XXIII. AUTOMATIC TRANSMISSION FRICTION COMPONENTS

A. Product Description

An automatic transmission consists of 5 to 15 small metal rings called friction clutches, which are housed, along with gears, in a metal band called the transmission band. Each friction clutch is covered with a thin friction clutch plate which is made from a friction paper that contains asbestos or some other friction material. In addition, a lining, also made from this friction paper, is bonded to the inside of the transmission band (Mead 1986, Borg-Warner 1986). These automatic transmission friction components -- friction clutch plates and transmission band linings -- are immersed in a fluid environment which dissipates much of the heat generated when gears are changed. Asbestos-based automatic transmission friction components made by S.K. Wellman for medium trucks, for example, are 1/16 of an inch thick and may contain approximately 0.11 lbs. of asbestos per component (15 percent asbestos by weight) (S.K. Wellman 1986).[1]

Paper for automatic transmission components is manufactured by conventional paper-making processes; i.e., raw materials (the chosen friction material, fillers, and resins) are pulped and fed into a continuous papermaking machine. Finished paper is then removed from the machine (ICF 1985). Automatic transmission friction components are then cut from the paper, and after they are pressed and shaped, grooves (these can vary in design) are either cut or stamped into the components (ICF 1985).[2]

---

[1] Raymark, another U.S. producer of asbestos-based automatic transmission friction components for automobiles, refused to provide information.

[2] Cut grooves are preferred over the stamped ones because they last longer (ICF 1985).

Two producers, Borg-Warner[3] and S.K. Wellman, purchase their friction paper. Information was not available on whether the other producer, Raymark, manufactures or purchases its friction paper. Armstrong World Industries (Fulton, NY) and Mead Corporation (South Lee, MA) produce friction paper for sale to the producers of automatic transmission components (ICF 1986a).[4]

Automobiles, light/medium trucks, and off-road vehicles use components made from friction paper (Borg-Warner 1986, S.K. Wellman 1986, Deere and Co. 1986). Friction components for the transmissions of heavy trucks, such as eighteen-wheel tractor trailers and logging and mining trucks, and certain off-road vehicles (heavy tractors and earth-moving equipment), however, are usually made from sintered metal that is molded into the desired shapes (S.K. Wellman 1986).

B. Producers and Importers of Automatic Transmission Friction Components

Table 1 lists the three current producers of (asbestos and non-asbestos) automatic transmission friction components. Borg-Warner produces only non-asbestos components (it did not produce asbestos-based components in 1981 either) (ICF 1986a). The other two manufacturers produced both asbestos and non-asbestos components in 1985 (S.K. Wellman 1986, Raymark 1986).[5] Borg-Warner produces transmission components for automobiles and trucks (ICF 1986a). S.K. Wellman produces components only for off-road vehicles and medium and heavy trucks (S.K. Wellman 1986). The third producer, Raymark,

---

[3] Borg-Warner only uses non-asbestos-based friction paper (ICF 1986a).

[4] Armstrong World Industries makes both asbestos and non-asbestos friction paper; Mead Corporation only makes a non-asbestos variety. The latter company discontinued production of asbestos-based paper in December, 1983 (ICF 1986a).

[5] S.K. Wellman stopped producing asbestos-based automatic transmission friction components in March, 1987 (S.K. Wellman 1986).

Table 1. Producers of Automatic Transmission Friction Components

Company	Plant Location	Product: Asbestos	Product: Non-Asbestos	Market	References
S.K. Wellman	LaVergne, TN	X[a]	X	Medium and heavy trucks, off-road vehicles[a]	S.K. Wellman 1986, ICF 1984
Raymark	Stratford, CT Crawfordsville, IN	X N/A	X N/A	Autos, trucks, off-road vehicles[b]	ICF 1986a, ICF 1984, TSCA 1982a, Deere and Co. 1986
Borg-Warner	Frankfort, IL		X	Autos, trucks	ICF 1986a, TSCA 1982b

N/A = Information not available.

[a]S.K. Wellman stopped the production of asbestos-based automatic transmission friction components in March, 1987 (S.K. Wellman 1986).

[b]Off-road vehicles include tractors and earth-moving equipment.

makes components for automobiles, trucks, and off-road vehicles (Raymark 1986, S.K. Wellman 1986, Deere and Co. 1986).

There were no secondary processors of automatic transmission friction components in 1985 or in 1981 (ICF 1986b, 1985).

Table 2 lists the importers of asbestos-based components.

C. Trends

In 1981, the industry was slowly moving away from asbestos in automatic transmission components, and by 1985 substitution had increased rapidly (Borg-Warner 1986, ICF 1985). It is estimated that approximately 25 percent of the original equipment market (OEM) is still asbestos-based.[6] Data were not available for the percent share for the aftermarket, although it is likely to be higher than in the OEM.

Table 3 gives the production and fiber consumption of asbestos-based components. Because of the lack of available data, it is difficult to determine the actual decline in production from 1981 to 1985; however, sources generally agree that the substitution of asbestos in automatic transmission components will be complete, in at least new vehicles, in the near future (Borg-Warner 1986, S.K. Wellman 1986, DuPont 1986, Mead 1986).

D. Substitutes

Automatic transmission components made from cellulose-based friction paper are currently the main substitute for asbestos-based components (DuPont 1986, Mead 1986). Borg-Warner is the leading producer of cellulose-based components (Borg-Warner 1986). The chief cellulose material in its components is cotton fiber (Borg-Warner 1986). Cellulose-based components can also contain other fibers in smaller proportions. Mead Corporation produces friction paper containing greater than 50 percent cotton fibers with varying amounts of

[6] See Attachment, Item 1.

Table 2. Imports of Asbestos-Based Automatic Transmission Friction Components

Company	Location	References
Volkswagen of America	Troy, MI	ICF 1984
Toyota Motor Sales, USA	Torrence, CA	ICF 1984
Mercedes-Benz of North America	Montvale, NJ	ICF 1984
Western Automotive Warehouse Distributors	Los Angeles, CA	ICF 1984
Raymark, via their Japanese subsidiary, Daikin	Trumbull, CT[a]	ICF 1984
American Honda Motor Company	Gardena, CA	Automobile Importers of America 1986
American Isuzu Motor, Inc.	Whittier, CA	Automobile Importers of America 1986
Jaguar	Leonia, NJ	Automobile Importers of America 1986
Mazda (North America) Inc.	Irvine, CA	Automobile Importers of America 1986
Mitsubishi Motors Corp. Services, Inc.	Southfield, MA	Automobile Importers of America 1986
Nissan Motor Corp.	Gardena, CA	Automobile Importers of America 1986
Renault USA, Inc.	New York, NY	Automobile Importers of America 1986
Rolls-Royce Motors, Inc.	Lyndhurst, NJ	Automobile Importers of America 1986
Subaru of America, Inc.	Pennsauken, NJ	Automobile Importers of America 1986
Alfa Romeo	Englewood Cliffs, NJ	Automobile Importers of America 1986
Fiat	Dearborn, MI	Automobile Importers of America 1986
Lotus Performance Cars	Norwood, NJ	Automobile Importers of America 1986
Porsche Cars North America	Reno, NV	Automobile Importers of America 1986
Hyundai Motor America	Garden Grove, CA	Automobile Importers of America 1986
Volvo Cars of North America	Rockleigh, NJ	Automobile Importers of America 1986

N/A = Information not available.

[a]Since Raymark refused to provide information, Raymark's corporate headquarters is given as the location.

Table 3. Production and Fiber Consumption for
Asbestos-Based Automatic Transmission Friction Components

	1981		1985		
	Production (pieces)	Asbestos Fiber Consumption (tons)	Production (pieces)	Asbestos Fiber Consumption (tons)	References
Total	N/A	N/A	585,500[a]	2.5[a]	TSCA 1982b ICF 1986a

N/A = Information not available.

[a] Raymark Corp. refused to provide production and fiber consumption data. This data has, therefore, been estimated using a method described in the Appendix A to this RIA.

fiberglass and/or aramid fiber and/or carbon or graphite filler, depending on the application (ICF 1986a).[7] S.K. Wellman, Borg-Warner, and Raymark produce cellulose-based automatic transmission components for agricultural tractors containing either:

- Cotton fiber, with carbon fiber, cellulite, graphite filler, and phenolic resin; or
- Cellulose fiber, with cellulite and phenolic resin (Deere and Co. 1986).

Industry experts agree that if asbestos were no longer available, the original equipment market (OEM) would switch entirely to cellulose-based components (ICF 1986a, DuPont 1986, Mead 1986). Borg-Warner stated, and repair shops (previously interviewed by ICF in 1983) agreed, that cellulose-based components are also entirely interchangeable in the automobile aftermarket with no loss of performance (Borg-Warner 1986, ICF 1985). Deere and Company, a major manufacturer of tractors, indicated that cellulose-based components were not interchangeable with asbestos components in the tractor aftermarket because these transmissions were designed for the particular coefficient of friction of the asbestos components. Deere and Company has redesigned transmission systems specifically for cellulose-based components. The company stated that it was unlikely that suppliers would develop substitutes in the tractor aftermarket because of the relatively low volume of the market (which is also diminishing) and the extreme technical difficulty of engineering a substitute for a transmission system that was designed specifically for asbestos components (Deere and Co. 1986).

Table 4 provides the data for the regulatory cost model.

---

[7] Armstrong World Industries stated its non-asbestos friction paper contained cellulose fibers and inorganic fillers; it did not indicate any additional fibers (ICF 1986a).

Table 4. Data Inputs on Automatic Transmission Friction Components for Asbestos Regulatory Cost Model

Product	Output	Product Asbestos Coefficient	Consumption Production Ratio	Price	Useful Life	Equivalent Price	Market Share	References
Asbestos Mixture	585,500 pieces	0.0000043 tons/piece	1.0	$1.60/piece	4-7 years	$1.60/piece	N/A	ICF 1986a, ICF 1985
Cellulose	N/A	N/A	N/A	$2.00/piece	4-7 years	$2.00/piece	100%	ICF 1986a, DuPont 1986, Mead 1986

N/A: Not Applicable.

[a]See Attachment, Items 2-4.

E. Summary

Automatic transmission friction components are either friction clutch plates or transmission band linings. Friction clutch plates are made from thin pieces of friction paper and cover friction clutches which are small metal rings found in each automatic transmission. A transmission band is a metal band that houses the gears and friction clutches; a lining made of friction paper is bonded to the inside of the transmission band (Mead 1986, Borg-Warner 1986).

Two companies consumed 2.5 tons of asbestos to produce 585,500 pieces of automatic transmission friction components in 1985 (ICF 1986a). In March, 1987 one of these companies ceased production of asbestos-based automatic transmission friction components, leaving one remaining U.S. producer (ICF 1986a). There are more than 14 companies importing asbestos-based components (ICF 1984, Automobile Importers of America 1986). Approximately 25 percent of the OEM for automatic transmission friction components is still asbestos based. The major substitute for asbestos-based components are made from cellulose-based friction paper, which contains cotton and possibly other fibers in smaller proportions (Mead 1986). If asbestos were no longer available, the OEM would switch entirely to cellulose-based components. There is disagreement as to whether asbestos-based automatic transmission friction components are completely interchangeable with cellulose-based components for all vehicle types in the replacement/repair market.

ATTACHMENT

1. According to a representative from Borg-Warner, the largest producer of automatic transmission friction components (all non-asbestos), asbestos-based components now account for roughly 50 percent of the OEM, but this share is rapidly declining (Borg-Warner 1986). Representatives from DuPont and Mead Corporation both stated that replacement of asbestos-based components in the OEM is now nearly 100 percent (DuPont 1986, Mead 1986). Using an average of the above estimates, and the fact that Borg-Warner is the largest producer, it is assumed that approximately 25 percent of the OEM is still asbestos-based.

2. The product asbestos coefficient was determined by dividing the total tons of asbestos fiber consumed by the number of pieces of components produced shown in Table 2.

3. The consumption production ratio was calculated assuming no imports for 1985. Importers did not provide information for 1985.

4. Since Raymark, the only remaining U.S. producer of asbestos-based components, did not provide information, the asbestos product price and useful life is assumed to be the same as that reported in 1984 in Appendix H (ICF 1985). Borg-Warner stated the purchase price of cellulose-based components was 25 percent higher than the asbestos product, thus the cellulose product price in the table is 1.25 times the asbestos product price. Borg-Warner also indicated that the useful life of the cellulose components was the same as the asbestos product (Borg-Warner 1986).

REFERENCES

Automobile Importers of America. 1986. Comments of Automobile Importers of America on Proposed Asbestos Ban Rule. EPA Document Control No. OPTS-62036.

Borg-Warner. T. Longtin. 1986 (November 20). Frankfort, IL. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, D.C.

Deere and Co. R. Grotelueschen. 1986 (October 30). Moline, IL. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, D.C.

DuPont. T. Merriman. 1986 (November 5). Wilmington, DE. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, D.C.

ICF Incorporated. 1984. Imports of Asbestos Mixtures and Products. Washington, D.C.: Office of Pesticide and Toxic Substances, U.S. Environmental Protection Agency. EPA CBI Document Control No. 20-8600681.

ICF Incorporated. 1985. Appendix H: Asbestos Products and Their Substitutes, in Regulatory Impact Analysis of Controls on Asbestos and Asbestos Products. Washington, D.C.: Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency.

ICF Incorporated. 1986a (July-December). Survey of Primary Processors of Automatic Transmission Friction Components. Washington, D.C.

ICF Incorporated. 1986b (July-December). Survey of Secondary Processors of Automatic Transmission Friction Components. Washington, D.C.

Mead Corp. L. McDonnold. 1986 (December 15). Dayton, OH. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, D.C.

Raymark Corp. 1986. Comments of Raymark Corp. on Proposed Asbestos Ban Rule. EPA Document Control No. OPTS-62036.

S.K. Wellman. B. Laditka. 1986 (October 29). Bedford, OH. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, D.C.

TSCA Section 8(a) submission. 1982a. Production Data for Primary Asbestos Processors, 1981. Washington, D.C.: Office of Toxic Substances, U.S. Environmental Protection Agency. EPA Document Control No. 20-8601012.

TSCA Section 8(a) submission. 1982b. Production Data for Secondary Asbestos Processors, 1981. Washington, D.C.: Office of Toxic Substances, U.S. Environmental Protection Agency. EPA Document Control No. 20-8670644.

XXIV. FRICTION MATERIALS

A. Product Description

Friction materials are used as braking and gear-changing (clutch) components in a variety of industrial and commercial machinery.[1] Applications include agricultural equipment such as combines, mining and oil-well-drilling equipment, construction equipment such as cranes and hoists, heavy equipment used in various manufacturing industries (e.g., machine tools and presses), military equipment, marine engine transmissions, elevators, chain saws, and consumer appliances such as lawn mowers, washing machines, and vacuum cleaners (Raymark 1986b, Design News 1984, ICF 1986a, 1985).

Friction materials are either molded or woven products for use in wet or dry friction systems (Design News 1984, ICF 1985, DuPont 1986, Deere and Co. 1986, Krusell and Cogley 1982).[2] Molded products include thin segments, blocks, and other components used as brake linings, as well as rings[3] and other molded components used as clutches (H.K. Porter 1986, Design News 1984). Brake linings may also be woven bands (Design News 1984, Krusell and Cogley 1982). Band applications range from large band brakes for oil-well-drilling equipment, cranes, and hoists, to light-duty general-purpose bands for a variety of commercial and industrial machines (Design News 1984).

---

[1] This product category includes all brake and clutch applications other than automobiles, trucks, and off-road vehicles (including tractors and earth-moving equipment).

[2] Heavy industrial equipment often use oil-cooled clutches and brakes, sometimes referred to as wet friction products, because of severe operating conditions and design considerations. Fluids facilitate the transfer of heat away from the working surface of the friction material providing superior durability and resulting in longer life between major overhauls and replacement. Large band brakes for oil-well drilling equipment, cranes, and hoists require a special fluid system (Design News 1984). Wet friction systems may also be used in other lighter-duty commercial and industrial applications (DuPont 1986).

[3] One producer, H.K. Porter, considers these molded rings to be washers (ICF 1986a).

Asbestos is used in friction materials for the following reasons:

- Stable friction properties under heat;
- Strength;
- Wear resistance;
- Flexibility (asbestos-based materials can be shaped or bent easily); and
- Relatively low cost (ICF 1985, Raymark 1986b).

Asbestos-based friction materials contain an average 0.37 lbs. of asbestos fiber per piece (ICF 1986a).[4]

Manufacturing methods for friction materials vary depending on the type and application of the material. For example, woven asbestos band-brakes for heavy-duty uses are produced by passing asbestos cord, possibly reinforced with wire, through a wet-mix to pick up resin and modifiers. The saturated cord is then woven into tapes. The tapes are heated to partially cure the resin, and then may be further cured to form flexible bands or rigid segments (Krusell and Cogley 1982). Information on secondary processing, as well as rebuilding and repair of worn friction materials, was not available.

B. <u>Producers and Importers of Friction Materials</u>

Table 1 lists the seven producers of (asbestos and non-asbestos) friction materials in 1985. All producers, except for Scan Pac, produced an asbestos product in 1985 (ICF 1986a, PEI Associates 1986). All firms except Virginia Friction Products currently produce non-asbestos-based materials (ICF 1986a, PEI Associates 1986). Gatke Corporation is a relatively small producer, making asbestos products for cranes, hoists, and oil-well-drilling equipment

---

[4] See Attachment, Item 1.

Table 1. 1985 Primary Processors of Friction Materials

Company	Plant Location(s)	Product: Asbestos	Product: Non-Asbestos	References
Raymark	Manheim, PA Stratford, CT[a]	X N/A	X N/A	ICF 1986a, TSCA 1982a
National Friction Products	Logansport, IN	X	X	ICF 1986a, TSCA 1982a
Virginia Friction Products	Houston, TX	X		PEI Associates 1986
Gatke Corp.	Warsaw, IN	X	X	ICF 1986a, TSCA 1982a
Wheeling Brake Block	Bridgeport, CT	X[b]	X	ICF 1986a, TSCA 1982a
H.K. Porter	Huntington, IN	X[c]	X	ICF 1986a, TSCA 1982a
Scan Pac	Menomonee Falls, WI		X	ICF 1986a, ICF 1985

N/A = Information not available.

[a]This plant refused to respond to our survey. It is assumed that they made asbestos friction materials in 1985.

[b]Wheeling Brake Block completely replaced its asbestos-based friction materials with non-asbestos products in 1986 (Wheeling Brake Block 1986).

[c]H.K. Porter stated it would phase out its asbestos-based friction materials by the end of 1986 (ICF 1986a, PEI Associates 1986).

(ICF 1986a, PEI Associates 1986). Information was not available on the size of Virginia Friction Products' production volume; however, the firm only makes asbestos-based friction materials for oil-well rigs and giant cranes (PEI Associates 1986). Wheeling Brake Block indicated it completely replaced its asbestos-based friction materials with non-asbestos products in 1986 (Wheeling Brake Block 1986). H.K. Porter stated it would phase out its asbestos-based friction-materials by the end of 1986, making only non-asbestos materials (ICF 1986a, PEI Associates 1986).

Table 2 lists the two secondary processors of friction materials in 1985. Hoover Company stopped consuming asbestos-based friction materials in 1986. The firm had purchased, and possibly further processed, asbestos brake linings for use in its vacuum cleaners (ICF 1986b).[5] Information is not available on the type of secondary processing in which Western Gasket Packing Company is involved.[6] Gasko Fabricated Products of Medina, OH (not listed in Table 2), discontinued secondary processing of its asbestos-based product prior to 1985 (ICF 1986b).[7]

There were no imports of asbestos-based friction materials in 1985 or in 1981 (ICF 1986a, 1986b, 1984).

C. Trends

Table 3 gives the production of asbestos-based friction materials and the corresponding consumption of asbestos fiber. The 1985 production value is 51

---

[5] Information is not available on the non-asbestos brake lining used by Hoover Co.

[6] Information is also not available on whether Western Gasket Packing Co. processes a non-asbestos product.

[7] The asbestos-based product was a vacuum cleaner control disc; information is not available on whether the firm consumes a non-asbestos product (TSCA 1982b).

Table 2. 1985 Secondary Processors of Friction Materials

Company	Plant Location	Product		References
		Asbestos	Non-Asbestos	
Hoover Co.	North Canton, OH	X	X	ICF 1986b, TSCA 1982b
Western Gasket Packing Co.	Los Angeles, CA	X	N/A	ICF 1986b, TSCA 1982b

N/A = Information not available.

Table 3. Production and Fiber Consumption of Asbestos-Based Friction Materials

	1981	1985	References
Production (pieces)	17,604,160	8,719,541[a]	ICF 1986a, TSCA 1982a
Asbestos Fiber Consumption (tons)	2,461.1	1,602.5[b]	ICF 1986a, TSCA 1982a

[a] Does not include production volume of Virginia Friction Products' Houston, TX, plant. Raymark's Stratford, CT plant and Wheeling Brake Block's Bridgeport, CT plant refused to provide production data for their asbestos friction materials. Data for these Raymark and Wheeling Brake Block plants were estimated using method described in Appendix A of this RIA.

[b] Does not include asbestos fiber consumption of Virginia Friction Products' Houston, TX, plant. Raymark's Stratford, CT plant and Wheeling Brake Block's Bridgeport, CT plant refused to provide fiber consumption data for their asbestos friction materials. Data for these Raymark and Wheeling Brake Block plants were estimated using the method described in Appendix A of this RIA.

percent less than that of 1981. The 1985 value does not include Virginia Friction Products' Houston, TX, plant; however, the production volume of this plant is probably small. The 1985 value for fiber consumption is 45 percent less than that of 1981; however, the 1985 value does not include consumption for Virginia Friction Products' plant.

Raymark, probably the largest producer of friction materials (asbestos and non-asbestos products combined)[8] stated that non-asbestos substitutes have been developed for most industrial applications, but not all of these substitutes are yet produced in sizeable quantities. Many of these substitutes must still undergo extensive field testing before they are accepted by customers (Raymark 1986b).

Other sources indicate that substitutes have been developed for many commercial and consumer applications, such as machine tools, chain saws, lawn mowers, washing machines, and vacuum cleaners (Design News 1984, Hoover 1986). DuPont, a major supplier of materials for friction products, e.g., Kevlar(R), stated that most friction materials are now non-asbestos (DuPont 1986). Thus, the current asbestos-based share of the total friction materials market is estimated to be 30 percent.[9]

D. Substitutes

Because of the large variety of friction material applications and the reluctance on the part of producers to reveal much more than one or two ingredients in their substitute formulations, it is very difficult to make price and performance comparisons between specific substitute and asbestos-based products, or to estimate market shares for specific substitutes

[8] Raymark, which produces mostly friction materials, stated that 40 percent of all of its friction products are now non-asbestos (Raymark 1986b). (Raymark also manufactures clutch facings, automatic transmission friction components, and brake blocks (ICF 1986a).)

[9] See Attachment, Item 2 for a full explanation of this estimate.

(ICF 1986a).[10] Nevertheless, all producers of substitute friction materials, except for Gatke Corporation,[11] indicated that their non-asbestos formulations contained fiberglass, Kevlar(R), or both, and other fibers (often mineral fibers) (ICF 1986a).[12] National Friction Products, which manufactures a broad range of friction materials, stated that these combinations would capture 80-85 percent of the friction materials market in the event of an asbestos ban. The remaining 15-20 percent of asbestos-based applications (application areas not specified) could not be replaced immediately (ICF 1986a).[13]

One example of a combination substitute product is Raymark's fiberglass and Kevlar(R) brake block used in large cranes and oil-well drilling equipment. The block is priced the same as its asbestos-based product and has the same service life, but does not perform as well at high temperatures (Raymark 1986a). H.K. Porter manufactures heavy-duty clutch components made of fiberglass and Nydag wollastonite board. These components, which are used for hoists, agricultural equipment, and large marine motors, are priced the same as asbestos-based clutches and have improved wear (ICF 1986a).

Gatke Corporation manufactures molded clutch facings, made chiefly from fiberglass, for use in cranes, hoists, and oil-well drilling equipment (ICF 1986a, PEI Associates 1986). The firm, however, considers these products to

---

[10] Producers often would not elaborate on the friction materials they produced, and often were vague or uncertain about the performance of their substitutes compared to asbestos-based products (ICF 1986a).

[11] Gatke produces clutch components chiefly made of fiberglass for use in heavy machinery (ICF 1986a).

[12] These formulations may be similar to formulations used in clutch facings for automotive and off-road vehicles, and similar to the non-asbestos-organic (NAO) compounds used in automotive drum brake linings and brake blocks for heavy trucks and off-road vehicles.

[13] Until other replacements can be found for the remaining 15-20 percent of asbestos-based applications, it is assumed that for the present that the Kevlar(R) and fiberglass combination substitute will replace 100 percent of the asbestos market if asbestos were no longer available.

be inferior. The facings are less heat-resistant, more expensive, and heavier than asbestos-based facings. Furthermore, the fiberglass facings are abrasive to the transmission systems, and they are difficult to manufacture (ICF 1986a).

DuPont indicated that brake and clutch components made chiefly from fiberglass would not be used in wet friction systems because the glass fibers tend to break loose, travelling through the fluid-filled environment and causing abrasion (DuPont 1986).

Table 4 provides the data for the regulatory cost model. The substitute product is a general mixture containing fiberglass and/or Kevlar(R) in combination with other fibers. It is assumed that the market share for friction materials made chiefly from fiberglass will be negligible.

E. Summary

Asbestos friction materials are used as braking and gear-changing (clutch) components in a variety of industrial and commercial machinery (ICF 1985). There were six primary processors of asbestos friction materials in 1985 which consumed 1,602.5 tons of asbestos to produce 8,719,541 pieces of asbestos friction material. Since 1985, Wheeling Brake Block and H.K. Porter have stopped producing asbestos friction materials, leaving four remaining producers of the asbestos product (ICF 1986a). The primary substitute is a Kevlar(R) and fiberglass combination which is projected to take 100 percent of if the asbestos products were no longer available. The Kevlar(R) and fiberglass combination substitute costs the same as asbestos friction materials (ICF 1986a).

Table 4. Data Inputs on Friction Materials for Asbestos Regulatory Cost Model[a]

Product	Output	Product Asbestos Coefficient	Consumption Production Ratio	Price	Useful Life	Equivalent Price	Market Share	References
Asbestos Mixture	8,719,541 pieces	0.00018 tons/piece	1.0	$34.65/piece	0.5 years	$34.65/piece	N/A	ICF 1986a, ICF 1985 Raymark 1986a
Fiberglass and Kevlar(R)	N/A	N/A	N/A	$34.65/piece	0.5 years	$34.65/piece	100%	Raymark 1986a, National Friction Products 1986

N/A: Not Applicable.

[a]See Attachment, Items 3-6.

<u>ATTACHMENT</u>

1. The value for asbestos fiber per piece was determined by dividing the total asbestos fiber consumption, 1,602.5 tons, by total pieces produced, 8,719,541 pieces. This equals 0.000184 tons/piece or 0.37 lbs./piece.

2. A conservative estimate for the asbestos-based share of the market in 1981 would be 95 percent (non-asbestos substitutes were, in fact, available in 1981 for various applications) (ICF 1985). If it is also assumed that the overall friction materials market (asbestos and non-asbestos) remained constant from 1981 to 1985, then since the decline in asbestos-based production of friction materials was approximately 51 percent from 1981 to 1985, the 1985 asbestos-based share of the total market would have been 49 percent of 95 percent, or 47 percent. H.K. Porter, furthermore, stated that by the end of 1986 it should have completely replaced its asbestos-based materials with non-asbestos substitutes. H.K. Porter's approximate share of the asbestos-based market in 1985 was 11 percent (the production volume of Virginia Friction Products' plant is not available; however, it is probably small) (ICF 1986a). Thus, if it is assumed that the total friction materials market remained constant from the end of 1985 to the end of 1986, then perhaps another 10 percent can be subtracted from the asbestos-based share of the market, to account for the loss of H.K. Porter's asbestos-based production. This would make the asbestos-based share of the market as of January 1, 1987, 37 percent. Finally, taking into account Raymark's statement that substitutes have been developed for most industrial applications and DuPont's statement that most friction materials are not non-asbestos, it is reasonable to assume the present asbestos-based share is even smaller than 37 percent. A share of 30 percent is thus assumed.

3. The product asbestos coefficient is the same number given in Item 1 above, shown in tons per piece.

4. Given the variety of friction material applications, it is very difficult to compute a weighted average asbestos product price or a substitute product price. The asbestos and substitute mixture prices are for Raymark's brake blocks used in large cranes and oil-well drilling equipment (stated in the text).

5. The useful life of the asbestos mixture is assumed to be the same as that reported in 1984 (in Appendix H) for an asbestos friction block (ICF 1985). The useful life of the substitute mixture is assumed to be the same as the asbestos mixture, since Raymark stated its substitute friction block had the same service life as its asbestos product.

6. A market share of the Kevlar(R) and fiberglass combination substitute of 80-85 percent is given by National Friction Products (stated in the text). However, until other replacements can be found for the remaining 15-20 percent of the market it is assumed that for now the Kevlar(R) and fiberglass combination substitute will replace 100 percent of the asbestos market.

REFERENCES

Deere and Co. R. Grotelueschen. 1986 (October 30). Moline, IL. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, D.C.

Design News. 1984 (March 26). Asbestos Substitutes in Friction Applications. S. Scott.

DuPont. T. Merriman 1986 (November 5). Wilmington, DE. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, DC.

H.K. Porter Co. F. Donnell. 1986 (November 20). Huntington, IN. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, D.C.

Hoover Co. A. McMullen. 1986 (July-December). North Canton, OH. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, D.C.

ICF Incorporated. 1984. Imports of Asbestos Mixtures and Products. Washington, D.C.: Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency. EPA Doc. Control No. 20-8600681.

ICF Incorporated. 1985. Appendix H: Asbestos Products and Their Substitutes, In Regulatory Impact Analysis of Controls on Asbestos and Asbestos Products. Washington, D.C.: Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency.

ICF Incorporated. 1986a (July-December). Survey of Primary Processors of Disc Brake Pads (Heavy Vehicles). Washington, D.C.

ICF Incorporated. 1986b (July-December). Survey of Secondary Processors of Disc Brake Pads (Heavy Vehicles). Washington, D.C.

Krusell N., Cogley D. 1982. GCA Corp. Asbestos Substitute Performance Analysis, Revised Final Report. Washington, D.C.: Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency. Contract 68-02-3168.

National Friction Products. E. Sydor. 1986 (July-December). Logansport, IN. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, D.C.

PEI Associates, Inc. 1986. OTS Survey of Asbestos Products Manufacturers. Washington, D.C.: Office of Pesticides and Toxic Substances, U.S. Environmental Protection Agency.

Raymark Corp. G. Houser. 1986a (July-December). Manheim, PA. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, D.C.

Raymark Corp. 1986b. Comments of Raymark Corp. on Proposed Asbestos Ban Rule. EPA Document Control No. OPS-62036.

TSCA Section 8(a) submission. 1982a. Production Data for Primary Asbestos Processors, 1981. Washington, D.C.: Office of Toxic Substances, U.S. Environmental Protection Agency. EPA Document Control No. 20-8601012.

TSCA Section 8(a) submission. 1982b. Production Data for Secondary Asbestos Processors, 1981. Washington, D.C.: Office of Toxic Substances, U.S. Environmental Protection Agency. EPA Document Control No. 20-8670644.

Wheeling Brake Block. G. Beckett. 1986 (November 20). Bridgeport, CT. Transcribed telephone conversation with Richard Hollander, ICF Incorporated, Washington, D.C.

XXV. ASBESTOS PROTECTIVE CLOTHING

A. Introduction

This chapter describes the uses and applications for asbestos protective clothing, the producers of these garments and the fibers that can substitute for asbestos in the production of alternative protective clothing.

B. Product Description

Asbestos clothing is formed by sewing asbestos cloth with asbestos thread. The asbestos cloth consists of any of the standard ASTM textile grades available (varying between 75 and 100 percent asbestos), that may contain wire, organic, or inorganic reinforcing strands (ATI 1967).

Asbestos cloth is woven from plied, twisted, and metallic yarns. Depending on the type of yarns used, asbestos cloth of five basic types is available. The classes of asbestos cloth are (ATI 1967):

- Class A -- cloth constructed of asbestos yarns containing no reinforcing strands;
- Class B -- cloth constructed of asbestos yarns containing wire reinforcing strands;
- Class C -- cloth constructed of asbestos yarns containing organic reinforcing strands;
- Class D -- cloth constructed of asbestos yarns containing non-metallic, inorganic reinforcing strands; and
- Class E -- cloth constructed of two or more of the yarns used i cloth Classes A through D.

The most widely used asbestos fabrics are woven from Class A and Class B yarns.

The asbestos thread that is used to sew the various grades of asbestos cloth can be either wire-inserted or non-metallic. Depending on the tensile strength and thermal stability requirements, asbestos thread is available in different grades, although the majority is 80-85 percent asbestos. These threads are often coated with an acrylic or wax coating to increase its strength and to facilitate the sewing of asbestos fabrics.

Traditionally, asbestos protective clothing has been used to ensure the health and safety of workers exposed to very high temperatures, molten metal splash, or the presence of fire. The use of asbestos gloves and mittens as well as coats and overalls has been widespread in laboratories, steel mills, and glass blowing and welding shops where these hazards are likely to be encountered (Utex 1986). In addition, there are other areas where fully-covering asbestos suits have been used to protect workers in very hazardous environments. Some examples of these more exotic job descriptions are oil-well firemen, steel furnace workers, race care drivers, military aircraft pilots, and astronauts (Garlock 1986).

C. <u>Producers</u>

The 1982 TSCA Section 8(a) survey of asbestos processors identified one company as a secondary processor (there were no primary processors) of asbestos textiles used as protective clothing. This company, A-Best Products Company, located in Cleveland, Ohio was involved in the manufacture of asbestos-containing safety clothing (TSCA 1982). A-Best Products Company manufactured gloves, mittens, coats, and coveralls by sewing asbestos cloth with asbestos thread (A-Best 1986). They ceased production of asbestos-containing protective clothing at the end of 1984 and since that time have used substitute fibers in the production of protective clothing (ICF 1986a).

Small quantities of asbestos gloves and mittens have been and continue to be imported from foreign countries such as Taiwan, South Korea, and Mexico (Aztec 1986), but no specific data could be identified.

D. <u>Substitutes</u>

The substitute materials that can replace asbestos fiber in protective clothing are: ceramics, fiberglass, carbon, aramid, and polybenzinidazole

(PBI) fibers. These fibers are used alone or in blends depending on the specific requirements of each application. Although fiberglass and ceramic fibers have very high temperature use ranges, the inflexibility of these materials make them unsuitable for protective clothing if abrasion resistance, durability, or flexibility are important characteristics. As higher temperatures are reached and the need for flexibility and integrity of the material increases (e.g., space suits, and fire-fighting equipment) it becomes necessary to blend these fibers with other more expensive, but more resilient fibers. Blends of ceramic or fiberglass with carbon, aramid, and PBI fibers can be formulated that meet or exceed the performance of any existing asbestos product, although the cost may be significantly higher (Utex 1986). In many applications, however, the added cost is insignificant when weighted against other costs. For example, the cost of a space suit, of any type, is insignificant in comparison to the cost of a space vehicle.

E. Summary

There are currently no domestic processors of asbestos-containing protective clothing, although some finished articles (e.g., gloves and mittens) continue to be imported in small quantities. Substitute fiber blends can be used to produce alternate protective clothing that meets or exceeds the quality standards required for asbestos protective clothing. To a large extent this replacement has already occurred in the protective clothing market. The demand for asbestos in this market is, therefore, negligible.

REFERENCES

A-Best Products Company. M. Knauzs. 1986 (October 28). Cleveland, OH, 44111. Transcribed telephone conversation with Mark Wagner, ICF Incorporated, Washington, D.C.

ATI. 1967. Handbook of Asbestos Textiles. American Textiles Institute.

Aztec Industries. W. Outcalt. 1986 (November 4). North Brookfield, MA, 01535. Transcribed telephone conversation with Mark Wagner, ICF Incorporated, Washington, D.C.

Garlock Inc. F. Piccola. 1986 (October 17). Sodus, NY, 14551. Transcribed telephone conversation with Mark Wagner, ICF Incorporated, Washington, D.C.

ICF Incorporated. 1986a (July-December). Survey of primary and secondary processors of asbestos textiles. Washington, D.C.

TSCA Section 8(a) submission. 1982. Production Data for Secondary Processors, 1981. Washington, D.C.: Office of Toxic Substances, U.S. Environmental Protective Agency. EPA Document Control No. 20-8670644.

Utex Industries. E.B. Pippert. 1986 (July-December). Houston, TX, 77279. Transcribed telephone conversation with Mark Wagner, ICF Incorporated, Washington, D.C.