Asbestos

By Robert L. Virta[1]

U.S. apparent consumption of asbestos declined in 1986. Shipments from domestic mines decreased 11% and imports for consumption decreased 24% from those of 1985. Adverse publicity on asbestos-related health risks and a proposed Environmental Protection Agency (EPA) ban of certain asbestos products contributed to the poor market conditions in the United States.

Domestic Data Coverage.—Domestic production data for asbestos are developed by the Bureau of Mines by means of a voluntary industry survey. Of the three canvassed operations to which a survey request was sent, all responded, representing 100% of the total production data shown in table 1.

Table 1.—Salient asbestos statistics

	1982	1983	1984	1985	1986
United States:					
Production (sales):					
Quantity, metric tons	63,515	69,906	57,422	57,457	51,437
Value[1], thousands	$24,917	$27,866	$24,238	$20,485	$17,367
Exports and reexports (unmanufactured):					
Quantity, metric tons	58,771	54,634	39,919	45,656	47,281
Value, thousands	$19,713	$19,683	$18,346	$16,489	$14,520
Exports and reexports of asbestos products:					
Value, do.	$127,867	$129,582	$163,347	$193,765	$163,896
Imports for consumption (unmanufactured):					
Quantity, metric tons	241,737	196,387	209,963	142,431	108,352
Value, thousands	$64,925	$57,956	$64,749	$44,093	$26,537
Consumption, apparent[2], metric tons	246,500	217,000	226,000	162,000	119,627
World: Production, do.	r4,559,495	r4,728,867	4,659,115	p4,678,287	e4,522,045

eEstimated. pPreliminary. rRevised.
[1]F.o.b. mine.
[2]Production, plus imports, minus exports, plus adjustments in Government and industry stocks.

Legislation and Government Programs.—On January 29, 1986, the EPA announced a proposed ruling that would immediately ban the manufacture, importation, and processing of certain asbestos construction materials (asbestos-cement pipe and fittings, roofing felt, flooring felt, felt-backed sheet flooring, vinyl asbestos floor tile, and asbestos clothing) under section 6 of the 1976 Toxic Substances Control Act.[2] In addition, the mining and importation of asbestos and the importation of asbestos products not directly banned would be placed under a permit system. The permit system would limit the mining and importation of asbestos to 30% of the 1981, 1982, and 1983 average values and would phase out asbestos use within 10 years.

The Occupational Safety and Health Administration (OSHA) enacted a ruling, effective July 21, that limits worker exposure to asbestos, tremolite, anthophyllite, and actinolite to 0.2 fiber per cubic centimeter per 8-hour work period.[3] OSHA also required employee training and medical surveillance when exposure levels exceed 0.1 fiber per cubic centimeter. A 9-month administrative stay was placed on that portion of the ruling covering the nonasbestiform varieties of tremolite, anthophyllite, and actinolite.[4]

Minerals Yearbook: Asbestos Chapters, 1986
ACL Doc 11023 · Page 1 of 8
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Worker exposure to the nonasbestiform varieties was limited to 2.0 fibers per cubic centimeter by the administrative stay.

The EPA enacted a ruling, effective June 9, that limits asbestos exposures for State and local government employees who were not protected by OSHA regulations or by State plans approved under the Occupational Safety and Health Act.[5] Exposures for workers engaged in the removal, enclosure, or encapsulation of any friable material containing more than 1% asbestos are limited to 2.0 fibers per cubic centimeter per 8-hour period.

The Consumer Product Safety Commission issued an enforcement policy for household products to which asbestos is intentionally added.[6] The policy, effective December 23, requires warning labels to be placed on asbestos-containing products that are likely to release asbestos fibers when handled or used.

The EPA announced a final ruling establishing effluent limitation guidelines for the discharge of conventional pollutants into navigable waters by specified industrial dischargers.[7] No changes were made to previous effluent limitation guidelines for asbestos manufacturing. Previous guidelines set no limitations on effluent discharge with regard to best conventional pollutant control technology except for solvent recovery, where the best conventional technology is required to control total suspended solids and pH.

On October 22, the Asbestos Hazard Emergency Response Act of 1986 was signed into law.[8] The act requires EPA to develop regulations for inspecting public and private school buildings for asbestos-containing materials, evaluating the risk that these materials represent, recommending corrective action and an air monitoring protocol, and issuing disposal guidelines for asbestos-containing materials.

Stockpile goals for asbestos were unchanged from those of 1985.

Table 2.—Stockpile goals and Government inventories for asbestos as of December 31

(Metric tons)

	Stockpile goals	Total inventories		
		1984	1985	1986
Amosite	15,422	30,855	30,855	30,853
Chrysotile	2,722	9,754	9,772	9,711
Crocidolite	--	33	33	33
Total	18,144	40,642	40,660	40,597

Source: General Services Administration, Federal Property Service.

Environmental Impact.—The International Labor Organization at its 1986 conference voted to support the controlled use of asbestos.[9] Its recommendations would require ratifying countries to enact legislation that would protect the worker from asbestos exposure; provide for safe, proven asbestos substitutes if the use of asbestos would represent an unacceptable hazard to the worker; ban the use of crocidolite and the use of sprayed asbestos except under special conditions; and establish worker exposure limits.

EPA announced the availability of a regulatory determination for solid waste from the extraction and beneficiation of ores and minerals as required by the Resource Conservation and Recovery Act (RCRA).[10] The report discussed wastes from asbestos, phosphate, uranium, and several metal mining operations. Approximately 5 million metric tons of waste containing greater than 5% chrysotile were generated from asbestos production according to the EPA report. EPA concluded that current RCRA criteria could not be used to evaluate asbestos waste sites and that different criteria would have to be developed.

DOMESTIC PRODUCTION

Mine shipments decreased 11% in quantity and 15% in value from those of 1985. The decreased activity was due primarily to adverse publicity on asbestos-related health risks.

Three mines in California and Vermont marketed asbestos. Calaveras Asbestos Ltd. in California led in asbestos sales in the United States, followed by KCAC Inc. and Vermont Asbestos Group Inc.

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Table 3.—Asbestos producers in the United States in 1986

State and company	County	Mine	Type of asbestos
California:			
Calaveras Asbestos Ltd	Calaveras	Copperopolis	Chrysotile.
KCAC Inc	San Benito	Santa Rita	Do.
Vermont: Vermont Asbestos Group Inc	Orleans	Lowell	Do.

CONSUMPTION AND USES

Total U.S. asbestos consumption decreased 26%. Approximately 98% of the asbestos consumed was chrysotile and 2% was crocidolite. Chrysotile grade 7 was most commonly used, followed by grades 4, 6, and 5. Spinning grades 1, 2, and 3 represented approximately 1% of the total consumption.

The packing and flange manufacturers increased their use of asbestos substitutes because of stricter asbestos regulations and increased concern over asbestos-related health risks.[11] Traditionally 80% to 90% of their products contained asbestos. In 1986, slightly over 50% of the products contained asbestos.

Table 4.—U.S. asbestos consumption by end use, grade, and type

(Thousand metric tons)

End use	Chrysotile[1]							Amosite	Crocidolite	Other[2]	Total asbestos[3]
	Grades 1 and 2	Grade 3	Grade 4	Grade 5	Grade 6	Grade 7	Total				
1985 total	0.1	1.7	18.8	12.1	13.7	104.0	150.4	0.3	4.8	7.3	155.5
1986:											
Asbestos-cement pipe	--	--	12.7	1.5	3.4	--	17.6	--	2.0	--	19.6
Asbestos-cement sheet	--	--	--	(4)	2.9	2.0	5.0	--	--	--	5.0
Coatings and compounds	--	--	--	--	--	17.4	17.4	--	--	--	17.4
Flooring products	--	--	--	--	--	5.3	5.3	--	--	--	5.3
Friction products	--	.1	.4	5.0	3.0	17.1	25.6	--	--	--	25.6
Insulation:											
Electrical	--	--	(4)	--	--	.2	.3	--	--	--	.3
Thermal	--	--	(4)	(4)	--	--	(4)	--	--	--	(4)
Packing and gaskets	--	.1	.5	2.5	.2	1.5	4.8	--	--	--	4.8
Paper	--	--	--	--	.4	12.3	12.7	--	--	--	12.7
Plastics	--	--	--	(4)	--	.5	.6	--	--	--	.6
Roofing products	--	--	--	(4)	.4	19.4	19.8	--	--	--	19.8
Textiles	--	.8	(4)	--	--	--	.9	--	--	--	.9
Other	--	(4)	.6	.2	(4)	2.8	3.6	--	--	--	3.6
Total[5]	--	1.1	14.2	9.3	10.3	78.6	113.7	--	2.0	3.9	115.7

[1]Estimated distribution based upon data provided by the Asbestos Institute, Montreal, Canada, and the Bureau of Mines, asbestos producer survey.
[2]Bureau of the Census.
[3]Does not include "Other" category in total. "Other" contains unspecified fiber type and end use.
[4]Less than 1/10 unit.
[5]Data may not add to totals shown because of independent rounding.

PRICES

The average unit value of domestically produced asbestos in 1986 was $338 per metric ton. The average unit value of exported asbestos was $307 per ton.

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Table 5.—Customs unit values of imported asbestos

(Dollars per metric ton)

	1982	1983	1984	1985	1986
Canada:					
Chrysotile:					
Cement	234	257	284	--	--
Crude	380	199	1,084	576	547
Spinning	917	932	699	731	507
Other	334	384	431	283	229
South Africa, Republic of:					
Amosite	771	840	869	830	--
Crocidolite	646	629	705	569	582

Source: Bureau of the Census.

FOREIGN TRADE

There was a 16% decrease in the total value of asbestos fibers and asbestos products exported from the United States. The asbestos fiber portion was 8% of total value. Exports of brake linings and disc pads accounted for 76% of the value of all asbestos products exported. Canada remained the largest importer of U.S. asbestos fibers and products, followed by Japan, Mexico, the Federal Republic of Germany, Brazil, and Venezuela.

Canada provided 96% of the asbestos imported into the United States, and the Republic of South Africa provided 4%. Several other countries provided minor amounts. Approximately 95% of asbestos fiber imports was chrysotile. The value of imported asbestos fiber decreased 40%.

Table 6.—Countries importing U.S. asbestos fibers and products

(Thousand dollars)

Country	1985			1986		
	Unmanufactured fibers	Manufactured products	Total	Unmanufactured fibers	Manufactured products	Total[1]
Australia	1	1,379	1,380	17	1,341	1,358
Brazil	251	3,592	3,843	467	2,555	3,022
Canada	714	148,663	149,377	605	123,819	124,424
Germany, Federal Republic of	75	1,948	2,023	300	2,746	3,047
Japan	3,294	10,140	13,434	2,981	7,867	10,848
Korea, Republic of	190	1,814	2,004	624	825	1,449
Kuwait	31	437	468	--	221	221
Mexico	6,261	6,483	12,744	2,667	5,593	8,260
Saudi Arabia	2	1,409	1,411	--	1,062	1,062
Thailand	2,330	332	2,662	2,490	354	2,844
Turkey	--	544	544	--	361	361
United Kingdom	50	926	976	166	1,313	1,479
Venezuela	267	3,487	3,754	218	2,688	2,906
Other	2,900	12,325	15,225	3,864	12,108	15,972
Total[1]	16,366	193,479	209,845	14,401	162,851	177,252

[1]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

Table 7.—U.S. exports and reexports of asbestos and asbestos products

Products		1984		1985		1986	
		Quantity	Value (thousands)	Quantity	Value (thousands)	Quantity	Value (thousands)
EXPORTS							
Unmanufactured:							
Crudes, fibers, stucco	metric tons	26,381	$14,106	29,382	$12,705	30,252	$9,728
Sand and refuse	do	13,398	4,115	15,693	3,661	16,645	4,673
Total	do	39,779	18,221	45,075	16,366	46,897	14,401

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Table 7.—U.S. exports and reexports of asbestos and asbestos products —Continued

Products	1984 Quantity	1984 Value (thousands)	1985 Quantity	1985 Value (thousands)	1986 Quantity	1986 Value (thousands)
EXPORTS —Continued						
Manufactured:						
Asbestos fibers metric tons	958	$5,067	607	$3,793	723	$3,902
Brake linings and disk brake pads do	NA	103,303	NA	144,262	NA	123,515
Clutch facings and linings number	NA	23,206	NA	20,718	NA	16,187
Gaskets metric tons	275	1,815	78	900	266	1,285
Insulation do	NA	5,720	NA	4,566	NA	1,889
Packing and seals do	1,150	9,063	1,192	6,716	820	6,373
Shingles and clapboard do	2,098	1,615	984	893	880	805
Other articles of asbestos do	1,759	2,595	1,521	2,437	1,614	1,553
Other articles, n.s.p.f do	NA	10,306	NA	9,191	NA	7,342
Total	XX	162,690	XX	193,476	XX	162,851
REEXPORTS						
Unmanufactured:						
Crudes and fibers metric tons	140	125	369	71	329	98
Sand and refuse do	--	--	212	52	54	20
Total[1] do	140	125	581	123	384	119
Manufactured:						
Asbestos fibers do	1	5	[2]	3	--	--
Brake linings and disk brake pads do	NA	47	NA	103	NA	222
Clutch facings and linings number	NA	194	NA	73	NA	604
Gaskets metric tons	46	136	1	18	6	65
Insulation do	[2]	10	NA	r2	NA	23
Packing and seals do	[2]	1	4	63	[2]	50
Other articles of asbestos do	NA	264	NA	20	NA	3
Other articles, n.s.p.f do	--	--	NA	1	NA	78
Total	XX	657	XX	r283	XX	1,045

rRevised. NA Not available. XX Not applicable.
[1]Data may not add to totals shown because of independent rounding.
[2]Less than 1/2 unit.

Source: Bureau of the Census.

Table 8.—U.S. imports for consumption of asbestos fibers, by type, origin, and value

Type	Canada Quantity (metric tons)	Canada Value (thousands)	South Africa, Republic of Quantity (metric tons)	South Africa, Republic of Value (thousands)	Other Quantity (metric tons)	Other Value (thousands)	Total[1] Quantity (metric tons)	Total[1] Value (thousands)
1984	195,651	$56,267	13,912	$8,033	400	$449	209,963	$64,749
1985:								
Amosite	--	--	121	100	--	--	121	100
Chrysotile:								
Crude	94	86	174	100	--	--	268	187
Spinning fibers	1,990	1,454	--	--	90	110	2,080	1,564
All other	127,307	36,045	522	301	37	16	127,866	36,362
Crocidolite (blue)	--	--	4,794	2,726	--	--	4,794	2,726
Other (unspecified asbestos type)	1,728	962	5,374	1,997	200	196	7,302	3,155
Total[1]	131,119	38,547	10,985	5,224	327	322	142,431	44,093
1986:								
Chrysotile:								
Crude	20	12	192	104	--	--	212	116
Spinning fibers	598	304	--	--	--	--	598	304
All other	101,273	23,065	227	139	107	94	101,607	23,291
Crocidolite (blue)	--	--	1,968	1,154	20	4	1,988	1,158
Other (unspecified asbestos type)	1,626	434	2,068	1,109	253	119	3,947	1,662
Total[1]	103,517	23,814	4,455	2,506	380	217	108,352	26,537

[1]Data may not add to totals shown because of independent rounding.

Source: Bureau of the Census.

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WORLD REVIEW

World production of asbestos decreased slightly from that of 1985. The major production change occurred in Canada, where shipments were down 110,000 tons. The U.S.S.R. remained the largest producer of asbestos, followed by Canada, Brazil, Zimbabwe, China, the Republic of South Africa, and Italy.

Canada.—Three Canadian asbestos producers, Asbestos Corp. Ltd., Bell Asbestos Mines Ltd., and Lac d'Amiante du Quebec, formed a partnership, effective July 1, 1986, that strengthened their resources and improved their position in domestic and export markets.[12] The new partnership was governed by a board of directors, although each facility operated under local management. The partnership controlled approximately 50% of the asbestos production in the Province of Quebec.

Carey Canada Inc., a subsidiary of the Jim Walter Corp., permanently closed its chrysotile mine in the Beauce Mountains, near East Broughton, Quebec.[13] Economic conditions made the mine unprofitable. Carey Canada produced chrysotile grades 4D to 7W for asphalt compounds, friction materials, asbestos paper, vinyl asbestos tile, gaskets, phenolic compounds, and caulking compounds. The company marketed asbestos primarily in North America and Asia.

China.—Approximately 100 asbestos-cement (A-C) manufacturing plants operated with 200 production lines.[14] Production of shingle and board were operating below capacity because of shortages of asbestos and cement. Expansion was anticipated to meet increasing demands for new markets such as in power station cooling towers, ventilation and roofing needs in textile mills, guard structures in fertilizer plants, and replacements for traditional clay brick structures. Plans were made to increase asbestos production and upgrade existing mill and plant equipment.

Italy.—Asbestos was produced by only one company, Amiantifera di Balangero S.p.A., from a surface mine at San Vittore.[15] The crushed rock was processed in an automated plant where the fibers were removed from the host rock, dried in static vertical and revolving horizontal driers, and graded. Automated sampling was performed every 6 minutes to determine fiber quality. Approximately 70% of the asbestos was used by the A-C industry. Other uses included gaskets, brake linings, paint filler, and insulation material. Over 50% of manufactured products was exported.

Morocco.—Although chrysotile deposits occur near Bou Azzer and Inguiem, no domestic production was undertaken.[16] Demand for asbestos was met by imports, primarily from Canada and Botswana. Asbestos was consumed primarily by the domestic A-C industry for building and irrigation projects. Despite domestic demand, 30% to 50% of A-C products was exported to neighboring countries.

South Africa, Republic of.—Griqualand Exploration and Finance Co. Ltd. implemented an environmental program to revegetate old mine dumps.[17] The mine dumps, which had been previously covered by soil and grass, were exposed owing to the grazing of livestock. The companies began planting vegetation that provides a dense soil cover and is impenetrable by animals.

Table 9.—Asbestos: World production, by country[1]

(Metric tons)

Country[2]	1982	1983	1984	1985[p]	1986[e]
Argentina	1,218	1,240	1,093	[e]1,200	1,100
Australia	18,587	[r]3,909	--	--	--
Brazil (fiber)	145,998	158,885	134,788	172,027	175,000
Bulgaria	600	700	500	400	500
Canada (shipments)	834,000	858,000	837,000	750,000	[3]640,000
China[e]	110,000	160,000	135,000	[r]150,000	150,000
Colombia	[e]5,400	[e]5,400	9,982	12,435	13,000
Cyprus	18,952	17,288	7,429	16,360	16,000
Egypt	424	245	[e]325	[e]325	300
Greece	17,016	31,811	45,376	46,811	48,000
India	26,761	24,873	25,450	30,183	30,000
Indonesia[e]	25,000	25,000	25,000	25,000	25,000
Italy	116,410	139,054	147,272	136,006	[3]115,208
Japan[e]	[3]4,135	4,000	4,000	4,000	4,000
Korea, Republic of	15,933	12,506	8,062	4,703	5,000
Mozambique	852	[r e]600	[r e]400	55	--
South Africa, Republic of	211,860	221,111	167,389	163,574	140,000
Swaziland	30,145	26,287	25,832	25,130	25,000

See footnotes at end of table.

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Table 9.—Asbestos: World production, by country[1] —Continued

(Metric tons)

Country[2]	1982	1983	1984	1985[p]	1986[e]
Taiwan	2,392	2,819	1,355	625	--
Turkey	958	1,510	1,499	[e]1,500	1,500
U.S.S.R.[e]	[r]2,700,000	[r]2,800,000	[r]2,850,000	[r]2,900,000	2,900,000
United States (sold or used by producers)	63,515	69,906	57,422	57,457	[3]51,437
Yugoslavia	11,657	10,502	8,556	6,916	7,000
Zimbabwe	[r]197,682	[r]153,221	165,385	173,580	174,000
Total	[r]4,559,495	[r]4,728,867	4,659,115	4,678,287	4,522,045

[e]Estimated. [p]Preliminary. [r]Revised.

[1]Table includes data available through Apr. 28, 1987.

[2]In addition to the countries listed, Afghanistan, Czechoslovakia, North Korea, and Romania also produce asbestos, but output is not officially reported, and available general information is inadequate for the formulation of reliable estimates of output levels.

[3]Reported figure.

TECHNOLOGY

A semiquantitative method for distinguishing between asbestiform and nonasbestiform crystals was developed.[18] The flexibilities of several asbestiform and nonasbestiform tremolite crystals were measured and their bending strengths were calculated. The asbestiform and nonasbestiform varieties of tremolite could be differentiated using this technique.

A process was developed to synthesize zeolites using chrysotile as a starting material.[19] The magnesium was stripped from the chrysotile structure. The remaining siliceous material was mixed with alumina and heated under pressure to synthesize zeolite crystals. Production of 1 ton of zeolite consumes 2 tons of chrysotile. If economically feasible, this synthesis process will create a new market for chrysotile.

Asbestos is used in pressure pipe to provide reinforcement strength, improve the drainage characteristics, and provide dimensional stability to uncured pipe. With concerns over asbestos-related environmental issues, asbestos used in A-C pipe and sheet was facing competition from a variety of artificial and natural fibers. In general, these substitute fibers did not have the same reinforcing properties, did not bind as well with the cement and silica particles, and did not disperse in the cement matrix as well as asbestos.[20]

A study of A-C pipe, polyvinyl chloride (PVC) pipe, and ductile iron (DI) pipe indicated that A-C pipe was more cost effective over a wide range of diameters, strength classes, and applications than either PVC or DI pipe.[21] A-C pipe is more versatile because interior and exterior coatings are not required for corrosion resistance; for a given diameter, A-C pipe has higher crush and burst strengths; use of rubber sealing rings provides joint flexibility, shock resistance, pipe-expansion and pipe deflection; A-C pipe has a smooth bore, which results in a low coefficient of friction; and a single manufacturing facility can make all forms of A-C pipe.

The packing and flange manufacturers investigated the use of asbestos substitutes in packings and gaskets.[22] The major replacements were flexible graphite, carbon and graphite yarn, glass fibers, aramid, polybenzimidazale, polytetrafluoroethylene, ceramics, mica, and metals. Although none of these substitutes possessed all of the desirable properties of asbestos, packings and gaskets of equal or superior quality were produced using a combination of asbestos substitutes. Asbestos substitutes, however, were still not adaptable to many severe use applications and were more costly than asbestos.

The Chlorine Institute estimated that replacing asbestos diaphragm cells with nonasbestos membrane cells would cost the U.S. chlor-alkali industry $2 million.[23] Approximately 97% of the chlorine produced in the United States was generated using diaphragm cells. No substitute had the strength, physical structure, and chemical resistance to acids and alkalies of asbestos. An alternative to replacing asbestos with asbestos substitutes was converting diaphragm cells to membrane cells. Membranes consisting of carboxylic-sulfonic compounds were developed to fit around the anodes of the diaphragm cell. Use of these membranes was reported to reduce electricity costs by 20% and produce high-purity

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caustic soda of 30% to 35% concentration.

Techniques for evaluating and controlling asbestos exposures were developed.[24] All of these techniques focus on evaluating the health risk posed by asbestos materials in the workplace. Detailed information on the type of asbestos, condition of the asbestos material, and activity levels are a few of the considerations of these risk management programs.

A technique for encapsulating asbestos in buildings using a low-density cellular polymer insulation was developed.[25] The polymer insulation formed a durable coating over the asbestos that was more abrasion and impact resistant than resin coatings. The durable coating reduced the risk of asbestos release through abrasion. Encapsulation using the cellular polymer insulation costs from 50% to 75% less than asbestos removal and eliminates the potential for fiber release that may occur during removal operations.

E. I. du Pont de Nemours & Co. Inc., Standard Oil Co., Rhodes-American, Ashland Oil Inc., and Union Carbide Corp. formed a coalition to promote the use of asbestos substitutes.[26] The coalition, called Alternative Materials Institute (AMI), reported that substitutes such as aramid fibers, carbon fibers, graphite, and other mineral and artificial fibers are available and that the transition to asbestos alternatives has already begun for some products. AMI will focus on providing up-to-date information on the availability and use of safe and effective alternatives to asbestos.

Several products that could replace asbestos in hot glass handling processes were developed.[27] Using glass fiber fabrics impregnated with fluorocarbon resins, materials with high temperature capabilities, and a dry lubricated wear surface were produced. Several of these materials could be molded to shape and had applications up to 1,000° F.

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[1]Physical scientist, Division of Industrial Minerals.

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