VI. HIGH-GRADE ELECTRICAL PAPER

A. Product Description

Classification of asbestos paper products into specific categories is difficult. Similar products may be classified differently by two manufacturers due to their differing end applications. Also, manufacturers may place all of their products into the category for which most of the material is used, or they may divide the products into each end application. Our division of paper products into different categories is based on the information obtained from both the manufacturers and users of these products.

Asbestos is used in electrical paper insulation because of its high thermal and electrical resistance that permit the paper to act effectively as an insulator and to protect the conductor from fire at the same time. Asbestos electrical insulation is composed of 80 to 85 percent asbestos fiber encapsulated in high temperature organic binders. It is formed on conventional papermaking machines and may be obtained in rolls, sheets, and semi-rigid boards (ICF 1986).

The major use of asbestos electrical paper is insulation for high temperature, low voltage applications such as in motors, generators, transformers, switch gears, and other heavy electrical apparatuses. Typically, operating temperatures are 250°F to 450°F (ICF 1986).

B. Producers of High-Grade Electrical Paper

At present, asbestos paper for electrical insulation is manufactured by only one firm, the Quin-T Corporation in Tilton, New Hampshire. A previous survey failed to identify any 1981 importers of asbestos electrical insulating paper, and the asbestos processor surveyed in 1986 was not aware of any such imports (ICF 1984, ICF 1986).

C. Trends

The production volumes and fiber consumption for electrical paper for

1985 are presented in Table 1. Production decreased by 20 percent between 1981 and 1985, from 841 short tons to 698 short tons (ICF 1986) (TSCA 1982a). Domestic fiber consumption declined between 1981 and 1985 by 11.5 percent, from 841 short tons to 744 short tons[1] (ICF 1986).

The only two secondary processors of high-grade electrical paper for insulation purposes have ceased manufacturing asbestos containing materials. In 1981, the Square D company, having plants in Clearwater, Florida and Milwaukee, Wisconsin, stopped processing. In 1985, Power Magnetics ceased all production of asbestos containing products (ICF 1986).

The sole manufacturer of asbestos electrical insulation estimates that asbestos products hold 10 percent of the total market. Their share of the market in high temperature applications may be as high as 75 to 80 percent (ICF 1986). The use of asbestos electrical paper in typical applications appears to be declining, as asbestos is being phased out in various applications. One manufacturer of transformers believes that the use of asbestos has been completely eliminated for this product (Square D 1986).

D. Substitutes

Asbestos is unique among raw minerals because it is a chemically inert and nearly indestructible mineral that can be processed into fiber. Asbestos

[1]Although the consumption value for electrical paper from the ICF 1986 survey indicates that the finished product is more than 100 percent asbestos, it is likely that some of the fiber consumption was in fact, inventory. The submitter could not be reached, however, for corroboration.

Table 1. Production of High-Grade Electrical Paper and Asbestos Fiber Consumption

	1985 Fiber Consumption (short tons)	1985 Production (short tons)	Reference
Total	744	698	ICF (1986a)

fibers partially adsorb the binder with which they are mixed during processing; they are then intertwined, and become the strengthening matrix of the product. By formulating the product with 85 percent asbestos fibers, manufacturers are also employing it as a filler. The remaining 15 percent of the product is the binder which holds the asbestos in the matrix. Industry leaders indicate that they have been unable to find a single substitute for asbestos that can reproduce the numerous qualities of the mineral. Hence, manufacturers have been forced to replace the asbestos fiber with a combination of substitute materials, including aramid and ceramic. The formulations of the substitute products most often include a combination of more than one type of substitute fiber and more than one filler in order to reproduce the properties of asbestos necessary for that application. Formulation of substitute products is done on an application-by-application basis by each manufacturer (ICF 1986).

The substitute products can be grouped into two major categories according to the type of asbestos substitute fiber used: aramid or ceramic (ICF 1986). Table 2 shows a comparison of these substitutes. The current market share of the different substitute formulations is presently unknown and our attempt to project the market shares in the event of an asbestos ban relies more on the informed judgement of industry rather than on specific data. It is evident from the survey that the market share of asbestos free electrical paper is increasing rapidly, as more companies replace asbestos (ICF 1986).

1. Aramid Paper

A typical aramid-based paper product, Nomex (R), the tradename for a substitute paper manufactured by Dupont, is made with an aromatic polyamide. It is thermally stable to 400°F and flame resistant. Quin-T Corporation in Tilton, NH, cites this substitute as performing better than asbestos paper in

Table 2. Substitutes for Asbestos High-Grade Electrical Paper

Paper Product	Manufacturer	Advantages	Disadvantages	Remarks	Reference
Aramid	Dupont	Performance is better. Thermal stability. Flame resistant.	Premium price. Low temperature range.	Aromatic polyamide paper.	ICF (1986a) ICF (1984a)
Ceramic	Carborundum Corp.	Good dielectric properties temperature resistance up to 2000°F. Easily handled. Easily cut.	Stiff. Expensive.	Ceramic paper.	ICF (1986a) ICF (1984a)

some situations. It is very expensive, however, and has a price of $10.48 per pound (five times that of the asbestos product). Quin-T indicated that this material would capture 80 percent of the asbestos market in the event of an asbestos ban (ICF 1986). The disadvantages of Nomex (R) are that it does not have the high temperature limits of asbestos and may not have the same range of applicability that asbestos has (DuPont 1980).

2. Ceramic Paper

Fiberfrax (R) is the name of a ceramic paper made by the Carborundum Corporation and is representative of other ceramic papers available. It has good dielectric properties as well as a temperature resistance up to 2000°F. Two advantages of this paper relative to asbestos are that it is easier to handle and easier to cut. Quin-T Corporation has indicated that this material will take 20 percent of the asbestos electrical paper market in the event of a ban of asbestos. The product is three times as expensive as the asbestos paper, and costs $7.04 per pound (ICF 1986).

Some of the drawbacks of ceramic paper products include the loss of tensile strength after exposure over extended periods, stiffness during use, and slightly more permeability than asbestos at low temperatures (Carborundum 1986).

E. Summary

It appears that substitutes for asbestos electrical paper currently exist. However, these products cost more to produce and may not perform as well. Asbestos is unique among known raw minerals because of its combination of strength, heat resistance, and low price. Since no across the board substitute fiber exists for the mineral, the manufacturer has been forced to replace asbestos with a combination of substitute materials, including aramid- and ceramic-based papers. The substitute materials are a combination of fibers and fillers designed with proprietary formulations.

The estimation of market shares and prices of the substitute formulations in the event of an asbestos ban relies to a large extent upon educated judgments of industry experts. Table 3 summarizes the findings of this analysis, and presents the data inputs for the Asbestos Regulatory Cost Model.

Table 3. Data Inputs for Asbestos Regulatory Cost Model
(006) High-Grade Electrical Paper

Product	Output	Product Asbestos Coefficient	Consumption Production Ratio	Price	Useful Life	Equivalent Price	Market Share	Reference
Asbestos Electrical Paper	698 tons	1.07 tons/ton	1	$2.53/lb.	3 years	$2.53/lb.	N/A	ICF (1986a)
Aramid Electrical Paper	N/A	N/A	N/A	$10.48/lb.	3 years	$10.48/lb.	80%	ICF (1986a), ICF (1984a)
Ceramic Electrical Paper	N/A	N/A	N/A	$7.04/lb.	3 years	$7.04/lb.	20%	ICF (1986a), ICF (1984a)

N/A: Not Applicable.

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VII. ROOFING FELT

A. Product Description

Asbestos roofing felt is made in two separate stages. In the first stage, asbestos fiber, cellulose fiber, and various fillers are combined to produce unsaturated roofing felt. The second stage involves saturating this felt by coating it with either coal tar or asphalt to produce the final product -- saturated roofing felt.

Unsaturated roofing felt is a paper product composed of 85 to 87 percent asbestos fiber (usually grades 6 or 7 chrysotile fiber), 8 to 12 percent cellulosic fibers, 3.5 percent starch fibers, and small amounts of fillers such as wet and dry strength polymers, kraft fibers,[1] fibrous glass, and mineral wool. The product is manufactured on conventional paper machines. The ingredients are combined and mixed with water and then fed through a series of machines that apply heat and rollers to produce a felt with uniform thickness. The felt can be either single- or multi-layered grade. For the multi-layered grade fiberglass filaments or wire strands may be embedded between the paper layers for reinforcement (Krusell and Cogley 1982).

These steps comprise the primary processing stage of production; the product is now considered an unsaturated felt and is ready to be coated. It can be coated at either the main plant, or it can be coated at geographical locations nearer to demand if lower transportation costs justify it.[2] The felt is coated by pulling it through a bath of hot asphalt or coal tar until it is thoroughly saturated. The paper then passes over a series of hot rollers so that the asphalt or coal tar is properly set. It may be coated with extra surface layers of asphalt or coal tar depending on the intended

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[1]Kraft fibers consist of a blend of cellulose and wood pulp fibers.

[2]It is less expensive to ship unsaturated felt because it weighs much less.

application. After saturation and coating, the roofing felt passes over a series of cooling rollers that reduce its temperature and provide a smooth surface finish. The felt is then air-dried, rolled, and packaged for marketing as saturated roofing felt (Krusell and Cogley 1982).

Asbestos roofing felt is used for built-up roofing. There are two types of built-up roofing systems -- hot roof systems and cold roof systems. The hot roof system is the more common; it involves the application of several plys or layers of roofing felt alternating with hot asphalt or tar, often with a top layer of gravel imbedded in the asphalt. The layers used may be fiberglass felts, organic felts, or asbestos felts.

The other system is a cold roof system. It does not require the application of hot tar or asphalt, instead, adhesive tars or roof coatings are used to bond the layers together. The layers used may be single-ply membrane, fiberglass felts, organic felts, or asbestos felts.

Asbestos is used in roofing felts because of its dimensional stability and resistance to rot, fire, and heat. Dimensional stability, which refers to the product's ability to expand and contract with changes in temperature, is important because roofs are exposed to wide temperature fluctuations that may cause the roof to actually crack, allowing water to penetrate and settle. Because this water may remain trapped for long periods of time, rot resistance becomes crucial. In addition, rot resistance is important because flat roofs (on which built-up roofing is typically used) tend to have poor drainage and do not allow water to run off (ICF 1985).

B. Producers and Importers of Asbestos Roofing Felt

There were three primary processors and three secondary processors of asbestos roofing felt in 1981. The primary processors were Nicolet, Inc., Celotex Corporation, and Johns-Manville Corporation[3] (TSCA 1982a). However, no primary processors produced any asbestos felt in 1985 and none are currently producing asbestos roofing felt (ICF 1986).

The secondary processors in 1981 were B.F. Goodrich Corporation, Mineral Fiber Manufacturing Corporation, and Southern Roofing & Metal Company (TSCA 1982b). Southern Roofing & Metal Company stopped processing asbestos roofing felt in 1982. B.F. Goodrich Corporation processed imported asbestos roofing felt in part of 1985, but has now stopped. Mineral Fiber Manufacturing Corporation is the only domestic company which still processes asbestos roofing felt (ICF 1986).

Mineral Fiber Manufacturing Corporation does not purchase[4] asbestos roofing felt. They simply receive unsaturated roofing felt, coat and saturate it with asphalt, and return the saturated roofing felt to their supplier, a Canadian firm called Cascades, Inc. Cascades, Inc. then sells this product in the U.S. through Power Marketing Group, a distributor that does not process any asbestos itself. Power Marketing Group believes they are the only company selling this product in the U.S., and no other processors or importers of asbestos roofing felt were identified (Power 1987b, ICF 1984, ICF 1986).

C. Trends

The three primary processors produced approximately 3,107,538 squares of asbestos roofing felt in 1981 (TSCA 1982a), and they had all ceased production of this product in 1985. Information on imports by Power Marketing Groups and other companies in 1981 is not available, but Power Marketing Group believes it is the only importer of this product in 1985. Thus, we see that both

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[3]Johns-Manville Corporation has changed its name to Manville Sales Corporation.

[4]The company insists that it does not purchase or process any roofing felt. They provide the service of coating the felt and charge a fee for their service.

production and consumption of asbestos roofing felt have declined significantly in the U.S.

D. Substitutes

There are currently four products which have served or may serve as substitutes for asbestos roofing felt -- fiberglass felt, organic felt, modified bitumen, and single-ply membrane. A discussion of each one will be presented separately.

1. Organic Felt

Organic felt is the oldest roofing felt, and it had dominated the market until recently because it was very economical. It is composed primarily of wood pulp or cellulosic fiber, and this makes it susceptible to rotting. Although asbestos felt could not compete with organic felt on price, it was able to outperform it because of its heat, fire, and rot resistance. These resistance properties were particularly important because they allowed commercial users to save on their insurance premiums (Manville 1986). The recent substitution away from asbestos roofing felt has resulted in some increased market share for organic felt, but the primary beneficiary has been fiberglass felt. The current producers of organic felt include: Manville Sales, Celotex, Koppers, and Certainteed (Washington Roofing 1986).

2. Fiberglass Felt

Fiberglass roofing felt is made of glass or refractory silicate mixed with a binder. The exact composition is not available. Owens-Corning Corporation invented the continuous filament manufacturing process in 1964. The introduction of fiberglass felt drastically changed the market because it took virtually the entire market share of asbestos roofing felt and now has a major share of the roofing felt market. Fiberglass felt was able to do this because it possesses the same heat, fire, and rot resistant qualities of asbestos felt, but it is much less expensive and may require fewer layers.

Most of the recent substitution away from asbestos roofing felt was achieved through the use of fiberglass felt. The current producers of fiberglass felt include: Owens-Corning, Manville Sales, Tamco, and GAF (Washington Roofing 1986).

3. Modified Bitumen

Power Marketing Group states that the asbestos felt they sell is used almost exclusively in flashing applications. This refers to the process of waterproofing roof valleys or the area around any object which protrudes from the roof. Asbestos felt is used in these applications because fiberglass felt has a tendency to pull away when it is applied vertically as is often the case in flashing applications (Power 1986). Organic felt is not suitable for such applications because it is susceptible to rotting.[5] Power Marketing Group believes the only effective substitute is modified bitumen. However, it costs 10-15 percent more than asbestos roofing felt, and it also presents a fire risk because it must be applied with a torch (Power 1986).

4. Single-Ply Membrane

Single-ply membrane is a cold roof system. The product itself is a laminate (roll of bonded or impregnated layers) of modified bitumen and polymeric materials. For example, Koppers KMM(R) system is a 160 mil, five layer laminate composed of a thick plastic core protected on each surface by a layer of modified bitumen and an outer film of polyethylene.

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[5]The view expressed by Power Marketing Group concerning the usefulness of asbestos are not shared by members of the industry. The National Roofing Contractors Association does not recommend the use of asbestos felt, and most roof suppliers do not carry the product (National Roofing Contractors 1986; Washington Roofing 1986). One roofing contractor claimed that using fiberglass felt for virtually an entire job and then using asbestos felt for only the flashing applications would not be practical because it would cause unnecessary delay and confusion while conferring limited benefits (Johnny B. Quick 1986).

A single-ply membrane is typically loosely laid (i.e. without layers of tar) with a covering of loose gravel. If more than one sheet of membrane is required to cover an area, the edges of the sheets are sealed together by ironing them together or through the application of a coal adhesive (Krusell and Cogley 1982).

The fact that single-ply membrane roofing can be applied cold to the roof deck is an important advantage when city ordinances or other considerations prohibit hot tar because of the dangers associated with tar kettles. At temperatures ranging between 650°F and 750°F, the tar or asphalt mixture will burn and has, in some instances, exploded and caused damage to property and pedestrians. As a result, some communities do not allow the use of hot tar or asphalt (Krusell and Cogley 1982). Manufacturers of single-ply membrane roofing systems include: Carlisle Syntex, Plymouth Rubber, Gates Engineering, and Koppers (Washington Roofing 1986).

Table 1 presents the advantages and the disadvantages of asbestos roofing felt and its substitutes, and Table 2 presents the inputs for the Regulatory Cost Model. Because asbestos felt is now used primarily in flashing applications, the projected market shares of the substitutes are based on their ability to substitute for asbestos felt in this particular application.

E. Summary

Asbestos roofing felt is no longer produced in the U.S. It is only distributed by Power Marketing Group, a company that imports the asbestos product from Canada. Total U.S. consumption of this product was 283,200 squares in 1985.

There appears to be some disagreement between representatives of Power Marketing Group and other industry sources on the likely substitutes of asbestos roofing felt in the case of an asbestos ban. Our estimated market shares are an attempt to reconcile these two views. Modified bitumen is

Table 1. Substitutes for Asbestos High-Grade Electrical Paper

Product	Manufacturer	Advantages	Disadvantages	References
Asbestos Felt	Cascades, Inc. Kingsley Falls, Quebec	Dimensional stability. Rot, fire, and heat resistance. Effective in flashing applications.	Potential environmental and occupational health problems.	ICF (1986) Krusell and Cogley (1982)
Organic Felt	Manville Sales Corp. Celotex Corp. Koppers Co. Certainteed Corp.	Low cost.	Low durability. Low strength. Low rot resistance.	ICF (1986)
Fiberglass Felt	Owens-Corning Corp. GAF Corp. Tamco, Inc. Manville Sales Corp.	Rot, fire, and heat resistance. Dimensional stability Requires less asphalt saturation.	Less effective in flashing applications.	ICF (1986)
Modified Bitumen	Many	Effective in flashing applications.	Can only be applied with a torch.	Power (1986)
Single-Ply Membrane	Carlisle Syntex, Inc. Plymouth Rubber Corp. Koppers Co. Gates Engineering Co. Firestone Corp. Goodyear, Inc. Manville Sales Corp.	Can be applied cold. Rot, fire, and heat resistant. Dimensional stability. Effective in flashing applications.	High cost.	ICF (1986)

Table 2. Data Inputs for Asbestos Regulatory Cost Model

Product	Imports[a]	Product Asbestos Coefficient	Consumption/ Production Ratio	Price	Useful Life	Equivalent Price	Market Share	References
Asbestos Felt	283,200 squares[b]	0.0045 tons/square[b]	N/A	$6.65/square[b]	18 years	$6.65/square	N/A	ICF (1984) Power (1987a)
Fiberglass Felt	N/A	N/A	N/A	$3.85/square	18 years	$3.85/square	40%[b]	Washington Roofing (1986)
Modified Bitumen	N/A	N/A	N/A	$7.48/square[b]	18 years	$7.48 square	50%[b]	Power (1986)
Single-Ply Membrane	N/A	N/A	N/A	$29.26/square	18 years	$29.26/square	10%[b]	Washington Roofing (1986)

N/A: Not Applicable.

[a]This table is slightly different from the other data input tables. The heading for the second column is usually output and this refers only to domestic production. This number is then multiplied by the consumption production ratio to compute total domestic consumption. Because domestic production for this production is zero, we have provided the amount of roofing felt imported. The consumption production ratio is not computed because it is infinite.

[b]See Attachment for explanations.

projected to capture 50 percent of the market at a price of $7.48/square, fiberglass felt is projected to capture 40 percent of the market at a price of $3.85/square, and single-ply membrane is projected to capture 10 percent of the market at $29.26/square (see Attachment).

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ATTACHMENT

Because the information about substitutes obtained from various sources is somewhat contradictory, the projected market shares are based on a synthesis of the various opinions expressed. Thus, they are not attributable to any specific source, but they are the results of conversations with various industry members. It has been assumed that organic felt cannot be used in flashing applications due to its susceptibility to rotting.

Power Marketing Group believes that modified bitumen is the only effective substitute for asbestos felt and that its share should be 100 percent. Several industry sources (Washington Roofing 1986, Johnny B. Quick 1986) and the National Roofing Contractors Association (National Roofing Contractors Association 1986) believe that asbestos felt would be replaced with more conventional roofing materials. They estimate that fiberglass felt will take 80 percent of the market and single-ply membrane will take the remaining 20 percent. We have computed our market shares by weighting both of these opinions equally. Therefore, we estimate the following market shares: modified bitumen -- 50 percent, fiberglass felt -- 40 percent, and single-ply membrane -- 10 percent.

VIII. FILLER FOR ACETYLENE CYLINDERS

A. Product Description

Asbestos is used to produce a sponge-like filler that is placed in acetylene cylinders. The filler holds the liquified acetylene gas (acetone) in suspension in the steel cylinder and pulls the acetone up through the tank as the gas is released through the oxyacetylene torch. The torch is used to weld or cut metal and is sometimes used as an illuminant gas. The filler also acts as an insulator that offers fire protection in case the oxidation of the acetylene becomes uncontrollable. The desirable properties of asbestos in this function include its porosity, heat resistance, anti-corrosiveness and its strength as a binding agent (ICF 1986).

B. Producers and Importers of Filler for Acetylene Cylinders

Currently, there are three primary processors of asbestos filler for acetylene cylinders in the United States. The amount of fiber consumed and the number of cylinders produced in 1985 are listed in Table 1. There were no secondary processors of the filler in 1985 (ICF 1986). There were no acetylene cylinders imported to the U.S. in 1985. (NI Industries 1986).

C. Trends

Since 1981, domestic production of acetylene cylinders has decreased. The decrease is attributed to the severity of the last recession that contributed to the closing of the Los Angeles plant of NI Industries (NI Industries 1986). Recently, the market for acetylene cylinders has been stable and is expected to remain so for the foreseeable future (ICF 1986). Table 2 lists the fiber consumed and the cylinders produced in 1981 and 1985.

Table 1. Fiber Use and Production of Asbestos Filler -- 1985

	Asbestos Fiber Consumed (short tons)	Asbestos-Containing Acetylene Cylinders Produced	Reference
Total	584.1	392,121	ICF (1986)

Table 2. Acetylene Cylinder Market 1981-1985

Year	Asbestos Fiber Consumed (short tons)	Asbestos-Containing Acetylene Cylinders Produced	Reference
1981	863.0	528,432	ICF (1986)
1985	584.1	392,121	ICF (1986)

D. Substitutes

Currently, only one of the filler processors is producing a substitute filler. NI Industries processes a filler that contains glass fiber and the company reports that the glass filler performs as well as the asbestos filler. The only disadvantage that NI Industries cites is that the non-asbestos cylinder costs about 3 percent more than the asbestos cylinder. NI Industries also reports that it is attempting to gain the right to use a Union Carbide developed graphite filler. In addition, NI Industries plans to stop processing asbestos within the next year (NI Industries 1986). The other processors gave no indication about their plans for substituting asbestos in the manufacture of acetylene cylinder filler (ICF 1986). Table 3 summarizes the findings of this analysis, and presents the data inputs for the Asbestos Regulatory Cost Model.

E. Summary

Asbestos is used to produce a sponge-like filler that is placed in acetylene cylinders. Currently, there are three primary processors or importers. The market for acetylene cylinders is relatively stable and is expected to remain so for the foreseeable future. One of the processors, NI Industries, is producing a substitute glass filler that performs as well as the asbestos filler and costs about 3 percent more that the asbestos filler.

Table 3. Data Inputs for Asbestos Regulatory Cost Model
(008) Acetylene Cylinders

Product	Output	Product Asbestos Coefficient	Consumption Production Ratio	Price	Useful Life	Equivalent Price	Market Share	Reference
Acetylene Cylinders w/ asbestos filler	392,121 pieces	0.0014896 tons/piece	1.0	$90.00/piece	1 use	$90.00/piece	N/A	ICF (1986)
Acetylene Cylinders w/ glass filler	N/A	N/A	N/A	$93.00/piece	1 use	$93.00/piece	100%	ICF (1986)

N/A: Not Applicable.

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IX. FLOORING FELT

A. Product Description

Asbestos flooring felt is a paper product which is used as a backing for vinyl sheet floor products. It consists of approximately 85 percent asbestos and 15 percent latex binder by weight. Short fiber chrysotile asbestos (usually grades 5 through 7) is used and is generally obtained from Canada (Krusell and Cogley 1982). The latex binder is usually a styrene-butadiene type, although acrylic latexes can be used.

Asbestos flooring felt is manufactured on conventional papermaking machines. The ingredients are mixed together and combined with water. This mixture is then placed on a belt and forced through a series of machines which remove some of the water by applying heat and by suction. The next step is to force the mixture through rollers in order to produce a flat and uniform paper product. The felt is then allowed to cool before being rolled and wrapped.

These felt rolls are then used in producing vinyl sheet flooring. They are fed into coating machines where they are coated with vinyl and possibly decorated through various printing techniques. At this point, the product is considered a vinyl plastisol, and it may be colored by various additives or techniques. This printed sheet then goes through a fusion step where it is coated with a final layer of material called the "wear layer." The wear layer is a homogeneous polymer application that provides an impervious surface for the finished floor product.

Asbestos flooring felt has a number of desirable qualities. These include dimensional stability as well as high moisture, rot, and heat resistance.[1] The flooring is able to withstand these conditions without cracking, warping, or otherwise deteriorating. Asbestos flooring felt is also particularly

[1]Dimensional stability refers to the product's ability to stretch and contract with temperature changes and "settling" of the floor deck.

useful in prolonging floor life when moisture from below the surface is a problem (Krusell and Cogley 1982).

B. Producers and Importers of Asbestos Flooring Felt

There were four domestic primary processors of this product in 1981: Armstrong World Industries, Congoleum Corporation, Nicolet, Inc., and Tarkett, Inc. (TSCA 1982a). There were no secondary processors of asbestos flooring felt in 1981 (TSCA 1982b). In addition, two importers of asbestos flooring felt were identified in 1981 -- Biscayne Decorative Products Division of National Gypsum Company and Armstrong World Industries (ICF 1984). Since that time, all four primary processors have ceased production of asbestos flooring felt, and both importers have stopped importing asbestos flooring felt (ICF 1986). Because none of the other respondents to our survey indicated that they had begun production of asbestos flooring since the 1981 survey or were aware of any other producers or importers of asbestos flooring felt, we have concluded that there are currently no domestic producers or consumers of this product (ICF 1986).

C. Trends

1981 production of asbestos flooring felt was 127,403 tons (TSCA 1982a). Because all four producers have since stopped processing asbestos, production declined to 0 tons in 1985. There is no information on 1981 or 1985 imports of asbestos flooring felt.

D. Substitutes

As previously discussed, the key advantages of asbestos flooring felt were its dimensional stability and high heat, moisture, and rot resistance. Substitutes fall into two categories -- raw materials which can be used to produce a non-asbestos flooring felt and products which replace flooring felt itself. The substitutes for asbestos in the production of flooring felt include fiberglass, Pulpex(R), ceramic fiber, clay, and Bontex 148(R). The substitutes for flooring felt include foam cushioned backings and backless sheet vinyl. Tables 1 and 2 list the various substitutes and their advantages and disadvantages.

All of the substitutes are purchased as raw materials to be used in the production of flooring felt which is then used to produce vinyl sheet flooring. As a result, there is no observable flooring felt market. Furthermore, flooring felt producers would not reveal how much of the substitute is required or what other ingredients are required to produce their particular non-asbestos felt. Fortunately, cost estimates are not needed since asbestos flooring felt is no longer produced or sold in the U.S. and is therefore not being modeled.

Fiberglass flooring felt is a product which shares all of the advantages of asbestos flooring felt. It possesses dimensional stability, and is resistant to heat, rot, and moisture. Furthermore, it we look at roofing felt, a very similar product, we see that the fiberglass felt is much less expensive than the asbestos felt. Although the roofing application is somewhat different, the result in the flooring felt market is probably analogous.

Hercules, Inc. has developed the product Pulpex(R) to replace asbestos in flooring felt. Pulpex(R) is a fibrillated polyolefin pulp and comes in two forms -- Pulpex E (composed of polyethylene) and Pulpex P (composed of polypropylene). Pulpex(R) is sold to four North American producers of flooring felt and to six flooring felt producers worldwide. It has been commercially available since 1981. Pulpex(R) shares many of the advantages of asbestos, but it has a lower tensile strength and is less heat resistent (Hercules 1986).

Tarkett, Inc. produces a flooring felt in-house which uses a clay product to substitute for asbestos. The company claims that there are no advantages

Table 1. Substitutes for Asbestos in Flooring Felt

Product	Manufacturer	Advantages	Disadvantages	References
Asbestos Felt	None	Dimensional stability. Moisture, rot, and heat resistance.	Potential environmental and occupational health hazards.	Krusell and Cogley (1982) ICF (1986)
Fiberglass	Many	Dimensional stability. Moisture, rot, and heat resistance.	None.	Krusell and Cogley (1982)
Pulpex(R)	Hercules Corp. Wilmington, DE	Dimensional stability. Moisture and rot resistance.	Low tensile strength.	Hercules (1986)
Bontex 148(R)	Georgia Bonded Fibers, Inc. Newark, NJ	Heat resistance.	High cost.	Georgia Bonded Fibers (1986)
Clay	Many	Dimensional stability. Moisture, rot, and heat resistance.	None.	Tarkett (1986)

Table 2. Substitutes for Asbestos Flooring Felt

Product	Manufacturer	Advantages	Disadvantages	References
Foam-Cushioned Backing	Many	Dimensional stability. Moisture resistance.	High cost.	Krusell and Cogley (1982)
"Backless" Vinyl	Many	Easy to install. Excellent elastic properties. Moisture resistance.	High cost.	Krusell and Cogley (1982)

or disadvantages relative to asbestos in making this change (Tarkett 1986). it is not known if any other producers are using clay to substitute for asbestos in flooring felt.

Georgia Bonded Fibers has developed the product Bontex 148(R) which can be used in producing a flooring underlay. Bontex 148(R) is composed of synthetic fibers and cellulose. Product samples have been sent to all major producers of flooring felt, but its use is still limited to experimental applications in this country. It has been used in flooring felt in Europe, but the major drawback in the U.S. appears to be price. The main advantage of this substitute is that it has high heat resistance (Georgia Bonded Fibers 1986).

In addition to substitutes for asbestos <u>in</u> flooring felt, it is also possible to substitute other products directly for the flooring felt. "Backless" sheet vinyl is a sheet flooring material with a special vinyl backing. This backing has excellent elastic properties which allow the flooring to stretch and contract under the most severe applications. In addition, this backless vinyl is easier and faster to install than asbestos felt-backed vinyl. It requires a minimum of adhesive deck bonding, usually only around the edges, and can be stapled into place (Krusell and Cogley 1982).

Another substitute for flooring felt is foam-cushioned backing. Foam-cushioned backing is formed by attaching a cellulosic foam layer to vinyl sheet. This product has very good dimensional stability and moisture resistance. Backless vinyl and foam-cushioned backings appear to be good, commercially available alternatives to felt-backed vinyl flooring (Krusell and Cogley 1982).

The durability of felt backing is not a factor in the service life of the vinyl sheet product. The service life is primarily a function of wear layer thickness, traffic, and maintenance. In addition, the cost of the felt backing is a very small percentage of the total cost of the vinyl sheet product. Because the costs of most substitute backings were likely to have been comparable to the cost of asbestos felt backing, user cost was probably not a significant obstacle to eliminating asbestos in flooring felt.

E. Summary

In 1981 there were four primary processors of asbestos flooring felt in the U.S. By 1985 they had all stopped using asbestos in the production of flooring felt. There are a number of different substitutes for asbestos in flooring felts such as fiberglass, Pulpex(R), ceramic fiber, clay, and Bontex 148(R). Because the cost of the felt backing is only a small portion of the total cost of the vinyl floor product, the removal of asbestos has had very little impact on this industry.

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X. CORRUGATED PAPER

A. Product Description

Corrugated paper is a type of commercial paper that is corrugated and cemented to a flat paper backing and is sometimes laminated with aluminum foil. It is manufactured with a high asbestos content (95 to 98 percent by weight) and a starch binder (2 to 5 percent) (Krusell and Cogley 1982).

The manufacturing of corrugated paper uses conventional paper making equipment in addition to a corrugation machine that produces the corrugated molding on the surface of the paper.

Corrugated asbestos paper is used as thermal insulation for pipe coverings and as block insulation. The paper can be used as an insulator in appliance, hot-water and low-pressure steam pipes, and process lines.

B. Producers of Corrugated Paper

At present, asbestos corrugated paper is no longer manufactured in the United States (ICF 1986a). In 1981 there were three producers of asbestos corrugated paper: Celotex Corporation, Johns-Manville Corporation, and Nicolet Industries (TSCA 1982). All three companies had ceased production by 1982 (ICF 1986a).

C. Trends

Production of asbestos corrugated paper fell from 46 tons in 1981 to 0 tons in 1985 (ICF 1985, ICF 1986a). A recent survey failed to identify any 1981 importers of asbestos corrugated paper (ICF 1984). In addition, none of the firms surveyed in 1986 are aware of any importers of asbestos corrugated paper (ICF 1986a).

D. Substitutes

Asbestos was used in corrugated paper primarily because it had heat and corrosion resistance, high tensile strength, and durability. It has been replaced by non-corrugated, asbestos-free commercial paper. The three main types of paper currently used for pipe and block insulation are ceramic fiber paper, calcium silicate, and fiberglass paper (ICF 1985).

Table 1 presents a summary of substitutes for asbestos corrugated paper. Ceramic fiber paper is used for both pipe and block insulation. It is heat resistant, resilient, has high tensile strength, low thermal conductivity, and low heat storage. Babcock & Wilcox produces a ceramic fiber pipe insulation blanket and a block insulation material. The raw material used is kaolin, a high purity alumina-silica fireclay. It has a melting point of 3200°F and a normal use limit of 2300°F, but it can be used at higher temperatures in specific applications.

Certain-Teed, Owens-Corning, and Knauf Corporation produce a fiberglass product that can be used up to 850°F. Fiberglass pipe insulation is also used at very low temperatures, (it can operate at temperatures as low as -50°F).

Calcium silicate pipe covering is produced by Owens-Corning under two brand names Kaylo(R), and Papco(R). These products are heat resistant and can be used in temperature applications from 1200°F to 1500°F. Calcium silicate is less efficient at low temperatures than fiberglass. Asbestos fiber previously was used in calcium silicate pipe covering for its strength, but it has been replaced with organic fiber.

No comparison of costs has been made between the asbestos and non-asbestos products because the asbestos product is no longer produced domestically and will not be a separate category in the cost model (ICF 1985).

E. Summary

Asbestos corrugated paper is no longer produced in the United States. In 1981, there had been a small amount left in inventory, but it has since been sold. Asbestos had been used in corrugated paper because of its high temperature resistance and its durability. Substitutes include ceramic fibers, fibrous glass, and calcium silicate fibers in conjunction with various

Table 1. Substitutes for Asbestos Corrugated Paper

Product	Manufacturer	Advantages	Disadvantages
Ceramic Block and Pipe Insulation Material	Babcock & Wilcox	Heat resistant, can operate up to 2300°F. High tensile strength. Low thermal conductivity.	Expensive. Not as strong as asbestos.
Calcium Silicate Pipe Insulation Material	Owens-Corning (Kaylo)	Heat resistant, can operate up to 1500°F. Easy application. Low thermal conductivity.	Expensive.
Fiberglass Block and Pipe Insulation Paper	Owens-Corning Certain-Teed	Used for both hot and cold temperatures. High insulating. Easy application.	Not as heat resistant as other substitutes. Not as strong as asbestos.

fillers. The entire market has already been substituted therefore market shares and price comparisons are not available.

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XI. SPECIALTY PAPERS

Asbestos is used in papers primarily due to its chemical and heat resistant properties. Two types of asbestos specialty papers that are covered in this section include beverage and pharmaceutical filters and cooling tower fill. However, since the asbestos fill product is no longer processed in the United States, cooling tower fill is only briefly discussed below. Asbestos diaphragms for electrolytic cells, which were previously treated as specialty papers, are presented separately in Section XIII.

A. Cooling Tower Fill

Cooling towers are used to air-cool liquids from industrial processes or air conditioning systems. The hot liquid is passed over sheets of material (the cooling tower fill) in order to provide maximum exposure to air. Sheets of asbestos paper impregnated with melamine and neoprene may be used as fill for applications requiring high temperatures or where a fire hazard may exist. Cooling tower sheets are manufactured in various sizes, with typical sheets being 18 inches by 6 feet and 0.015 to 0.020 inches thick (ICF 1985). The composition of cooling tower fill includes a blend of two grades of chrysotile asbestos bound with neoprene latex. The asbestos content is 90 to 91 percent, the remaining 9 to 10 percent consisting of a binder material (Krusell and Cogley 1982).

The major use of asbestos fill has been cooling tower applications where high heat resistance was necessary. Due to the availability of good and inexpensive substitute products, however, asbestos fill has been forced out of the market. As a result, the 1981 producers of asbestos fill, Marley Cooling Tower Co. and Munters Corp., are no longer manufacturing asbestos fill in the United States (Krusell and Cogley 1982, Marley Cooling Tower 1986).

A wide variety of substitute materials are currently available for cooling tower fill including polyvinyl chloride (PVC), wood, stainless steel mesh, and polypropylene. Each of these substitutes is manufactured by Munters Corporation (ICF 1986). The PVC plastic is the primary asbestos fill substitute because it is, by far, the most cost-effective product, with high durability and modest cost. One industry source stated that PVC has actually increased the market for cooling tower fill (Munters 1986). Other products available as asbestos fill substitutes have limited application due to specific disadvantages. For example, it is not economically feasible to manufacture wood into the forms (e.g., sheet materials) required for cooling tower fill; and stainless steel, although more durable than PVC, is too expensive for extensive use (Marley Cooling Tower 1986). Portland cement reinforced with such fibers as mineral and cellulose is presently under development as a substitute for asbestos fill. Although not presently marketed, this substitute's use is restricted due to its availability only in limited shapes and at a high cost (Marley Cooling Tower 1986).

B. Beverage and Pharmaceutical Filters

1. Product Description

Asbestos has been used in filters for the purification and clarification of liquids because it offers an exceptionally large surface area per unit of weight and has a natural positive electrical charge which is very useful for removing negatively charged particles found in beverages (Krusell and Cogley 1982). Asbestos filter paper is made on a conventional cylinder or Fourdrinier papermaking machine but, due to the very low demand for the asbestos filters, these machines are primarily used to produce more popular paper products, such as the non-asbestos filter substitutes (i.e., diatomaceous earth and cellulose fiber product and loose cellulose fiber products) (Krusell and Cogley 1982).

Asbestos filters may contain, in addition to asbestos, cellulose fibers, various types of latex resins, and occasionally, diatomaceous earth (Krusell and Cogley 1982). The asbestos content of beverage filters ranges from 5 percent, for rough filtering applications, to 50 percent, for very fine filtering. In general, as the asbestos content of the filter increases, the filtering qualities improve (Krusell and Cogley 1982).

Applications of asbestos filter paper are found primarily in the beer, wine, and liquor distilling industries where they are used to remove yeast cells and other microorganisms from liquids. Asbestos filters are also used for filtration of some fruit juices (e.g., apple juice) and for special applications in the cosmetics and pharmaceuticals industries (Krusell and Cogley 1982).

2. Producers of Beverage and Pharmaceutical Filters

In 1981 there were four companies manufacturing asbestos filters:

- Alsop Engineering, NY;
- Beaver Industries, NY;
- Cellulo Company, CA; and
- Ertel Engineering, NY.

In 1985, two companies, Cellulo and Ertel, discontinued the use of asbestos in the production of filters (Ertel Engineering 1986). The primary substitute materials used consisted of either diatomaceous earth and cellulose fibers, or loose cellulose fibers (ICF 1986). The other two companies, Alsop Engineering and Beaver Industries, refused to respond to the ICF survey. As a result, production estimates for these companies were estimated based on the methodology presented in Appendix A.

3. Trends

For many years the use of asbestos in filters has been declining. Nearly 1000 short tons of asbestos fiber were consumed per year for the production of filters in the late 1960s and early 1970s. In 1985, however, only about 300 short tons of asbestos fiber were used for the production of asbestos filters (ICF 1986).

4. Substitutes

The primary reason for the use of asbestos filters is their ability to remove haze from liquids. Asbestos filters absorb less liquid than non-asbestos filters due to the low porosity of asbestos fiber. Filters containing asbestos are also more compressible than non-asbestos filters, making it easier to fit them into filter equipment thereby reducing the chances of developing leaks (Krusell and Cogley 1982).

Filter papers manufactured with cellulose fibers and diatomaceous earth and those made with loose cellulose fibers are available as substitutes for asbestos beverage filters. Both substitute products are comparable in performance to the asbestos product, although they are more difficult to handle and more expensive (Cellulo 1986). In addition, the all cellulose filter product cannot be made in grades high enough for very fine filtration and, therefore, "filter aids", consisting of chemically treated cellulose fibers or diatomaceous earth, may be added to all cellulose filters to improve their performance. Table 1 presents the advantages and disadvantages of each substitutes compared to the asbestos filter product, while Table 2 presents the data inputs for the Asbestos Regulatory Cost Model. Non-asbestos substitute filters can be used almost interchangeably with asbestos filters in most applications because, like asbestos filters, they have high wet strength and can clarify, polish, and sterilize a wide variety of liquids (e.g., acids, alkalis, antiseptics, beer, wine, fruit juices) (Krusell and Cogley 1982). The non-asbestos substitutes were reported to have comparable service life when used in similar applications. These two substitutes are expected to each take over about half of the filter market.

5. Summary

Asbestos filter papers are used for the purification and clarification of liquids in the beer, wine and liquor distilling industries. The trends

Table 1. Advantages/Disadvantages of Non-Asbestos Filter Substitute Products

Substitute Products for Asbestos Beverage and Pharmaceutical Filters	Price ($/lb.)	Advantages	Disadvantages	References
Diatomaceous Earth and Cellulose Fiber	2.00	Generally same performance as asbestos product	More difficult to handle for end-user vs. asbestos product.	Cellulo Co. (1986)
			More costly than asbestos product.	Cellulo Co. (1986)
Loose Cellulose Fiber	1.00	Generally same performance as asbestos product.	More difficult to handle for end-user.	Cellulo Co. (1986)
			More costly than asbestos product.	Cellulo Co. (1986)
			Not made with grades high enough for very fine filtering.	ICF (1984)
			Many need "filter aid"-chemically treated cellulose fiber for a positive charge -- to improve performance.	ICF (1984)

Table 2. Data Inputs for Asbestos Regulatory Cost Model

Product	Output[a]	Product Asbestos Coefficient[b]	Consumption Production Ratio	Price[c]	Useful Life[d]	Equivalent Price	Market Share	Reference
Asbestos Filter Paper	434 tons	0.212	1.0	$4,300/ton[e]	1 use	$4,300/ton	N/A	TSCA (1982a), ICF (1984a), Cellulo (1986)
Diatomaceous Earth and Cellulose Filter Paper	N/A	N/A	N/A	$4,000/ton	1 use	$4,000/ton	50%	Cellulo (1986)
Loose Cellulose Fiber Filter Paper	N/A	N/A	N/A	$2,000/ton	1 use	$2,000/ton	50%	Cellulo (1986)

[a] The two producers of this asbestos product both refused to respond to our survey. We have assumed that their 1985 output is equal to their 1981 output.

[b] The two producers of this product both refused to respond to our survey. We have assumed the product asbestos coefficient is the same as the value used by RTI in the Regulatory Impact Analysis (RTI 1985).

[c] Prices in the text are given on a per pound basis, they have been converted into prices per ton for use in the ARCM.

[d] The product's useful life is typically 1 use, but some filters may have a longer life.

[e] The two producers of this product both refused to respond to our survey. We have assumed that the ratio between the price of asbestos filter paper and diatomaceous earth and cellulose filter paper is still the same as that reported in 1981 (ICF 1985).

show a definite decline in the use of asbestos fiber in filter production. Of the four companies producing asbestos filters in 1981, two (Alsop Engineering and Beaver Industries) have been assumed to still be producing in 1985 because they refused to respond to the ICF survey. The 1985 asbestos filter production was assumed to be 434 tons; 92 tons of asbestos fiber were consumed in this production. One reason for this decline is that the non-asbestos substitute products, which include diatomaceous earth and loose cellulose fibers, have been found to be comparable in performance to the asbestos product for most applications. These non-asbestos products are, however, more expensive.

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