed)	800	C-343		HH-I-551
	CELLULAR SILICA (Foamed)	1600 (cyclic) 2200 (cont.)			
	DIATOMACEOUS SILICA (Diatomaceous Silica and Asbestos)	1600 1900	C-333 C-333	MIL-I-2819, Classes b & c MIL-I-002819, Class 3 MIL-I-002819, Class 4	
	85% MAGNESIA (Basic Magnesium Carbonate and Asbestos)	600	C-319	MIL-I-2819, Class a MIL-I-002819, Class 1	HH-I-554, Type I
	MINERAL FIBER (Rock, Slag or Glass) Low Temp (Organic Binder)	250	C-378	32-MC-2[a] MIL-I-742[a]	HH-I-564, Class A HH-I-526, (for Roofs) HH-I-562, Type I
	Low Temp (Fine Fiber, Organic Binder)	400	C-378, C-392, Class 1		HH-I-562, Type I
	High Temp (Inorganic Binder)	1800	C-392, Class 2		HH-I-564, Class B, C, D
CEMENTS	CALCIUM SILICATE (Calcium Silicate, Asbestos and Binders)	1200			HH-I-523, Class 3
	DIATOMACEOUS SILICA (Diatomaceous Silica and Asbestos)	1900	C-197	MIL-C-2861, Type A	HH-I-00500, Type V
	MAGNESIA (Basic Magnesium Carbonate, Asbestos and Binder)	600	C-193	MIL-P-2886	HH-I-00500, Type I
	MINERAL FIBER (Rock, Slag or Glass) Insulating (Colloidal Clay and Binder)	1800	C-195	MIL-C-2861, Type B	HH-I-00500, Type III HH-C-168
	Finishing (Hydraulic-setting Cement and Binder)	1200	C-449	MIL-C-2908, Type II	
BLANKETS and FELTS	MINERAL FIBER (Rock, Slag or Glass) Metal-Reinforced Blanket	1200	C-263	MIL-I-2818	HH-I-563, Type I
	Flexible (Organic Bonded)	400	C-264 C-302	MIL-I-942 MIL-I-22023[a] MIL-B-5924 } [a] MIL-I-16658 MIL-I-7171 } [a] 32-MA-3[a] MIL-I-15475	HH-I-542, Type I
	Industrial Batt (No Binder)	1200	C-262	MIL-W-15427	
	Felt (Semi Rigid, Organic Bonded)	400	C-264 C-302	MIL-I-16658 } [a] MIL-I-942 MIL-I-15475 } [a] 32-MC-1[a]	HH-I-521, Type I HH-I-542, Type II HH-I-563, Type II
LOOSE and GRANULATED	MINERAL FIBER (Rock, Slag or Glass)	1200			HH-I-521, Type I—Loose Type II—Gran

[a] These temperatures are generally accepted as maximum. For specific applications consult the manufacturer. [b] See latest revisions of these specifications.

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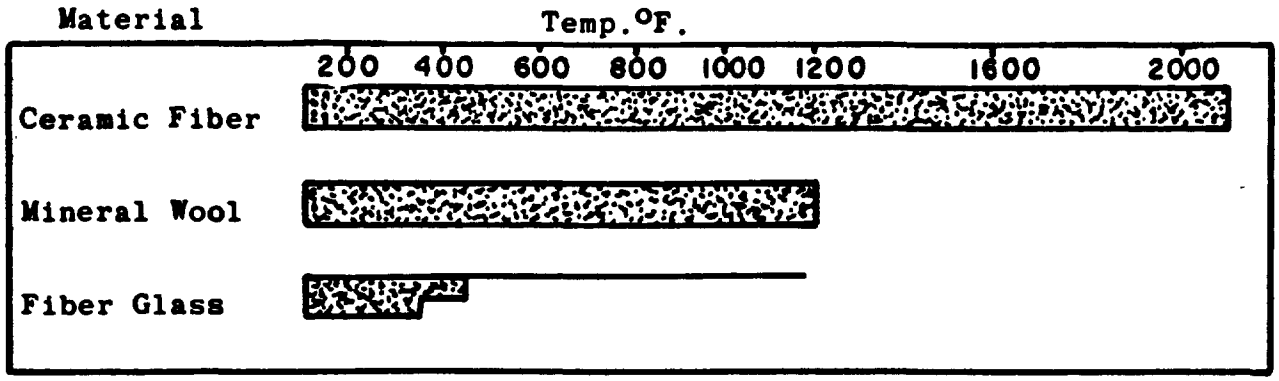
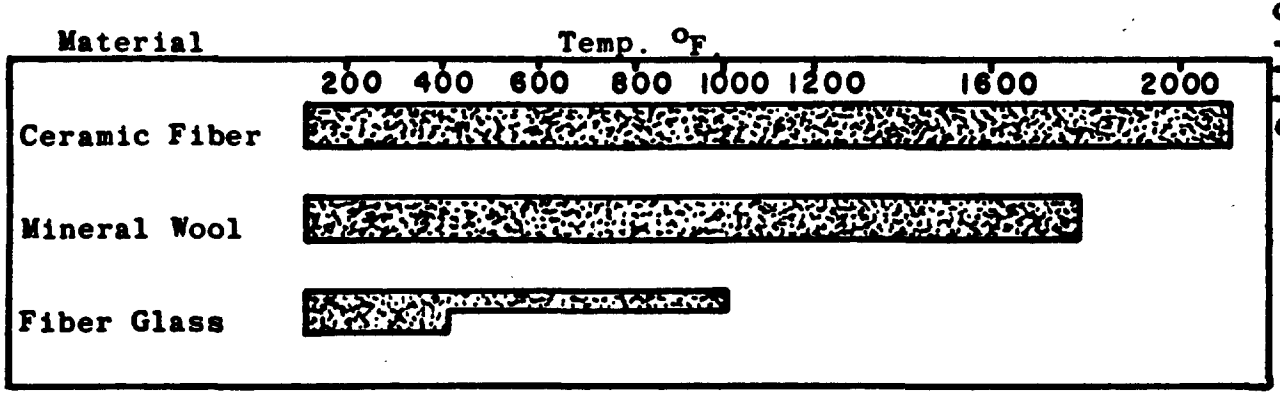
Table V

The Insulation Product System

A. Blanket: Fiber Glass - Mineral Wool - Ceramic Fiber



B. Block-Board: Fiber Glass - Mineral Wool - Ceramic Fiber



C. Pipe Covering: Fiber Glass - Mineral Wool - Ceramic Fiber

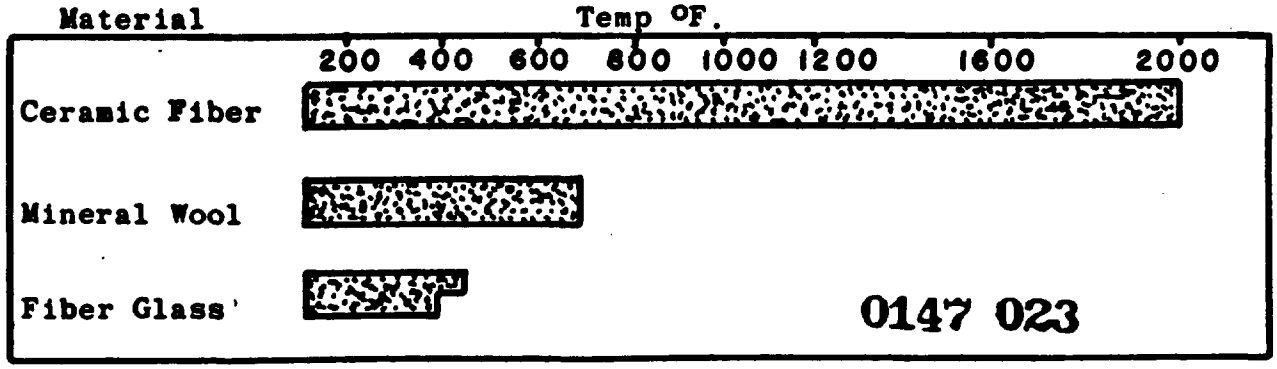


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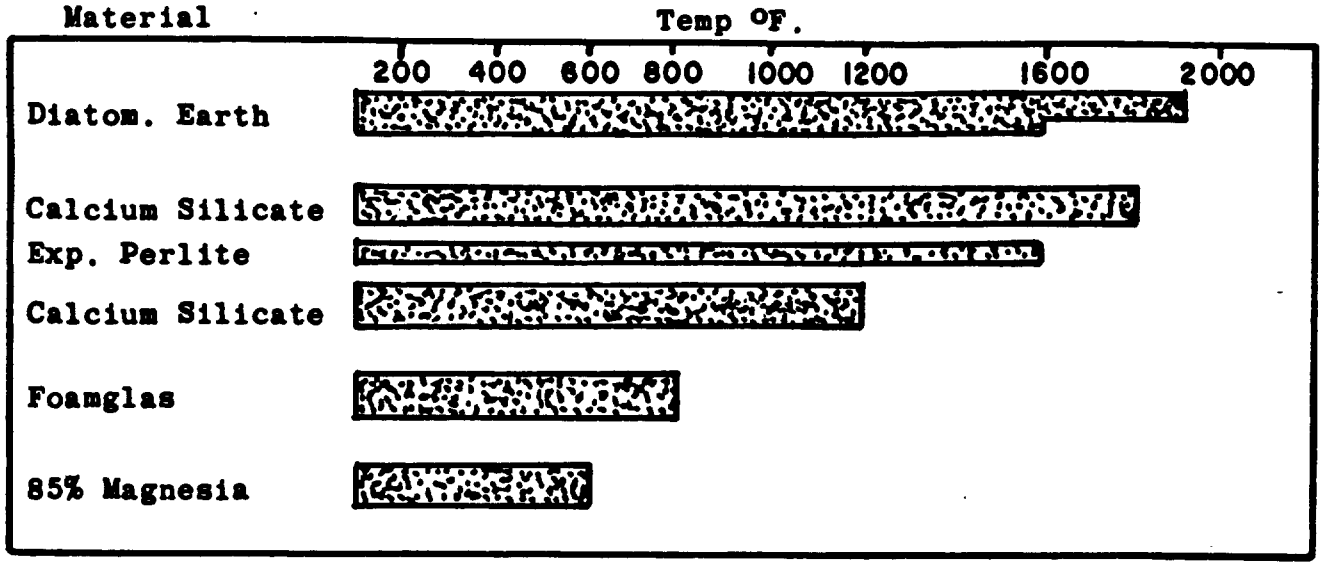
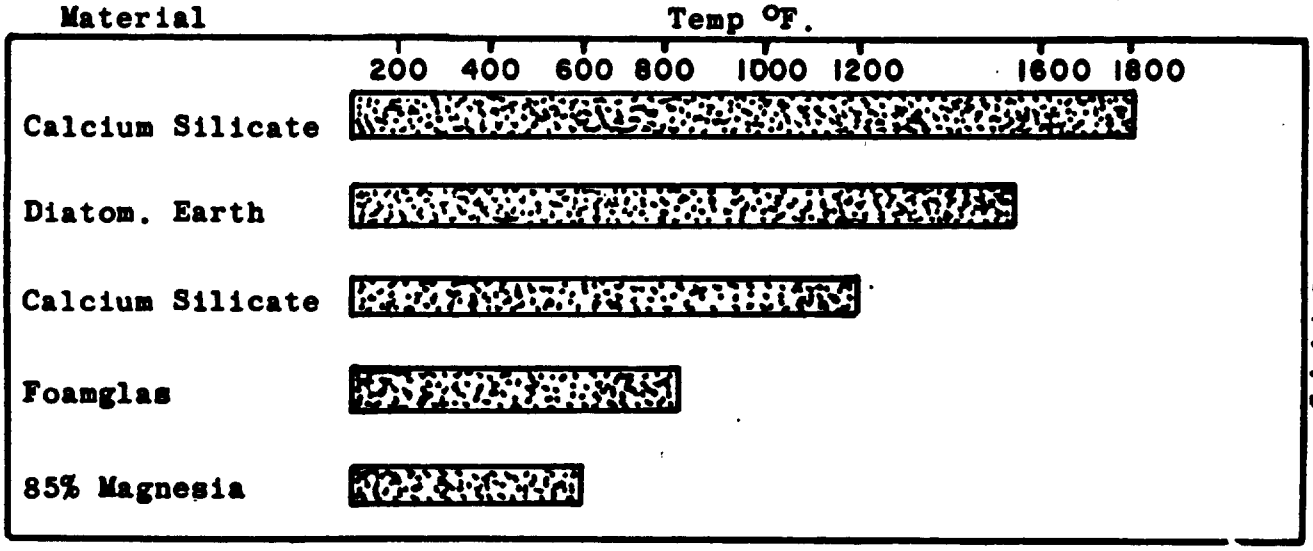
Table VI

D. Block-Board: Diatomaceous Earth - Calcium Silicate - 85% Magnesia



E. Pipe Covering: Diatomaceous Earth - Calcium Silicate - 85% Magnesia



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F. Spray Insulations:

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Material	Temp °F.
Asbestos Mineral Wool Fibers and Inorganic Binder	700 - 2000°F

DOW 05490

TABLE VI-A - Blanket: Ceramic Fiber, Fiberglass, Mineral Wool

Manufacturer or Supplier	Tradename	Type	Density	Temperature, °F (200 400 600 800 1000 1200 1400 1600 1800 2000 2200 2400 2600)
Johns-Manville	Micro-quartz	C	3-6	
du Pont	Tipersul	C	12-28	
Babcock & Wilcox	Kaowool	C	3-8	
Carborundum	Fiberfrax	C	4-8	
H. I. Thompson	Refrasil	C	4½-6	
Johns-Manville	Cerafelt	C	3-24	
Philip Carey	Min. Wool Blanket	M	8	
Eagle-Picher	Min. Wool Blanket	M	8	
Baldwin-Ehret-Hill	Blanket Ins. #101	M	6-10	
Unarco	Unimat Blanket	F	8	
Unarco	Woven Glass Felt	F	9	
Pittsburgh-Corning	Temp-mat	F	7½	
Johns-Manville	Unbonded B-Fiber	F	4½	
Johns-Manville	Banroc Blanket	M	8	
Forty-Eight Ins.	ETR Blanket	M	8	
Armstrong	Armaglas TWL	F	2½-7½	
Owens-Corning	Fiberglas TWL	F	2½-7½	
Pabco	Pabco TW-F	F	2½-7½	
Unarco	Insubestos A	A	12	
Johns-Manville	Spintex	M	3-9	
Philip Carey	Thermoglas Roll	F	½-3	
Ruberoid	Spec. Fiber Ins.	F	3-9	
Baldwin-Ehret-Hill	Fine-Fyber	M	½-3	
Gustin Bacon	Ultralite	F	1½-3	
Gustin Bacon	Ultrafine	F	½-3	
Johns-Manville	Microlite	F	½-3	
Johns-Manville	Microtex	F	¾-3	
Pitts. Plate Glass	Textrafine	F	½-3	
Pitts. Plate Glass	Superfine	F	½-3	
Ruberoid	Fiber Glass	F	¾-3½	
Owens-Corning	Fiberglas 300-310	F	½-	

A - Asbestos
C - Ceramic fiber
F - Fiber glass
M - Mineral wool

xxx

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DOW 05491

TABLE VI-B - Block-board: Ceramic Fiber, Fiberglass, Mineral Wool

Manufacturer or Supplier	Tradename	Type	Density
du Pont	Tipersul	C	12-28
Carborundum	Fiberfrax F-13	C	13
Carborundum	Fiberfrax XB	C	25
Gen. Refract.	Grefco MX-17	M	16-20
Detrick	Griptex	M	18-22
Philip Carey	Min. Wool Block	M	---
No. Amer. Ref.	Narco Block	M	16-20
Unarco	Unarco Min. Wool	M	16-20
Eagle-Picher	PV Super Temp.	M	16-20
Kaiser	M-Block	M	---
Baldwin-Ehret-Hill	Mono-Block	M	14-18
Armstrong	Armatemp MW	M	15
Forty-Eight Ins.	Webers HT Block	M	14-17
Johns-Manville	H. T. Banroc	M	18
A. P. Green	High Temp. Block	M	18-22
Holmes	Uniblock	M	17-19
Ref. & Ins.	R. & I. Min. Wool	M	18
Owens-Corning	High Temp.	F	10.75
Johns-Manville	Banroc M	M	8
Eagle-Picher	MT-10 Board	M	---
Eagle-Picher	MT Board	M	9
Baldwin-Ehret-Hill	Therma K	M	10
Forty-Eight Ins.	N-700	M	9
U.S. Min. Wool	9 Lb. Felt	M	9
Owens-Corning	I. S. Board	F	3
Armstrong	I. S. Board	F	3
Owens-Corning	PF-600 Series	F	2-10
Armstrong	PF-600 Series	F	
Pabco	PF-600 Series	F	
Eagle-Picher	PF-600 Series	F	
Eagle-Picher	LT Felt	M	4-6-8

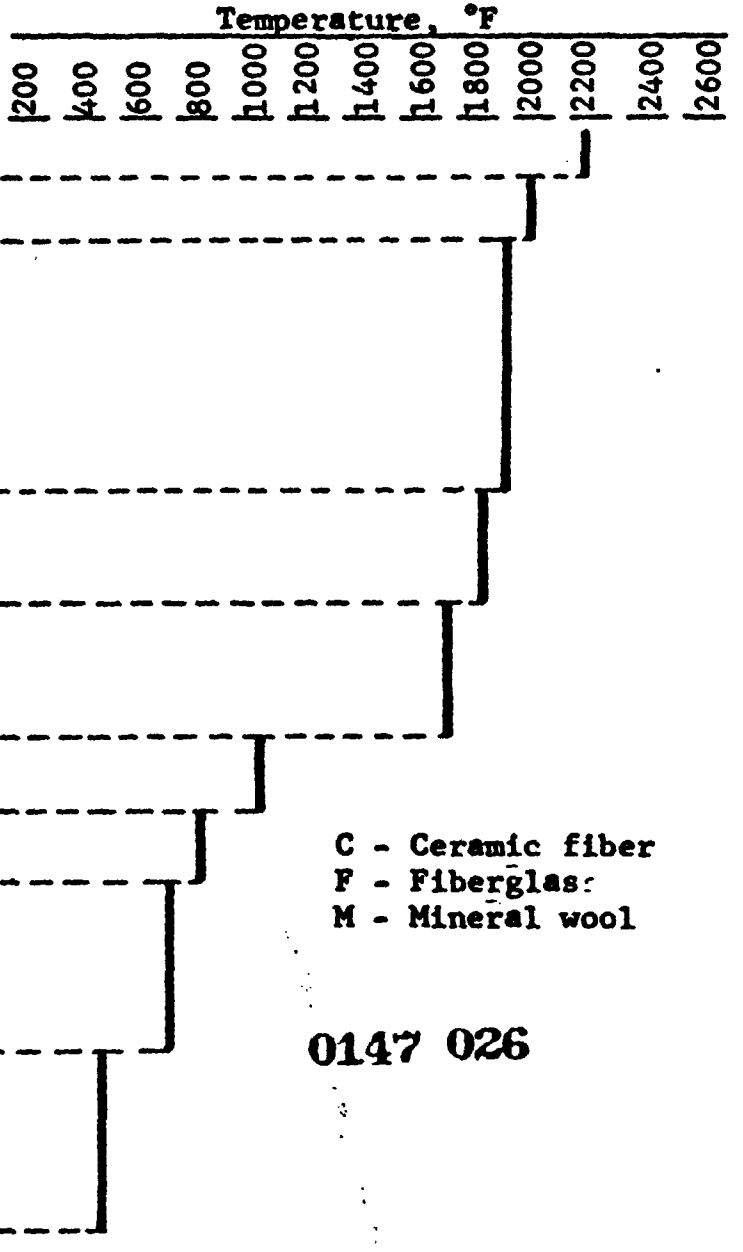

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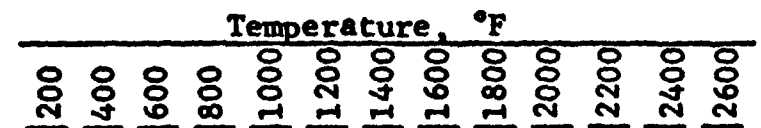
TABLE VI-D - Block: Calcium Silicate, Perlite, Diatomaceous Earth, Asbestos, 85% Magnesia

Manufacturer	Tradename	Type	Density
Philip Carey	Careytemp 2000	D	23
Baldwin-Ehret-Hill	Enduro Block	D	24
Johns-Manville	Superex	D	24
Pabco	Prasco 19-C	D	23
Ref. & Ins.	No. 19 Ins. Block	D	--
Armstrong	LK-20	C	12
Owens-Corning	Kaylo-20	C	12
Ruberoid	Calsilite Hi	C	12
Baldwin-Ehret-Hill	Enduro M	C	12.5
Philip Carey	Careytemp	P	9
Johns-Manville	Superex M	D	21
Pabco	Prasco 15-C	D	22
Pabco	Super Caltemp	C	12
Pabco	Caltemp	C	12
Ref. & Ins.	No. 12 Ins. Block	P	--
Pitts.-Corning	Unibestos	A-D	16
Holmes	Caposite	A-D	14
Owens-Corning	Kaylo	C	12
Ruberoid	Calsilite	C	12
Baldwin-Ehret-Hill	Thermasil	C	11
Johns-Manville	Thermobestos	C	11
Eagle-Picher	Hylo Regular	C	12
Pitts.-Corning	Foamglas	G	9
Baldwin-Ehret-Hill	Thermalite	85	11
Pabco	Precision Molded	85	11
Johns-Manville	85% Mag	85	11
Armstrong	85% Mag	85	11
Johns-Manville	Asbestocel	A	9-16
Nicolet	AirCell	A	



A - Asbestos
C - Calcium silicate
D - Diatomaceous earth
G - Glass
P - Perlite
85 - 85% Magnesia

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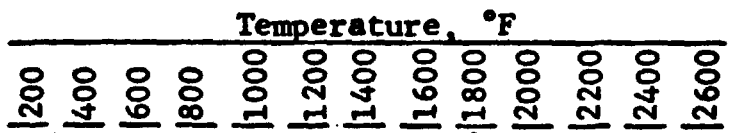
DOW 05493

TABLE VI-E - Pipe Covering: Calcium Silicate, Perlite, Diatomaceous Earth: Asbestos; 85% Magnesia

Manufacturer or Supplier	Tradename	Type	Density
Armstrong	LK-20	C	12
Owens-Corning	Kaylo-20	C	12
Ruberoid	Calsilite Hi	C	12
Baldwin-Ehret-Hill	Enduro M	C	12.5
Philip Carey	Careytemp	P	9
Johns-Manville	Superex M	D	21
Pabco	Prasco-15	D	22
Pabco	Caltemp	C	12
Pittsburgh-Corning	Unibestos	A-D	16
Holmes	Caposite	A-D	14
Ruberoid	Calsilite	C	12.5
Baldwin-Ehret-Hill	Thermasil	C	11.5
Johns-Manville	Thermobestos	C	11
Owens-Corning	Kaylo	C	12
Eagle-Picher	Hylo Regular	C	12
Pittsburgh-Corning	Foamglas	G	9
Baldwin-Ehret-Hill	Thermalite	85	11
Pabco	Precision Molded	85	11
Johns-Manville	85% Mag.	85	11
Philip Carey	Dual Careytemp	P	10
Johns-Manville	Asbestocel	A	7-16
Nicolet	AirCell	A	9-16



A - Asbestos
C - Calcium silicate
D - Diatomaceous earth
G - Glass
P - Perlite
85 - 85% Magnesia

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DOW 05494

TABLE VI-F - Spray Insulations: Asbestos and Asbestos-Mineral Wool with Inorganic Binders

Manufacturer or Supplier	Tradename	Temperature, °F: 200	400	600	800	1000	1200	1400	1600	1800	2000	2200	2400	2600
Columbia Acoustics & Fireproofing	Cafco-Blaze Shield													
	Cafco-Heat Shield													
Baldwin-Ehret-Hill	Pyrospray													
Baldwin-Ehret-Hill	Mono-Spray													
Smith & Kanzler	SprayCraft S													
Smith & Kanzler	SprayCraft H													
Armstrong	Limpet LB-8													
Armstrong	Limpet LW-25													
National Gypsum	Gold Bond Sprayolite													

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DOW 05495

From:
Sargent & Lundy
Chicago

Subject:
Ridgeland Station
Commonwealth Edison Company

Table VI-F-1

Notes of Sprayed-on Thermal Insulation
Inspection at Job Site on
December 8, 1964

1. The cyclones on Ridgeland Unit 4 boilers are being rebuilt and are being reinsulated with sprayed-on insulation in lieu of the normal block type material. The spray-on insulation being used is Mono-Spray, manufactured by Baldwin-Ehret-Hill, Inc. This is a mineral wool and asbestos material with a temperature use limit of 1800 F which is sprayed on the equipment to a density of approximately 12 lb/cu. ft. and to the specified thickness.

2. The insulation work at the station is being done by the Commonwealth Edison maintenance personnel under the direction of the manufacturer's technician. The cyclones have all been sprayed to a 4" thickness and the results are excellent. The maintenance personnel contend that this is the simplest, best, and least expensive method of insulating irregular surfaces.

3. During the past two years portions of the insulation on the Unit 1, 2 and 4 turbines has been replaced or repaired with sprayed-on material. In all cases the sprayed-on areas are in excellent condition and the surfaces feel cool to the touch with no hot spots.

4. The following spray-on insulations are suitable for high temperature service:

   Limpet ..... Armstrong Contracting & Supply Corp.
   Mono-Spray..... Baldwin-Ehret-Hill, Inc.
   Cafco..... Columbia Acoustics & Fireproofing Co.

5. Commonwealth Edison Company has used Limpet and Mono-Spray for replacement and repairs at Ridgeland and State Line Stations. Cafco is being sprayed on the deaerators, closed feed water heaters and water treating equipment at Joliet 7 and 8.

6. The above sprayed materials are very satisfactory for use in power plants and have proven more economical than wired on calcium silicate or mineral wool block insulations. In time there will probably be a wider acceptance and use of this type of insulation because of its overall efficiency and economy. It can be successfully used on most of the hot equipment and ductwork in a plant including the turbine and steam generating unit.

7. One of the major disadvantages of the sprayed insulations is that the end results are very highly dependent on the skill of the operator. If not properly sprayed on and tamped to the necessary thickness and density the results can be very inefficient as well as unsightly.

8. If we decide to specify sprayed-on insulation for future jobs, we should make every effort to insure that the insulation contractors that are allowed to bid the work are thoroughly experienced in this type of application.

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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

⅛" 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

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