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1950

MATERIALS SURVEY

ASBESTOS

Compiled for the

NATIONAL SECURITY RESOURCES BOARD

by the

UNITED STATES DEPARTMENT OF THE INTERIOR

BUREAU OF MINES

February 1952

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PREFACE

The Materials Survey series is being prepared under the sponsorship of the National Security Resources Board. A number of departments and agencies are cooperating with the NSRB in developing these studies. This volume, covering the commodity ASBESTOS, is one of several in the series prepared by the Bureau of Mines in the Department of the Interior.

Certain grades of asbestos are essential to the Defense Program, and all grades occupy an important place in our normal industrial economy. As the United States depends upon foreign sources for all but a small fraction of its needs of raw asbestos, this report has world-wide scope. It is in looseleaf form to facilitate revision as new data become available.

The data appearing herein were assembled by Oliver Bowles, commodity specialist, employed in the Bureau of Mines as a consultant. Assistance of outstanding importance was rendered by Jesse M. Weaver, consultant to Emergency Procurement Service, General Services Administration. G. W. Josephson, chief, Construction and Chemical Materials Branch, Bureau of Mines, contributed essentially to the plan and scope of the report and to the factual data therein. J. E. Comeforo and other members of the staff of the Bureau of Mines Region VII, Norris, Tenn., supplied valuable information for the sections on substitutes, beneficiation, and synthesis. Acknowledgment is also made of helpful assistance from S. H. Manian of the Research and Development Board, J. H. Chilcote and G. M. Van Lear of the Navy Department, and T. D. Callinan of the Naval Research Laboratory. Several asbestos producers and fabricators of asbestos products furnished pertinent assistance and advice. Important statistical data were furnished by the Foreign Minerals Region of the Bureau of Mines. The manuscript of this report has been reviewed by Fred G. Rockwell and H. B. Sharpe formerly of the National Security Resources Board, by Dr. Timothy C. May of the Munitions Board, and by John Croston, Mineral Raw Materials, National Security Resources Board.

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SUMMARY

Introduction

Asbestos is a name applied to a group of naturally fibrous minerals. A material that has the characteristics of silk or cotton, and at the same time will not burn is unique. Because it combines these qualities with other advantageous properties, asbestos has specialized uses for which no adequate substitutes are yet available. Asbestos furnishes a major raw material for a great variety of essential products the manufacture of which constitutes a vast industry.

Asbestos generally occurs in irregular veins scattered throughout rock masses deep in the earth. Most of the fiber-bearing rock is mined in huge open-pit or underground workings. The fibers are separated from the rock and sorted into groups, according to length, in large, complex mills. The longer fibers are shipped to textile plants, where they are further fiberized and prepared in special machines and are used for spinning into yarn and weaving into unburnable cloth that has many important uses. The shorter fibers, which are much more abundant than the long ones, are used in asbestos-cement building materials in heat-insulating products, and for a multitude of other applications. These processes and uses are covered in considerable detail in later sections of this report.

Essentiality of Asbestos

The United States has developed the greatest asbestos-products industry in the world. The value of such products manufactured in 1947 was about $274,000,000. These products are not only vital to building construction and industry but absolutely essential to certain other important fields of use. Two striking examples may be cited:

(1) There is no known substitute for asbestos used as brake lining and clutch facings of automobiles, trucks, or other mobile equipment used in peace or war. Hence, a shortage of asbestos used in friction materials would immobilize highway transport to a corresponding degree.

(2) There is no known substitute for asbestos used in steam packings. Accordingly a shortage of such products would interfere seriously with many lines of industrial activity.

Many other examples might be cited indicating the essentiality of asbestos to our modern way of life and to any program of military preparedness.

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Shortage of Domestic Supplies

This great asbestos-products industry has been built up under conditions of overwhelming dependence upon foreign supplies of raw asbestos. Our domestic mines furnish only 6 to 8 percent of our requirements of all grades and not more than 1 or 2 percent of the important strategic grades. Canada and Africa are our principal foreign sources. Canada supplies most of the short-fiber demands of the United States and a major part of the longer textile-grade fibers. Africa supplies a low-iron asbestos essential to important military needs where fireproof electrical insulation is involved. Africa is our only source of an asbestos variety named amosite, which is of first importance as lightweight insulation on ships and airplanes. Africa is the principal source of crocidolite (blue asbestos), which has certain special uses. Bolivia supplies small amounts and is the only source of crocidolite in the Western Hemisphere.

Growing Inadequacy of Foreign Supplies

Although in the past foreign sources of asbestos have supplied United States need moderately well, a condition of increasing stringency seems inevitable. The asbestos-products industries are expanding to pace growing industrial activity, therefore the demand for raw asbestos is increasing steadily. British and continental European needs are also expanding. Central European asbestos-products industries, stagnant during the war, have revived, and increasing quantities of African and Canadian fibers are being diverted from United States to European markets. Australian demands are also rising substantially. Asbestos production is not increasing rapidly enough to pace these growing needs. There is a definite world shortage of asbestos, which probably will increase in severity as time goes on.

Adequate Information an Imperative Need

The procurement of necessary supplies is a problem of world-wide scope, and in every war emergency asbestos assumes top priority among strategic minerals. It is of paramount importance, therefore, that a thorough knowledge should be gained of the composition and properties of asbestos, its uses and requirements for each use, grades and specifications, the degree of essentiality of each application, the nature and extent of sources of supply throughout the world, mine and mill capacity, reserves, transportation facilities, political and commercial control, world requirements by countries, import and export data, allocation of supplies, fiber beneficiation, possibilities of synthetic asbestos manufacture, use of substitute materials, past war controls, war history, and various other problems that may appear. The purpose of this report is to furnish information on as many as possible of these pertinent questions.

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I. VARIETIES AND COMPOSITION OF ASBESTOS

Varieties

There are several varieties of asbestos, differing considerably in composition and physical properties. The most important commercially is chrysotile, which constitutes about 95 percent of total world production. Its wide use is due to the fact that its fibers are generally strong and flexible and therefore can be applied to many uses, such as manufacture of textiles and steam packing, for which weak and brittle fibers are not adapted.

Species of asbestos other than chrysotile fall in the amphibole group of minerals. The only varieties having significant use are anthophyllite, tremolite, amosite, and crocidolite. Fibers of anthophyllite and tremolite are generally weak and brittle, and the uses are limited. Sales are small, and very little of the materials enters international trade. Amosite and crocidolite are mainly African varieties exported to the United States and other countries in considerable quantities for specialized uses.

Chrysotile Asbestos

Chrysotile is a hydrous magnesium silicate having a composition represented by the chemical formula $3MgO.2SiO_2.2H_2O$. It is a fibrous form of the mineral serpentine. Antigorite is a platy form having no commercial value.

Recent work by Shaw 1/ indicates that both (OH), the hydroxyl radical or water of constitution, and H_2O, the water of crystallization, are present in chrysotile. To indicate the dual nature of the water content he writes the chemical formula $(OH)_6Mg_6Si_4O_{11}H_2O$. He claims also that, in fibers from different locations, the proportions of these compounds vary. Thus, in Canadian chrysotile a greater part of the hydration is present as water of crystallization, while in the Rhodesian chrysotile the hydration is due largely to the presence of the hydroxyl radical. He expresses the view that such a difference in chemical constitution may explain in part the superior electrical resistance of the Rhodesian fiber.

The composition of chrysotile, however, is not rigidly fixed according to either of the formulas given above. Minor quantities of

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1/ Shaw, Myril C., The Asbestos Content of Asbestos Textiles. New Jersey Ceramic Research Sta., Rutgers Univ., New Brunswick, N. J., March 27, 1950, pp. 7.

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iron, nickel, manganese, or aluminum may replace part of the magnesium. Such small replacements may result in some modifications in the physical properties of the fibers. Furthermore, these properties are influenced to some extent by the presence of impurities; but, in general, chrysotile is more constant and dependable in quality than are other varieties of asbestos.

Amphibole Asbestos

The amphibole group of minerals was formerly regarded as consisting of anhydrous silicates of magnesium, calcium, iron, and other elements. When analyses were made, water was always found, but it was regarded as occluded moisture. However, as early as 1916 Schaller 2/, using five exact analyses of tremolite, found, by calculating the molecular ratios, that water was an integral part of the composition, and he derived a formula $2CaO.5MgO.8SiO_2.H_2O$, which is now the recognized composition in contrast with the widely published formula $CaO.3MgO.4SiO_2$. Strange as it may seem, no general recognition was accorded this new concept for many years. When x-ray studies of minerals were begun in the early 1920's, Schaller's findings were confirmed, and it was further learned that all amphiboles contained water of crystallization. It is only in textbooks of mineralogy published since about 1940 that the definite statement appears "all amphiboles contain hydroxyl". The water content of amphiboles is low - only 1 or 2 percent - whereas chrysotile contains about 14 percent water.

As mentioned previously, the principal varieties of amphibole asbestos are amosite, anthophyllite, tremolite and crocidolite.

There is some doubt that amosite is a distinct mineral species. Rabbitt 3/ found by x-ray analysis of two amosite samples from South Africa that both were monoclinic in crystallization and therefore were not anthophyllites. The chemical composition of one indicated that it was probably actinolite, and the other was probably cummingtonite. However, it seems desirable to retain the name, amosite, in commercial usage where it serves a useful purpose.

Amosite may contain as high as 40 percent iron oxide, but, as it is monoclinic in crystallization it is not a true anthophyllite, although it is commonly classed as a high-iron anthophyllite. Amosite,

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2/ Schaller, W. T. The Chemical Composition of Tremolite; Mineralogical Notes Series 3: Geol. Survey Bull. 610, 1916, pp. 133-136.

3/ Rabbitt, John C. A New Study of the Anthophyllite Series: Am. Mineral., vol. 33, May-June 1948, p. 287.

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unlike the true anthophyllites that are almost invariably weak and brittle, consists commonly of long, fairly strong fibers that have certain specialized uses. It is mined only in Africa.

The composition of anthophyllite is now generally expressed by the formula $Mg_7(Si_4O_{11})_2(OH)_2$, sometimes written $7MgO.8SiO_2.H_2O$. The magnesium may be replaced in part by certain other elements, but complete replacement is not possible because the anthophyllites possess only limited isomorphism. Ferrous iron may replace magnesium to a maximum of 26.53 percent, but such an anthophyllite would still contain as much as 11.48 percent MgO. When the ferrous iron content exceeds 26.53 percent, the mineral ceases to be anthophyllite, as it becomes monoclinic in crystallization while all anthophyllites are orthorhombic

The MgO content of anthophyllite is said to range from 5 to 50 percent. A series of 46 chemical analyses of anthophyllites assembled by Rabbitt 4/ shows a maximum of 31.53 percent and a minimum of 11.48 percent. The one with the maximum MgO content contained 5.6 percent FeO. The CaO content of anthophyllites averages about 0.5 percent, and rarely exceeds 2 percent.

Aluminum is more important in anthophyllites than is generally supposed. Of Rabbitt's 46 tabulated analyses, 14 show more than 10 percent Al_2O_3, and 20 show more than 5 percent. The aluminum may replace magnesium or silicon.

As previously mentioned, the composition of tremolite is expressed by the formula $Ca_2Mg_5(Si_4O_{11})_2(OH)_2$ or sometimes written $2CaO.5MgO.8SiO_2.H_2O$. The calcium may be replaced in small part by sodium. The magnesium is replaceable by iron in considerable quantities, and by aluminum to a lesser degree. Also, a small part of the silicon may be replaced by aluminum. Tremolite generally consists of gray to white silky fibers, which are, for the most part, weak and brittle, although fibers of considerable strength and flexibility are found at times. Both tremolite and anthophyllite are superior to chrysotile in resistance to chemical reaction.

Crocidolite or blue asbestos belongs to the hornblende group of amphiboles. Its simplest chemical formula is $3Na_2O.6FeO.2Fe_2O_3.16SiO_2.H_2O$. Considerable variation in composition has been noted. Sodium may be replaced by potash, ferric and ferrous iron by magnesium or manganese, and ferrous iron by aluminum. Mineralogists now regard crocidolite as identical with riebeckite, being merely a fibrous form of that mineral. Crocidolite, therefore, bears the same relation to riebeckite that

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4/ Rabbitt, John C., work cited, p. 271.

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chrysotile bears to massive serpentine. Blue asbestos is produced chiefly in South Africa, but several commercial deposits occur in Australia, and a small output is obtained in Bolivia. Except for those in Bolivia, no commercial deposits of blue asbestos are known in the Western Hemisphere. In Bolivian blue a large part of the iron is replaced by magnesium. The magnesium content of African blue asbestos is somewhat lower.

Erratic character of amphibole fibers. - It may be observed from the foregoing discussion that the replacement of one element by another in varying proportions is a prevalent characteristic of the several varieties of amphibole asbestos. This variation in composition results in corresponding changes in their physical properties. These properties may also be influenced by the presence of impurities. The somewhat erratic and unpredictable physical characteristics of the amphibole fibers have a profound influence on their use. An anthophyllite from one locality may give satisfactory service for some specific use, while one from another deposit, although appearing to be exactly the same, may be quite unsatisfactory. Thus problems in amphibole asbestos procurement are much more difficult and complex than the procurement of mineral products like iron or copper, which, when pure, have constant properties, irrespective of the part of the world in which they may originate.

Importance of Physical Properties

The outstanding physical characteristic of asbestos is its fibrous structure. Other important fibers found in nature are those of animal origin, such as wool and silk, and those of vegetable origin, such as cotton and flax. Nonflammability is one of the striking differences between asbestos and the fibrous products of animal or vegetable origin. Of perhaps equal importance is the difference in structure. Each filament of cotton, wool, or silk is of measurable and fairly constant diameter and indivisible into finer sizes. On the other hand, fibers of chrysotile asbestos can be divided and subdivided until a fineness is attained that is limited only by the delicacy of the machinery used and the skill of manipulation. The ultimate fiber size is presumably the size of the ultimate molecule or crystal lattice of asbestos. In other words, fiberization is a cleavage process, and cleavage in minerals is defined as a tendency to split in a certain direction, that is, to separate along and between layers of molecules.

From the standpoint of use, fiber size is important, and the size will depend upon the degree of fiberization attained in milling. Fibers obtained from different deposits vary in the ease with which they may be fiberized. Thus, two samples of chrysotile asbestos, given exactly the same mill treatment, may furnish products differing considerably in fiber diameter, because one of them separates or fiberizes more easily than the other. Such differences may have great practical

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importance because an asbestos having difficult cleavage may require such intense milling to reduce the fibers to desirable fineness that they may be broken into undesirable short lengths. Ease or difficulty of fiberization is therefore an important property of asbestos.

The use to which a chrysotile asbestos may be applied is governed primarily by fiber length. The longest fibers command the highest prices, and prices are progressively lower for the shorter grades. It is apparent, therefore, that primary attention must be given to milling processes that will separate the fibers from the parent rock and will fiberize them adequately with a minimum of fiber breakage.

The heat resistance of asbestos is important in many applications. Some users of asbestos confuse nonflammability with refractoriness. Many substances that will not burn will, nevertheless, melt or decompose at relatively low temperatures. The fireproof property of asbestos is one of its chief assets; but, although unburnable, it will decompose and lose its essential physical properties at moderately high temperatures. The concept of asbestos as a highly refractory substance has been created in the minds of some students of the subject by reading the statement made by Cirkel 5/ that temperatures of 2,000° to 3,000°F. are easily withstood, while with some varieties a temperature of 5,000°F. has apparently produced no visible effects. With due respect to Dr. Cirkel, who wrote a splendid pioneer volume on a mineral of which little was known at that time, he was quite in error regarding the heat resistance of chrysotile.

Brandenberger and co-workers 6/ who have made a comprehensive study of temperature effects on chrysotile at the Mineralogical Institute of the University of Zurich, state that the so-called adsorbed water of chrysotile is driven off at about 300°C. Between 550° and 600°C., all of the water of crystallization is driven off, and the mineral gradually alters to olivine. Accompanying this dehydration is a pronounced change in physical properties. At 400°C. there is a notable deterioration in fiber quality; and above 550°C., with more or less complete dehydration, chrysotile is completely decomposed. The amphibole varieties of asbestos will withstand somewhat higher temperatures than chrysotile. However, crocidolite, although having a low water content, is easily fused into a black, magnetic mass.

5/ Cirkel, Fritz, Chrysotile Asbestos, Its Occurrence, Exploitation, Milling, and Uses: Canada Dept. of Mines, Mines Branch, 2d ed., 1910, p. 30.

6/ Brandenberger, E., Epprecht, W., and Niggli, F., The Serpentine Minerals and Their Synthesis.II: Helv. Chim. Acta, vol. 30. 1947, pp. 9-14 (trans. by Frank Riordan, Jr.).

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asbestos are or have been produced in several
asbestos is produced in North Carolina,
and small quantities have been mined in
Montana, Oregon, Virginia, and Washington.
/ counties in California, and a small output
's, but the history of development is disap-
the fiber in some of the deposits appears
eposits large enough for sustained production
During 1950 several promising deposits of
ality were found in a large serpentine belt in
kiyou Counties. Milling and processing tests
ne of these deposits gave such promising results
ation is fully justified. California may yet
ource of supply.

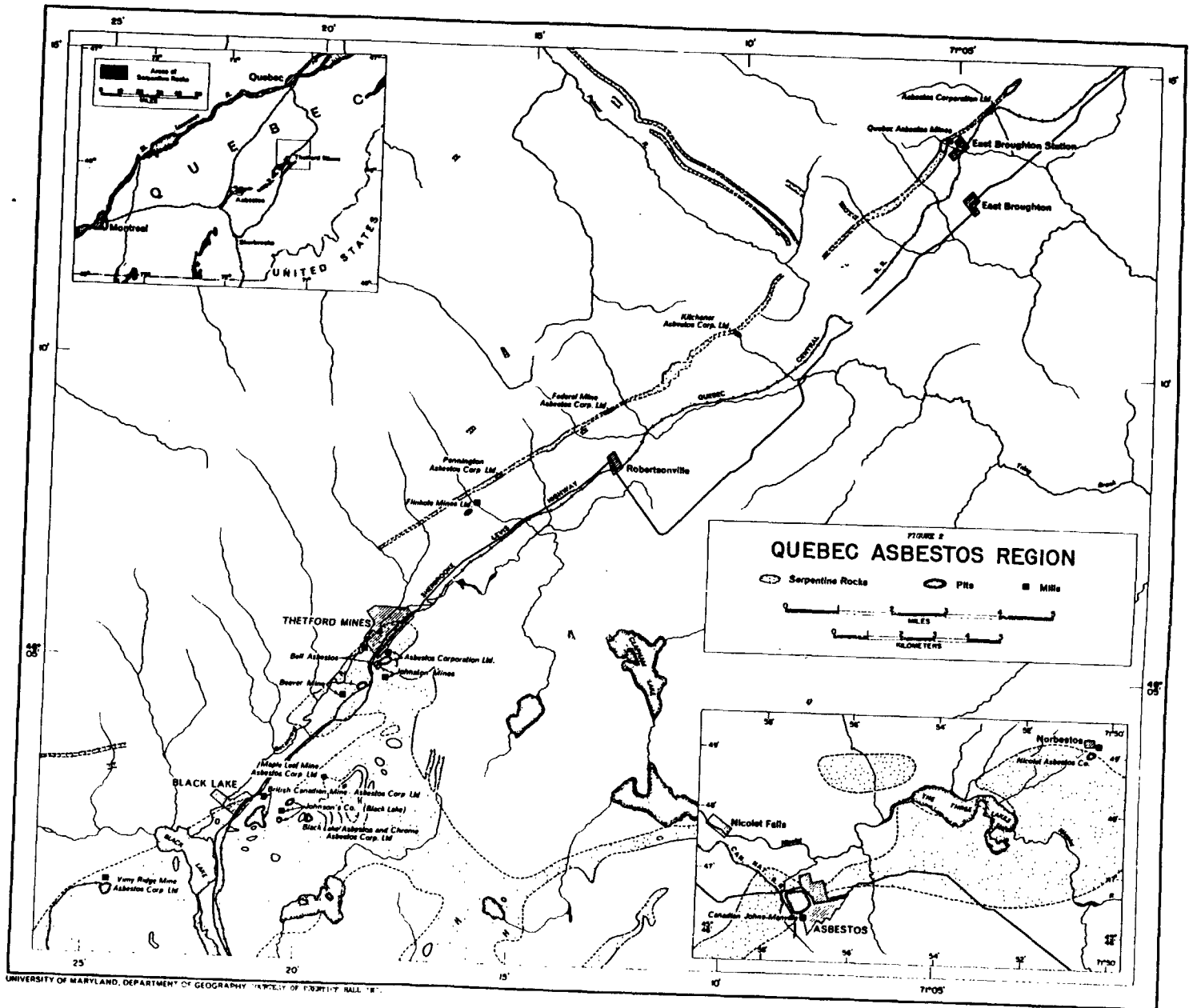
chrysotile has been recorded from near Casper,
ave been noted in Alaska, Montana, Oregon, and
No deposits that bear promise of substantial
in any of these locations.

Foreign Deposits

extensive asbestos operations in the world are
s of the Province of Quebec. The asbestos
miles long and 5 or 6 miles wide, lies between
hton. Within this section are six producing
on, Robertson, Thetford Mines, Black Lake,
. The asbestos is chrysotile of high quality,
sfiber veins in a serpentine formation of
ntine is regarded as an alteration product of
te, which consists essentially of olivine and
eposits have been described in considerable
oke 4/.

f the Black Lake, Thetford, and Danville areas
er veins ranging in width from hair lines to
he bulk of the output is obtained from veins

rysotile Asbestos in Canada: Canada Dept. of
. 707, 1931, 146 pp.
Thetford, Disraeli, and Eastern Half of Warwick
da Dept. of Mines and Resources, Geol. Survey,
- 140.



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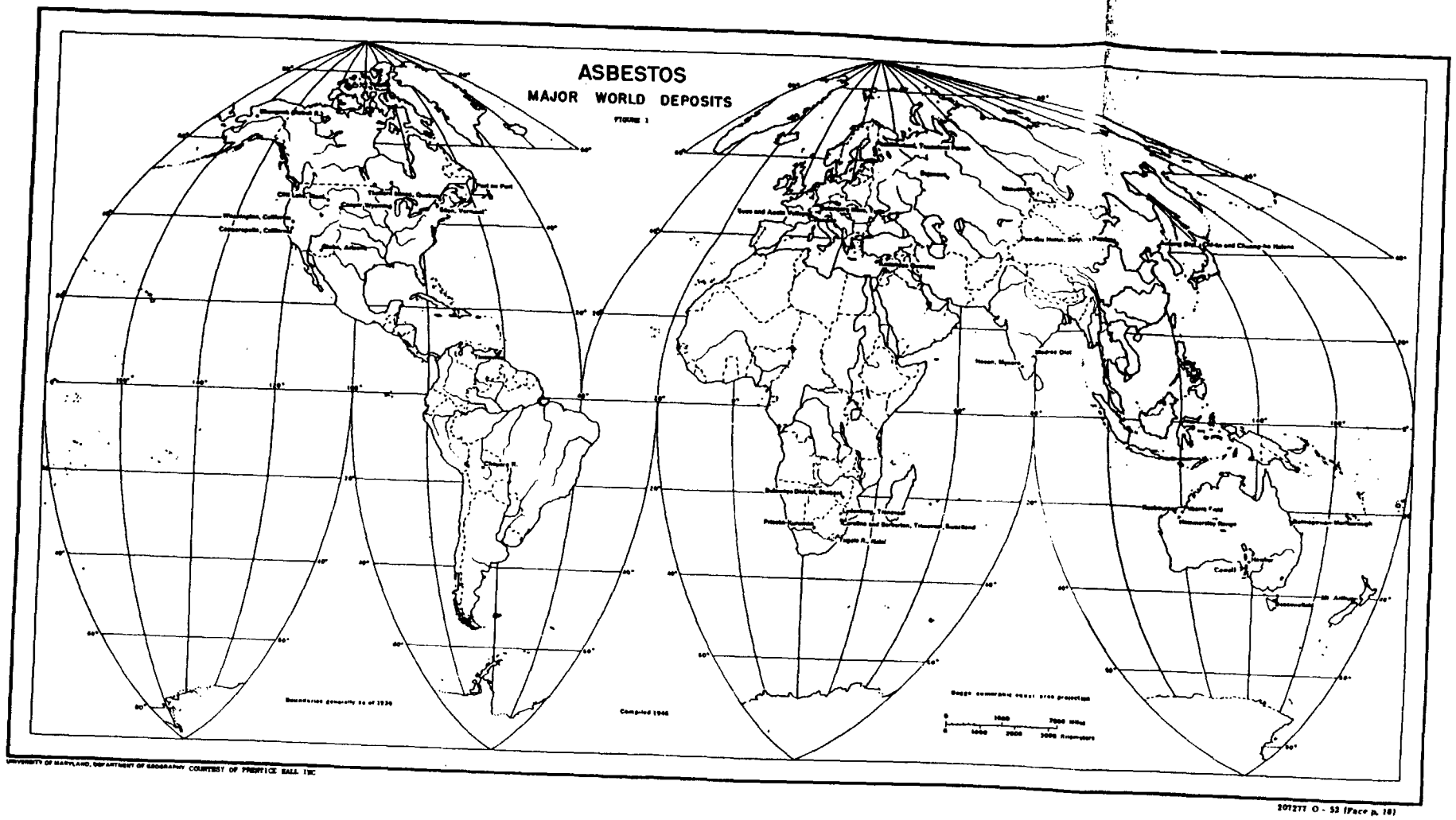
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1914-45

	Short tons
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	-
	464
	648
	942
	904
	1,197
	2,574
	1,742
	1,459
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II. DESCRIPTION OF DEPOSITS

Asbestos deposits of commercial value are widely distributed throughout the world. The most important are in Canada, Southern Rhodesia, Union of South Africa, and Soviet Russia, but there are smaller deposits in many other countries. The locations of known commercial deposits are indicated in figure 1, prepared by the Department of Geography, University of Maryland, in cooperation with the Bureau of Mines.

Domestic Deposits

Vermont

The Vermont chrysotile asbestos deposits are regarded as a southward extension of the well-known Canadian belt. They differ in character, however, in that most of the asbestos so far obtained is of the slip-fiber type. Some of the slip fiber is quite long but is not well-adapted for spinning and textile use. Minor quantities of crossfiber occur in veins that are rarely more than 3/4 inch wide. Vermont is, accordingly, a predominantly short-fiber-producing area. The output of 3Z, and groups 4 and 7 (Canadian classification) is small. Production of group 5 is large and group 6 largest of all. The fiber is used for asbestos-cement products, asbestos paper, molded brake linings, and pipe and boiler covering and as a paint constituent. The sole producer is Vermont Asbestos Mines, subsidiary of The Ruberoid Co. A new, modern mill has recently been built.

Although the Vermont deposits have great commercial value, they are less important from a strategic standpoint, because there is a very small output of the spinning-grade fibers that are of greatest strategic importance at this time. Furthermore, the fibers, like the Canadian, cannot be classed as low-iron.

Arizona

Chrysotile asbestos occurs in Arizona in numerous localities over an area 60 miles long and 25 miles wide in the Salt River and Cherry Creek Basins, Gila County. The region is more easily accessible than in earlier years. The nearest railway station is Globe, which is 40 or more miles from most of the deposits. Hard-surfaced roads from Globe reach the vicinity of the deposits, and good access roads connect the main highways with most of the mines. Access to some of the undeveloped claims is difficult. Arizona asbestos differs in origin and occurrence from the deposits of Canada, Rhodesia, and Soviet Russia. Here the fibers occur in serpentine associated with dolomitic limestone intruded by diabase. The veins are generally confined to more or less horizontal zones several inches in thickness. They may become lean or peter out within relatively short distances, or may become richer.

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Some of the Arizona fiber is soft, flexible, and of excellent quality, but other occurrences are harsh, or semi-harsh. The scattered character of the fiber veins, the high cost of mining, the presence in places of harsh fiber, and long distance from markets have tended to discourage production. Table 1 shows production by years. The urgent demands of World War I failed to stimulate production of more than a few hundred tons in any one year.

TABLE 1. Sales of asbestos in Arizona, 1914-45

Year	Short tons	Year	Short tons
1914	50	1931	184
1915-18 (inc.)	1/1,900	1932-34 (inc.)	1/ 34
1919	423	1935	-
1920	1,200	1936	464
1921	413	1937	648
1922	93	1938	942
1923	4	1939	904
1924	1/ 132	1940	1,197
1925	1/ 80	1941	2,574
1926	100	1942	1,742
1927	1/1,250	1943	1,459
1928	1/1,500	1944	696
1929	934	1945	-
1930	683		

Note.- Data for 1914-44 compiled by Arizona Bureau of Mines. Figures for 1945 and following years are confidential but are of approximately the same range as in the early 1940's.

1/ Estimated.

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As discussed elsewhere, low-iron chrysotile has great strategic importance for electric insulation products, such as electrical tapes and cable coverings. The C. & G. grades of Rhodesian chrysotile constitue virtually our sole source of supply of these highly important fibers. The Arizona fiber, however, is low in iron, and the soft varieties are eminently suitable for electrical insulation uses; the Arizona deposits are, in fact, the only low-iron chrysotile occurrences known at present on the American continent.

During the early stages of World War II, it seemed desirable to stimulate production in Arizona as a safeguard against shortage of supply from Rhodesia. To determine the possibilities of the Arizona area, the Bureau of Mines undertook an exploratory project in 1943, the results of which have been published. 1/ Mining was conducted in five locations that were regarded as most favorable. "Commerical ore" that could presumably be mined at a profit was found in two of these locations but the exploratory work failed to indicate extensive reserves. However, mining operations extending from one of these exploratory tunnels has uncovered a large area of fiber-bearing rock of much higher quality than that which appeared in the preliminary tunnel. In three of the locations "commercial ore" was not found. In general, the occurrences were found to be erratic, noncontinuous, and limited in area by rather exacting geologic conditions, such as intersecting fissure and fault zones in proximity to diabase sills and dikes.

Another handicap is lack of a profitable market for the shorter grades, the disposal of which is discouraged by the high cost of transportation. Because of the uncertainty of the occurrences and the high cost of mining, only a moderate increase in production is to be expected even with the stimulus of exceptionally high prices. Weaver 2/, who has made a first-hand study of the region, hopes that Arizona can produce up to 1,000 tons a year of grades 1 and 2 that will satisfy the stockpile specification for low-iron chrysotile. Financial assistance in some form may, however, be required before such an objective can be attained.

1/ Stewart, Lincoln A., and Haury, P. S., Arizona Asbestos Deposits, Gila County, Ariz.: Bureau of Mines Rept. of Investigations 4100, 1947, 28 pp.

2/ Weaver, Jesse M.; Raybestos-Manhattan Inc., personal communication; 1951.

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Other Occurrences

Small quantities of asbestos are or have been produced in several other States. Amphibole asbestos is produced in North Carolina, Georgia, and California, and small quantities have been mined in Alaska, Idaho, Maryland, Montana, Oregon, Virginia, and Washington. Chrysotile occurs in many counties in California, and a small output has been reported at times, but the history of development is disappointing. The quality of the fiber in some of the deposits appears to be adequate, but no deposits large enough for sustained production have yet been developed. During 1950 several promising deposits of chrysotile of textile quality were found in a large serpentine belt in Shasta, Trinity, and Siskiyou Counties. Milling and processing tests on a large sample from one of these deposits gave such promising results that a program of exploration is fully justified. California may yet prove to be a valuable source of supply.

A small output of chrysotile has been recorded from near Casper, Wyo. and occurrences have been noted in Alaska, Montana, Oregon, and several other States. No deposits that bear promise of substantial output have been found in any of these locations.

Foreign Deposits

Canada

Quebec--The most extensive asbestos operations in the world are in the eastern townships of the Province of Quebec. The asbestos area, which is about 70 miles long and 5 or 6 miles wide, lies between Danville and East Broughton. Within this section are six producing centers -- East Broughton, Robertson, Thetford Mines, Black Lake, Coleraine, and Danville. The asbestos is chrysotile of high quality, occurring chiefly as crossfiber veins in a serpentine formation of Cambrian age. The serpentine is regarded as an alteration product of the ultrabasic rock dunite, which consists essentially of olivine and chromite. The Quebec deposits have been described in considerable detail by Ross 3/ and Cooke 4/.

The entire output of the Black Lake, Thetford, and Danville areas is derived from crossfiber veins ranging in width from hair lines to 4 or 5 inches across. The bulk of the output is obtained from veins

3/ Ross, J. G., Chrysotile Asbestos in Canada: Canada Dept. of Mines, Mines Branch, No. 707, 1931, 146 pp.

4/ Cooke, H. C., Thetford, Disraeli, and Eastern Half of Warwick Map Areas, Quebec: Canada Dept. of Mines and Resources, Geol. Survey, Mem. 211, 1937, pp. 86 - 140.

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from ¼ to ½ inch across. The length of the fiber is governed primarily by the width of the vein. Slip fiber originating in fault planes is the chief product of the East Broughton area.

The percentage of fiber recovered from the rock is low. A fair average is 5 percent of the rock mined and 7½ to 8 percent of the rock milled. It was estimated in early years that 7.8 percent of the fiber produced was of spinning grade; in 1928-32 it averaged 6 percent. With increasing utilization of shorts, the percentage is now somewhat lower.

The following companies were operating in the Quebec area in 1950: Asbestos Corp., Ltd., Johnson's Co., Bell Asbestos Mines, Canadian Johns-Manville Corp., Nicolet Asbestos Mines, Ltd., Quebec Asbestos Corp., and Flintkote Mines, Ltd. The following companies were carrying on development work but have had no production; International Asbestos Co., Ltd. (Dominion Asbestos Co. since 1950), Continental Asbestos Co., Ltd., St. Lawrence Asbestos Co., United Asbestos Co., and properties owned jointly by Asbestos-Cement Associates, and J. A. Jacobs of Montreal.

The locations of the mines are indicated in the accompanying map, figure 2, prepared by the Department of Geography, University of Maryland, in cooperation with the Bureau of Mines.

Ontario. - The most important recent event in the Canadian asbestos industry is the development, by the Johns-Manville Co., of a new property - the Munro mine - 12 miles east of the town of Matheson, Munro Township, district of Cochrane, Ontario. The deposit is about 325 miles northwest of Ottawa. The chrysotile asbestos occurs in crossfiber veins in a nearly vertical serpentinized sill having a width of 500 to 900 feet. The sill is cut by later dikes and displaced by crossfaults. The veins have a maximum width of about 1 inch. It is anticipated that the deposit will furnish considerable quantities of the longer group 4 grades, but little or no fibers of spinning grade. Drilling indicates that fiber persists to a depth of several hundred feet. The rock is mined by open-pit methods. Initial milling capacity is 50 tons of rock an hour, with provision for addition of a second 50 ton-an-hour unit. Production was begun in April 1950. It is stated that much of the output will be used for asbestos-cement products. The Quebec Asbestos Co. (owned by Philip Carey, Cincinnati, Ohio) and other prospective producers hold adjoining properties. The asbestos-bearing rock has been traced eastward to the Quebec boundary and may extend through several townships to the west.

There has been a small production of asbestos in Ontario during the past. Two mines in Deloro Township, district of Cochrane, and one in the Matachewan area farther south have, in various years up to 1948, produced a total of 233 tons of chrysotile. The Ontario deposits,

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particularly those recently discovered, offer what may prove to be an important supplementary source of asbestos fiber, but it would appear that they could furnish only quite limited quantities of the strategic-grade long fibers.

British Columbia. - Conwest Exploration Co., Ltd., of Toronto, Canada, was planning extensive development work during 1951 on a property in northern British Columbia. Diamond drilling has established the presence of a large deposit of chrysotile of good quality.5/

Newfoundland. - A deposit of chrysotile asbestos that may be an extension of the Quebec field has been found in Newfoundland. Fiber of good quality and spinning length is available, but its commercial possibilities are still undetermined. Asbestos Corporation, Ltd., held an option on the property for a time but allowed it to lapse. Difficulties of access and transportation are probably the chief handicaps to development. It constitutes a potential reserve.

Southern Rhodesia

Southern Rhodesia ranks next to Canada as a world source of chrysotile asbestos. The Russian deposits are doubtless larger, but the Russian output is applied principally to domestic uses; only minor, fluctuating, and uncertain quantities enter international trade.

The most-important asbestos area in Southern Rhodesia is the Shabani, 120 miles east of Bulawayo. The widely known Shabani mine is not a single opening but a group of four mines comprising 177, 170, Birthday, and Nil Desperandum. The fiber-bearing serpentine zone is 2½ to 3 miles long and 20 to 200 feet thick. The footwall is a talc schist. The fiber-bearing rock is an ultrabasic dunite-serpentine complex intruded by gneissic granite. Cross- and slip-fiber chrysotile occurrences of commercial size are found only in masses of serpentinized dunite. The fiber is white, silky, and very flexible. The formation dips 25° to 45° in the hill country and 5° to 10° in the flat area. It extends down the dip for an unknown distance, probably far below practical working depth. Fiber veins attain a maximum of 6 inches in thickness, but the fibers are rarely more than 3 inches in length. The Shabani Area is a prolific producer, furnishing 4,000 tons a month or more of commercial fiber. Transportation was at first quite difficult, but since 1928 the fiber has become much more easily available to foreign consumers because of completion of a 63-mile railway from Shabani to Somabula. The Croft mine at Filibusi has attained some importance.

5/ M. F. Goudge, Communication, January 1951.

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The Mashaba district 42 miles east of Shabani on the road to Fort Victoria produces a well-known commercial grade of asbestos, VRA. The principal mines are the Gath's and the King, 4 miles apart. Historically they are the older producers. Mining was first undertaken about 1907. Production rose from 2,010 tons in 1915 to 9,799 tons in 1919 and 18,823 in 1920. A small production is obtained at times from the Ethel mine in the Lomagudi district, more than 200 miles north of Victoria.

Other occurrences of chrysotile are known in Southern Rhodesia, and some have produced at times. Because of the current demands for low-iron fiber, much interest is centered on these deposits, and more extensive development is forecast. In view of the complexity of treatment involved in producing the well-known C. & G. grade fibers in the Shabani area it is unlikely that small operators can produce acceptable grades.

Rhodesian asbestos is especially important for two reasons:

(1) The proportions of long fibers of strategic grade is relatively high. It has been estimated that 25 to 30 percent of the fiber produced may be classed as spinning grade, whereas only 4 to 6 percent of the Canadian fiber if of this grade. The preponderance of long fiber in the Shabani area is, however, overemphasized on a percentage basis by the fact that there is an enormous market for Canadian short grades, whereas the shorter fibers are recovered in small quantity in Rhodesia because they cannot be shipped profitably to markets, the chief of which are remote from the mines.

(2) The second reason for the outstanding importance of the Rhodesian asbestos is its low iron content, which adapts it well for use as electrical insulation.

There is only a small local market for Rhodesian fiber. The product of the mines is exported chiefly to Europe and America by way of the port of Beira, Portuguese East Africa.

Union of South Africa

Cape of Good Hope. - The largest deposits of crocidolite (blue fiber) known in the world are found in the Cape Province. They occur in a belt of banded ironstones of sedimentary origin extending from a point 20 miles south of Prieska northward beyond Kuruman, with an over-all length of about 240 miles. The maximum width is about 30 miles. The lavender-blue crocidolite occurs in interbedded cross-fiber veins widely distributed throughout the belt. The dip and strike of the folded beds are variable, and adequate knowledge of the geology is essential to intelligent prospecting and development. The fibers range in length from less than ½ inch to 2 inches or more but rarely

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exceed 4 inches. The proportion of spinning fiber is high, ranging from 10 to 20 percent. The principal producer is the Cape Asbestos Co., which operates several mines north of Prieska. The Dominion Blue Asbestos Mines, Ltd., a subsidiary of Turner & Newall, operates mines in the northern section of the belt. Amosite & Blue Asbestos, Ltd., also operates mines. Transportation is difficult, as the nearest railway is 100 to 130 miles from the workings. Production has exceeded 8,000 tons annually during recent years but increased remarkably to over 30,000 tons in 1950.

Transvaal. - Four varieties of asbestos - chrysotile, crocidolite, amosite, and anthophyllite - occur in the Transvaal. The last variety is produced in small quantities for local use. Chrysotile was first produced in the Carolina district from deposits in altered dolomite overlying a diabase sill. They seem to be similar in origin to the Arizona deposits. A second occurrence 47 miles from Carolina is the usual type of crossfiber veins in serpentine. Production from the Carolina district has never been large.

The Barberton district was a prolific producer some years ago, when the rich Amianthus and Munick-Myburgh mines were in active operation, but they are now virtually exhausted. However, a new mine and mill operated by Kinloch Asbestos (Pty.), Ltd., promise to renew large production in this area. The deposit, which is about 25 miles from Barberton, is said to comprise over 5,000,000 tons of fiber-bearing rock containing about 3 percent asbestos in the eastern part and 5 percent in the western section. A mill capacity of 300 to 400 tons a month is anticipated. The plant is now in production.

Except for some unverified sources in Southern Rhodesia, the only commercial deposits of amosite known in the world occur in the Transvaal. As indicated in the introductory part of this report, amosite does not appear to be a separate mineral species but it has distinctive qualities that justify its continued consideration as a commercial type. The fiber occurs most prominently near Penge, about 30 miles north of Lydenburg in northeastern Transvaal. The amosite belt extends from the Steelpoort River northwestward along the basin of the Olifants River, thence westward to Chuniespoort. The asbestos occurs in crossfiber veins associated with diabase sills in a series of shales, slates, and quartzites that dip about 18°. The depth to which the asbestos veins persist down the dip has not been determined. The strike of the rock parallels the Olifants River, accordingly, the tributaries of the river cut across the strike and create favorable conditions for driving strike adits along the fiber veins.

The asbestos occurs in three bands. The upper band is 42 inches thick and contains 14 percent asbestos. Below it are 72 inches of waste rock, beneath which is the main band, 60 inches thick, about 25

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percent of which is asbestos. A band of waste rock 108 inches thick lies below it, and beneath is the lower band, 30 inches thick, 11 percent of which is amosite fiber.

Four mines are located along the outcrop. The Amosa and Penge mines adjacent to each other are at the town of Penge. The main milling facilities are located at these mines. The Kremellanboog mine is about 8 miles southeast along the strike, and the Malips mine is 25 miles northwest of Penge. Each of these mines has its own milling and housing facilities. Many smaller mines are also worked.

Much of the fiber is 6 inches or more in length. It is of strategic importance and is in strong demand. Output has increased greatly exceeding 31,000 tons in 1949.6/

Crocidolite occurs with amosite in the western part of the belt. Production is small, and in general the fiber is of lower quality than that obtained in the Cape Province.

Natal. - A small production of chrysotile is obtained at times from a deposit east of Kranz Kop, Zululand.

Swaziland

Development was begun in 1937 of an important deposit of chrysotile asbestos in an area in Swaziland about 12 miles south - southeast of Barberton in the Transvaal. The asbestos occurs as crossfiber veins in serpentine. The Havelock mine, owned by Turner & Newall Ltd., began production in June 1939. The mine is connected with the railroad at Barberton by means of an overhead cableway 12.6 miles long. This has become a major producing area.

Soviet Russia

The Russian asbestos deposits are generally regarded as ranking next in importance to the Canadian. The region providing the major part of Russian production is known as the Bajenova district in the Urals.7/ The industry is centered at Asbest, about 90 kilometers

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6/ Many of the data on amosite are abstracted from an unpublished manuscript by Jesse M. Weaver.

7/ Rukeyser, W. A., Chrysotile Asbestos in the Bajenova District, U. S. S. R.: Eng. and Min. Jour., August 1933, p. 338.

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northeast of Sverdlovsk (Ekaterinburg). The asbestos-bearing serpentinized intrusion is about 21 kilometers long and 200 to 1200 meters wide. It consists of peridotites bounded by schist or slate on the west and by granite on the east. The asbestos occurs in ellipsoidal masses of serpentine, which may attain a length of 3,500 and a width of 1,000 feet. The highest percentage of asbestos is in the central parts of these masses. The crossfiber veins generally run north and south, with a vertical dip. Slip fiber appears in places. Although Russian asbestos is generally regarded as being higher in iron than the Canadian, it is claimed that ferrous iron prevails in the Russian fiber, whereas in the Canadian fiber ferric iron predominates. This may account for the greater discoloration of the Russian fiber upon weathering. The deposits have a comparatively shallow overburden, and asbestos in the weathered rock is somewhat harsh and lacks silkiness. Below the 50-foot level it resembles Canadian fiber more closely. The percentage of spinning fiber is said to be a little higher in the Russian than in the Canadian deposits, but the percentage of total recovery is about the same.

There are three major groups of mines in the district. The most northerly, known as the Proletariat, produces shorts almost exclusively. The major producing groups are the October (central) and the Ilyinsk (southern).

Venezuela

A chrysotile-asbestos deposit similar to those in Canada occurs near Tinaquillo, Venezuela, The deposit has been developed, and a mill is in operation, but production has been small. As Venezuela has few or no facilities for utilizing spinning fibers, the plan was to utilize the shorter grades for local use in an asbestos-cement products plant and to export the spinning grades. Venezuela, therefore, becomes a potential source of long fibers for the United States market, but output so far bears little promise of a substantial supply.

Bolivia

Crocidolite (blue asbestos) has been mined in a small way in Bolivia for many years. The deposits are about 200 kilometers northeast of Cochabamba in the Province of Chapare, Department of Cochabamba. The asbestos veins range from ½ to 30 cm. (12 inches) in width. They dip about 45°, the same as the associated shale. The veins are fairly close together in places, and six veins have been found in a cut 1 meter wide. The fiber-vein area is evidently very extensive. The asbestos fibers are weaker than the African or Australian blue, but the material is in demand for certain important uses, particularly as

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a filter medium for gas masks. Development work during 1950 uncovered fiber of much greater strength and flexibility than any found heretofore. Conditions for production are not favorable. Transportation is over a road 210 kilometers long, 60 of which are liable to traffic interruption during the rainy season. Development work is not extensive, and very little mechanical equipment is available. A 6-month rainy season (November to April) hampers operations. Sustained production of even moderate magnitude is yet to be demonstrated.

Italy

Both tremolite and chrysotile are produced in Italy. The Balangero chrysotile mine in Torino, about 20 kilometers north of Turin, has been the chief producer during recent years. The fiber is said to be inferior to Canadian asbestos for spinning purposes. Although production of all kinds of asbestos reached a maximum of 21,433 metric tons in 1950, very little reaches the United States.

Australia

Several deposits of both chrysotile and blue asbestos are mined in Australia, but production is small, never exceeding a few hundred tons annually. There is no promise of substantial supplies from this source.

New Zealand

Chrysotile asbestos in veins up to 3 inches wide occurs in a serpentine area at least 3 miles long near Mount Arthur in the upper Takaka district. Both cross fiber and slip fiber are available. It is reported that a mill and power plant were completed in 1941 but very little production has been recorded. The deposit is said to be extensive.

China

Several chrysotile deposits are known in China. The most important are in the Laiyuan district, Hopeh Province. It is estimated that production reached as high as 20,000 tons a year during war years under Japanese stimulation. Information concerning China is not dependable, and under the highly unsatisfactory political and industrial conditions that generally prevail China must be regarded as a very uncertain source of supply.

Japan

Prior to 1939, a small production of asbestos was obtained from various scattered deposits, but after that date intensive exploration

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and development were undertaken, and a subsidized asbestos industry of moderate size was established. The most important mines are in the Hokkaido district where about 94 percent of the chrysotile output originates. The other 6 percent is mined in south-western Honshu district. In the Hokkaido district the chrysotile occurs in irregular veins in serpentine. Virtually the entire output consists of short fibers used chiefly in asbestos-cement products. The fiber is prepared in processing mills patterned after those in Quebec, Canada.

Finland

Finland is a steady producer, but the fiber is of an amphibole type which is unimportant from the strategic angle.

Cyprus

The asbestos deposits of Cyprus occur at Amiandos, on Mount Troodos, in the west-central area. Short-fiber chrysotile occurs in irregular veins in serpentine. The veins have a maximum thickness of about one-half inch. The asbestos content of the rock runs only 1 to 2 percent. It is predominantly a short-fiber operation, and "shingle stock" is said to comprise about 90 percent of production. Although the deposit is large, it has little interest from the strategic viewpoint.

India

Chrysotile asbestos of good quality occurs near Cuddapah in the Madras Presidency about 125 miles northwest of Madras. No data are available on the extent of the deposit. Small tonnages of the fiber reach the United States market at times. A deposit of chrysotile said to occur in veins up to 7 inches wide, occurs near Pulivendla, a considerable distance south of Cuddapah. The veins appear at contacts of trap rock with limestone. The extent of development has not been indicated.

Morocco

In the early 1940's, there was considerable interest in the Bon Azzer asbestos mine located in desert country about 100 kilometers (62 miles) north of the Sahara Desert. The asbestos is chrysotile occurring at a contact of a mass of greenstone with grano-diorate. The fiber occurs in lenses many of which are small. Samples of fiber sent to the Bureau of Mines were of good spinning quality but only a small fraction of the fiber is of spinning length. The association of the asbestos with cobalt is unique. Up to 1944, about 500 tons of short fibers had been hauled by truck to Casablanca where it was used in the manufacture of building materials. No activity has been reported since that date.

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Other Countries

Sporadic production from small deposits is reported from many other countries, but none appears to offer substantial supplies.

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III. Mining Methods

Asbestos deposits throughout the world differ widely in character, and as mining must be adapted to the prevailing conditions, a great variety of methods is followed. Open-pit quarry methods, glory-hole, underground room-and-pillar, shrinkage-stoping, block-caving, and other methods are represented . A brief description of mining operations, by locality, follows.

Arizona

In Arizona there is no massive fiber-bearing rock, as in Canada. The serpentine with which the asbestos veins are associated is in bands from a few inches to a few feet thick extending parallel with the Mescal limestone. The mines are entered from cliff faces or the steep sides of canyons. The veins pinch and swell irregularly and are so erratic in size and direction that development cannot be planned as definitely as in the mining of many other minerals. The fiber is mined in drifts and tunnels, and conditions are most favorable where two or more veins of workable size are close enough to be worked in one drift. Modified room-and-pillar methods are followed. Mining is so costly that a high price must be obtained for the fiber if any profit is to be earned.

Vermont

The chrysotile-asbestos deposit of Vermont is on Belvidere Mountain approximately 15 miles from Hyde Park, Vt. About 1944 a new quarry opening was made over the ridge about 1 mile from the quarry formerly worked. Overburden is not heavy; and, as the asbestos veins occur in massive serpentine as in Canada, open-pit methods can be followed to advantage. The quarry face is 100 feet high. A series of 7-inch blast holes is sunk with churn drills, and about 50,000 tons of rock are thrown down with each multiple blast. The rock is loaded with 3-yard electric shovels into 15-ton Euclid trucks which dump into a 48-by 60-inch jaw crusher. The crusher will handle such large masses that very little secondary blasting is necessary. Secondary crushing is accomplished in Symons cones, which reduce the rock to walnut sizes. The product of the cones is passed through a drier, and the dried rock and fiber are carried on a belt conveyor about one-fourth mile to the mill situated in the valley. When the quarry was first opened the rock was carried 1 mile by overhead cableway to the old mill, but when the new mill adjacent to the quarry began operation in 1949 the cableway was abandoned.

Canada

Canadian asbestos occurs in irregular veins in massive serpentine deposits that are extensive both laterally and at depth. Accordingly, well-ordered, large-scale mining operations have been developed. For

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many years asbestos rock was obtained from large, open-pit quarries served by massive overhead cableways. About 1927 methods were modified by the introduction of cranes or power shovels for loading, locomotives for hauling cars on the quarry floor, and cable cars for removing rock from the pits up inclined planes or through tunnels. Crudes were hand-cobbed on the quarry floor or removed from picking belts after the rock was crushed.

A later development was the introduction of shrinkage stoping, but the block-caving method first introduced in the King Mine of the Asbestos Corp., Ltd., is found to be the most economical and is coming into more general use. It has been employed by the Johnson's Co. some years, and the Canadian Johns-Manville Corp. has nearly completed an extensive block-caving system that has been under development for several years. Each block will be 200 feet square. The crushing plant is situated at an underground level of 816 feet and loading facilities at a 950-foot level. The program was said to be over 75 percent complete in March 1950. The Bell Asbestos Mines is preparing for block caving. This rather complex system of mining has been described in several publications. 11/

Southern Rhodesia

The largest asbestos mines in Southern Rhodesia comprise the Shabani group. They are classed among the most important asbestos mines in the world, having attained a production rate of over 72,000 metric tons of fiber a year in 1949. The most important ore bodies are the 170, Birthday. 177, and Nil Desperandum. The 170 and Birthday ore bodies have a length of over 2,000 feet and a width of about 100 feet. They dip about 25° south. Mining is concentrated on the 400-and 500-foot levels (vertical depth). The Nil Desperandum ore body is 500 to 600 feet long and dips about 45°. The mining method is being changed from a room-and-pillar to a caving system.

It was reported in 1949 that conditions had developed underground which made it necessary to change from a room-and-pillar to a caving system of mining, and that mining had to be pursued with care to avoid excessive caving that might obstruct operations. The precautionary measures designed to preserve the safety and integrity of the mine tend to restrict output. As the areas affected are sources of long fibers, the modification in mining method may account in some measure for the shortage of Rhodesian spinning fibers in 1951 and 1952.

11/ Ross, J. C., Block Caving at the King Mine of the Asbestos Corp., Ltd., Thetford Mines, Quebec: Canadian Min. and Met. Bull. 264, April 1934, pp. 184-218.

Sherman, Gerald, Review of Progress in the Caving of Asbestos Ore: Min. Eng. vol. 187, No. 4, April 1950, pp. 467-474.

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Union of South Africa

The principal production of chrysotile in the Union is from a new mine operated by Kinloch Asbestos (Proprietary), Ltd. about 25 miles from Barberton. A description of the mining methods followed is not yet available.

Amosite of the Lydenburg district in the Transvaal occurs in banded ironstones that are so highly folded and contorted that they are unsuited for open-pit working, and underground mining is generally followed. Where the beds are intersected by transverse valleys, tunnels are driven along the strike, and the fiber-bearing rock is coped out at various levels, usually at relatively shallow depths. The largest mines are the Egnep and Amosa. The Egnep was worked on seven levels several years ago. The vertical shaft was then 215 feet deep. The Amosa mine (described by Hall in 1930) comprised seven drifts. Its inclined shaft 320 feet long corresponded to a vertical depth of 290 feet.

According to the South African Mining and Engineering Journal of October 23, 1949, the Transvaal Asbestos Co. and Union Minerals have reopened mines that have been shut down. There is increasing activity among small operators.

Crocidolite (blue asbestos) occurs over a wide area in the Prieska and Kuruman district of the Cape Province. The veins are so irregular and discontinuous that systematic mining cannot be followed generally. A few of the larger mines have been worked to depths of 250 feet with drifts over 1,000 feet long. Much of the fiber is obtained from small open pits or shallow mines.

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Swaziland

At the Havelock mine about one-quarter of the rock is obtained from open-pit quarries and three-quarters from underground stopes. After crushing, the fiber-bearing rock is passed through a rotating grizzly with 4-inch openings. The minus-4-inch product passes through a trommel with 2½-inch circular openings. The plus-4-inch, and minus-4-inch, plus-2½-inch products are carried on a picking belt where fiber-bearing and barren rock is separated and the latter is carried to waste.

Soviet Russia 3/

The asbestos deposits of the Bajanova district have a thin overburden. Hand methods of removal were first employed, but power shovels or hydraulic methods have superseded them to quite an extent.

More than 20 shallow, open quarries were worked for many years. Up to 1929 drilling was the only mechanical process used, and all other operations were conducted with hand tools. Owing to inadequate milling facilities, hand picking became an important concentration process, and only one-fourth to one-fifth of the rock quarried was sent to the mill. The average fiber content of the rock mined was only about 6 percent; but, because of the concentration attained by hand picking, rock sent to the mill contained 22 percent.

The first steps toward more complete mechanization were taken in 1929, with installation of 2-to 4-ton-capacity overhead cableways with fixed foot towers and traveling head towers, supplemented by inclined haulageways served by electric hoists. The rock was blasted in benches 5 to 6 meters high and classified into crudes, mill feed, and waste.

In 1929 two shafts were sunk and connected with a haulage level at a depth of 50 meters. They were designed for glory-hole mining, which proved uneconomical. This method was supplemented and largely superseded in 1930 by electric-shovel loading in open pits, with transportation by locomotives to inclined haulageways, up which cars are taken by electric hoists .

Other Countries

The Cyprus mines are quite extensive; but, as the short chrysotile fibers produced have no strategic importance, a description of mining methods is not pertinent to this report. The same is true of the amphibole-asbestos mines of Finland. The chrysotile and blue-asbestos mines of Australia are small and have no unusual features. The Venezuela deposit is worked as an open quarry.

3/ Rukeyser, W. A., Mining Asbestos in the U. S. S. R.: Eng. and Min. Jour., vol. 134, September 1933, pp. 375-381.

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IV. Milling Methods

Definitions

Asbestos fibers fall in two main groups -- crudes and mill fibers. The term "crude" in Canada and the United States is applied to fiber of spinning grade measuring three-eighths inch or longer that is hand-cobbed and not passed through a mill. In other countries the term is used more loosely. In both Soviet Russia and Africa it includes fibers prepared by hand cobbing alone or in conjunction with simple mechanical crushing, disintegrating, and screening processes. Mill fibers are obtained by crushing and beating the fiber-bearing rock until the asbestos is freed and then removing the fiber from the rock by screening and air separation.

General Features

Chrysotile, the principal asbestos of commerce, is a fibrous form of serpentine and is always associated with massive serpentine. The concentration process is therefore unique in that it involves separation of a fibrous mineral from a massive form of the same mineral. Neither chemical composition nor specific gravity can therefore be used as a basis for separation. The property that makes mechanical separation possible is the fibrous structure, which permits it to be opened or divided into filaments that are amenable to separation from the gangue by air suction or screening.

The value of chrysotile asbestos depends largely upon the length of the fibers, the long fibers being worth several times as much as the short ones. A most important principle underlying asbestos milling is separation of fiber from rock with a minimum of fiber breakage. Unnecessarily rough treatment is to be avoided. Modern mills are designed to remove the separated fiber after each crushing process. If fiber already freed from rock enters the next crushing unit along with sand and rock fragments, it will be broken into shorter grades. Asbestos milling consists essentially of coarse crushing, drying, and recrushing in stages, each step being followed by screening and air separation of fiber from rock.

The milling process separates the fibers from each other (fiberizes them) more or less completely and also separates rock fragments and dust from the asbestos. Spinning-grade milled fibers require considerable further processing at the asbestos textile-manufacturing plant. Crude asbestos retains more or less of the natural solid form in which it occurs in the veins, and several successive opening processes are required. These processes are conducted at the textile plant.

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The development of improved processes, whereby fiberization may be accomplished with minimum breakage of fibers, is a profitable field for research. Some success has been attained by using dispersing agents to supplement or replace mechanical means. Impregnation with air at high pressure followed by sudden release of the pressure has been tried. This is essentially the same process as that followed by the Masonite Co. for fiberizing wood. When applied to masses of crude asbestos the method gave satisfactory fiberization but is said to be uneconomic.1/

The milling process not only breaks the longer fibers into shorter lengths but it tends to weaken the fibers, and this also should be avoided as far as possible. Methods have been devised whereby the tensile strength of asbestos fibers can be tested and the results expressed in terms of pounds per square inch.2/ Although this is a slow and tedious process, it has at least one important application. It has been found possible to submit bundles of crude asbestos to processing equipment, such as crushers, rolls, hammer mills, etc., and to test the tensile strength of the fiber before and after processing. By comparing the degree of weakening of the fiber one can determine which type of equipment is best-suited for opening the fiber with minimum effect on the fiber strength.

Canada

Canadian milling practice is described first because it is the most complete and is the pattern followed in most asbestos regions.

Primary crushing is the first step in milling. Rock from the mines is dumped into a "sluice" having a railroad-rail grizzly bottom providing a bypass for fines. The primary-crusher feed from the sluice is controlled by finger gates, that is, suspended rails that may be moved up or down. A jaw crusher with a 36-by 24-inch opening set for a 4- to 6-inch discharge is the most popular primary breaker, but larger or smaller units may be used. The crusher may discharge to a picking belt where liberated crudes are removed by hand. The crusher product passes through standard rotary driers 40 to 60 feet long. The dried rock is stored in bins having capacities of 25,000 to 150,000 tons each.

1/ Information supplied by Jesse M. Weaver, Raybestos-Manhattan Co. Inc., 1951.

2/ Badollet, M. S., Research on Asbestos Fibers: Canadian Min. and Met. Bull., vol. 51, 1948, pp. 213-216.

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The following stages vary greatly in different mills of the Quebec area because they must be modified to suit the hardness and other physical qualities of the rock. Secondary crushing may be done with gyratory crushers, rolls, Symons cones, or hammer mills. An impact that frees and fluffs the fiber is better than a grinding or shearing action, therefore rolls are less desirable than impact mills. The following flow sheet given by Ross 3/ represents the best modern practice.

Grizzly in rock sluice.
Jaw crusher.
Drier.
Grizzly, fines to screens fitted with suction.
Gyratory crusher.
Screens with suction.
Rolls.
Screens with suction.
Jumbo.
Screens with suction.
Jumbo.
Screens with suction.
Jumbo.
Screens with suction.
Jumbo.
Screens with suction.
Rotary graders and flat cleaning screens.
Floats bin.
Sand to dump.

It will be observed that the free fiber is removed after each stage of crushing. The jumbo mentioned in this flow sheet is a specially designed hammer mill manufactured locally. Both shaking screens actuated by eccentrics and vibrating screens of the Hum-mer type are used. Perforated-steel plates are used more generally than wire mesh. Suction hoods are 3 to 4 inches wide and extend across the full width of the screens at their lower ends. Large fans provide the suction that lifts the fiber from the screen and carries it to the collecting chambers. The dust-laden air is carried to dust chambers. The extremely short grades collected in the dust chambers are bagged and sold as "floats."

The fibers that accumulate in the collecting chambers are graded according to length in trommels about 8 feet long and 28 inches in

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3/ Ross, J. G., Chrysotile Asbestos in Canada: Canada Dept. of Mines Bull. 707, 1931, p. 42.

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diameter fitted with woven-wire cloth. Any number of grades may be made, depending upon the size of the screen openings. Special grades may be made by blending.

A new type of mill (the aerofall) recently developed offers certain advantages. The typical flow sheet for standard practice as indicated heretofore employes a series of successive hammer-mill reductions with removal of fiber at each stage to reduce fiber breakage. The new mill reduces the rock in a single stage. It is air-swept and designed to remove the fiber continuously as soon as it is freed from the rock. This design should tend to reduce breakage to a minimum. Tests at the Bureau of Mines in Ottawa indicate that, compared with standard practice, a considerably higher recovery is obtained, and the product is upgraded in quality.

The most pronounced recent trend in the Canadian asbestos industry is the great increase in the use of shorts for such products as asphalt floor tile. Some of these products contain 35 percent or more asbestos, which is said to impart exceptionally high qualities. All companies now operating mills in Quebec have introduced additional screens and suction facilities to recover part of the shorts formerly regarded as waste.

The dry process is universally used in asbestos milling. Wet methods were tried experimentally many years ago, but a commercial process was not developed. Recently, however, the Johnson's Co. has erected a new wet-process plant for re-treating mill tailings to recover shorts. The process was developed by Selective Treatment Company, Ltd., under patents now expired. If operation of this mill proves advantageous, it may mark the beginning of a trend toward wet milling in the Quebec area.

Capacity

Table 2 shows the milling capacity of the Canadian asbestos industry, as recorded in a recent report.4/ Such mill capacity, on a 300-day basis, would represent an annual capacity of 10,260,000 tons. The actual quantity of rock milled in the peak year of production (1950) was 8,635,036 short tons. Milling capacity in Quebec will, according to

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4/ Notes on the Canadian Asbestos Supply Situation, prepared by Drafting Officer S. T. Hays and submitted by U. S. Consul General Cecil M. P. Cross, Jan. 16, 1951. Mineral Trade Notes, Bureau of Mines, February 1951.

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this report, be increased considerably in the near future. Johnson's Co. is planning to build a new mill at Black Lake, with a daily capacity of 4,000 tons of rock.

TABLE 2. Canadian milling capacity, 1950

Company and mill	Daily rock capacity, short tons
Asbestos Corp., Ltd.	
Beaver and King mills	6,000
British Canadian mill	4,000
Vimy Ridge mill	2,800
Canadian Johns-Manville Co., Ltd.:	
Danville mill	12,500
Johnson's Co.	
Thetford Mines mill	2,000
Coleraine mill	1,200
Bell Asbestos Mines, Ltd. (Turner & Newall):	
Bell mill	1,500
Nicolet Asbestos Mines, Ltd. (Nicolet Industries, Inc.):	
Danville mill	1,500
Quebec Asbestos Corp., Ltd. (Philip Carey Manufacturing Co.): East Broughton mill	1,500
Flintkote Mines (Flintkote Co.): Thetford Mines mill	1,200
	34,200

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It is reported that the Coleraine Asbestos Co. is erecting a new mill at Coleraine with a capacity of 300 tons of rock a day. Canadian Johns-Manville Co., Ltd., and Asbestos Corp., Ltd., are contemplating expansion of facilities.

Arizona

There are several small mills with rather simple equipment in Arizona. Due partly to inadequate equipment and partly to faulty operation, Arizona fiber is commonly unsatisfactory in grading or in consistency of quality and classification.

Vermont

A new mill recently built about one-fourth mile from the new quarry of the Vermont Asbestos Mines is said to be one of the most modern and complete asbestos mills in existence. (See figure 3). The rock, of walnut sizes, delivered to the mill by belt conveyor is broken in a series of vertical hammer mills with fiber separation by air suction at each stage. Ro-Tap table screens are used. The fiber is classified in regular graders, as in Canada. The major output falls in groups 5 and 6 of the Canadian classification. Output of groups 4 and 7 is small. Limited quantities of 3Z are obtained. Groups 4, 5, and 6 are used in the company asbestos-products plants and are supplemented by purchases from outside sources.

Union of South Africa

The milling of amosite and blue asbestos differs considerably from the milling of chrysotile. Hand-cobbed fiber generally is first passed through a jaw crusher, followed by screening to remove barren rock. Further crushing is usually accomplished with rolls. By successive crushing and screening, rock fragments are removed, and the asbestos becomes fiberized or fluffed. The fiber cannot be removed satisfactorily by aspiration through a hood placed over screens, as in chrysotile milling.

Methods of milling crocidolite vary greatly in different localities. In the Southern Belt of the Cape Provinces, the workings are numerous, and many are relatively small. At the smaller workings, all the fiber is hand-cobbed and hand-sorted into grades according to length, but at the larger workings, the hand-cobbed asbestos is graded by machinery. A hand-turned trommel of perforated sheet iron covered with wire netting usually is employed. Cobbed fiber from several workings may be shipped to a central screening plant, where asbestos one-half inch and over is recovered, and the minus-one-half-inch product is taken to a mill for crushing and grading. At one mill the rolls travel at slightly different speeds so as to subject the fiber to a tearing action. Double-grading trommels sometimes are used.

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Figure 3. New Mill of Vermont Asbestos Mines
Courtesy of The Ruberoid Company

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In the Northern Belt, material over three-fourths inch long is hand-cobbed. At first the mill grades were not standardized, but later a large mill was erected at Kuruman, and the grades manufactured there were established standards that offered decided marketing advantages. In this mill, rock carrying the shorter fibers is passed through crushers, heavy rolls, and disintegrators. The fiber thus separated is classified on grading screens.

Because of its unusual length, most of the amosite produced is hand-cobbed. The fiber thus freed from adhering rock is passed through a series of rolls and disintegrators and then graded on shaking screens or trommels.

According to the South African Mining and Engineering Journal of October 23, 1949, five new mills are operating in the Northern Transvaal asbestos area. The Associated Asbestos (Pty.) operates three mills in the asbestos fields and has a central mill in Pietersburg, where fiberized asbestos from the fields is further treated. The company exports both blue fiber and amosite.

Southern Rhodesia

At the Shabani mines as much as possible of the asbestos is separated from the rock close to the working face to avoid damage to the fibers. Handcobbing is, therefore, an important part of the operation. Fiber-bearing quarry rock is first broken in jaw crushers and rolls and sorted on a picking belt into three groups. Rock containing little or no fiber is left on the belt and conveyed to the waste dump. Rock containing large seams of fiber is carried on a second belt to the cobbing sheds. Rock carrying small fiber seams is conveyed on a third belt to the mill. Cobs from both the cobbing sheds and the quarries and stopes are fiberized and graded in one mill, and the fiber-bearing rock is reduced in another.

After primary crushing in the mill the rock is dried and reduced in a series of small grinding pans operated like pug mills. Fiber is separated from rock with shaking screens and air suction as in Canada. Undesirable brittle fiber is ground in the pans and passes through the screens with the waste. Fiber carried in the air current is deposited in a centrifugal settler, and the air passes on through a dust trap to an outlet. The recovered asbestos is freed further from dust and graded in hexagonal trommels. Fiber recovery represents about 3 percent of the rock milled.

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Swaziland

At the Havelock mine the minus-2½-inch product from the primary crusher is dried and the fiber removed by suction fans. The rock, with hand-sorted materials from the picking belt mentioned under Mining Methods, is crushed and the fiber removed in successive stages by air suction. Initial reduction is by a 16-by 10-inch jaw crusher, but the later stages of reduction are accomplished with least damage to the fibers by the use of edge runners. The longest fibers, known as HVL, correspond with the C. & G. grades from Rhodesia but are of somewhat poorer quality.

Soviet Russia 6/

At the Russian quarries, most of the crude fiber is hand-sorted on picking belts after the rock is crushed. At a mill that began operation in 1932, the quarry rock was reduced to about 6-inch size with a No. 9 Gates gyratory crusher. It discharged to a picking belt, where 20 percent or more of the primary feed (consisting of rock too lean to justify milling) was thrown out as waste. The asbestos-bearing rock was reduced to 1½ - to 2-inch size in two No. 7 Gates gyratory crushers discharging to heavy shaking screens. The oversize passed to picking belts, where more barren rock was eliminated. The good rock from the picking belt was reduced to about 1-inch size in a jaw crusher and joined the undersize from the shaking screens in a wet-storage bin. Moisture was reduced in three rotary driers, and the product conveyed to a dry-storage bin.

The most noteworthy feature of the preliminary milling stage was the concentration on picking belts. Because the serpentine tends to break cleanly along the borders of the fiber veins, effecting a more or less distinct separation of barren and fiber-bearing rock, conditions particularly favor this method of concentration. Of the original mill feed, consisting of 2,400 tons a day, about 1,400 tons was eliminated as waste, leaving only 1,000 tons for the later milling processes. Thus picking belts saved operators a great deal of useless milling.

In the more advanced milling stages the dried rock was passed over heavy shaking screens, from which four products were obtained. (1) Fiber removed by suction fans, (2) oversize rock conveyed to a set of rolls, (3) middlings that bypass the rolls and are carried to the next screen, and (4) fines conveyed to a Humboldt disintegrator.

6/ Rukeyser, W. A., Asbestos Milling in the Urals: Eng. and Min. Jour., vol. 134, October 1933, pp. 415-419.

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By means of a series of such rolls, screens, suction pipes, and disintegrators, virtually all of the fiber was recovered. Fiber from the collecting hoppers was sent to a series of shaking screens for cleaning. The cleaned fiber was collected again by suction fans and classified by length in slowly rotating grading trommels.

A large, new mill designed to handle 2,000,000 tons of rock annually and produce 80,000 tons of fiber in six grades was nearing completion in 1934. This mill, with other Russian facilities, would, it was estimated provide the nation with a total milling capacity of approximately 175,000 tons of fiber a year. Production in 1936 was reported to be 125,117 metric tons; in 1937, 125,000 metric tons; and in 1938, only 86,000 metric tons.

Supplementary Milling in Asbestos Textile Factories

As pointed out in the preceding pages, the milling process is designed to remove impurities and to separate the fibers from each other (fiberize) effectively. Crude fibers are not milled before delivery to the user and are opened in the asbestos-products manufacturing plant. Even the milled fibers require considerable processing before they are in satisfactory condition for use.

The preliminary opening of crude fibers is generally accomplished in a pan crusher, also known as a chaser mill or edge runner. A steel wheel with a 14- to 18-inch face runs in a circle in a pan to which a batch of crude fiber is added. Scrapers push the fiber inward from the circumference and outward from the center to keep it under the roller. Conical rolls running in a circular trough are sometimes used to reduce the grinding action between the surface of the roller and the bottom of the pan. The running time required to complete a batch varies greatly, depending upon the ease or difficulty of fiberization of the particular asbestos under treatment. It may range from 2 to 12 minutes on milled fiber and 12 to 20 minutes on crudes. The time of completion is determined by the operator who, by long experience, can judge the condition of the fiber by its feel. To conserve fiber length and strength excessive crushing and grinding are avoided. Separated impurities are removed by screening.

Some milled fibers, which are more or less completely opened, do not require pan-crusher treatment; others require some degree of "pan softening." The extent to which pan treatment is needed depends entirely upon the character of the fiber. Some milled fibers may bypass the pan, while others bearing the same brand and grade may

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require "pan softening." Milled fibers that require no pan treatment are passed through a vertical opener or some other type of equipment that disintegrates the fibers. A rotating toothed cylinder may be used.

The next stop in treatment beyond the preliminary pan crushing or other fiberizing machine is conducted in a P. & S. (Proctor & Schwartz) grader. It consists of a sheet-metal enclosure with a horizontal rotating shaft in the center, furnished with steel paddles set at intervals and in spiral positions. These paddles beat the fiber, separating iron minerals, rock particles, or dust, as well as splinters of unopened fiber. The latter are returned to the openers for further treatment. The fluffy fiber is picked up by an air current and carried away for further treatment in ceiling condensers and breaker cards. Fiberization is one of the most critical operations in the textile plant, for it involves as complete separation of the fibers from each other as can be accomplished without sacrificing their length or strength. Bloomfield 7/ has described these processes in some detail.

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7 Bloomfield, Gerd M., Speaking about Asbestos Yarn: Asbestos, vol. 31, No. 12, June 1950, pp. 4-10; vol. 32, No. 1, July 1950, pp. 6-12; vol. 32, No. 2, August 1950, pp. 10-13.

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V. GRADING AND CLASSIFICATION

Canada

Canadian asbestos is graded into nine major groups, most of which are divided into several subgroups. Group 1 consists of Crude No. 1 and group 2 of Crude No. 2, Crude Run-of-Mine, and Crudes Sundry. Groups 3 to 7, known as mill fibers, are classified according to tests made with a Quebec standard testing machine. This equipment and its operation have been described so fully in several asbestos reports that it seems unnecessary to enlarge upon them here. The machine consists of three screens - $\frac{1}{2}$-inch-mesh, 4-mesh, and 10-mesh --, and a box for the shortest materials. The four-figure designation of the grade indicates the number of ounces from a total of 16 that collects in each of the four receptacles. Thus, a fiber designated 4-7-4-1 is one 4 ounces of which remain on the first screen, 7 on the second, and 4 on the third; 1 ounce passes through into the box. Groups 8 and 9 are graded on the basis of weight per cubic foot. "Crude" asbestos consists of hand-selected and hand-cobbed crossvein material, essentially in its native or unfiberized form. "Milled" asbestos consists of all grades produced by mechanical treatment such as crushing, screening and air separation.

"Shipping test" is the average, for each carload or smaller shipment, of tests of representative samples taken at the time of shipping. "Guaranteed minimum shipping test" is that below which the actual shipping test shall not fall.

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Following is the Canadian standard classification as of January 1, 1949:

Group 1: Crude No. 1 -- Consists basically of crude 3/4-inch staple or longer.

Group 2: Crude No. 2 -- Consists basically of crude 3/8-inch staple to 3/4-inch.

Crude Run-of-Mine -- Consists basically of unsorted crudes.

Crudes sundry- Consists of crudes other than above specified.

Mill Fibers

Group 3: Standard designation of grades:	Guaranteed minimum shipping test, Canadian standard testing machine:
3F	7 - 7 - 1.5 - 0.5
3K	4 - 7 - 4 - 1
3R	2 - 8 - 4 - 2
3T	1 - 9 - 4 - 2
3Z	0 - 8 - 6 - 2
Group 4:	
4H	0 - 5 - 8 - 3
4K	0 - 4 - 9 - 3
4M	0 - 4 - 8 - 4
4R	0 - 3 - 9 - 4
4T	0 - 2 - 10 - 4
4Z	0 - 1.5-9.5 - 5
Group 5:	
5D	0 - 0.5-10.5- 5
5K	0 - 0 - 12 - 4
5M	0 - 0 - 11 - 5
5R	0 - 0 - 10 - 6
Group 6:	
6D	0 - 0 - 7 - 9
Group 7:	
7D	0 - 0 - 5 - 11
7F	0 - 0 - 4 - 12
7H	0 - 0 - 3 - 13
7K	0 - 0 - 2 - 14
7M	0 - 0 - 1 - 15
7R	0 - 0 - 0 - 16
7T	0 - 0 - 0 - 16
Group 8:	
8S	Under 75 pounds per cubic foot loose measure.
Group 9:	
9T	More than 75 pounds per cubic foot loose measure.

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The affix "F" designates "floats" in all subsections of group 7. Floats consist of dust, collected in chambers and bagged. It may be sized by screening before bagging.

Following are the qualities and uses of the various groups:

Group 1 (Crude No. 1) is asbestos fiber greater than 3/4 inch in length. It should be silky and have enough tensile strength to permit its use for making asbestos yarn, tape, cloth, carded fiber, and other textiles.

Group 2 (Crude No. 2) is generally referred to as fiber that has not been milled and which has a length from 3/8 to 3/4 inch. It must have good tensile strength.

Group 3 is generally considered as milled spinning or textile fiber and tests 0 - 8 - 6 - 2 and over.

Group 4, known as shingle fiber, includes fiber suitable for the manufacture of asbestos-cement products, such as pipe, shingles, and siding; compressed sheet packing; and 85-percent magnesia and high-temperature molded pipe covering. These fibers are also used with portland cement for the manufacture of asbestos corrugated and flat interior and exterior sheets, wallboard, switchboard panels, and other products. This grade tests below 0-8-6-2 and includes 0-1½-9½-5. The better-known grades for asbestos-cement shingles are 4H, 4M, 4T, 6D, and 5R.

Group 5, known as paper stock, includes fibers testing below 0-1½-9½-5, including 0-0-10-6. They are used chiefly for the manufacture of asbestos paper and millboard and sometimes are mixed with higher grades for the manufacture of asbestos-cement shingles.

Group 6, known as stucco or plaster fiber, has only one grade, namely 6D.

Group 7 includes all fibers having a minimum shipping test of 0-0-5-11 and below. These are known as refuse and shorts and are used in manufacturing asbestos boiler and roofing cements, roofing paints, and occasionally for making millboard. The prefix "F" designates "floats" in all subsections of this group.

Groups 8 and 9 are known as sand and gravel and stone, respectively. They contain a preponderance of rock and sand. These materials are used chiefly in manufacturing asbestos flooring, wall tiles, and similar products.

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Union of South Africa

Following is the classification of Cape blue (crocidolite) recognized by the Cape Asbestos Co., Ltd.

Grade	Length of fiber, inches
X	Minus 1/4
No. 3 or S or MS	1/4 to 3/8
No. 2 or A	3/8 to 3/4
No. 1 or B	3/4 to 1 1/2
Long or C, D and E	Plus 1 1/2

Almost all of the imports are of Grade S or MS (mixed short)

Grades of Transvaal blue, as given by the Department of Mines, Union of South Africa. are as follows: 1/

Crude	Fiberized	
Grade	Grade	Length of fiber, inches
TX	TDX	Plus 1 1/2
T1	TD1	7/8 to 1 1/2
T2	TD2	1/2 to 7/8
T3	TD3	1/4 to 1/2
T4	TD4	minus 1/4

Amosite

B-1 is the longest and best grade of amosite and is a grayish-white fiber. The second grades are B-3 and D-3. They are virtually the same grade but come from different sources, the B-3 originating in the Penge mine, and the D-3 in the Amosa mine. However, it has been stated recently that B-3 is no longer produced. The fibers vary in length from $2\frac{1}{2}$ to 3 inches and in color from yellow to dark brown. Other designations that are applied to this grade are 3/B, 3/D, 3/BX and 3/DX. Another grade nearly as good as B-3 or D-3 is 3DMI. Although called 3DMI, it is really 3 D Mi, the "Mi" meaning "mixture." It consists chiefly of D-3.

M-1 is the most popular grade and is used in greatest quantities. It consists of a mixture of five types of fiber, prepared at the Maitland mixing plant near Cape Town, Cape of Good Hope. The following five types are used: K3, the output of the Kromellanboog mine; WEG, the output of the Malips mine; UB, the Upper Band of the Penge and Amosa mines; D11, shorts (not over $1\frac{1}{2}$ inches long) from the main band of the Penge and Amosa mines; and MD, a product obtained from re-treat-

1/ Asbestos, Asbestos Grades in South Africa: Vol. 30, No. 6, December 1948, p. 16.

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ing old mill dumps of the earlier operations of the Penge and Amosa mines.2/

Regarding chrysotile classification, various publications on asbestos include the classification of the New Amianthus and Munnik-Myburgh mines in the Barberton district; but, as these deposits are virtually exhausted, there is no point in recording the fiber classification. A new producer of considerable promise in the Barberton district, said to be the largest exporter of chrysotile in the Union of South Africa, is Kinloch Asbestos (Proprietary), Ltd. Its product has recently appeared on the market, and the classification of its fibers is not yet available.

Southern Rhodesia

Chrysotile --
  Milled fiber:
    C. & G./1 - high-grade textile fiber (equivalent to Canadian Crude No. 2)
    C. & G./2 - high-grade textile fiber (equivalent to Canadian 3F)
    C. & G./3 - shingle stock
    C. & G./4 - shingle stock
    VRA/2 - comparable but not equivalent to C&G/2
    VRA/3 - comparable but not equivalent to C&G/3
    VRA/4 - comparable but not equivalent to C&G/4

Swaziland

Chrysotile --
  Havelock Mine
    Milled fiber:
      HVL/1 - long spinning fiber
      HVL/2 - short spinning fiber
      HVL/3 - comparable but not equivalento to C&G/3
      HVL/3XX - comparable to C&G/4 (by one manufacturer)

Soviet Russia

Chrysotile --
  Crude:
    AA - not less than 18 mm. in length

  Milled fiber:
    0-1 - textile fiber (comparable to Canadian 3F or 3K)
    0-2 - textile fiber (comparable to Canadian 3R)
    I-2 - textile fiber (comparable to Canadian 3Z)
    G-3 - textile fiber (comparable to Canadian 3Z)
    0-3 - shingle fiber (comparable to Canadian 4H)
    0-4 - shingle fiber (comparable to Canadian 4Z)

2/ Data from an unpublished manuscript of Jesse M. Weaver, Raybestos-Manhattan Inc., 1950.

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I-4 - shingle fiber (comparable to Canadian 4R)
G-4 - shingle fiber (comparable to Canadian 4Z)
WS - shingle fiber
R-5 - paper fiber (comparable to Canadian 6D)
I-5 - paper fiber (comparable to Canadian 6D plus)
S-4 - paper fiber (comparable to Canadian 5D)
R-6 - shorts
I-6 - shorts
6A - shorts

Note: Grades S-4 and WS are completely opened fibers; grades marked "I" are soft but not completely opened; grades marked "G" contain more unopened crudes; grades marked "O" and "R" contain much hard, crude fiber.

India

Chrysotile --
Crudes:
Special A - comparable to Canadian Crude No. 1
Regular A - comparable to Canadian Crude No. 1
Regular B - comparable to Canadian Crude No. 1

Stockpile Grades and Specifications

At the end of 1950 low-iron chrysotile, South African amosite, and Bolivian crocidolite or its equivalent were the only types designated for stockpiling. Other types and grades may be added to the list as the need arises.

Chrysotile:

Chrysotile for stockpiling is the low-iron type. It must conform with National Stockpile Specification P-3 dated June 29, 1950, and must be equal to that obtained at the Shabani mines, Southern Rhodesia. The Rhodesian grades designated are C. & G.1, C & G.P.1, C. & G.2 and C. & G.P.2. The use of the letter P simply indicates a processed rather than a crude fiber. The fiber-length requirements of C. & G.1 and C. & G.P1 is that a minimum of 15 ounces shall be retained on the first and second screens of the Quebec standard testing machine. The requirement of C. & G.2 and C. & G.P2 is that a minimum of 13 ounces shall be retained on the first and second screens of the Quebec standard testing machine. Arizona Crude No. 1 and No. 2, as well as nonferrous crudes from other sources, are acceptable for stockpiling when strong and "silky."

It is presumed that Canadian fiber will satisfy the specification if the iron content can be reduced enough. Accordingly the fiber lengths of acceptable Canadian fibers are also specified as follows:

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Crude No. 1, consisting of fibers at least 85 percent of which shall be 3/8 inch in length or longer. Crude No. 2, consisting of fibers at lease 90 percent of which shall be 3/8 to 3/4 inch in length. Spinning fibers of the following grades according to Canadian standard tests (see p. V-2):

3D,	8.0	-	6.0	-	1.0	- 1.0
3F,	7.0	-	7.0	-	1.5	- 0.5
3K,	4.0	-	7.0	-	4.0	- 1.0
3M,	2.0	-	9.0	-	4.0	- 1.0
3R,	2.0	-	8.0	-	4.0	- 2.0
3T,	1.0	-	9.0	-	4.0	- 2.0

On the basis of iron content, the acceptable fiber falls in two classes. Class 2 shall contain not more than 1.75 percent total iron and not more than 0.75 magnetic iron. Class 4 shall contain not more than 3.5 percent total iron and not more than 2.0 percent magnetic iron. The specification includes items on impurities, moisture-content, sampling, methods of test, etc. Late in 1951 the specification was revised to include M-1.

Amosite:

Amosite for stockpiling must conform with National Stockpile Specification P-4, dated August 27, 1946. The specification simply states that the material shall conform to the standard commercial Grade B-1, Grade B-3, Grade D-3, or Grade 3/DM-1. According to the specifications used in World War II, B-1 was designated as white and B-3 or D-3 as light gray. Written certification that the material conforms with the requirements of these grades must be received from not less than three users representing not less than 50 percent of United States current use of the specified grades.

Crocidolite:

Crocidolite (blue asbestos) shall conform with National Stockpile Specification P-80, dated April 18, 1950, which designates that the material purchased shall be Bolivian crocidolite asbestos or its equivalent. Three grades are covered, as follows: Crude No. 1, a minimum of 85 percent (by weight) of which shall be in fibers 3/4 inch in length, or longer; Crude No. 2, a minimum of 85 percent of which shall consist of fibers 3/8 inch to 3/4 inch in length; and Run-of-Mine (crude or milled), a minimum of 90 percent of the lumps and fibers of which shall be retained on a No. 16 sieve. Fifty percent of the retained fibers shall be 3/8 inch in length or longer. The specification includes items covering purity, moisture content, methods of test, etc.

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VI. WORLD PRODUCTION

World production of asbestos and production by countries are shown graphically in the columnar chart, figure 4. The figures used in compiling this chart are the averages of production for three selected years, 1938, 1941, and 1945. This chart was compiled by the Department of Geography, University of Maryland, from data supplied by the Bureau of Mines, United States Department of the Interior.

World Output

World output from 1935 to 1949, as compiled by the Bureau of Mines, appears in table 3. Before 1943 no attempt was made to estimate a total. The figures for total output in 1943 and following years are more or less rough estimates because Russian output is large but unrecorded. For 1948 -- the latest year for which relatively complete figures are available (except for Soviet Russia) -- Canada produced nearly two-thirds of the total tonnage. A considerable part of the Canadian production, however, is of the shorter grades, for which there is an extensive market in the United States but which are produced in quite limited quantities in the other producing countries.

Output by Countries

United States production, as indicated in table 3, is a relatively small factor in the world supply. Although it has increased substantially since 1947, in 1950 it constituted only about 3 percent of the world output. Most of the United States fiber is of the shorter chrysotile grades. Table 4 shows domestic production over a period of years.

Table 5 shows Canadian production by grades during recent years. From this table it appears that about two-thirds of the production is designated "shorts." Crudes and spinning fibers constitute only a small proportion of total output (a little over 4 percent in 1948 and 1949), and the proportion may become still smaller in the future. Drill records seem to indicate decreasing quantities of the longer fibers with increasing depth. An igneous contact is believed to be an important element in the genesis of chrysotile fiber, and the contact with the serpentine of the original igneous intrusion may have been at a higher level than the present rock surface in rock masses that were removed by glaciation. If so, rock at progressively greater depths would be farther and farther from the igneous contact and accordingly would naturally have smaller and smaller fiber veins. Such a condition has not, however, been definitely established.

Canadian production has, in the past, been confined almost exclusively to the Province of Quebec, but in 1950 the Munro mine in Ontario produced more than 10,000 tons.

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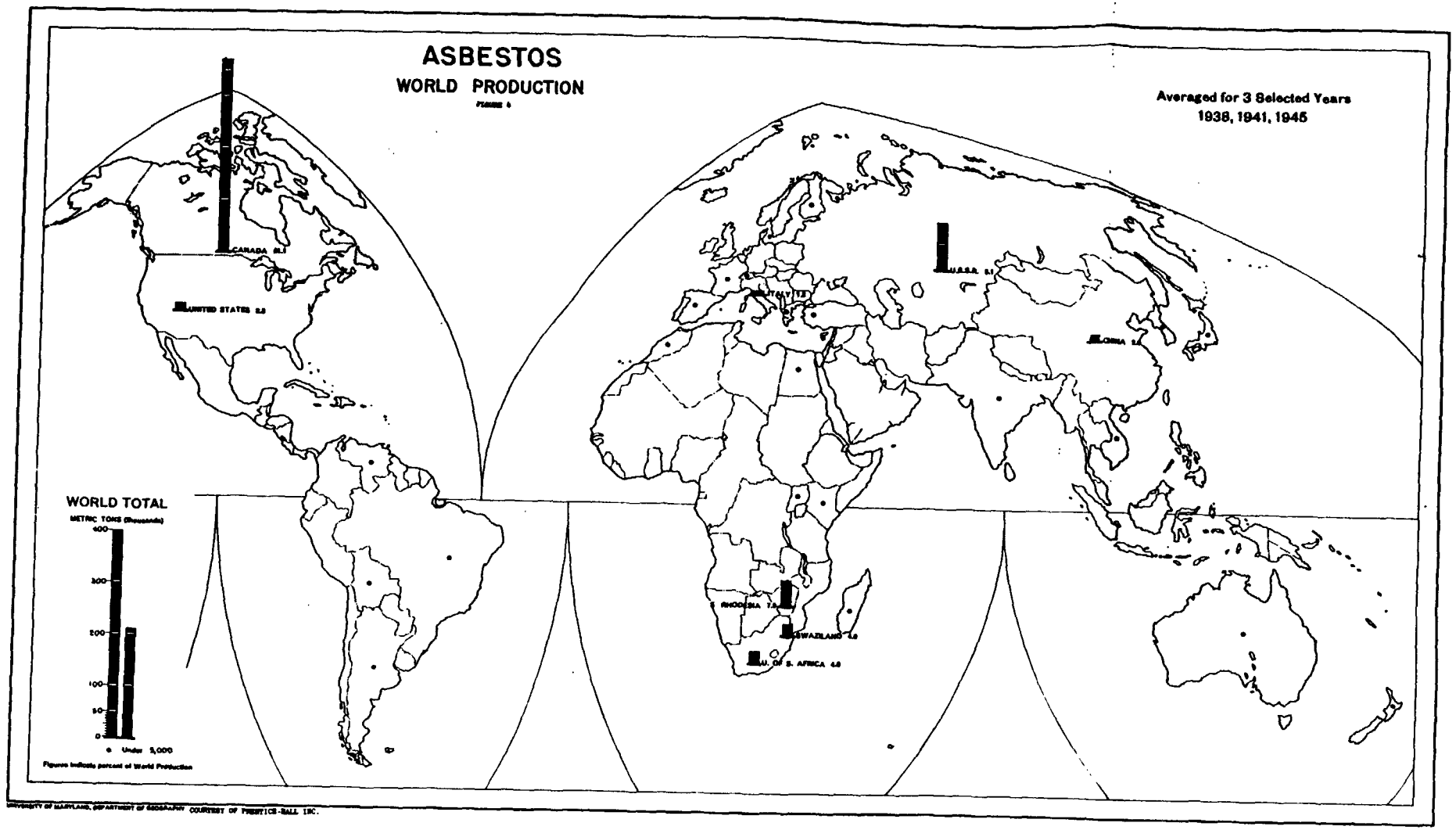
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TABLE 3.--World production of asbestos, unmanufactured, by principal countries, 1935-50, in metric tons

(Bureau of Mines, Minerals Yearbook)

Country	1935	1936	1937	1938	1939	1940	1941	1942
Africa:								
Southern Rhodesia	38,644	51,116	51,722	53,352	52,900	50,809	40,037	50,623
Union of South Africa	20,600	22,894	25,975	21,025	20,003	24,849	25,422	31,351
Swaziland	--	--	--	--	7,233	18,873	19,166	23,219
Australia	179	243	168	176	325	498	256	334
Canada 1/ (sales)	190,931	273,322	371,967	262,894	330,642	313,504	433,492	398,669
China	(3)	(3)	(3)	700	18,015	20,015	20,515	20,615
Cyprus 2/	7,634	9,659	11,892	5,668	10,377	9,673	4,874	3,128
Finland	1,742	3,963	7,260	6,422	6,220	5,337	3,842	4,679
Italy	4,320	6,113	6,393	6,860	6,765	8,271	10,766	11,695
Japan	(3)	(3)	(3)	1,000 4/	1,000 4/	1,000 4/	(3)	1,526
U. S. S. R.	95,500	125,117	125,000	86,000	(3)	(3)	(3)	(3)
United States	8,092	10,037	10,958	9,471	14,024	18,198	22,127	14,044
Other (estimate) 5/	3/	3/	3/	3/	3/	3/	3/	3/
Total (estimate) 5/	3/	3/	3/	3/	3/	3/	3/	3/

Country	1943	1944	1945	1946	1947	1948	1949	1950
Africa:								
Southern Rhodesia	52,749	52,882	51,068	50,686	49,073	62,502	72,246	64,888
Union of South Africa	32,347	31,372	25,597	18,348	27,344	41,490	64,334	79,298
Swaziland	17,179	29,628	21,243	29,155	25,360	29,421	30,814	29,635
Australia	699	3,035	4,071	629	1,399	1,348	1,619	6/ 783
Canada 1/ (sales)	423,831	380,349	423,559	506,371	600,391	650,239	521,543	794,107
China	4/20,000	(3)	(3)	(3)	(3)	(3)	(3)	(3)
Cyprus 2/	1,189	2,568	3,182	4,142	6,795	8,106	12,556	(3)
Finland	7,466	7,733	4,197	5,781	6,351	10,818	8,395	(3)
Italy	8,459	7,238	5,222	8,814	10,719	13,044	15,365	21,433
Japan	5,302	12,900	8,044	3,997	4,249	4,809	5,456	4,948
U. S. S. R.	(3)	(3)	(3)	(3)	(3)	(3)	(3)	(3)
United States	5,456	6,048	11,091	12,769	21,804	33,649	39,360	38,495
Other (estimate) 5/	59,123	68,247	74,726	83,308	118,515	139,574	123,312	173,428
Total (estimate) 5/	633,800	602,000	632,000	724,000	872,000	995,000	895,000	1,206,000

1/ Exclusive of sand, gravel, and stone.
2/ Exports.
3/ Data not available.
4/ Estimate.
5/ Includes small production in about 20 countries and a probable large production in Soviet Russia.
6/ January to June, inclusive.

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TABLE 4.--Asbestos sold or used by producers in the United States, 1925-50

(Bureau of Mines, Minerals Yearbook)

Year	Short tons	Value	Year	Short tons	Value
1925	1,258	$51,700	1938	10,440	$247,264
1926	1,358	134,731	1939	15,459	512,788
1927	2,981	336,882	1940	20,060	674,508
1928	2,239	351,178	1941	24,391	725,753
1929	3,155	351,004	1942	15,481	498,857
1930	4,242	289,284	1943	6,014	334,815
1931	3,228	118,967	1944	6,667	380,334
1932	3,559	105,292	1945	12,226	446,045
1933	4,745	130,677	1946	14,075	504,761
1934	5,087	158,347	1947	24,035	918,558
1935	8,920	292,927	1948	37,092	1,806,261
1936	11,064	314,161	1949	43,387	2,614,416
1937	12,079	344,644	1950	42,434	2,925,050

TABLE 5.--Production of asbestos in Canada, 1935-50, in short tons

(Dominion Bureau of Statistics)

Year	Crudes	Fibers	Shorts	Total
1935	2,278	102,270	105,919	210,467
1936	3,440	133,288	164,559	301,287
1937	3,846	200,247	205,933	410,026
1938	2,911	163,097	123,785	289,793
1939	3,121	193,992	167,359	364,472
1940	2,076	181,890	161,615	345,581
1941	2,845	223,767	251,234	477,846
1942	2,890	199,829	236,741	439,460
1943	2,016	217,889	247,291	467,196
1944	1,547	190,233	227,485	419,265
1945	981	219,767	246,148	466,896
1946	742	228,234	329,205	558,181
1947	958	222,196	438,667	661,821
1948	977	241,953	473,839	716,769
1949	652	194,583	379,671	574,906
1950	904	305,194	569,246	875,344 1/

1/ Includes 10,519 tons produced in Ontario.

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Ontario production was begun in April 1950.

Table 6 shows production in the Union of South Africa for the period 1935-50, by varieties. South African production has special importance, because it includes the principal world supply of amosite and crocidolite (blue asbestos).

Table 7 shows production in Southern Rhodesia for the same 16-year period. The chrysotile produced is much more important than its tonnage would imply, because it is of the low-iron type much in demand for electrical insulation uses. Rhodesia is, in fact, the major source of such fiber in the world.

Production was begun in Swaziland in 1939, with the opening of the Havelock mine which has become an important producer of chrysotile (see Table 3).

An important asbestos-products industry exists in Soviet Russia, and production in the late 1930's exceeded 100,000 tons a year during some years. Table 8 is of historic value and is indicative of present possibilities.

TABLE 6.--Production of asbestos in the Union of South Africa, by kinds 1935-50 in short tons 1/

Year	Amosite	Blue	Chrysotile	Total
1935	4,684	2,541	15,483	22,708
1936	4,823	4,264	16,149	25,236
1937	6,531	5,247	16,855	28,633
1938	8,793	8,810	5,573	23,176
1939	11,299	10,127	612	22,038
1940	17,767	8,901	646	27,314
1941	19,211	7,352	1,658	28,221
1942	24,924	7,641	1,917	34,482
1943	23,189	10,344	2,034	35,567
1944	22,848	9,666	2,014	34,528
1945	16,737	9,671	1,765	28,173
1946	9,838	8,691	1,666	20,195
1947	18,780	9,079	2,253	30,112
1948	30,372	10,909	4,441	45,722
1949	41,974	21,180	7,609	70,763
1950	42,391	30,597	14,336	87,324

1/ A small output of anthophyllite is omitted because it has no strategic importance.

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TABLE 7.--Asbestos production in Southern Rhodesia, 1935-50

(Annual report: chief Government mining engineer and chief inspector of mines, Southern Rhodesia)

Year	Short tons	Year	Short tons	Year	Short tons
1935	42,598	1941	44,134	1947	54,094
1936	56,346	1942	55,803	1948	68,897
1937	57,014	1943	58,146	1949	79,638
1938	58,811	1944	58,293	1950	71,527
1939	58,313	1945	56,293		
1940	57,891	1946	55,872		

TABLE 8.--Asbestos production in Soviet Russia

(Economic Review of the Soviet Union and other sources)

Year	Metric tons	Year	Metric tons	Year	Metric tons
1913	17,494	1922	3,215	1931	64,674
1914	15,691	1923	2/4,780	1932	59,800
1915	9,779	1924	2/8,456	1933	71,700
1916	8,192	1925	2/12,330	1934	92,500
1917	(1)	1926	2/18,334	1935	95,500
1918	(1)	1927	2/21,156	1936	125,117
1919	(1)	1928	2/26,492	1937	125,000
1920	1,478	1929	2/29,520	1938	86,000
1921	2,604	1930	54,083	1939	(3)

1/ Data not available.
2/ Year ended Sept. 30.
3/ No figures available for 1939 or subsequent years.

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VII. WORLD RESERVES

Importance of Reserves

Current production throughout the world is an important element in the asbestos supply situation, but consideration of the availability of asbestos fibers cannot be confined merely to the present. Even though immediate supplies may be adequate, the question inevitably arises, What are the prospects for obtaining equal or larger quantities of suitable fiber in the years to come? The answer depends largely upon the extent of reserves of commercial fiber in the various asbestos-producing areas of the world. Knowledge of reserves is so important in planning future operations that the larger companies have spent vast sums on geologic surveys and prospect drilling so that adequate reserves may be definitely established as a solid basis for investment in mining and milling facilities. Unfortunately, much of the information thus assembled is confidential. However, considerable data on reserves are available, and whatever could be found is recorded in following paragraphs.

United States

Afer a careful survey in 1944 by the Geological Survey and the Bureau of Mines, it was estimated that United States reserves of all grades of chrysotile amounted to about 750,000 short tons. Since that time, considerable prospect drilling has been conducted in the deposit at Eden, Vt., to a depth of about 800 feet, and a 20-year supply at the current or even an enlarged production rate seems to be assured. This would imply a reserve of at least 800,000 to 1,000,000 tons of fiber in that area. To be conservative, estimates of reserves are generally confined to producing areas, but there is always the possibility of discovery of new deposits that may supplement those already known. Prospect drilling by a private company was conducted on a chrysotile deposit north of Redding, Calif. during 1950 but was discontinued, presumably because the deposit proved to be too small to justify large-scale operations. Promising deposits of spinning-grade chrysotile have, however, been found in several places in Shasta, Trinity, and Siskiyou Counties, Calif., in an extensive serpentine area that merits exploration. It is possible that reserves of considerable size may be discovered in that territory.

Long chrysotile fibers of good spinning quality are available in Arizona, but the known reserves are small. Nearly all of the asbestos mined in Vermont is of the shorter grades. Further exploration in Vermont may uncover deposits having a larger proportion of spinning fibers.

From the standpoint of asbestos that can be classed as strategic, known United States reserves are very small, but there is some basis

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for expecting more promising developments in the future. There are no known reserves of either amosite or crocidolite.

Canada

Estimates of Canadian reserves are incomplete. A great deal of prospect drilling has been done, but only in some instances are the results available. Asbestos Corp., Ltd., the second - largest producer in Quebec, has published quite complete data in its annual reports. The company estimates its ore reserves as of December 1950 as follows:

	Short tons
King mine	8,400,000
Beaver mine	11,000,000
British Canadian mine	35,600,000
Vimy Ridge mine	25,450,000
Other properties	7,300,000
Total	87,750,000

Assuming a 6-percent fiber recovery, this would indicate a fiber reserve of more than 5 million tons. Drill exploration at the King mine shows asbestos-bearing serpentine to a depth of 1,700 feet. Johnson's Co. has increased its reserves greatly by diamond drilling. Bell Asbestos Mines has purchased a new property in Range 4, Thetford Township, on which it has developed a high-grade 2,000- by 800-foot ore body at least 300 feet deep.

The Johns-Manville Corp. has conducted extensive prospect drilling for many years. From information supplied by drill cores, the company has constructed large models of its undeveloped areas showing the quantity and grade of fibers, both laterally and vertically, as a guide to future development. The comprehensive data thus assembled have enabled the company to estimate that it has, within its present holdings, enough available fiber to last at least 100 years at the present rate of mining. These extensive deposits at Danville are predominantly short-fiber occurrences.

The over-all picture of reserves in the Quebec area is indefinite. The heavy investment in facilities and their expansion indicates that the principal producers have assured themselves of reserves adequate for continuous operation at the current rate, or on an enlarged scale, for at least 25 or 30 years. As current production is at a rate exceeding 800,000 tons of asbestos a year, a reserve of at least 30,000,000 tons for the Quebec area seems to be assured simply on the basis of expectations implied by capital investment and current rate of production. In view of the supplies available for a much longer period of extensive operations established by exploration by the largest producer, together with probable reserves in unexplored areas, the figure of 30,000,000 tons could easily be doubled or trebled.

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Of greatest immediate interest are the reserves of crudes and spinning fibers. In 1948, 1949, and 1950 these groups comprised about 4 percent of the total output. Accordingly, if total reserves are tentatively estimated at a minimum of 60,000,000 tons, the reserves of crudes and spinning fibers would appear to be about 2,400,000 tons. Such a figure is based on the assumption that the proportion of longer fibers will be approximately the same in the future as it was in 1948-50, but there is no assurance that such a proportion will be maintained. Production by grades was not published from 1933-47, hence no definite figures are available for that period. For 1928-32, during which such figures were published, the proportion of crudes and spinning fibers to total production averaged about 6 percent. Accordingly, the figure of 4 percent for 1948-50 indicates a decline, which may be more apparent than real. Consideration must be given to the recent great increase in recovery and sale of the very short fibers. This accession to the total will automatically lower the percentage of crudes and spinning fibers, although the actual quantities of these fibers produced may be as high as in earlier years. There is no statistical evidence that would imply a reduction in output of spinning grades in the near future.

From the foregoing, it may be concluded that Quebec reserves are adequate for a half century of production, even at an increasing rate.

The new development in Munro Township, Ontario, provides a supplementary supply. The reserves are probably extensive but not of the magnitude of those in Quebec. This development has not produced grades and qualities of fiber suitable for textiles.

Soviet Russia

In the early 1930's, when information concerning Russian minerals was more readily available than at present, a statement was published to the effect that extensive and systematic coredrilling had established a reserve for the entire Bajenova district of more than 3,000,000 metric tons of fiber within 50 feet of the surface. This estimate was based on a 2-percent recovery; and, as recovery is probably about $4\frac{1}{2}$ percent, the estimate of reserves given above might easily be doubled. As the deposits extend far below the 50-foot level, a further substantial enlargement of the figure would be justified. In January 1934 the reserves of asbestos in the Soviet Union were estimated at 19,400,000 metric tons.

Southern Rhodesia

According to an estimate made in 1928, the reserves of asbestos in Southern Rhodesia deposits amounted to about 7,000,000 tons. During the ensuing 22 years, about 1,000,000 tons have been mined, which would reduce the reserves to about 6,000,000 tons; however, the rate of depletion probably has been reduced to some extent by enlargement of

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established reserves through prospect drilling. The 170 and Birthday ore bodies, which are approximately 2,000 feet long and 100 feet wide and dip 25°, have been proved by drilling to a vertical depth of 1,000 feet. One diamond-drill hole in the Birthday section intercepted rock of good grade at a depth of 2,300 feet. The Nil Desperandum ore body has been proved to a depth of 850 feet.

The proportion of spinning-grade fiber produced in the Shabani area is exceptionally high. An estimate as high as 25 or 30 percent has been made, but in 1949 it was said that 20 percent of the output would satisfy stockpiling specifications, which call for Grades C. & G. Nos. 1 and 2. As the largest Rhodesian reserves are in the Shabani area, a reserve of spinning fibers exceeding 1,000,000 tons may be assumed.

Union of South Africa

Transvaal

Moderate reserves of chrysotile occur in the Carolina district, but the rich mines of the Barberton district (the New Amianthus and the Munnick - Myburgh) are virtually exhausted. However, recent exploratory work by Kinloch Asbestos (Proprietary), Ltd., has revealed large reserves. It is claimed that in this property 25 miles from Barberton there is in sight 5,000,000 tons of fiber-bearing rock with an asbestos content of about 170,000 tons. New possibilities for chrysotile occurrences appear also from recent exploration mentioned under Swaziland, because it was found that the serpentine belt extends at least 14 miles into Transvaal from the Swaziland border.

Amosite deposits cover a wide area and the fiber-veins show remarkable continunity over long distances. Hence it is inferred that the reserves are extensive, but no definite figures seem to be available. Koehler 1/ estimates that there are ample reserves to last 100 years at present rate of output. Crocidolite occurs with amosite in the Pietersburg district in the western part of the amosite belt. The reserves are probably not extensive.

Cape of Good Hope

The crocidolite deposits of the Cape extend over an area 240 miles long, with a maximum width of 30 miles. The area is so large and the fiber veins are distributed so generally throughout it that the reserves are undoubtedly very great, but no definite figures are available.

Swaziland

The reserves at the Havelock mine are said to comprise 14,000,000 tons of rock carrying 4 percent asbestos. This would indicate the

1/ Koehler A. W., Cape Asbestos Co., personal communication 1951.

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presence of over half a million tons of fiber. The reserves may, in fact, be greater than these estimates would indicate, because recent exploration has revealed an extension of the serpentine belt from the Havelock mine south-southwest to the Transvaal border, a distance of 17 miles.

China

China may have large reserves of asbestos. It was estimated in 1935 that Hopei Province had a reserve of 400,000 tons.

Summary

The world as a whole appears to have adequate asbestos reserves for at least 25 or 30 years at current or moderately enlarged rates of output. United States reserves of the shorter fibers are small compared with domestic needs. Of the longer grades, the reserves are very small. The chief suppliers of United States markets - Canada and Africa - appear to have adequate reserves for long-range planning. The Soviet Union probably has reserves large enough to supply its domestic economy in war or peace for many years. To provide for a possible downward scaling of reserves or for a greatly enlarged consumption, the discovery and development of new deposits, especially in the United States, are highly desirable.

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VIII. POLITICAL AND COMMERCIAL CONTROL

Asbestos deposits of commercial importance are not abundant and are widely scattered over the earth. The demand for this mineral exceeds the supply, therefore both political and commercial control of asbestos deposits has primary interest, not only to individual consumers but to national governments, because it is regarded as a mineral of strategic importance.

Political Control

The Russian deposits are under absolute control of the Soviet Union. All other producing areas of primary importance -- those of Canada, Southern Rhodesia, Union of South Africa, and Swaziland -- are within the political orbit of the British Empire. Moderately important deposits in Cyprus, Australia, New Zealand, and India are also under British political control. Deposits of moderate importance outside the British Empire are in the United States, Venezuela, Italy, Finland, China, and Japan. Relatively small deposits are controlled politically by Argentina, Bolivia, Portugal, France, Turkey, French Morocco, and several other countries.

Commercial Control

The only large asbestos producer in the United States -- Vermont Asbestos Mines -- is a subsidiary of the Ruberoid Co. of New York City and is controlled by United States capital. All of the smaller United States companies are similarly controlled.

Commercial control of the Canadian asbestos industry is diverse. The largest operation in Quebec, Canada -- in fact, the largest operation in the world -- that of Canadian Johns-Manville, is a subsidiary of the Johns-Manville Corp. of New York City. This company also is operating a new property - the Munro mine - near Matheson, Ontario, which began production in 1950. The Quebec Asbestos Corp., Ltd., is a subsidiary of the Philip Carey Manufacturing Co. of Cincinnati, Ohio; the Nicolet Asbestos Mines, Ltd., of Nicolet Industries, Inc., 70 Pine Street, New York, N. Y., and Flintkote Mines, Ltd., of the Flintkote Co. of New York City.

British capital also is represented. The Bell Asbestos Mines, a large producer, is a subsidiary of Turner & Newall, Ltd., of Manchester, England. Asbestos Corp., Ltd., the second - largest producer in the Quebec area, and the Johnson's Co., one of the pioneer operators, are reported to be financed by Canadian capital.

Two British companies, Turner & Newall, Ltd., and the Cape Asbestos Co., control most of the asbestos production in Southern Rhodesia, the Union of South Africa, and Swaziland.

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Turner & Newall have extensive asbestos - products manufacturing plants that must be supplied with raw fiber. Thus the home markets are favored, and furthermore the allotments to central European countries are of considerable magnitude.

The one company operating in Cyprus is controlled by British capital. The Australian mines are controlled by British and Australian interests. Most of the production of blue asbestos in Bolivia has come from Bolivian owned mines. A French company is reported to hold a 48-percent interest in the Venezuelan asbestos industry at Tinaquillo, and the balance is held by Venezuelan interests. The Soviet Union controls, both politically and commercially, the activities of the asbestos industry of the Urals.

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IX. INTERNATIONAL TRADE

Extent of International Trade

The Soviet Union stands alone with respect to its position as a large producer as well as a large consumer of asbestos. Southern Rhodesia and the Union of South Africa had small asbestos-product-manufacturing industries in the past but are attaining increasing importance. It was reported in March 1947 that there were seven such plants in Africa - two long-established factories (one at Durban and one at Johannesburg) and five of more recent construction (one at Cape Town, three in the Transvaal, and one in Salisbury, Southern Rhodesia). The fourth important asbestos-producing country - Canada - has, in the past, consumed only a small part of its asbestos output, not more than about 5 percent annually of the crudes and mill-fiber grades. Recently two new modern plants for making asbestos products have been built, one in Montreal and one near Toronto. In 1948 Canada had 15 asbestos-products plants compared with 12 in 1946. Therefore consumption is increasing; it reached about 7 percent domestic production in 1949 of the crudes and milled fibers. In 1950, when production reached an all-time high, domestic consumption dropped percentagewise, to 5. What are normally the important asbestos-consuming countries outside the Russian Empire -- the United States, England, France, Germany, Belgium, Netherlands, and Japan - produce no asbestos or only relatively small quantities. Because nearly all important asbestos-producing countries are minor consumers and nearly all important consuming countries have quite limited domestic asbestos resources, a large proportion of all asbestos mined enters international trade, and all the principal nations are profoundly interested in foreign sources of supply and their availability in times of emergency. Figure 5 presents a general picture of the export and import situation throughout the world for three selected years. This figure appears in an Atlas of World Mineral Resources, published by the Department of Geography, University of Maryland, in cooperation with the Bureau of Mines.

As the United States depends so extensively on foreign supplies, international trade in asbestos and its products merits careful scrutiny. Furthermore, the trade of the principal asbestos-producing countries with the United States and other importers is likewise significant, for it indicates the proportion that each consuming country receives from year to year.

Foreign Trade of the United States

Consumption

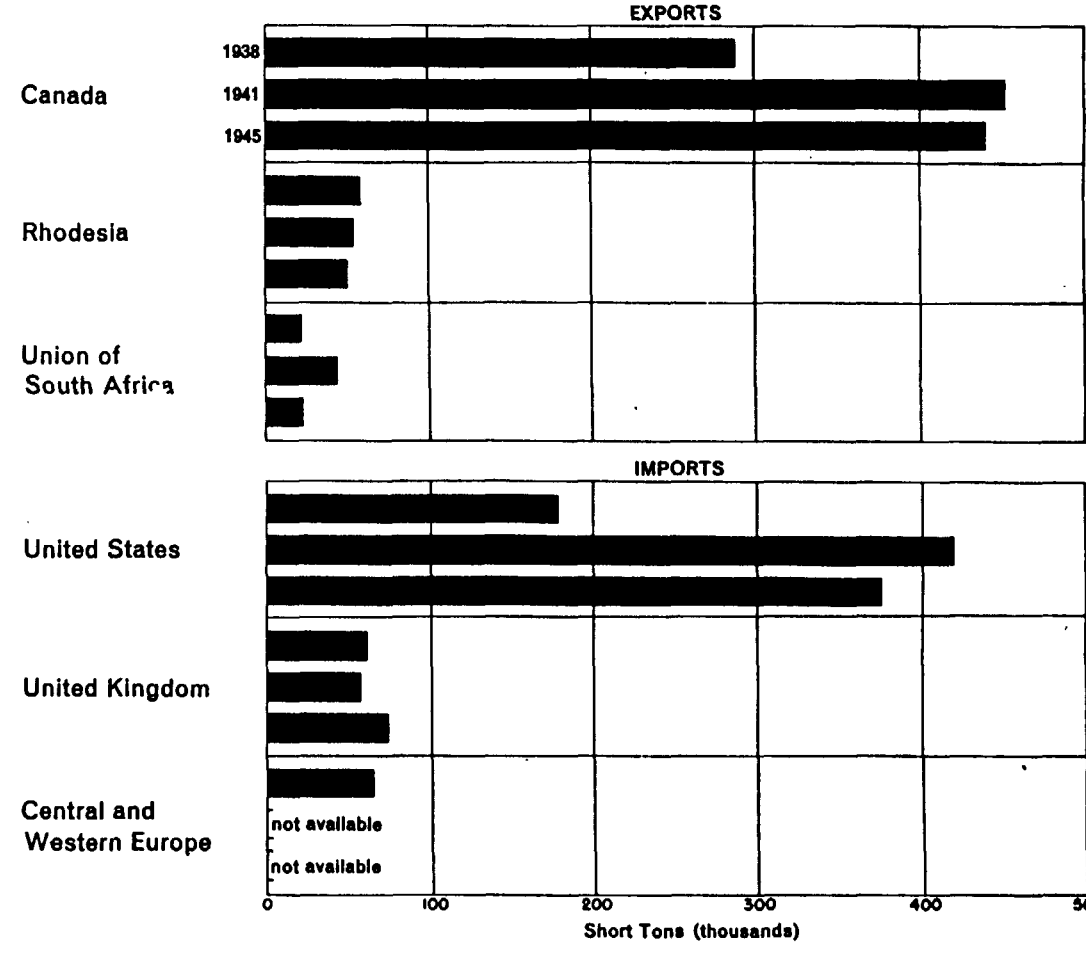
The United States is the largest consumer of asbestos in the world. Consumption during the 16-year period, 1935-50, is indicated in table 9. Imports comprise 92 to 96 percent of the annual require-

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FIGURE 5

ASBESTOS EXPORTS AND IMPORTS BY COUNTRIES



UNIVERSITY OF MARYLAND, DEPARTMENT OF GEOGRAPHY COURTESY OF PRENTICE-HALL INC.

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ments. These imported supplies constitute the major part of the raw materials employed by more than 100 asbestos-products plants that manufactured goods valued in 1947, the latest year for which figures are available, at more than 273 million dollars. Table 10 shows the principal products manufactured and their value by groups. Although most of these materials are consumed in the United States, the export trade is of some significance, as indicated in table 11.

TABLE 9.--Apparent consumption 1/ of asbestos in the United States, 1935-50

(Bureau of Mines, Minerals Yearbook)

Year	Short tons	Year	Short tons
1935	174,655	1943	445,902
1936	250,922	1944	389,241
1937	316,263	1945	378,030
1938	187,150	1946	459,752
1939	255,547	1947	616,787
1940	262,199	1948	678,443
1941	438,741	1949	535,131
1942	433,949	1950	728,704

1/ Production plus imports minus exports.

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TABLE 10.--Shipments of asbestos products in the United States, 1947

(Dept. of Commerce, Bureau of the Census)

Product	1947 shipments, value
Asbestos-cement products	$ 70,410,000
Asbestos friction materials	58,606,000
Asbestos insulation	24,488,000
Asbestos textiles	16,991,000
Asbestos-metallic and asbestos-rubber gaskets	31,915,000
Asbestos compressed sheet	2,795,000
Asbestos-metallic and asbestos-rubber packing (except compressed sheet)	9,45 ,000
Asbestos millboard	.2,812,000
Asbestos paper	10,592,000
Asphalt floor tile	37,825,000
Other	7,812,000
Total	$273,705,000

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TABLE 11.--Value of manufactured asbestos products exported [illegible] from the United States, 1935-50

(Dept. of Commerce, Bureau of the Census)

Year	Brake linings	Paper, millboard, pipe covering, etc.	Textiles, yarn, and packing	Other	Total
1935	$ 682,719	$273,935	$662,321	$442,958	$2,261,929
1936	1,024,969	244,520	676,853	532,931	2,479,273
1937	1,113,741	380,610	789,398	763,329	3,047,078
1938	919,944	228,700	611,549	773,723	2,533,916
1939	1,022,216	374,455	965,923	992,326	3,354,920
1940	921,740	367,790	1,028,229	1,155,489	3,473,248
1941	1,799,998	348,658	1,356,793	1,329,745	4,835,194
1942	2,549,039	237,818	1,154,161	1,175,901	5,116,919
1943	1,888,918	293,522	1,132,411	1,563,013	4,877,864
1944	2,228,788	385,486	1,346,407	1,653,562	5,614,243
1945	2,372,746	349,487	1,994,297	2,547,557	7,264,087
1946	3,027,865	721,631	2,674,573	2,839,023	9,263,092
1947	4,748,813	1,424,779	2,622,055	4,027,833	12,823,480
1948	3,412,827	1,062,981	2,302,384	3,692,867	10,471,059
1949	3,919,739	963,599	1,891,831	4,122,848	10,898,017
1950	4,003,675	205,185	1,814,105	2,919,631	8,942,596

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Imports

Table 12 shows United States imports of asbestos by years for a 16-year period, 1935-50, by countries of origin. Over 90 percent on a tonnage basis ordinarily is imported from Canada, but a large part of it consists of the shorter, nonstrategic grades. Of greatest significance in time of emergency are the imports of crudes and spinning fibers designated as strategic grades. Imports from Canada of these grades for the 8-year period, 1943-50, are indicated in table 13.

As these grades are generally in short supply in the United States and particularly scarce in times of emergency, it is especially interesting to note the proportion of them shipped from Canadian mills that reach United States markets. Table 14 shows such data for 1948-50, the only recent years for which figures of production and shipments are broken down by crudes and spinning fibers. In 1948, as indicated in table 19, Canada shipped 70 percent of its total production of crudes and mill fibers to the United States. A large proportion of the mill fibers received are of the shorter grades. Table 14 shows that the United States received in that year 68 percent of the spinning grades. In 1949 the United States received 65 percent of the total crudes and mill fibers (table 19), but only 59 percent of the spinning grades (table 14). In 1950, however, circumstances were much more favorable. The United States received only 59 percent of total crudes and mill fibers but received 72 percent of the total shipments of spinning grades.

As referred to elsewhere in this report, there is urgent need of asbestos with a lower iron content than that produced in Canada; and such supplies, known as the C. & G. Nos. 1 and 2 grades, are obtained from Southern Rhodesia. Table 15 shows imports of these grades during the 8-year period 1943-50. According to current report, imports in 1951 and 1952 will be reduced substantially below the levels of recent years.

Amosite also has strategic importance. This variety is mined almost exclusively in the Union of South Africa, but a small output has been reported from Southern Rhodesia. Importations of amosite for the same 8-year period are shown in table 16. African crocidolite (blue asbestos), although not classified as strategic at this time, has important uses, particularly in the manufacture of asbestos-cement pipe, and it is in strong demand in the United States. Imports are indicated in table 16.

Limited quantities of blue asbestos (crocidolite) are regarded as essential for gas and air filters, and a type of blue fiber mined in Bolivia is preferred for this specialized use. Production in Bolivia is quite small. Importation of 69 tons in 1949 is the maximum recorded figure. According to official records, only 39 tons were imported in 1950.

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TABLE 12.--United States imports of asbestos, by country of origin, 1935-50, in short tons

(Dept. of Commerce, Bureau of the Census)

Country 1/	1935	1936	1937	1938	1939	1940	1941	1942
Africa:								
Southern Rhodesia	1,183	3,266	7,099	2,745	4,836	8,462	8,234	8,665
Union of S. Africa	945	2,080	4,248	3,677	6,359	8,752	21,447	20,278
Australia	--	--	--	--	--	28	62	35
Bolivia	--	--	--	--	--	1	22	16
Canada	154,236	226,078	276,010	166,071	223,840	225,856	389,391	386,621
Cyprus	4,628	4,386	8,129	6	3,940	3,266	--	--
Finland	11	81	88	89	46	--	--	--
Italy	545	1,069	989	1,569	567	187	--	--
U. S. S. R.	4,313	6,422	10,213	5,265	2,611	--	--	3,610
United Kingdom 2/	202	220	290	44	298	18	1	--
Total 3/	166,585	243,602	307,188	179,490	242,561	246,613	419,196	419,242

Country 1/	1943	1944	1945	1946	1947	1948	1949	1950
Africa:								
Southern Rhodesia	28,555	7,966	2,545	5,463	8,992	10,513	13,722	9,892
Union of S. Africa	24,009	19,196	13,247	6,050	20,034	19,551	22,730	14,805
Australia	3	--	2	24	--	3	249	273
Bolivia	22	15	--	--	--	68	69	39
Canada	385,655	353,247	355,768	442,073	559,279	602,216	470,788	678,358
Cyprus	--	--	--	--	--	--	--	--
Finland	--	--	--	--	--	--	--	1
Italy	--	--	--	8	8	10	100	19
U. S. S. R.	1,144	2,610	2,625	2,750	6,524	15,514	1,221	426
United Kingdom 2/	--	1	1	--	1	--	5	5
Total 3/	440,255	383,049	374,354	456,688	594,839	647,881	509,366	705,253

1/ Small imports have been received sporadically from Brazil, Cuba, Chile, China, France, India, Mozambique, Morocco, Netherland Indies, Turkey, and Venezuela.
2/ Asbestos from United Kingdom probably originated either in Rhodesia or Union of South Africa
3/ Includes, for most of the years, small quantities imported from 1 or more of the countries mentioned in footnote (1).

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TABLE 13.--Imports of spinning grades of asbestos into the United States from Canada, 1943-50, in short tons

(Based on Dominion Bureau of Statistics data)

Grades	1943	1944	1945	1946	1947	1948	1949	1950
Crude No. 1	700	498	184	221	168	274	215	390
Crude No. 2	567	649	419	291	278	307	192	260
Other crudes	577	381	176	8	49	94	437	180
Spinning and textile	21,577	21,004	18,063	18,704	17,836	20,770	12,987	24,417
Total	23,421	22,532	18,842	19,224	18,331	21,445	13,831	25,247

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TABLE 14.--Total shipments and imports into the United States of Canadian crudes and spinning fibers, 1948-50

(Based on Dominion Bureau of Statistics data)

Year	Total shipments, short tons	Shipments into the United States, short tons	Percent of total shipments imported into the United States
1948	31,685	21,445	68
1949	23,296	13,831	59
1950	34,859	25,247	72

TABLE 15.--Imports of chrysotile asbestos into the United States, by grades, from Southern Rhodesia, 1943-50, in short tons

(Dept. of Commerce, Bureau of the Census)

Grades	1943	1944	1945	1946	1947	1948	1949	1950
C. & G. No. 1	1,566	1,490	459	762	1,593	1,174	1,270	2,124
C. & G. No. 2	5,618	4,519	1,911	1,475	4,226	4,697	2,905	1,844
Other	21,927	1,957	--	3,225	3,156	3,551	15,052	4,950
Spinning and textile	--	--	--	--	--	--	--	556
Total	1/29,111	7,966	2,370	5,462	8,975	9,422	19,227	9,474 1/

1/ Includes imports from Mozambique.

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TABLE 16.--Imports of amosite crudes and blue asbestos into the United States, 1943-50, in short tons

(Dept. of Commerce, Bureau of the Census)

	1943	1944	1945	1946	1947	1948	1949	1950
Amosite	20,129	15,660	9,034	4,314	10,801	12,551	14,892	8,105
Crocidolite (blue)	3,880	3,051	4,515	1,261	7,851	4,060	5,260	5,056

TABLE 17.--Exports of asbestos from the United States, 1934-50

(Dept. of Commerce, Bureau of the Census)

Year	Short tons	Value	Year	Short tons	Value
1934	1,669	$94,182	1943	367	$36,856
1935	850	37,896	1944	475	58,983
1936	3,744	310,197	1945	8,550	837,175
1937	3,004	253,734	1946	11,011	1,395,367
1938	2,780	288,617	1947	2,036	308,414
1939	2,473	218,839	1948	6,530	1,173,259
1940	4,474	449,105	1949	17,621	3,618,703
1941	4,846	325,825	1950	18,901	3,619,428
1942	774	134,411			

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Exports

Although the United States produces only a fraction of its requirements of asbestos, it, nevertheless, exports substantial quantities. Table 17 shows the tonnage and value of exports from 1934-50. Minor quantities of Vermont asbestos are exported, chiefly to France and Belgium, for the manufacture of asbestos-cement products. At times Arizona asbestos is shipped to Europe and the Far East. Exports from the United States consist principally of Canadian fibers blended in various ways to suit the needs of Latin-American or European countries. South America has over 20 asbestos-products plants. Some of them are supplied in part from small local asbestos mines, and fiber shipments are sometimes received from Africa, but the plants must depend primarily on direct shipments from Quebec or on imports of prepared fibers from United States suppliers.

Some of the asbestos export trade of the United States might be classed as gray-market transactions. Dealers or processors obtain fiber in various ways and sell it abroad, either as purchased or after processing, at the very high prices they can command because of acute shortages. Canadian asbestos producers try to confine their sales to legitimate consumers, but occasionally their asbestos falls into the hands of jobbers or traders who sell it to foreign consumers at prices far above regular market quotations. As indicated in table 17, the average prices of asbestos exported during the 5 years 1946-50 ranged from about $100 to more than $200 a ton. As exports were predominantly of the shorter grades, these relatively high averages reflect the prices that asbestos-hungry industries in foreign lands are willing to pay.

It may be interesting to trace the destination of the substantial quantities of asbestos that are exported from the United States even under conditions of acute shortages. Such information for 1949 and 1950 is shown in table 18.

Current national policies directed toward betterment of economic conditions in foreign countries preclude drastic export restrictions. Nevertheless, export control is highly desirable, because, under present conditions of asbestos scarcity and its essentiality, security needs may weigh more heavily than the needs of foreign consumers or other possible justifications for foreign trade.

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TABLE 18.--Exports of unmanufactured asbestos from the United States, by destination, in 1949 and 1950, in long tons

(Dept. of Commerce, Bureau of the Census)

Area of Destination	1949	1950
Latin America	1,412	1,817
United Kingdom	729	28
Continental Europe	9,986	10,663
Other countries	3,606	4,368
Total	15,733	16,876

Foreign Trade of Canada

As Canada is the principal source of supply of asbestos for the United States and a substantial source for many other countries, figures have been compiled in some detail indicating Canada's trade with foreign countries and the proportion of the more critical types shipped to the leading consuming nations. Table 19 presents the data thus assembled. Of the more important grades - crudes and mill fibers -- produced in Canada in 1948, about 70 percent was shipped to the United States, 10 percent to the United Kingdom, and 18 percent to other countries. The remaining 2 percent represents consumption and stocks in Canada. In 1949 the proportion to the United States dropped to 65 percent and the proportions to the United Kingdom and to other countries remained the same as in 1948, while domestic consumption and stocks rose to 7 percent. In 1950 there was a further reduction to 59 percent in the proportion shipped to the United States; shipments to the United Kingdom remained the same, but the proportion shipped to other countries rose from 18 to 26 percent.

Shipments of crudes and mill fibers from Canada to countries other than the United Kingdom and the United States reached large proportions before World War II, attaining a high of 55 percent in 1938. During the war, however, such shipments declined greatly, reaching a low of only 7 percent in 1942. Since the war the percentage has risen gradually, ranging from 18 to 26 percent during 1945-50. Such recovery reflects the rehabilitation of the asbestos-products plants of central Europe and the increasing demands of the Latin-American countries. Because of the urgency of the needs for asbestos in the United States and the United Kingdom, neither Central Europe nor South America is receiving as much as it desires.

Foreign Trade of Southern Rhodesia

Rhodesia has a very small asbestos-products-manufacturing industry which is gradually expanding. One new plant was built in Salisbury

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during recent years. Accordingly, a large percentage of the asbestos produced is exported. The destination of exports for the period 1936-48 is indicated in table 20. Before World War II, 70 to 80 percent of the exports were consigned to the United Kingdom and other European countries. During the war continental Europe received very little, and the quantities shipped to the United States increased from a prewar 6 to 12 percent to a maximum of 58 percent in 1943 to supply war needs. Australia also received much larger quantities during the war than in the 1930's. Recently about half of the exports have been consigned to the United Kingdom, 15 to 20 percent to the United States, and the remainder chiefly to continental European countries, Australia, India, and South America.

Foreign Trade of the Union of South Africa

Exports of asbestos from the Union of South Africa present a confusing statistical problem until the figures are understood. From 1936-39, as indicated in table 21, exports fell just a little below total production, which is to be expected, as the country had a quite small asbestos-products manufacturing industry at that time. Beginning with 1940, however, exports increased greatly and presented a seeming paradox in that the quantity exported exceeded greatly, year after year, the total quantity produced. For instance, in 1944 the Union produced 31,372 metric tons and exported 52,869. The key to the solution of this problem is nearby Swaziland. In 1939 the Havelock mine in Swaziland began to produce, and by 1940 its output exceeded 18,000 tons. This was the first year in which exports from the Union far exceeded production within its borders. The Havelock mine is close to the Transvaal border, and the asbestos is carried by cableway to Barberton and shipped from that point in the Union of South Africa. In the preface to the official report (Annual Statement of Trade and Shipping of the Union of South Africa), it is stated that export figures include shipments from Swaziland. Accordingly, to get a true picture of the proper balance between production and exports, the output of Swaziland must be added to that of the Union to obtain a complete figure of the supply available for export, because exports comprise fiber from both sources.

Table 22 shows the production of both regions, as well as total exports and exports by country of destination. Exports are somewhat erratic in distribution; they do not show a constant pattern from year to year. For instance, in 1945, 24 percent of the exports came to the United States, 57 percent to the United Kingdom, and 17 percent to other European countries. In 1946 the United States received 21 percent, the United Kingdom only 25 percent, other European countries 32 percent, and Australia 17 percent. For the total period covered in this table, up to 1946 the United Kingdom has received about 48 percent of the exports and the United States about 24 percent. For the period 1947-50 export data are available only for the production of the Union.

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TABLE 19.--Salient Statistics of the Canadian Asbestos Industry, 1935-50

(Based on Dominion Bureau of Statistics data)

	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Production, total, crudes, fibers, and shorts, short tons	210,467	301,287	410,026	289,793	364,472	345,581	477,846	439,460	467,196	419,265	466,896	558,181	661,821	716,769	574,906	875,344
Same in metric tons	190,931	273,322	371,967	262,894	330,642	313,504	433,492	398,669	423,831	380,349	423,559	506,371	600,391	650,239	521,543	794,107
Production, crudes and fibers only, short tons	104,548	136,728	204,093	166,008	197,113	183,966	226,612	202,719	219,905	191,780	220,748	228,976	223,154	242,930	195,235	306,098
Same in metric tons 1/	94,844	124,037	185,149	150,599	178,817	166,890	205,578	183,903	199,493	173,979	200,258	207,722	202,441	220,381	177,113	277,690
Exports, total, crudes, fibers, and waste, metric tons	181,628	266,915	354,747	262,073	313,902	305,336	411,771	387,782	401,879	359,185	399,665	471,901	577,780	626,355	485,340	752,940
Exports, crudes and mill fibers only, metric tons	90,867	123,873	178,278	150,360	168,954	164,787	199,804	182,569	193,072	166,203	191,078	195,835	203,795	215,863	165,356	263,666
Exports to United Kingdom, total, metric tons	7,420	10,326	18,552	22,618	27,369	49,399	32,320	23,489	34,788	20,930	34,080	24,989	28,863	34,684	26,171	47,532
Exports to United Kingdom, crudes and milled fibers only, metric tons	4,159	6,184	12,785	18,140	20,512	38,325	25,175	20,066	24,984	14,540	26,126	20,922	18,522	22,166	17,289	27,136
Percent of Canadian production, crudes and milled fibers exported to United Kingdom	4	5	7	12	12	23	12	11	13	8	13	10	9	10	10	10
Exports to United States, total metric tons	139,587	203,002	249,387	151,379	204,171	205,052	352,125	351,781	354,739	318,353	370 63	396,922	505,898	544,080	418,627	605,095
Exports to United States, crudes and mill fibers only, metric tons	55,392	70,480	89,081	49,281	70,271	76,749	147,630	150,249	145,971	132,314	122,861	136,167	146,813	153,182	115,029	164,571
Percent of Canadian production, crudes and mill fibers, exported to United States	58	57	48	33	39	46	72	82	73	76	61	66	72	70	65	59
Exports to other countries, total metric tons	34,621	53,587	86,808	88,076	82,362	50,885	27,326	12,512	12,352	19,902	44,022	49,990	43,019	47,591	40,542	100,314
Exports to other countries, crudes and mill fibers only, metric tons	31,336	47,209	76,412	82,939	78,171	49,713	26,999	12,254	22,117	19,349	42,091	38,746	38,460	40,515	33,038	71,959
Percent of Canadian production, crudes and mill fibers, exported to other countries	33	38	41	55	44	30	13	7	11	11	21	19	19	18	18	26
Percent of production represented by consumption and stocks (production minus exports) 2/	5	0	4	0	5	1	3	0	3	5	5	5	0	2	7	5

1/ Canadian production in short tons, converted to metric tons.
2/ Imports negligible.

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TABLE 20.--Salient statistics of the Rhodesian asbestos industry, 1936-50, in metric tons

(Based on annual reports, chief Government mining engineer and chief inspector of mines, Southern Rhodesia)

	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Production	51,116	51,722	53,352	52,900	50,909	40,037	50,623	52,749	52,882	51,119	50,686	49,073	62,502	72,246	64,888
Total exports	46,472	58,471	53,170	46,278	52,518	49,191	56,546	51,149	42,415	45,587	56,014	51,097	61,473	66,050	66,931
Exports to United States	3,725	7,274	3,075	4,777	7,525	11,502	11,789	29,486	6,174	2,069	4,061	9,963	9,201	12,314	10,266
Percent of total exports shipped to United States	8	12	6	10	14	23	21	58	15	5	7	19	15	19	15
Exports to United Kingdom	16,898	20,778	18,018	19,179	23,241	14,360	17,354	10,481	16,000	15,875	23,784	23,319	32,446	33,887	36,261
Percent of total exports shipped to United Kingdom	36	36	34	41	44	29	31	20	38	35	43	46	52	51	54
Exports to other European countries	21,200	23,017	23,275	14,051	5,284	316	272	545	889	11,170	13,161	6,323	5,966	6,636	2,672
Percent of total exports shipped to other European countries	45	39	44	30	10	1	--	1	2	25	23	12	10	10	4
Exports to South America	252	575	777	928	1,459	1,552	2,323	1,769	3,551	3,357	2,961	2,234	2,816	1,189	2,496
Percent of total exports shipped to South America	1	1	1	2	3	3	4	3	8	7	5	4	4	2	4
Exports to Australia and New Zealand	1,965	3,094	2,996	3,420	7,410	13,421	17,267	6,622	9,173	7,886	4,833	5,849	6,958	4,122	--
Percent of total exports shipped to Australia and New Zealand	4	5	6	7	14	27	31	13	21	17	9	11	11	6	--
Exports to India	913	1,600	3,083	1,839	5,562	7,403	6,844	1,361	5,596	4,641	5,745	3,175	4,926	5,851	6,690
Percent of total exports shipped to India	2	3	6	4	11	15	12	3	13	10	10	6	8	9	10
Exports to Japan	1,035	1,534	1,417	1,606	1,123	--	--	--	--	--	--	--	--	--	--
Percent of total exports shipped to Japan	2	3	3	3	2	--	--	--	--	--	--	--	--	--	--

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	1946	1947	1948	1949	1950
Production, total, crudes, fibers, and shorts, short tons	558,181	661,821	716,769	574,906	875,344
Same in metric tons	506,371	600,391	650,239	521,543	794,107
Production, crudes and fibers only, short tons	228,976	223,154	242,930	195,235	306,098
Same in metric tons 1/	207,722	202,441	220,381	177,113	277,690
Exports, total, crudes, fibers, and waste, metric tons	471,901	577,780	626,355	485,340	752,940
Exports, crudes and mill fibers only, metric tons	195,835	203,795	215,863	165,356	263,666
Exports to United Kingdom, total, metric tons	24,989	28,863	34,684	26,171	47,532
Exports to United Kingdom, crudes and milled fibers only, metric tons	20,922	18,522	22,166	17,289	27,136
Percent of Canadian production, crudes and milled fibers exported to United Kingdom	10	9	10	10	10
Exports to United States, total metric tons	396,922	505,898	544,080	418,627	605,095
Exports to United States, crudes and mill fibers only, metric tons	136,167	146,813	153,182	115,029	164,571
Percent of Canadian production, crudes and mill fibers, exported to United States	66	72	70	65	59
Exports to other countries, total metric tons	49,990	43,019	47,591	40,542	100,314
Exports to other countries, crudes and mill fibers only, metric tons	38,746	38,460	40,515	33,038	71,959
Percent of Canadian production, crudes and mill fibers, exported to other countries	19	19	18	18	26
Percent of production represented by consumption and stocks (production minus exports) 2/	5	0	2	7	5

1/ Canadian production in s
2/ Imports negligible.

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From a strategic standpoint, amosite is the most important fiber produced in the Union. Accordinly, table 23 is presented to show exports by country of destination. It is evident from this table that exports to the United States in 1950 declined considerably, while exports to the other principal marketing areas were maintained at a high level. This situation is due in some measure to the fact that much of the recent increase in production is said to be of the shorter grades, which are not acceptable for United States requirements. These shorter grades are, however, suitable for the manufacture of shingles and other asbestos-cement products and are shipped for such uses to Europe and Australia.

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TABLE 21.--Asbestos produced in and exported from the Union of South Africa and Swaziland, 1936-50

(Annual Statement of Trade and Shipping of the Union of South Africa, and Union of South Africa, Dept. of Mines)

Year	Production in the Union				Production in Swaziland, metric tons	Total both regions, metric tons	Exports	
	Transvaal, short tons	Cape Province, short tons	Total, short tons	Total metric tons			Metric tons	Value
1936	21,188	4,048	1/ 25,236	1/ 22,894	--	22,894	22,415	£ 326,464
1937	23,921	4,712	1/ 28,633	1/ 25,975	--	25,975	25,238	427,557
1938	16,505	6,484	1/ 23,176	1/ 21,025	--	21,025	19,938	422,156
1939	15,827	5,144	1/ 22,050	1/ 20,003	7,233	27,236	20,535	514,119
1940	21,011	6,381	27,392	24,849	18,873	43,722	39,446	934,417
1941	21,704	6,576	28,280	25,422	19,166	44,588	39,542	990,756
1942	27,278	7,281	34,559	31,351	23,219	54,570	50,097	1,348,977
1943	27,768	7,888	35,656	32,346	17,179	49,526	45,524	1,256,902
1944	26,747	7,835	34,582	31,372	29,628	61,000	52,869	1,507,256
1945	20,016	8,200	28,216	25,597	21,243	46,840	36,560	1,095,330
1946	12,636	7,589	20,225	18,348	29,155	47,503	43,448	1,256,160
1947	21,959	8,183	30,142	27,344	25,360	52,704	2/30,152	2/ 927,371
1948	37,434	8,301	45,735	41,490	29,421	70,911	2/34,972	2/1,138,792
1949	58,918	11,999	70,917	64,334	30,814	95,148	2/57,541	2/2,600,323
1950	72,113	15,211	87,324	79,219	29,635	108,854	2/63,945	2/3,472,457

1/ Includes small production in Natal.
2/ Exports of asbestos produced in Union only.

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1950	72,113	15,211	87,324	64,334 79,219	30,614 29,635

1/ Includes small production in Natal.
2/ Exports of asbestos produced in Union only.

TABLE 22.--Salient Statistics of the asbestos industry of the Union of South Africa and Swaziland 1935-50, in metric tons

(Based on Annual Statement of Trade and Shipping of the Union of South Africa, and Union of South Africa Dept. of Mines)

	1935	1936	1937	1938	1939	1940	1941	1942	1943	1944	1945	1946	1947	1948	1949	1950
Production in Union of South Africa	20,600	22,894	25,975	21,025	20,003	24,849	25,422	31,351	32,346	31,372	25,597	18,348	27,344	41,490	64,334	79,219
Production in Swaziland	--	--	--	--	7,233	18,873	19,166	23,219	17,179	29,628	21,243	29,155	25,360	29,421	30,814	29,635
Total production both regions	20,600	22,894	25,975	21,025	27,236	43,722	44,588	54,570	49,526	61,000	46,840	47,503	52,704	70,911	95,148	108,854
Total exports 1/	21,513	22,415	25,238	19,938	20,535	39,446	39,542	50,097	45,524	52,869	36,560	43,448	2/ 30,152	2/ 34,972	2/ 57,541	2/ 63,945
Exports to United States	1,010	1,704	2,731	2,854	6,450	7,971	16,339	20,428	21,092	17,097	8,776	9,011	2/ 15,283	2/ 14,195	2/ 15,940	2/ 11,995
Percent of total exports shipped to United States	5	8	11	14	31	20	41	41	46	32	24	21	3/ 51	3/ 41	3/ 28	3/ 19
Exports to United Kingdom	11,144	12,348	13,551	9,869	8,007	26,716	17,240	23,349	18,214	23,525	20,973	10,967	2/ 6,709	2/ 8,938	2/ 15,531	2/ 17,630
Percent of total exports shipped to United Kingdom	52	55	54	49	40	68	44	47	40	44	57	25	3/ 22	3/ 26	3/ 28	3/ 28
Exports to other European countries	4,718	3,427	4,121	3,016	3,971	911	--	1,361	372	4,708	6,089	14,034	2/ 5,183	2/ 6,639	2/ 14,474	2/ 17,268
Percent total exports to other European Countries	22	11	16	15	19	2	0	3	1	9	17	32	3/ 17	3/ 19	3/ 25	3/ 27
Exports to Australia and New Zealand	2,001	2,219	1,588	1,701	561	1,802	1,896	4,099	796	1,726	167	7,172	2/ 1,263	2/ 2,413	2/ 5,662	2/ 7,597
Percent of exports to Australia and New Zealand	9	10	6	9	3	5	5	8	2	3	0	17	3/ 4	3/ 7	3/ 10	3/ 12
Exports to India	270	330	468	892	--	--	3,012	--	3,416	4,799	--	2,002	--	--	--	--
Exports to Japan	2,088	2,207	2,517	1,461	1,379	1,943	--	--	--	--	--	--	--	--	2/ 364	2/ 718
Percent of total exports shipped to Japan	9	10	10	7	7	5	--	--	--	--	--	--	-	--	3/ 1	3/ 1

1/ Includes exports of Swaziland asbestos, 1935-46.
2/ Trade of Union only; does not include product of Swaziland.
3/ Percent of total exports of asbestos produced in Union.
NOTE: Exports in 1950 to Latin America, 6,313 metric tons or 10 percent of total exports.

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TABLE 23.--Exports of amosite from the Union of South Africa, by country of destination, 1946-50, in short tons

(Union of South Africa, Dept. of Mines)

Year	Total exports	Exports to United States	Exports to United Kingdom	Exports to other European countries	Exports to Australia and New Zealand
1946	12,540	6,322	2,928	2,333	882
1947	19,659	11,002	4,986	1,833	1,288
1948	27,635	12,182	7,052	4,472	2,566
1949	39,267	13,194	12,541	7,746	4,613
1950	37,175	8,342	12,097	7,093	7,799

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X. MARKETING

General Features

Asbestos is used in so many diverse products that its markets are numerous and widespread and its marketing complex. With increasing diversity in use and great expansion in long-established uses, the consumption of asbestos has increased steadily.

Some fiber is handled by agents or jobbers, but most of it is shipped direct from mine to consumer. Fiber length and quality are usually guaranteed. The larger manufacturers of asbestos products have their own testing machines and can check a producer's classification. The producer is generally so familiar with manufacturing conditions that he can prepare the material to suit each particular use.

Asbestos is sold in 100- or 125-pound bags on a short-ton basis, bags included. Canadian quotations are f.o.b. mines. Quotations on African fibers are usually f.o.b. port of embarkation, such as Beira or Lourenco Marques. The weight of a given volume varies with fiber length; the longer fibers are bulkier. The volume of a short ton ranges from 60 to 90 cubic feet. A minimum carload of fiber is 20 tons and of refuse and shorts 30 tons. Settlements usually are made on the basis of 2 percent discount within 10 days, or 30 days net.

Market requirements are based principally on fiber length, but strength, flexibility, color, chemical composition, and cleanliness may have an important bearing on use. The principal market outlets are indicated in the following brief summary of uses.

The longer and more valuable crudes and mill fibers are used in manufacturing woven brake linings, electrical insulation products, textile fabrics, packings, and gaskets. The next lower grades are used in making asbestos-cement products such as pipe for underground use, flue pipe, roofing shingles, lumber, and corrugated sheathing. Shorter fibers are used for paper and millboard manufacture and the lowest grades for heat-insulating cements, molded articles, and fillers in such products as asphalt tile. There are multitudes of other uses.

Most of the world supply of raw asbestos is in strong hands, and distribution is to asbestos-products manufacturers, most of whom are also strong, well-organized concerns.

The largest producer in the world, Canadian Johns-Manville Corp., and several other important producers such as Turner & Newall, Ltd., Bell Asbestos Mines, the Quebec Asbestos Corp., Nicolet Asbestos Co., Flintkote Co., and Vermont Asbestos Mines, are of the vertical type.

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that is, they mine and mill the raw materials and fabricate the finished products. The asbestos from these so-called captive mines provides first of all, raw materials for the company-owned manufacturing plants; and the surplus, together with grades that cannot be used, is sold to other consumers. These companies also purchase fibers from other producers, because generally they do not produce the full range of fibers that they use. Some important producers however, such as Asbestos Corporation, Ltd., and Johnson's Co., are producers only, having no asbestos-product-manfuacturing facilities.

Necessity for a Balanced Market

In any asbestos deposit, the length of the fibers varies considerably from point to point. Thus, when the total fiber recovered is classified into grades according to length, quite a number of grades may result. Canadian asbestos, for instance, falls into seven major grades, ranging from the longest (Crude No. 1) to the very short fibers in the classification "refuse and shorts." Most of the major groups are divided into several subgroups. The proportions falling in the several grades are fairly constant for any one deposit; and, as the miner has to take the rock as it comes, he has little control over the proportions of the various grades in his mill product. The demand for certain grades may be stronger than for others; during some periods in the past, when the supply of most grades exceeded the demand, producers were obliged to stock up on the less salable types or sell them at a sacrifice. Success in an asbestos-mining enterprise under such conditions depended to some extent upon developing a balanced market that would absorb all grades, roughly in the proportion in which they were produced. During the past 5 years, however, the demand for all grades has exceeded supply, and marketing problems have therefore been simplified. When, under emergency conditions, abnormal demands for some grades develop, specifications should be modified as much as possible toward easing the pressure on the critical grades. For certain uses, grades are interchangeable to come extent, and in such instances the maximum use of the most plentiful grade is to be encouraged. Where grades are interchangeable, a price differential favoring the more abundant type will tend to keep demand in step with supply.

Sale and Distribution Practices

Virtually all of the important asbestos deposits of the world, except those in Soviet Russia, are within the British Empire. Such deposits are those in Canada, Southern Rhodesia, Union of South Africa, Swaziland, Australia, and Cyprus. British Empire needs naturally receive first attention, but large quantities of asbestos are shipped to outside countries. During World War II the Combined Raw Materials Board worked out plans for equitable distribution of Canadian and African asbestos between the United States and Great Britain, and the allocations were quite satisfactory. Since the war, the United States has been receiving a somewhat smaller proportion of the spinning and

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strategic grades. For instance the United States received 76 percent of the total Canadian exports of these grades in 1944, and only 59 percent in 1950. Amosite imports into the United States were a little higher in 1944 than in 1949 (15,660 short tons compared with 14,892), but such imports declined greatly in 1950 (See Table 16). The C. & G. Nos. 1 and 2 grades imported from Southern Rhodesia show a similar picture. The United States imported only 4,175 tons in 1949 and 3,968 tons in 1950 compared with 6,009 tons in 1944 (See Table 15). On the other hand, the United States receives at all times a very large proportion of the shorter grades of Canadian fiber.

Quebec asbestos production is in the hands of a number of operators. Canadian Johns-Manville is the leading producer, but there are four other large and several smaller independently owned companies. The Quebec Miners' Association is an industry organization.

The distribution of Canadian asbestos is strongly influenced by control of individual companies. Most of the output is from captive mines whose products are used principally in the manufacturing plants of the mine owners, but surplus asbestos and the output of independent producers enter normal distribution channels. The way in which customers' orders are filled may seem arbitrary at times, but the rejection of orders, or allocations on a reduced basis, has been due in large measure to the shortage of supply that has characterized recent years. One authority in the asbestos production field claims that world production of group 4 or its equivalent is less than two-thirds of that needed to supply plants in the world now using these grades even for operation at 85 percent of capacity. During this stringency of supply, the establishment of new asbestos-products industries has been difficult because new customers are at a disadvantage in having orders filled for raw asbestos as producers customarily give preference to old customers, and when supplies are short the newcomers may get nothing.

The distribution of asbestos to continental Europe is an important factor. The asbestos-products industries, which were virtually paralyzed during the recent war, are now endeavoring to re-establish their activities. As they have little or no domestic fiber resources, they depend chiefly upon Africa and Canada for supplies. Substantial quantities are now being obtained from Africa, but imports from all sources are inadequate. Canada is shipping what it can and is allocating available supplies on the basis of prewar consumption of each plant. Obviously newcomers are at a decided disadvantage.

SAIAC (Switzerland Société Anonyme International de l' Asbestos Ciment) has been mentioned as an organization that exerts some influence over asbestos distribution. According to a press report 1/

1/ Rock Products, Great European asbestos cartel formed: Vol. 33, No. 21, October 11, 1930; p. 48.

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this international organization established in the 1920's had among its objectives a provision for mutual assistance among its members in securing the necessary raw materials on the best terms. The organization is said to be concerned primarily with the grades of asbestos used in making asbestos-cement products.

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XI. PRICES

Price History

Prices of Canadian asbestos have fluctuated greatly since the close of World War I. In 1920 they sky-rocketed to unprecedented heights, Crude No. 1 selling for more than $3,000 a ton. In 1921 the price dropped to less than half that amount, and by 1925 the highest grades were selling at only about one-eight of the price received in 1920. Figure 6, which appears in an Atlas of World Mineral Resources published by the Department of Geography, University of Maryland, shows the general trend of prices of Canadian fibers and shorts from 1929 to 1950. Figure 7 shows price history by grades. Table 24 shows prices of the better grades of Canadian asbestos from 1926 to 1950. Except for the depression years in the early 1930's, the trend has been generally upward. Prices have virtually doubled during the 25 years shown in this table, and they advanced in 1951.

Table 25 shows prices of the better grades of Vermont asbestos from 1931 to 1950. The upward movement was more rapid for the Vermont than for the Canadian fibers, the 1950 figures being two-and-one-half to three times as great as those of 1931.

The wide demand for all grades of asbestos and the general inadequacy of supply tend to elevate prices abnormally, a situation that may be aggrevated further as the demands of national defense increase.

Table 26 shows the price range of African asbestos during recent years. Only small proportions of the varieties covered in this table are sold in the open market. Turner & Newall, Ltd., and the Cape Asbestos Co., which handle the major part of the supplies, allocate materials available for export to America to the several consuming companies. As supplies were short during 1950 and 1951, the fiber was prorated to consumers in proportion to their normal allotments, and the price trend has been sharply upward.

PRICES OF CANADIAN FIBERS

Figure 6

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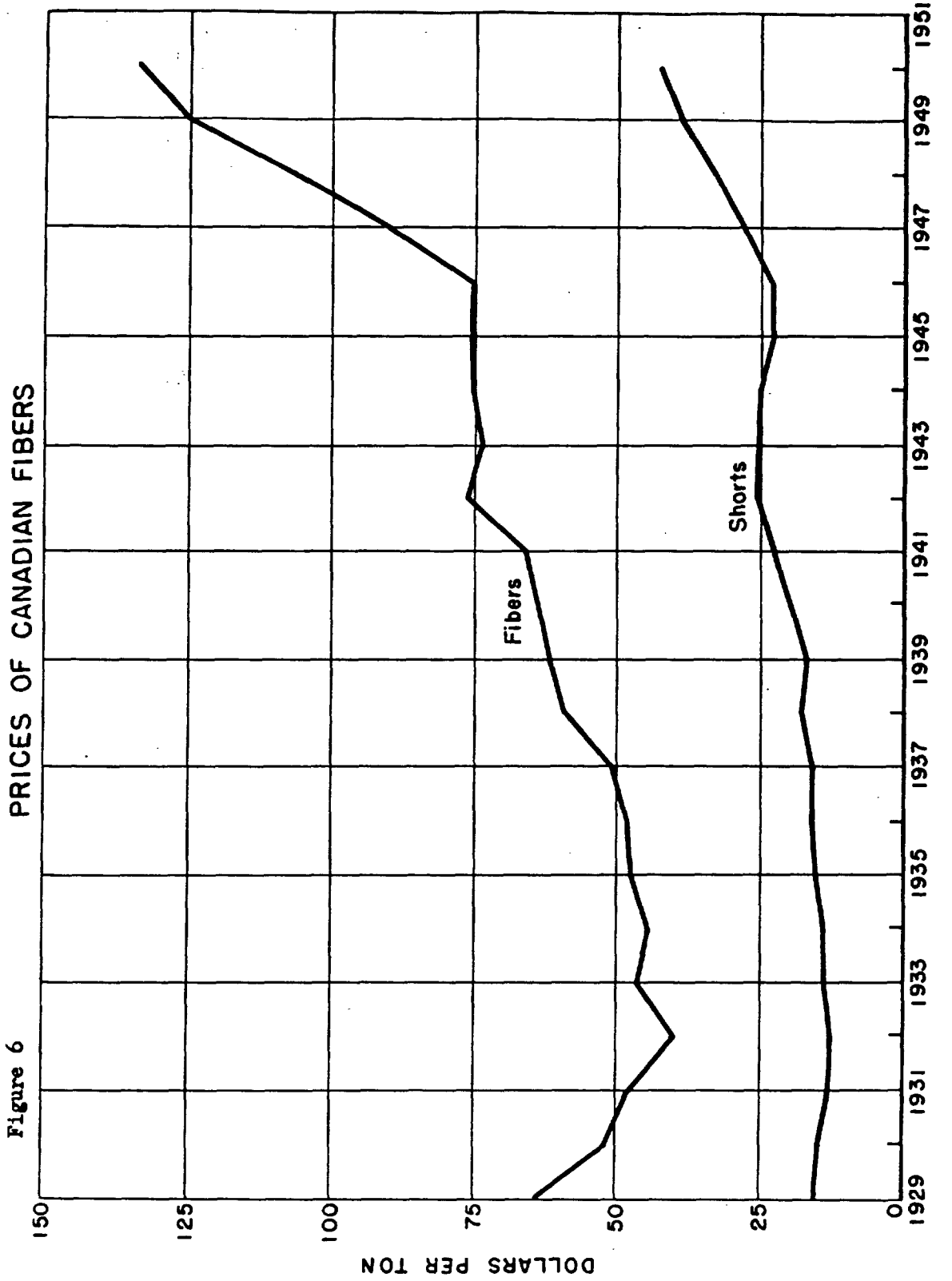


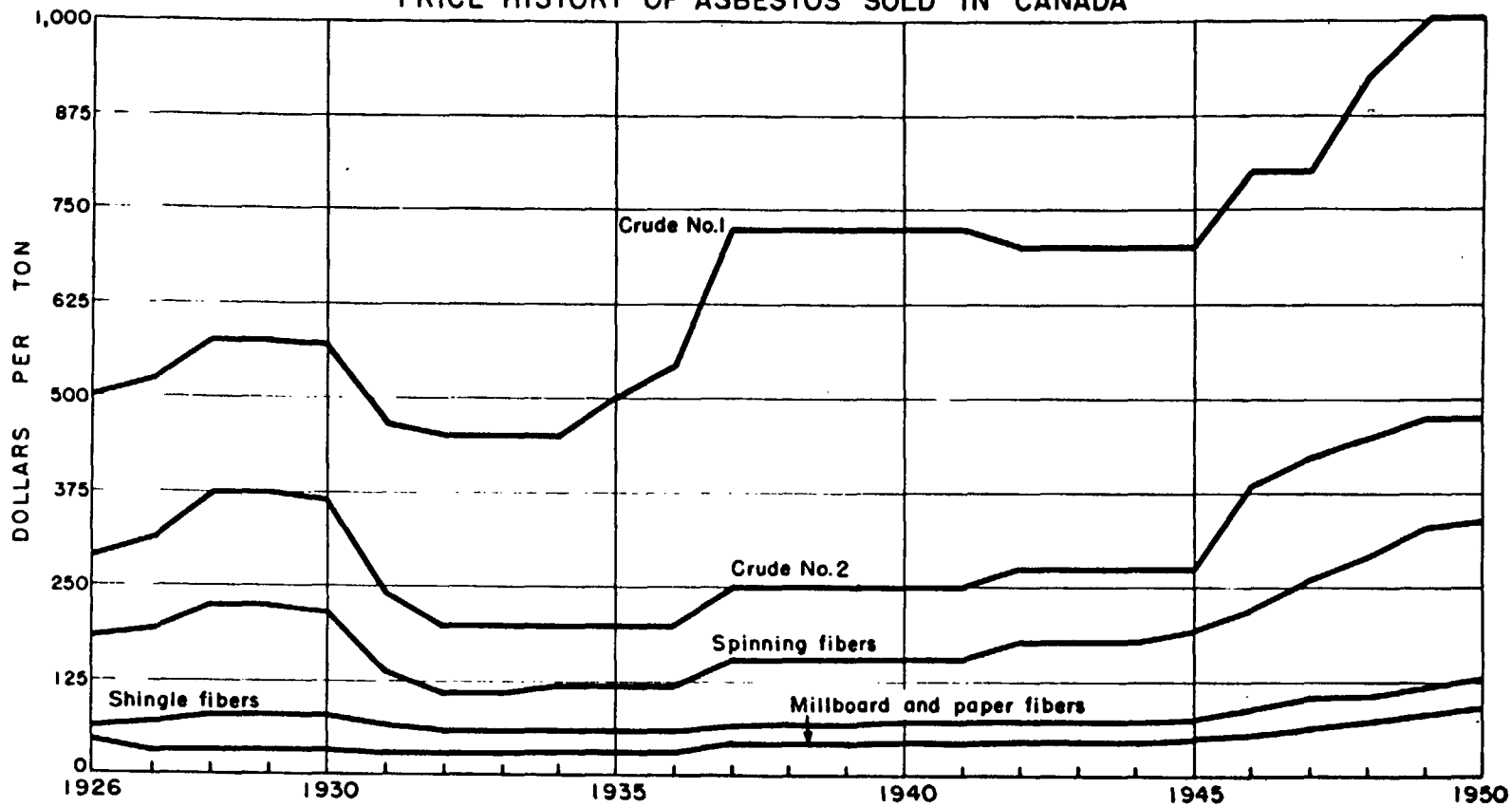
Figure 6

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Figure 7

PRICE HISTORY OF ASBESTOS SOLD IN CANADA



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TABLE 24.--Price History of asbestos sold in Canada, in dollars per short ton, 1926-50 1/

Year	Crude No. 1	Crude No. 2	Spinning fibers	Shingle fibers	Millboard and paper fibers
1926	$504.16	$289.58	$185.00	$65.00	$45.00
1927	525.00	312.50	193.75	70.83	39.17
1928	575.00	375.00	225.00	80.00	35.00
1929	575.00	375.00	225.00	80.00	35.00
1930	570.83	362.50	216.67	78.33	34.17
1931	466.67	241.67	135.00	65.00	30.00
1932	450.00	200.00	110.00	60.00	30.00
1933	450.00	200.00	110.00	60.00	30.00
1934	450.00	200.00	120.00	60.00	32.50
1935	500.00	200.00	120.00	60.00	32.50
1936	545.83	200.00	120.00	60.00	32.50
1937	725.00	250.00	155.00	66.75	42.50
1938	725.00	250.00	155.00	67.75	42.50
1939	725.00	250.00	155.00	67.75	42.50
1940	725.00	250.00	155.00	71.25	44.75
1941	725.00	250.00	155.00	71.25	44.75
1942	700.00	275.00	178.75	72.50	46.75
1943	700.00	275.00	178.75	72.50	46.75
1944	700.00	275.00	178.75	72.50	46.75
1945	700.00	275.00	192.00	76.25	48.50
1946	900.00	385.00	220.50	88.75	55.75
1947	900.00	423.75	262.50	104.75	65.75
1948	928.00	447.50	291.25	106.25	73.75
1949	1,005.00	475.00	328.50	118.25	83.25
1950	1,005.00	475.00	337.50	130.00	91.00

1/ Figures for 1926-36 from Dominion Bureau of Statistics, yearly averages; for 1937-50 figures are from magazine Asbestos, furnished by Canadian producers, averages of December range for each year.

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TABLE 25.--Prices of Vermont asbestos, in dollars per short ton, 1931-50 1/

Year	Shingle fiber	Paper fiber	Cement stock 2/	Year	Shingle fiber	Paper fiber	Cement stock
1931	$50.71	$35.00	$20.00	1941	$58.50	$44.00	$30.00
1932	42.92	32.92	20.00	1942	64.00	48.50	33.00
1933	42.92	32.71	20.25	1943	64.00	49.00	33.00
1934	45.00	35.00	23.00	1944	64.00	49.00	33.00
1935	46.25	35.00	23.00	1945	64.00	49.00	33.00
1936	47.50	35.00	23.00	1946	79.00	55.75	39.00
1937	57.00	40.00	25.00	1947	97.50	69.00	48.50
1938	57.00	40.00	25.00	1948	102.00	76.75	51.00
1939	57.00	40.00	25.00	1949	117.75	87.75	59.00
1940	57.00	40.00	25.00	1950	135.55	96.50	64.90

1/ Average of quotations, Metal & Mineral Markets.
2/ "Cement stock" classification changed to "Waste" since 1940.

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TABLE 26.--Price quotations per short ton of African asbestos, 1936-50

(Prices 1936-41 E. & M. J. Metal and Mineral Markets)

Year	Rhodesian chrysotile		Amosite		Crocidolite	
	No. 1	No. 2	B-1	B-3	B	MS or S
1936	$210	$185	$ -	$ -	$ -	$ -
1937	250	225	-	-	-	-
1938	300	260	140	120	450	140
1939	300	260	140	120	400	140
1940	300	260	150	120	400	150
1941	300	260	150	120	400	150
1942	-	-				
1943	-	-				
1944 1/	330	236	140	123	-	-
1945	325 2/	223 2/	5/	5/	5/	5/
1946	325 2/	223 2/				
1947	296 2/	224 2/				
1948	350 2/ 3/	268 2/ 3/				
1949	387 2/	322 2/				
1950	418 4/	385 4/				

1/ Prices fixed by OPA for fiber supplied through Metals Reserve.
2/ F.o.b. Beira, South Africa. Data 1945-50 supplied by Jesse M. Weaver, Raybestos-Manhattan Inc.
3/ Average.
4/ F.o.b. U. S. port
5/ Data not available 1945-50. There is virtually no open market.

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XII. USES AND REQUIREMENTS OF USE

Textile Products

General features

Asbestos has a great variety of uses. For some of them the requirements are quite exacting. For others fibers of varying quality and character may be used, and grades are interchangeable to some extent, depending upon price and availability. The longer fibers (such as Canadian groups, 1, 2 and 3; Rhodesian C. & G. 1, C. & G. 2, and to some extent C. & G. 3 and VRA2; Swaziland HVL1 and HVL2; the longer African and Australian blue fibers; and Russian C-1, C-2 and I-2) are adaptable for making textile products (such as cloth, yarn, tape, rovings, etc.). The asbestos is spun and woven in much the same way as cotton, silk, or wool.

An outstanding characteristic of asbestos fabrics is their fireproof quality. Also they have superior heat-insulating properties but lower tensile strength than products made from other fibers. The low tensile strength is not due to lack of strength of the individual fibers, which in many instances are as strong as or stronger than silk; it is due to their shortness, because fiber lengths generally range from 1/4 to 3/4 inch. Because of the shortness and smoothness of the fibers, it is difficult to make a 100-percent asbestos cloth, and only small quantities, applied to specialized uses, as in electrolytic cells, are now manufactured.

To give adequate strength to asbestos fabrics, cotton, rayon, or other organic fibers are blended with the asbestos in varying proportions. As the organic fiber content is increased the strength increases, but the resistance to heat decreases. Accordingly, the proportion of organic fiber is adjusted to suit the conditions of end use. The higher the asbestos content, the more difficult are the manufacturing processes, but these difficulties may be overcome to some extent by making a heavier cloth. Table 27 presents the standard code under which asbestos fabrics are classified and the heat resistance of each grade. 1/

Asbestos fabrics are used extensively for lagging cloth, brakeband linings, clutch facings, safety clothing, curtains, packings, gaskets, and various other applications.

1/ Tucker, J. L. Blending Fibers for Fabrication of Asbestos Textiles: Asbestos vol. 32, No. 12, June 1951, pp. 4-11.

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TABLE 27.--Asbestos content and heat resistance of Asbestos Fabrics

Grade	Asbestos content, percent	Maximum temperature for end use, degrees Fahrenheit
Commercial	75 to, but not including 80	350 - 400
Underwriters'	80 to, but not including 85	400 - 450
A	85 to, but not including 90	450 - 550
AA	90 to, but not including 95	550 - 600
AAA	95 to, but not including 99	600 - 750
AAAA	99 to, and including 100	750 - 900

Spinning-grade fibers are used also for certain nonspinning uses, such as compressed sheet packings and gaskets. Another important non-textile use is the manufacture of low-iron spinning-grade fibers into strong asbestos paper known as "Pyrotex". When used in tape form for wrapping electric wires, it is said to make a covering superior to that obtained by wrapping the wire with asbestos roving. 2/ Because of their superior electrical resistance, Rhodesian C. & G. 1 and C. & G. 2 are used for electric cable coverings and for primary electrical insulating on magnet wire.

For the purpose of this report, emphasis is placed on the uses of the strategic grades. The longer Canadian fibers, groups 1, 2 and 3, are used extensively for making woven fabrics, which are in turn manufactured into fire-proof clothing, gloves for handling hot metals, mechanical packings and gaskets, and lagging cloth used in large quantities by the Navy. Long fiber in the form of rovings is used as cable filler (material used to fill in spaces in groups of insulated cables on shipboard). Long fibers are also used in making compressed sheet packings of high strength for the high steam pressures now in general use.

Friction Materials

A very important use of asbestos fabrics is for the manufacture of friction materials. Such materials are brought into contact with moving members (brake drums, fly wheels, or other rotating equipment) in such a manner as to retard the free motion of the rotating part. The effect of the friction is to convert the kinetic energy of the moving member into heat. The best braking materials are those that convert the kinetic energy into heat the most rapidly and then dissipate the heat as quickly as possible. The friction material must also be

2/ Data from Jesse M. Weaver, March 1951.

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heat-resistant and nonflammable. Asbestos is regarded as indispensable in most types of friction materials.

Brake linings are of three principal types. In early days virtually all brake bands were of woven asbestos fabrics, but at the close of World War I the molded type was invented and is now used extensively. Molded linings are of several types, but all consist primarily of asbestos fibers bonded with an organic matrix. Metallic reinforcing, such as brass, zinc, or lead, is commonly added, and the shaped products are thoroughly cured. The asbestos required is chrysotile ranging in length from fibers just under spinning grades to those as short as 7-F in the Canadian classification. A preponderance of the shorter fibers is used because of the price advantage.

A second type of friction materials is the rubberized fabric lining. It consists of multilayer woven structures held together with wire-inserted asbestos yarn. The asbestos used is of spinning grades.

The third type is the woven brake lining made in roll form in a variety of widths and thicknesses. It permits a wide range of service with a relatively small inventory. Its general utility popularizes it, particularly in the industrial field. As such linings are woven fabrics, chrysotile of spinning grades is required.

The evolution of friction materials from the all-woven to a wide use of molded types has had a profound effect on the asbestos industry in that it has permitted a wide substitution of shorter fibers for the spinning grades. This is a fortunate circumstance because spinning fibers constitute a relatively small proportion of the asbestos recovered.

Friction materials are of primary strategic importance because they are essential to all types of mobile military equipment, as well as many kinds of industrial and oil-well machinery.

Miscellaneous Nontextile Uses

Fibers that are somewhat shorter, such as Canadian group 4, (to some extent groups 5 and 6), and Grade MS of Cape Blue, are used widely for asbestos-cement products. These consist of about 80 percent portland cement and 20 percent asbestos fiber. Roofing shingles, flat and corrugated siding, and asbestos-cement water, gas, oil, or sewer pipe are also well-known products.

Canadian groups 4 and 5 and African amosite are used extensively in making 85-percent magnesia block and pipe insulation. These products consist of about 85 percent basic magnesium carbonate, and about 15 percent asbestos.

Canadian group 5 is suitable for asbestos paper and millboard manufacture. Such products are made on standard papermaking machines.

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An important use of asbestos paper is for making the so-called air-cell pipe covering.

The shortest fibers are used for boiler and roofing cements and as filler in asphalt floor tile and various other products.

Interchangeability of grades

As pointed out elsewhere in this report, the asbestos miner has virtually no control over the percentage of the various grades produced. He must mine the rock as he finds it and extract from it all grades present, the proportions of which are fixed in nature. It is inevitable that some grades are more in demand than others, and the most desirable grades may be those that are in short supply. Thus shortages may develop for the preferred grades; and, at times, accumulation of stocks of the less valuable fibers. Currently, however, all grades are in demand.

To meet this condition, a great deal of research has been devoted to substitution of the more abundant grades for those that are less plentiful but more in demand. For instance, much work has been done on adapting Canadian group 6 fibers for use in asbestos-cement products for which groups 4 or 5 are preferred. It was found that a thorough fiberization permitting intimate contact between cement and fiber made it possible to use the group 6 short fibers successfully. Similar problems are under investigation constantly.

Uses of amosite

The uses of amosite, in order of importance, are:

(1) Lagging in felted form for high-temperature insulation up to 900°F. It is commonly used as a protective covering over 85-percent magnesia or other kinds.

(2) Felted, loosely compacted covering for marine turbines, jet engines, and similar applications. It is expecially well-adapted for this use because it does not pack under vibration, and if it becomes wet it dries without detriment to the product. Amosite insulation mattresses weigh only 9½ pounds per cubic foot; if made of chrysotile they would weigh 50 percent more and therefore would not conform with Navy specification.

(3) As a constituent of 85-percent magnesia. Some manufacturers of magnesia insulation use 40 to 60 percent amosite and the remainder of Canadian groups 4 or 5. When fibers of fair length are used, the proportion of fiber may be reduced, possibly as low as 11 percent. If shorter fibers are used, the percentage must be increased, possibly to 15 percent or more. The shorter the fibers that are used, the greater

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is the breakage loss in the finished product. Amosite furnishes long fibers at lower cost than those obtained by employing Canadian chrysotile. One product, "Unibestos", consists almost entirely of amosite. The 85-percent magnesia is used for temperatures up to about 550°F. above which the magnesia disintegrates. Unibestos is used for temperatures of 550° to 900°F. Another high-temperature insulating material named "Calsilite" consists of amosite, Canadian 3Z, and a siliceous binder. It is said to withstand temperatures up to 1,200°F.

An important special use for B-1 amosite is for insulating underground steam pipes. Its quality of moisture resistance prevents or reduces corrosion and electrolytic reaction detrimental to the pipes.

Another special use for amosite is for making a lightweight, fireproof wallboard (Marinite board) used for partitions on ships. The weight per cubic foot would be increased considerably if other fibers were substituted for amosite.

Uses of Crocidolite

Crocidolite (blue asbestos) is characterized by high tensile strength, acid resistance, and harshness in wet mix. The longer fibers are used for spinning and weaving. It is reported that during World War II the American Asbestos Co., Norristown, Pa., manufactured yarn from crocidolite in a small way, and Green Tweed & Co., North Wales, Pa., wove it into fabrics for chemically-resistant packing. According to current information, no spinning or weaving of blue fiber is carried on in the United States at present; these processes are conducted only in the United Kingdom. J. W. Roberts, Ltd., at Armley, Leeds, a subsidiary of Turner & Newall, specializes in woven products of blue fiber, particularly mattresses for locomotive-boiler lagging. Blue-asbestos fabrics for acid-resistant packings or for other uses in the United States are now imported. Canadian fiber cannot be substituted for blue asbestos in such packings. The shorter blue fibers are used extensively in the manufacture of asbestos-cement pipe, as both the high tensile stength and the harshness in wet mix adapt it well for such use. It was presumed during World War II that Canadian asbestos could be substituted for blue in an emergency but that methods of manufacturing asbestos-cement conduits, pressure pipe, and flue pipe would require many modifications, with probable changes in existing machinery. It was further presumed that much costly experimentation would be required and that the end product at its best might not be of a quality that would meet Underwriters' requirements or Government specifications, also that the modified methods and equipment would probably be obsolete when blue fiber again became available.

Recent developments have changed this situation considerably. Some of the harsh chrysotile mined in Quebec is substituted for blue fiber in asbestos-cement pipe manufacture with fair success. The new Munro mine in Ontario furnishes a harsh type of chrysotile that may,

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after further experimentation, replace blue fiber entirely. Accordingly, crocidolite is not as essential as was formerly supposed.

Long blue fibers are exceptionally well adapted for gas filters. Bolivian blue is preferred for this use. This is the only type of blue fiber that is regarded as strategic at this time.

Distribution of Asbestos According to Use

Much has been written on the multitudinous uses of asbestos, but little information is available on the quantities or proportions that are applied to the several uses. The classification by use, such as spinning fibers, cement stock, paper stock, and magnesia and compressed sheet fibers would seem to indicate distribution by use, but mixed grades are used so extensively that such a classification affords no criterion of the actual quantities applied to each use. Data on the grades, qualities, and quantities of fiber used, for instance, in asbestos-cement pipe, 85 percent magnesia, or brake-band linings are not easily available.

For the purpose of this report the distribution according to use of the strategic grades is of paramount importance. Fortunately a record of allocations by end use of strategic asbestos during World War II was made by the War Production Board, and these records furnish a basis for tables 28 and 29.

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TABLE 28.--Allocation of strategic grades of asbestos in 1944, by end use 1/ - Asbestos textiles

Product	Textiles from Canadian fiber, short tons	Textiles from Rhodesian C. & G. Nos. 1 & 2, short tons
Mechanical packings and gaskets	4,300	
Asbestos safety clothing	820	
Woven brake linings and clutch facings	6,700	
Navy lagging cloth	3,000	
Navy cable filler and conductor insulation 2/	4,000	4,000
Aircraft	675	
Navy and aircraft hose	135	
Laminated plastics		630
Electrical equipment, new and maintenance		1,500
Maintenance and repair other than electrical	1,000	
Asbestos yarn in flexible metal tubing	220	
Miscellaneous textile uses	1,600	
Total textiles	22,450	6,130
Asbestos content of textiles 3/	19,000	5,300
Deduct C. & G. 3 substituted for Canadian 4/	3,200	
Net allocation of Canadian	15,300	

1/ Compiled from records of WPB.

2/ The filler was probably Canadian fiber; the conductor insulation C. & G. Nos. 1 and 2; hence one-half of total is arbitrarily assigned to each.

3/ Assuming that 85% of textiles consists of asbestos fibers.

4/ WPB Conservation Order M-79 as amended October 1943 required 1 ton of Rhodesian C. & G. No. 3 be used with every 5 tons of Canadian 3R used in textile manufacture.

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TABLE 29.--Allocation of strategic grades of asbestos in 1944 by end use nontextile uses 1/

Product	Canadian spinning grades, short tons	African amosite, short tons
Compressed sheet packing	3R & 3T 3,000 2/	
Molded amosite insulation		5500
85% magnesia and other high-temperature insulation		4800
Navy felt insulation (light-weight blankets)		8700
Marine insulating board		2400
Sprayed insulation 3/		700
Total	3,000	22,100

1/ Compiled from records of WPB.
2/ Omitting 650 tons 3Z.
3/ Sprayed insulation also required 500 tons of Rhodesian C. & G. No. 3.

Total allocations indicated in tables 28 and 29 may be summarized as follows:

Canadian chrysotile spinning fibers, textile uses	15,800
Canadian chrysotile spinning fibers, nontextile uses	3,000
Total Canadian spinning fibers	18,800
Rhodesian chrysotile C. & G. Nos. 1 and 2	5,800
Amosite	22,100
Total strategic grades	46,700

In table 30, the allocations according to end use are compared with actual end use during 1944, also compiled by the WPB.

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TABLE 30.--Correlation of allocations and actual use of strategic grades of asbestos during 1944

Kind of asbestos	Allocations, short tons	Actual consumption, short tons
Canadian Groups 1, 2 and 3	18,800	18,122 1/
Rhodesian C. & G. Nos. 1 and 2	5,800	6,646
Amosite	22,100	15,698

1/ Canadian groups 1, 2 and 3, except 3%.

From this table it appears that there is a fair correlation, except for amosite, where actual use fell considerably below the allocations. However, the proportional distribution by use is probably fairly accurate.

On the basis of WPB figures as given in tables 23 and 29, the strategic grades of asbestos were distributed by use in 1944 approximately as indicated in table 31.

TABLE 31.--Allocation of asbestos by end use in 1944

	Percent
Canadian spinning fibers	
Woven brake linings and clutch facings	30
Mechanical packings and gaskets	19
Navy cable filler	18
Navy lagging cloth	13
Maintenance and repair other than electrical	4
Asbestos safety clothing	4
Aircraft	3
Asbestos yarn in flexible metal tubing	1
Miscellaneous textile uses	8
	100
Rhodesian C. & G. Nos. 1 and 2	
Navy cable insulation	65
Electrical equipment new and maintenance	25
Laminated plastics	10
	100
African amosite	
Navy felt insulation (lightweight blankets)	39
Molded amosite insulation	25
85% magnesia and other high-temp. insulation	22
Marine insulating board	11
Sprayed insulation	3
	100

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These proportions are to be regarded as approximations only. They might vary considerably from year to year depending upon circumstances, but at least they present a use pattern that existed under the war emergency. Under present conditions, the allocation by use for Canadian and Rhodesian spinning fibers would probably follow approximately the same pattern as that given in the preceding table, but the amosite proportions might change considerably. The manufacture of marine insulating board, used extensively by the Maritime Commission but not by the Navy, required about 2,400 tons of amosite in 1944. Although amosite makes a board of considerably lighter weight than one in which chrysotile is used, it is probable that a heavier board could be used if it became necessary to conserve amosite for more essential uses. Sprayed insulation is another product that might be eliminated from the list of uses requiring amosite. Very little of this type of insulation is now used by the Navy; and, when used by either the Navy or Maritime Commission, fiber glass may be employed in place of asbestos.

Directory of Asbestos Products Manufacturer:

There are over 100 manufacturers of asbestos products in the United States. The following lists include only the larger manufacturers of products that may be regarded as of greatest strategic importance at present.

Asbestos textile products

Company	Plant location
American Asbestos Textile Corp.	Norristown, Pa.
Asbestos Textile Co., Inc.	N. Brookfield, Mass.
Asten Hill Mfg. Co.	Philadelphia, Pa.
Carolina Asbestos Co.	Davidson, N. C.
Garlock Packing Co.	Palmyra, N. Y.
Johns-Manville Sales Corp.	Manville, N. J.
Keasbey and Mattison Co.	Ambler, Pa.
Raybestos-Manhattan, Inc.	Manheim, Pa.
	N. Charleston, S. C.
Russell Manufacturing Co.	Middletown, Conn.
Southern Asbestos Co.	Charlotte, N. C.
Standco Brake Lining Co.	Houston, Tex.
Tallman-McCluskey Fabrics Co.	Kirkwood, Mo.
Union Asbestos & Rubber Co.	Marshville, N. C.
U. S. Rubber Co.	Hogansville, Ga.

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Asbestos packings and gaskets

Company	Plant location
American Asbestos Textile Corp.	Norristown, Pa.
Atlas Asbestos Co.	North Wales, Pa.
Colt's Patent Fire Arms Co.	Hartford, Conn.
Crane Packing Co.	Chicago, Ill.
Detroit Gasket & Mfg. Co.	Detroit, Mich.
Garlock Packing Co.	Palmyra, N. Y.
Goodyear Tire & Rubber Co.	Akron, Ohio
Green Tweed & Co.	North Wales, Pa.
Johns-Manville Products Corp.	Manville, N. J.
	Waukegan, Ill.
Keasbey & Mattison Co.	Ambler, Pa.
Philip Carey Mfg. Co.	Cincinnati, Ohio
Raybestos-Manhattan Inc.	Manheim, Pa.
	Stratford, Conn.
	North Charleston, S. C.
Rubber & Asbestos Corp.	Bloomfield, N. J.
Union Asbestos & Rubber Co.	Marshville, N. C.

85-percent magnesia insulation

Company	Plant location
Ehret Magnesia Mfg. Co.	Valley Forge, Pa.
Johns-Manville Products Corp.	Manville, N. J.
	Waukegan, Ill.
	Redwood City, Calif.
Keasbey & Mattison Co.	Ambler, Pa.
Mundet Cork Corp.	North Bergen, N. J.
Pabco Products, Inc.	San Francisco, Calif.
Philip Carey Mfg. Co.	Cincinnati, Ohio

Molded brake linings

Company	Plant location
American Brake Shoe Co.	Detroit, Mich.
	Winchester, Va.
Asbestos Mfg. Co.	Huntington, Ind.
Asbestos Textile Co.	Chicago, Ill.
General Motors Corp.	Dayton, Ohio
Johns-Manville Products Corp.	Waukegan, Ill.
Lasko Brake Products Corp.	Oakland, Calif.
L. J. Miley Co. of Ind.	No. Manchester, Ind.
Palmer Asbestos & Rubber Co.	Chicago, Ill.
Raybestos-Manhattan, Inc.	Manheim, Pa.
	Passaic, N. J.
	Stratford, Conn.
Russell Mfg. Co.	Middletown, Conn.
Thermoid Co.	Trenton, N. J.

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XIII. SUBSTITUTES FOR ASBESTOS

A general world-wide shortage of asbestos is a strong incentive for seeking substitute materials. Germany's virtual isolation from sources of asbestos during World War II prompted a great deal of experimentation on possible substitutes. Materials tested included glass wool, steel wool, iron wire, synthetic rubber, organic plastics, cellulose, and treated paper. Work on substitutes has also been carried on in the United States and other countries. Consideration may be given to individual substitutes as follows:

Soda-Lime-Silica-Glass Fibers and Mineral Wool

Glass and related fibers are manufactured in two basic forms--a woollike material and a filament. Rock wool, glass wool, and slag wool are used primarily as lightweight thermal insulation, such as house fill. Such applications in general are not substitutes for asbestos. Glass filaments made by more-refined processes involving the use of platinum dies are of high quality and uniform size. Some of them are less than $\frac{1}{2}$ micron in diameter and are adaptable to highly specialized uses, such as weaving into fabrics. Attempts have been made to use glass fibers in place of asbestos in asbestos-cement products; but such tests have given unsatisfactory results, chiefly because of a chemical reaction between the glass and cement, which decomposes the fibers and destroys their effective strength.

Neither glass filaments nor cloth woven from them are resistant to high temperatures. The fibers will not burn, but they will soften and coalesce when the temperature reaches a certain point, and this point varies, depending upon the composition of the glass. The organic film used on woven-glass textiles will decompose and volatilize at about 300°C., and its loss impairs the fabric to some extent. Normally, glass resists weathering very well. Windowpanes generally show no weathering effects, even after many decades of use. However, the surface area per unit volume of very fine glass fibers is so great that exposure to water vapor results in relatively rapid deterioration.

Glass fibers are efficient thermal insulators in various types of equipment, such as stoves and refrigerators, where temperatures are moderate and corrosive conditions are not encountered. The high tensile strength, the greater thermal stability compared with organic fibers, and the electrical resistance of glass fibers make them suitable for electrical insulation such as sleeving for wire and tapes for the construction of some types of motors. Fiber glass is used to some extent in conjunction with, or as a substitute for, asbestos in Navy cable insulation. It is claimed however, that the use of asbestos insulation permits greater flexibility in finished cables than can be obtained with fiber-glass insulation. Glass fibers are said to be unsatisfactory for cable filler (material that fills in the spaces in a group of insulated cables), but recent improvements in glass fibers are said to have made

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them more satisfactory. Because of its high electrical and heat resistance, very thin glass-fiber paper may find advantageous use in condensers for electronic equipment; for instance, its use may make it possible to reduce the size of the condensers.

A glass-asbestos cloth was designed during World War II to extend the supply of asbestos textile fibers. It has continued in use as a covering on thermal insulation applied to piping on naval vessels. It is woven with a plied yarn having one strand each of glass and asbestos yarn.

United States Rubber Co. has announced production of a new fabric named "Asbeston", consisting of interwoven glass and asbestos yarns. It is said to be well-adapted for theatre curtains as well as for fireproof draperies in schools, hospitals, libraries, hotels and ships. 1/

Coarse glass fibers compressed into bats are efficient lightweight air filters that are used extensively for cleaning large volumes of air. Asbestos is not widely used in this field, but blue asbestos has found important use in gas-mask filters. The Naval Research Laboratory has found that glass fibers make superior gas filters. In recent gas-mask tests in a smoke-filled room, only one particle in 100,000 passed through the filter, and at the same time the mask caused no increase in normal breathing resistance. The glass filter paper is said to be "5,000 times more effective than present commercially available filters." The filter paper can be made in any ordinary paper mill. 2/ The success experienced in these tests indicates that fiber glass may displace asbestos in this important application.

A considerable part of the present production of fiber glass is being applied to military uses. Many manufacturers of electric insulating materials are listed as users of fiber glass; for instance, manufacturers of asbestos cloth and tapes, laminates, varnished tubing, magnet-wire covering, and mica-insulating products. Fiber glass was widely used during World War II for heat, sound, and electric insulation on aircraft. Over 90 percent of the output during World War II was used for military or essential civilian use.

The use of fiber glass as a substitute for asbestos in friction equipment has in general given unsatisfactory results.

Since it appears that fiber glass can take the place of asbestos in certain fields of application, its future availability is of first

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1/ Asbestos, Draperies of Asbestos Glass Fabric: Vol. 31, No. 10, April 1950, p. 8.

2/ Dept. of Defense, Office of Public Information. Glass Fiber Filter Insulator Developed by Naval Laboratory: Dec. 7, 1950.

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1950 Materials Survey: Asbestos (1952)
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importance. It has been claimed that the process of manufacture of fiber glass in the hands of a single company, the Owens-Corning Fiberglas Corp., imposed a serious limitation on any program of enlarged production. However, the claim that high-grade fiber-glass manufacture is in the hands of a single company is not now correct. Glass Fibers, Inc., of Waterville, Ohio, is now manufacturing, under patent rights from Owens-Corning Fiberglas Corp., material used for glass-fabric manufacture. Also Oklahoma Glass Fibers Co., Newport, Ark., and Glass Floss Corp., Long Island, N. Y., are operating under patent rights for the manufacture of insulating mats. A fourth company, Gustin-Bacon Manufacturing Co., Kansas City, Mo., will soon be in production of insulating nontextile fiber glass under license from Owens-Corning Fiberglas Corp.

The parent company, Owens-Corning Fiberglas Corp., is increasing its capacity greatly. It now has two plants manufacturing fiber-glass textiles, one at Ashton, R. I., and the other at Huntingdon, Pa. A third plant for this type of products, to be built at Anderson, S. C., was expected to be in operation by July 1951. The operation of this plant will increase the plant capacity of the company for making fibers suitable for textiles by 50 percent. The company also has four plants making nontextile fiber-glass products, such as block and blanket insulation and pipe covering. These plants are located at Newark, Ohio; Kansas City, Kans.; Santa Clara, Calif.; and Sarnia, Ontario, Canada.

A question has also been raised as to the limitations on fiber-glass manufacture imposed by the need of platinum. At one stage in the process of fiber-glass manufacture, the molten glass is drawn through perforations in a platinum-bottomed cell or bushing, and it appears that no other substance can be substituted for the platinum so used. Because platinum is produced in limited quantities - a world production of about 500,000 troy ounces a year - and has wide scientific and industrial use, its availability for wider application in this industry deserves careful consideration. Platinum is a critical material during war periods. Three important circumstances tend to relieve, to some extent, the threat of a possible shortage:

(1) There is very little loss of platinum during the process of fiber-glass manufacture. The holes through which the fibers are drawn will gradually enlarge, and the platinum bushing will accordingly have to be rebuilt, using the same platinum. Care is taken to recover any dust or fragments of platinum. The first installation is the important consideration, but subsequent replacement of losses is very small.

(2) Research is being conducted constantly to find ways of reducing the quantity of platinum required in each bushing. Presumably some saving will be accomplished.

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(3) Research is also being devoted to possible substitution of some less costly and more abundant substance for platinum. Limited progress has been made, and there is at least some promise of success.

Another raw material essential to fiberglass manufacture that may be in short supply in times of emergency is cryolite, sodium-aluminum fluoride ($Na_3Al\ F_6$) which is mined only in Greenland. The supply, however, is augmented by artificial cryolite manufactured from fluorspar. If supplies of both these materials are limited, sodium silicofluoride may be substituted, but as this commodity also is a derivative of fluorspar it may likewise fall in the category of scarce materials.

High-Silica-Glass Fibers

Glass fibers approximating vitreous silica in composition are superior to soda-lime-silica glass fibers in resistance to deterioration from the action of water vapor and to high temperatures, but their manufacture is a difficult problem. Fused silica is so viscous, even at temperatures as high as 1,700°C., that its manufacture into thin filaments is very difficult. To overcome this high viscosity, fluxes are added, the fibers are made, and the fluxes are then removed. Several methods are used, but they are similar in principle. First, filaments are formed from an easily workable composition, such as an alkali silicate. Second, the alkali or flux in the filament is removed by leaching o. ionic substitution. The resulting fibers are relatively porous and of high silica content. They will withstand with little deterioration temperatures exceeding 1,000°C. The minimum diameter of high-silica fibers on which data are now available is about 2 microns, and the average is much greater. On the other hand, natural asbestos fibers are only a fraction of a micron in diameter. Correspondingly, the silica fibers are much less flexible than natural chrysotile. Because of their high moisture resistance and ability to withstand high temperatures, the vitreous silica filaments undoubtedly can be substituted for asbestos in some applications, but it is doubtful that they can replace asbestos where flexibility or elasticity are prime considerations. Furthermore, the cost of manufacture is very high.

Dr. Rudolf Leutz claimed to be the inventor of a process for making synthetic asbestos in Germany. His product, however, could not be called synthetic because its base was sodium silicate, and an analysis of the final product indicated that it consisted of over 97 percent SiO_2. It was, in fact, a silica-glass fiber. Three companies were licensed to manufacture this product in 1943, but because of the military reverses suffered by Germany no progress was made. 3/

Other Siliceous Fibers

The Carborundum Co. has announced a new series of fibers made by the mineral-wool process after fusion by means of an electric arc. This process has the decided advantage of eliminating the use of platinum.

3/ FIAT Final Report 1070, Technical and Scientific Developments related to the Asbestos Industry in Germany, 1947.

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The product, which is available under the trade name "Fiberfrax", possesses thermal stabilities in the order of 3,000°F. It has been successfully incorporated in filters where extremely high temperatures are encountered and where glass fibers are unsatisfactory. Possible substitution of these new fibers for asbestos in cable coverings and electronics is being explored. 4/

It was reported in February, 1952, that Glass Fibers Inc., Toledo, Ohio had developed a process for making pure quartz fiberglass in submicron sizes.

Organic Substitutes

German scientists attempted to manufacture yarn using short-fiber asbestos mixed with long organic fibers such as cotton, cellulose, or synthetics, but the product obtained was very weak. 5/ Cardboard with an organic plastic was used in Germany as a substitute for asbestos packing in flanges of steam and water pipes. This packing was satisfactory for pressures up to 5 atmospheres and temperatures up to 160°C. It is stated that substitutes for asbestos in high-pressure packings have not been successful and that all substitutes developed and used up to 1944 were inferior to asbestos. 6/

A diaphragm of Perlon paper coated with barite paste was tried by I. G. Farbenindustrie as a substitute for asbestos cloth as a diaphragm in a Stemens-Billiter cell in the manufacture of NaOH by electrolysis of NaCl solution. It failed within 30 minutes. However, a polyvinal chloride diaphragm gave results equal to those obtained with asbestos cloth. 7/

Although reports are somewhat conflicting, it appears that polyvinal fibers are inferior to asbestos in asbestos-cement products. Silicone rubber has been used successfully as a wire covering in certain applications.

Substitutes for Amosite

As indicated elsewhere, an important use for amosite is for manufacture of light, fluffy insulation for use on marine turbines and jet planes. The fluffiness appears to be a function of fiber diameter, the

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4/ Data supplied by Thomas D. Callinan, Naval Research Laboratory.
5/ Blakely, J. D. Dawson, E. L., Gaze, R., and Henderson, M. B., BIOS Final Report 404 PB 34022, 1945.
6/ Krannich, W., I. G. Farbenindustrie A.-G., Ludwigshafen, PB 52025, 1944, pp. 176-181.
7/ Liebenwirth, I. G. Farbenindustrie A.-G., Ludwigshafen, FBL-70305, FIAT Reel B-31 Fr 40694-5.

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finer fibers showing the higher degree of thermal efficiency per unit weight. Accordingly, it has been found that fiber glass having fiber diameters of less than 1 micron has a thermal efficiency comparable with that of amosite. However, an ordinary lime-soda glass has too low a thermal efficiency for the specialized insulation uses of amosite, for it will melt at about 1,100°F. Recently progress has been made in developing fibers of pure aluminum silicate having a melting point over 3,000°F. If such fibers can be made in the minus-1-micron-diameter range, a satisfactory substitute for amosite may become available. The cost, however, probably would be much higher than that of amosite.

Summary of Conclusions on Substitutes

Substitution of other materials for asbestos is possible in some fields of use. Glass fibers are satisfactory as thermal insulators for low-temperature equipment and other applications in which the fibers are not exposed to water vapor or continued flexure. Glass fibers are good electric insulators and therefore are used to some extent for wire covering and similar applications. Vitreous silica fibers will withstand more severe weathering conditions and higher temperatures than the soda-lime-silica glass fibers, but their manufacture is difficult. Also their flexibility is much inferior to that of asbestos. In some applications where the temperatures encountered are low and where chemical resistance is not important, organic fibers are satisfactory substitutes. In some instances, silicone rubber is substituted for asbestos in wire covering.

Glass fibers are now substituted to some extent for long-fiber chrysotile in cable coverings and fabrics, and more extensive substitution is anticipated. Shortage of platinum may impose a limitation on the available supply of fiber glass. The glass fabrics, or the combined glass-asbestos fabrics, have some advantages over asbestos fabrics in lighter weight per square yard and in strength, but they are generally inferior to asbestos fabrics in resistance to high temperatures, flexure. and chemical action. 8/

8/ Important data on substitutes included in this discussion were supplied by Dr. Jay E. Comeforo, Electrotechnical Laboratory, Bureau of Mines, Norris, Tenn.

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XIV. BENEFICIATION OF ASBESTOS

As asbestos is in short supply for certain important strategic uses, for which the quality requirements are exacting, it is wise to explore the possibilities of purifying or otherwise beneficiating the unsatisfactory fibers to render them suitable for such uses.

Treatment of High-Iron Asbestos

Low-iron asbestos required for important electric-insulation uses is in very short supply on the American continent. The National Stockpile Specification calls for a Class 2 chrysotile asbestos containing not more than 1.75 percent total iron and not more than 0.75 percent magnetic iron. Canadian asbestos does not satisfy this specification. A logical approach to this problem is to find a way to reduce the iron content of the Canadian fiber to a point low enough to meet the requirements. Sporadic attempts have been made during past years to remove magnetite from the Canadian fibers but with small success.

The Johns-Manville Corp. has recently conducted a great deal of research on this problem in its laboratories and has obtained results justifying the erection of a special plant at Tilton, N. H., for manufacture of an asbestos-base, inorganic, electric-insulating paper or tape named "Quinterra" paper. Tilton was chosen because it has a dust-free atmosphere, is within easy reach of the Canadian asbestos mines, and is favorably located for marketing. Another reason was an abundant water supply. Water is a prime necessity, as 7,500 pounds are required in the manufacture of each pound of Quinterra paper. Canadian asbestos is beaten and agitated in water to separate the magnetite from the fiber. The purified asbestos, blended with clay, is fabricated by a special papermaking process. The paper has a closed structure; that is, it has neither holes nor interstices such as are present in woven products. It is said to withstand temperatures as high as 800°C. The severe mechanical treatment required to free the magnetite tends to weaken the asbestos fibers considerably. Furthermore, short fiber is used as raw material. The operation is evidently designed in part as a waste utilization process. To give additional strength, experiments are being tried using an open fiber-glass fabric or grid covered on both sides with Quinterra paper. This gives it adequate strength, and research is being continued on methods of further improving its electrical resistance.

Raybestos-Manhattan, Inc., is also conducting experimental work on a wet-process method that differs from that employed by Johns-Manville in that longer fibers, even up to spinning grade, are used. To free the magnetite from the fibers, a method has been devised whereby defiberization is accomplished with a dispersing agent. Many agents were tried, and one was finally found that would disperse or separate the fibers from each other with a minimum mechanical force. In other words,

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a chemical process of fiber separation is substituted for the mechanical beating or crushing method. Thus, the magnetite is set free so that it can be removed magnetically with very little damage to the fibers. The extremely fine fibers are made into strong papers and tissues. Tests are being made by the United States Navy to determine the success with which this purified fiber, known as "Novabestos," will meet low-iron specifications. The process is quite promising.

The Naval Research Laboratory has successfully demonstrated the ability of a paper-maker's Vortrap to remove magnetite from a wet slurry of asbestos. Essentially the separation is effected by the swirling action that arises when rapidly flowing water is introduced into a pipe in a tangential manner. The concomitant centrifugal action tends to throw the heavy magnetite against the walls, while the asbestos fibers, freed from magnetite, remain suspended and ultimately pass up and out of the instrument to a decker or other fiber-recovery apparatus. Fibers of spinning length have been cleaned successfully in a laboratory-size Vortrap (1 3/4-inch). Asbestos initially having a content of 4.2 percent magnetite was found, after passage through the Vortrap, to contain only 0.2 percent magnetite. The separated magnetite consisted of a granular mass associated with little or no fiber. Accordingly, it appears that, contrary to popular opinion, only very minor quantities of the magnetite grains adhere intimately to asbestos fibers.

A single Vortrap unit of 4-inch diameter, operating under a pressure differential of 18 pounds, handling a stock suspension containing 0.5 percent fiber at a rate of 220 gallons per minute, will deliver about 6 tons of air-dried paper fiber in 24 hours. It may be assumed that asbestos fiber could be purified and delivered at a comparable rate. It would appear, therefore, that the Vortrap which is being used successfully in paper mills may solve the low-iron problem.

Attention is being given to a possible Bureau of Mines project to approach the beneficiation of Canadian asbestos on a dry-treatment basis, but the high costs involved in necessary equipment discourage any immediate prospect of such work.

Some investigators believe that the actual quantity of total iron and magnetic iron present in asbestos or its products is a faulty criterion of its electrical resistance because much depends upon the condition of the iron that is present. For instance, a large fragment of magnetite would be more detrimental than the same quantity in the form of numerous small fragments, because the large mass might constitute an uninterrupted path for the electric current, whereas the small particles separated from each other by comparatively resistant materials would provide a less ready pathway along which the electric current could travel. Accordingly, removal of the larger fragments would improve the electrical resistance of the product more than removal of the same quantity of iron in the form of small fragments only.

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Furthermore, it is recognized in the specifications that magnetic iron is more detrimental than the nonmagnetic forms. It has been pointed out that, if the iron-bearing asbestos were carried between the terminals of an electric arc, the short circuit created when a relatively large piece of magnetite reaches the space between the terminals would not only break up the fragment into small particles but would reduce the magnetite to ferrous forms, which are less harmful. Methods of modifying the form and particle size of the iron minerals present in asbestos have not yet been fully explored. Possibly the best results can be obtained by combining processes of iron removal with methods of modifying the form and grain size of the iron particles that remain.

The Jeffrey Manufacturing Co. developed a method about 1925 whereby woven asbestos tapes were passed between electrodes, with the result that the larger particles of magnetite were volatilized or converted to nonmagnetic compounds of iron. The resulting perforations in the tape were sealed by a following treatment with resins. When nonferrous tape became available, this practice was discontinued, but recently it has been applied successfully to Novabestos sheet made by Raybestos-Manhattan, Inc. 1/

To remove or render ineffective the iron in Canadian chrysotile without unduly damaging the fiber does not appear to be an insurmountable problem. It is a field of research that offers fair hope of success.

It is pertinent in this connection to point out the desirability of a more complete investigation of types of asbestos that may be high in iron, but in which the iron is present in silicate forms that are relatively resistant to the passage of electricity. Crocidolite, for instance is high in iron, but little free iron oxide is present. The possibility of using crocidolite for fabrics suitable for wire covering has not been fully explored.

Elongation of Short Fibers

There is urgent need for a larger supply of long spinning fibers of both the low-iron and the higher-iron types. As pointed out elsewhere in this report (VI-1) spinning fibers produced in Canada constitute only about 4 percent of total production. If some method could be devised for converting short fibers into long ones, the situation might be relieved. To make short fibers out of long ones is easy; all mill

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1/ Data supplied by Jesse M. Weaver.

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operators wish that it were not so simple, but the elongation of short fibers is more difficult. Fortunately the research scientist is not terrified by apparently insurmountable barriers, and some research has already been done in this field.

Driscoll and Bruce 2/ claim an improved product can be made by mixing a slightly soluble metal compound, such as lime, with the short asbestos fibers. A soluble silicate is then used to impregnate the asbestos mass and cause precipitation of a bonding agent such as calcium silicate.

Ludke 3/ claims that short fibers can be converted into long fibers. The fibers are oriented by some means, such as electrostatically, into parallel position, and are then exposed to water and fluorine vapors at elevated temperatures.

Callinan 4/ has devised a method of improving the structural and mechanical properties of asbestos. It is claimed that the reaction between asbestos and silicon tetrachloride results in a product that has a higher silicon content and greater tensile strength. It is postulated that the silicon tetrachloride reacts with the terminal hydroxyl groups of chrysotile and causes a condensation which leads to a substantial increase in chain length.

Brandenberger et al. 5/ found that, when serpentine synthesis was conducted in the presence of natural serpentine fibers (chrysotile), no enlargement in the grain size of the natural fibers took place.

The Electrotechnical Laboratory of the Bureau of Mines plans to investigate the feasibility of binding short-fiber chrysotile by hydrothermal treatment with magnesium and silicon compounds. 6/

2/ Driscoll, James, and Bruce, Donald S., Treated fabric and process of making the same; U. S. Patent 2,033,928, Mar. 17, 1936.

3/ Ludke, W., Asbesten mit langeren Fasern aus Kurzfasrigen synthetischen Asbesten, German patent 740,911, Nov. 1, 1943.

4/ Callinan, T. D., Mineral Products and Method of Preparation, U. S. Patent 2,394,040, Feb. 5, 1946.

5/ Brandenberger, E., Epprecht, W., and Niggli, P., The Serpentine Minerals and Their Synthesis. II. Helv. chim. acta., vol. 30, 1947, pp. 9-14 (trans. by Frank Riordan, Jr.).

6/ Data on treatment of short fibers supplied by Jay E. Comeforo, Electrotechnical Laboratory, Bureau of Mines, Norris, Tenn.

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XV. SYNTHETIC ASBESTOS

As the United States mines only a small fraction of its requirements of asbestos, the synthesis of long-fibered, flexible asbestos is highly desirable, for it would tend to overcome our major dependence upon foreign countries in times of emergency. Therefore, a review of the status of the problem is highly important. Some of the data that follow were made available through the kindness of Dr. Jay E. Comeforo, Electrotechnical Laboratory, Bureau of Mines, Norris, Tenn.

European Synthetic Studies

Brandenberger et al. 1/ have reviewed current progress in asbestos synthesis and pointed out two ways in which it may be accomplished: (1) Hydrothermal treatment (in an autoclave) up to 500°C. of MgO and SiO_2 with an excess of water. (2) The reaction of a magnesium salt solution, such as $MgCl_2$, with an alkali silicate, such as waterglass, at 100°C. The fibers formed by either method are extremely small but can be recognized under an electron microscope. By increasing the time of reaction and adding more alkali, appreciable grain enlargement was attained. This points to the possibility of eventual synthesis of usable fiber crystals.

Noll, 2/ who conducted research on the second method outlined above, found that the filaments could be enlarged by increasing the crystallization velocity and at the same time decreasing the number of nuclei. The speed of reaction could be accelerated greatly by using fresh silica gel rather than "aged" gel. The solutions, waterglass and caustic soda on the one hand, and magnesium chloride on the other, were carefully stratified in a nickel or silver tube at ordinary temperatures, so that a gel film formed at the interface. This served as a diffusion membrane which hindered rapid mixing of the solutions. Then the tube was heated rapidly, and diffusion took place. As a result, groups or packets of chrysotile fibers were formed. The greatest length of filament was 0.2 mm., which is about 100 times the fiber length of the product made without the diffusion process. Apparently the conditions of crystallization are more important than the chemical changes. Noll has made some progress toward fiber enlargement.

Jander and Wuhrer 3/ synthesized serpentine without mineralizers at temperatures below the critical point of water. The raw materials

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1/ Brandenberger E., Epprecht W., and Niggli, P., The Serpentine Minerals and Their Synthesis: Helv. chim. acta., vol. 30, 1947, pp. 9-14 (trans. by Frank Riordan, Jr.).

2/ Noll, W., (Serpentine Asbestos, $Mg_6(OH)_6.(Si_4O_{11}).H_2O$): I. G. Farbenindustrie A.-G. June 30, 1942, Inorganic Scientific Laboratory Leverkusen, Germany, PB L74889, FIAT microfilm reel T-14, Frames 58-67.

3/ Jander, Wilhelm, and Wuhrer, Josef, (Hydrothermal Reactions, the Production of Magnesium Hydrosilicates) Ztschr. anorg. u. allge. Chemie, vol. 235 (4), March 1938, pp. 273-294).

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used were the pure oxides, MgO and alkali-free silicic acid. Nothing is said concerning the fibrous or nonfibrous character of the serpentine.

Ipatiew and Muromtseff 4/ claim to have obtained long-fibered chrysotile from a silica gel and magnesium salt solutions at 300°C. and under a hydrogen pressure of 250 atmospheres.

As early as 1935 Dr. Werner Lüdke claimed to have made synthetic asbestos. Lüdke's process was a type of pneumatolitic synthesis, that is, it involved the reaction resulting from the passage of heated vapor over compounded mixtures. Gerd M. Bloomfield, 5/ who made a thorough review of all attempts to make synthetic asbestos in Germany, was present at a meeting in 1935 at which the representatives of the asbestos industry expressed the opinion that Dr. Lüdke's product at the current state of development was not a satisfactory replacement for natural asbestos. Faced with a shortage of asbestos, however, the Anhaltische Studiengesellschaft supported Dr. Ludke; and a pilot plant was built in Bernburg in 1940, where attempts were made to develop the process to a commercial scale. The synthetic asbestos fibers produced, however, were of inferior quality and were never improved. An attempt was made to manufacture high-pressure gaskets, but the synthetic material was chemically unstable and did not withstand the mechanical handling necessitated by quantity production. The requirements demanded for these gaskets could not be satisfied by the experimental samples made of synthetic asbestos. Asbestos paper and millboard made of synthetic asbestos did not compare favorably with those made of natural asbestos. Bloomfield has the impression that Dr. Lüdke's claims were exaggerated and premature.

Sitz 6/ has described Lüdke-process asbestos which, in a somewhat later stage of development, came from the furnace in the form of a large plate about 300 mm. thick. He states that it was broken up, shredded, and used in high pressure packings, brakebands, insulation, airplane coverings, and paints. Sitz's report shows no improvement over the previously stated results obtained by Dr. Lüdke.

Research in the United States

The Bureau of Mines Electrotechnical Laboratory at Norris, Tenn., began synthetic asbestos research in 1949. By use of a hydrothermal method

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4/ Ipatiew, W., and Muromtseff, B., Bull. Soc. Chim. Fr., vol. 41, 1927, pp. 1588-1591.

5/ Bloomfield, Gerd. M., Technical and Scientific Developments Related to the Asbestos Industry in Germany, FIAT Final Report 1070, 1947.

6/ Sitz, G., The Technical Development of the Ludke Asbestos Synthesis: PBL 52025, 1941, pp. 141-147.

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employing pressures of 4,000 to 5,500 p.s.i. in bombs at 400° to 500°C., v short fibers of chrysotile of very small diameter were made. :ral investigations are planned for inducing the growth of long fibers.

A second method followed is to melt the ingredients in crucibles and obtain columnar crystallization during cooling. Substitution of fluorine for hydroxyl is followed, just as in the phlogopite-mica synthesis. Research has shown the field of stability of fluoramphiboles to be restricted. Slight variations in composition may result in the crystallization of other phases, for example, mica, forsterite, beta-spodumene, and pyroxene. To determine the most satisfactory compositions for crystallizing amphibole asbestos relatively free of impurities, an extensive study of the isomorphism of synthetic fluoramphiboles has been made. This work has resulted in the synthesis of amphiboles of widely varying chemical compositions, some of which are unknown in nature. Considerable progress has been made in the synthesis of acicular crystals of amphiboles (see fig. 8). The fibers, however, are extremely brittle, and further research is being conducted on methods of improving their quality.

Controlled thermal gradients are used to induce alignment of the crystals, first, by cooling the melt from the bottom, and second, by varying the shape of the container so that cooling would begin at one small area. The results show that a definite vertical orientation of the amphibole crystals may be obtained by these techniques. Figure 8 shows definite orientation of synthetic amphibole fibers.

Dr. Herbert Insley of the National Bureau of Standards, Washington, D. C., has also made a small beginning in synthetic asbestos research. By a hydrothermal method using bombs, fibers of chrysotile were obtained, but they were so small that they could be seen only with an electron microscope. The Bureau is planning a program of asbestos synthesis by crystallization from a melt similar to the mica synthesis, which has been fairly successful. Substitution of fluorine for hydroxyl, as in mica synthesis, will be followed. It is believed that maintenance of a temperature gradient between top and bottom of the crucible will promote columnar crystallization in a vertical direction. Results are still in the future. 7/

It is reported that State College, Pa., has synthesized chrysotile asbestos in bombs at 400 atmospheres pressure and 400°C. The fibers were extremely small. Photographs taken with an electron microscope showed some evidence that the filaments were tubular in concentric layers. 8/

7/ Personal interview, 1950.

8/ Bates, Thomas F., Sand, Leonard B., and Mink, John F., Tubular Crystals of Chrysotile Asbestos: Science, vol. 111, May 12, 1950, pp. 512-513

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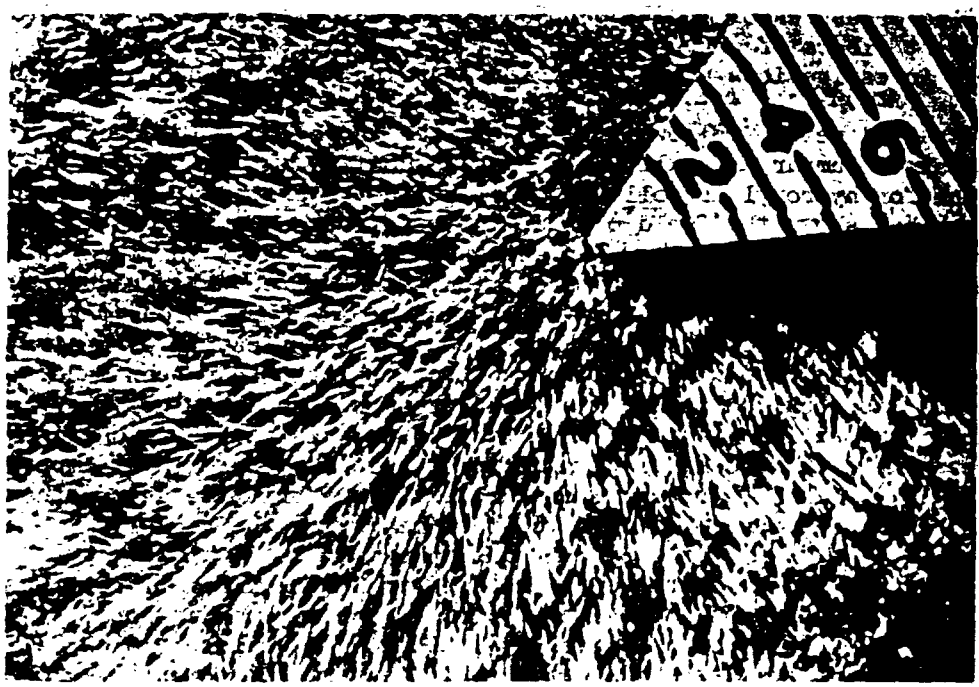


Figure 8. Synthetic amphibole asbestos
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The Geophysical Laboratory of the Carnegie Institution in Washington, D. C., has shown that chrysotile can be synthesized at temperatures below 500°C. and at pressures of 2,000 to 40,000 p.s.i. The fibers formed were very small. 9/

Dr. M. S. Badollet conducted some experiments on the synthesis of chrysotile in hydrothermal bombs at the Johns-Manville Research Center, Manville, N. J. Photographs with an electron microscope show that very small fibers were made. The work has been temporarily discontinued. 10/

The Asbestos Institute is conducting research on asbestos synthesis at the School of Ceramics of Rutgers University. Hydrothermal synthesis in bombs is the only work contemplated, and no results have yet been reported.

Wells, 11/ of the University of Minnesota, has produced chrysotile by interaction of Na_2OSiO_2 solution with $MgCO_3$ at 375° to 400°C. under pressure of 200 to 230 atmospheres.

Summary

It is evident that quite limited progress has been made toward the manufacture of synthetic asbestos either at home or abroad. Weak and brittle fibers of amphibole have been made, but the market for this type of asbestos is quite small. Except for the one instance recorded by Noll, chrysotile synthesis has not passed beyond the stage of making fibers so small that they cannot be seen even with an ordinary microscope. Chrysotile is the most important asbestos of commerce, and its manufacture on a commercial scale is apparently far from attainment. It is evident that chrysotile can be synthesized readily, but the filaments are too small to have any practical value. The important research problem is to find ways of increasing the size and length of the fibers. Several research organizations are devoting time and money to this problem, and their accomplishments are worthy of constant scrutiny. It is one of those long-range problems for which immediate results are not to be expected, but the urgent need of a successful solution demands unremitting and vigorous pursuit.

9/ Bowen, N. L., and Tuttle, O. F., The System MgO-SiO_2-H_2O: Bull. Geol. Soc. America, vol. 60, 1949, pp. 439-460.

10/ Personal interview, November 1950.

11/ Wells, F. G., The Hydrothermal Alteration of Serpentine: Am. Jour. Science, vol. 18, 1929, pp. 35-52.

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XVI. PROBLEM OF LOW-IRON ASBESTOS

One of the most critical problems in the asbestos industry is the assurance, in times of emergency, of adequate supplies of asbestos fibers low enough in iron content to render them suitable for electrical insulation uses, such as cable coverings on naval vessels. This problem arises from the fact that Canadian asbestos, our principal source of supply, contains considerable magnetite and therefore is not suitable for low-iron uses. The Bureau of Ships is vitally interested in this problem because it uses large quantities, chiefly in cable coverings, but it would appear that the volume of cable covering needed under current conditions will be considerably smaller than the requirements of the intense warship-construction period of World War II. The innermost layer and the third layer of the cable coverings are of low-iron Rhodesian fiber. The outer insulation on the cables is largely of asphalt - impregnated materials, and asbestos used therein may be of the high-iron Canadian type. About one-third of the total fiber used must meet exacting low-iron specifications. Methods of solving the problem are discussed as follows:

Importation of Low-Iron fibers

The problem has been solved during past emergencies by importation of the C. & G. grades of low-iron asbestos from Southern Rhodesia. These fibers are quite satisfactory. There are, however, certain unfavorable aspects to this source of supply. The procurement situation is critical because (1) except for small quantities from the Havelock mine in Swaziland and small and uncertain tonnages from Arizona, our entire supply of low-iron chrysotile originates in the Shabani area in Southern Rhodesia and (2) the African source of supply is currently unable to supply the demand.

Another unfavorable factor is the great distance of the deposits from United States centers of consumption and the consequent shipping hazards during war emergencies.

Stimulation of Arizona Output

Arizona chrysotile is low in iron and eminently suitable for electric insulation uses. These are the only low-iron chrysotile deposits known in the Western Hemisphere. As pointed out in the sections of this report dealing with the Arizona deposits, production has always

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been small; the stimulation of two world wars and exceptionally high prices during the First World War failed to bring any substantial increase in production. Possibly, Arizona can furnish as much as 1,000 tons a year of fiber that will satisfy low-iron specifications, although, to attain that goal some form of Federal assistance might be required.

Liberalization of Specifications

There is a tendency on the part of consumers to play safe by formulating overexacting specifications. This was notably true with respect to mica specifications during the World War II. When supplies of clear sheet mica were difficult to obtain, it was found that, for certain uses for which clear mica was specified, stained mica gave quite satisfactory service, and specifications were modified accordingly. The same condition has existed in the past with respect to asbestos. In a special report 1/ prepared in 1941, it is stated that the Navy Department had modified a more exacting specification to permit 2 percent magnetite and 3½ percent total iron oxide for class 4 asbestos to be used as Navy cable filler which is the present specification. Any movement toward modification of specifications that will permit a more-abundant fiber to take the place of one in short supply is a step in the right direction. Such action does not imply that specifications for highly important uses should be relaxed to a point where failure of the product might result. It is apparent, however, that a careful appraisal of specifications is in order. A safe relaxation for the less important uses tends to insure more abundant supplies of high-grade fibers for the more exacting applications.

Manufacture of Low-Iron Synthetic Asbestos

In making synthetic asbestos, the proportions of the raw materials are under control. Accordingly when synthetic asbestos is made, a low-iron fiber can undoubtedly be manufactured. However, the very limited progress already made in synthetic research, as indicated in another section of this report, forces the conclusion that synthetic fibers of adequate length, strength and flexibility for use in cable coverings are still a long way in the future.

Conservation of Low-Iron Asbestos for Low-Iron Uses

It is probable that considerable quantities of low-iron chrysotile are applied to uses for which a high-iron type would be satisfactory. If consumers would substitute larger quantities of Canadian chrysotile for Rhodesian, larger supplies of the C. & G. grades could be released

1/ Report on Asbestos to Advisory Committee on Metals and Minerals, National Academy of Sciences, December 1941, p. 8.

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for strategic uses. When, however, Canadian spinning fibers are in short supply, as at present, such substitution is difficult.

Following are instances of the diversion of low-iron fibers to uses wherein the iron content has no significance. A low-iron fiber is not essential for cable filler, but a good spinning asbestos of 3R grade is needed. Unfortunately, such fibers are not abundant in Canada. During World War II, 3R was in short supply; and, although reports are somewhat conflicting, it appears that C. & G. Nos. 1 and 2 were used at times for cable filler, because of the shortage of 3R. It would seem, therefore, that requirements of C. & G. grades could have been reduced if applications had been confined strictly to low-iron uses. It is highly desirable that steps be taken to insure supplies of Canadian spinning fibers large enough to prevent a repetition of such an undesirable situation. C. & G. spinning fibers are also used in making textiles that are not employed in electrical insulation. This statement applies particularly to additions of Rhodesian fiber to improve workability. It has been found that a blend of C. & G. fibers with Canadian fibers increases production capacity fully 10 percent owing to better processing conditions. Reduction to a minimum of non-electrical uses is an important step in the conservation of low-iron supplies.

Use of Substitute Products Other Than Asbestos

Glass fibers are good electric insulators and are used to some extent for cable covering, and for tapes and sleeves used in motors and other appliances. A wider substitution of glass fibers for asbestos in this field is anticipated. It is predicted, in fact, that the time will come, although not in the immediate future, when asbestos will no longer be needed for wire and cable covering. Silicone rubber is now substituted for asbestos in some types of wire covering.

Beneficiation of High-Iron Asbestos

As pointed out in a previous section of this report, entitled "Beneficiation of Asbestos", the purification of high-iron fiber to make a low-iron product probably can be accomplished effectively with a Vortrap. An objection to this method urged by some is the short supply of even the high-iron types. However, figures for 1950 and the early months of 1951 indicate that spinning fibers are being imported from Canada at a rate nearly 7,000 tons higher than the 1945-49 average. Moreover, Canadian facilities for fiber production are being increased. Although demands are also increasing, the situation with respect to Canadian spinning fibers is becoming less critical. Beneficiation therefore is by far the more promising solution of the low-iron problem.

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XVII. SEARCH FOR NEW SOURCES OF SUPPLY

Urgent need for new discoveries

Although much has been said with respect to the critical situation in the field of low-iron fibers and spinning fibers of all kinds, it must be recognized that all grades of asbestos are in short supply. Preceding sections of this report have dealt with possible substitution, with beneficiation, and with the possibility of making synthetic asbestos. These avenues of approach all have a place in the problem of meeting shortages; but, after all, the most desirable solution is to find more extensive supplies of asbestos in nature. It is imperative that new sources be uncovered, and the Government has recognized this need and established funds for exploratory work on terms of decided advantage to participating mining firms. On February 20, 1951, the Defense Minerals Administration allocated $10,000,000 for mineral exploration, and several asbestos companies have applied for and have received assistance under the terms of the loan fund. It is hoped that the stimulation thus provided will encourage aggressive search for new deposits of asbestos, and active development of them. The Bureau of Mines and the Geological Survey are rendering assistance in exploration insofar as their limited resources will permit. Help is also being received from some State geological surveys. Several asbestos companies are conducting exploratory work as a part of their regular development programs.

Modern prospecting aids

The magnetometer that has proved useful in prospecting for other minerals has recently been applied with some success to prospecting for asbestos. Chrysotile asbestos is generally found associated with massive serpentine, and the presence of such masses can be detected with a magnetometer even though they may be blanketed with overburden. The magnetometer will not detect the presence of asbestos, but it enables the prospector to delineate the areas where serpentine, the host rock of the asbestos, exists, and thus it narrows the field for later core drill prospecting. Diamond-bit core drills are usually found to be the most satisfactory type for asbestos prospect drilling. The modern bulldozer is a useful tool for stripping or trenching.

Essential requirements of new discoveries

Four important questions must be satisfactorily answered before successful commercial operation of a new asbestos deposit can be reasonably assured.

1 Quality of the fiber - Chrysotile fibers of commercial grade must be strong and flexible. These qualities are adequate in most occurrences. Surface weathering tends to weaken the fibers, accordingly samples should be taken below the weathered zone.

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2 Fiber length - Some asbestos deposits are worked profitably even though virtually all of the fiber is below spinning grade because there are extensive uses for short fibers. However the presence of fiber of spinning length is highly desirable, especially in times of national emergency. Even a small proportion of fiber veins three-eights of an inch or more in thickness is a favorable factor. Deposits furnishing both spinning and non-spinning fibers are more likely to prove profitable than those producing short fibers only.

3 Proportion of fiber in the rock - Normally, the percentage of fiber recovery ranges from 4 to 6 of the rock mined. However, a deposit with smaller yield might be workable if the fibers were of exceptionally high value, if, for instance, the deposit furnished a substantial proportion of spinning asbestos. Fiber yield can best be determined by making a commercial mill run using a large representative sample.

4 Extent of reserves - Asbestos milling is a costly process that requires a heavy investment in equipment. The investment is justified therefore only if the deposit is large enough to insure adequate supplies of commercial-quality, fiber-bearing rock for at least 20 years of operation at an established rate. Prospect core drilling to determine the extent of reserves is a necessary forerunner of any asbestos milling project.

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XVIII. WORLD WAR II CONTROLS AND EXPERIENCES

Following is a brief chronological history of asbestos procurement during World War II. Copies of the various restrictive orders follow the outline.

Chronological Outline of a History of Asbestos Procurement During World War II 1/

1940 (early). Dr. Oliver Bowles, Bureau of Mines, recommended to the National Defense Commission action to insure production and importation of adequate supplies of Canadian and African asbestos.

June 27, 1940. Meeting of asbestos importers and manufacturers held with government officials to discuss means of ascertaining stocks in the United States and measures to insure adequate supply.

October 15, 1940. National Defense Commission, Mining and Mineral Products Division, outlined a plan for asbestos procurement; recommended government purchase for stockpile:

	Short tons
Chrysotile, Rhodesian	8,500
Amosite	8,000
Crocidolite	3,500
Total	20,000

October 25, 1940. National Defense Commission official recommended the following purchases:

	Short tons
Chrysotile, Rhodesian	3,000
Amosite	9,000
Crocidolite	8,000
Total	20,000

August 20, 1941. National Defense Commission official recommended to Deputy Administrator, Federal Loan Agency, the following purchases:

		Short tons
Chrysotile, Rhodesian	C. & G. 1	900
	C. & G. 2	3,600
Amosite	B1	1,000
	B3 or D3	15,000
Crocidolite	A	100
	C	100
	MS	10,000
Total		30,700

1/ Source: War Production Board, History of Asbestos Procurement During World War II, 1945.

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December 1941. Critical need for asbestos was recognized: It was decided at a meeting of Office of Production Management and asbestos industry officials to conserve available stocks. A draft conservation order was given preliminary discussion. Demands for asbestos-cement corrugated sheets and asbestos textiles exceeded supply (sheets used for aircraft hangers and ordnance works).

January 20, 1942. Office of Production Management Conservation Order M-79 was issued to effect conservation of the asbestos supply and restrict the usage of African fibers.

February 28, 1942. Order M-79 was revised to tighten restrictions.

1942 (early). War Production Board Order M-123 was issued to restrict the sale of asbestos textiles, and packings containing asbestos textiles.

April 1942. A ship carrying 3,300 tons of African fiber was lost by sinking. Conservation Order M-79 was amended to tighten restrictions.

July 4, 1942. Order M-123 was amended to include woven friction materials.

July 1942. Cork and Asbestos Section, WPB, had received questionnaire replies from manufacturing plants showing estimated raw-fiber requirements; it recommended to Stockpiling and Shipping Branch, WPB, the following Government purchases:

	Short tons
Chrysotile, Rhodesian C. & G. 1	2,600
C. & G. 2	10,000
Amosite B1	2,000
B3 or D3	17,000
Crocidolite A	100
C	100
MS	12,500
Total	44,300

July 1942. Cork and Asbestos Section "made diligent efforts to obtain requirements from the armed forces for asbestos products. These requirements were finally obtained (date not stated) but were presented in a form that was not useful, nor was much faith placed in these figures."

December 1942. Order M-123 was amended to add a list of prohibited uses and restrictions on permitted types of asbestos textiles; it was decided in consultation with Canadian producers and with the cooperation of the Canadian Controller of Metals, to develop an allocation method for the distribution of asbestos fibers of groups 1, 2, and 3. The plan provided for suggestions to the Canadian Controller on the distribution of shipments to United States manufacturers.

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Contracts were signed for the purchase of asbestos by the Government, after a number of conferences between representatives of the Board of Economic Warfare and of the British Mission of Supply. These contracts called for delivery of the following types of African asbestos during 1943:

	Short tons
Chrysotile C. & G. 1	1,861
C. & G. 2	6,459
C. & G. 3	18,746
C. & G. 4	6,404
Amosite B1	1,200
B3 or D3	6,000
3DM-1	3,600
M-1	10,020
Crocidolite MS	2,300
S	400
Total	57,490

February 20, 1943. Some Order M-123 restrictions were combined with Conservation Order M-283, which placed asbestos textiles under complete allocation procedure; allocations were based on quarterly decisions, established by the Requirements Committee (WPB).

Chief Asbestos Section, WPB, protested to Chief, Minerals and Metals Division, Board of Economic Warfare, objecting to phases of the purchase contract (for African asbestos), particularly to the large amount of C. & G. 4 and the small amount of crocidolite purchased. This letter was acknowledged March 5, 1943, "but up until August 7 that year no changes were made in the stockpiling and purchase recommendation. There were unquestionably errors in judgment made by all concerned in this transaction."

March 17, 1943. Order M-283 changed to remove lamp and burner wicks from restricted list.

April 1943. Order L-41-d was issued. This exempted asbestos-cement siding and roofing from the provisions of Order L-41. (Under Order L-41, the use of asbestos-cement siding and roofing shingles was limited. Since about 95 percent of Canadian asbestos was then so used the mines had no outlet, and could not continue production of the needed long fiber.)

July 1943. Combined Raw Materials Board (United States, British, and Canadian) assumed responsibility for distribution of the supply of Canadian and African asbestos among the three countries. "Had they entered the picture earlier it would have been very beneficial, for, by and large, a fair distribution of asbestos was made after the completion of the Board of Economic Warfare's 1943 contracts, which had been signed at London in December 1942."

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October 1, 1943. Conservation Order M-79 was amended to include restrictions on the use of Canadian long-fiber asbestos and require the use of 1 ton of Rhodesian C. & G. 3 for each 5 tons of Canadian 3R; also, further to restrict the use of Rhodesian chrysotile fibers.

October 11, 1943. Conservation Order M-283 was amended to include remaining restrictions on the uses of asbestos in Order M-123, which was then revoked.

January 31, 1944. Conservation Order M-79 was amended to change restrictions on the uses of Rhodesian fibers and changing allocations of Canadian 3R from a monthly to a quarterly basis.

April 1944. The Navy called for a larger increase in requirements for Navy lagging cloth and asbestos textiles for Navy cable construction. After discussion with the industry, it was decided to expand facilities. Orders were placed for additional machinery. Research was started on the production of a combination glass and asbestos cloth for Navy lagging. By August this cloth had been developed and approved, and the resultant increase in production largely solved the Navy lagging-cloth problem.

November 1944. Navy radically reduced requirements for cable.

December 8, 1944. Order M-79 was amended to remove restrictions on the use of African asbestos.

January 4, 1945. Order M-283 was amended to permit certain uses of asbestos textiles (due to lower Navy requirements) and to permit the filing of applications for Navy cable construction on a quarterly basis and thus enable manufacturers better to schedule their production.

March 20, 1945. Order M-79 was changed to allow the use of 1 ton of Rhodesian C. & G. 1 or C. & G. 2 (as well as C. & G. 3) per 5 tons of Canadian spinning fiber, Grade 3R.

August 11, 1945. Order M-283 was amended to permit production of civilian passenger car and truck friction materials.

August 20, 1945. Order M-79 was revoked.

August 31, 1945. Order M-283 was revoked (all controls on the asbestos industry were ended).

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Restrictive Orders Promulgated During World War II

TITLE 32 - NATIONAL DEFENSE

CHAPTER IX - OFFICE OF PRODUCTION MANAGEMENT

Subchapter B - PRIORITIES DIVISION

Part 1064 - ASBESTOS

CONSERVATION ORDER NO. M-79 CURTAILING THE USE OF CERTAIN TYPES OF ASBESTOS

WHEREAS, national defense requirements have created shortage of certain types of asbestos for the combined needs of defense, private account, and export; and the supply now is and will be insufficient for defense and essential civilian requirements unless their use in certain products manufactured for civilian use is curtailed; and it is necessary in the public interest, to promote the defense of the United States, to conserve the supply and direct the distribution thereof:

NOW, THEREFORE, IT IS HEREBY ORDERED THAT:

1064.1 (a) Restrictions on the Use of Certain Types of Asbestos

(1) Unless otherwise specifically authorized by the Director of Priorities, after February 1, 1942, no person shall fabricate, spin, or process in any other way asbestos fibre imported from South Africa except where such fabrication, spinning or processing is necessary to fill Defense Orders as defined in Priorities Regulation No. 1, as amended from time to time.

(2) In addition to the above limitation, unless otherwise specifically authorized by the Director of Priorities, after February 1,1942, no person shall fabricate, spin or process in any other way:

(i) Chrysotile asbestos fibre (Rhodesian) Grade C and G-1 and 2 except where such fabricating, spinning or processing is necessary to fill Defense Orders for:

(a) core rovings to meet Navy specifications Number 17-1-29 (INT); (Insulation, electrical, asbestos fibre, treated and untreated, dated October 1, 1941, or as same may be amended.)

(b) tapes and cloth which are required by specification to be of a nonferrous nature;

(c) nonferrous lapps.

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(ii) Amosite asbestos fibre (Grade B-1 or amosite asbestos having a fibre length equivalent to that of Grade B-1) except where such fabricating, spinning or processing is necessary to fill Defense Orders for Amosite woven felt blankets and mattresses for turbine insulation for use on naval and maritime ships.

(iii) Amosite asbestos fibre (Grade B-3, D-3 or amosite asbestos having a fibre length equivalent to that of Grade B-3 or D-3) except where such fabricating, spinning or processing is necessary to fill Defense Orders for:

(a) Woven felt blankets and mattresses and fittings for turbine insulation for use on naval and maritime ships;

(b) Fire proof board;

(c) Sprayed Amosite;

(d) Eighty-five per cent magnesia pipe covering and blocks;

(e) Molded Amosite pipe covering and blocks

(f) Flexible amosite pipe insulation

(g) Dry pack insulation.

(3) In addition to the above limitations unless otherwise specifically authorized by the Director of Priorities, after February 1, 1942, no person shall install eighty-five per cent magnesia or other high temperature pipe covering except in installations where temperatures of 200° Fahrenheit or over occur.

(b) Reports

(1) Any person who manufactures or processes asbestos fibre shall, on or before the 10th day of February, 1942, and on or before the 10th day of each calendar month thereafter, file with the Office of Production Management, Ref: M-79, all of the information required by Forms PD-251 and PD-252, whichever is applicable.

(2) In addition, any person who manufactures or processes asbestos fibre shall, when requested, file with the Office of Production Management, Ref: M-79, all the information required by Form PD-253.

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(c) Prohibitions against Sales or Deliveries. No person shall hereafter sell or deliver asbestos fibre to any person if he knows, or has reason to believe, such material is to be used in violation of the terms of this Order.

(d) Limitation of Inventories. No manufacturer shall receive delivery of asbestos fibre or products thereof, in the form of raw materials, semi-processed materials, finished parts or sub-assemblies, nor shall he put into process any raw material, in quantities which in either case shall result in an inventory of such raw-semi-processed or finished material in excess of a minimum practicable working inventory, taking into consideration the limitations placed upon the production of asbestos fibre products by this Order.

(e) Miscellaneous Provisions.

Applicability of Priorities Regulation No. 1. This Order and all transactions affected thereby are subject to the provisions of Priorities Regulation No. 1, (Part 944) as amended from time to time, except to the extent that any provision hereof may be inconsistent therewith, in which case the provisions of this Order shall govern.

(2) Appeal. Any person affected by this Order who considers that compliance therewith would work an exceptional and unreasonable hardship upon him or that it would result in a degree of unemployment which would be unreasonably disproportionate compared with the amount of asbestos fibre conserved, or that compliance with this Order would disrupt or impair a program of conversion from non-defense work to defense work, may appeal to the Office of Production Management, Ref: M-79, setting forth the pertinent facts and the reason he considers he is entitled to relief. The Director of Priorities may thereupon take such action as he deems appropriate.

(3) Applicability of Order. The prohibitions and restrictions contained in this Order shall apply to the use of material in all articles hereafter manufactured irrespective of whether such articles are manufactured pursuant to a contract made prior or subsequent to the effective date hereof, or pursuant to a contract supported by a preference rating. Insofar as any other Order of the Director of Priorities may have the effect of limiting or curtailing to a greater extent than herein provided, the use of asbestos fibre in the production of any article, the limitations of such other Order shall be observed.

(4) Correspondence and Communication. All reports required to be filed hereunder, and all communications concerning this Order, shall, unless otherwise directed, be addressed to:

"Office of Production Management
Washington, D. C. Ref: M-79"

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(5) Violations. Any Person who wilfully violates any provision of this Order, or who by any Act or omission falsifies records to be kept or information to be furnished pursuant to this Order, may be prohibited from receiving further deliveries of any Material subject to allocation, and such further action may be taken as is deemed appropriate, including a recommendation for prosecution under Section 35 A of the Criminal Code (18 U.S.C. 80).

(6) Effective Date. This Order shall take effect immediately and shall continue in effect until revoked.

(P.D. Reg. 1, Amended, Dec. 23, 1941, 6 F.R. 6680; O.P.M. Reg. 3 Amended, Sept. 2, 1941, 6 F.R. 4865; E.O. 8629, Jan. 7, 1941, 6 F.R. 191; E.O. 8875, Aug. 28, 1941, 6 F.R. 4483; sec. 2 (a), Public No. 671, 76th Congress, Third Session, as amended by Public No. 89, 77th Congress, First Session).

Date this 20th day of January, 1942.

(Signed) J. S. Knowlson

J. S. Knowlson
Acting Director of Priorities

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TITLE 32 - NATIONAL DEFENSE

CHAPTER IX - WAR PRODUCTION BOARD

Subchapter B - DIVISION OF INDUSTRY OPERATIONS

PART 1064 - ASBESTOS

AMENDMENT NO. 1 OF CONSERVATION ORDER NO. M-79
CURTAILING THE USE OF CERTAIN TYPES OF ASBESTOS

(a) Paragraph (a) (3) of Section 1064.1 (Conservation Order No. M-79) is hereby amended to read as follows:

> "In addition to the above limitations, unless otherwise specifically authorized by the Director of Industry Operations, after February 1, 1942 no person shall install eighty-five percent magnesia or other high temperature pipe covering except (1) in installations where temperatures of 200°F or over occur, or (2) in installations on ships."

(b) This amendment shall take effect immediately.

Issued this 28th day of February, 1942.

(Signed) J. S. Knowlson

J. S. Knowlson
Director of Industry Operations

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TITLE 32 - NATIONAL DEFENSE

CHAPTER IX - WAR PRODUCTION BOARD

Subchapter B - DIVISION OF INDUSTRY OPERATIONS

PART 1172 - ASBESTOS TEXTILES

CONSERVATION ORDER M-123

The fulfillment of requirements for the defense of the United States has created a shortage in the supply of Asbestos Textiles for defense, for private account and for export; and the following Order is deemed necessary and appropriate in the public interest and to promote the national defense:

Section 1172.1, Conservation Order M-123

(a) Unless otherwise specifically authorized by the Director of Industry Operations, after April 4, 1942, no manufacturer of Asbestos Textiles shall deliver Asbestos Textiles except
(1) for use in the manufacture of industrial packings or
(2) on orders bearing a preference rating of A-10 or higher.

(b) Applicability of Priorities Regulation No. 1. This Order and all transaction affected hereby are subject to the provisions of Priorities Regulation No. 1 (Part 944), as amended from time to time, except to the extent that any provision hereof may be inconsistent therewith, in which case the provisions of this Order shall govern.

(c) Appeals. Any person affected by this Order who considers that compliance herewith would work an exceptional and unreasonable hardship upon him may appeal to the War Production Board, setting forth the pertinent facts and the reasons such person considers that he is entitled to relief. The Director of Industry Operations may thereupon take such action as he deems appropriate.

(d) Communications. All communications concerning this Order, shall, unless otherwise directed, be addressed to:
War Production Board
Washington, D. C. Ref: M-123

(e) Violations. Any person who wilfully violates any provision of this Order, or who by any act or omission falsifies records to be kept or information to be furnished pursuant to this Order may be prohibited from receiving further deliveries of any material subject to allocation, and such further action may be taken as is deemed appropriate, including a recommendation for prosecution under Section 35 (A) of the Criminal Code (18 U. S. C. 80).

(f) Effective Date. This Order shall take effect immediately.

Issued this 30th day of March, 1942.

(Signed) J. S. Knowlson
J. S. Knowlson, Director of Operations

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TITLE 32 - NATIONAL DEFENSE

CHAPTER IX - WAR PRODUCTION BOARD

Subchapter B - DIVISION OF INDUSTRY OPERATIONS

PART 1064 - ASBESTOS

CONSERVATION ORDER NO. M-79 AS AMENDED JUNE 18, 1942.

Section 1064.1 (Conservation Order No. M-79) is hereby amended to read as follows:

1064.1 CONSERVATION ORDER NO. M-79

(a) Restrictions on the Use of Certain Types of Asbestos.

(1) Unless otherwise specifically authorized by the Director of Industry Operations, no Person shall fabricate, spin, or process in any way asbestos fibre imported from South Africa except where such fabrication, spinning or processing is necessary to fill Defense Orders as defined in Priorities Regulation No. 1, as amended from time to time.

(2) In addition to the above limitation, unless otherwise specifically authorized by the Director of Industry Operations, no Person shall fabricate, spin, or process in any way:

(i) Rhodesian chrysotile asbestos fibre of Grade C and G-1 or Grade C and G-2, or Rhodesian chrysotile asbestos having a fibre length equivalent to that of Rhodesian Grade C, G-1 and G-2, except where such fabrication, spinning, or processing is necessary to fill Defense Orders for:

(a) Products covered in Navy specification Number 17-I-29 (Insulation, electrical, asbestos fibre, treated and untreated, dated January 2, 1942 or as same may be amended).

(b) Lapps, yarns, tapes, and cloth which are required by Army, Navy, or Maritime Commission specifications or Underwriter's or governmental safety regulations in effect on May 1, 1942, to be of a non-ferrous nature;

(ii) Amosite asbestos fibre of Grade B-1, or amosite asbestos having a fibre length equivalent to that of Grade B-1, except where such fabricating, spinning,

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or processing is necessary to fill Defense Orders for amosite woven felt blankets and mattresses and fittings for use as insulation on ships.

(iii) Amosite asbestos fibre of Grade B-3 or D-3, or amosite asbestos having a fibre length equivalent to that of Grade B-3 or D-3, except where such fabricating, spinning, or processing is necessary to fill Defense Orders for:

(a) Amosite woven felt blankets and mattresses and fittings for use as insulation on ships.

(b) Fireproof insulating board for installation on ships.

(c) Molded amosite pipe covering and blocks for use as insulation on ships, provided, however, that the amount of D-3 or B-3 or equivalent length amosite fibre used in such pipe covering or blocks shall not exceed 15 per cent by weight of finished product.

(d) Flexible amosite pipe insulations for installation on ships.

(b) Restrictions on the Use of Certain Types of Asbestos Pipe Coverings. In addition to the above limitations, No Person shall install 85 per cent magnesia pipe covering or other high temperature molded asbestos pipe covering except (1) in installations where temperatures of 212° Fahrenheit or over occur, (2) in installations underground or in ships, or (3) as specifically authorized by the Director of Industry Operations.

(c) Use of Waste Asbestos Materials. Waste or scrap materials produced in the fabrication, spinning, or processing of asbestos fibre imported from South Africa, which cannot be reprocessed and used in fabricating, spinning, or processing operations permitted under the foregoing limitations of this Order, may be sold or disposed of without further restriction.

(d) Reports

(1) Any Person who manufactures or processes any type of asbestos fibre shall on or before the 10th day of each calendar month file with the War Production Board, Ref: M-79, all of the information required by Forms PD-251 and PD-252, whichever is applicable.

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(2) Any Person who manufactures or processes any type of asbestos fibre shall, when requested, also file with the War Production Board, Ref: M-79, all the information required by Form PD-253.

(e) Prohibitions Against Sales or Deliveries. No Person shall hereafter sell or deliver South African asbestos fibre or products made therefrom, to any Person if he knows, or has reason to believe, such material or products are to be used in violation of the terms of this Order.

(f) Limitation of Inventories. No Person shall receive delivery of Rhodesian or Amosite Asbestos fibre products in the form of semi-processed materials, finished parts or sub-assemblies, nor shall he put into process said fibre as raw material, in quantities which in either case shall result in an inventory of such semi-processed or finished material in excess of a minimum practicable working inventory, taking into consideration the limitations placed upon the production of asbestos fibre products by this Order.

(g) Miscellaneous Provisions.

(1) Applicability of Priorities Regulation No. 1. This Order and all transactions affected thereby are subject to the provisions of Priorities Regulation No. 1 (Part 944) as amended from time to time, except to the extent that any provision hereof may be inconsistent therewith, in which case the provisions of this Order shall govern.

(2) Appeal. Any Person affected by this Order who considers that compliance therewith would work an exceptional and unreasonable hardship upon him or that it would result in a degree of unemployment which would be unreasonably disproportionate compared with the amount of asbestos fibre conserved, or that compliance with this Order would disrupt or impair a program of conversion from non-defense work to defense work, may appeal to the War Production Board, Ref: M-79, by letter or other written communication, in duplicate, setting forth the pertinent facts and the reason he considers he is entitled to relief. The Director of Industry Operations may thereupon take such action as he deems appropriate.

(3) Applicability of Order. The prohibitions and restrictions contained in this Order shall apply to the use of material in all articles hereafter manufactured irrespective of whether such articles are manufactured pursuant to a contract made prior or subsequent to the effective date

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hereof, or pursuant to a contract supported by a preference rating. Insofar as any other Order of the Director of Industry Operations may have the effect of limiting or curtailing to a greater extent than herein provided, the use of asbestos fibre in the production of any article, the limitations of such other Order shall be observed.

(4) Correspondence and Communications. All reports required to be filed hereunder, and all communications concerning this Order, shall, unless otherwise directed, be addressed to:

War Production Board
Washington, D. C. Ref: M-79

(5) Violations. Any Person who wilfully violates any provision of this Order, or who, in connection with this Order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such Person may be prohibited from making or obtaining further deliveries of, or from processing or using, material under priority control and may be deprived of priorities assistance.

Issued this 18th day of June, 1942.

J. S. Knowlson
Director of Industry Operations

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TITLE 32—NATIONAL DEFENSE

Chapter IX—War Production Board

Subchapter B—Division of Industry Operations

PART 1172—ASBESTOS TEXTILES

[Conservation Order M-123 as Amended July 4, 1942]

Section 1172.1 (*Conservation Order M-123*) is hereby amended to read as follows:

§ 1172.1 *Conservation Order M-123.* (a) Unless otherwise specifically authorized by the Director of Industry Operations, no manufacturer of asbestos textiles shall use asbestos textiles or deliver asbestos textiles for use except

(1) In the manufacture of industrial packings or woven friction material; or

(2) On orders bearing a preference rating of A-10 or higher.

(b) *Applicability of Priorities Regulation No. 1.* This order and all transactions affected thereby are subject to the provisions of Priorities Regulation No. 1 (Part 944), as amended from time to time, except to the extent that any provisions hereof may be inconsistent therewith, in which case the provisions of this order shall govern.

(c) *Appeal.* Any person affected by this order who considers that compliance therewith would work an exceptional and unreasonable hardship upon him, or that it would result in a degree of unemployment which would be unreasonably disproportionate compared with the amount of asbestos textiles conserved, or that compliance with this order would disrupt or impair a program of conversion from non-defense to defense work, may appeal to the War Production Board by letter or other written communication, in triplicate, setting forth the pertinent facts and the reason he considers he is entitled to relief. The Director of Industry Operations may thereupon take such action as he deems appropriate.

(d) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Cork-Asbestos Branch, Washington, D. C. Ref.: M-123.

(e) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using, material under priority control and may be deprived of priorities assistance. (P.D. Reg. 1, as amended, 6 F.R. 6680; W.P.B. Reg. 1, 7 F.R. 561; E.O. 9024, 7 F.R. 329; E.O. 9040, 7 F.R. 527; E.O. 9125, 7 F.R. 2719; sec. 2 (a), Pub. Law 671, 76th Cong., as amended by Pub. Laws 89 and 507, 77th Cong.)

Issued this 4th day of July 1942.

Director of Industry Operations.

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WAR PRODUCTION BOARD

PART 1064—ASBESTOS

[Conservation Order M-79 as of September 30, 1942]

Whereas national defense requirements have created a shortage of certain types of asbestos for the combined needs of defense, private account, and export; and the supply now is and will be insufficient for defense and essential civilian requirements unless their use in certain products manufactured for civilian use is curtailed; and it is necessary in the public interest, to promote the defense of the United States, to conserve the supply and direct the distribution thereof:

Now, therefore, it is hereby ordered, That:

§ 1064.1 *Conservation Order M-79.*—(a) *Restrictions on the use of certain types of asbestos.* (1) Unless otherwise specifically authorized by the Director General for Operations, no person shall fabricate, spin, or process in any way asbestos fibre imported from South Africa except where such fabrication, spinning, or processing is necessary to fill defense orders as defined in Priorities Regulation No. 1, as amended from time to time.

(2) In addition to the above limitation, unless otherwise specifically authorized by the Director General for Operations, no person shall fabricate, spin, or process in any way:

(i) Rhodesian chrysotile asbestos fibre of Grade C and G–1 or Grade C and G–2, or Rhodesian chrysotile asbestos having a fibre length equivalent to that of Rhodesian Grade C, G–1 and G–2, except where such fabrication, spinning, or processing is necessary to fill defense orders for:

(a) Products covered in Navy specification number 17–I–29 (insulation, electrical, asbestos fibre, treated and untreated, dated January 2, 1942, or as same may be amended).

(b) Lapps, yarns, tapes, and cloth which are required by Army, Navy, or Maritime Commission specifications or underwriter's or governmental safety regulations in effect on May 1, 1942, to be of a non-ferrous nature;

(ii) Amosite asbestos fibre of Grade B–1, or amosite asbestos having a fibre length equivalent to that of Grade B–1, except where such fabricating, spinning, or processing is necessary to fill defense orders for amosite woven felt blankets and mattresses and fittings for use as insulation on ships.

(iii) Amosite asbestos fibre of Grade B–3 or D–3, or amosite asbestos having a fibre length equivalent to that of Grade B–3 or D–3, except where such fabricating, spinning, or processing is necessary to fill defense orders for:

(a) Amosite woven felt blankets and mattresses and fittings for use as insulation on ships.

(b) Fireproof insulating board for installation on ships.

(c) Molded amosite pipe covering and blocks for use as insulation on ships: *Provided, however,* That the amount of D–3 or B–3 or equivalent length amosite fibre used in such pipe covering or blocks shall not exceed 15 per cent by weight of finished product.

(d) Flexible amosite pipe insulations for installation on ships.

(b) *Restrictions on the use of certain types of asbestos pipe coverings.* In addition to the above limitations, no person shall install 85 per cent magnesia pipe covering or other high temperature molded asbestos pipe covering except (1) in installations where temperatures of 212° Fahrenheit or over occur, (2) in installations underground or in ships, or (3) as specifically authorized by the Director General for Operations.

(c) *Use of waste asbestos materials.* Waste or scrap materials produced in the fabrication, spinning, or processing of asbestos fibre imported from South Africa, which cannot be reprocessed and used in fabricating, spinning, or processing operations permitted under the foregoing limitations of this order, may be sold or disposed of without further restriction.

(d) *Reports.* (1) Any person who manufactures or processes any type of asbestos fibre shall on or before the 10th day of each calendar month file with the War Production Board, Ref.: M–79, all of the information required by Forms PD–251 and PD–252, whichever is applicable.

(2) Any person who manufactures or processes any type of asbestos fibre shall, when requested, also file with the War Production Board, Ref.: M–79, all the information required by Form PD–253.

(e) *Prohibitions against sales or deliveries.* No person shall after June 18, 1942, sell or deliver South African asbestos fiber or products made therefrom, to any person if he knows, or has reason to believe, such material or products are to be used in violation of the terms of this order.

(f) *Limitation of inventories.* No person shall receive delivery of Rhodesian or amosite asbestos fibre products in the form of semi-processed materials, finished parts or sub-assemblies, nor shall he put into process said fibre as raw material, in quantities which in either case shall result in an inventory of such semi-processed or finished material in excess of a minimum practicable working inventory, taking into consideration the limitations placed upon the production of asbestos fibre products by this order.

(g) *Miscellaneous provisions.*—(1) *Applicability of Priorities Regulation 1.* This order and all transactions affected thereby are subject to the provisions of Priorities Regulation 1 (Part 944), as amended from time to time, except to the extent that any provision hereof may be inconsistent therewith, in which case the provisions of this order shall govern.

(2) *Appeal.* Any person affected by this order who considers that compliance therewith would work an exceptional and unreasonable hardship upon him or that it would result in a degree of unemployment which would be unreasonably disproportionate compared with the amount of asbestos fibre conserved, or that compliance with this order would disrupt or impair a program of conversion from non-defense work to defense work, may appeal to the War Production Board, Ref.: M–79, by letter or other written communication, in duplicate, setting forth the pertinent facts and the reason he considers he is entitled to relief. The Director General for Operations may thereupon take such action as he deems appropriate.

(3) *Applicability of order.* The prohibitions and restrictions contained in this order shall apply to the use of material in all articles manufactured after June 18, 1942, irrespective of whether such articles are manufactured pursuant to a contract made prior or subsequent to June 18, 1942, or pursuant to a contract supported by a preference rating. Insofar as any other order of the Director General for Operations may have the effect of limiting or curtailing

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to a greater extent than herein provided, the use of asbestos fibre in the production of any article, the limitations of such other order shall be observed.

(4) *Correspondence and communications.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Washington, D. C., Ref.: M-79.

(5) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using, material under priority control and may be deprived of priorities assistance.

(P.D. Reg. 1, as amended, 6 F.R. 6680; W.P.B. Reg. 1, 7 F.R. 561; E.O. 9024, 7 F.R. 329; E.O. 9040, 7 F.R. 527; E.O. 9125, 7 F.R. 2719; sec. 2 (a), Pub. Law 671, 76th Cong., as amended by Pub. Laws 89 and 507, 77th Cong.)

Issued June 18, 1942.

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WAR PRODUCTION BOARD

PART 1172—ASBESTOS TEXTILES

[Conservation Order M-123 as Amended Dec. 14, 1942]

Section 1172.1 (Conservation Order M-123) is hereby amended to read as follows:

§ 1172.1 *Conservation Order M-123*—(a) *Definitions.* For the purposes of this order:

(1) "Asbestos textile" means any material produced from the mineral asbestos by a carding operation. The term also includes such material at any stage of process subsequent to the carding operation, except where it has become a finished item, or part thereof, or has been physically incorporated in a finished item, or part thereof. The term does not include scrap.

(2) "Supplier" means any person who produces any asbestos textiles in any form, either for use by himself as a manufacturer or for sale to other manufacturers. The term also includes any person who offers any asbestos textile for sale to manufacturers.

(3) "Manufacturer" means any person who uses any asbestos textile to manufacture or fabricate a finished item.

(4) "Put into process" means the first change by the manufacturer in the form of material from that form in which it is received by him.

(5) "Process" means change in any way the size, form, shape, or characteristics of the material. It also means assemble.

(6) "Assemble" means combine or add parts, whether of asbestos textile or any other material, with or to other products or parts manufactured or fabricated in whole or in part of asbestos textile, where the final product will not be a finished item ready for immediate sale or use without the combination or addition of such products or parts. The term shall not be deemed to include the putting together of a finished item after delivery to a sales outlet or consumer in knockdown form pursuant to an established custom. The term shall also not be deemed to include adding finished parts to an otherwise finished item where the placing of one or more finished parts, or the size or type of one or more finished parts, is determined by the use to which the ultimate consumer is to put the item.

(7) "Finished item" means oil burner wicking or any item on List A or List B.

(8) "Inventory" of a person includes the inventory of affiliates and subsidiaries of such person, and the inventory of others where such inventory is under the control of, or under common control with, or available for the use of, such person.

(9) "Implements of war" means combat and products, complete for tactical operations (including, but not limited to, aircraft, ammunition, armament, weapons, ships, tanks, and military vehicles), and any parts, assemblies, and materials to be incorporated in any of the foregoing items being produced for the Army or the Navy of the United States, the Maritime Commission, the War Shipping Administration, or for any foreign government pursuant to the act approved March 11, 1941, entitled "An Act to Promote the Defense of the United States" (Lend-Lease Act), where the use of any asbestos textile to the extent employed is required by the latest issue of government specifications (including performance specifications, unless otherwise directed by the Director General for Operations) applicable to the contract, subcontract, or purchase order. The term does not include facilities or equipment used to manufacture the foregoing items.

(10) "Scrap" means any asbestos textile, the further process of which as an asbestos textile is not practicable.

(b) *Restrictions on delivery of asbestos textiles.* On and after December 14, 1942, no supplier shall deliver any asbestos textile to any manufacturer when he knows, or has reason to know, that such manufacturer will receive or use such asbestos textile in violation of the terms of this order.

(c) *Restrictions on manufacture of List A products*—(1) *Putting into process.* On and after December 14, 1942, no manufacturer shall put into process any asbestos textile to make any item on List A or part thereof.

(2) *Processing.* On and after December 14, 1942, a manufacturer may continue the processing of any asbestos textile already in process on such date to make any item on List A or part thereof, provided the processing thereof will be completed on or before February 1, 1943. On and after February 1, 1943, no manufacturer shall process in any way any asbestos textile to make any item on List A or part thereof.

(d) *Restrictions on manufacture of List B products.* On and after the governing date specified in List B, no manufacturer in the manufacture of any item on List B shall put into process any asbestos textile of a grade containing a greater percentage of asbestos than underwriter's grade as defined in paragraph (5) (a) of A. S. T. M. Designation: D299-37.

(e) *Restrictions on manufacture of oil burner wicking.* In the period between December 14, 1942, and January 1, 1943, and in any calendar month thereafter, no manufacturer shall put into process any asbestos textile in the manufacture of oil burner wicking in excess of 1/24 of the aggregate amount by weight of such asbestos textile put into process by such manufacturer in the manufacture of oil burner wicking in the calendar year 1941.

(f) *Restrictions on delivery of finished items.* No person shall deliver or accept delivery of any finished item which he knows, or has reason to know, was manufactured in violation of the terms of this order.

(g) *General exception.* Except as provided in paragraph (f), none of the provisions of this order shall be deemed to limit or restrict the sale, delivery, or use of any finished item, or the further processing of any such item, provided such further processing is necessary for purposes of installation, application, servicing, or repair of such item.

(h) *Limitations of inventories*—(1) *Suppliers' inventories.* No supplier shall produce asbestos textiles which shall result in an inventory of such material in excess of a minimum practicable working inventory, taking into consideration the limitations placed upon the use of asbestos textiles by this order.

(2) *Manufacturers' inventories.* No manufacturer shall receive delivery of any asbestos textile in the form of raw materials, semi-processed materials, finished parts or sub-assemblies, nor shall he put into process any raw material in quantities which in either case shall result in an inventory of raw, semi-processed, or finished material in excess of a minimum practicable working inventory, taking into consideration the limitations placed upon the use of asbestos textiles by this order.

(i) *Reports.* Each supplier, each manufacturer, and every other person affected by this order shall file such reports as may be requested from time to time by the Director General for Operations.

(j) *Miscellaneous provisions*—(1) *Appeal.* Any appeal from the provisions of this order shall be made by filing a letter in triplicate, referring to the particular provision appealed from and stating fully the grounds of the appeal.

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(2) *Applicability of order.* The prohibitions and restrictions contained in this order shall apply to the use of material in all items manufactured after December 14, 1942, irrespective of whether such items are manufactured pursuant to a contract made prior or subsequent to such date. Insofar as any other order of the Director General for Operations may have the effect of limiting or curtailing to a greater extent than herein provided, the use of asbestos textile in the production of any item, the limitations of such other order shall be observed.

(3) *Applicability of priorities regulations.* This order and all transactions affected thereby are subject to all applicable provisions of the priorities regulations of the War Production Board, as amended from time to time.

(4) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Cork-Asbestos Division, Washington, D. C.: Ref.: M-123.

(5) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using, material under priority control and may be deprived of priorities assistance.

(P.D. Reg. 1, as amended, 6 F.R. 6680; W.P.B. Reg. 1, 7 F.R. 561; E.O. 9024, 7 F.R. 329; E.O. 9040, 7 F.R. 527; E.O. 9125, 7 F.R. 2719; sec. 2 (a), Pub. Law 671, 76th Cong., as amended by Pub. Laws 89 and 507, 77th Cong.)

Issued this 14th day of December 1942.

ERNEST KANZLER,
Director General for Operations.

RESTRICTED USES OF ASBESTOS TEXTILES UNDER CONSERVATION ORDER M-123 AS AMENDED DECEMBER 14, 1942

LIST A

1. Theater curtains and scenery.
2. Vibration eliminators (except for implements of war).
3. Gun covers.
4. Radiator hose (except for implements of war).
5. Ammunition containers.
6. Fire stops in automotive vehicles, buses, or trucks.
7. Conveyor belts (except for glass industry).
8. Heaters and heater accessories (except for implements of war).
9. Filter sacks for liquids.
10. Parachute flare shields.
11. Clutch facing for automotive vehicles (except for implements of war), in accordance with numbers assigned by the Brake Lining Manufacturers Association in B. L. M. A. Catalog as shown in the 1939 edition, the 1940 supplement to the 1939 edition, and the 1941 edition, to-wit:

416	621	637	736A
606	621A	638	736B
516	628	718	738
614	629	719B	821B
620	636	732	827
839	946	986A	1053
862A	953A	987	1056
862B	953C	988	1057
880	953D	988A	1057A
891	953E	990	1057B
896A	954	990A	1057C
898	955	991	1058
900	955A	991A	1059
902A	955B	991B	1059A
905	956	993	1059B
905A	956A	993A	1068
905D	966	994	1072
905E	967	995	1142B
905F	967A	999	1142C
909	968	1005A	1154A
909A	968B	1007A	1169
909B	969	1008A	1169A
929B	975	1033	1170
929D	979	1047	1173
930-1	980	1047A	1181
940	982	1051	
941A	985	1052	

12. Brake lining in widths less than 2" or in thickness less than ¼" (except for implements of war and except for B. L. M. A. Nos. 336 and 341A).

LIST B

	Governing date
1. Laminated plastics	February 14, 1943.
2. Mechanical packing or gasket material, which means any asbestos textile material which has been graphited, friction treated, or otherwise treated with an adhesive or impregnating substance, for use as, or for use in the manufacture of, mechanical packings or gaskets (except that produced from blue asbestos fiber, and except for implements of war)	December 14, 1942.

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WAR PRODUCTION BOARD

PART 1172—ASBESTOS TEXTILES

[Conservation Order M-283]

The fulfillment of requirements for the defense of the United States has created a shortage in the supply of asbestos textiles for defense, for private account and for export; and the following order is deemed necessary and appropriate in the public interest and to promote the national defense:

§ 1172.3 *Conservation Order M-283*—(a) *Definitions.* For the purposes of this order:

(1) "Asbestos textiles" means any material initially produced from the mineral asbestos by means of a carding operation and includes all such material in the following forms subsequent to the carding operation:

Carded fiber
Plain roving (underwriter's and commercial)
Plain roving (above underwriter's grade)
Reinforced roving
Cable filler
Lapps
Wick made from roving
Wick made on wicking card
Yarn—single
Yarn—plied
Yarn—metallic
Cloth—1¼ pounds per square yard and lighter, all weaves
Cloth—heavier than 1¼ pounds per square yard, non-metallic, plain weave
Cloth—heavier than 1¼ pounds per square yard, metallic, plain weave
Cloth—all weights, metallic and non-metallic other than plain weave
Tape—.010 to .025" thick
Tape—1/32" thick and up
Cord—Plain or treated
Tubing—woven or braided

(2) "Supplier" means any person who produces asbestos textiles from the mineral asbestos by means of a carding operation.

(3) "Consumer" means any person who purchases or accepts delivery of asbestos textiles from a supplier for resale, or for use in the manufacture of other forms of asbestos textiles or of articles made in whole or in part of asbestos textiles, or for any other use. A supplier, who uses asbestos textiles which he has produced in the manufacture of any product which is not itself an asbestos textile as defined in paragraph (a) (1), shall be deemed also to be a consumer.

(b) *Restrictions on use and delivery of asbestos textiles.* (1) On and after April 1, 1943, no supplier shall deliver asbestos textiles, and no person shall accept delivery of asbestos textiles from a supplier, except upon specific authorization by the Director General for Operations upon application pursuant to paragraph (d) or except as provided in paragraph (c).

(2) Each person specifically authorized to accept delivery of asbestos textiles shall use such asbestos textiles for the purpose for which the authorization was requested, except as otherwise directed by the Director General for Operations.

(3) The Director General for Operations at his discretion may at any time issue special directions to any person with respect to the use, process to final product, delivery, acceptance of delivery, or placing of orders, of asbestos textiles by such person, notwithstanding the provision of paragraph (c) hereof, or special directions to any supplier with respect to the kinds of asbestos textiles which he may or must manufacture, and the grades and types of asbestos fiber which he may or must use in the production of asbestos textiles.

(4) Such authorizations and directions will be made to ensure the satisfaction of requirements, direct and indirect, for the defense of the United States and for essential civilian supply; and may also be made in consideration of any possible dislocation of labor, of the problems of transportation, including cross-hauling, and of the necessity of keeping a plant in operation so that it may be able to fulfill war orders and essential requirements; and may be issued, and, unless otherwise specified by the Director General for Operations, shall be complied with, without regard to preference ratings.

(c) *Small order exemption.* (1) Any person may accept delivery of 100 pounds or less of asbestos textiles in the aggregate during any one calendar month without specific authorization, provided that such person has not been specifically authorized to accept delivery of any quantity of asbestos textiles during such month; and

(2) Any supplier may deliver asbestos textiles without specific authorization to any person who shall certify to him in writing that he is entitled, pursuant to paragraph (c) (1), to accept delivery, provided that:

(i) No supplier shall deliver in the aggregate in any calendar month, pursuant to this paragraph (c), an amount in excess of 5 per cent by weight of his actual shipments of asbestos textiles for the preceding month;

(ii) No supplier shall make deliveries during any calendar month, pursuant to this paragraph (c), if such deliveries will prevent completion of any deliveries which have been specifically authorized for such month;

(iii) Such certification shall be signed by an authorized official, either manually or as provided in Priorities Regulation No. 7, and shall be in substantially the following form:

The undersigned hereby certifies pursuant to War Production Board Order M-283 that the requested delivery of asbestos textiles plus other deliveries of asbestos textiles heretofore accepted during the month for which delivery is requested does not exceed 100 pounds in the aggregate; and that the undersigned has not been specifically authorized by the War Production Board to accept delivery of any quantity of asbestos textiles during the month for which delivery is requested.

Dated_____

_____

By_____
Authorized Official

(iv) No supplier shall make deliveries, even against such certification, if he knows or has reason to believe that the certification is false; but in the absence of such knowledge or reason to believe, he may rely on such certification.

(3) For the purpose of this paragraph (c), the 100 pounds exemption for each person shall be deemed to extend only to an individual, partnership, association, business trust, corporation, governmental corporation or agency, or other business organization as a unit, and shall not be deemed to extend to each division, plant, store, or purchasing agency of such unit.

(d) *Applications and reports*—(1) *Consumers.* Each consumer seeking authorization to accept delivery of asbestos textiles during any calendar month shall file application on Form PD-779. Six copies shall be prepared, of which three (with table II left blank) shall be forwarded, not later than the 1st day of the month preceding the month for which authorization for delivery is requested, to the supplier with whom the order or orders described in such application are placed, and two (with table II filled out) shall be sent, not later than the 10th day of the month preceding the month for which authorization for delivery is requested, to the War Production Board. A separate set of forms shall be prepared for each plant location of the applicant and for each supplier from whom the delivery of asbestos textiles is sought.

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(2) *Suppliers.* Suppliers shall seek authorization to deliver asbestos textiles only to consumers who have filed with them Form PD-779 in triplicate. Each supplier seeking authorization to make such deliveries to any consumer during any calendar month shall fill out all three copies of Form PD-779 received from such consumer, indicating thereon his proposed deliveries during such month to such consumer, and shall file two of such copies with the War Production Board on or before the 15th day of the month preceding the month for which delivery is requested by the consumer.

(3) *Other reports.* All persons affected by this order shall file such other reports as may be requested from time to time by the Director General for Operations.

(e) *Special provisions.* (1) Each supplier who consumes all or part of his production of asbestos textiles in the manufacture of any product which is not itself an asbestos textile, as defined in paragraph (a) (1), shall treat the production and consumption parts of his operations as separate divisions, and delivery to himself for consumption shall be deemed delivery, requiring authorization within the meaning of paragraph (b) (1). Each such supplier in his separate capacity as a consumer and as a supplier shall file all the applications and reports required by paragraphs (d) (1) and (d) (2). A supplier who consumes all or any part of his production of asbestos textiles in the manufacture of products which are not asbestos textiles as defined in subparagraph (a) (1) must request allocation only for that type of asbestos textile that immediately precedes the manufacturing process which changes its form beyond that shown in the list of asbestos textiles in paragraph (a) (1).

(2) Each supplier shall notify the War Production Board of the cancellation by a consumer of any authorized delivery or of his own inability to make authorized delivery within 5 days after he has notice of such fact.

(f) *Miscellaneous provisions*—(1) *Applicability of priorities regulations.* This order and all transactions affected thereby are subject to all applicable provisions of the priorities regulations of the War Production Board, as amended from time to time.

(2) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Cork-Asbestos and Fibrous Glass Division, Washington, D. C. Ref: M-283.

(3) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using, material under priority control and may be deprived of priorities assistance.

Issued this 9th day of February 1943.

CURTIS E. CALDER,

Director General for Operations.

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WAR PRODUCTION BOARD

PART 1172—ASBESTOS TEXTILES

[Conservation Order M-283 as Amended March 17, 1943]

The fulfillment of requirements for the defense of the United States has created a shortage in the supply of asbestos textiles for defense, for private account and for export; and the following order is deemed necessary and appropriate in the public interest and to promote the national defense:

§ 1172.3 *Conservation Order M-283*— (a) *Definitions.* For the purposes of this order:

(1) "Asbestos textiles" means any material initially produced from the mineral asbestos by means of a carding operation and includes all such material in the following forms subsequent to the carding operation:

[NOTE: Items pertaining to wicks were deleted March 17, 1943]

Carded fiber
Plain roving (underwriter's and commercial)
Plain roving (above underwriter's grade)
Reinforced roving
Cable filler
Lappe
Yarn—single
Yarn—plied
Yarn—metallic
Cloth—1¼ pounds per square yard and lighter, all weaves
Cloth—heavier than 1¼ pounds per square yard, non-metallic, plain weave
Cloth—heavier than 1¼ pounds per square yard, metallic, plain weave
Cloth—all weights, metallic and non-metallic other than plain weave
Tape—.010 to .025" thick
Tape—1/32" thick and up
Cord—Plain or treated
Tubing—woven or braided

(2) "Supplier" means any person who produces asbestos textiles from the mineral asbestos by means of a carding operation.

(3) "Consumer" means any person who purchases or accepts delivery of asbestos textiles from a supplier for resale, or for use in the manufacture of other forms of asbestos textiles or of articles made in whole or in part of asbestos textiles, or for any other use. A supplier, who uses asbestos textiles which he has produced in the manufacture of any product which is not itself an asbestos textile as defined in paragraph (a) (1), shall be deemed also to be a consumer.

(b) *Restrictions on use and delivery of asbestos textiles.* (1) On and after April 1, 1943, no supplier shall deliver asbestos textiles, and no person shall accept delivery of asbestos textiles from a supplier, except upon specific authorization by the Director General for Operations upon application pursuant to paragraph (d) or except as provided in paragraph (c).

(2) Each person specifically authorized to accept delivery of asbestos textiles shall use such asbestos textiles for the purpose for which the authorization was requested, except as otherwise directed by the Director General for Operations.

(3) The Director General for Operations at his discretion may at any time issue special directions to any person with respect to the use, process to final product, delivery, acceptance of delivery, or placing of orders, of asbestos textiles by such person, notwithstanding the provision of paragraph (c) hereof, or special directions to any supplier with respect to the kinds of asbestos textiles which he may or must manufacture, and the grades and types of asbestos fiber which he may or must use in the production of asbestos textiles.

(4) Such authorizations and directions will be made to ensure the satisfaction of requirements, direct and indirect, for the defense of the United States and for essential civilian supply; and may also be made in consideration of any possible dislocation of labor, of the problems of transportation, including cross-hauling, and of the necessity of keeping a plant in operation so that it may be able to fulfill war orders and essential requirements; and may be issued, and, unless otherwise specified by the Director General for Operations, shall be complied with, without regard to preference ratings.

(c) *Small order exemption.* (1) Any person may accept delivery of 100 pounds or less of asbestos textiles in the aggregate during any one calendar month without specific authorization, provided that such person has not been specifically authorized to accept delivery of any quantity of asbestos textiles during such month; and

(2) Any supplier may deliver asbestos textiles without specific authorization to any person who shall certify to him in writing that he is entitled, pursuant to paragraph (c) (1), to accept delivery, provided that:

(i) No supplier shall deliver in the aggregate in any calendar month, pursuant to this paragraph (c), an amount in excess of 5 per cent by weight of his actual shipments of asbestos textiles for the preceding month;

(ii) No supplier shall make deliveries during any calendar month, pursuant to this paragraph (c), if such deliveries will prevent completion of any deliveries which have been specifically authorized for such month;

(iii) Such certification shall be signed by an authorized official, either manually or as provided in Priorities Regulation No. 7 and shall be in substantially the following form:

The undersigned hereby certifies pursuant to War Production Board Order M-283 that the requested delivery of asbestos textiles plus other deliveries of asbestos textiles heretofore accepted during the month for which delivery is requested does not exceed 100 pounds in the aggregate; and that the undersigned has not been specifically authorized by the War Production Board to accept delivery of any quantity of asbestos textiles during the month for which delivery is requested.

Dated_____

_____

By_____
Authorized Official

(iv) No supplier shall make deliveries, even against such certification, if he knows or has reason to believe that the certification is false; but in the absence of such knowledge or reason to believe, he may rely on such certification.

(3) For the purpose of this paragraph (c), the 100 pounds exemption for each person shall be deemed to extend only to an individual, partnership, association, business trust, corporation, governmental corporation or agency, or other business organization as a unit, and shall not be deemed to extend to each division, plant, store, or purchasing agency of such unit.

(d) *Applications and reports* — (1) *Consumers.* Each consumer seeking authorization to accept delivery of asbestos textiles during any calendar month shall file application on Form PD-779. Six copies shall be prepared, of which three (with table II left blank) shall be forwarded, not later than the 1st day of the month preceding the month for which authorization for delivery is requested, to the supplier with whom the order or orders described in such application are placed, and two (with table II filled out) shall be sent, not later than the 10th day of the month preceding the month for which authorization for delivery is requested, to the War Production Board. A separate set of forms shall be prepared for each plant location of the applicant and for each supplier from whom the delivery of asbestos textiles is sought.

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(2) *Suppliers.* Suppliers shall seek authorization to deliver asbestos textiles only to consumers who have filed with them Form PD-779 in triplicate. Each supplier seeking authorization to make such deliveries to any consumer during any calendar month shall fill out all three copies of Form PD-779 received from such consumer, indicating thereon his proposed deliveries during such month to such consumer, and shall file two of such copies with the War Production Board on or before the 15th day of the month preceding the month for which delivery is requested by the consumer.

(3) *Other reports.* All persons affected by this order shall file such other reports as may be requested from time to time by the Director General for Operations.

(e) *Special provisions.* (1) Each supplier who consumes all or part of his production of asbestos textiles in the manufacture of any product which is not itself an asbestos textile, as defined in paragraph (a) (1), shall treat the production and consumption parts of his operations as separate divisions, and delivery to himself for consumption shall be deemed delivery, requiring authorization within the meaning of paragraph (b) (1). Each such supplier in his separate capacity as a consumer and as a supplier shall file all the applications and reports required by paragraphs (d) (1) and (d) (2). A supplier who consumes all or any part of his production of asbestos textiles in the manufacture of products which are not asbestos textiles as defined in subparagraph (a) (1) must request allocation only for that type of asbestos textile that immediately precedes the manufacturing process which changes its form beyond that shown in the list of asbestos textiles in paragraph (a) (1).

(2) Each supplier shall notify the War Production Board of the cancellation by a consumer of any authorized delivery or of his own inability to make authorized delivery within 5 days after he has notice of such fact.

(f) *Miscellaneous provisions.*—(1) *Applicability of priorities regulations.* This order and all transactions affected thereby are subject to all applicable provisions of the priorities regulations of the War Production Board, as amended from time to time.

(2) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Cork-Asbestos and Fibrous Glass Division, Washington, D. C. Ref: M-283.

(3) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using, material under priority control and may be deprived of priorities assistance.

Issued this 17th day of March 1943.

CURTIS E. CALDER,
Director General for Operations.

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WAR PRODUCTION BOARD

PART 1075—CONSTRUCTION

[Supplementary Conservation Order L-41-d]

In accordance with the provisions of § 1075.1, *Conservation Order L-41*, which the following order supplements:

§ 1075.11 *Supplementary Conservation Order L-41-d.* Conservation Order L-41, as amended, shall not apply to the residing of any structure with asbestos siding or the re-roofing of any structure with asbestos roofing material, where any part of the existing siding or roofing, as the case may be, is in need of repainting or other maintenance and repair: *Provided, however*, That no rubber, metal other than fastenings, nor lumber restricted by the provisions of paragraph (c) of Conservation Order M-208 shall be used in such re-siding or re-roofing.

Paragraph (e) of Interpretation No. 1 of Conservation Order L-41 as amended is hereby revoked.

Issued this 16th day of April 1943.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

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WAR PRODUCTION BOARD

(Corrected Copy)

PART 3301—CORK, ASBESTOS AND FIBROUS GLASS[1]

[Conservation Order M-79, as amended October 1, 1943]

ASBESTOS

Section 3301.6[1] (*Conservation Order M-79*) is amended to read as follows:

§ 3301.6 (*Conservation Order M-79*)—(a) *References to Canadian grades.* References to Canadian grades of asbestos are in accordance with the Canadian Chrysotile Asbestos Classification as revised December 1, 1942, and adopted by the Quebec Asbestos Producers Association March 22, 1943.

(b) *Restrictions on the use of South African asbestos.* (1) No person shall process Rhodesian chrysotile asbestos Grade C&G/1 or C&G/2 or Rhodesian chrysotile asbestos having a fibre length equivalent to that of Rhodesian Grade C&G/1 or C&G/2, except for:

(i) Products covered in Navy Specification No. 17-I-29 (Insulation, Electrical, Asbestos Fibre, Treated and Untreated; dated January 2, 1942, or as same may be amended), or

(ii) Rovings, lapps, yarns, tapes, and cloth which are approved or required to be of non-ferrous nature by Army, Navy, or Maritime Commission performance or other specifications or Underwriters or governmental safety regulations in effect May 1, 1942.

(2) No person shall process amosite asbestos Grades B-1, B-3, D-3, or 3/DM-1, or amosite asbestos having a fibre length equivalent to that of Grades B-1, B-3, D-3, or 3/DM-1, except for:

(i) Amosite woven insulating felt for use on ships, or

(ii) Fireproof insulating board for use on ships, or

(iii) Molded amosite insulations provided, however, that the amount of 3/DM-1, B-3, or D-3 or equivalent length amosite fibre used in such insulations shall not exceed 15 per cent by weight of finished product, or

(iv) Flexible amosite pipe insulation for use on ships.

(c) *Restrictions on Canadian asbestos.* On and after November 1, 1943:

(1) No person shall process Canadian crudes or spinning fibre Grades 3F or 3K for asbestos textiles of commercial grade (as defined in paragraph (7) (a) of A. S. T. M. Designation D-299-42).

(2) No person shall accept delivery of Canadian crudes or spinning fibre Grades 3F or 3K for the manufacture of compressed asbestos sheet packing.

(3) No person shall accept delivery of Canadian fibre Grades 3F, 3K, 3R, or 3T for the manufacture of 85% magnesia or other high temperature molded insulations.

(4) No person shall put into process Canadian spinning fibre Grades 3F or 3K at a greater monthly rate than his average monthly consumption for June and July 1943.

(5) No person shall put into process during any one calendar month Canadian spinning fibre Grades 3R or 3T in amount by weight greater than 20 per cent of the finished compressed asbestos sheet packing which he produced during that month.

(6) No person shall process Canadian spinning fibre Grade 3R for textile purposes during any calendar month unless during that month he uses at least one ton of Rhodesian fibre Grade C&G/3 for every five tons of Canadian spinning fibre Grade 3R.

(d) *Exemption for waste asbestos materials.* Waste or scrap materials produced in the fabrication, spinning or processing of asbestos fibre which cannot be reprocessed and used in fabricating, spinning or processing operations permitted under the foregoing limitations of this order, may be sold or disposed of without restriction under this order.

(e) *Reports.* The War Production Board may send copies of Form WPB-2916, WPB-2917 or WPB-2918 (formerly PD-251, PD-252 and PD-253) to any person who manufactures any product containing asbestos or who maintains a stock of asbestos. The person receiving the forms shall return them with the required information to the War Production Board on or before the following 10th of the month.

(f) *Prohibitions against sales or deliveries.* No person shall sell or deliver asbestos fibre or any product made therefrom if he knows or has reason to believe such material or product is to be used in violation of the terms of this order.

(g) *Special directions.* The War Production Board at its discretion may at any time issue special directions to any person with respect to his use, processing, delivery or acceptance of delivery of any grade or type of asbestos, notwithstanding any other provision of this order.

(h) *Miscellaneous provisions.*—(1) *Applicability of regulations.* This order and all transactions affected thereby are subject to all applicable regulations of War Production Board, as amended from time to time.

(2) *Appeals.* Any appeal from the provisions of this order shall be made by filing a letter in triplicate, referring to the particular provision appealed from and stating fully the grounds of the appeal.

(3) *Forms.* Forms WPB-2916, WPB-2917, and WPB-2918, referred to in paragraph (e), have been approved by the Bureau of the Budget in accordance with Federal Reports Act of 1942.

(4) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States Government is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using material under priority control and may be deprived of priorities assistance.

(5) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Cork, Asbestos & Fibrous Glass Division, Washington 25, D. C., Ref.: M-79.

Issued this 1st day of October 1943.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

[1] Formerly Part 1064; § 1064.1.

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M-123
REVOCATION
OCTOBER 11, 1943

WAR PRODUCTION BOARD

PART 1172—ASBESTOS TEXTILES

[*Revocation of Conservation Order M-123*]

Section 1172.1 *Conservation Order M-123* is hereby revoked. The subject matter of this order is now covered by § 3301.16, Conservation Order M-283.

Issued this 11th day of October 1943.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

MTC 001129

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WAR PRODUCTION BOARD

PART 3301—CORK, ASBESTOS AND FIBROUS GLASS

[Conservation Order M-79, as Amended Jan. 31, 1944]

ASBESTOS

§ 3301.6 (*Conservation Order M-79*)—(a) *References to Canadian grades.* References to Canadian grades of asbestos are in accordance with the Canadian Chrysotile Asbestos Classification as revised December 1, 1942, and adopted by the Quebec Asbestos Producers Association March 22, 1943.

(b) *Restrictions on the use of South African asbestos.* (1) No person shall process Rhodesian Chrysotile Asbestos Grade C&G/1 or C&G/2, or Rhodesian Chrysotile Asbestos having a fibre length equivalent to that of Rhodesian Grade C&G/1 or C&G/2 except for:

(i) Products covered in Navy Specification No. 17-I-29 (Insulation, Electrical, Asbestos Fibre, Treated and Untreated; dated January 2, 1942, or as same may be amended), or

(ii) Rovings, lapps, yarns, tapes, and cloth which are approved or required to be of non-ferrous nature by Army, Navy, Maritime Commission or War Shipping Administration performance or other specifications or Underwriters or governmental safety regulations in effect May 1, 1942.

Provided, however, That one ton of Rhodesian Asbestos Grade C&G/1 and C&G/2 may be used for other textile purposes during any calendar quarter for every five tons of Rhodesian Asbestos Grade C&G/3 used for textile purposes during the same calendar quarter.

(2) No person shall process amosite asbestos Grades B-1, B-3, D-3, or 3/DM-1, or amosite asbestos having a fibre length equivalent to that of Grades B-1, B-3, D-3, or 3/DM-1, except for:

(i) Amosite woven insulating felt for use on ships, or

(ii) Fireproof insulating board for use on ships, or

(iii) Molded amosite insulations provided, however, that the amount of 3/DM-1, B-3, or D-3 or equivalent length amosite fibre used in such insulations shall not exceed 15 per cent by weight of finished product, or

(iv) Flexible amosite pipe insulation for use on ships.

(c) *Restrictions on Canadian asbestos.* On and after November 1, 1943: (1) No person shall process Canadian crudes or spinning fibre Grades 3F or 3K for asbestos textiles of commercial grade (as defined in paragraph (7) (a) of A. S. T. M. Designation D-299-42).

(2) No person shall accept delivery of Canadian crudes or spinning fibre Grades 3F or 3K for the manufacture of compressed asbestos sheet packing.

(3) No person shall accept delivery of Canadian fibre Grades 3F, 3K, 3R, or 3T for the manufacture of 85% magnesia or other high temperature molded insulations.

(4) No person shall put into process Canadian spinning fibre Grades 3F or 3K at a greater monthly rate than his average monthly consumption for June and July 1943.

(5) No person shall put into process during any one calendar month Canadian spinning fibre Grades 3R or 3T in amount by weight greater than 20 per cent of the finished compressed asbestos sheet packing which he produced during that month.

(6) No person shall process Canadian spinning fibre Grade 3R for textile purposes during any calendar quarter unless during that quarter he uses at least one ton of Rhodesian Fibre Grade C&G/3 for textile purposes for every five tons of Canadian Spinning Fibre Grade 3R.

(d) *Exemption for waste asbestos materials.* Waste or scrap materials produced in the fabrication, spinning or processing of asbestos fibre which cannot be reprocessed and used in fabricating, spinning or processing operations permitted under the foregoing limitations of this order, may be sold or disposed of without restriction under this order.

(e) *Reports.* The War Production Board may send copies of Form WPB-2916, WPB-2917 or WPB-2918 (formerly PD-251, PD-252 and PD-253) to any person who manufactures any product containing asbestos or who maintains a stock of asbestos. The person receiving the forms shall return them with the required information to the War Production Board on or before the following 10th of the month.

(f) *Prohibitions against sales or deliveries.* No person shall sell or deliver asbestos fibre or any product made therefrom if he knows or has reason to believe such material or product is to be used in violation of the terms of this order.

(g) *Special directions.* The War Production Board at its discretion may at any time issue special directions to any person with respect to his use, processing, delivery or acceptance of delivery of any grade or type of asbestos, notwithstanding any other provision of this order.

(h) *Miscellaneous provisions.*—(1) *Applicability of regulations.* This order and all transactions affected thereby are subject to all applicable regulations of War Production Board, as amended from time to time.

(2) *Appeals.* Any appeal from the provisions of this order shall be made by filing a letter in triplicate, referring to the particular provision appealed from and stating fully the grounds of the appeal.

(3) *Forms.* Forms WPB-2916, WPB-2917, and WPB-2918, referred to in paragraph (e), have been approved by the Bureau of the Budget in accordance with Federal Reports Act of 1942.

(4) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States Government is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using material under priority control and may be deprived of priorities assistance.

(5) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Cork, Asbestos & Fibrous Glass Division, Washington 25, D. C., Ref.: M-79.

Issued this 31st day of January 1944.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

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PART 3301—CORK, ASBESTOS AND FIBROUS GLASS

[Conservation Order M-79, as Amended Dec. 8, 1944]

ASBESTOS

§ 3301.6 *Conservation Order M-79*—(a) *References to Canadian grades.* References to Canadian grades of asbestos are in accordance with the Canadian Chrysotile Asbestos Classification as revised December 1, 1942, and adopted by the Quebec Asbestos Producers Association March 22, 1943.

(b) [Revoked Dec. 8, 1944.]

(c) *Restrictions on Canadian asbestos.* On and after November 1, 1943: (1) No person shall process Canadian crudes or spinning fibre Grades 3F or 3K for asbestos textiles of commercial grade (as defined in paragraph (7) (a) of A. S. T. M. Designation D-299-42).

(2) No person shall accept delivery of Canadian crudes or spinning fibre Grades 3F or 3K for the manufacture of compressed asbestos sheet packing.

(3) No person shall accept delivery of Canadian fibre Grades 3F, 3K, 3R, or 3T for the manufacture of 85% magnesia or other high temperature molded insulations.

(4) No person shall put into process Canadian spinning fibre Grades 3F or 3K at a greater monthly rate than his average monthly consumption for June and July 1943.

(5) No person shall put into process during any one calendar month Canadian spinning fibre Grades 3R or 3T in amount by weight greater than 20 per cent of the finished compressed asbestos sheet packing which he produced during that month.

(6) No person shall process Canadian spinning fibre Grade 3R for textile purposes during any calendar quarter unless during that quarter he uses at least one ton of Rhodesian Fibre Grade C&G/3 for textile purposes for every five tons of Canadian Spinning Fibre Grade 3R.

(d) *Exemption for waste asbestos materials.* Waste or scrap materials produced in the fabrication, spinning or processing of asbestos fibre which cannot be reprocessed and used in fabricating, spinning or processing operations permitted under the foregoing limitations of this order, may be sold or disposed of without restriction under this order.

(e) *Reports.* The War Production Board may send copies of Form WPB-2917 or WPB-2918 to any person who manufactures any product containing asbestos or who maintains a stock of asbestos. The person receiving the forms shall return them with the required information to the War Production Board on or before the following 10th of the month.

(f) *Prohibitions against sales or deliveries.* No person shall sell or deliver asbestos fibre or any product made therefrom if he knows or has reason to believe such material or product is to be used in violation of the terms of this order.

(g) *Special directions.* The War Production Board at its discretion may at any time issue special directions to any person with respect to his use, processing, delivery or acceptance of delivery of any grade or type of asbestos, notwithstanding any other provision of this order.

(h) *Miscellaneous provisions*—(1) *Applicability of regulations.* This order and all transactions affected thereby are subject to all applicable regulations of War Production Board, as amended from time to time.

(2) *Appeals.* Any appeal from the provisions of this order shall be made by filing a letter in triplicate, referring to the particular provision appealed from and stating fully the grounds of the appeal.

(3) *Forms.* Forms WPB-2917 and WPB-2918, referred to in paragraph (e), have been approved by the Bureau of the Budget in accordance with Federal Reports Act of 1942.

(4) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States Government is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using material under priority control and may be deprived of priorities assistance.

(5) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Cork, Asbestos & Fibrous Glass Division, Washington 25, D. C., Ref.: M-79.

Issued this 8th day of December 1944.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

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PART ... 1—CORK, ASBESTOS AND FIBROUS GLASS [1]

[Conservation Order M-283, as Amended Jan. 4, 1945]

ASBESTOS TEXTILES

Section 3301.16 [1] *Conservation Order M-283* is amended to read:

§ 3301.16 *Conservation Order M-283*—(a) *Definitions.* (1) "Asbestos textiles" means any material initially produced from the mineral asbestos by means of a carding operation and includes all such material in the following forms subsequent to the carding operation, including scrap:

Carded fiber.
Plain roving (underwriter's and commercial).
Plain roving (above underwriter's grade):
Reinforced roving.
Cable filler.
Lapps.
Yarn—single.
Yarn—plied.
Yarn—metallic.
Cloth—1¼ pounds per square yard and lighter, all weaves.
Cloth—heavier than 1¼ pounds per square yard, non-metallic, plain weave.
Cloth—heavier than 1¼ pounds per square yard, metallic, plain weave.
Cloth—all weights, metallic and non-metallic other than plain weave.
Tape—.010 to .025" thick.
Tape—1/32" thick and up.
Cord—Plain or treated.
Tubing—woven or braided.

(2) "Supplier" means any person who produces asbestos textiles from the mineral asbestos by means of a carding operation.

(3) "Consumer" means any person who purchases or accepts delivery of asbestos textiles from a supplier for resale, or for use in the manufacture of other forms of asbestos textiles or of articles made in whole or in part of asbestos textiles, or for any other use. A supplier, who uses asbestos textiles which he has produced in the manufacture of any product which is not itself an asbestos textile as defined in paragraph (a) (1), shall be deemed also to be a consumer.

(4) "Implements of war" means combat end products, complete for tactical operations (including, but not limited to, aircraft, ammunition, armament, weapons, ships, tanks and military vehicles), and any parts, assemblies and materials to be incorporated in any of the foregoing items being produced for the Army or the Navy of the United States, the Maritime Commission, the War Shipping Administration, Veterans Administration, or for any foreign government pursuant to the act approved March 11, 1941, entitled "An Act to Promote the Defense of the United States" (Lend-Lease Act), where the use of any asbestos textiles to the extent employed is required by the latest issue of government specifications (including performance specifications, unless otherwise directed by the War Production Board) applicable to the contract, subcontract, or purchase order. The term does not include facilities or equipment used to manufacture the foregoing items.

(b) *Restrictions on delivery and use.* (1) No supplier shall deliver or use asbestos textiles and no person shall accept delivery of asbestos textiles from a supplier, except as specifically authorized in writing by War Production Board, upon application pursuant to paragraph (d).

(2) War Production Board may from time to time issue special directions to any person with respect to his use, processing to final product, delivery, acceptance of delivery, or placing of orders, of asbestos textiles, notwithstanding the provision of paragraph (c), or special directions to any supplier with respect to the kinds of asbestos textiles which he may or must manufacture, and the grades and types of asbestos fiber which he may or must use in the production of asbestos textiles.

(3) No supplier shall deliver any asbestos textiles to any person if he knows or has reason to believe that such person would receive or use it in violation of the terms hereof, nor may any person deliver or accept delivery of any item which he knows or has reason to believe was manufactured in violation of the terms hereof.

(4) Each supplier shall notify the War Production Board of his inability to make authorized delivery, or of cancellation by a consumer of any authorized delivery, within 5 days after he has notice of such fact.

(c) *Small order exemption.* Specific authorization shall not be required for:

(1) Any person to accept delivery of 500 pounds or less of asbestos textiles in the aggregate from all sources during any calendar month, provided that he has not been specifically authorized to accept delivery of any quantity of asbestos textiles during such month; and

(2) Any supplier to deliver 500 pounds or less of asbestos textiles to any person in any calendar month, provided that:

(i) No supplier shall deliver in the aggregate in any calendar month, pursuant to this paragraph (c), an amount in excess of 5 per cent by weight of his actual shipment of asbestos textiles for the preceding month;

(ii) No supplier shall make deliveries during any calendar month, pursuant to this paragraph (c), if such deliveries will prevent completion of any deliveries which have been specifically authorized for such month.

(3) For the purposes of paragraphs (c) (1) and (c) (2) above, the term "person" means usual purchasing unit, whether plant, distributing agency, corporation or other legal entity.

(d) *Applications and reports*—(1) *Consumers.* Each consumer seeking authorization to accept delivery of asbestos textiles during any calendar month shall file application on Form WPB-2137 as prescribed in that form.

(2) *Suppliers.* Suppliers shall seek authorization to deliver asbestos textiles only to consumers who have filed with them WPB-2137 as prescribed in that form.

(3) Applications for allocations of plain roving, reinforced roving, cable filler, and lapps for incorporation into Navy cable shall be made on a calendar quarterly basis on Form WPB-2137.2 as prescribed therein, beginning with the first quarter of 1945.

NOTE: Subparagraph (4) formerly (3) redesignated Jan. 4, 1945.

(4) War Production Board may from time to time issue special instructions with respect to the method or time of filing or content of WPB Form 2137.

(e) *Separation of functions.* Each supplier who consumes all or part of his production of asbestos textiles in the manufacture of any product which is not itself an asbestos textile, as defined in paragraph (a) (1), shall treat the production and consumption parts of his operations as separate divisions, and delivery to himself for consumption shall be deemed delivery, requiring authorization within the meaning of paragraph (b) (1). Each such supplier in his separate capacity as a consumer and as a supplier shall file all the applications and reports required by paragraphs (d) (1), (d) (2) and (d) (3). A supplier who consumes all or any part of his production of asbestos textiles in the manufacture of products which are not asbestos textiles as defined in paragraph (a) (1) must request allocation only for that type of asbestos textile that immediately precedes the manufacturing process which changes its form beyond that shown in the list of asbestos textiles in paragraph (a) (1).

(f) *Restrictions on manufacture of List A products.* No person shall use any asbestos textile in the manufacture of any item, or part for an item, on List A.

(g) *Restrictions on manufacture of List B products.* On and after the governing date specified in List B, no person in the manufacture of any item on List B shall use any asbestos textile which is either of a grade (in terms of percentage of asbestos content) higher than the grade specified in List B, or is of a cut finer than the cut specified in List B.

(h) [Revoked Jan. 4, 1945.]

(i) *Miscellaneous provisions*—(1) *Applicability of regulations.* This order and all transactions affected hereby are subject to all applicable War Production Board regulations, as amended from time to time.

[1] Formerly Part 1172, § 1172.3.

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(2) *Forms.* Forms WPB-2137 and WPB-2137.2, referred to in paragraph (d), has been approved by the Bureau of the Budget in accordance with Federal Reports Act of 1942.

(3) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States government, is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using, material under priority control, and may be deprived of priorities assistance.

(4) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Cork, Asbestos & Fibrous Glass Division, Washington 25, D. C. Ref: M-283.

Issued this 4th day of January 1945.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

RESTRICTED USES OF ASBESTOS TEXTILES UNDER CONSERVATION ORDER M-283, AS AMENDED OCTOBER 11, 1943

LIST A

1. Theatre curtains and scenery.
2. Vibration eliminators (except for implements of war).
3. Gun covers.
4. Radiator hose (except for implements of war).
5. Ammunition containers.
6. Fire stops in automotive vehicles, buses, or trucks.
7. Covering for heat insulation, except:
(i) As cuffs not over 12 inches long on pipe covering ends next to flanges or fittings where pipe temperature may under normal operating conditions exceed 500 degrees.
(ii) Where outside covering is next to hot metals such as steam boilers or auxiliaries.
(iii) On downcomer piping inside boiler casing.
(iv) For making portable flanges and fitting covers.
8. Yarn for heaters and heater accessories except for implements of war, except for electric heater cords to the extent permitted under Order L-277 as from time to time amended, and except for heater cords to be used in connection with electric soldering irons.
9. Filter sacks for liquids.
10. Parachute flare shields.
11. Clutch facing for automotive vehicles (except for implements of war), in accordance with numbers assigned by the Brake Lining Manufacturers Association in B. L. M. A. Catalog as shown in the 1939 edition, the 1940 supplement to the 1939 edition, and the 1941 edition, to-wit:

416	621	827	736A
506	621A	838	736B
516	628	718	738
614	629	719B	821B
620	636	732	827
859	946	986A	1053
862A	953A	987	1056
862B	953C	988	1057
880	953D	988A	1057A
891	953E	990	1057B
896A	954	990A	1057C
898	955	991	1058
900	955A	991A	1059
902A	955B	991B	1059A
905	956	993	1059B
906A	956A	993A	1068
906D	966	994	1072
906E	967	995	1142B
906F	967A	999	1142C
909	968	1006A	1154A
909A	968B	1007A	1169
909B	969	1008A	1169A
929B	976	1033	1170
929D	979	1047	1173
930-1	980	1047A	1181
940	982	1051	
941A	985	1052	

12. Brake lining in widths less than 2 inches or in thickness less than ¼ inch (except for implements of war and except for B. L. M. A. Nos. 336 and 341A).

LIST B

Item	*Governing date*	*Grade (max. % of asbestos)*	*Minimum permissible cut.*
1 Laminated plastics	February 14, 1943	Underwriters	------
2. Mechanical packing or gasket material made of asbestos textile material which has been graphited, friction treated, or otherwise treated with an adhesive or impregnating substance, for use as, or for use in the manufacture of, mechanical packings or gaskets (except that produced from blue asbestos fiber, and except for valve rings, seamless boiler gaskets and implements of war)	October 16, 1943	*Commercial	10
3. Friction material	October 16, 1943	Commercial	10

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PART 3301—CORK, ASBESTOS AND FIBROUS GLASS

[Conservation Order M-79, as Amended Mar. 20, 1945]

ASBESTOS

The fulfillment of requirements for the defense of the United States has created a shortage in the supply of asbestos for defense, for private account, and for export; and the following order is deemed necessary and appropriate in the public interest and to promote the national defense:

§ 3301.6 *Conservation Order M-79*—(a) *References to Canadian grades* References to Canadian grades of asbestos are in accordance with the Canadian Chrysotile Asbestos Classification as revised December 1, 1942, and adopted by the Quebec Asbestos Producers Association March 22, 1943.

(b) [Revoked Dec. 8, 1944.]

(c) *Restrictions on Canadian asbestos.* On and after November 1, 1943: (1) No person shall process Canadian crudes or spinning fibre Grades 3F or 3K for asbestos textiles of commercial grade (as defined in paragraph (7) (a) of A. S. T. M. Designation D-299-42).

(2) No person shall accept delivery of Canadian crudes or spinning fibre Grades 3F or 3K for the manufacture of compressed asbestos sheet packing.

(3) No person shall accept delivery of Canadian fibre Grades 3F, 3K, 3R, or 3T for the manufacture of 85% magnesia or other high temperature molded insulations.

(4) No person shall put into process Canadian spinning fibre Grades 3F or 3K at a greater monthly rate than his average monthly consumption for June and July 1943.

(5) No person shall put into process during any one calendar month Canadian spinning fibre Grades 3R or 3T in amount by weight greater than 20 per cent of the finished compressed asbestos sheet packing which he produced during that month.

(6) No person shall process Canadian spinning fibre Grade 3R for textile purposes during any calendar quarter unless during that quarter he uses at least one ton of Rhodesian Fibre Grades C&G/1, C&G/2 and C&G/3 in the aggregate for textile purposes for every five tons of Canadian Spinning Fibre Grade 3R.

(d) *Exemption for waste asbestos materials.* Waste or scrap materials produced in the fabrication, spinning or processing of asbestos fibre which cannot be reprocessed and used in fabricating, spinning or processing operations permitted under the foregoing limitations of this order, may be sold or disposed of without restriction under this order.

(e) *Reports.* The War Production Board may send copies of Form WPB-2917 or WPB-2918 to any person who manufactures any product containing asbestos or who maintains a stock of asbestos. The person receiving the forms shall return them with the required information to the War Production Board on or before the following 10th of the month.

(f) *Prohibitions against sales or deliveries.* No person shall sell or deliver asbestos fibre or any product made therefrom if he knows or has reason to believe such material or product is to be used in violation of the terms of this order.

(g) *Special directions.* The War Production Board at its discretion may at any time issue special directions to any person with respect to his use, processing, delivery or acceptance of delivery of any grade or type of asbestos, notwithstanding any other provision of this order.

(h) *Miscellaneous provisions*—(1) *Applicability of regulations.* This order and all transactions affected thereby are subject to all applicable regulations of War Production Board, as amended from time to time.

(2) *Appeals.* Any appeal from the provisions of this order shall be made by filing a letter in triplicate, referring to the particular provision appealed from and stating fully the grounds of the appeal.

(3) *Forms.* Forms WPB-2917 and WPB-2918, referred to in paragraph (e), have been approved by the Bureau of the Budget in accordance with Federal Reports Act of 1942.

(4) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States Government is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using material under priority control and may be deprived of priorities assistance.

(5) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Cork, Asbestos & Fibrous Glass Division, Washington 25, D. C., Ref.: M-79.

Issued this 20th day of March 1945.

WAR PRODUCTION BOARD.
By J. JOSEPH WHELAN,
Recording Secretary.

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L-41-d
REVOCATION
MAY 29, 1945

WAR PRODUCTION BOARD

PART 1075—CONSTRUCTION

[Supplementary Conservation Order L–41–d, Revocation]

Section 1075.11 *Supplementary Conservation Order L–41–d* is revoked.

Issued this 29th day of May 1945.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

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PART 3301—CORK, ASBESTOS AND FIBROUS GLASS

[Conservation Order M-283, as Amended Aug. 11, 1945]

ASBESTOS TEXTILES

§ 3301.16 *Conservation Order M-283*—(a) *Definitions.* (1) "Asbestos textiles" means any material initially produced from the mineral asbestos by means of a carding operation and includes all such material in the following forms subsequent to the carding operation, including scrap:

Carded fiber.
Plain roving (underwriter's and commercial).
Plain roving (above underwriter's grade)
Reinforced roving
Cable filler.
Lapps.
Yarn—single.
Yarn—plied.
Yarn—metallic.
Cloth—1¼ pounds per square yard and lighter, all weaves.
Cloth—heavier than 1¼ pounds per square yard, non-metallic, plain weave.
Cloth—heavier than 1¼ pounds per square yard, metallic, plain weave.
Cloth—all weights, metallic and non-metallic other than plain weave.
Tape—.010 to .025" thick.
Tape—1/32" thick and up.
Cord—Plain or treated.
Tubing—woven or braided

(2) "Supplier" means any person who produces asbestos textiles from the mineral asbestos by means of a carding operation.

(3) "Consumer" means any person who purchases or accepts delivery of asbestos textiles from a supplier for resale, or for use in the manufacture of other forms of asbestos textiles or of articles made in whole or in part of asbestos textiles, or for any other use. A supplier, who uses asbestos textiles which he has produced in the manufacture of any product which is not itself an asbestos textile as defined in paragraph (a) (1) shall be deemed also to be a consumer.

(4) "Implements of war" means combat end products, complete for tactical operations (including, but not limited to, aircraft, ammunition, armament, weapons, ships, tanks and military vehicles), and any parts, assemblies and materials to be incorporated in any of the foregoing items being produced for the Army or the Navy of the United States, the Maritime Commission, the War Shipping Administration, Veterans Administration, or for any foreign government pursuant to the act approved March 11, 1941, entitled "An Act to Promote the Defense of the United States" (Lend-Lease Act), where the use of any asbestos textiles to the extent employed is required by the latest issue of government specifications (including performance specifications, unless otherwise directed by the War Production Board) applicable to the contract, subcontract, or purchase order. The term does not include facilities or equipment used to manufacture the foregoing items.

(b) *Restrictions on delivery and use.* (1) No supplier shall deliver or use asbestos textiles and no person shall accept delivery of asbestos textiles from a supplier, except as specifically authorized in writing by War Production Board, upon application pursuant to paragraph (d). Even though asbestos textiles have been allocated by the War Production Board for incorporation into friction materials for new civilian passenger cars and trucks, they may not be used for that purpose if to do so will interfere with the production of implements of war or with the filling of rated orders for which asbestos textiles have been allocated by the War Production Board.

(2) War Production Board may from time to time issue special directions to any person with respect to his use, processing to final product, delivery, acceptance of delivery, or placing of orders, of asbestos textiles, notwithstanding the provision of paragraph (c), or special directions to any supplier with respect to the kinds of asbestos textiles which he may or must manufacture, and the grades and types of asbestos fiber which he may or must use in the production of asbestos textiles.

(3) No supplier shall deliver any asbestos textiles to any person if he knows or has reason to believe that such person would receive or use it in violation of the terms hereof, nor may any person deliver or accept delivery of any item which he knows or has reason to believe was manufactured in violation of the terms hereof.

(4) Each supplier shall notify the War Production Board of his inability to make authorized delivery, or of cancellation by a consumer of any authorized delivery, within 5 days after he has notice of such fact.

(c) *Small order exemption.* Specific authorization shall not be required for:

(1) Any person to accept delivery of 500 pounds or less of asbestos textiles in the aggregate from all sources during any calendar month, provided that he has not been specifically authorized to accept delivery of any quantity of asbestos textiles during such month; and

(2) Any supplier to deliver 500 pounds or less of asbestos textiles to any person in any calendar month, provided that:

(i) No supplier shall deliver in the aggregate in any calendar month, pursuant to this paragraph (c), an amount in excess of 5 per cent by weight of his actual shipment of asbestos textiles for the preceding month;

(ii) No supplier shall make deliveries during any calendar month, pursuant to this paragraph (c), if such deliveries will prevent completion of any deliveries which have been specifically authorized for such month.

(3) For the purposes of paragraphs (c) (1) and (c) (2) above, the term "person" means usual purchasing unit, whether plant, distributing agency, corporation or other legal entity.

(d) *Applications and reports*—(1) *Consumers.* Each consumer seeking authorization to accept delivery of asbestos textiles during any calendar month shall file application on Form WPB-2137 as prescribed in that form.

(2) *Suppliers.* Suppliers shall seek authorization to deliver asbestos textiles only to consumers who have filed with them WPB-2137 as prescribed in that form.

(3) Applications for allocations of plain roving, reinforced roving, cable filler, and lapps for incorporation into Navy cable shall be made on a calendar quarterly basis on Form WPB-2137.2 as prescribed therein, beginning with the first quarter of 1945.

(4) War Production Board may from time to time issue special instructions with respect to the method or time of filing or content of WPB Form 2137.

(e) *Separation of functions.* Each supplier who consumes all or part of his production of asbestos textiles in the manufacture of any product which is not itself an asbestos textile, as defined in paragraph (a) (1), shall treat the production and consumption parts of his operations as separate divisions, and delivery to himself for consumption shall be deemed delivery, requiring authorization within the meaning of paragraph (b) (1). Each such supplier in his separate capacity as a consumer and as a supplier shall file all the applications and reports required by paragraphs (d) (1), (d) (2) and (d) (3). A supplier who consumes all or any part of his production of asbestos textiles in the manufacture of products which are not asbestos textiles as defined in paragraph (a) (1) must request allocation only for that type of asbestos textile that immediately precedes the manufacturing process which changes its form beyond that shown in the list of asbestos textiles in paragraph (a) (1).

(f) *Restrictions on manufacture of List A product.* No person shall use any asbestos textile in the manufacture of any item, or part for an item, on List A.

(g) *Restrictions on manufacture of List B products.* On and after the governing date specified in List B, no person in the manufacture of any item on List B shall use any asbestos textile which is either of a grade (in terms of percentage of asbestos content) higher than the grade specified in List B, or is of a cut finer than the cut specified in List B.

(h) [Revoked Jan. 4, 1945.]

(i) *Miscellaneous provisions*—(1) *Applicability of regulations.* This order and all transactions affected hereby are subject to all applicable War Production Board regulations, as amended from time to time.

(2) *Forms.* Forms WPB-2137 and WPB-2137.2, referred to in paragraph

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(d), have been approved by the Bureau of the Budget in accordance with Federal Reports Act of 1942.

(3) *Violations.* Any person who wilfully violates any provision of this order, or who, in connection with this order, wilfully conceals a material fact or furnishes false information to any department or agency of the United States government, is guilty of a crime, and upon conviction may be punished by fine or imprisonment. In addition, any such person may be prohibited from making or obtaining further deliveries of, or from processing or using, material under priority control, and may be deprived of priorities assistance.

(4) *Communications to War Production Board.* All reports required to be filed hereunder, and all communications concerning this order, shall, unless otherwise directed, be addressed to: War Production Board, Cork, Asbestos & Fibrous Glass Division, Washington 25, D. C. Ref: M-283.

(5) *Appeals.* Any appeal from the provisions of this order must be made by letter in triplicate addressed to the War Production Board, Cork, Asbestos and Fibrous Glass Division, Washington 25, D. C., Ref: M-283, referring to the particular provision appealed from, stating fully the grounds of the appeal and setting forth the necessary supporting information. The supporting information shall include:

1. The List A or B product for which the asbestos textiles will be used;
2. The period of time, not exceeding one calendar quarter, for which relief is requested;
3. The monthly schedule of the amount of asbestos textiles which would be required in the production of the List A or B product;
4. The type of asbestos textile to be used and the grade and cut.

Ordinarily consideration will be given only to those appeals where compliance by the appellant or another would work an exceptional and unreasonable hardship on the manufacturer or user of the List A or B product which is not suffered generally by others in the same industry or activity.

Issued this 11th day of August 1945.

WAR PRODUCTION BOARD.
By J. JOSEPH WHELAN,
Recording Secretary.

RESTRICTED USES OF ASBESTOS TEXTILES UNDER CONSERVATION ORDER M-283, AS AMENDED AUGUST 11, 1945

LIST A

1. Theatre curtains and scenery.
2. Vibration eliminators (except for implements of war).
3. Gun covers.
4. Radiator hose (except for implements of war).
5. Ammunition containers.
6. Fire stops in automotive vehicles, buses, or trucks.
7. Covering for heat insulation, except:
   (i) As cuffs not over 12 inches long on pipe covering ends next to flanges or fittings where pipe temperature may under normal operating conditions exceed 500 degrees.
   (ii) Where outside covering is next to hot metals such as steam boilers or auxiliaries.
   (iii) On downcomer piping inside boiler casing
   (iv) For making portable flanges and fitting covers.
8. Yarn for heaters and heater accessories except for implements of war, and except for electric heater cords.
9. Filter sacks for liquids.
10. Parachute flare shields.
11. Clutch facing for automotive vehicles (except for implements of war and except in the production of new passenger cars and trucks authorized by the War Production Board), in accordance with numbers assigned by the Brake Lining Manufacturers Association in B. L. M. A. Catalog as shown in the 1939 edition, the 1940 supplement to the 1939 edition, and the 1941 edition, to-wit:

416	621	627	796A
506	621A	636	796B
516	628	716	736
614	629	719B	821B
620	636	732	827
859	946	966A	1053
862A	959A	967	1056
862B	959C	968	1067
880	959D	968A	1067A
891	959E	990	1067B
896A	954	990A	1067C
898	956	991	1068
900	966A	991A	1069
902A	956B	991B	1069A
905	956	998	1069B
906A	956A	998A	1068
906D	966	994	1072
906E	967	995	1142B
906F	967A	999	1142C
909	968	1005A	1154A
909A	968B	1007A	1160
909B	969	1008A	1169A
929B	975	1033	1170
929D	979	1047	1178
930-1	980	1047A	1181
940	982	1051	
941A	985	1052	

12. Brake lining in widths less than 2 inches or in thickness less than ¼ inch (except for implements of war and except for B. L. M. A. Nos. 396 and 941A and except in the production of new passenger cars and trucks authorized by the War Production Board).

LIST B

Item	*Governing date*	*Grade (max. % of asbestos)*	*Minimum permissible cut.*
1. Laminated plastics	February 14, 1943	Underwriters	------
2. Mechanical packing or gasket material made of asbestos textile material which has been graphited, friction treated, or otherwise treated with an adhesive or impregnating substance, for use as, or for use in the manufacture of, mechanical packings or gaskets (except that produced from blue asbestos fiber, and except for valve rings, seamless boiler gaskets and implements of war)	October 18, 1943	Commercial	10
3. Friction material	October 18, 1943	Commercial	10

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WAR PRODUCTION BOARD

PART 944—REGULATIONS APPLICABLE TO THE OPERATION OF THE PRIORITIES SYSTEM

[Priorities Reg. 31, Amdt. 2]

BLANKET REVOCATION OF CERTAIN WPB ORDERS

Section 944.52, *Priorities Regulation 31*, is amended in the following respects:

By adding the following orders to the list of orders revoked:

List of orders revoked and effective date of revocation

BUILDING MATERIALS

Sec. 3284.26, L–303 Metal Insect Screen Cloth, August 23, 1945.

CORKS, ASBESTOS AND FIBROUS GLASS

Sec. 3301.1, M–6–a Cork, August 23, 1945.
Sec. 3301.16, M–283 Asbestos Textiles, August 31, 1945.

PAPER

Sec. 3270.27, L–261 Grocers and Variety Bags, August 23, 1945.
Sec. 3281.91, L–279 Paper Shipping Sacks, August 23, 1945.
Sec. 3270.28, L–304 Specialty Bags (Paper), August 23, 1945.

Issued this 23d day of August 1945.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

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PART 944—REGULATIONS APPLICABLE TO THE OPERATION OF THE PRIORITIES SYSTEM

[Priorities Reg. 31, as Amended Aug. 29, 1945]

BLANKET REVOCATION OF CERTAIN WPB ORDERS

§ 944.52 *Priorities Regulation 31*—(a) *Revocation of orders.* The orders of the War Production Board listed below in this regulation and all published directions to those orders are revoked, effective on the dates shown opposite the orders.

(b) *Effect of revocation of orders.* (1) Regardless of paragraph (b) of § 944.10a of Priorities Regulation 1, all directions, authorizations, production and delivery schedules and other instruments addressed to named persons pursuant to the orders listed below are also revoked to the extent that they apply to any transactions after September 30, 1945.

(2) To the extent that any such directions, authorizations, production or delivery schedules or other instruments addressed to named persons apply to any transactions before October 1, 1945, the following rules govern:

(i) If they were issued under one of the Chemical Orders listed below, they are revoked on the effective date shown opposite the applicable order.

(ii) If they were issued under any of the other orders listed below, they remain in force through September 30 under the rules explained in paragraph (b) of § 944.10a of Priorities Regulation 1 unless revoked by other action of the WPB.

(3) Nothing in this regulation changes the rule regarding "Suspension Orders" and "Consent Orders" as stated in paragraph (c) of § 944.10a of Priorities Regulation 1.

(4) The revocation of the orders listed below does not affect any liabilities incurred for violation of those orders or for violation of actions taken by the War Production Board under those orders.

(5) Pending and future applications filed pursuant to the orders listed below will not be acted upon by the War Production Board after the effective date of revocation of those orders, and individual notice of this may not be given to each applicant.

(6) It is not necessary to file any reports under the orders listed below which would be due after the effective date of revocation, unless required under the rules explained in Priorities Regulation 8.

LIST OF ORDERS REVOKED AND EFFECTIVE DATE OF REVOCATION

AIRCRAFT

Section 3191.31, M-360, Aircraft, August 27, 1945.

AUTOMOTIVE

Section 3292.1, L-1-c, Motortrucks and Truck Trailers, August 20, 1945.

Section 3292.46, L-158, Production of Replacement Parts for Motor Vehicles, August 20, 1945.

Section 3292.51, L-180, Replacement Storage Batteries, August 20, 1945.

Section 3178.1, L-264, Internal Combustion Air-Cooled Engines, August 20, 1945.

Section 3292.56, L-270, Automotive Maintenance Equipment, August 20, 1945.

Section 3292.126, L-331, Motorcycles, August 20, 1945.

BUILDING MATERIALS

Section 1293.1, L-157, Hand Tools Simplification, August 20, 1945.

Section 1293.9, Sch. 8 to L-157, Wood Boring Bits, August 20, 1945.

Section 3284.81, L-236, Hardware Simplification, August 20, 1945.

Section 3284.85, Sch. 4 to L-236, Tackle Blocks, August 20, 1945.

Section 3284.26, L-303, Metal Insect Screen Cloth, August 23, 1945.

CHEMICALS

Section 3193.1, L-263, Matches, August 31, 1945.

Section 3293.36, M-12, Cotton Linters and Hull Fibre, August 20, 1945.

Section 3293.101, M-69, Distilled Spirits, August 31, 1945.

Section 3293.171, M-150, Aromatic Solvents, August 31, 1945.

Section 1246.1, M-157, Chemical Cotton Pulp, August 31, 1945.

Section 3293.1008, Sch. 8 to M-300, Hide Glue, Extracted Bone Glue and Green Bone Glue, August 31, 1945.

Section 3293.1009, Sch. 9 to M-300, Formaldehyde and Paraformaldehyde, August 31, 1945.

Section 3293.1010, Sch. 10 to M-300, Hexamethylenetetramine, August 31, 1945.

Section 3293.1011, Sch. 11 to M-300, Pentaerythritol, August 31, 1945.

Section 3293.1012, Sch. 12 to M-300 Isopropyl Alcohol, August 31, 1945.

Section 3293.1016, Sch. 16 to M-300, Metallic Sodium, August 31, 1945.

Section 3293.1017, Sch. 17 to M-300, Acrylic Monomer and Acrylic Resin, August 31, 1945.

Section 3293.1018, Sch. 18 to M-300, Styrene and Dichlorostyrene, August 31, 1945.

Section 3293.1019, Sch. 19 to M-300, Polystyrene and Polydichlorostyrene, August 31, 1945.

Section 3293.1020, Sch. 20 to M-300, Hexahydric Alcohols, August 31, 1945.

Section 3293.1023, Sch. 23 to M-300 Xylene (Xylol), August 31, 1945.

Section 3293.1024, Sch. 24 to M-300, Methyl Isobutyl Ketone, August 31, 1945.

Section 3293.1026, Sch. 26 to M-300, Acetic Acid, Acetic Anhydride and Acetaldehyde, August 31, 1945.

Section 3293.1028, Sch. 28 to M-300, Acetylene Black, August 31, 1945.

Section 3293.1029, Sch. 29 to M-300, Ammonium Silicofluoride, August 31, 1945.

Section 3293.1030, Sch. 30 to M-300, Phosphorus, August 31, 1945.

Section 3293.1031, Sch. 31 to M-300, Barium Chemicals, August 31, 1945.

Section 3293.1039, Sch. 39 to M-300, Diphenylamine, August 31, 1945.

Section 3293.1040, Sch. 40 to M-300, Ferro- and Ferri-Cyanides, August 31, 1945.

Section 3293.1045, Sch. 45 to M-300, Sodium Cyanide, August 31, 1945.

Section 3293.1048, Sch. 48 to M-300, Pyrethrum, September 30, 1945.

Section 3293.1049, Sch. 49 to M-300, Rotenone, September 30, 1945.

Section 3293.1055, Sch. 55 to M-300, Adipic Acid, August 31, 1945.

Section 3293.1058, Sch. 58 to M-300, Penicillin, August 31, 1945.

Section 3293.1060, Sch. 60 to M-300, Polyethylene, August 31, 1945.

Section 3293.1062, Sch. 62 to M-300, Primary Chromium Chemicals, September 30, 1945.

Section 3293.1069, Sch. 69 to M-300, Gasoline Gum Inhibitors, August 31, 1945.

Section 3293.1070, Sch. 70 to M-300, Ethyl Cellulose, August 31, 1945.

Section 3293.1077, Sch. 77 to M-300, Isopropyl Acetate, August 31, 1945.

Section 3293.1078, Sch. 78 to M-300, Carbon Tetrachloride, August 31, 1945.

Section 3293.1079, Sch. 79 to M-300, Synthetic Ammonia, September 30, 1945.

Section 3293.1080, Sch. 80 to M-300, Nitrogen Compounds, September 30, 1945.

Section 3293.1081, Sch. 81 to M-300, By-Product Phosphoric Acid, August 31, 1945.

Section 3293.1085, Sch. 85 to M-300, Potassium Carbonate, August 31, 1945.

Section 3293.1089, Sch. 89 to M-300, Theobromine and Caffeine, August 31, 1945.

Section 3293.1090, Sch. 90 to M-300, Yellow Iron Oxide, August 31, 1945.

Section 3293.1091, Sch. 91 to M-300, Ethyl Ether, August 31, 1945.

Section 3293.1092, Sch. 92 to M-300, Matches, August 31, 1945.

Section 3293.1093, Sch. 93 to M-300, High Test Calcium Hypochlorite, August 31, 1945.

Section 3293.1094, Sch. 94 to M-300, Trichlorethylene, August 31, 1945.

Section 3293.1095, Sch. 95 to M-300, Perchlorethylene, August 31, 1945.

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Issued this 29th day of August 1945.

WAR PRODUCTION BOARD,
By J. JOSEPH WHELAN,
Recording Secretary.

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