MINUTES of the General Meeting of the Asbestos Textile Institute held March 12, 1953 at the Essex House, New York, N. Y.

IN ATTENDANCE:

F. J. Wakem, Vice President
JOHNS-MANVILLE CORP.

AMERICAN ASBESTOS TEXTILE CORP.
A. J. Scanlan
J. W. Weber

ASTEN-HILL MFG. CO.
D. R. Holmes

JOHNS-MANVILLE CORP.
L. R. Hoff
S. V. Dillon
J. L. Tucker
E. A. Schuman
R. Jackson
H. M. Jackson

KEASBEY & MATTISON CO.
C. R. Frederick
A. E. Whitfield
T. G. Schmidt

RAYBESTOS-MANHATTAN, INC.
G. W. Marshall
J. A. Bettes
J. M. Weaver
M. W. Oliver

SOUTHERN ASBESTOS CO.
G. J. Harris
J. T. Griffis
O. C. Ferens

UNION ASBESTOS & RUBBER CO.
R. E. Cryor
A. W. Summers
A. R. Byrnes
A. F. Jerome
E. C. Johnson

CADWALADER, WICKERSHAM & TAFT
M. I. Ruddock

RUTGERS UNIVERSITY
M. C. Shaw

1. The meeting was called to order by Vice President, F. J. Wakem. In opening the meeting, appropriate remarks were addressed by the presiding officer, in memory of an official of one of the member companies, Mr. George R. Weber, Raybestos-Manhattan, Inc., who passed away recently. The following resolution was unanimously adopted upon a motion by L. R. Hoff and a second by R. E. Cryor, to be spread upon the Minutes of this meeting and to be transmitted to the members of the family of the deceased.

"Resolved that the Asbestos Textile Institute hereby expresses its deep sense of loss in the passing of George R. Weber, Vice President, Raybestos-Manhattan, Inc., a pioneer in the asbestos textile industry who, by his friendly guidance and counsel throughout the years, immeasurably aided in the development of this industry."

In closing this memorial, all in attendance arose and stood in silence for one minute.

2. The first order of business placed before the meeting called for the reading of the Minutes of the last meeting. However, since all members had received copies of these minutes and were, therefore, familiar with the contents thereof, it was moved by R. E. Cryor, seconded by A. J. Scanlan and unanimously agreed that such reading be omitted.

3. The Treasurer's report was presented by A. J. Scanlan. (Copy attached). Following a brief discussion it was moved by A. E. Whitfield, seconded by J. A. Bettes and unanimously agreed that the report be approved.

4. The Secretary's report was presented by M. C. Shaw. (Copy attached

5. The Legal Counsel addressed the meeting relative to the changes which are occurring in the business world as a result of the changing administration and an apparent change in the attitude of the general public in regard to "big business".

6. The Air Hygiene Committee report was presented by Mr. H. M. Jackson, Chairman. (Copy attached). Following a discussion of the subject presented, two specific actions were taken.

a) It was moved by D. R. Holmes, seconded by R. E. Cryor and unanimously agreed that medical doctors representing member firms should be invited to attend the next meeting of the Air Hygiene Committee to be held in Philadelphia on June 11.

b) It was moved by G. W. Marshall, seconded by D. R. Holmes and unanimously agreed that T. G. Schmidt be authorized to confer with the Industrial Hygiene Foundation and other authorities relative to the determination and establishment of satisfactory air sampling techniques.

7. The Sales Promotion Committee report was presented by G. J. Harris Chairman. (Copy attached). The first subject discussed concerned the Asbestos Textile Handbook which is being composed by this committee. The first draft of this book was circulated and each member was requested to review the work and submit criticisms and suggestions at an early date. The method of distribution was also discussed and it was agreed that the sale price for each copy of the handbook should be $1.00 and distribution of the 10,000 copies to be printed should be as follows: Each Associate member is to receive 100 copies without charge; the Secretary is to receive 2000 copies; and the remaining 7500 copies are to be distributed to the member companies on the basis of each members proportion of the total paid assessment.

The second subject presented for consideration by the Sales Promotion Committee concerned the distribution of Visual Aid Displays. It was pointed out that several of the displays are in need of reconditioning since in some cases the samples have become loosened and some of the cloth samples soiled and discolored. In view of this, it was unanimously agreed that one of the cabinets should be send to Gardner Displays Co., the manufacturers, so that an estimate on refurbishing costs might be ascertained.

8. The Technical Committee report was presented by J. L. Tucker, Chairman. (Copy attached). This report covers the activities of this committee and the two subcommittees during the quarter just passed and sets forth certain actions resulting from the committee meeting held on March 11th.

9. The Fellowship report was presented by M. C. Shaw and Report #24 was distributed among the members present.

10. At the General meeting of the Institute held in Philadelphia on Dec. 11, 1952, President Widmayer appointed G. J. Harris, J. L. Tucker and M. C. Shaw to serve on a Fellowship review task group. It was the purpose of this group to investigate the advisability of renewing the Fellowship program at Rutgers University and to further explore the possibilities of procuring a greater service through other channels of endeavor. This group met on Jan. 12, 1953 and the reports covering the findings and recommendations are herewith attached. As a result of these deliberations, it was moved by R. E. Cryor, seconded by G. W. Marshall and unanimously approved that the Fellowship program be renewed at Rutgers University for the term from October 1, 1953 to October 1, 1954 at a cost of $11,475.00.

11. The next subject presented for consideration concerned the patent application work on the Abradoflex conducted by Ward, Crosby & Neal. It was reported by the Secretary that final approval to proceed in this work was granted by President D. W. Widmayer in

accordance with directions received at the last General meeting and that the application work was completed on February 26th. Upon completion of this work a final bill in the amount of $522.45 was received and is here presented for authorization of payment. It was moved by J. L. Tucker, seconded by R. E. Cryor and unanimously agreed that such payment be made.

12. The presentation of applications for membership in the Institute was the next matter considered. During recent months one application for Associate membership has been received, that from Societe Anonyme Francaise Du Ferode, Paris, France. Following a full discussion concerning this application and a review of this company's qualifications, it was moved by R. E. Cryor, seconded by G. W. Marshall and unanimously agreed that Societe Anonyme Francaise Du Ferode be accepted as an Associate member, such membership dating from April 1, 1953, with dues of $375 to cover the balance of 1953.

13. In closing the meeting Mr. L. R. Hoff addressed the Institute wit reflections upon the growth of the activities of the Institute ar its committees through the nine years since its founding. It was pointed out that through the cooperative efforts of the individua companies in carrying out the interests of the Institute, the benefits to the industry as a whole have been of incalculable value and that through a continuation of this interest still greater values may be expected.

Mr. Hoff's remarks were appreciatively received and the Chairman expressed the hope that the Institute will have the privilege of his counsel for many years to come.

14. There being no further business to come before this meeting, it was unanimously agreed that the meeting be adjourned.

Myril C. Shaw,

Secretary

Report of Technical Committee for
March 12, 1953 General Meeting, New York, N. Y.
by J. L. Tucker

The Technical Committee has held only one meeting since the General Meeting of December 11, 1952. This one meeting was held March 10, 1953.

The sub-committees appointed at the December Technical Committee meeting, namely, Committee for Cloth Standardization and Committee for Braid Standardization have been very active and the results of their work will be mentioned in detail later in this report.

A. Asbestos Textile Institute Handbook

The Sales Promotion Committee requested that the Technical Committee review and discuss the material now ready for printing,

It was only possible to discuss the titles and headings mentioned in the pages. It is necessary that each of our members have a couple of weeks to go over this material and make their recommendations as soon as possible.

We extend our congratulations to the Sales Promotion Committee for the good job done in assemblying this material for the handbook.

B. Cloth Standardization Committee Report

Chairman: J. D. McCluer
Members: Messrs. Oliver, Lanz, Cutler, Beyard

Recommendations made by all members of this committee have been presented by Mr. McCluer. The recommendations this time pertained to time and temperatures for the obtaining of asbestos cloth tensile strengths after heat treatment.

Previous to the origination of this committee, one temperature (200F) and one time period (5 minutes) were considered as standard by the Government Agencies who purchase asbestos cloth. The results were never accepted by our industry as being practical and there were complaints from both customer and fabricator. Recently, Westinghouse changed their heat-treating period from 5 to 30 minutes but specify 300C as the temperature for their test specifications for two or three asbestos cloths.

This committee now knows that it is the concensus of the industry that the time period should be the same for all cloths, but different temperature should be either standardized for each grade of cloth or the cloth grades should be grouped and each group have its own standard temperature for testing.

Dr. M. C. Shaw has agreed to cooperate with this committee and will investigate the possibilities of finding those temperatures which will result in tensile strengths for each grade of cloth, after heat treatment, that will be 80 per cent of their original strength.

This committee has done an outstanding job and I personally thank them at this time for the services rendered and for the cooperation that has also been outstanding.

C. Braid Standardization Committee Report

Chairman: C. R. Fredericks
Members: Messrs. McCluer, Summers, Oliver, Tucker

This committee also has been active accumulating valuable data in order to eventually present our industry more practical Braid Specifications and standardization procedures than are presently used in our industry and by our customers.

This committee, at our meeting March 10, evaluated standards now in effect in our industry relating to:

1. Inside diameter of braids.
2. Wall thickness
3. Feet per pound
4. Methods of measuring braid
5. Conversion factor for use when the flat length is known and the applied length is to be estimated
   a. .85 is now being considered as the conversion factor

Mr. Fredericks will present at our next meeting the minimum feet per pound for each braid now on the list for standardization.

This committee has done an outstanding job and I personally thank all its members for services rendered and cooperation given.

D. Fellowship Work -- Dr. M. C. Shaw

Report No. 24

MS 003564

a. This report has in it much valuable information and the comments that I am to make are more detailed in Dr. Shaw's report and it should be read by every one active in this Institute.

You should note the results of the steam, water, acid, and heat treatment of cotton ducks, asbestos, and asbestos-glass cloths.

The cotton duck, when wet and when in a steam atmosphere for 48 hr, increased in strength whereas the asbestos cloths deteriorate. The asbestos cloths having continuous glass strands in them showed exceptional decrease in strength, under those same conditions, whereas asbestos cloths having low percentages of staple glass fibers in them gave more encouraging results.

We have recommended that Dr. Shaw carry on his steam tests with cotton duck for a longer period of time, possibly two to four weeks as low temperatures deteriorate cotton over period of time.

b. Dr. Shaw is keeping in contact with Westinghouse regarding the use of testing procedures for asbestos cloth that are more acceptable to our industry as a whole.

I wish to thank Dr. Shaw for his many kindnesses and cooperation.

E. Harris-Tucker Report on Fellowship Program at Rutgers

A report on this subject will be read during this meeting but it is the recommendation that the Fellowship be continued at Rutgers for 1953-54 period and that a committee be set up to review the value of the Fellowship at Rutgers each year.

The following was added after Mr. Harris read the report.

It is being brought to the attention of the Institute at this time the fact that the amount of work necessitating the use of expensive University equipment was practically nil during 1952. Our programs for 1953 do not appear at this moment to be much different than those for 1952. The following equipment has been used to a great extent in our work in the past.

Tensile Strength Tester	- ATI property
Hot Plate	- University property
Oven	- ATI property
Bunsen Burner and Stands	- University property
Brabender Apparatus	- University property
Electric Oven	- University property

Our Fellowship programs at Rutgers do not include fundamental research although at intervals the following types of studies have been suggested. In fact, a few members of our Institute and representatives of other industries seem to think it strange that we do not include the following in our programs:

X-Ray Studies
Spectograph - Chemical Analysis
Thermo - Analysis
Petrographic Work - Microscopic Analysis
High Temperature Investigations
Burn-Out Investigations
Infra-red - Chemical Bonds in Asbestos

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We have never considered programs relating to the improvement of our products other than through standardizing of specifications, nor the development of new products. Therefore, in addition to recommending that the Fellowship be continued at Rutgers for the 1953-54 period, we also recommend:

1. That each year a new committee be originated specifically to study the opportunities at (a) Rutgers, (b) at other institutions, and (c) rental of space in a public or private building.

2. That a committee be originated made up of one member from each of our present committees plus a member of the Board of Governors. This committee to meet as often as necessary to discuss:

   a. Various approaches to new markets.
   b. Origination of new products.
   c. Collecting of information from each member company regarding the shortcomings of our products
   d. Presentation of facts, movies, speakers, etc. on our products or competitive products.
   e. Improvement of our present grades of products
      1. Modern equipment
      2. Addition of other fibers or agents
      3. Round-robin experiments
   f. Review the work of the other committees and recommend programs to these other committees.

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SECRETARY'S REPORT

During the past quarter your Secretary has been concerned with the following activities in pursuance of the duties of the office.

(1) The printing of the Handbook was completed during the latter part of October and each member company received his quota immediately thereafter. A total of 15,320 copies were printed in the final run and, with the 60 copies furnished at the last General meeting, the total printing amounted to 15,380 copies. The Secretary received 4000 copies for general distribution and 11,320 copies were distributed among the Institute members. Publicity releases covering the publication were sent to forty-seven trade journals and technical magazines. The response, to date, has been largely the result of the release carried in the magazine "Asbestos", however, most of the journals which were furnished these releases distribute their publications at the end or beginning of each month and therefore our releases as carried in these journals have not, as yet, brought any great response. Indications are, however, that such response will be forthcoming and that the 4000 copies on hand may be insufficient to meet the demand.

(2) There were no meetings of the regular standing committees held during the present quarter other than those in connection with this meeting, however, a conference was held with Mr. J. L. Tucker for the purpose of reviewing proposed specification revisions for presentation to the Technical and Sales Promotion Committees. In addition, the Budget Committee met on December 1st in the office of Mr. J. G. Schoepf for consideration of the budget for 1954. The results of these deliberations will be presented at the appropriate time in this meeting.

(3) It is customary at each year-end meeting to tentatively set the meeting schedule for the ensuing year. If the present schedule is to be adopted for 1954, the following meeting dates would be in order:

March 11 ----------- New York
June 10 ------------ Philadelphia
September 9 -------- New York
December 9 --------- Philadelphia

However, it has been suggested that it might be advisable to alter the schedule for the next year in order to avoid conflicts with other allied association interests. The meeting today, for example, is in conflict with the automotive industries meeting in Chicago and accounts for the absence of some of our members. Some members who are here in attendance would have attended that meeting were it not in conflict with this meeting. In view of this, we offer here an alternate schedule and would appreciate your consideration as to which schedule would be most desirable. The alternate schedule moves each of the meetings up one month from the time normally held and is as follows:

February 11 --------- New York
May 13 -------------- Philadelphia
August 12 ----------- New York
November 4 ---------- Philadelphia

We would like, in closing this report, to express our appreciation to all of those who have assisted us in properly executing the several duties of this office and trust that our efforts have been acceptable to the membership and that through them, the interests of the Institute have been advanced.

We are, however, ever-mindful of the responsibilities of the office and hope that any member will feel free to offer criticisms or suggestions which may afford the Institute an opportunity for greater service to the industry of which it is part.

Respectively submitted

Myril C. Shaw

ATI-81

FELLOWSHIP REPORT

MYRIL C. SHAW

RESEARCH FELLOW

ASBESTOS TEXTILE INSTITUTE

NEW JERSEY CERAMIC RESEARCH STATION

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

REPORT #24

March 12, 1953

INTRODUCTION

History tells us that the emperor Charlemagne delighted to mystify his dinner guests by throwing an asbestos tablecloth into a roaring fire and then removing it, unharmed, from the flames.

Thus was demonstrated, more than eleven hundred years ago, the complete incombustibility which is one of the characteristics of textiles made from the fibers of that remarkable mineral, asbestos.

Today, the products which come from the cards, spinning frames and looms of asbestos textile manufacturers constitute a virtually indispensable part of our modern industrial economy.

In the electrical industry, for example, asbestos textiles meet the special requirements of an efficient insulation for wires and cables. They insulate toasters, broilers, roasters, coffee-makers, sweepers, fans, refrigerators, washing machines and other electrical appliances. They are a basic component of mechanical packings and gaskets. They assure the stamina and heat resistance so essential in automotive and industrial brake linings, clutch facings, gears, bushings, bearings and other vital mechanical parts. They serve such widely diversified uses as safety clothing, fire-smothering blankets, ironing board covers, conveyor belts, industrial furnace hoods, insulation for red-hot exhaust pipes, filter cloths and fireproof curtains and draperies. And as binding agents for plastics and other materials they provide advantages that are attainable in no other way.

In fact, there is scarcely a major industry or activity that does not benefit in some way from the use of asbestos textiles. They have raised safety standards, improved product performance, lowered costs and contributed other important advantages in numerous fields--and their range of usefulness is ever-increasing.

THE MINERAL ASBESTOS

Asbestos is the name given to a group of fibrous minerals which occur in different forms in many countries throughout the world. The word is derived from the ancient Greek language and its first recorded use was by the Roman naturalist, Pliny the Elder, in the first century A. D., although asbestos itself was known to the Greeks and used by them at an even earlier date.

Early in the first century, the Greek geographer Strabo referred to a stone from southern Greece that was carded and woven into handkerchiefs. "Karystos lithos," the Greeks called it, naming it after the city where it was found. The Romans had also developed uses for this amazing stone for it is known that they wove it into lamp wicks and cremation cloth for wrapping their dead. And that famous Venetian traveler Marco Polo, home from wandering in Siberia in the thirteenth century, brought news of a "fossil substance" which, "when woven into cloth and thrown into the fire, remains incombustible." He, too, had become acquainted with asbestos.

These early uses were of minor importance, however, and it was not until modern times that asbestos really came into its own as an essential industrial mineral. The nineteenth century saw the discovery of large deposits in Canada and South Africa and since then its development and exploitation have been rapid. Today asbestos is an important or a major component in the manufacture of a wide variety of products, many of which are vital to our everyday living.

Major Properties

The commercial value of asbestos depends largely on two physical characteristics -- its incombustibility and its unique fibrous structure. The latter permits it to be separated into filaments or fibers, many of which possess high tensile strength and unusual flexibility and are adaptable to numerous uses. Some of them can be spun into yarn and woven into cloth and are thus the basic raw materials from which asbestos textiles are made.

Other valuable properties of asbestos are its resistance to heat, moisture and corrosion. However, these properties, like some of those already mentioned, are found to vary considerably with the different species of asbestos and, to a lesser extent, between different specimens of the same mineral. Tables A and B provide an interesting comparison of the variations in physical, chemical and mineralogical properties between several species of asbestos.

Origin

Although there is no doubt that asbestos is definitely of mineral origin, authorities differ about how it was formed. One widely held theory is that during former geologic periods, when the rock in which asbestos deposits are found was thousands of feet below the earth's surface, it was subjected to the action of hot ground waters containing dissolved salts and carbon dioxide. In the course of time, as the basic composition of the rock was altered, innumerable cracks were opened up. The hot waters entered those cracks and the various mineralizers present acted as solvents, dissolving part of the rock and depositing the closely packed fibers which we know as asbestos.

(For a "time-table" of the geologic events leading up to the formation of one type of asbestos--Canadian chrysotile--see page _ .)

Varieties of Asbestos

Some thirty or more minerals of fibrous crystalline structure comprise the asbestiform group but only six have economic significance. These are, in order of importance, chrysotile, crocidolite, amosite, anthophyllite, tremolite and actinolite. Chrysotile is a fibrous form of serpentine; the other five are amphiboles.

Because it is superior to other types of asbestos for textile processing, as well as for industrial purposes generally, chrysotile accounts for about 95 per cent of the total world production of natural mineral fibers.*

Chrysotile

Chrysotile is a hydrated silicate of magnesium corresponding to the formula $(OH)_6Mg_6Si_4O_{11}.H_2O$.# It occurs as veins in the serpentine rock.

Nature, however, has exercised some variety in the formation of chrysotile, as is apparent by the fact that "impurities" in the crystal structure are the rule, not the exception. An example is the presence of atoms of iron replacing magnesium in the crystal lattice. Such replacement is quite variable. Other elements may also be present. These include traces of calcium, aluminum and other ingredients in amounts so small that they are disclosed only

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*1950 Materials Survey, Asbestos, U.S. Department of the Interior, Bureau of Mines, February, 1952.

#The chemical formula of chrysotile is also variously expresses as $2SiO_2.3M_gO.2H_2O$, $Mg_3Si_2O_5(OH)$ and $H_4Mg_3Si_2O_9$.

by spectrographic analyses. Magnetite and, to a lesser extent, chromite are found frequently lying between the serpentine and the vein of chrysotile and consequently small pieces may be found in fiberized chrysotile. But despite these variations, chrysotile is generally more uniform in quality than other types of asbestos.

Properties: The properties of chrysotile fibers which particularly adapt them to the manufacture of asbestos textiles are length, strength, toughness, flexibility or pliability and a minimum of magnetic or conductive particles. Chrysotile fibers are the most flexible of any asbestos fibers. Their tensile strength is high, ranging from 18,000 to 469,000 psi.* In isolated cases, chrysotile asbestos fibers as long as six inches have been found but most fibers range from less than one inch in length down to small fractions of an inch. In general, only the longest available fibers are used in the processing of textiles.

Chrysotile also rates high among the asbestos minerals in heat resistance. Thermal analysis investigations conducted in the research laboratory of the Asbestos Textile Institute reveal that at a temperature up to approximately 1490 F, the chrysotile structure is stable; above this temperature it is permanently altered and inverted to another non-fibrous crystalline structure, olivine. However, at somewhat lower temperatures the physical structure of chrysotile is affected through the process of dehydration. At 750 F there is a notable deterioration in fiber quality through the permanent

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*See Table E for a comparison of the tensile strengths of various fibers with chrysotile asbestos.

depletion of a part of the structural water of crystallization and at 1300 F the structure is nearly completely void of the hydrous elements with attendant further fiber quality deterioration.* Table H shows the effect of heat on the tensile strength of chrysotile.

The better grades of chrysotile are characterized by their extreme fineness or silkiness which, together with their exceptional flexibility and high tensile strength, results in superior spinnability. Chrysotile asbestos may be subdivided into fibers so fine that they are revealed only by the electron microscope. As shown in Table F, the diameter of chrysotile fibers is many times smaller than that of other commercially used fibers.

The crude chrysotile from different localities is, however, variable in yielding to the fiberizing process, the types which are easily fiberized being in general the finest, strongest and silkiest fibers.

Fibers from different sources have distinctive, characteristic "working" properties. Chrysotile may be soft and unctious to the touch, or it may be somewhat harsh. Harshness, which generally is accompanied by a lack of optimum pliability, resists fiberizing and requires more time in processing. When harshness is accompanied by brittleness the fiber may be unsuitable for textile processing. These objectionable properties may be found in chrysotile derived from both igneous and sedimentary formations -- in massive

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*Shaw, Myril C., The Asbestos Content of Asbestos Textiles, New Jersey Ceramic Research Station, Rutgers University, New Brunswick, N. J., March 27, 1950.

serpentine or in the thin serpentine of altered limestone. They are not peculiar to either. But in the chrysotile of Arizona there are degrees of harshness, including "semi-harsh." Semi-harsh chrysotile requires a special technique to make it suitable for textile use.

The knowledge of these things that may impair the quality of chrysotile is a part of the know-how gained through experience and possessed by the personnel of the producing organizations in the asbestos textile industry.

Sources: Chrysotile, the most important natural mineral fiber, is fortunately also the most abundant. It occurs in many countries but Canadian and African deposits are the principal sources of the fiber that supports the American asbestos textile industry.

In Canada, Quebec has long been the principal source of chrysotile and Canadian deposits supply about two-thirds of the world's production of asbestos fiber (794,107 metric tons in 1950).* In its crude rock form, Canadian Chrysotile usually has a dark green luster, but the fibers appear white when fully opened. For this reason, it is known in the trade as "white asbestos."

Chrysotile fiber from Southern Rhodesia is second in tonnage (64,888 metric tons in 1950)* and is noted for its low magnetic iron content. The United States ranks next in importance with a production of 38,495 metric tons of fiber in 1950* and is followed by Swaziland, which produced 29,635 metric tons in the same year.*

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*Bureau of Mines, Minerals Yearbook.

Recently chrysotile has been found in other areas, including Turkey and British Columbia. These deposits are expected to be producing and shipping fiber in 1953. Large deposits of chrysotile are also located in Russia but no data are available regarding current Russian production.

Other Types

Crocidolite: An amphibole of the hornblende group, crocidolite is the blue asbestos of commerce. It is a complex silicate of iron and sodium corresponding approximately to the chemical formula $3Na_2O.6FeO.2Fe_2O_3.16SiO_2.H_2O$.* Its composition, like that of chrysotile, is found to vary.

Crocidolite is more difficult to process into a spinnable fiber than chrysotile, although some yarns and other textile products are made of this fiber. Its resistance to heat is lower than that of chrysotile but its tensile strength is generally very high, averaging between 100,000 and 300,000 psi. The most important advantage of crocidolite is its superior resistance to chemical attack.

The major source of crocidolite is the Cape Province of South Africa, which produced more than 27,000 metric tons in 1950.# Deposits also exist in the Transvaal and in Australia and Bolivia. Because of its low strength, the soft silky Bolivian crocidolite falls just short of being a textile fiber. It has good dielectric properties and is suitable for felting.

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*The chemical formula of crocidolite is also expressed as $NaFe(SiO_3)_2.FeSiO_3$.

#1950 Materials Survey, Asbestos, U. S. Department of the Interior, Bureau of Mines, February, 1952.

Amosite: A silicate of iron, amosite is generally regarded as belonging to the group of orthorhombic amphiboles, although some doubt apparently exists that it is a distinct mineral species. Its formula is usually expressed as $(Fe.Mg)SiO_3$ or as $(FeO.MgO)SiO_2$.

Amosite possesses good tensile strength and is more resistant to heat than crocidolite. Its fibers are flexible and unusually long but because of their relative harshness they are not well adapted to spinning.

Deposits located in Transvaal province, Union of South Africa, provide the only commercial source of amosite fiber. Approximately 38,000 metric tons were produced there in 1950.*

Anthophyllite: Anthophyllite is essentially a silicate of magnesium and iron, usually with a small amount of aluminum. It belongs to the group of orthorhombic amphiboles. Its chemical formula is written various ways, sometimes as $(Fe.Mg)_7Si_8O_{22}(OH)_2$, sometimes as $Mg_7(Si_4O_{11})_2(OH)_2$. The fibers of anthophyllite are usually brittle and lacking in tensile strength and in the past have not been considered suitable for textiles.

Tremolite and Actinolite: These monoclinic amphiboles are least important of the commercially used varieties of asbestos.

Tremolite $(Ca_2Mg_5Si_8O_{22}(OH)_2)$ is a calcium-magnesium silicate whose fibers are often long and silky but generally too brittle and of

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*1950 Materials Survey, Asbestos, U. S. Department of the Interior, Bureau of Mines, February, 1952.

inadequate tensile strength for use in the fabrication of textiles. It is of value principally for filtration purposes because of its freedom from iron and its resistance to attack by acids. Most of the tremolite fiber produced comes from deposits located in northern Italy.

Actinolite ($Ca(Mg.Fe)_3.(SiO_3)_4$) is similar in composition to tremolite except for the presence of iron which replaces some of the magnesium. Like tremolite, the fibers are too weak and brittle for spinning but have good resistance to acids. Its practical value is limited and production is small.

THE MINING, MILLING AND GRADING OF ASBESTOS FIBERS

Because asbestos is found both on or near the earth's surface as well as at considerable depths below it, various methods are used for extracting the ore. Either open pit or underground mining may be employed, depending on the character of the deposit and also on the extent to which it has been exploited.

In the past, most of the Canadian chrysotile, which is the principal source of the fiber used for processing asbestos textiles in the United States, has been removed from open pits. The fiber-bearing rock is loosened by blasting after holes have been drilled into the face of the deposit with compressed air drills. Following a rough separation of ore and barren rock in the pit, the ore is transported to the mill, either by means of a cableway ststem or by cars or trucks into which it is loaded, usually be cranes or power shovels.

In recent years, as some of the open pits have become worked to the economic limit, it has been necessary to use other methods. Consequently, underground mining, similar to that used in the removal of coal and other minerals, has been introduced. In one method, known as block caving, large blocks of ore are extracted with a minimum of drilling and blasting by undercutting the ore body at a predetermined depth below the surface and allowing the ore to break down from its own weight.

Whatever the mining methods employed, the percentage of fiber recovered from the ore is small, the average yield from Canadian mines being about five per cent.* This means that approximately twenty tons of asbestos-bearing rock must be mined in order to produce a single ton of usable fiber. Of the total tonnage of fiber recovered in recent years, only about four per cent consists of grades that are suitable for processing into textiles.//

Cobbing and Milling

From a production standpoint, Canadian asbestos fibers may be divided into two main groups: crude and milled. Crude fibers -- those grades measuring from 3/8" to 3/4" and longer -- are recovered in a different manner than the milled fibers of shorter length. The ore containing veins of these longer fibers is segregated when it is broken in mining or subsequently on picking belts. It is first dried and screened, then each piece that has any adhering rock or other impurities is pounded with a special cobbing hammer to free the undesirable portion. The operation, known as hand cobbing, is better adapted to preserving the long fibers intact than a mechanical process would be. After cobbing, the fibers are further cleaned, sorted into lengths and then bagged in 100 lb. bags for shipment. The long fibers recovered in this way are used for processing asbestos textiles of the finest quality.

Milled fibers, which include all grades up to 3/8" in length, are recovered by mechanical milling, the process being based upon

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*C. V. Smith "Asbestos Mining Methods," Asbestos, Philadelphia, Pa.

//1950 Materials Survey, Asbestos, U. S. Department of the Interior, Bureau of Mines, February, 1952.

physical differences between the asbestos fibers and the serpentine rock in which they occur. The flexible fibers, when subjected to crushing pressure, simply split into smaller groups, while the rock, which is brittle, is shattered into fragments.

In consequence, the milling process consists essentailly of several successive stages of crushing to open up the fibers and free them from the rock. Each step is followed by screening to remove the fines produced by crushing and by air separation to remove the semi-opened fibers. Although the fibers are tough and strong, specially designed crushing machines and techniques are used to minimize fiber damage. Separation is usually accomplished by large suction hoods that operate on the vacuum cleaner principle.

Following separation, the milled fibers are further opened, cleaned, graded according to length and bagged for shipment.

The crude grades when shipped are in lump form and must therefore be fiberized at the textile plant. Milled fibers that are to be used for spinning, although opened up to a considerable extent by the milling operation, also require additional processing before they are suitable for use in textiles.

Grading

Since the end uses of asbestos fibers are governed primarily by their length, it is important that they be carefully and accurately graded at the mill. A standard method of grading Canadian chrysotile fibers according to their length has been adopted and generally accepted by the American asbestos industry. It is known as the

Quebec Screen Test.

The machine used consists of three rectangular screens held in frames measuring 24½" by 3/4", one above the other. The top screen is the coarsest, the middle screen is of intermediate size and the bottom screen is the finest. Under the bottom screen is a box for collecting the fibers that pass through all three of the screens. The screens are made to the following specifications:

Box No.	Screen Opening	Diameter of Wire
1	0.500"	0.105"
2	0.187"	0.063" (4-mesh)
3	0.053"	0.047" (10-mesh)

To conduct a test, 16 ounces of fiber are placed on the top screen. The lid is closed and the entire machine is shaken horizontally at 328 rpm for two minutes by means of a standard mechanical device which is driven by an eccentric with 25/32" throw and 1 9/16" travel. The fiber grade is then determined on the basis of the number of ounces remaining on each of the screens and in the collecting box. Thus, if two ounces remain on the top screen, eight ounces on the intermediate screen, four ounces on the bottom screen and two ounces in the box, the fiber is known as 2-8-4-2, one of the spinning grades.

Other methods of grading are in use in other countries.

Textile Grades

Canadian Chrysotile: Only the longest, costliest grades of Canadian chrysotile fibers are used in the processing of asbestos textiles.

The standard classifications are as follows:

Group	Grade Designation	Fiber Length
Group No. 1	Crude No. 1	3/4" and longer
Group No. 2	Crude No. 2	3/8" to 3/4"
Group No. 3	Spinning Fibers (milled)	Guaranteed Minimum Shipping Test
	3D	8-6-1-1*
	3F	7-7-1½-½*
	3K	4-7-4-1*
	3M	2-9-4-1*
	3R	2-8-4-2*
	3T	1-9-4-2*
	3Z	0-8-6-2*

Note: Canadian chrysotile is also produced as shorter milled fibers, designated as Groups 4 to 9, inclusive. These fibers are adapted to numberous commercial uses but are not of sufficient length for processing into textiles.

African Chrysotile: The Southern Rhodesian grades of milled fiber are as follows:

C&GP/1 - a high grade textile fiber equivalent to Canadian Crude No. 2

C&GP/2 - a high grade textile fiber equivalent to Canadian 3F

Milled fibers from the Havelock mine in Swaziland are graded as follows:

HVL/1 - long spinning fiber

HVL/2 - short spinning fiber

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*See "Grading"

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Crocidolite: Following are the grades of Cape blue (Union of South Africa) as recognized by the Cape Asbestos Co., Ltd.

Grade	Length of Fiber
X	Minus ¼"
No. 3 or S or MS	¼" to 3/8"
No. 2 or A	3/8" to 3/4"
No. 1 or B	3/4" to 1½"
Long or C, D and E	Plus 1½"

The following grades of Transvaal blue are as given by the Department of Mines, Union of South Africa.

Crude	Fiberized	Length of Fiber
TX	TDX	Plus 1½"
T1	TD1	7/8" to 1½"
T2	TD2	½" to 7/8"
T3	TD3	¼" to ½"
T4	TD4	Minus ¼"

Amosite: (Grade designations to come)

PROCESSING ASBESTOS TEXTILES

The asbestos fibers as received at the textile plant may be of two types: (a) crude or unmilled fibers, which are in the form of small lumps and must be fiberized or opened up before using, and (b) milled fibers, which are in a semi-opened condition but require further treatment to effect the degree of fiberization so essential to the production of quality textiles. The processing consists of several operations, each of which brings about additional subdivisions of the fibers until they are eventually transformed into a soft, silky fluffiness.

Fiberization

After each bag of fiber has been inspected for quality, the crude fibers undergo preliminary opening. This is usually done in a pan crusher or chaser mill, the fibers passing under conical rolls running in a circular trough or being subjected to the crushing action of a large steel wheel with a 14 to 18 inch face. Separated impurities are then removed by screening.

Milled fibers may or may not require this preliminary chaser mill treatment depending on the extent to which they have been opened at the asbestos mill. Those that do not require it are passed through a vertical opener or a rotating toothed cylinder known as a willow that effects finer fiberization.

The fibers next go to a grader which consists of an enclosed shaft revolving horizontally and furnished with steel paddles which literally beat the fibers, removing magnetic iron particles as well as traces of serpentine and other extraneous non-fibrous impurities. Unopened fibers are also separated here and returned to the openers for further processing.

After additional treatment by means of specially designed opening equipment and further screening to remove fibers too short for textile purposes, the fibers are ready for the blending and mixing processes.

Blending and Mixing

To obtain desired characteristics in the finished produce, different types or grades of asbestos fibers are sometimes blended at this point, after which small percentages of organic fibers such as cotton or nylon are added as carriers or supporting agents to improve spinning properties or to meet certain requirements in the specific end product. The latter operation is known as mixing.

Carding

This operation, similar to that employed in the processing of wool, completes the opening and cleaning of the fibers. Under the teasing action of thousands of needle-pointed wires which form the working face of the "clothing" that covers the cylinders of the carding machine, the fibers are combed or arranged parallel to each other, forming a tenuous web.

When it is separated into ribbons, rubbed mechanically and condensed into untwisted strands, this web becomes roving, the asbestos textile product from which yarns are produced.

Lapping

The parallel fibers as they come from the carding machines are in a form known as slivers. In the lapping operation, a number of slivers are placed alongside each other and wound into roll forms. These laps, as they are called, are supplied to fabricators who re-process them for insulating electrical wires and cables.

Spinning

The previously carded strands of roving are spun into yarn in much the same manner as cotton and woolen yarns are produced. The spinning process is essentially one of imparting a twist to the roving in order to facilitate further processing and provide tensile strength. The resultant product is known as a single yarn. When single yarns are twisted together to form larger, stronger yarns, the process is known as twisting or plying.

The asbestos yarns produced by spinning or plying are manufactured in various sizes and plies and serve as the basic components in the fabrication of many other asbestos textile products of both woven and braided types.

Weaving

Asbestos yarn is woven into cloth on looms similar in principle to those used for weaving other types of fabrics. The designated number of strands of warp yarn are threaded into the reeds of the loom and sufficient yarn is wound on bobbins and placed in the shuttle for the filling or woof. The warp yarns run longitudinally or parallel to the selvage edges of the fabric, while the filler strands bind these together transversely. The construction of the cloth is controlled by regulating the number of ends and picks.

Techniques of processing have been developed to such an extent that a large variety of woven products now come from the looms of asbestos textile manufacturers. Fabrics can be woven in either flat or tubular forms and are available in many styles, textures, weights and thicknesses.

Braiding

The braiding process is done from a series of yarn-carrying spindles, half of which travel in one direction and half in the opposite direction. The action is similar to that in a maypole dance, the yarns being plaited together to form a braided product.

Many strands of braids may be produced by varying the number of ends of yarn wound parallel on the braider tube, by changing the tension applied and by adding mechanical attachments to the braider.

Inspection and Quality Control

During their manufacture, asbestos textiles are inspected, weighed and tested for strength, heat resistance and other qualities that are important in the service in which they are to be used. Before packaging, the finished products are given a final inspection for possible flaws and to insure that the quality standards established by the manufacturer have been met.

ASBESTOS TEXTILE PRODUCTS

On the following pages is presented information about the various products made from asbestos fibers by the American asbestos textile industry. This includes a brief description of each product and how it is made, together with pertinent data relating to styles, sizes, weights, etc., and a list of uses. It should be understood that the latter is by no means complete in most cases. The uses given are merely intended to convey some idea of the general type of service for which each product is best adapted. Further information, as well as helpful assistance in selecting asbestos textiles for specific applications may be obtained from any of the member companies of the Asbestos Textile Institute.

Grades

The word "grade" as used in the asbestos textile industry indicates a system of classification based on the percentage of asbestos by weight in the finished product. In Table K are listed the standard grades established by the American Society for Testing Materials with the percentage of asbestos content for each grade.* This method of grading applies to all products described on the following pages except carded asbestos fibers, although not every product is manufactured in every grade. The available grades will be found listed under each product.

The grade most satisfactory for a given purpose is largely dependent on service temperatures.

Temperature Limits

In general, the approximate temperature limits for each grade are as follows:

Commercial Grade	up to 400 F
Underwriters' Grade	up to 450 F
Grade A	up to 550 F
Grade AA	up to 600 F
Grade AAA	up to 750 F
Grade AAAA	up to 900 F

For higher temperatures than those shown above, a textile made with metallic (wire-inserted) asbestos yarn is sometimes employed.

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*See A.S.T.M. Specification D 299, reproduced on pages _ to _, for the test methods used to determine grades.

Carded Asbestos Fiber

Carded asbestos fiber is 100% pure asbestos which has been fiberized by passing the crude through the several operations of the fiberizing process and by screening and carding. It is furnished in various qualities which are determined by the fiber length and type of crude asbestos used and by the operations necessary to produce the carded fiber.

USES One of the major uses of carded asbestos fibers is for the clarification of such liquids as beer, wine, oils and chemicals. The mass of tiny fibers forms a filter medium of extremely close texture which captures the undesirable suspended impurities when the liquid is allowed to pass through it. Because of the fibrous nature of asbestos, it may be opened up in processing to any extent desired. Consequently, carded asbestos fibers can be furnished in many degrees of fineness to provide exactly the right screening for the liquid to be filtered.

This product is also widely used to increase the efficiency and enhance the appearance of gas heater logs and grates, for wire wiping pads, stuffing box packing and as a fireproof decorative "snow."

STANDARD PACKAGES Carded asbestos fiber is packaged in 10, 25 and 50 pound cartons and in boxes containing one pound and smaller amounts.

Asbestos Lap

Asbestos lap is a felted form of processed chrysotile asbestos fibers which have been blended with organic fibers. It is furnished in two styles: Style I, a single ribbon-like formation of fibers, and Style II, a paralleled assemblage of Style I lap.

USES A specialized product made for the electric wire and cable industry, asbestos lap is designed for re-carding into an insulation for heater cords, fixture wires and other electrical conductors. The re-carded slivers are spiraled around the conductor to form a homogeneous wall of asbestos fibers which serve as a carrier for the electrical insulating compounds.

GRADES, WEIGHTS Asbestos lap is made in the following standard A.S.T.M. grades: Underwriters', A, AA and AAA. (See Table K for percentage of asbestos content in each grade.) It is supplied in unit rolls ranging from 350 to 4200 grains* per linear yard.*

IRON CONTENT Asbestos lap as made for the electrical industry is of two types with respect to iron content -- ferrous and non-ferrous. Each of these conforms to A.S.T.M. requirements for maximum percentage of total iron and magnetic iron, as follows:

Type	Total Iron Content Max. per cent	Magnetic Rating Maximum
Ferrous	6	3
Non-Ferrous		
Underwriters' Grade	1.75	0.75
Grades A, AA and AAA	2	1

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STANDARD PACKAGE Asbestos lap is packaged in rolls wound on paper tubes which vary in size in accordance with the number of slivers in the assemblage. (A sliver is approximately 1¼" wide.)

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*Grain: a unit of weight. 8000 grains = 1 pound.

\#For permissible weight variations, methods of test and other detailed information about asbestos lap not given above, see A.S.T.M. Specification D 1061, reproduced on pages _ and _ of this Handbook.

Asbestos Roving

Asbestos roving is an assemblage of carded chrysotile asbestos fibers blended with cotton or other organic fibers and condensed into a single strand without twist. It is produced in various degrees of density from a soft, fluffy roving to a firmly compacted one, to meet specific requirements of the user.

Reinforced Roving (also known as core or inserted roving) is similar to the plain roving described above but has a core of cotton or other organic fiber to give it added tensile strength.

USES Asbestos rovings were developed for the electric wire industry to serve as insulation for heater cords, cables and electrical heating elements and are extensively used for this purpose. The strands are wrapped or "served" by wire covering machines to form a relatively soft, complete sleeve over the wire.

GRADES Asbestos roving is supplied in four standard A.S.T.M. grades: Underwriters', A, AA and AAA. (See Table K for percentage of asbestos content in each grade.)

SIZE OR CUT The size of asbestos roving is denoted by the "cut" number which, when multiplied by 100 indicates the approximate number of yards per pound. Standard cut numbers, with nominal yards per pound and permissible variations are shown in Table 1, A.S.T.M. Specification D 375, reproduced on pages _ to _.

IRON CONTENT Asbestos roving is of two types with respect to iron content -- ferrous and non-ferrous. Each of these conforms to A.S.T.M. standards for maximum percentage of total iron and magnetic iron, as follows:

Type	Total Iron Content (Max. per cent)	Magnetic Rating (Maximum)
Ferrous	6	3
Non-Ferrous		
Underwriters' Grade	1.75	0.75
Grades A, AA and AAA	2	1

The non-ferrous type is generally specified where the principal insulation is dependent on asbestos. Where another insulation predominates, the ferrous type is used.

STANDARD PACKAGES Asbestos roving is furnished on cones and tubes which vary somewhat in size in accordance with customer requirements.

Asbestos Yarn

Made from roving which has been mechanically twisted to give it tensile strength, asbestos yarns are the principal components of all asbestos textiles produced by the weaving and braiding processes. As such, they impart to the finished product advantages of thermal stability, electrical insulating value, fire protection, durability and other characteristics of the asbestos fibers from which they are spun.

To meet the many and varied requirements of their intended use, asbestos yarns are produced by the asbestos textile industry in a wide range of constructions. The basic styles are as follows:

Plain Asbestos Yarn is defined as yarn which consists of (1) asbestos fiber or (2) asbestos and other fibers. The "other fibers," which are usually cotton or nylon, are introduced in small percentages during processing either to improve the spinning properties of the asbestos fibers or to meet certain specifications in the end product.

Metallic Asbestos Yarn, also known as wire-inserted yarn, is plain asbestos yarn with an insert of fine wire. The standard insert is one or more strands of .008" brass wire but for special purposes wire of smaller or larger diameter may be used and such metals or alloys as copper, zinc, nickel, nichrome, inconel and monel may also be substituted for brass. Metallic asbestos yarns are extensively used in processing asbestos textiles where the end product requires unusually high tensile strength, exceptional resistance to heat or abrasion, or a combination of these properties.

Reinforced Asbestos Yarn is plain asbestos yarn with an insert of yarn made of other fibers, usually cotton or nylon, or a combination of both. Glass filament may also be used. Reinforced yarns, also referred to as inserted yarns, are particularly adapted to the braiding and weaving processes because of their higher than average tensile strength.

. . . .

The plain, metallic and reinforced asbestos yarns described above are produced as both single and plied yarns, the latter consisting of a number of strands of single yarns twisted together to form a heavier yarn of greater strength. Asbestos yarns are made in a great variety of cuts (sizes) and in the grades given below. The cut numbers of plain single asbestos yarns with nominal yards per pound and permissible variations are shown in Table 1, A.S.T.M. Specification D 299, reproduced on pages _ to _.

For special purposes, asbestos yarns are also coated or impregnated with various compounds to increase tensile strength, lay the fibers or impart certain qualities of the compound. These are known as treated yarns.

GRADES Asbestos yarns are made in all standard A.S.T.M. grades as follows: Commercial, Underwriters', A, AA, AAA and AAAA. (See Table K for percentage of asbestos content in each grade.)

DIRECTION OF TWIST Asbestos yarns are produced in "S" and "Z" twists. (See Glossary for definitions.)

YARN NUMBERS In the asbestos textile industry, the yarn numbering system used designates the cut, number of plies, and whether the yarn is plain or metallic. In a four digit figure, the first two digits indicate the cut, the next digit indicates the number of plies and the final digit indicates the number of metallic strands. If the final digit is a zero, it indicates a plain (non-metallic) yarn. For example, No. 1022 is a 10-cut, 2-ply metallic yarn containing two wires, and No. 2430 is a 24-cut, 3-ply plain yarn. In a three digit figure, the first digit only indicates the cut. Thus, No. 810 is an 8-cut single ply plain yarn.

STANDARD PACKAGES Paper tubes are the standard method of packaging asbestos yarns. Tubes may be of various lengths and wound to purchaser's requirements.

Asbestos Cord

Twisted Asbestos Cord is made of several strands of asbestos yarn tightly twisted together to form a cord of uniform diameter and high tensile strength. The yarn used may be single or plied, ferrous or non-ferrous, sized or unsized, or plain or metallic, depending on the end use of the product.

When the cord is made by braiding one or more jackets over a yarn core, it is known as braided asbestos cord.

USES Because of their uniformity, strength and ability to withstand high temperatures with negligible structural change, asbestos cords have many specialized uses. They provide an ideal core for electric resistance wires and are widely employed as an insulation for glass handling tools, as a seal on high temperature corrugated metal gaskets, as a valve stem packing and as a braided wall in the construction of steam hose.

The metallic cords have inserts of fine wire and are designed for use under exceptionally severe conditions. They are especially suitable for flare signal cords and for such uses as suspending retorts, crucibles and other objects that are in contact with flame or heat.

GRADES Asbestos cord is made in all standard A.S.T.M. grades as follows: Commercial, Underwriters', A, AA, AAA and AAAA. (See Table K for percentage of asbestos content in each grade.)

SIZES Standard diameters of asbestos cord range from 1/16" up to 3/8".

IRON CONTENT Asbestos cord is produced in two types with respect to iron content -- ferrous and non-ferrous. Each of these conforms to A.S.T.M. standards for maximum percentage of total iron and magnetic iron, as follows:

Type	Total Iron Content (Max. per cent)	Magnetic Rating (Maximum)
Ferrous	6	3
Non-Ferrous		
Underwriters' Grade	1.75	0.75
Grades A, AA, AAA and AAAA	2	1

The non-ferrous cord is generally specified where exceptional electrical resistance is required.

STANDARD PACKAGES The form of package varies with the practice of the individual textile manufacturer. Fractions of a pound are usually packaged as balls; quantities of 1, 5 and 10 pounds are generally wound on tubes or spools; larger quantities up to 50 pounds are on spools or reels.

Asbestos Thread

Asbestos thread is made by treating asbestos yarns with special compounds to lay the fibers and to produce an exceptionally smooth, uniform finish. It is produced in both plain and wire-inserted styles, the latter being noted for its great tensile strength and high thermal stability. Asbestos thread is adapted to either hand or machine sewing.

USES Because it possesses the advantages that are inherent in the inorganic mineral fibers from which it is made, asbestos thread can be used under conditions that would be destructive to thread made from organic fibers. For example, one of its well-established uses is for tying incandescent gas mantles.

Other typical uses include sewing the asbestos fabrics used in the manufacture of theater curtains, belting and safety clothing; sewing insulation jackets on piping and turbines; wrapping electric resistance wires; and fastening the asbestos roving insulations at each end of heater cords.

GRADES ?

STANDARD PACKAGES Asbestos thread is supplied wound on tubes as specified by the user.

Asbestos Wick

Asbestos wick is a soft pliable strand of asbestos formed by loosely twisting together several strands of roving, slubbing or felted asbestos. It is supplied either with or without cotton yarn in the center.

USES Furnished in convenient ready-to-use form, asbestos wick is a general utility product of many and varied applications. The power plant engineer keeps it handy as an emergency packing. The plumber finds it useful for packing steam and hot water valves. The roofer depends on it as a weather seal when applying corrugated roofing. And maintenance workers generally use it for caulking retorts, for sealing ovens and furnace doors and similar jobs.

GRADES The standard grade of asbestos wick is Commercial but other grades are supplied on order by most manufacturers. (See Table K for percentage of asbestos content in each grade.)

SIZES The $\frac{1}{4}$" diameter is standard for most purposes but other diameters (usually from 1/8" or 3/16" up to 7/32" or $\frac{1}{2}$") are also furnished.

STANDARD PACKAGES Asbestos wick is sold in handy $\frac{1}{4}$, $\frac{1}{2}$ and 1 pound balls and in larger quantities (usually 10, 25 and 50 pounds) wound on spools or reels.

Asbestos Rope

This product is produced in two styles: twisted and braided.

Twisted Asbestos Rope is made by twisting tightly together two or more strands of asbestos wick. In the heavier ropes, a binder is generally used to hold the twist.

Braided Asbestos Rope is made in three constructions: (1) by braiding one or more jackets of asbestos yarn over a core of asbestos rope or wick; (2) by braiding asbestos yarn jacket over jacket to form a finished product of either square or round cross-section; and (3) by plaiting asbestos yarn into square cross-section. The braid over braid rope is firmer and stronger; the plaited rope is softer and conforms more readily when compressed.

USES Asbestos rope, a companion product to asbestos wick, is used where a thicker material than wick is desired. The twisted style is widely used as a seal between furnace doors and brickwork, as an expansion joint in plastic walls of boiler settings, for covering diesel engine exhaust lines, for packing boiler expansion and gas generator doors and as a gasketing material for manhole covers.

The braided style is used as a groove packing for inspection doors, as filling for expansion joints in furnace brickwork, as a gasket for sealing doors of water gas generators and similar services.

GRADES Asbestos rope is furnished in Commercial grade for most general uses and in grades A, AA, AAA and AAAA to meet particular service requirements. The grades with higher asbestos content are used for high temperature applications. (See Table K for percentage of asbestos content in each grade.)

SIZES Asbestos rope is made in a wide range of diameters, usually from 1/8" or ¼" up to 1½" or 2".

STANDARD PACKAGES Asbestos rope is generally sold in 10, 25 and 50 pound units wound in coils or on reels and packed in individual cartons.

Asbestos Cloth

Asbestos cloth, woven from asbestos yarns, is produced in many textures, grades, weights and thicknesses to meet the numerous diversified uses of this versatile asbestos textile product. Textures range from open mesh to lightproof and the choice of weaves includes plain, twill and herringbone. Various styles of cloth are also available, including plain, metallic and reinforced, as described under "Asbestos Yarn." Representative fabrics are illustrated on the following pages.

In addition to the standard asbestos cloths, specially treated cloths are made by most asbestos textile manufacturers to meet unusual conditions or where special characteristics such as resistance to extreme abrasion are required.

USES Because of its inherent incombustibility and thermal stability, asbestos cloth is extensively used wherever these properties are essential in a fabric. Typical examples are the familiar asbestos curtains of theaters and auditoriums, fire-smothering blankets and flameproof draperies, all of which are made of asbestos cloth. The fire-fighting suits worn by personnel in the oil fields and the military services is another familiar application. Coats, trousers, aprons, shoes, gloves, mittens, leggings and helmets made of asbestos cloth are also extensively used to protect workers in industrial plants.

Asbestos cloths are widely used as facings for the traveling conveyor belts that carry heated objects into ovens and dryers, as covers for ironing boards and laundry machine rolls, as industrial furnace hoods, shields for welding booths, belts for blueprint and mat-drying machines and insulation for diesel exhaust pipes.

The dust bags for removing dust, fumes and vapors in mechanical dust collecting systems are among the more specialized uses. Here, conditions of temperature, humidity and corrosion are such that often only bags made of asbestos cloth will satisfactorily meet the requirements of this exacting service. Other specialized applications are in the glass industry, where treated asbestos cloths serve as paddle covers, tray linings and lehr curtains under extremely severe conditions. Asbestos cloth also serves in clarification processes by providing a highly efficient, durable filter cloth.

In combination with other materials, asbestos cloth provides special advantages resulting from the inorganic mineral fibers of which it is woven. A typical example is in the fabrication of moulded and laminated plastics where asbestos fabrics, used as binding agents, provide increased strength and ductility in the finished product.

The metallic asbestos cloths are noted for their superior tensile strength and high resistance to heat and abrasion. These qualities make them virtually indispensable as ingredients in automotive and industrial friction materials, mechanical packings and gaskets and as an insulation over high temperature boiler covering..

GRADES Asbestos cloth is made in the complete range of standard A.S.T.M. grades as follows: Commercial, Underwriters', A, AA, AAA and AAAA. In general, the grades containing the higher percentages of asbestos provide greater thermal stability. (See Table K for percentage of asbestos content in each grade.)

WIDTHS The standard widths of asbestos cloth are 36" and 40" but other widths can be woven for special applications.

WEIGHTS The weight of asbestos cloth varies from a few ounces to several pounds per square yard, depending on type of weave, grade of yarn used, its cut, ply, whether plain, reinforced or metallic and other factors. A selected list of asbestos cloths designed for general requirements and weighing from one to nearly five pounds per square yard, with construction details, thicknesses and grades available is shown in Table L.

THICKNESSES The thickness of single ply cloths ranges from approximately .015" to .100". Fabrics up to ½" in thickness can be woven in multi-ply construction.

TOLERANCES The tolerances for width, weight, thickness, yarn number (cut) and construction of asbestos cloth are in accordance with A.S.T.M. Specification D 677.*

STANDARD PACKAGES Asbestos cloth is supplied in rolls of 50 and 100 yards.

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*See pages _ and _. For A.S.T.M. Specification D577 (standard methods of testing woven asbestos cloth) see pages _ and _.

Asbestos Tape

Asbestos tape is a narrow woven fabric with selvage edges. It is made in two styles: plain or non-metallic, and metallic or wire-inserted.

USES Asbestos tapes are widely used in the electrical industry as an insulation and have numerous other applications where an incombustible woven tape of high tensile strength and thermal stability is required.

Plain (non-metallic) tapes of thin dimension are designed primarily for electrical insulating purposes such as motor windings, where there is need for a heat conductive, thermally stable insulation capable of absorbing a high percentage of insulating varnishes and treatments. The impregnated tape forms a moisture barrier essential to efficient motor operation.

Heavier plain tapes are widely used as a durable flameproof, oil- and water-resistant wrapping for lead sheathed cables, as safety protection for covering hot piping such as used on steam locomotives, and as a component of packings and gaskets.

The metallic or wire-inserted tapes are designed for use where the service requires higher tensile strength or a high coefficient of friction or where abrasive conditions are present. Large quantities are used as the major component in woven brake linings and clutch facings. Asbestos tapes are woven with special alloy wires for applications where excessively high temperatures are encountered, as in the glass industry.

Special metallic tapes are made to serve as oil burner wicking. These are produced in many different designs to meet the requirements of the various types of burners in use and to provide for the proper vaporization of fuel, quick lighting and maximum efficiency in the operation of the burner.

The thermal stability of asbestos tape also adapts it particularly for use as a conveyor belting for carrying hot materials. Tapes for this purpose are made in ¼" thickness and in widths up to 22" in both the plain and metallic styles. Some are woven with the top and bottom plies of plain yarn and are treated with special compounds to increase their resistance to abrasion.

Another of the many specialized uses of asbestos tape is in the field of horticulture, where it serves for binding up the wounds of trees after grafting. Because asbestos tapes are inorganic and thus immune to bacterial attack, their use helps prevent infection and hastens healing.

GRADES Asbestos tapes for electrical purposes are made in Underwriters' grade. Tapes for other uses are available in all standard A.S.T.M. grades from Commercial through AAAA. In general, the tapes with higher asbestos content are used where high temperature conditions are encountered. (See Table K for percentage of asbestos in each grade.)

THICKNESSES, WIDTHS The thinner plain tapes -- those designed for electrical insulation -- are woven in thicknesses from .010" to .030". Heavier plain tapes are made in thicknesses up to 1/8". Metallic tapes can be woven in thicknesses from ¼" up to 1". Standard widths of asbestos tape range from ½" to 6". Tolerances conform to A.S.T.M. specifications."

IRON CONTENT Asbestos tape for electrical use is made in two types with respect to iron content -- ferrous and non-ferrous. The non-ferrous tape is generally used for electrical applications where the tape acts as an insulator or where voltages and temperatures are extremely high. Both types conform to A.S.T.M. standards for maximum percentage of total iron and magnetic iron, as follows:

Type	Total Iron Content (Max. per cent)	Magnetic Rating (Maximum)
Ferrous	6	3
Non-Ferrous		
Underwriters' Grade	1.75	0.75
Grades A, AA, AAA and AAAA	2	1

STANDARD PACKAGES Asbestos tapes for electrical insulation are furnished in rolls wound on bushings. Rolls are of varying footage, depending on width and thickness. Packaging of tapes for other uses varies with the specific tape.

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*For permissible variations in thickness, width, weight and construction, as well as other detailed information about asbestos tape not given above, see A.S.T.M. Specification D 315, reproduced on pages _ to _ of this Handbook.

Asbestos Tubing

Asbestos tubing, sometimes called tubular sleeving, is made from asbestos yarns braided or woven to form a flexible sleeving or tubing. The braided style is supplied in many diameters and textures and in several wall thicknesses to meet a variety of service conditions. It is furnished unsized or with a finish coat of sizing to facilitate application if required. The woven style can be manufactured in various constructions and is usually made to specifications for each requirement.

USES Braided asbestos tubings provide a fireproof, heat- and chemically-resistant sleeving for insulating electrical wires and cables. This effectively shields the cable from possible damage resulting from the failure of adjoining cables. They are also extensively used for covering the lead wires of thermocouples and in the glass industry they protect the hot glassware from injury by serving as a covering for pincers and tongs.

An important practical advantage of braided tubing is the ease with which it can be fitted over the surface to be covered. A braided tubing will slide readily over a rod, wire or cable of the same outside diameter as the inside diameter of the tubing, and if necessary its flexibility will allow it to be expanded or contracted to fit slightly larger or smaller diameters.

The woven style of asbestos tubing is particularly adapted for the insulation of bus bars, automobile heaters, as a flexible connection in hot air ducts and for other uses where a flexible woven type of sleeving is required. Woven tubing of large diameters is sometimes formed into the dust bags used in pneumatic systems for filtering hot waste gases which constitute a fire and dust hazard.*

GRADES Asbestos tubing is made in all standard A.S.T.M. grades -- Commercial, Underwriters', A, AA, AAA and AAAA. (See Table K for percentage of asbestos content in each grade.)

SIZES Braided tubings are produced with inside diameters of 1/64" up to several inches. Wall thicknesses range from less than 1/32" to approximately 1/8". Woven tubings are made in diameters from less than 1" up to 22½".

STANDARD PACKAGES Braided tubing is packaged on spools, or wound on reels in quantities of 25 and 50 pounds. Woven tubing is sold in rolls, or cut to specified lengths.

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For A.S.T.M. standard methods of testing asbestos tubing, see page _.

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*See also "Asbestos Cloth."

CALENDAR OF GEOLOGIC EVENTS RELATING TO FORMATION OF CANADIAN SERPENTINE DEPOSITS*

The asbestos bearing rock of the Canadian serpentine belt is chiefly peridotite, whose main constituent is olivine $(Mg,Fe)SiO_4$.

There were two periods of serpentinization in the Canadian serpentine belt. The first one immediately followed the injection of the ultrabasic rocks and was carried out by hydrothermal solutions genetically related to the ultrabasic magma. The second serpentinization period is much younger and closely followed the Acadian uplift. Asbestos veins were formed only during or immediately after the second serpentinization period.

Order	Geological Event	Temp. C	Geological Age
0	Taconic uplift		Post-ordovician and pre-Devonian
1	Injection and consolidation of ultrabasic rocks and of disseminated chromite	1200 to 900	At end of or immediately after the Taconic uplift
2	First serpentinization of the ultrabasic rocks		
3	Acadian uplift		Post-lower Devonian
4	Injection of massive chromite	500	
5	Injection of aplite and granite		Middle (?) Devonian
6	Second serpentinization; alteration of aplite dikes	500	
7	Formation of asbestos veins followed by talcification	350 or higher	Middle or upper (?) Devonian
8	Injection of magnetite	300 or higher	
9	Precipitation of lime-magnesia silicates	250	
10	Precipitation of zeolites, carbonates and similar minerals	200 or lower	Upper Devonian

*Canadian Mining Journal, Vol. 68, No. 3, 1947, pp. 157-167

TABLE A - PHYSICAL

	Chrysotile	Crocidolite	Amosite
Color	Green gray, amber to white	Blue	Gray, Yellow to dk. brown
Texture	Soft to harsh, also silky	Soft to harsh	Coarse but somewhat pliable
Flexibility	High	Good	Good
Spinnability	Very good	Fair	Fair
Resistance to Heat	Good. Brittle at high temp.	Poor, fuses	Good. Brittle at high temp
Tensile Strength, psi	18,000 to 469,000*	100,000 to 300,000*	16,000 to 90,000*
Fusion Point, ^{o}F	2770*	2180*	2550*
Specific Heat, Btu/lb/^{o}F	0.266*	0.201*	0.193*
Electric Charge	Pos.	Neg.	Neg.
Filtration Properties	Slow	Fast	Fast

HYSICAL PROPERTIES OF ASBESTOS FIBERS

ite	Anthophyllite	Tremolite	Actinolite
, Yellow k. brown,	Yellowish brown, grayish white	Gray-white, greenish, yellowish, bluish	Greenish
se but what ble	Harsh	Generally harsh, sometimes soft	Harsh
	Poor	Poor	Poor
	Poor	Poor	Poor
.Brittle igh temp.	Very good	Fair to good	----
00 0,000*	4,000 and less*	1,000 to 8,000*	1,000 and less*
	2675*	2400*	2540*
5*	0.210*	0.212*	0.217*
	Neg.	Neg.	Neg.
	Medium	Medium	Medium

*The Canadian Mining and Metallurgical Bulletin, April, 1951

**Harris Research Laboratories, Washington, D. C.

TABLE B-CHEMICAL AND MINERALOGICAL PROPERTIES OF ASBESTOS FIBERS*

	Chrysotile	Crocidolite
Essential Composition	Hydrous silicate of magnesia	Silicate of Na and Fe with some water
Theoretical Formula	$3MgO \cdot 2SiO_2 \cdot 2H_2O$	$NaFe(SiO_3)_2 \cdot FeSiO_3$ X H_2O
Crystal Structure	Fibrous and asbestiform	Fibrous
Crystal System	Monoclinic (pseudo-orthorhombic ?)	Monoclinic
Mineralogical Structure	In veins of serpentine, etc.	Fibrous in iron stones
Mineral Association	In altered peridotite adjacent to serpentine and limestone near contact with basic igneous rocks	Iron rich silicious argillite in quartzose schists
Origin	Alteration and metamorphism of basic igneous rocks rich in magnesian silicates	Regional metamorphism
Veining	Cross and slip fibers	Cross fiber
Luster	Silky	Silky to dull
Hardness	2.5 - 4.0	4
Specific Gravity	2.4 - 2.6	3.2 - 3.3
Cleavage	010 perfect	110 perfect
Optical Properties	Biaxial positive, extinction parallel	Biaxial ∓ extinction inclined
Refractive Index	1.50 - 1.55	1.7 pleochroic

*Canadian Mining and Metallurgical Bulletin, April, 1951

Amosite	Anthophyllite	Tremolite	A
Silicate of Fe and Mg; higher iron than anthophyllite	Mg silicate with iron	Ca and Mg silicate with some water	Ca Mg F water u
(Fe.Mg)SiO_3 1-5% H_2)	$(Mg.Fe)_7Si_8O_{22}(OH)_2$	$Ca_2Mg_5Si_8O_{22}(OH)_2$	Ca(Mg.F
Prismatic, lamellar to fibrous	Prismatic, Lamellar to fibrous	Long and thin co- lumnar to fibrous	Long and to fibr
Orthorhombic	Orthorhombic	Monoclinic	Monocli
Lamellar, coarse to fine fibrous and asbestiform	Lamellar, fibrous asbestiform	Long, prismatic and fibrous aggregates	Reticul matic c fibers
In crystalline schists, etc.	In crystalline schists and gneisses	In Mg Limestones as alteration prod. of magnesian rocks, metamorphic & igneous rocks	In lime crystal
Metamorphic	Metamorphic, usually from olivine	Metamorphic	Results metamor
Cross fiber	Slip, mass fiber unor- iented and interlacing	Slip or mass fiber	Slip or
Vitreous, somewhat pearly	Vitreous to pearly	Silky	Silky
5.5 - 6.0	5.5 - 6.-	5.5	6 ±
3.1 - 3.25	2.85 - 3.1	2.9 - 3.2	3.0 - 3.
110 perfect	110 perfect	110 perfect	110 perf
Biaxial positive, extinction parallel	Biaxial positive, extinction parallel	Biaxial negative, extinction inclined	Biaxial extincti
1.64 ±	1.61 ±	1.61 ±	1.63 ±

	Anthophyllite	Tremolite	Actinolite
nd Mg;	Mg silicate with iron	Ca and Mg silicate with some water	Ca Mg Fe silicate; water up to 5%
H_2)	$(Mg.Fe)_7Si_8O_{22}(OH)_2$	$Ca_2Mg_5Si_8O_{22}(OH)_2$	$Ca(Mg.Fe)_3(SiO_3)_4$ X H_2O
lar	Prismatic, Lamellar to fibrous	Long and thin columnar to fibrous	Long and thin columnar to fibrous
	Orthorhombic	Monoclinic	Monoclinic
to	Lamellar, fibrous asbestiform	Long, prismatic and fibrous aggregates	Reticulated long prismatic crystals and fibers
	In crystalline schists and gneisses	In Mg Limestones as alteration prod. of magnesian rocks, metamorphic & igneous rocks	In limestone and in crystalline schists
	Metamorphic, usually from olivine	Metamorphic	Results of contact metamorphism
	Slip, mass fiber unoriented and interlacing	Slip or mass fiber	Slip or mass fiber
at	Vitreous to pearly	Silky	Silky
	5.5 - 6.-	5.5	6 ±
	2.85 - 3.1	2.9 - 3.2	3.0 - 3.2
	110 perfect	110 perfect	110 perfect
, lel	Biaxial positive, extinction parallel	Biaxial negative, extinction inclined	Biaxial negative, extinction inclined
	1.61 ±	1.61 ±	1.63 ± weakly pleochroic

TABLE C - CHEMICAL COMPOSITION OF VARIOUS TYPES OF ASBESTOS*

	Chrysotile	Crocidolite	Amosite	Anthophyllite	Tremolite
SiO_2	37-44%	49-53%	49-53%	56-58%	51-62%
MgO	39-44%	0-3%	1-7%	28-34%	0-30%
FeO	0.0-6.0%	13-20%	34-44%	3-12%	1.5-5.0%
Fe_2O_3	0.1-5.0%	17-20%	----	----	----
Al_2O_3	0.2-1.5%	----	2-9%	0.5-1.5%	1.0-4.0%
H_2O	12.0-15.0%	2.5-4.5%	2-5%	1.0-6.0%	0-5.0%
CaO	Tr.-5.0%	---	---	---	0-18%
Na_2O	----	4.0-8.5%	---	---	0-9%
CaO+Na_2O	----	----	0.5-2.5%	---	---

*Encyclopedia of Chemical Technology, Vol. 2 - Anthrone to Carbon

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TABLE D - EFFECT OF TEMPERATURE ON LOSS IN WEIGHT OF ASBESTOS FIBERS*

Temp. F	Time	Loss in Weight (per cent)				
		Amosite	Anthophyllite	Chrysotile	Crocidolite	Tremolite
400	2 hrs	0.23	0.05	0.30	0.08	0.04
600	"	0.57	0.24	0.85	0.25	0.08
700	"	0.80	0.30	1.78	0.49	0.13
800	"	0.98	0.38	2.17	0.73	0.22
900	"	1.07	0.41	2.85	0.83	0.26
1000	"	1.16	0.44	3.99	0.86	0.29
1100	"	1.36	0.52	10.38	1.00	0.37
1200	"	1.39	0.54	12.75	1.04	0.37
1400	"	1.43	0.54	13.43	1.03	0.47

*Canadian Mining and Metallurgical Bulletin, April, 1951

TABLE E - COMPARISON OF TENSILE STRENGTHS OF VARIOUS FIBERS WITH ASBESTOS*

Type of Fiber	Tensile Strength (psi)
Acetate Rayon	18,000 to 23,000; 22,000 to 30,000[a]
Nylon	65,000 to 80,000; 88,000 to 117,000[a]
Glass	250,000 to 315,000
Orlon	60,000 to 80,000
Cotton	42,000 to 125,000
Silk	45,000 to 83,000
Wool	17,000 to 28,000
Asbestos (Chrysotile)	18,000 to 469,000[b]

*Tests conducted by Harris Research Laboratories, Washington, D. C.
[a]Depending on type
[b]The average tensile strength of 56 asbestos fibers tested was 72,000 psi

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TABLE F - COMPARISON OF APPROXIMATE FIBER DIAMETERS*

Type of Fiber	Fiber Diameter in Inches	Fibrils in One Linear Inch
Human Hair	0.00158	630
Ramie	0.000985	1,015
Wool	0.0008 to 0.0011	910 to 1,250
Cotton	0.0004	2,500
Rayon	0.0003	3,300
Nylon	0.0003	3,300
Glass	0.00026	3,840
Rock Wool	0.000142 to 0.000284	3,520 to 7,040
Asbestos (Chrysotile	0.000000706 to 0.00000118	850,000 to 1,400,000

*The Canadian Mining and Metallurgical Bulletin, April 1951

TABLE G - COMPARISON OF SURFACE AREA OF VARIOUS FIBERS WITH ASBESTOS*

Type of Fiber	Surface Area by N_2 Adsorption (Sq.Cm./Gram)
Nylon	3,100
Acetate Rayon	3,800
Cotton	7,200
Silk	7,600
Wool	9,600
Viscose Rayon	9,800
Asbestos (Chrysotile)	130,000 to 220,000

*The Canadian Mining and Metallurgical Bulletin, April 1951

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TABLE H - EFFECT OF HEAT ON TENSILE STRENGTH OF CANADIAN CHRYSOTILE CRUDE*

	Tensile Strength (psi)	Per Cent of Original Tensile Strength
Original crude - No heat	131,000	----
Heated 3 minutes at 600 F	120,000	91.6
Heated 3 minutes at 800 F	96,000	73.3
Heated 3 minutes at 1000 F	78,000	59.5
Heated 3 minutes at 1200 F	42,000	32.0

*The Canadian Mining and Metallurgical Bulletin, April 1951

TABLE J - COMBUSTION ANALYSIS OF CHRYSOTILE ASBESTOS*

Source of	Temp. F	Per Cent H_2O	Per Cent CO_2	Total Per Cent H_2O CO_2	Per Cent Ignition Loss of Fiber	Per Cent CO_2 Calculated In Terms of Percentage of $MgCO_3$	$CaCO_3$
Arizona	1000	3.37	0.54	3.91	3.87	1.03	
	1800	12.89	1.91	14.80	14.80	1.03	3.[illegible]
Australian	1000	1.50	0.66	2.16	2.06	1.26	
	1800	12.48	0.96	13.44	13.33	1.26	0.6[illegible]
Canadian (A)	1000	5.47	0.85	6.32	6.23	1.62	
	1800	14.28	0.97	15.25	15.17	1.62	0.2[illegible]
Rhodesian	1000	1.82	2.54	4.36	4.28	4.85	
	1800	12.00	2.89	14.89	14.84	4.85	0.79
Canadian (B)	1000	3.75	0.45	4.20	4.14	0.86	
	1800	13.31	0.48	13.79	13.75	0.86	0.07
Russian	1000	1.98	0.77	2.75	2.64	1.47	
	1800	11.74	1.06	12.80	12.72	1.47	0.66
Canadian (C)	1000	2.25	0.47	2.72	2.66	0.90	
	1800	11.93	0.51	12.44	12.40	0.90	0.09

*Canadian Mining and Metallurgical Bulletin, April, 1951

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TABLE K - PERCENTAGE OF ASBESTOS CONTENT BY WEIGHT

IN ASBESTOS TEXTILE PRODUCTS

As Established by the American Society for Testing Materials

Grade	Asbestos Content by Weight
Commercial	75% up to but not including 80%
Underwriters'	80% up to but not including 85%
Grade A	85% up to but not including 90%
Grade AA	90% up to but not including 95%
Grade AAA	95% up to but not including 99%
Grade AAAA	99% up to and including 100%

TABLE L - GRADES AND CONSTRUCTION OF STANDARD ASBESTOS CLOTHS

(Thicknesses-after calendering)

Weight lbs/sq yd	ATI Style	Thickness inches	Ends/" (Warp)	Picks/" (Fill)	Warp Yarn	Filling Yarn	ATI Grades
1.00	16P18	.035	16	13	1820	1810	U
1.05	17P24	.035	16	15	2420	2420	U
1.25	20P28	.036	27	13	2820	2820	U
1.30	21P10G	.035	16	9	1010	1010	U
1.30	21P14	.050	16	10	1420	1210	U
1.33	21P10	.055	8	8	1020	1020	C-U
1.35	21P16	.045	12	15	1620	1620	AA
1.37	22BT38	.034	30	28	3820	3820	U-AAA
1.40	22P16	.051	19	10	1620	1620	U-AAA
1.40	22P10G	.052	18	9	1010	1010	C-U
1.40	22P18	.045	24	15	1820	1810	U
1.45	23P18	.050	17	14	1820	1820	U
1.50	24P10	.055	9	9	1020	1020	U
1.50	24P18	.050	20	14	1820	1820	U
1.65	26P14	.053	14	14	1420	1420	U-AA
1.75	28P16	.063	24	10	1620	1620	C-U-A
1.75	28P18	.060	26	13	1820	1820	U
1.80	29P10	.060	16	10	1020	1010	U
1.80	29P14	.058	20	10	1420	1420	C-U-A-AA
2.10	34P10	.062	16	9	1020	1020	C-U-A-AA
2.15	34P12	.062	20	10	1220	1220	C-U
2.25	36P10	.070	18	9	1020	1020	C-U-AA-AAA
2.40	38P12	.065	20	12	1220	1220	AAA
2.45	39P12	.075	27	9	1220	1220	AAA
2.45	39T12	.075	27	9	1220	1220	U-AA-AAA
2.50	40P10	.075	20	10	1020	1020	C-U-AA-AAA
2.50	40BT14	.070	27	14	1420	1420	C-U-A-AA
2.50	40H14	.070	27	14	1420	1420	C-U
3.00	48P10	.080	18	9	1030	1020	C-U-AA-AAA-AAAA
3.00	48T12	.075	30	10	1220	1220	C-U-AAA-AAAA
3.33	53T12	.080	36	12	1220	1220	AAA-AAAA
3.50	56T8	.085	24	7	820	820	AAA-AAAA
3.65	58T12	.080	36	14	1220	1220	AAA-AAAA
3.70	59T12	.080	40	14	1220	1220	AAA-AAAA
3.90	62T12	.085	24	9	1230	1230	AAA
4.75	7610DC	.135	37	16	1020	1020	C-U

G-Glass Reinforced　　P-Plain Weave　　DC-Double Cloth
H-Herringbone Weave　　T-Twill Weave　　BT-Broken Twill

ATI-81

FELLOWSHIP REPORT

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REPORT #25

June 11, 1953

Fellowship Report

During the quarter just passed the Fellow has been chiefly concerned with three problems, namely, 1) Determination of Asbestos Content of Asbestos-glass Combination Textiles, 2) Determination of Serviceability Temperatures for all Grades of Asbestos Textiles and 3) The Significance of the Combined Iron Content of Chrysotile.

The second and third subjects have received the greater amount of attention and will be discussed in some detail in later sections of this report; however, while the determination of the asbestos content of asbestos-glass combination textiles has been under consideration, not a great deal of progress can be reported.

We have endeavored to direct our attentions to those problems of greatest interest to the membership and the views expressed at the last General meeting indicated that subjects 2 and 3 should receive priority. The greater part of this report is, therefore, concerned with these subjects.

Asbestos-Glass Textiles

The work on asbestos-glass combination cloths has been in the direction of further studies to ascertain the possibility of determining the asbestos content of such textiles by means of specific gravity methods rather than by chemical methods which has been proposed. In earlier work reported by us, specific gravity determinations by means of the pycnometer method were advanced. However, the techniques involved in such determinations require a precision which is far too critical for normal laboratory work and this type of procedure has, therefore, been abondoned for the present.

During recent weeks we discussed the problem with Mr. A. R. Fisher, Bell Telephone Laboratories, who has been carrying on similar determinations in connection with the establishment of a control test for porcelain ceramic parts. In this work, the specific gravity of a porcelain is determined and from this evaluation the extent and degree of maturity can be established. In conducting these tests, heavy liquids having known specific gravities, ranging from 1.5 to 3.5 are used and the materials for test are evaluated on the basis of these liquids. By measuring the ability of the porcelain to float or sink in such a liquid, reading values to the third decimal place, a very close control of the specific gravity can be maintained.

We are now exploring the possibility of physically separating the asbestos from the glass, using a liquid having a specific gravity higher than the glass and lower than the calcined chrysotile. The liquid we have obtained for this work is acetylene tetrabromide which has a specific gravity of 2.943. The glass with a specific gravity of approximately 2.75 should float in such a liquid while the calcined chrysotile with a specific gravity of something over 3.00 should sink. We have not had sufficient time to conduct extensive experiments on these tests but will endeavor to carry on this work during the coming months.

During the past week we obtained an article from Mr. J. L. Tucker titled "The Quantitative Separation of Fibre Mixture by Flotation", and in this work it is reported that the same technique as we contemplate has been found adaptable for the separation of many organic fibers. For example, cotton with a specific gravity of 1.55 was effectively separated from jute having a specific gravity of 1.48, using a liquid having a specific gravity of 1.51. If such separations can be made with the accuracy indicated, there is no reason to expect that our two materials, having such wide differences in specific gravity--2.75 and 3.00, cannot as easily be separated.

Serviceability Temperatures of Asbestos Cloths

Introduction

At the last meeting of the Technical Committee attention was directed to the desirability of establishing a scale of serviceability temperatures for asbestos textiles. Fellowship Reports #23 and #24 set forth the thermal degradation characteristics for a group of asbestos textiles, however, the data as presented offers no specific temperature of serviceability vs grade relationship. In view of this, the Technical Committee recommended that tests be conducted by the Fellow, such tests to be so designed as to classify the strength deterioration characteristics for the various grades at some evelated temperature for one hour so that there would be strength retention of 80% of the original cloth strength.

Before initiating this work the entire subject was reviewed and there was made an analysis of the work previously reported. The results of this analysis were transmitted to Mr. J. D. McCluer, Chairman of the task group assigned to this problem, and are also here set forth for consideration by the entire technical committee.

The first provision of the recommended tests prescribes that the test period should be one hour in duration. We have consistantly raised objections to short period tests of this character due to the fact that such results are misleading and are in no way indicative of the serviceability which will be obtained over extended time periods. This condition is particularly misleading at temperatures of 450°F and lower, the range wherein Commercial and Underwriters grades will fall. It would appear that since the purpose of this work is to establish engineering data to assist consumers of these materials in selecting the proper materials for a given application, the information should be factual and should indicate the relative serviceability over extended periods of time.

The second provision of the recommendations states that the tests should be conducted so that the temperature at which 80% strength retention may ascertained. It is well known that grade alone does not dictate the elevated temperature serviceability of asbestos textiles. Weight, weave and yarn construction all contribute to this characteristic and it would seem that some recognition of this fact should be promoted. An indication of the influence of these factors is set forth in Table I where a statistical analysis approach has been advanced in order that a more understandable picture may be revealed. This table and the two paragraphs immediately following are taken from our letter to Mr. McCluer and serve to summarize our statistical analysis.

Grade	Style	No. Samples	% Tensile Strength Retention (24 hours) 400°F.	800°F.
Commercial	36P10	1	18.4	6.4
	48P10	1	42.5	27.2
	40H14	1	34.8	23.8
			$\bar{X}$ = 31.9% a = 10.0% v = 31.4%	$\bar{X}$ = 19.1% a = 9.2% v = 48.1%
Underwriters	16P28	1	57.5	38.2
	17P24	1	43.6	23.0
	22P16	1	35.7	23.2
	26P14	5	41.7	28.7
	36P10	4	34.6	21.5
	40P10	1	43.5	23.0
	40H14	1	34.8	23.8
			$\bar{X}$ = 41.6% a = 7.6% v = 18.25%	$\bar{X}$ = 26.6% a = 5.4% v = 20.3%
A	30P14	1	72.5	56.8
AA	36P10	8	62.0	55.9
	38T12	1	86.8	68.5
			$\bar{X}$ = 74.4% a = 4.1% v = 5.5%	$\bar{X}$ = 62.2% a = 2.0% v = 3.2%
AAA	36P10	4	81.5	74.5
	48P10	1	88.3	94.4
			$\bar{X}$ = 84.9% a = 4.5% v = 5.3%	$\bar{X}$ = 84.4% a = 10.5% v = 12.4%
AAAA	56T8	1	92.5	74.0

$\bar{X}$ - Arithemitic Mean (Average)

a - The standard deviation, the root-mean square deviation about the average $\bar{X}$

v - The coefficient of variation, a measure of relative dispersion based on the standard deviation.

From this data it will be observed that at 400°F the Commercial and Underwriters grades retain averages of 31.9% and 41.6% repsectively and have standard deviations of 10.0% and 7.6% respectively. In my work, I have had but one sample of true Grade A cloth and this was manufactured in England. It bears our number 147 in report #23. The inclusion here is perhaps unfair since it does not represent a product from our membership but is set forth merely for information. Grades AA and AAA retain 74.4% and 84.9% strengths respectively at 400°F with 4.1% and 4.5% respective deviations while at 800°F, 62.2% and 84.4% strengths are retained with 2.0% and 10.5% respective standard deviations. The AAAA cloth here set forth is again but one sample and should not perhaps be included in this analysis.

The influence of construction and yarn number upon performance is clearly emphasized in the case of the Underwriters Grade cloths here tested. In this work seven styles were tested, covering fourteen cloths and the strength retentions at 400°F ranged from 57.5% for 16P28 to 34.6% for 36P10. The grand average for all of the cloths in this group was 41.6%.

On the basis of this brief analysis it is quite apparent that any attempt to identify a given grade with a specific temperature will work to a disadvantage for some constructions and will overgrade other constructions. While it perhaps is not practicable to attempt to identify each grade and construction with a specific temperature, it does seem that it would be more logical to indicate ranges of temperature for a group of cloths as a whole rather than attempt to fix a temperature that might cover the group.

Experimental Data

In substantiation of the above remarks relative to the unreliability of short period test data, submitted herewith are some figures obtained in recent tests. It was suggested by Mr. McCluer that tests on Commercial and Underwriters Grade Cloths be run at 350°F for one hour and on Grade AA cloths at 450°F. Tests on a few of these cloths were run at these temperatures for 1 hour and for 24 hours. Table 2 sets forth the results of these tests.

Present Strength Retained

		350°F		450°F	
Cloth #	Grade	1 hour	24 hours	1 hour	24 hours
128	Und.	83.7	58.0	---	---
139	Und.	89.0	---	---	---
154	Und.	102.0	50.0	---	---
160	Comm.	84.0	62.0	---	---
124	Und.	93.4	58.0	---	---
133	Und.	86.0	---	---	---
138	Und.	90.0	---	---	---
125	AA	---	---	84.0	---
143	AA	---	---	94.0	---
146	AA	---	---	90.8	69.0
153	AA	---	---	69.3	48.5
142	AA	---	---	---	79.0

Summary

These results offer further evidence in support of earlier work showing the dangers to be encountered in accepting the results of one hour tests as indicative of serviceability characteristics.

In view of the observations here presented it would appear desirable to have the Technical Committee again review all of the data presented by the Fellow in the several recent reports along with similar data developed with each individual company's laboratories and on the basis of this collective information endeavor to develop a formula which will factually portray elevated temperature serviceability.

It may well be that a different type of test procedure is desirable. Considerable thought by the Fellow has been directed along these lines and, among other things, there has been considered the possibility of a load test at elevated temperatures which might serve to provide more correlatable data and at the same time give information which is new. A few such tests of an exploratory character have been carried out along these lines and the results would seem to indicate that useful information might be so procurred. For example, a strip of AAA, 2.25# cloth was mounted in the furnace so that a weight equivalent to 7 pounds per yard of width was supported in tension and this assemby heated to 1500°F and held for 2 hours. At the end of this period the cloth continued to support this load and showed no signs of destruction as a result of it. From appearances it would seem that much more weight could have been applied without destruction.

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Such a test would seem to be simulative service in character and should prove of great interest from an engineering standpoint. If it is the desire of this committee that such a test program be pursued we will be pleased to initiate the work immediately and should have a considerable amount of data for the next writing.

SIGNIFICANCE OF COMBINED IRON IN CHRYSOTILE

Introduction

Iron may exist in chrysotile fiber either as a constituent or as a contaminant and as such may markedly determine the suitability of products made from such fibers for electrical insulation applications. The routine chemical analysis of these fibers does not necessarily reveal how the iron is present, since in reporting such an analysis the iron is usually identified either as FeO or Fe_2O_3 or perhaps as a combination of the two oxides. Actually, the iron in chrysotile is most often present as Fe_3O_4 (magnetite) or as a structural constituent of the chrysotile lattice, as a complex magnesium--iron silicate.

Iron as Fe_3O_4 is a highly undesirable contaminant since it is electrically conductive and exhibits a high magnetic permeability. On the other hand, iron as Fe_2O_3 or FeO (not normally a naturally occurring compound) or as a silicate are not particularly objectionable from an electrical viewpoint, having extremely low magnetic permeabilities and high resistance to the conduction of electric current.

During recent years there have been movements initiated wherein the significance of the iron content and its relationship to electrical conductivity might be established. Many specifications contain sections concerned with this relationship which endeavor to set forth testing techniques that will reveal the applicability of a desired asbestos textile to a given set of conditions or operations. The American Society for Testing Materials sets forth a tentative method for determining magnetic rating by the Mapes method and also provides a conducting particle test (D 315-52) which are essentially concerned with the same end results. Various investigations have proposed an adaption of the dielectric strength test as used on solid materials as an applicable test for such determinations. MIL-1-3053A, in section 4.5.4.3 advances still another method wherein the sample is heated to 815° for 1 hour, after which the sample is pulverized and the magnetic portion removed by an electromagnet.

These are but a few of the techniques in use today and all appear to fall short in providing a completely satisfactory evaluation of the true electrical characteristics of an asbestos textile. It has been our purpose during recent months to consider this problem in a rather detailed fashion in an effort to evaluate the methods presently in use and to endeavor to establish a test technique which might yield results having more significance than those now obtained. In addition, some work has been here included in an effort to establish the significance of the type of iron and its relationship to electrical properties.

Experimental Work

Magnetic Analyses

In initiating this investigation several methods of magnetic analysis were considered in an effort to establish a testing technique which would provide the highest degree of accuracy and reproduceability for the materials with which we are here concerned.

Magnetic measurements using the ballistic galvanometer for detection were first studied, however, with the equipment available only very small samples (0.5 grams or less) could be studied. This limitation on sample size proved to be the objectionable feature of this test method since in selecting samples of such small quantities a marked variation in resultant permeabilities among the several samples of the same material could be observed. In order to utilize such a test method in this work it was felt that it would be necessary to redesign the available equipment so that it would accommodate samples of not less than 5 grams and preferrably 10 grams in size. The equipment made available to us was and is being used on another project and in order for us to proceed further along these lines it would be necessary to expend a considerable amount of time in developing a new set-up. Before proceeding further along these lines it was felt desirable to investigate other avenues of study for a possible solution.

A second test set-up here available to us for consideration in this work was a Helmhotz coil analyzer wherein the samples to be investigated are subjected to a known magnetic force and the induced torque resulting therefrom measured through an analytical balance. Here again the equipment design was inadequate for our purpose. The coils, although nearly 2" in cross-sectional diameter by 10" in coil diameter, were incapable of producing a magnetic field with sufficient intensity to activate our materials which contained so small an amount of magnetic materials. A redesign of this equipment would undoubtedly provide a suitable test instrument for such determinations, however, it was felt highly unlikely that the results which might be obtained would be any more significant or reliable than those now obtained by means of the presently used Mapes Analyzer.

The third method investigated was that proposed by A.S.T.M. designation D 1118-50T, originally proposed by F. S. Mapes. The equipment as prescribed under procedure A was procurred in exact compliance with the specifications, except that the amplifier and indicating instrument here used are in one unit--a Hewlett Packard Vacuum Tube Voltmeter. This instrument has twelve ranges for voltage readings with the lowest range reading from 0 to .001 volts (1 millivolt) full scale, readable to 0.01 millivolt while the highest range reads from 0-300 volts. With this equipment ten gram fiber samples can be tested in MR values ranging from much less than 1 to in excess of 12 can be easily determined.

Analysis of A.S.T.M.-D 1118-50T

Before considdring specific test data it would seem advisable to review briefly the purpose of the test, the test procedure, and the significance of the data so obtained.

The stated purpose of this test is to determine the magnetic rating (MR) of an asbestos fiber or material produced therefrom, such a rating to serve as a criterion upon which may be established the ability of said materials to serve satisfactorily for electrical purposes. The MR values cover a range from 1 to 6 and are established on the basis of known weights of a standard magnetite (Bureau of Standards #29a) uniformily distributed throughout a volume equivalent to that occupied by a ten gram sample of asbestos fiber. An MR equal to 1 is obtained by thoroughly mixing a sample of some inert material, such as zinc oxide, in an amount equal to the volume occupied by 10 grams of chrysotile (40 grams of zinc oxide) with 0.18 grams of the standard magnetite. A mixture so prepared will yield a reading equivalent to an MR equal to 1. With further additions of magnetite in multiples of that necessary to produce the MR-1 reading, additional ratings up to MR-6 are procurred.

Curve I sets forth the MR vs millivolt reading relationship for the equipment we have in operation. These values were obtained using a reasonably pure grade of magnetite obtained from our chemical supplies and may not be exactly the same as might be obtained when the #29a sample is used. We have had the standard material ordered for some time but have not received it to date, however, upon its arrival a check run will be made.

On the same Curve I there is presented the MR vs Fe_3O_4 percentage content relationship for chrysotile fiber.

Through the relationships here set forth it would seem that it should be possible to roughly determine the amount of magnetic iron in a given unknown sample. However, this technique does not take into account the extent of dispersion, fineness of grain or degree of orientation, all of which, no doubt, have some influence upon any magnetic permeability measurements which may be made. The extent of effect of the first two of these factors are, at this point, not too well established by this work, however, the effect of orientation has been studied and the variations obtained are set forth in Table I. In this table, the results of determinations on eighteen different chrysotile fiber samples are presented. Each sample was read ten times with the sample being removed, fluffed and repacked after each reading. The range of values shown in the first column are the minimum and maximum values for the ten readings taken and the second column sets forth the average value for the ten readings. The values are presented in millivolts.

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The State University of New Jersey
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SUBJECT

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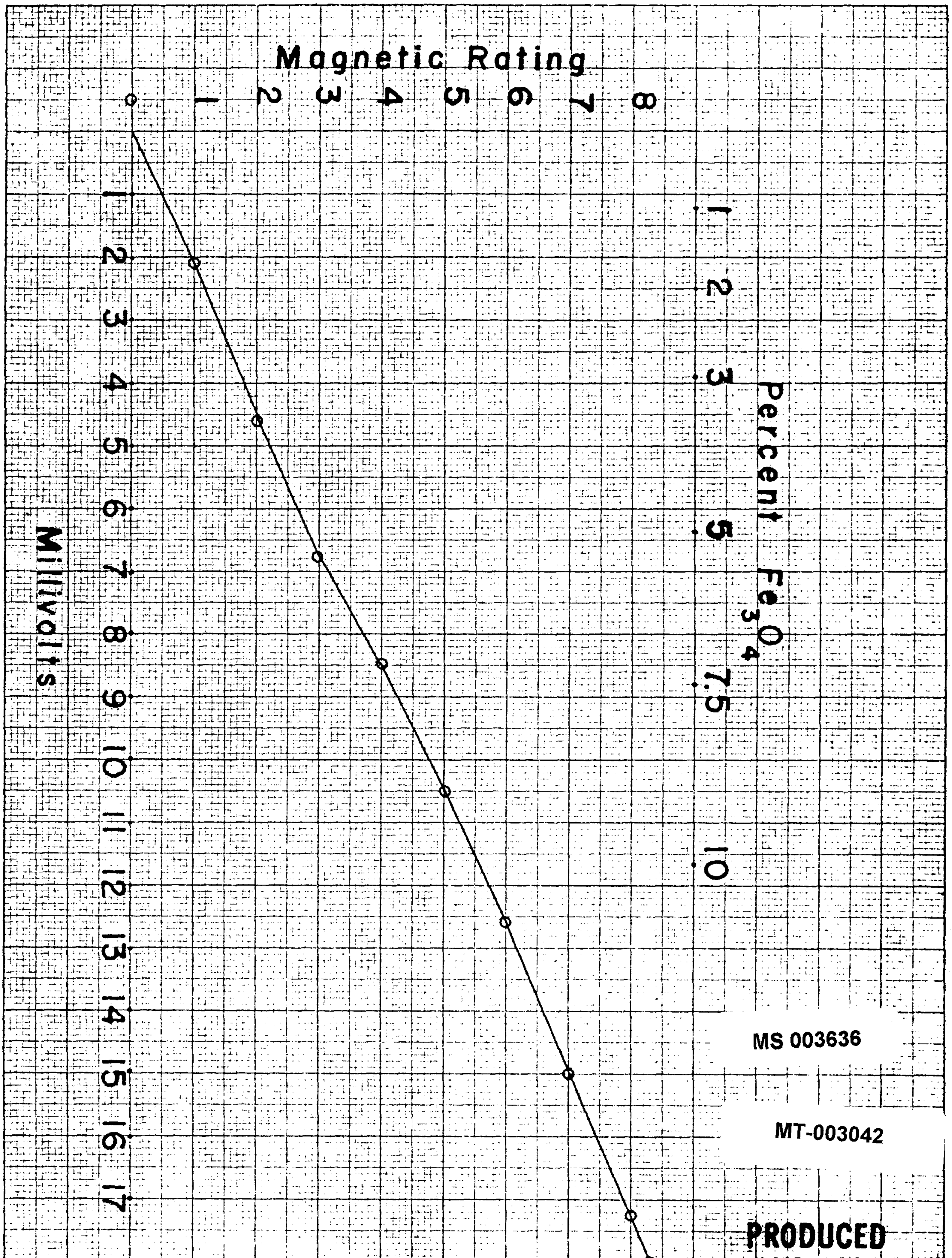

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Table I

	Range	Average
Johnson #1	6.1 - 7.3	6.55
" #1 - 25%) 75%)	11.8 -13.9	12.60
" #3K	4.25 - 5.45	4.80
" #3R	4.45 - 5.10	4.80
Bell #1	10.5 -13.1	11.75
" #2	6.6 - 8.8	7.25
" #3K	3.25 - 3.60	3.45
" #3R	3.90 - 4.75	4.25
King #2	12.40 -16.40	14.40
" #3R	3.10 - 3.60	3.35
Danville #2	5.30 - 6.60	5.90
" #3R12	2.70 - 2.90	2.85
" #3R34	2.85 - 3.25	2.90
Shebanie #1	1.00 - 1.10	1.00
" #2	-----	0.60
" #3	1.00 - 1.20	1.10
C&G #1	1.00 - 1.30	1.25
" #2	0.85 - 1.00	0.90

An analysis of these results will show that while the millivolt readings in most cases appear to be considerable, the range of values usually falls well within one MR group which, in general, covers 2 millivolts.

Carrying this analysis still further in an effort to determine the effect of orientation, several cloth and yarn samples were tested. The cloth samples were first tested with the warp direction in the long direction of the specimen holder, secondly with the fill direction in the long direction of the holder and finally with the diagonal direction in the long direction of the holder. Finally, the cloths were carefully dissected and all of the yarns first placed parallel in the long direction of the holder and secondly, wrapped around a small spindle so that they could be placed in the holder in a circular position at right angles to the first position. The results of some of these tests are interesting and show the definite effect of orientation.

Table 2

	Warp	Fill	Diagonal
Cloth #132 (3"x3")	4.10 mv	3.41 mv	3.80 mv
Yarns #132	4.4 mv	3.2 mv	
Cloth #75 (3"x3")	2.95 mv	1.80 mv	2.40 mv
Yarns #75	3.10 mv	1.75 mv	
Grade AAA yarn 10 cut, 2 ply	6.7 mv	3.2 mv	

It will be observed that yarns which had been removed from each of the cloths gave higher readings in the warp direction and lower readings at right angles to the warp direction than was obtained for any positioning of the individual cloths. It must be assumed that the maximum values are most nearly correct since in these determinations the greatest susceptability intensities have been induced through the alinement of the magnetic particles in a manner which will produce the highest degree of interception in the magnetic field. In the production of the cloths here tested, the preparation of the fiber from the cards through the spinning frames has acted to aline the fibers and the attached magnetite particles so that all are reasonably parallel. Through such an alinement the maximum magnetic susceptabilities are obtained.

The tests to date, though few in number, would indicate that the maximum millivolt readings for a given cloth are between 5% and 10%

lower than the probable maximum value which would be obtained by alining all of the yarns to produce a maximum value and that the average values for a cloth are approximately 15% to 25% lower than the yarn maximum value. In terms of the MR rating this would mean an increase of from 0.1 to 0.2 of 1 MR on the maximum value or 0.3 to 0.5 of 1 MR on the average value.

On the basis of these observations it would appear that testing technique and procedure are the critical points in such determinations. The effect of grain size, packing and distribution of the magnetic particles on such determinations will probably exert some further influence upon the MR values so obtained, however, it would also appear that the extent of such influence should be determinable and accountable. It would seem advisable at this point to institute a program of investigation to determine the extent of influence exerted by the above mentioned variables and upon the basis of these determinations to draft a specific method of test procedure. It is conceivable that one or more factors related to each of the above variables will have to be included in the formual for the determination of MR. Such a factor is now used in the determination of asbestos content, 0.86, and in this latter case we realize that figure may range ± .01. The same degree of reliability should be sought and expected in the work on magnetic ratings.

Having determined the proper test procedure and formula for evaluation there is no logical reason why the determination of MR values should not be consistant and reproducable and why such values should not be translatable, within tolerable limits, into Fe_3O_4 content.

Test Results - A.S.T.M. D 1118-50T

In this investigation of the A.S.T.M. method for determining the magnetic rating of asbestos materials eighteen varieties of chrysotile, two grades of amosite and one sample of crocidolite were studied. In addition, of the nineteen chrysotile samples fourteen of the samples are divided into three components as follows: 1) carded fiber, 2) waste from licker in cylinder and doffer, and 3) waste from feed rolls. Three of the chrysotile fibers are divided into two components - 1) carded fiber and 2) card fly. The over-all study included tests on fifty-two separate samples.

In the test work, ten readings were taken on each sample of carded fibers and five readings were taken on the waste fiber samples. In addition, following the test on the carded fibers, the samples were placed in a furnace at 810°C and held for one hour, after which another set of five readings was taken. This latter procedure is in compliance with the specification set forth in MIL-3053A.

In carrying out an individual test, each sample, 10 grams in weight, was placed in the holder and the reading taken. Following this the sample was removed, opened and fluffed and then repacked in the holder in preparation for another reading. This procedure

	Carded Fiber		Waste	
	A	A (Calcine)	B	C
Johnson #1	6.55	1.25	30.0	37.5
Johnson #1 - 25% #2 - 75%	12.60	1.35	--	--
Johnson 3K	4.80	0.60	20.20	25.00
Johnson 3R	4.80	0.50	11.80	18.30
Bell #1	11.75	0.85	25.00	23.25
Bell #2	7.25	0.75	23.90	14.70
Bell #3K	3.45	0.50	11.60	10.20
Bell #3R	4.25	0.70	14.25	15.40
King #2	14.40	1.80	40.00	46.50
King #3R	3.35	0.50	7.30	12.60
Danville #2	5.90	1.05	14.50*	---
Danville #3R12	2.85	0.95	4.40*	---
Danville #3R34	2.90	0.90	3.90*	---
Shebanie #1	1.00	0.00	10.20	16.00
Shebanie #2	.60	<0.40	0.50	9.00
Shebanie #3	1.10	<0.50	1.25	8.05
C&G #1	1.25	<0.10	13.20	4.80
C&G #2	.90	0.00	8.05	7.10
Amosite B-1	0	---	---	---
Amosite 3DM-1	0	---	---	---
Crocidolite	<0.50	---	---	---

B = Waste from Licker-in Cylinder & Doffer
C = Waste from Feed Rolls
* = Card Fly

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was repeated until ten readings had been taken in the case of the carded fibers and five readings in the remaining fibers.

The results of the tests so conducted are set forth in Table 3, where Column A presents the average values, in millivolts, for ten determinations on each sample; column A (Calcine) presents the average values, in millivolts, for five determinations on each sample of the same carded fiber which had been held at 810°C for one hour; column B presents the average values, in millivolts, for five determinations on waste from the licker-in cylinder and doffer resulting from the processing of the carded fibers shown in column A; and column C presents the average values, in millivolts, for five determinations on waste from the feed roll resulting from the processing of the carded fibers shown in column A.

It will be observed that there are marked differences in relative magnetic permeability over the range of fibers here investigated and that there are even greater differences, in most cases, between the carded fibers and the waste fibers. This latter observation gives a clear indication of how effective a processing operation may be in improving the purity of a carded fiber and also should perhaps indicate the care which should be exercized in using waste fiber as a batch ingredient where iron-free products are sought.

In order to evaluate the results here presented, in terms of MR values, the following table sets forth the relative MR values covering a millivolt range:

MR 1	=	2.2 -	4.6	Millivolts
2	=	4.6 -	6.8	"
3	=	6.8 -	8.5	"
4	=	8.5 -	10.5	"
5	=	10.5 -	12.6	"
6	=	12.6 -	15.0	"
7	=	15.0 -	17.3	"
8	=	17.3 -	19.6	"
9	=	19.6 -	21.7	"
10	=	21.7 -	24.0	"

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On the basis of the above tabulation, it will be seen that two samples, (1) Johnson #1 and #2 blend and (2) King #2 have MR values of 6 or greater; Bell #1 has an MR value of 5, etc. Most of the Canadian carded 3K and 3R fibers have ratings between 1 and 2 while the African carded fibers are much less than 1. However, the waste fibers of most of these fibers show a high concentration of iron bearing minerals which if not properly eliminated through processing or if added as a batch ingredient could well account for a marked deterioration in electrical property quality.

The data presented under column A (Calcine) was included in order that the specification as set forth in MIL-3053A might be evaluated. In reviewing all of the available information covering the subject we are here investigating there could be found no substantiation for the technique advanced under this Military Specification. It appears to us that such a treatment, wherein the Fe_3O_4 is submitted to an oxidizing atmosphere at this elevated temperature, 810°C, the only possible result would be the oxidation of the magnetite with the resultant reduction of magnetic properties. Such results are obviously obtained since it will be seen that the magnetic properties are, in every case, markedly reduced to the point of being practically eliminated. In the African fibers particularly, the oxidation was found to be practically complete.

SUMMARY

The work here reported has been largely exploratory and few, if any, definite conclusions can be established on the basis of the results obtained. The Mapes Analyzer has been quite thoroughly investigated and it would appear that many of the irrationalities attributed to this instrument are misplaced and should perhaps be charged against testing procedure and technique. The test procedure as set forth by A.S.T.M. is far too sketchy to provide a degree of accuracy consistant with the details of construction set forth in the design of the instrument. Also, the method of sample selection, the number of samples and the positioning of the samples during the test are very important factors which must be considered if reliable results are to be expected. A method of test should be developed and specified which will take into account all of the above variables. Under these conditions the Mapes analyzer should provide reasonable accurate and reliable information.

The second phase of this investigation has been to determine the significance of chemically combined iron in chrysotile asbestos. The terminology is perhaps somewhat misleading here since most, if not all, of the iron found in chrysotile is chemically combined; free iron or tramp iron being practically non-existant. The iron may be chemically combined as one of the several oxides or as one of the silicates. The interest here rests chiefly in the consideration of whether the iron if present as Fe_3O_4 or as one of the complex magnesium-iron silicates wherein the iron may be a unit constituent of the chrysotile molecule. In this latter case, the resultant structure provides no difficulties electrically, however, as Fe_3O_4 the iron is present as an undesirable impurity.

Proof of the electrical inertness of iron as a silicate may be seen in table 3 where two samples of amosite and one of crocidolite are listed. The two amosite samples showed no magnetic properties whatsoever while the crocidolite gave an indication so feeble in intensity that it was hardly noticeable. In these, amosite may contain between 35% and 45% iron reported as iron oxide and crocidolite may contain between 35% and 40% iron, again reported as iron oxide. Actually, in both cases, the iron is present as iron silicate.

Further, the difference between iron in its several states of oxidation are quite marked. Reference is again made to Table 3, columns A and A (Calcine). In column A, the values show the magnetic properties of the Fe_3O_4 contained in the several chrysotiles listed. Upon heating these same samples to a sufficient temperature, 810°C, under oxidizing conditions, the greater part of the Fe_3O_4 has been oxidized to Fe_2O_3 which exhibits no magnetic properties. The resultant values show that nearly complete oxidation has been obtained and the magnetic and electrical properties markedly improved.

This latter specification, as covered in MIL-3053A is, we believe, meaningless. Under this specification, all of the fibers here studied would have an MR value of less than 1.

CONCLUSIONS

It would seem advisable to continue this work in an effort to develop a test method that would provide uniformity in procedure with a resultant greater consistancy in results. It does not seem unreasonable to expect that a suitable method can be developed and that on the basis of such a method a reasonable degree of correlation between MR and Fe_3O_4 content in chrysotile can be established.

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1. Heat Aging Tests
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1. Elevated Temperature Strength Characteristics
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3. Significance of Chemically Combined Iron in Chrysotile

Report #24--- March 12, 1953

1. Physical Tests on Asbestos Textiles
   a) Steam, water and acid.
2. Westinghouse Heat Aging Test
3. Significance of Chemically Combined Iron in Chrysotile

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FELLOWSHIP REPORT

MYRIL C. SHAW

RESEARCH FELLOW

ASBESTOS TEXTILE INSTITUTE

NEW JERSEY CERAMIC RESEARCH STATION

RUTGERS UNIVERSITY

NEW BRUNSWICK, N. J.

REPORT #26

September 10, 1953

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Introduction

The Fellowship report for this quarter contains reports covering two of the major projects in the Fellowship program.

The first report, "The Elevated Temperature Serviceability of Asbestos Textiles", has been prepared as an initial effort in an endeavor to write an article that may be used for publicity purposes which will more or less summarize the results of our work and present it for public consumption in a form which may be understood and used. It is not intended that the article shall be used as written, but rather that it may serve as a starting point from which a suitable publicity release may be developed. It is hoped that each member of the Institute will take it upon himself to seriously consider the subject and material here presented and will offer suggestions as to how it may best be used for good publicity.

The second report, "The Significance of Combined Iron in Chrysotile", is a continuation of the discussion presented in the report submitted at the last meeting. Additional significant information has been included in this report and it is felt that through continued work on this problem, a clearer understanding of many of the problems involved in connection with this subject will be had. It is our intention to present the information we have thus far obtained at a meeting of the task group of A.S.T.M. which is considering this problem, when it meets in New York in October.

In addition to the work covered in the reports here presented, the Fellow has engaged in further efforts to clarify and correct several of the Federal specifications. During the past month, the Fellow met with Mr. Tucker and Mr. Frederick for the purpose of reviewing the several Federal specifications and the revisions which have from time to time been proposed by our membership. Copies of the proposed revisions are being distributed at this meeting and it is hoped that some specific actions may result from this consideration. Also, Westinghouse Electric Manufacturing Company has concluded its efforts to revise their specification PDS 2060. A full discussion of the proposed revisions will be conducted during the course of this meeting.

The Fellow trusts that the program of research and investigation being conducted meets with the satisfaction of the Institute membership and will welcome suggestions as to how the work may be expanded or changed to further increase its usefulness. We are now entering our eighth year of service with the Institute in the capacity of Research Fellow and would like to take this opportunity to thank the membership for its support and interest in the work in which we have engaged. We trust that our service and contributions have been as satisfactory to the Institute as it has been pleasurable for the Fellow.

The Elevated Temperature Serviceability of Asbestos Textiles

The elevated temperature serviceability of asbestos textiles is a direct function of the grade of the material, the weight, weave and thickness of construction and the atmospheric conditions under which the specific service is to be endured. In addition, physical abuse such as abrasion, load in tension or shear and the corrosive action of chemicals, all contribute in some degree to the deterioration and ultimate destruction of asbestos textiles in service.

The specific effect of elevated temperatures upon the serviceability of asbestos textiles has long been a subject of considerable concern and efforts to define this characteristic in terms of grades alone has not proven to be accurate. Excessive temperatures do contribute markedly to the physical alteration of the basic asbestos fibers, however, at temperatures below 1000 ^{o}F the structure of the fibres remains fundamentally unchanged and they exhibit, in great part, the same strength imparting characteristics originally inherent. The strength deterioration of the lower grade asbestos textiles, such as Commercial and some Underwriters grades, observed at relatively low temperatures is related in great part to the yarn construction since shorter length fibres are used in these classifications. In view of this and since the ultimate yarn strength is, to a marked degree, a function of the fibre to fibre contact affected in the spinning of the yarn, the real or true tensile strength of the individual fibres contribute in only a very small measure to the overall resultant strength. In the higher grade textiles, wherein longer fibre lengths are used and, consequently, a more effective spinning is accomplished, the tensile strengths are proportionately increased and the true strength of the individual fibres finds opportunity for expression.

The various designs and constructions of the many asbestos textiles are the results of an engineering approach to the problem of developing the most suitable material to meet specific applications. Where temperature requirements alone are the determining factors, the selection of a suitable construction is relatively simple. However, when high strength and abrasion resistance requirements must also be taken into consideration, the development of the most serviceable design and construction requires an application of the knowledge and understanding which has been gained through years of experience by the manufacturers of asbestos textiles. Further, the requirement for light-weight fabrics with one or all of the foregoing properties necessitates the application of additional engineering know-how.

In an effort to provide the consumers of asbestos textiles with authoritative information regarding the products of this industry, the Asbestos Textile Institute has selected a group of asbestos textiles which are considered standard throughout the industry and has tabulated the significant data pertaining to each. The list is not, and should not be so considered, a complete list of all of the cloths manufactured and supplied by this

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Table 1

GRADES AND CONSTRUCTION OF STANDARD ASBESTOS CLOTHS
(Thicknesses-after calendering)

Weight lbs/sq yd	ATI Style	Thickness (inches)	Ends/Inch (Warp)	Picks/Inch (Filling	Warp Yarn	Filling Yarn	Grades
1.00	16P18	.035	16	13	1820	1810	U
1.05	17P24	.035	16	15	2420	2420	U
1.25	20P28	.036	27	13	2820	2820	U
1.30	21P10G	.035	16	9	1010	1010	U
1.30	21P14	.050	16	10	1420	1210	U
1.33	21P10	.055	8	8	1020	1020	C-U
1.35	21P16	.045	12	15	1620	1620	AA
1.37	22BT38	.034	30	28	3820	3820	U-AAA
1.40	22P16	.051	19	10	1620	1620	U-AAA
1.40	22P10G	.052	18	9	1010	1010	C-U
1.40	22P18	.045	24	15	1820	1310	U
1.45	23P18	.050	17	14	1820	1820	U
1.50	24P10	.055	9	9	1020	1020	U
1.50	24P13	.050	20	14	1820	1820	U
1.65	26P14	.055	14	14	1420	1420	U-AA
1.75	28P16	.065	24	10	1620	1620	C-U-A
1.75	28P18	.060	26	13	1820	1820	U
1.80	29P10	.060	16	10	1020	1010	U
1.80	29P14	.058	20	10	1420	1420	C-U-A-AA
2.10	34P10	.062	16	9	1020	1020	C-U-A-AA
2.15	34P12	.062	30	10	1220	1220	C-U
2.25	36P10	.070	18	9	1020	1020	C-U-AA-AAA
2.40	38P12	.065	20	12	1220	1220	AAA
2.45	39P12	.075	27	9	1220	1220	AAA
2.45	39T12	.075	27	9	1220	1220	U-AA-AAA
2.50	40P10	.075	20	10	1020	1020	C-U-AA-AAA

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Table 1 (Continued)

Weight lbs/sq yd	ATI Style	Thickness (inches)	Ends/Inch (warp)	Picks/Inch (Filling)	Warp yarn	Filling yarn	Grades
2.50	40BT14	.070	27	14	1420	1420	C-U-A-AA
2.50	40H14	.070	27	14	1420	1420	C-U
3.00	48P10	.080	18	9	1030	1020	C-U-AA-AAA-AAAA
3.00	48T12	.075	30	10	1220	1220	C-U-AAA-AAAA
3.33	53T12	.080	36	12	1220	1220	AAA-AAAA
3.50	56T8	.085	24	7	820	820	AAA-AAAA
3.65	58T12	.080	36	14	1220	1220	AAA-AAAA
3.70	59T12	.080	40	14	1220	1220	AAA-AAAA
3.90	62T12	.085	24	9	1230	1230	AAA
4.75	76P10DC	.135	37	16	1020	1020	C-U

G-Glass reinforced
H-Herringbone Weave

P-Plain Weave
T-Twill Weave

DC-Double cloth
BT-Broken Twill

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Table 2

MINIMUM TENSILE STRENGTH OF STANDARD ASBESTOS CLOTHS

Weight lb/sq yd	ATI Style	Commercial Warp	Commercial Fill	Underwriters' Warp	Underwriters' Fill	A Warp	A Fill	AA Warp	AA Fill	AAA Warp	AAA Fill	AAAA Warp	AAAA Fill
1.00	16P18			60	22								
1.05	17P24			55	50								
1.25	20P28			80	35								
1.30	21P10G			120	65								
1.30	21P14			50	20								
1.33	21P10	40	33	40	33								
1.35	21P16							55	60				
1.37	22BT38			80	60					80	60		
1.40	22P16			75	35					80	35		
1.40	22P10G	90	65	90	65								
1.40	22P18			80	25								
1.45	23P13			65	45								
1.50	24P10			45	37								
1.50	24P18			85	45								
1.65	26P14			65	55			70	60				
1.75	28P16	95	35	95	35	100	35						
1.75	28P18			100	40								
1.80	29P10			80	25								
1.80	29P14	90	35	90	35	90	35	85	35				
2.10	34P10	80	33	80	33	90	33	85	33				
2.15	34P12	95	40	95	40								
2.25	36P10	90	37	90	37			100	35	110	45		
2.40	38P12									100	50		
2.45	39P12									110	45		
2.45	39T12			100	35			100	35	110	45		
2.50	40P10	100	40	100	40			110	45	110	45		

Table 2 (Continued)

Weight lb/sq yd	ATI Style	Commercial Warp	Commercial Fill	Underwriters' Warp	Underwriters' Fill	A Warp	A Fill	AA Warp	AA Fill	AAA Warp	AAA Fill	AAAA Warp	AAAA Fill
2.50	40BT14	130	45	130	45	130	45	125	35				
2.50	40H14	130	45	130	45								
3.00	48P10	170	50	170	50			225	55	225	55	225	55
3.00	48T12	170	50	170	50					170	50	170	50
3.33	53T12									180	55	180	55
3.50	56T8									160	40	160	40
3.65	58T12									215	65	215	65
3.70	59T12									300	70	300	70
3.90	62T12									165	45		
4.75	76P10DC	180	80	180	80								

G-Glass Reinforced
H-Herringbone Weave

P-Plain Weave
T-Twill Weave

DC-Double Cloth
BT-Broken Twill

NAME

SUBJECT

RUTGE' . UNIVERSITY
The State U ... ersity of New J...
NEW BRUNSWICK NEW JERSEY

ATI-81

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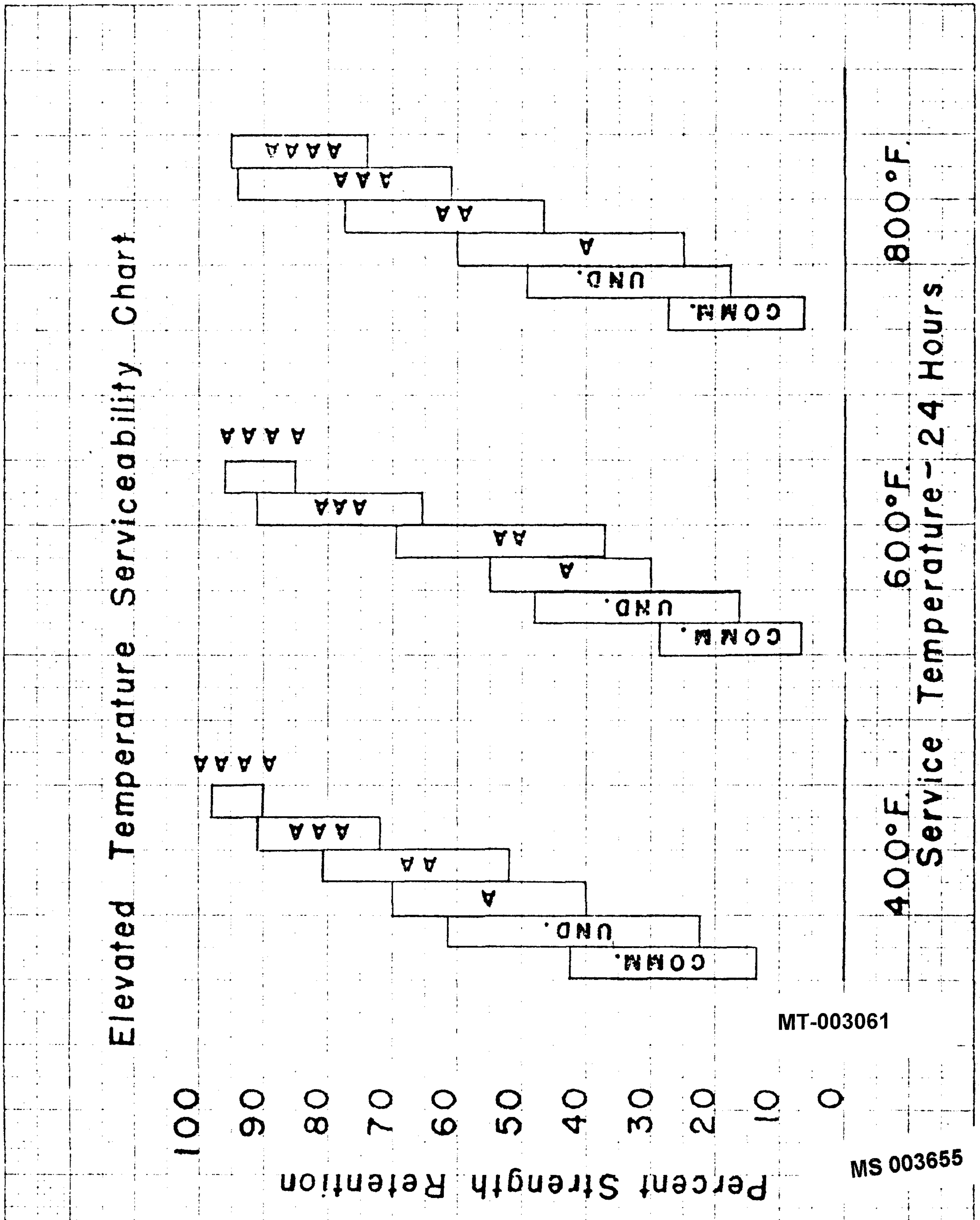

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industry. Many applications require special designs and constructions which are unique and as such are supplied on a "customer special" basis. However, for the most part, the list generally covers the full range of textiles readily available or normally procurable from most manufacturers. The tabulation in Tables 1 and 2 sets forth the pertinent information regarding weight, weave, construction and tensile strength data for the materials as produced. In addition, Chart 1 presents tensile strength data for the various classifications at elevated temperatures.

The elevated temperature data is the result of extensive research and investigation conducted at Rutgers University under the sponsorship of the Asbestos Textile Institute. It will be observed that the elevated temperature-tensile strength data is presented in graphic form and specific relationships are avoided. However, the data does offer a range of tensile strength retentions for given temperatures and should serve as assistance in selecting a suitable material for a given service. As herebefore pointed out, serviceability at a given temperature is dependent upon a number of factors and it is intended that the elevated temperature serviceabilities here established should permit the consideration of varying designs, constructions and conditions of service. In general, it may be expected that for cloths having the same weight, those constructed of finer cut yarn or those woven in twill or herringbone rather than plain woven, will exhibit the higher strength retention characteristics at elevated temperatures.

The selection of the proper cloth for a given application must be made with a full understanding of the service conditions to be encountered. If and when the operating temperatures are known with a reasonable degree of certainty, the selection of the proper material to withstand those temperatures may be ascertained within tolerable limits by means of the information here presented. However, when there is a question of doubt as to the temperatures to be engaged, it is suggested that the minimum retention values as here given be applied in order that a reasonable factor of safety may be permitted.

Appendix

MS 003656

The investigation of the serviceability of asbestos textiles at elevated temperatures has been one of the more active projects of the Fellowship for the past year. In this report, the results of tests on all of the samples which have been made available to us are set forth.

This work has been conducted in the Despatch Oven procurred for these tests and for similar tests as covered in Westinghouse Specifications. The temperatures at which these tests have been carried out are 400°F, 600°F and 800°F, and all for a period of 24 hours.

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The results are expressed in terms of (1) Tensile strength (warp-grab) and (2) per cent tensile strength retained, at the above noted temperatures.

Table 1 presents the pertinent data for all of the cloths included in this work, setting forth (1) Cloth number, (2) style, (3) grade, (4) asbestos content, as determined in our laboratory, and (5) warp-grab tensile strength, as received.

Table 2 presents the heat aging test data with the cloths classified by style and by grade within each style. In this tabulation it will be observed that there exists a wide range of properties between materials having the same grade but of different styles and in some cases it will be seen that materials having the same grade and style produced by different manufacturers exhibit marked variations.

The graphic presentation offered in the main body of the report covering this subject is based upon the data set forth in Table 2.

Table I

Sample Number	Style	Grade	Asbestos Content	Tensile Strength As Received Warp-Grab
20	56T12	AAA	98.33	245.2
37	36P10	Und.	82.50	145.8
38	36P10	AAA	96.20	161.2
60	40P10	Comm.	77.90	151.0
61	40P10	Und.	82.93	154.7
70	40P10	Comm.	78.40	155.4
77	38P10	AA	91.03	134.7
79	36P10	Und.	80.00	126.9
81	24P14	Und.	82.20	114.7
82	16P28	Und.	83.17	69.5
86	38P10	Und.	82.77	125.8
87	40P10	Und.	80.73	134.9
88	16P28	Und.	82.47	69.1
91	36P10	Und.	82.43	147.0
92	36P10	AA	93.00	174.2
93	36P10	AAA	96.86	161.4
116	36P10	Comm.	76.52	161.4
117	40P10	Und.	82.03	174.2
124	36P10	Und.	82.20	120.0
125	36P10	AA	92.36	134.0
126	48P10	Comm.	79.22	195.0
127	48P10	AAA	96.63	263.0
128	26P14	Und.	82.57	82.5
129	36P10	AAA	96.03	166.0
130	36P10	AA	91.83	144.0
131	36P10	AAA	97.26	120.0
132	56T8	AAAA	99.03	181.5
133	36P10	Und.	81.36	150.0
134	30P10	AA	92.90	151.0
135	40H14	Comm.	77.92	163.0
136	17P24	Und.	81.95	77.0
137	40H14	Und.	82.46	221.5
138	26P14	Und.	82.10	91.2
139	36P10	Und.	81.25	137.0
140	36P10GS	AA	-----	149.0
141	40P10	Und.	82.10	140.5
142	38P10	AA	94.51	152.0
143	38P10	AA	91.27	140.5
144	26P14	Und.	80.13	80.5
145	16P28	Und.	80.68	61.5
146	36P10	AA	91.44	135.0
147	30P14	A	87.22	169.0
148	36P10GS	AAA	-----	107.0
149	36P10GS	AA	-----	123.0
152	22P10G	Und.	-----	138.0
153	36P10	AA	90.30	109.0
154	36P10	Und.	80.64	130.0

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Table I (Continued)

Sample Number	Style	Grade	Asbestos Content	Tensile Strength As Received Warp-Grab
155	22P10G	Und.	-----	145.0
156	22P16	Und.	82.77	112.0
157	26P14	Und.	82.55	92.0
158	39T12	AA	92.45	204.0
159	22P10G	Und.	-----	162.0
160	36P10	Comm.	73.66	141.0
161	36P10	Und.	31.76	132.0
162	36P10	AA	91.80	127.0
165	26P14	Und.	83.25	103.0
166	36P10GS	AAA	-----	168.0
167	36P10GS	AA	-----	129.0
175	16P24	Und.	82.31	60.5
176	26P14	Und.	81.24	76.1
177	26P14	Und.	82.94	81.4
178	17P24	Und.	83.25	77.9
179	36P10	AA	91.59	130.0
180	36P10	Und.	80.45	142.0
182	36P10	Und.	82.00	114.0
183	26P14	AA	92.21	88.0
184	36P10	AA	91.75	110.5
185	26P14	Und.	81.02	82.6
187	36P10	Comm.	76.67	126.0
190	26P14	AA	92.97	99.0
191	36P10	AAA	96.68	123.0
193	36P10	Comm.	75.47	130.0
196	40P10	Und.	84.95	126.0
198	36P10	AA	93.41	125.0
200	36P10	AA	91.37	102.5
201	36P10	AA	91.54	98.0
202	17P38	Und.	82.15	61.5

Table II

Sample Number	Grade	As Received #	Tensile Strength 400°F #	400°F %Ret.	600°F #	600°F %Ret.	800°F #	800°F %Ret.
Style: 16P24								
175	Und.	60.5	32.3	53.5	22.2	36.7	22.9	37.8
Style: 17P24								
136	Und.	77.0	33.6	43.6	21.6	28.0	21.6	28.0
178	Und.	77.9	31.0	39.8	21.8	28.0	24.4	31.3
Style: 16P28								
82	Und.	69.5	36.0	51.8	30.0	43.1	32.1	46.2
88	Und.	69.1	40.5	58.5	33.2	48.0	34.0	49.[illegible]
145	Und.	61.5	35.4	57.5	23.7	38.4	23.5	38.2
Style: 17P28								
202	Und.	61.5	37.9	61.5	25.6	41.6	29.1	47.3
Style: 26P14								
128	Und.	82.5	26.2	31.7	18.3	22.1	18.1	21.9
138	Und.	91.2	30.8	33.8	22.1	24.2	22.6	24.8
144	Und.	80.5	28.0	34.7	15.6	19.4	19.9	24.7
157	Und.	92.0	52.0	56.5	27.0	29.3	30.6	33.2
165	Und.	103.0	53.5	52.0	41.0	39.8	40.0	38.9
176	Und.	76.1	34.5	45.4	22.0	28.9	23.5	30.3
177	Und.	81.4	28.0	34.4	16.9	20.8	15.8	19.4
185	Und.	82.6	26.4	31.9	17.4	21.1	21.8	26.4
183	AA	88.0	55.2	62.7	46.5	52.8	50.9	57.9
190	AA	99.0	63.2	63.8	60.8	61.5	59.1	59.8
Style: 38P10								
86	Und.	128.5	47.3	37.6	20.2	16.1	22.5	17.9
77	AA	134.7	77.0	57.0	69.1	51.4	69.1	51.4
142	AA	152.0	123.0	81.0	104.5	69.3	118.0	77.5
143	AA	140.5	106.0	75.5	82.0	58.4	94.0	66.2

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Table II (Continued)

Sample Number	Grade	As Received #	Tensile Strength 400°F #	%Ret.	600°F #	%Ret.	800°F #	%Ret.
Style: 36P10								
116 (T)	Comm.	161.4	62.5	38.8	26.9	16.7	34.6	21.4
160	Comm.	141.0	26.0	18.4	8.0	5.7	9.0	6.4
187	Comm.	126.0	17.2	13.7	9.5	7.6	10.4	8.2
193	Comm.	130.0	22.1	17.0	9.0	6.9	13.9	10.7
37	Und.	145.8	33.0	22.6	23.6	16.2	29.8	20.4
79	Und.	126.9	42.0	33.2	25.6	20.2	25.9	20.4
91	Und.	147.0	64.8	44.0	47.0	32.0	52.2	35.5
124	Und.	120.0	39.0	32.5	27.9	23.2	28.0	23.3
133	Und.	150.0	43.9	29.2	36.7	24.4	36.0	24.0
139	Und.	137.0	36.7	26.8	25.8	18.8	24.5	[illegible]
154	Und.	130.0	65.0	50.0	29.0	22.3	27.0	[illegible]
161	Und.	122.0	37.0	30.3	25.5	20.9	25.4	[illegible]
180	Und.	142.0	58.6	41.2	26.1	18.4	27.5	19.4
182	Und.	114.0	27.0	23.6	23.3	20.4	22.1	19.4
92	AA	174.2	129.0	74.0	103.2	59.5	123.0	70.6
125	AA	134.0	78.0	58.0	76.6	57.2	83.5	[illegible]
130	AA	144.0	102.0	71.0	98.1	68.0	104.0	[illegible]
134	AA	151.0	105.0	70.0	97.0	65.0	88.0	[illegible]
146	AA	135.0	95.6	71.0	78.4	58.0	92.1	[illegible]
153	AA	109.0	67.0	61.5	50.0	45.9	52.5	[illegible]
162	AA	127.0	85.9	67.5	70.8	55.7	82.4	[illegible]
179	AA	130.0	99.0	76.2	79.9	61.5	67.5	[illegible]
184	AA	110.5	61.1	55.3	53.6	48.5	53.9	[illegible]
198	AA	125.0	73.1	58.5	67.2	53.7	66.1	[illegible]
200	AA	102.5	57.4	56.0	46.0	44.9	47.8	[illegible]
201	AA	98.0	57.0	58.2	47.0	48.0	50.9	[illegible]
38	AAA	161.2	130.0	80.5	138.0	85.5	134.0	83.1
93	AAA	161.4	146.0	90.5	129.0	80.0	140.0	86.8
129	AAA	166.0	148.0	89.0	151.0	91.0	145.0	87.5
131	AAA	120.0	110.0	91.0	106.0	88.0	85.0	72.0
191	AAA	128.0	93.0	72.5	85.2	66.5	78.4	61.3
Style: 48P10								
126	Comm.	195.0	82.8	42.5	56.2	28.8	53.0	[illegible]
127	AAA	263.0	232.0	88.3	222.0	84.5	248.0	94.4
Style: 56T8								
132	AAAA	181.5	168.0	92.5	166.0	91.0	135.0	74.0

Table II (Continued)

Sample Number	Grade	As Received #	Tensile Strength 400°F #	400°F %Ret.	600°F #	600°F %Ret.	800°F #	800°F %Ret.
Style: 40P10								
60	Comm.	151.0	32.5	21.5	21.9	14.5	27.0	17.8
70	Comm.	155.4	58.0	37.4	33.9	21.8	32.8	21.1
61	Und.	154.7	41.0	26.5	29.3	18.9	33.0	21.4
87	Und.	134.9	46.4	34.4	30.0	22.2	32.5	24.1
117	Und.	174.2	80.6	46.2	52.9	30.3	52.0	29.8
141	Und.	140.5	61.0	43.5	35.0	25.0	31.0	23.0
196	Und.	126.0	38.0	30.1	31.0	24.6	35.8	28.4
Style: 56T12								
20	AAA	245.0	---	---	200.0	81.5	167.0	68.0
Style: 36P10GS								
140	AA	149.0	82.3	55.1	55.5	37.2	55.6	37.3
149	AA	123.0	64.0	52.0	52.9	43.0	58.0	47.1
167	AA	129.0	74.0	57.4	63.0	48.9	69.0	53.5
148	AAA	107.0	77.0	72.0	76.1	71.0	77.0	72.0
166	AAA	162.0	119.0	73.5	106.0	65.5	108.0	66.5
Style: 22P10G								
152	Und.	138.0	103.0	74.6	15.0	10.9	12.0	8.7
155	Und.	145.0	142.0	97.8	16.4	11.3	14.0	9.7
159	Und.	162.0	101.0	62.4	22.0	13.6	21.6	13.3

September 11, 1953

Minutes of the Technical Committee
Asbestos Textile Institute

Essex House, New York, N. Y.
September 9, 1953

Those present: B. L. Carpenter, R. L. Lanz, C. R. Fredericks, Keasbey & Mattison Co.; M. W. Oliver, Raybestos-Manhattan, Inc; J. D. McCluer, Southern Asbestos Co.; E. C. Cutler, American Asbestos Textile Corp.; Dr. M. C. Shaw, Rutgers University; Jacques Tesniere, Societe Anonyme Francaise; A. W. Summers, Union Asbestos Co.; R. Jackson, K. Beyard, J. L. Tucker, Johns-Manville Corp.

Reading of the minutes of the last meeting was eliminated.

A. Dr. M. C. Shaw reviewed his Fellowship Report No. 26 after which the information in the report was discussed. The subjects covered in this report were:

1. The Elevated Temperature Serviceability of Asbestos Cloths
2. The "Significance of Combined versus Magnetic Iron in Chrysotile"

Dr. Shaw's data and charts lead us to believe that compactness of yarn, twist per inch, wet and dry weaving, also how well the fiber is processed had a direct affect on the results he obtained.

B. Cloth Standardization Committee Report--J. D. McCluer, Chairman

Similar samples of AA Grade - 36P10 cloth were forwarded to members of this committee. These samples were tested for tensile strength before and after subjugation to 450F for 24 hr. Results received for this meeting were:

Tested by	Method	Normal Strength Warp	Normal Strength Filling	24 Hr-450F Warp	24 Hr-450F Filling	% Strength Retained Warp	% Strength Retained Filling
Southern	Rack	100.6	56.8	47.0	27.4	46.7	48.2
K & M	Vertical	110.0	52.0	43.0	17.0	39.1	32.7
R & M	Flat	109.0	53.2	45.8	15.4	42.0	28.9
Dr. Shaw	Horizontal	114.0	54.5	54.8	25.2	47.9	46.2
J-M	Flat	120.8	57.0	47.0	20.2	38.80	35.43

After discussion of these results a testing program was outlined, results of which will be discussed at the December meeting.

Dr. Shaw will send the cloth samples to each participant. They will be sealed as much as possible.

J. D. McCluer will send each participant directions on how to test the samples, also on what information is needed in order to compare and evaluate the results.

C. Braid Standardization Committee Report--C. R. Frederick, Chairman

Testing procedures for the evaluation of braid were discussed.

Program for testing of additional braids were outlined. A. W. Summers will forward 4 yd of braid to each of the following, the braid to be 1/16 in. wall thickness, 1/16 in. inside diameter, and 3/16 in. outside diameter:

J. D. McCluer, Southern Asbestos Company
C. R. Fredericks, Keasbey & Mattison
J. L. Tucker, Johns-Manville
A. W. Summers, Union Asbestos
M. W. Oliver, Raybestos-Manhattan

J. L. Tucker to send 4 yd of a 1/16 in. wall thickness, 7/8 in. inside diameter, and 1 in. outside diameter braid to the same members mentioned previously for testing.

Testing is to include:

1. Length measurement, ft per lb, flat and on mandrel
2. Inside diameter measurement check
3. Outside diameter
4. Wall thickness

All results to be forwarded to C. R. Frederick. Information on procedures, difficulties encountered, etc. should be forwarded with results.

C. R. Frederick to circulate resume of tolerances suggested by different companies.

D. Rewriting of Government Specifications

The following specifications were rewritten and discussed:

SS-C-466 MIL-C-4117 MIL-C-10316

Additional changes were made as follows:

SS-C-466 - Class 6, add (no strip)
3.5, Eliminate all words after the second sentence.
4.3.1.3, Eliminate "to constant weight"
6.1.4, Grade AAA not AAAA
6.3.1, Add "Other widths can be supplied."
7.2.2.3, Change "Tape" - Tape shall be wound in rolls of specified length.

MIL-C-10316 - 3.3.2, Eliminate last sentence regarding 27 ends/in.

MIL-C-4117 - 1.2.2, Class 3, 64M10
Class 4, 112M10
3.1.1, This should be worded differently.

There will be a joint meeting of the Sales Promotion and Technical Committees on December 9 at which time these and other specifications will be discussed.

E. Government Specification Committee

This committee was originated in order to obtain advice and cooperation on the rewriting of Government specifications to make these more practical for fulfillment by industry in general.

Members of this committee are:

C. R. Frederick, Chairman
Dr. M. C. Shaw
M. W. Oliver
E. C. Cutler
J. D. McCluer
A. W. Summers
J. L. Tucker

All members of this committee should study and discuss the Government specifications and the recommended changes with management, sales representatives, and all those interested in Government specifications such as these and all others that should be revised.

General

We were glad to have Mr. Jacques Tenniere attend this meeting and hope that he will be able to attend such future meetings.

J. L. Tucker

September 11, 1953

Report of Technical Committee
for the Sept. 9, 1953 General Meeting
Essex House, New York, N. Y.

There were representatives of seven member companies and a total of thirteen who attended the third 1953 Technical Committee meeting. The work of this committee at this meeting and since the June meeting will be reviewed for your approval and comments.

A. Fellowship Report--Dr. M. C. Shaw

Report No. 26 of which you have a copy was discussed at our meeting. This report is a continuation of Report No. 25 issued for the previous meeting of June 10, 1953. It relates specifically to two of our important fellowship projects, namely -

1. Serviceability of asbestos textiles
2. Combined versus magnetic iron in chrysotile

We would like to draw your attention to the "Elevated Temperature Serviceability Chart" which you will find just previous to page 7. This chart, although not complete, can be of considerable value to our Sales Promotion Committee as it is. This chart can be a basis on which you can recommend the various grades of asbestos cloths. In that asbestos cloth characteristics vary with each fabricator, the strength retained after subjugation to 400, 600, and 800F for 24 hr also varied, but the chart shows you the minimum and the maximum strength retention which you can expect.

Dr. Shaw's summary of his work, "Significance of Combined Iron versus Magnetic Iron in Chrysotile", completed since our last meeting on the project, is of importance to all of us. He specifically has found out since our last meeting that the grain size of the impurities has a "marked influence upon the magnetic rating". His results lead us to believe that more thorough opening of the fibers previous to carding, also efficient carding, will minimize the influence upon the magnetic rating. In closing our comments on Dr. Shaw's Fellowship Report, we would like to again draw your attention to the fact that in the previous Report No. 24, he mentioned that the use of card droppings has a "marked influence upon the magnetic rating" of a product.

B. Committee Reports

MS 003666

1. Cloth Standardization Committee--J. D. McCluer, Chairman

As stated previously, the work of this committee is directly connected with the work being carried on by the Fellowship on "Serviceability Temperatures of Asbestos Cloths".

This committee, under the leadership of J. D. McCluer, is now carrying on a series of round-robin check tests. Similar cloth samples are being subjugated to the same temperatures by each member of the committee, and although the results are not identical, the resulting trends are similar.

2. Braid Standardization Committee--C. R. Fredericks

This committee, under the leadership of Mr. C. R. Fredericks, is active accumulating information and data on testing procedures for braid. Round-robin tests are being made relating to flat versus mandrel ft per lb, methods for the measuring of wall thickness, and tolerances for other characteristics requested in various specifications.

3. Tape Standardization Committee

We have not as yet appointed any chairman for this committee.

4. Government Specification Committee

We practically have completed the rewriting or revising of three government specifications: SS-C-466, MIL-C-4117, MIL-C-10316.

We feel that the revised specifications should be first discussed with the Sales Promotion Committee after which we feel a committee made up of representatives of the Sales and Technical Committees should discuss the recommended changes with those government representatives who are directly responsible for the rewriting of specifications.

In order to obtain information and assistance from those who supply asbestos products to government agencies, we have originated a committee which will be responsible for further changes or revisions to be made in these and other government specifications which may be rewritten.

Mr. C. R. Fredericks will head up this subcommittee and will have as his assistants Dr. M. C. Shaw, M. W. Oliver, J. D. McCluer, E. C. Cutler, A. W. Summers, and J. L. Tucker.

It was recommended at our meeting that a joint meeting of the Sales Promotion and Technical Committees take place previous to the next general meeting of December 10 to discuss proposed specification revisions; also for the setting up of a committee that would discuss revisions with governmental agencies.

5. Westinghouse Specifications

Dr. Shaw and C. R. Fredericks have been responsible for contacts with Westinghouse regarding the changes which we feel are necessary in their specification No. 2060-Q

We have been notified that Westinghouse would like us to make our recommendations and the following changes are recommended:

a. The specification now states that 28 cut yarn be used in the fabrication of the cloth designated 2060-2. We recommend that 24 cut yarn replace 28 cut in this specification since 24 cut is actually used in the fabrication of the cloth purchased by this customer.

b. The following tensile strengths before and after subjugation to 300°C for 30 min are recommended:

	As Received		After Heating		Cloth No.
	Warp	Filling	Warp	Filling	A.T.I.
2060-1	75	70	16	14	26P14
2060-2	55	50	15	12	17P24

Westinghouse specifications will be discussed with the Sales Promotion Committee at the next joint meeting.

We were pleased in having Mr. Jacques Tesniere at our meeting and hope that he will continue to attend our meetings whenever possible. We will appreciate his continued interest in our activities and any information on asbestos that he can send us will be appreciated.

We wish to congratulate the Sales Promotion Committee on the publication of the Handbook which they have originated for our industry.

I personally wish to thank every member of the Technical Committee for the grand cooperation they are giving me and for the job they are doing on the subcommittees.

In addition, I extend my thanks to Dr. Shaw for his cooperation and advice.

J. L. Tucker

Federal Specification

Cloth, Yarn, Thread, and Tape; Asbestos

I. CLASSIFICATION

1.1 Types, Grades, and Classes - Asbestos cloth, yarn, thread, and tape covered by this specification shall be of the following types, grades, and classes as specified:

Type I - Cloth
Underwriters' Grade - Not less than 80% asbestos, blue stripe
Class 1 - Style 36P10 - 2.25 lb per sq yd
Class 2 - Style 22P16 - 1.40 lb per sq yd
Class 3 - Style 39T12 - 2.45 lb per sq yd
Class 4 - Style 22BT35- 1.37 lb per sq yd
Class 5 - Style 22P10G- 1.40 lb per sq yd

Grade AA - Not less than 90% asbestos, red stripe
Class 1 - Style 36P10 - 2.25 lb per sq yd
Class 3 - Style 39T12 - 2.45 lb per sq yd

Grade AAA - Not less than 95% asbestos, green stripe
Class 1 - Style 36P10 - 2.25 lb per sq yd
Class 2 - Style 22P16 - 1.40 lb per sq yd
Class 3 - Style 39T12 - 2.45 lb per sq yd
Class 6 - Style 56M10 - 3.50 lb per sq yd

Type II - Yarn, reinforced with wire

MS 003669

Type III - Thread, sewing, without wire

Type IV - Tape
Class 1 - Plain weave

MT-003075

1.2 Sizes - The asbestos cloth, yarn, thread, and tape shall be furnished in the sizes specified (See 6.3).

2. Applicable Specifications
2.1 Specifications - The following federal specification, of the issue in effect on date of invitation for bids, forms a part of this specification:
CCC-T-191--Textiles: General Specifications, Test Methods
2.2 Specifications and other publications applicable only to individual departments are listed in Section 7.

3. REQUIREMENTS
3.1 Material - Asbestos cloth, yarn, thread, and tape shall be made of chrysotile asbestos and organic fiber.
3.1.1 Asbestos - The dry asbestos fiber shall contain not less than 12 per cent by weight of chemically combined water.
3.2 Hygroscopic Moisture - Hygroscopic moisture shall not exceed 5%. (See 4.3.1.2 and 4.3.3.1)
3.3 Type I, Cloth
3.3.1 Fabrication - All cloth shall be woven with plied yarns.
3.3.2 Grade - Underwriters', not less than 80% asbestos, blue stripe.
3.3.2.1 Class I, plain weave, regular weight. The construction shall be 18±1 warp ends by 9±1 picks per inch. The weight shall be 2.25 lb per sq yd, plus or minus 7%. The tensile strength shall meet requirements of Table I. A stripe of blue cotton yarn shall be woven in each selvage edge.

3.3.2.2 Class 2, plain weave, light weight. The construction shall be 19±1 ends by 10±1 picks per inch. The weight shall be 1.40 lb per sq yd, plus or minus 7%. The tensile strength shall meet the requirements of Table I. A stripe of blue cotton yarn shall be woven in each selvage edge.

3.3.2.3 Class 3, twill weave. The construction shall be 27±1 ends by 9±1 picks per inch. The weave shall be 1 up and 2 down twill. The weight shall be 2.45 lb per sq yd, plus or minus 7%. The tensile strength shall meet the requirements of Table I. A stripe of blue cotton shall be woven in each selvage edge.

3.3.2.4 Class 4, broken twill weave. The construction shall be 30±2 ends by 28±2 picks per inch. The weave shall be 1 up and 3 down twill. The weight shall be 1.37 lb per sq yd, plus or minus 7%. The tensile strength shall meet the requirements in Table I. A stripe of blue cotton yarn shall be woven in each selvage edge.

3.3.2.5 Class 5, combination asbestos and glass, plain weave. The construction shall be 18±1 ends by 9±1 picks per inch. The yarn shall be 2 ply, composed of one 10 cut asbestos yarn containing not less than 80% asbestos, and one continuous filament glass yarn (225-3/2 or its equivalent). The weight shall be 1.40 lb per sq yd, plus or minus 7%. The tensile strength shall meet the requirements of Table I. A stripe of blue cotton yarn shall be woven in each selvage edge.

3.3.3 Grade AA, not less than 90% asbestos, red stripe.

3.3.3.1 Class 1, plain weave. The construction shall be 18±1 ends by 9±1 picks per inch. The weight shall be 2.25 lb per sq yd, plus or minus 7%. The tensile strength shall meet the requirements of table I. A stripe of red cotton yarn shall be woven in each edge.

3.3.3.2 Class 3, twill weave. The construction shall be 27±1 ends by 9±1 picks per inch. The weight shall be 2.45 lb per sq yd, plus or minus 7%. The tensile strength shall meet the requirements in Table I. A stripe of red cotton yarn shall be woven in each selvage edge.

3.3.4 Grade AAA, not less than 95% asbestos, green stripe.

3.3.4.1 Class 1, plain weave. The construction shall be 18±1 ends by 9±1 picks per inch. The weight shall be 2.25 lb per sq yd, plus or minus 7%. The tensile strength shall meet the requirements of Table I. A stripe of green cotton yarn shall be woven in each edge.

3.3.4.2 Class 2, plain weave. The construction shall be 19±1 ends by 10± 1 picks per inch. The weight shall be 1.40 lb per sq yd, plus or minus 7%. The tensile strength shall meet requirements of Table I. A stripe of green cotton yarn shall be woven in each selvage edge.

3.3.4.3 Class 3, twill weave. The construction shall be 27±1 ends by 9±1 picks per inch. The weight shall be 2.45 lb per sq yd, plus or minus 7%. The tensile strength shall meet the requirements of Table I. A stripe of green cotton yarn shall be woven in each selvage edge.

3.3.4.4 Class 6, plain weave, wire inserted. The cloth shall contain not less than 95% asbestos, exclusive of the wire insertion. The construction shall be 18±1 ends by 9±1 picks per inch. The warp and filling yarns shall be two strands of asbestos yarn combined with two strands of nickel-copper wire. The wire shall contain a minimum of 58% nickel and shall be 0.008±0.001 inch in diameter. The weight shall be 3.50 lb per sq yd plus or minus 7%. A stripe of green cotton yarn shall be woven in each selvage edge.

Table I

Breaking Strength of Asbestos Cloth,
Minimum by Grab Test Method

Style	Wt/sq yd		As Received		After heating to 200F	
			Warp	Filling	Warp	Filling
		Grade - Underwriters				
36P10	2.25	Class 1	90	37	75	30
22P16	1.40	Class 2	75	35	60	30
38T12	2.40	Class 3	100	35	90	30
22BT38	1.37	Class 4	80	60	60	55
22P10G	1.40	Class 5	90	65	80	60
		Grade - AA				
36P10	2.25	Class 1	100	35	80	30
38T12	2.40	Class 3	100	35	95	30
		Grade - AAA				
36P10	2.25	Class 1	110	45	105	40
22P16	1.40	Class 2	80	35	75	30
38T12	2.40	Class 3	110	45	105	40
56M10	3.50	Class 6	—	—	—	—

3.3.5 Tolerances in Width. A tolerance of plus or minus 1/2 inch will be permitted in the specified width of cloth.

3.4 Type II, yarn reinforced with wire. The strands shall be composed of three nickel-copper wires, each of which shall have asbestos yarns spun around it, twisted together to definitely interlock the asbestos and wire. The yarn shall be 10 cut and shall contain not less than 95% asbestos. The wire insertion shall contain not less than 58% nickel and shall be 0.008±0.001 inch in diameter.

3.5 Type III, thread, sewing, without wire. The thread shall be made from yarn not heavier than 10 cut two ply and shall contain not less than 75% asbestos. One pound of the thread shall provide not less than 450 yd. The tensile strength shall be not less than 8 lb when tested as described in 4.3.2.

3.6 Type IV, tape.

3.6.1 Class 1, plain weave. The tape shall contain not less than 80% asbestos. The construction shall be 16±1 ends by 8±1 picks per inch. The warp yarn shall be 10 cut three ply and the filling shall be 10 cut two ply. The tape shall be a plain weave with woven selvage edges.

3.6.2 Tolerances in width. (No changes)

3.7 Workmanship. (No changes)

4. SAMPLING, INSPECTION, and TEST PROCEDURES (No changes)

4.1 Sampling (No changes)

4.1.1 Cloth (No changes)

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4.1.2 Yarn and thread (No changes)

4.1.3 Tape (No changes)

4.2 Inspection (No changes)

4.3 Tests (No changes)

MT-003077

4.3.1 Cloth (No changes)

4.3.1.1 Preparation of specimens (No changes)

4.3.1.2 Hygroscopic moisture. Five test specimens, each weighing not less than five grams, shall be weighed and then dried for one hour at 105 to 110C (221 to 230F) in an electric oven, cool in desiccator for one hour, and weigh. The loss in weight is termed the hygroscopic moisture. This weight divided by the weight of the sample and multiplied by 100 gives the percentage of hygroscopic moisture in the specimens.

4.3.1.3 Asbestos content. Five test specimens, each weighing not less than five grams, after drying for 1 hr at 105 to 110C (221 to 230F) shall be placed in a desiccator for 1 hr, again weighed, then shall be placed in a furnace and heated for not less than 1 hr at 800 to 810C (1470 to 1490F). After removal from furnace, they shall be cooled for 1 hr in a desiccator and then again weighed. The weight of the residue shall be divided by 0.86* to determine the original weight of the asbestos content. The weight of the asbestos content shall be divided by the weight of the dried specimen and the quotient multiplied by 100 to obtain the percentage of asbestos. The average of five determinations shall be taken as the asbestos content. The percentage of organic matter equals 100 minus the percentage of asbestos.

4.3.1.4 Chemically combined water. When specified certified samples of well-opened asbestos fiber of the type used in the manufacture of the asbestos cloth shall be supplied to the inspector to make determinations of chemically combined water. This test shall be made on five samples each weighing approximately five grams. The hygroscopic moisture shall be removed as specified in 4.3.1.2, the weight recorded, and the dried material ignited in an electric furnace at 800 to 810C (1470 to 1490F) for 1 hr. The difference between the dried weight and the residual weight of the ignited specimen, divided by the dried weight of the specimen and multiplied by 100, gives the percentage of chemically combined water in the asbestos fiber.

4.3.1.5 Breaking strength, cloth (No changes)

4.3.1.6 Cloth construction (No changes)

4.3.1.7 Weight (No changes)

4.3.2 Thread (No changes)

4.3.2.1 Breaking strength, thread (No changes)

4.3.3 Tape (No changes)

4.3.3.1 Hygroscopic moisture, etc. (No changes)

4.3.3.2 Tape construction, number of ends and picks in woven tape. (See federal spec. CCC-T-191, Section XI, cloth constructions) The total number of ends shall be determined by counting the warp yarns in the full width of the tape. When possible, in determining the ends per inch, start the count one-quarter inch in from selvage and divide this number by the width over which the count was made. The number of picks per inch shall be the average of the count made in three 5-inch lengths taken from each end and the middle of a 24-in. sample.

5. PREPARATION FOR DELIVERY (No changes)

MS 003672

5.1 Packaging (No changes)

5.2 Packing (No changes)

MT-003078

5.3 Marking (No changes)

6. NOTES (No changes)

6.1 Intended Use (No changes)

6.1.1 Type I, Grade Underwriters' cloth and Type IV tape are intended for use as the jacketing material, etc.

6.1.2 Type I, Grade AA cloth is intended, etc.

6.1.3 Type I, Grade AAA cloth, Class 6 is intended for same purpose as Type I, Grade AA cloth, but where metal in contact is more than 315C (600F).

6.1.4 Type I, Grade AAA cloth, Classes 1, 2, and 3 is intended for same conditions as Type I, Grade AAA cloth, Class 6 but where a more flexible cloth is desired.

6.2 Ordering Data (No changes)

6.3 Commercial Sizes (No changes)

6.3.1 Cloth - Asbestos cloth is normally available in a width of 40 inches. It is commonly supplied in rolls of 50 yards, plus or minus five yards, and can be supplied in rolls of 25 and 100 yards. Ten per cent of the total number of rolls may contain two pieces.

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*The value obtained in Section 4.3.1.4, chemically combined water, subtracted from 100 should yield the proper factor for determination. The factor 0.86 is based upon an average theoretical value of 14% chemically combined water.

ATI-81

December, 1953

MIL-C-10316 (ORD)

Military Specification

CLOTH, ASBESTOS: FOR THERMAL INSULATION
ON MILITARY VEHICLES

1 CLASSIFICATION (No changes)
1.1 Types (No changes)
1.2 Grades - Asbestos cloths shall be of the following grades as specified (see 6.2):

Grade - Underwriters'	-- Not less than 80% asbestos
Grade - AA	-- Not less than 90% asbestos
Grade - AAA	-- Not less than 95% asbestos
Grade - AAAA	-- Not less than 98% asbestos

1.3 Weights (No changes)
2 APPLICABLE SPECIFICATIONS AND DRAWINGS (No changes)
2.1 Specifications (No changes)
2.2 Drawings (No changes)
3 REQUIREMENTS (No changes)
3.1 Materials (No changes)
3.1.1 Type I without wire insertion. The Type I asbestos cloth shall be made of chrysotile asbestos yarn.
3.1.2 Type II wire insertion (No changes)
3.2 Construction. Warp and filling of the asbestos cloth shall be in accordance with Tables I and II, as determined in accordance with the cloth construction requirements of Spec. CCC-T-191. The number of ends and picks shall not vary more than plus or minus one from the nominal values shown in tables.
3.2.1 Asbestos content (No changes)
3.2.2 Weave. Plain weave cloth shall have warp threads passed alternately over and under the filling picks. Twill weave cloth shall be one up and two down in the warp and filling respectively.
3.2.3 Weight. The nominal weight of the asbestos cloth shall be as shown in Tables I and II, with a tolerance of not more than plus or minus 7%, when determined by Spec. CCC-T-191
3.2.4 Dimensions (No changes)
3.2.4.1 Width. The width of the asbestos cloth shall be 40 inches, plus or minus 1/2 in., unless otherwise specified (see 6.3).
3.2.4.2 Thickness. The thickness of the asbestos cloth shall not vary, from the specified values in Table I and II, by more than the following:

MS 003673

MT-003079

Nominal Thickness	Permissable Variation
Inches	
0.050 and under	±0.005
over 0.050	+0.010, -0.005

3.2.4.2 Length. Unless otherwise specified, the asbestos cloth shall be furnished in rolls in length of 50 lin yd, ± 5 yd (see 6.3).
3.3 Physical Properties (No changes)
3.3.1 Hygroscopic Moisture (No changes)
3.3.2 Chemically combined water. The carded asbestos fiber used in the manufacture of the asbestos cloth shall contain not less than 12% by weight, of the chemically combined water, when tested in accordance with 4.3.4.
3.3.3 Breaking Strength. When tested in accordance with 4.3.5, the average breaking strength of Type I (without wire insertion) asbestos cloth shall not fall below the values specified in Table III.

3.4 Identification. Unless otherwise specified, a colored stripe shall be woven in each selvage edge of the cloth, as follows:

Grade - Underwriters	-	Blue
Grade - AA	-	Red
Grade - AAA	-	Green

3.5 Workmanship (No changes)

4 SAMPLING, INSPECTION, AND TEST PROCEDURES

4.1 Sampling (No changes)

4.2 Inspection (No changes)

4.3 Tests (No changes)

4.3.1 Preparation of Sample. Discard 4 in. of each selvage edge and cut 10 test specimens 4 in. wide by 6 in. long, the long dimension being parallel to the warp, so that each specimen will represent different strands of work yarn. Cut 10 additional specimens 4 in. wide by 6 in. long, the long dimension being parallel to the filling so that each specimen will represent different strands of filling yarn.

4.3.2 Asbestos content. Five test specimens, each weighing not less than five grams, after drying for one hour at 105 to 110°C (221 to 230°F) shall be placed in a desiccator for one hour, again weighed, then shall be placed in a furnace and heated for not less than one hour at 800 to 810°C (1470 to 1490°F). After removal from furnace, they shall be cooled for one hour in a desiccator and then again weighed. The weight of the residue shall be divided by 0.86* to determine the original weight of the asbestos content. The weight of the asbestos content shall be divided by the weight of the dried specimen and the quotient multiplied by 100 to obtain the percentage of asbestos. The average of five determinations shall be taken as the asbestos content. The percentage of organic matter equals 100 minus the percentage of asbesto

4.3.3 Hygroscopic moisture. Five test specimens each weighing not less than five grams shall be weighed and then dried for one hour at 105 to 110°C (221 to 230°F) in an electric oven, cool in desiccator for one hour and weigh. The loss in weight is termed the hygroscopic moisture. This weight divided by the weight of the sample and multiplied by 100 gives the percentage of hygroscopic moisture in the specimens.

4.3.4 Chemically-combined water. When specified certified samples of well-opened asbostos fiber of the type used in the manufacture of the asbestos cloth shall be supplied to the inspector to make determinations of chemically combined water. This test shall be made on five samples each weighing approximately five grams. The hygroscopic moisture shall be removed as specified in 4.3.3, the weight recorded, and the dried material ignited in an electric furnace at 800 to 810°C (1470 to 1490°F) for one hour. The difference between the dried weight and the residual weight of the ignited specimen, divided by the dried weight of the specimen and multiplied by 100, gives the percentage of chemically-combined water in the asbestos fiber.

*Note. The factor obtained in Section 4.3.2. Chemically-combined water subtracted from 100 should yield the proper factor for determination. The factor 0.86 is based upon an average theoretical value of 14 per cent chemically-combined water.

4.3.5 Breaking strength. (No changes)

4.3.5.1 As received. (No changes)

4.3.5.2 After heating. The test to determine breaking strength after heating shall be made with five warb and five filling specimens. These shall be supported on a wire screen or perforated metal plate not less than 1/2 in. above the floor of an oven with automatic temperature control, and with not more than five specimens superimposed upon one another. A thermo-couple shall be centrally located in the oven, not more than 1/2 in. above the topmost specimen. After being introduced into the oven at the appropriate heating temperature (See Table III), the specimen shall remain in the oven for one hour at such temperature, then shall be removed and allowed to cool in a desiccator for one hour. They shall then be tested for breaking strength and the average values determined separately for the warp and filling specimens, by the methods used for the "as received" specimens (see 4.3.5.1).

5 PREPARATION FOR DELIVERY (No changes)

5.1 Packaging and Packing. The asbestos cloth shall be packaged in rolls covered with kraft paper. The paper shall be covered with waterproof-barrier material in accordance with Spec. JAN-P-125, Type B-2, and overwrapped with suitable cloth, flat or tubing. The baling material shall be securely fastened at the ends, the longitudinal edges fully sewn or secured, and held in position by wire straps around circumference of the roll.

5.2 Marking (No changes)

6 NOTES (No changes)

6.1 Intended Use. The asbestos cloth covered by this specification is intended for use as a thermal insulation on exhaust or on other high-temperature applications on military vehicles. The Type I cloth is suitable for installations where a covering resistant to heat and chemicals is required; and the Type II cloth, where additional strength and wearing resisting qualities are essential. As a rule, the cloth will withstand the following temperatures (of contacted or adjacent metals) for the following grades indicated:

Grade	Temperature, °F
Underwriters'	450
AA	650
AAA	800

6.2 Ordering Data (No changes)

6.3 Standard Width and Length. Asbestos cloth is normally available in a width of 40 in. It is commonly supplied in rolls of 50 yd, plus or minus 5 yd, and can be supplied in rolls of 25 and 100 yd. Ten per cent of the total number of rolls may contain two pieces.

NOTICE (No changes)

Table I

Physical Properties of Type I (without wire insertion) Asbestos Cloth

Grade (see 1.2)	Weave	Nom. Wt Lb per Sq yd	Thick.	Warp Yarn (1)	Filler Yarn (1)	Warp Ends/ in.	Filling picks/ in.	A.T.I. Desig.
Und.	P	1.50	.055	10-2	10-2	9	9	24P10
"	P	1.80	.058	14-2	14-2	20	10	29P14
"	P	1.80	.060	10-2	10-1	16	10	29P10
"	P	2.25	.070	10-2	10-2	18	9	36P10
"	P	2.50	.075	10-2	10-2	20	10	40P10
"	BT	2.50	.070	14-2	14-2	27	14	40BT14
"	DC	4.75	.135	10-2	10-2	37	16	76P10DC
AA	P	1.40	.051	16-2	16-2	19	10	22P16
"	P	1.80	.058	14-2	14-2	20	10	29P14
"	P	2.25	.070	10-2	10-2	18	9	36P10
"	P	2.50	.075	10-2	10-2	20	10	40P10
AAA	P	2.10	.062	10-2	10-2	16	9	34P10
"	P	2.40	.065	12-2	12-2	20	12	38P12
"	T	3.00	.075	12-2	12-2	30	10	48T12
"	T	3.33	.080	12-2	12-2	36	12	53T12
"	T	3.50	.085	8-2	8-2	24	7	56T8

Table II

Physical Properties of Type II (wire insertion)
Asbestos Cloth

A.T.I. Desig.	Asbestos Content (Min)	Nom. Wt Lb per Sq yd	Warp Yarn (1)	Filling Yarn (1)	Warp ends per inch	Filling Picks/in.
48M10	90	3.00	10-2-1	10-2-1	20 ± 1	10 ± 1
44M14	90	2.75	14-2-1	14-2-1	20 ± 1	10 ± 1
44M8	95	2.75	8-2-2	8-1-1	14 ± 1	11 ± 1
43M8	98	2.70	8-2-2	8-1-1	14 ± 1	11 ± 1

NOTE (1) - First figure signifies number of cut, second figure -- number of plies, and third figure -- number of wires.

Table III

Minimum Breaking Strength, Lb/In. Width, for Type I
(without wire insertion) Asbestos Cloth

Grade (see 1.2)	Nom. Wt Lb per Sq yd.	As Received		After heating for 1 Hr			A.T.I. Desig.
		Warp	Filling	Warp	Filling	Heating Temp. °F	
Und.	1.50	45	37	35	30	350	24P10
"	1.80	90	35	60	25	"	29P14
"	1.80	80	25	50	15	"	29P10
"	2.25	90	37	65	25	"	36P10
"	2.50	100	40	70	30	"	40P10
"	2.50	130	45	80	35	"	40BT14
"	4.75	180	80	110	50	"	76P10G
AA	1.40	80	35	25	10	600	22P16
"	1.80	85	35	30	10	"	29P14
"	2.25	100	35	60	25	"	36P10
"	2.50	110	45	65	30	"	40P10
AAA	2.10	85	33	60	25	850	34P10
"	2.40	100	50	70	30	"	38P12
"	3.00	170	50	125	35	"	48T12
"	3.33	180	55	130	40	"	53T12
"	3.50	160	40	120	30	"	56T8

MIL-M-01199A
December 30, 1953

Military Specification
Mittens, Asbestos, M-1942

1. SCOPE (No changes)
1.1 Scope (No changes)
1.2 Classification (No changes)

2. APPLICABLE SPECIFICATIONS, STANDARDS, DRAWINGS, AND PUBLICATIONS (No changes)
2.1 The following, etc. (No changes)

SPECIFICATIONS (No changes)
Federal (No changes)
Military (No changes)

STANDARDS (No changes)
Military (No changes)

DRAWINGS (No changes)
Quartermaster Corps (No changes)

3. REQUIREMENTS (No changes)
3.1 Standard sample (No changes)
3.2 Preproduction sample (No changes)
3.3 Material (No changes)
3.3.1 Fabrics (No changes)

Table I. - Physical Requirements

Style	Weight per sq. yard (lb)	Yarn size (cut system)		Cloth Construction (per in.)		Breaking strength (lb) (grab method)	
		Warp	Filling	Warp Ends	Filling Picks	Warp	Filling
40P10	2.5±7%	10 cut/2 ply	10 cut/2 ply	20± 1	10±1	100	40

3.3.1.2 Duck (No changes)
3.3.1.3 Knitted napped interlining (No changes)
3.3.1.4 Webbing, cotton (No changes)
3.3.2 Thread, cotton (No changes)
3.3.3 Rings, etc. (No changes)
3.4 Design (No changes)
3.5 Patterns (No changes)
3.6 Stitches, seams and stitching (No changes)
3.7 Operations (No changes)
3.8 Identification marking (No changes)
3.8 (Change to 3.9; then when changed will be:
3.9 Workmanship (Insert details, as is, regarding Workmanship)

Table II. - Sequence of Operations
(No changes)

4. SAMPLING, INSPECTION, AND TEST PROCEDURES (No changes)
4.1 Sampling (No changes)
4.2 Inspection (No changes)
4.3 Tests (No changes)

Table I

Asbestos Cloth

Properties	Type I	Type II	Type III	Type IV
Style	40P10	44M8	64M10	112M10
Color stripe selvage	Black	Black	Green	Green
Weave	Plain	Plain	Plain	Plain
Thread Count, inch				
Ground warp ends	20±1	14±1	22±1	28±1
Binder warp ends	None	None	None	7±1
Filling	10±1	10±1	11±1	12±1
Width, inch	40±1/2	40±1/2	40±1/2	40±1/2
Thickness, inch	.075 (+.010 (-.005	.064 (+.010 (-.005	.093 (+.010 (-.005	.135 (+.010 (-.005
Ply of yarns, min				
Ground warp ends	2	2	2	2
Binder warp ends	None	None	None	2
Filling	2	1	2	2
Weight, lb/sq yd	2.50±7%	2.75±7%	4.0±5%	7.0±5%
Breaking strength, min.lb/in.				
As received:				
Warp	100	--	--	--
Filling	40	--	--	--
After heating at 200F				
Warp	80	--	--	--
Filling	30	--	--	--
Grade	Commercial	Commercial	AAA	AAA
Asbestos fiber content % min	75	75	95	95
Ply of wire insert				
Ground warp	None	2	2	2
Binder warp	None	None	None	2
Filling	None	1	2	2
Wire diameter, in single	None	.008±.001	.008±.001	.008±.001

Table II

Asbestos Tape

	Type V	Type VI	Type VII	Type VIII	Type IX	Type X
Weave	Plain	Plain	see Fig. 1	see Fig. 1	see Fig. 1	Plain
Width, in.	1-1/2±1/16	1-1/2±1/16	3±1/8	2±1/8	5/8±1/16	1-1/2±1/16
Thickness, in.	1/16±.010	1/16±.010	$1/8^{+.063}_{-0}$	$1/8^{+.063}_{-0}$	1/8±.032	1/16±.010
Construction:						
Total ground warp ends	32±1	30±1	91±3	63±1	23±1	30±1
Total binder warp ends	None	None	21	15	5	None
Picks (in.)	10±1/2	7-1/2±1/2	11±1/2	11±1/2	11±1/2	8±1/2
Ply of yarns:						
Ground warp ends	2	*2	2	2	3	2
Binder warp ends	None	None	2	2	3	None
Filling	2	2	2	2	2	1
Weight (ft/lb)	28±10%	26±10%	3.5±10%	5.8±10%	11.5±10%	22±10%
Grade	A	A	A	B	B	A
Asbestos fiber content per cent min	75	75	75	75	75	75
rly of wire insertion:						
Ground warp yarn	None	None	2	2	None	2
Binder warp yarn	None	None	2	2	None	None
Filling yarn	None	None	2	2	None	1
Wire diameter (in.) single	None	None	.008±.001	.008±.001	None	.008±.001

* or as specified

Figure 1
(No change)

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Table III

Asbestos Tape

	Type XI	Type XII	Type XIII	Type XIV	Type XV	Type XVI
Weave	Plain	Plain	Plain	Plain	Plain	Plain
Width, in.	2±1/16	1-1/2±1/16	5/8±1/16	1-1/2±1/16	2±1/16	3±1/16
Thickness, in.	1/16 (+.031 (-.016	1/16 (+.031 (-.016	1/8±.031	1/8±.031	1/8±.031	1/8±.031
Construction:						
Total ground warp ends	40±2	32±1	23±1	47±2	61±2	87±2
Total binder warp ends	None	None	5	11	14	21
Picks (in.)	8±1/2	10±1/2	12±1	12±1	12±1	12±1
Ply of yarns:						
Ground warp ends	2	2	2	2	2	2
Binder warp ends	None	None	2	2	2	2
Filling	1	1	2	2	2	2
Weight (ft/lb)	17±10%	19.6±10%	20±10%	9.4±10%	7.2±10%	4.85±10%
Grade	Commercial	AAA	AAA	AAA	AAA	AAA
Asbestos fiber content per cent min	75	95	95	95	95	95
Ply of wire insertion:						
Ground warp yarn	2	2	*2	2	2	2
Binder warp yarn	None	None	2	2	2	2
Filling yarn	1	2	2	2	2	2
Wire diameter (in.) single	.008±.001	.008±.001	.008±.001	.008±.001	.008±.001	.008±.001

* or as specified

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Table IV
Asbestos Tape

	Type XVII	Type XVIII	Type XIX	Type XX	Type XXI
Weave	Plain	Plain	Plain	Plain	Plain
Width, in.	1-1/2±1/10	5/8±1/16	1-1/2±1/16	2±1/16	3±1/16
Thickness, in.	1/16 (+.031 (-.016	1/8±.031	1/8±.031	1/8±.031	1/8±.031
Construction:					
Total ground warp ends	34±1	23±1	45±2	61±2	87±2
Total binder warp ends	None	5	10	14	21
Filling	10±1/2	12±1	12±1	12±1	12±1
Ply of yarns:					
Ground warp ends	2	3	3	3	3
Binder warp ends	None	3	3	3	3
Filling	2	3	3	3	3
Weight (ft/lb)	28.0±10%	19.6±10%	9.6±10%	7.0±10%	4.83±10%
Grade	AAA	AAA	AAA	AAA	AAA
Asbestos fiber content (per cent min.)	95	95	95	95	95

4.3 Sampling (No change)
4.3.1 Cloth (No change)
4.3.2 Tape (No change)
4.4 Test Conditions (No change)
4.5 Test Procedure (No change)
4.6 Physical Tests
4.6.1 Breaking strength for cloth (No change)
4.6.1.1 Preparation of cloth samples (No change)
4.6.1.2 Test procedure
4.6.1.2.1 In order to prevent, etc. (No change)
4.6.1.3 Breaking strength after heating (No change)
4.6.1.3.1 Specimens shall be, etc. (No change)
4.6.2 Tape construction (No change)

4.6.3 Asbestos content - Five test specimens, each weighing not less than five grams, after drying for one hour at 105 to 110°C, shall be placed in a desiccator for one hour, again weighed, then shall be placed in a furnace and heated for not less than one hour at 800 to 810°C (1470 to 1490F). After removal from the furnace, they shall be cooled for one hour in a desiccator and then weighed. The weight of the residue shall be divided by 0.86* to determine the original weight of the asbestos content. The weight of the asbestos content shall be divided by the weight of the dried specimen and the quotient multiplied by 100 to obtain the percentage of asbestos. The average of five determinations shall be taken as the asbestos content.

4.6.4 Chemically combined water - When specified certified samples of well-opened asbestos fiber of the type used in the manufacture of the asbestos cloth or tape shall be supplied for determinations of chemically combined water. This test shall be made on five samples each weighing not less than five grams. The hygroscopic moisture shall be removed as specified in 4.6.3, the weight recorded, and the dried material ignited in an electric furnace at 800 to 810C (1470 to 1490F) for one hour. The difference between the dried weight and the residual weight of the ignited specimen, divided by the dried weight of the specimen and multiplied by 100, gives the percentage of chemically combined water in the asbestos fiber. The percentage of organic matter equals 100 minus the percentage of asbestos.

4.7 Rejections and Retests (No change)
4.8 All samples of asbestos, etc. (No change)
5. PREPARATION FOR DELIVERY (No change)
5.1 Application of requirements, etc. (No change)
5.2 Cloth (No change)
5.3 Tape (No change)
5.3.1 Unit packaging (No change)
5.3.2 Intermediate packaging (No change)
5.3.3 Exterior packing and marking (No change)
5.3.3.1 Exterior packing (No change)
5.3.3.1.1 Domestic packing (No change)

*Note: The factor obtained in 4.6.3, Chemically combined water 4.6.4 subtracted from 100 should yield the proper factor for determination. The factor 0.86 is based upon an average theoretical value of 14 per cent chemically-combined water.

5.3.3.2 Marking (No change)
5.3.3.2.1 Intermediate packages (No change)
5.4 Exterior containers (No change)
6. NOTES (No change)
6.1 Intended Use (No change)
6.2 Ordering Data (No change)
6.3 Commercial sizes (No change)
6.3.1 Cloth - Asbestos cloth is normally available in 40-in. width. Unless otherwise specified, the cloth shall be furnished in rolls in lengths of 50 yd, plus or minus five yards, and can be supplied in rolls of 25 and 100 yd. Ten per cent of the total number of rolls may contain two pieces.
6.3.2 Tape - Asbestos tape is normally supplied in approximately 100 ft rolls and in widths of 5/8, 1, 1-1/4, 1-1/2, 2, 2-1/2, and 3 inches. Tape can be supplied in other lengths when so specified.

J.L.T.

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Minutes of the Technical Committee
Asbestos Textile Institute
Warwick Hotel - Philadelphia, Pennsylvania
December 9th and 10th, 1953. Meetings

December 9th Meeting

Present:	B. L. Carpenter) R. L. Lanz) C. R. Frederick)	Keasbey & Mattison
	A. W. Summers	Union Asbestos
	Dr. M. S. Maier) M. W. Oliver)	Raybestos-Manhattan
	Dr. M. C. Shaw	Rutgers University
	E. C. Cutler	American Asbestos
	J. D. McCluer	Southern Asbestos
	K. Beyard) J. L. Tucker)	Johns-Manville

A. It was suggested, due to the long agenda, that the reading of the minutes of the previous meeting be eliminated.

B. Government Specifications - C. R. Frederick, Chairman

Five Government specifications were discussed and revisions made previous to being presented to a joint meeting of the Sales Promotion and Technical Committees. The specifications were:

1 - SS-C-466
2 - MIL-C-4117
3 - MIL-C-10316
4 - MIL-M-11199A
5 - MIL-I-3053A

C. Cloth Standardization Committee - J. D. McCluer, Chairman

Results of the round-robin heat aging tests showed a wide variation in the original tensile strengths of each sample within the lots sent to each participant. The averages of these lots were fairly consistant, but the extremes in the individual lots were trememdous.

It was recommended that the round robin investigations be continued but that the number of samples in each lot be increased.

D. Braid Standardization Committee - C. R. Frederick, Chairman

The results of the round robin investigations relating to (1) methods of measuring feet per pound, and (2) methods of measuring wall thickness emphasized what had previously been dismissed in a general way, that:

a - results varied with the individual
b - previous testing procedures either are not the most practical or are not interpreted correctly.

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E. Joint Meeting of Sales Promotion and Technical Committees

Technical Committees

1 - The five Government specifications revised by the Technical Committee were discussed, additional revisions were recommended by the Sales Promotion Committee. The specification as revised will be typed and circulated to members of both committees for discussion at the next committee meetings.

2 - Asbestos Cloths for A.S.T.M. Standardization

Fifteen cloths were recommended for use in A.S.T.M. standards. They are:

	lb/sq yd	ATI Style No.	Type
1 -	1.05	17P24	Plain (non-metallic)
2 -	1.25	20P28	" " "
3 -	1.40	22P16	" " "
4 -	1.50	24P18	" " "
5 -	1.65	26P14	" " "
6 -	2.10	34P10	" " "
7 -	2.25	36P10	" " "
8 -	2.40	38P12	" " "
9 -	2.45	39P12	" " "
10 -	2.50	40P10	" " "
11 -	3.00	48P10	" " "
12 -	4.75	76P10DC	" " "
13 -	2.50	40H14	herringbone " "
14 -	3.33	53T12	twill " "
15 -	3.70	59T12	twill " "

3 - Specifications Relating to Dielectric Standards and Procedures

It was recommended that C. R. Frederick contact and discuss with J. Chilcote of Washington, D. C.

a - the value of present dielectric standards and procedures
b - possible elimination of dielectric standards, procedures, and their results

4 - Additional Government Specifications to be Studied With the Possibility of Revision

a - MIL-G-15902 - Bureau of Medicine
b - LP-406 - Dielectric Strength

December 10th Meeting

Present:	M. W. Oliver	Raybestos-Manhattan
	E. C. Cutler	American Asbestos
	C. R. Frederick	Keasbey & Mattison
	J. D. McCluer	Southern Asbestos
	A. W. Summers	Union Asbestos
	Dr. M. C. Shaw	Rutgers University
	J. L. Tucker	Johns-Manville

The following programs were recommended and the results will be accumulated and prepared for discussion at the first 1954 meeting of the Technical Committee:

A - Cloth Standardization - J. D. McCluer, Chairman

Additional samples of cloth, warp direction only, will be forwarded to all members active in the round robin testing program. Mr. McCluer will forward the procedures to all concerned. Dr. Shaw will forward the cloth samples.

B - Braid Standardization - C. R. Frederick, Chairman

Additional samples will be forwarded to each participant in the round robin testing program. Samples will be the responsibility of Messrs. Summers and Tucker. The methods and procedures will be sent to those concerned by C. R. Frederick.

J. L. Tucker

Report of the Technical Committee
December 10th, 1953 - General Meeting
Warwick Hotel, Philadelphia, Pennsylvania

Representatives of seven member companies attended the December 9th and 10th meetings of the Technical Committee.

A - Revising government specifications

Practically all of the December 10th session was spent in revising five government specifications; namely:

1 - SS-C-466
2 - MIL-C-4117
3 - MIL-C-10316
4 - MIL-M-11199A
5 - MIL-I-3053A

B - Sales Promotion and Technical Committee - Joint Meeting

1 - Government Specifications

The five government specifications which were revised by the Technical Committee were presented during a joint meeting to the Sales Promotion Committee. Additional revisions were requested. Four of these specifications will be rewritten and presented for final approval at the next general meeting.

2 - Specifications Relating to Dielectric Standards and Procedures

During the joint session it was recommended that C. R. Frederick contact and discuss with J. Chilcote of Washington, D. C. the value of the results obtained under present standards and procedures, also the possibilities of eliminating these procedures and results from government specifications.

3 - A.S.T.M. Standardization of Asbestos Cloths

At the request of the A.S.T.M. Committee the Sales Promotion and Technical Committees of our Institute have recommended 15 asbestos cloths for standardization in A.S.T.M. specifications. These cloths are:

lb/sq yd	ATI Style No.	Type		
1 - 1.05	17P24	plain	(non-	metallic)
2 - 1.25	20P28	"	"	"
3 - 1.40	22P16	"	"	"
4 - 1.50	24P18	"	"	"
5 - 1.65	26P14	"	"	"
6 - 2.10	34P10	"	"	"
7 - 2.25	36P10	"	"	"
8 - 2.40	38P12	"	"	"
9 - 2.45	39P12	"	"	"
10 - 2.50	40P10	"	"	"
11 - 3.00	48P10	"	"	"
12 - 4.75	76P10DC	"	"	"
13 - 2.50	40H14	herringbone	"	"
14 - 3.33	53T12	Twill	"	"
15 - 3.70	59T12	"	"	"

C - Cloth Standardization Committee - J. D. McCluer, Chairman

This committee is now evaluating the results of their round-robin heat aging tests. The evaluation is not completed, but the information obtained from each participant in this program does show that the cloths used in this particular program varied considerably in tensile strength, one area to another. If these cloths represent the quality of asbestos cloth made throughout our industry, then we should note our quality checking procedures.

Additional round-robin tests are contemplated.

D - Braid Standardization Committee - C. R. Frederick, Chairman

This committee also has been carrying on round-robin tests. These tests relate to:

1- methods of measuring feet per pound
2- methods of measuring wall thickness

The results, although not completely tabulated, do emphasize what had previously been considered a fact without any substantiating data; that is:

1 - results varied with the individual
2 - previous testing or checking procedures are not the most practical or are not interpreted correctly

Additional work and tests are contemplated and are necessary before procedures or standards can be recommended.

E - Fellowship Report - Dr. M. C. Shaw

Report #27 issued by Dr. Shaw for this meeting will be of most interest to our Technical Committee but we would like to call the attention of all members to certain subjects in this report as to their value in our 1954 calendar.

1 - Magnetic Iron Content and Abrasion Resistance Projects

These subjects are of importance to industry in general and relate to government specifications in one instance and to a characteristic of asbestos cloth on which there is insufficient information for use by our Sales Promotion Committee. We feel these projects should be considered as important projects for the Fellowship during 1954.

2 - Elevated Temperature Serviceability of Asbestos Cloth

This project should be considered as a desired project for 1954 as it relates to investigations now active with the Cloth Standardization Committee and is necessary part of those investigations.

I personally wish to thank all members of the Technical Committee for the cooperation given during the past two years and for the work each member has done in their sub-committees. In addition, I wish to thank all members of the Institute for the cooperation they have given the Technical Committee. Dr. Shaw and members of the Sales Promotion Committee especially have assisted the Technical Committee in our work for which we extend thanks.

J. L. Tucker

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FELLOWSHIP REPORT

MYRIL C. SHAW
RESEARCH FELLOW
ASBESTOS TEXTILE INSTITUTE

NEW JERSEY CERAMIC RESEARCH STATION
RUTGERS UNIVERSITY
NEW BRUNSWICK, N. J.

REPORT #27

December 10, 1953

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INTRODUCTION

The activities of the Fellowship during recent months have been concerned with a number of different problems of interest to the Institute membership. The subjects are quite diversified and all do not perhaps rigidly conform with the Fellowship project list which was last established in 1951. In this connection, it would seem advisable that there be an early reconsideration of the Fellowship program in light of present day problems to determine whether or not the projects presently listed should be continued or revised or if perhaps some problems should be discontinued and new problems added. We are eager to carry on a program of work that will not only contribute technological advancements within our industry but also will add further prestige and stature to the Asbestos Textile Institute. The cooperation of each member in the development of the most effective program is necessary if the greatest gains are to be made.

We would not, however, wish to leave the impression that the Fellowship work has slackened in activity during recent months but rather would like to be sure that our efforts are being directed toward subjects which are of interest and value to the entire membership. Each of our present projects is of known interest to certain segments of the membership and perhaps of equal interest to all members, however, until there is some clarification we can not be sure that we are proceeding in the direction or manner acceptable to everyone.

RESEARCH PROJECTS

Magnetic Iron Content of Chrysotile.

Fellowship Report #26, presented at the last meeting set forth much of the exploratory work here carried on in an effort to organize and clarify the thinking regarding the possible relationship between total iron, magnetic portion of the total iron and the electrical properties of materials manufactured from chrysotile which may contain these contaminants. Work along these lines is continuing and through the cooperation of the task group of Committee A-4, A.S.T.M. which is equally as interested in the problems involved, it is anticipated that significant progress in this investigation may be made in the near future.

Our present activities are related to the accumulation and distribution of representative samples of materials which will be submitted to cooperating laboratories for test and evaluation. One of the fundamental problems to be faced in this work is lack of uniformity in test equipment, test procedures and testing techniques. It is hoped that it will be possible to interest both producers and consumers in these cooperative tests and that through the considered evaluation of the results, a standard test can be evolved which will serve to yield reliable results which will be indicative of the electrical resistance properties.

Efforts are now being made to obtain chemical analyses of the materials to be tested so that the Fe_2O_3 - Fe_3O_4 content of each sample may be ascertained, and the electrical properties related thereto, determined. In addition, the field of radiography is being further explored in the hopes that perhaps the graphic reproductions thus obtainable may serve as a quantitative indicator of the proportions of magnetic iron contamination present within a given sample. We have recently obtained the cooperation of a firm known as Industrial X-Ray, Inc., who are now making a series of radiographs of some of our materials and will further assist us as we progress in this investigation.

Elevated Temperature Abrasive Resistance.

During recent months several members of the Institute have sought information regarding the abrasive resistance characteristics of various types of asbestos textiles at elevated temperatures. The first inquiries prompted the construction of an oven with a heating unit which could be mounted over the Abradoflex and with this assembly it was possible to run tests at temperatures approximating 350°F. However, since initiating this work, inquiries relating to higher service temperatures characteristics have been received and we have accordingly proceeded to develop a unit capable of providing the desired information. In the latest efforts, a semi-permanent oven has been constructed about the abradoflex and within which, at an input of around 2000 watts, it is possible to run such tests at 650°F. In these tests, a temperature of 400°F is obtained rather quickly, in a matter of about 10 minutes, however, approximately one hour is required to attain the peak operating temperature of 650°F.

The abradant normally used on the Abradoflex is No. 1 Grit, Emery Cloth. However, at the elevated temperatures here encountered this cloth is, of course, destroyed and it was therefore necessary to explore other types of abrasive materials. We are now using an 18 mesh bronze wire screen and are hopeful that it will provide the necessary abrasive qualities during the normal 3-hour cycle. This abradant is handled in the same manner as the emery cloth, being stretched around the permanent steel cylinders and being renewed with the start of each test.

The conditions under which these tests are to be run are somewhat different than the normal abradoflex test and will perhaps, therefore, require a somewhat different interpretation of the results. The fact that during the first hour the temperature is constantly rising will undoubtedly be a factor that must be given consideration since it will be during this period that the organic portions of the textiles will be destroyed. It is our intention, however, to establish a fixed rate of rise so that every test will be run under exactly the same conditions as every other test. In this way the results of the elevated temperature tests should be comparable with each other, however, the relationship between tests run at elevated temperatures and those run at atmospheric temperatures can only be determined after a sufficient number of tests have been run to make a proper evaluation.

The use of bronze screen wire as the abradant will also, undoubtedly, introduce a factorial difference between tests so run and those run using an emery cloth as the abradant. This again will make it somewhat difficult to correlate "cold run tests" with those run at elevated temperatures.

On the whole, however, it would appear that elevated temperature abrasive resistance serviceability tests such as those here contemplated should provide much useful and significant information. We know of no other abrasion tester that will provide such information and feel certain that a continuation of this work will be well justified.

Elevated Temperature Serviceability

Fellowship Report #26 set forth a rather complete report on the status of the work here conducted related to the determination of the elevated temperature serviceability characteristics of asbestos textiles. However, at the time of the meeting at which the report was issued some of the data required completion. This work was completed immediately following the meeting and the revised data inserted in the report as finally issued and sent out with the Minutes of that meeting.

There have been no further activities in this particular endeavor since that time, however, as a cooperative effort with five other members of the Institute, a round robin heat aging test on two representative asbestos textiles has been conducted. It was the purpose of these tests to endeavor to correlate the various types of ovens and furnaces available in the several laboratories and the testing techniques there employed with those which have been standardized in the Fellowship laboratory. The cloths selected and furnished by the Fellow were (1) Underwriters Grade, 40P10 and (2) Grade AA, 36P10.

In addition to the determination of the elevated temperature serviceability characteristics of each of the cloths, the values for loss in weight as a result of the heat aging and the asbestos content of each material was determined.

The results of these tests are set forth in Table I. Each value is an average of five test specimens.

Laboratory 1 carried out the heat aging tests in an air-circulating oven 19"x19"x14" and suspended the test specimens in a vertical position, ten specimens to a test.

Laboratory 2 carried out the heat aging tests in a non-air-circulating oven 7½"x5"x13" and the samples were held in a vertical position on a frame, ten specimen to a test.

Laboratory 3 carried out the heat aging tests in an air-circulating oven 37"x37"x24" and the samples were placed horizontally.

Laboratory 4 carried out the tests in a non-air-circulating oven 7"x5"x15", with the samples laying horizontally in two layers, 1/2" apart.

Laboratory 5 carried out the tests in an air-circulating oven 17"x48"x32". The positioning is not known.

The A. T. I. tests were carried out in the Despatch oven which has been described in earlier reports and the samples were positioned horizontally during the test.

The results of this test will no doubt be discussed by Mr. J. D. McCluer, the chairman of the task group directly concerned with this project, however, a few brief observations at this time may be in order.

It will be observed that the asbestos content values are all within reasonable ranges, with the Underwriters cloth ranging from 81.70 percent to 82.25 percent and the Grade AA cloth ranging from 92.50 to 93.40 percent. Since all of the samples representing each of the respective grades were taken from a single piece of cloth, it would be expected that the asbestos contents should be reasonably close and the figures here presented would seem to indicate that the techniques employed in the several laboratories must be quite similar in order to have yielded such closely related results.

However, the results of the remaining tests carried out in this investigation do not lend themselves to such close comparisons, particularly with respect to the Underwriters grade cloth. The loss in weight of the Underwriters cloth, after heating for 24 hours at 400°F, for example, shows a range of from 3.80 percent to 8.10 percent. Both of these extremes, by the way, were obtained in air-circulating type ovens, however, the high value was obtained with the cloths in the vertical position while the low value was obtained with the cloths positioned horizontally. The vertically positioned cloths likewise show greater loss in strength (with one exception) than do any of the others tested. In our early work in these heat aging investigations, we detected the tendancy of cloths suspended in a vertical position to act as a wick which permitted the burning of the organic portion in an upward direction with an intensification of the rate of combustion and cloth temperature as it progressed. The net result of this action would appear to be that the actual cloth temperature is considerably

Round Robin Heat Aging Tests

Table I

Style - 40P10 Und.

Laboratory	Tensile Strength: As Received, Warp #	As Received, Fill #	400°F./24 Hour, Warp #	400°F./24 Hour, Warp % Ret.	400°F./24 Hour, Fill #	400°F./24 Hour, Fill % Ret.	Loss in Weight %	Asbestos Content %
A.T.I.	136.8	48.4	59.3	43.4	19.7	40.6	5.32	82.10
1	132.8	40.5	39.8	30.0	11.3	27.9	8.10	81.70
2	134.2	42.6	68.2	50.7	20.2	47.4	6.875	81.90
3	139.4	42.7	56.0	40.2	20.0	46.8	3.80	81.90
4	134.6	44.6	56.0	41.6	20.0	44.8	5.86	81.80
5	139.6	42.2	47.0	33.6	11.2	26.5	5.25	82.25
Avr.	136.2	43.5	54.4	39.9	17.1	39.0	5.87	81.94

Style - 36P10 AA

Laboratory	As Received, Warp #	As Received, Fill #	(500°F./24 Hour) Warp #	Warp % Ret.	Fill #	Fill % Ret.	Loss in Weight %	Asbestos Content %
A.T.I.	151.0	75.0	95.8	63.5	49.0	65.3	6.53	92.90
1	140.6	70.9	85.4	60.8	34.5	48.7	7.00	93.00
2	135.4	60.2	85.6	63.2	30.0	49.8	7.02	93.40
3	143.7	64.8	93.4	65.0	42.3	65.4	6.53	92.90
4	144.0	77.6	98.6	68.5	39.2	50.5	8.07	92.50
5	122.8	56.8	94.2	76.7	47.6	83.8	6.36	93.25
Avr.	139.6	67.6	92.2	66.3	40.4	60.6	6.92	92.99

higher in those cloths vertically positioned over those placed horizontally. The loss in weight values and the lower resultant tensile strengths would seem to bear this out.

The reasoning here set forth for the Underwriters cloth appears also to be applicable in the Grade AA cloth although the effect and the differences resulting are not nearly so pronounced. As a matter of fact, the vertically positioned cloths tested in an air-circulating oven yielded loss in weight and tensile strength results very nearly the same as those obtained in a much smaller, non-circulating oven.

The observations here related refer to only a few of the more interesting results obtained in these tests. After the Technical Committee has had an opportunity to study this information and the significance of the several variables introduced through differences in furnaces and techniques established, a full appraisal of the over-all results will be set forth.

Standard Cloth List.

At the last meeting of Committee D-13, A.S.T.M., Subcommittee A-4, the Fellow was asked to serve that group in ascertaining from industry the composition of a list of those asbestos cloths which should be included in A.S.T.M. Standard Specification for Woven Asbestos Cloth, Designation D677-50. Presently, included in this specification is a list containing twelve representative asbestos textiles, however, criticisms have frequently been voiced in this connection, based on the contention that many cloths now being furnished as standard materials by our industry are not there included. In an effort to determine the views of our membership in this matter, all members have been questioned and asked to express their opinions relative to this subject.

Committee A-4, in assigning this task, expressed the desire that the list not be expanded to include a number of cloths much greater than is now presented, twelve. The reason for this confinement is not clear to the writer at this point and will not greatly influence our efforts if we can definitely establish a list of cloths that can be considered commercially available and standard with respect to industry wide availability.

The results of our questioning, thus far, would indicate that perhaps the following cloths might well be eliminated from the present A.S.T.M. list: 16P18, 20P28, 21P16, 28P18, 29P14, 34P12, and the 3.00# cloth, 10/3 warp and 10/2 fill. Suggested additions include: 22P16, 22P18, 22P10G, 23P18, 34P10, 39P12, 48T12, 59T12, 62P10DC or 76P10DC.

Further recommendations would seem to indicate that the Grade A classification for cloths be eliminated from the A.S.T.M. grades. This same recommendation is apparently directed to such grades as carried in the A.T.I. standard cloth list.

It is hoped that during the course of the current meeting a further clarification relative to this subject may be forthcoming.

Abradoflex Patent.

During recent weeks word has been received from our patent attorney, Mr. Ward, of Ward, Crosby and Neal, that our patent application has been examined by the patent office examiner and the results of this review have been transmitted to us. Copies of this correspondence are herewith attached.

It is the view of Mr. Ward that a patent can be obtained to cover the subject machine, however, it is recommended that certain changes in the application be made in order that maximum coverage may be achieved. On the basis of the correspondence here presented and the recommendations of the patent attorney, we would ask the direction of the proper authorities within the Institute regarding the next steps to be taken in this endeavor.

Theatre Curtains.

As a result of the circulation of our most recent publication "A Handbook of Asbestos Textiles", we are in receipt of some interesting correspondence from C. E. Tompkins, President, J. R. Clancy, Inc., manufacturers and installation engineers of theatre curtains. Copies of this correspondence is herewith attached and may prove of interest.

It would seem that perhaps our industry has, in this firm, an ally which may serve to stimulate a greater interest in asbestos materials for application in threatre curtains, if properly exploited. We are not, of course, familiar with all aspects of this problem and some members may have had sufficient experience in this field to know that the outlet is not significant, however, if we can serve to promote an interest in these materials through efforts of research or promotion, we will welcome an expression of your desires to so proceed.

CONCLUSIONS

During the recent months we have engaged in a rather wide range of activities. It is hoped that the projects discussed are considered to be in accord with the interests of the Institute membership and that the work is serving a useful purpose. We would welcome a complete review of the Fellowship program in order that we may be sure that our efforts are being directed along productive lines and will likewise be glad to engage in any new investigations which might be of particular interest at this time.

In concluding, I would like at this time to pay my respects and extend an appreciative hand to Mr. Jesse Tucker for his great help and many kindnesses during his term as Chairman of the

Technical Committee. I doubt if any member of the Institute knows, as I do, of the time and effort Mr. Tucker devoted to his job as Chairman of the Technical Committee. Much good work has been accomplished under his leadership and the Institute can be justifiably proud of the high calibre of the men it can call upon to direct the committee work. In like manner, I would extend my grateful appreciation to Mr. George Harris, Chairman of the Sales Promotion Committee for the past two years, who has been equally helpful and understanding and has provided me with much necessary information and support in my endeavors in the work of the Fellowship. Having worked rather closely with George on the "Handbook", I was afforded the opportunity to gain a great deal of practical information related to our industry and for this I am deeply appreciative.

MIL-C-4117

Military Specification

CLOTH AND TAPE, ASBESTOS

1. SCOPE AND CLASSIFICATION (No change)
1.1 Scope (No change)
1.2 Classification (No change)
1.2.1 Type (No change
1.2.2 Grade - Asbestos cloth and tape shall be of the following grades, as specified (see 6.2):
Grade - Commercial (asbestos content, not less than 75%). Cloths of this grade shall have a black stripe in selvage edges.
Grade - AAA (asbestos content, not less than 95%). Cloths of this grade shall have a green stripe in selvage edges.

2. APPLICABLE SPECIFICATIONS (No change)
2.1 Specifications (No change)
3. REQUIREMENTS (No change)
3.1 Materials (No change)
3.1.1 Asbestos - The asbestos used in the yarns to manufacture the cloth and tape shall be chrysolite fiber.
3.1.1.1 Chemically combined water (No change)
3.1.2 Wire - Wire inserted yarn shall consist of one or two brass wires as specified herein, twisted with the required number of asbestos yarns. The wire shall be soft brass, 70% copper, and 30% zinc-type alloy.
3.2 Physical Properties (No change)
3.2.1 Cloth (No change)
3.2.1.1 Colored stripe selvage - Unless otherwise specified, the cloth shall have a woven colored organic yarn in each selvage edge of the color indicated in Table I.
3.2.2 Tape (No change)
3.3 Put-up (No change)
3.3.1 Cloth - Asbestos cloth is normally available in a width of 40 inches. It is commonly supplied in rolls of 50 yards, plus or minus five yards, and can be supplied in rolls of 25 and 100 yards. Ten per cent of the total number of rolls may contain two pieces.
3.3.2 Tape - Unless otherwise specified, the asbestos tape shall be furnished in approximately 100 ft length rolls. No more than three rolls in ten shall contain two pieces.
3.4 Marking - Each roll of asbestos cloth or tape shall have a ticket securely attached. The ticket shall be made of heavy cardboard and be provided with a reinforced eyelet for attaching. The ticket shall have thereon the following information: (No additional changes)
3.5 Workmanship (No change)
4. SAMPLING, INSPECTION, AND TEST PROCEDURE (No change)
4.1 General Instructions (No change)
4.1.1 The asbestos cloth, etc. (No change)
4.1.2 Acceptance or approval, etc. (No change)
4.1.3 When specified, the contractor shall furnish a test report, etc. (No additional change)
4.2 Lot (No change)
4.2.1 Cloth (No change)
4.2.2 Tape (No change)

ATI-81

Military Specification
Mittens, Asbestos, M-1942

4.3.1 Heat transfer markings (No changes)
4.3.2 Asbestos cloth (No changes)
4.3.2.1 Asbestos content - The asbestos cloth of the mittens shall be tested as follows: Five test specimens, each weighing not less than 5 grams, after drying for one hour at 105 to 110C (221 to 230F) shall be placed in a desiccator for one hour, again weighed, then placed in a furnace for not less than one hour at 800 to 810C (1470 to 1490F). After removal from the furnace, the residue shall be cooled for one hour in a desiccator, then weighed. The weight of the residue shall be divided by 0.86* to determine the original weight of the asbestos content. The weight of the asbestos content shall be divided by the weight of the dried specimen and the quotient multiplied by 100 to obtain the percentage of asbestos. The average of the five determinations shall be taken as the asbestos content. The percentage of organic matter equals 100 minus the percentage of asbestos.

* Note: The value shown in 4.3.2.1 is based upon an average theoretical value of 14% chemically-combined water.

5. PREPARATION FOR DELIVERY (No changes)
5.1 Army (No changes)
5.1.1 Packing (No changes)
5.1.1.1 For domestic shipping (No changes)
5.1.1.1.1 Wood cleated fiberboard boxes (No changes)
5.1.1.1.2 Wood cleated plywood boxes (No changes)
5.1.1.1.3 Nailed wood boxes (No changes)
5.1.1.1.4 Kraft paper liners (No changes)
5.1.1.5 (Delete) (This was deleted by Amendment I dated May 18, 1953).
5.1.1.2 For overseas shipment (No changes)
5.1.1.2.1 Wood cleated fiberboard boxes (No changes)
5.1.1.2.2 Wood cleated plywood boxes (No changes)
5.1.1.2.3 Nailed wooden boxes (No changes)
5.1.1.2.4 Waterproof barrier (No changes)
5.1.2 Marking (No changes)

6. NOTES (No changes)
6.1 Ordering data (No changes)
6.2 Standard sample (No changes)

J.L.T.

J. L. T.

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