

FELLOWSHIP REPORT

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THE ELEVATED TEMPERATURE SERVICEABILITY
OF
ASBESTOS TEXTILES UNDER CONSTANT STRESS

Introduction

Asbestos textiles are frequently placed in service under the combined conditions of elevated temperature and load or stress. The ability of these materials to resist destruction as a result of a constant or intermittent application of a load or stress may often serve as the prime factor in determining its suitability for a given service. Curtains, draperies and temporary or movable partitions wherein the materials are supported at the top and permitted to hang more or less free from that support, are examples of such services. Under these conditions the stress may be the result of the weight of the cloth itself or may consist of a combination of the cloth weight plus a roller or other super structure which may be attached to the bottom of such a curtain. Tapes and cloths used as lagging materials may be tightly wrapped or applied over a pipe or cable and with an increase in temperature the expansion of the pipe or cable may be greater than that of the tape or cloth, putting a stress on the lagging material. There are innumerable other applications in which, at some stage in the performance of a service, asbestos textiles are called upon to resist destruction due to stress while serving as a non-combustible protection medium.

The industry has for many years accepted an arbitrary range of temperature limits of serviceability for the various grades of asbestos textiles available, as follows:

Commercial Grade	-- Up to 400°F
Underwriters Grade	-- " " 450°F
Grade A	-- " " 550°F
Grade AA	-- " " 600°F
Grade AAA	-- " " 750°F
Grade AAAA	-- " " 900°F

This system of grading is based solely upon asbestos content and does not take into account such important factors as cloth construction and design or stress bearing characteristics.

Yarn construction and cloth constructions are very closely related and the grades of fiber or the lengths of asbestos fibers used will exert some influence upon the resultant elevated temperature serviceability characteristics. For example, a 36P10 cloth may contain fibers which are predominately of 3R quality, however, when a cloth bearing the construction of 17P24 is required the asbestos fiber quality may need some improvement in grade and fiber length if the requisite 24 cut yarns are to be produced for incorporation in this latter cloth. Such improvements in fiber quality usually reflect improvements in several properties including elevated temperature serviceability.

In an effort to determine the relative elevated temperature characteristics of a group of asbestos textiles designed to meet specific applications, some consumers have directed attention to so-called heat-aging tests as a means of evaluation. In such tests the textiles are subjected to a predetermined heat treatment, some at 200°F, others at 572°F and some at higher temperatures for periods of time ranging from 30 minutes to several hours and following such treatments are tested to determine the loss in tensile strength resulting from

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the heat treatments. Such heat aging tests do serve a useful purpose in that the results usually reflect to some degree the fiber quality which was used in the cloth construction and on the basis of comparative tests a consumer may be able to establish which of several cloths so tested exhibit the characteristics which will best serve the intended application. However, it is doubtful that the results of such tests provide simulative service data of universal significance since the time cycle of test is much shorter than most service applications. Further, the stress is applied after the sample has been permitted to cool to room temperature following the heat treatment while in service the stress would undoubtedly be active during the heating up period as well as the cooling period. The selection of arbitrary temperatures and periods of duration for these tests limits the data resulting therefrom to specific areas of serviceability which in most cases will not serve to define either the maximum or minimum parameters of serviceability.

In an effort to overcome some of the indicated short comings of heat aging tests as they are currently conducted it was felt that a study wherein asbestos textiles subjected to live loads continuously at elevated temperatures might provide data that could be interpreted in terms that would serve to define the ranges of elevated temperature serviceability as a function of the tensile strength properties at these temperatures. The work covered in this report represents the initial undertaking in this investigation and, although the data covers only a relatively few cloths and tapes and cannot therefore be considered with any degree of finality, it does provide some interesting relationships which serve to indicate the trends that may be expected in the more extensive study being pursued.

Testing Equipment

The equipment used in this investigation was designed and built specifically for this study. The main unit of the equipment set-up is the electric furnace wherein the samples under test are subjected to elevated temperatures. The furnace has over-all outside dimensions, 24" long by 14" wide by 10" deep and inside dimensions, 15" long x 5" wide x 5" deep. The heating elements, consisting of two coils of nichrome wire, each rated at 1000 watts at 110V and each being capable of separate control, are embedded in the two side walls of the furnace. The furnace is constructed with a one-inch wide slit running length-wise along the center of both the top and bottom sections of the furnace so that the samples of cloth under test may be supported above and outside of the furnace, passed through the furnace and extend six inches below the bottom of the furnace, at which point loads may be attached to bottom of the sample.

The furnace was constructed on wheels so that it could be moved along a track-way. The purpose of the movable feature was to provide the possibility of carrying out shock tests wherein the furnace might be first heated to a given temperature without test samples and upon the attainment of that temperature be moved in place over the test specimens, under a given load. In this manner heat shock or instantaneous heating tests are to be conducted.

The auxiliary equipment necessary for the operation of the furnace consists of a Powerstat Variable Transformer for controlling the power input, a voltmeter to indicate the voltage input and a potentiometer equipped with a chromel-alumel thermocouple for measuring the temperature attainments.

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The furnace was originally designed to operate at a maximum temperature of 1500°F, however, in actual usage the practical limit of operation was found to be 1415°F. The heating schedule is set forth in Plate I.

Test Procedure

The procedure followed in carrying out the tests in this investigation represents a departure from that pursued in most heat aging tests currently in use. Tensile strength characteristics serve in both instances as the factors of significance, however, in the normal heat aging tests grab test specimens are studied while in the work here undertaken 1" ravel-strip samples 21" long are used. The samples must be 21" in length in order that they may extend through the test furnace being supported above the furnace and extending below the furnace sufficiently to accommodate the desired loads. The segment of each specimen that is actually subjected to the heat treatment is approximately 7 inches.

The test samples are first prepared by cutting representative specimens 21" long by 1-1/2" wide, and then ravelled to a 1" width. The tensile strength of the ravelled sample is then determined using the prescribed technique for strip tests, with 2" jaws both front and back, top and bottom, on the tensile tester, with the top and bottom jaws 3" apart. The tensile strength so determined serves as the basis for stress application and is noted as the "Tensile Strength, As Received".

The load or stress to which each of the samples is subjected is based upon the "As Received" tensile strength in increments of 10%, 20%, 30% and 50% of the original strength.

In carrying out a given test, two specimens are mounted in the furnace at one time and are loaded with respective weights, determined as above noted. The furnace is then engaged and the temperature permitted to rise according to the schedule set forth on Plate I until the samples have broken as a result of the combined high temperature and load, the temperature at the time of rupture being noted.

Presentation of Results

The results of the tests conducted thus far in the investigation are tabulated in Table I and are also set forth in Plates II, III and IV.

Table I presents the specific data relating sample number, style, tensile strength, as received and, in the last four columns, the temperatures and loads at failure. In explanation of the presentation of the data in the last four columns, refer to sample T-1 and it will be observed that in the column designated 10% load the figures are presented as 920/21 which indicates that at 21 pounds load, which is 10% of the as received tensile strength for that particular sample, the tape failed at 920°F. Likewise under 20% load or 42 pounds, failure was induced at 515°F. The figure preceeding the hash mark denotes temperature of failure and the figure following the hash mark denotes applied load.

TABLE I

Sample Number	Style	Tensile Strength 1" Ravel Strip As Received (Except Tapes)	Failure Temperature °F Pounds Stress/ 1" Ravel Strip Percent Load/As Received			
			10	20	30	50
<u>Commercial</u>						
T-1	Tape 1"x.0638	209.16	920/21	515/42	440/63	375/105
T-5	1x.0675	128.00	915/13	615/26	490/39	390/64
T-22	1x.0633	113.66	705/11.3	565/22.7	495/34.0	440/57.0
T-24	1x.1404	287.00	1060/28.7	725/57.4	570/86.1	500/143.5
199	4OP10	102.00	1040/10.2	515/21.4	425/31.6	400/51.0
<u>Underwriters</u>						
T-3	Tape 1"x.1415	261	970/26	685/52	585/78	490/130
T-7	1x.0728	198	1145/20	975/40	675/60	440/99
T-9	1x.0824	178	680/18	605/36	555/54	410/89
T-11	1x.0321	100	1065/10	915/20	470/30	415/50
T-13	1x.090	209	1175/21	990/42	895/63	455/104
T-15	1x.1688	317		1045/64	935/95	585/158
T-30	1x.0633	99.2	1440/9.9	985/19.8	575/29.7	450/49.6
243	17P24	60.0	1110/6.0	950/12.0	865/18.0	645/30
271	17P26	55.33	1090/5.5	920/11.0	600/16.6	410/27.6
250	24P10	50	975/5.0	780/10.0	475/15.0	420/25
S-1	26P14	68.0	1090/6.8	645/13.6	615/20.4	395/34.0
244	"	55.0	1030/5.5	615/11.0	450/16.5	390/27.5
269	"	79.66	1085/7.9	935/15.8	655/23.8	515/39.8
259	36P10	99.00	1080/9.9	905/19.8	500/29.7	390/49.5
263	4OP10	109.0	1145/10.9	980/21.8	500/32.7	435/54.5
240	"	104.0	975/10.4	625/20.8	580/31.2	385/52.0
278	"	88.33	1190/8.8	950/17.6	650/26.4	510/44.16
251	"	91.33	1205/9.1	970/18.2	565/27.3	485/45.6
<u>Grade A</u>						
203	36P10	90.0	1185/9.0	990/18.0	600/27.0	485/45.0
260	"	79.66	1135/8.0	975/16.0	915/24.0	440/40.0
<u>Grade AA</u>						
246	36P10	68.0	1410NF/6.8	1070/13.6	1030/20.4	900/34
S-2	"	96.7	1410NF/9.7	1195/19.5	1025/29.2	860/48.3
275	"	84.66	1410NF/8.4	1135/16.9	1035/25.3	930/42.3
274	29P14	80.0	1410NF/8.0	1115/16	1005/24	855/40
192	4OP10	82.0	1410NF/8.2	1045/16.4	1025/24.6	900/41.0

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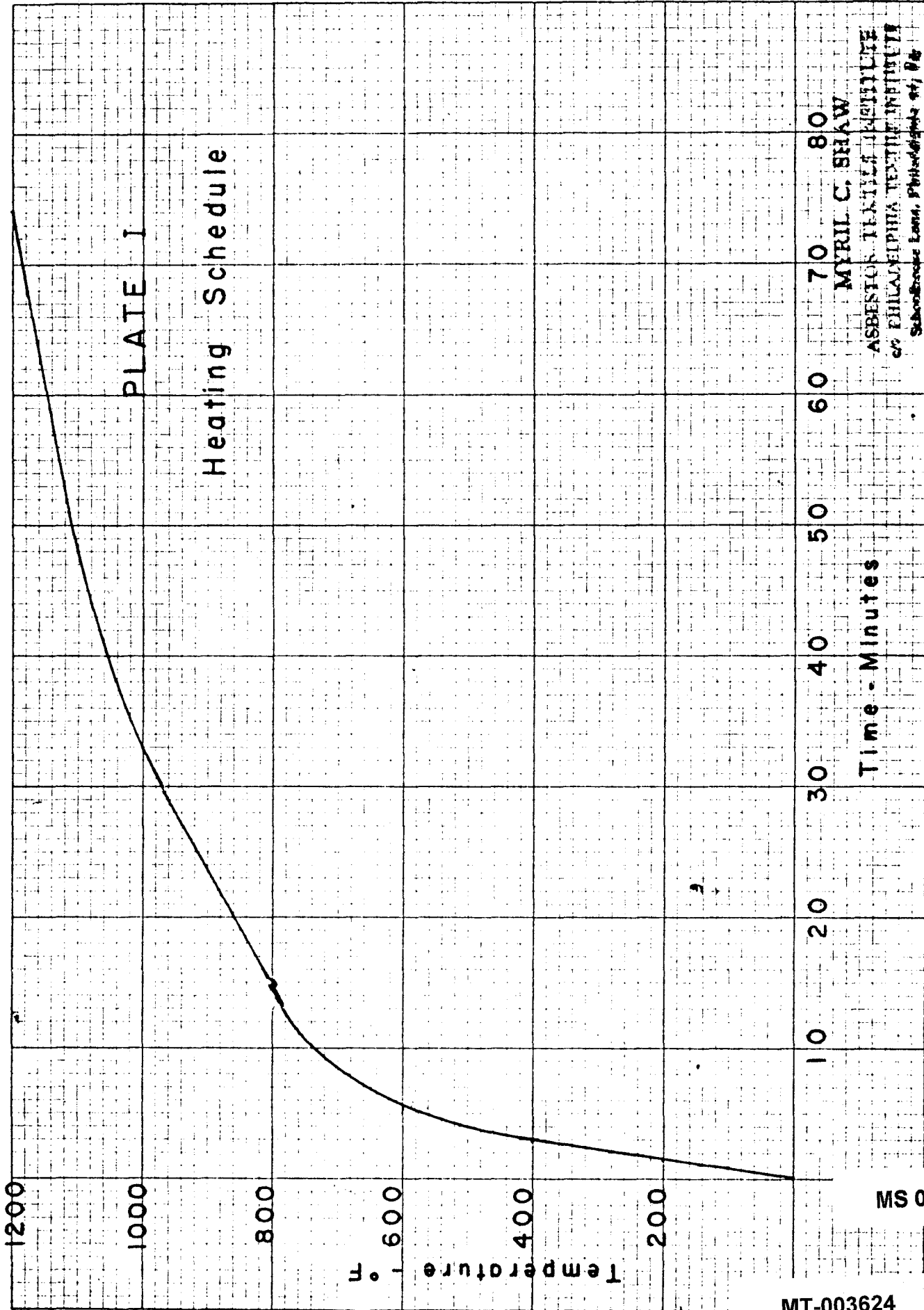
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Sample Number	Style	Tensile Strength	Failure Temperature °F			
		1" Ravel Strip As Received (Except Tapes)	10	20	30	50
<u>Grade AAA</u>						
247	36P10	110.5	1410NF/11.0	1120/22.1	1055/33.15	985/55.2
257	"	73.0	1410NF/7.3	1050/14.6	975/21.9	855/36.5
272	22P16	87.0	1410NF/8.7	1410/17.4	1025/26.10	970/43.5
248	"	81.3	1410NF/8.1	1180/16.2	1095/24.3	965/40.6
280	48T12	138.33	1410NF/13.8	1410NF/27.6	1365/41.7	1085/69.1
X	48P10	195.0	1410NF/19.5	1380/39.0	1045/58.5	995/97.5

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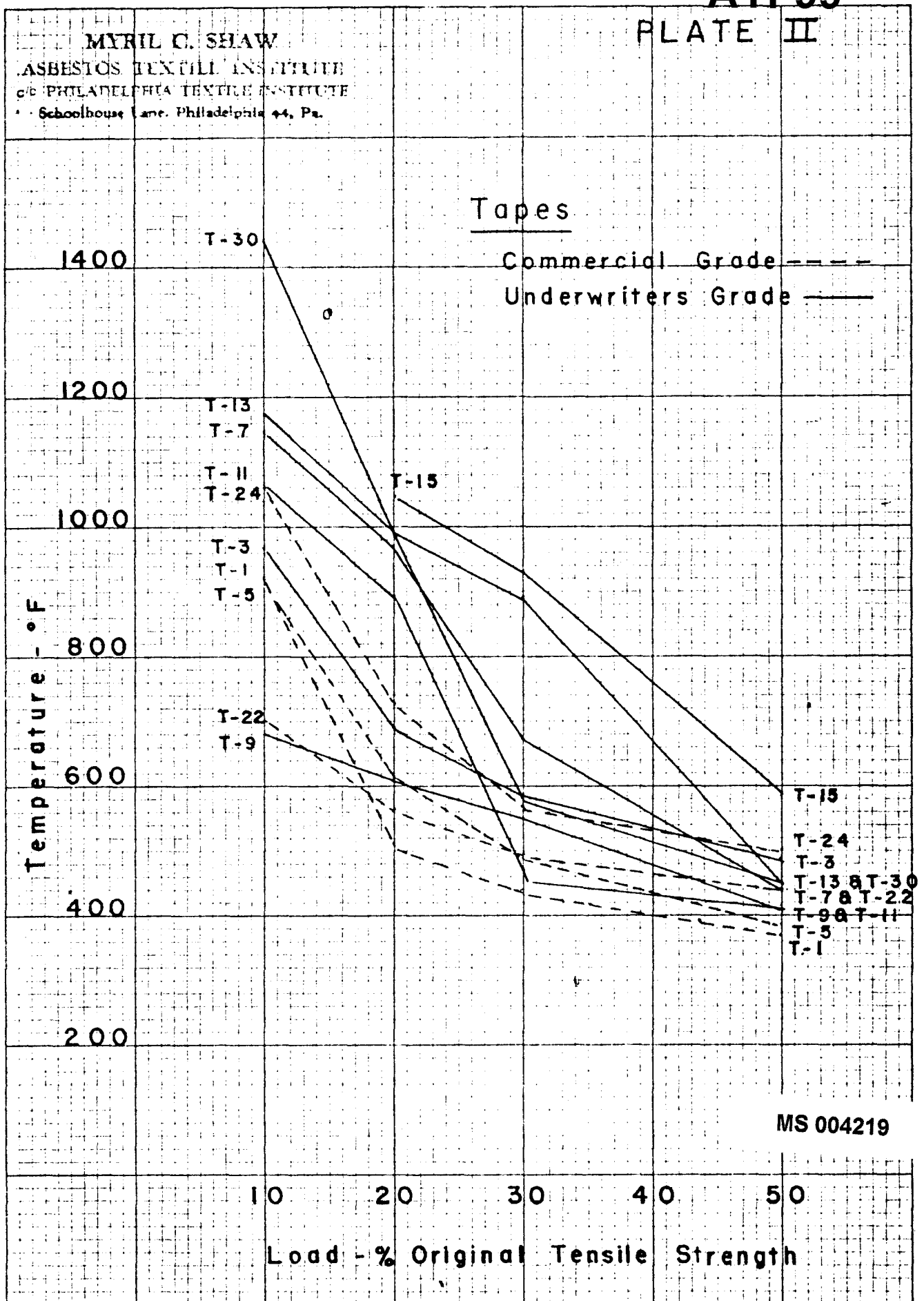
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J. H. WEIL & CO., PHILA.

NO. 316-F
10 X 10 TO 1 INCH



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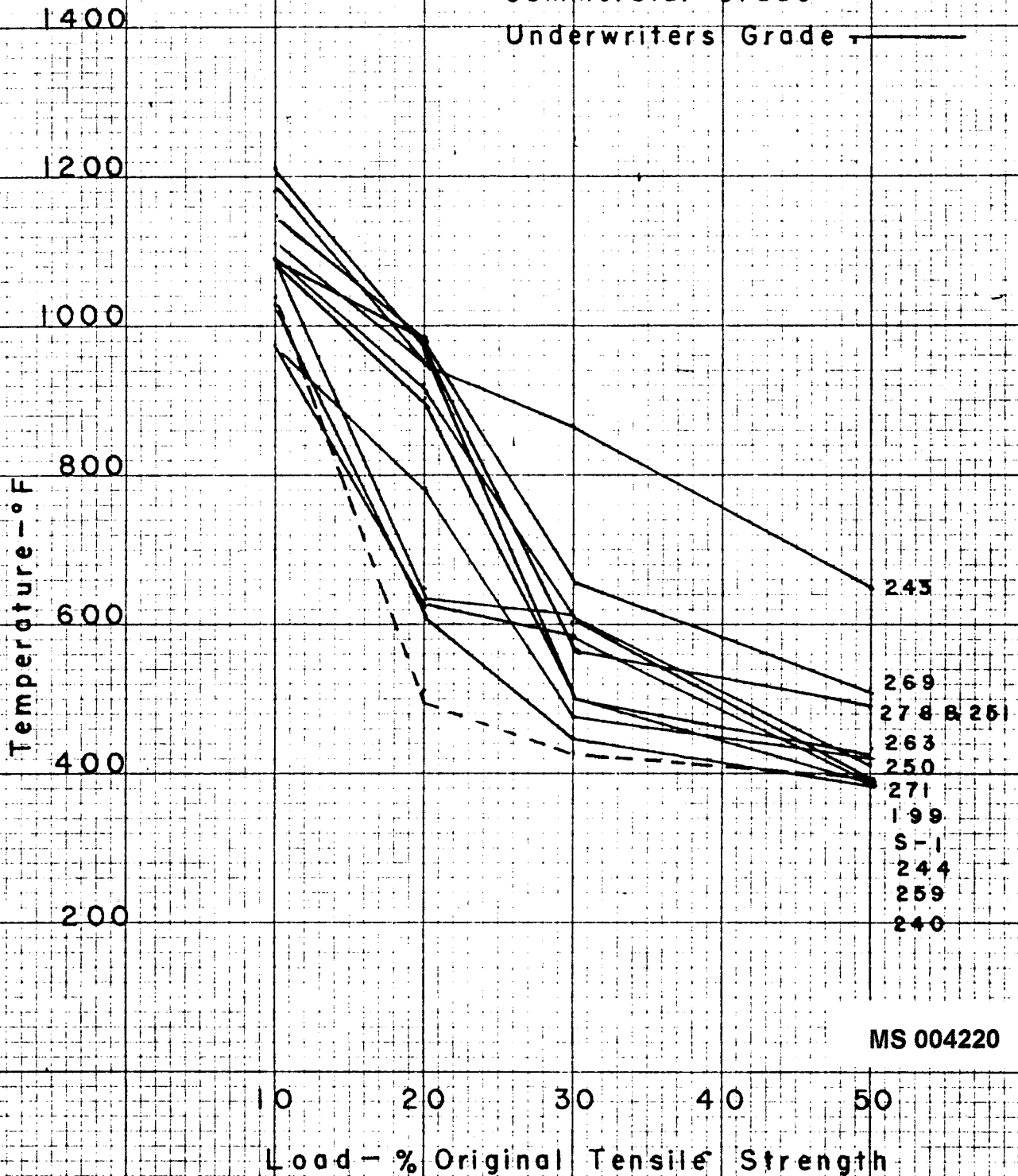
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Cloths

Commercial Grade - - - - -

Underwriters Grade - - - - -



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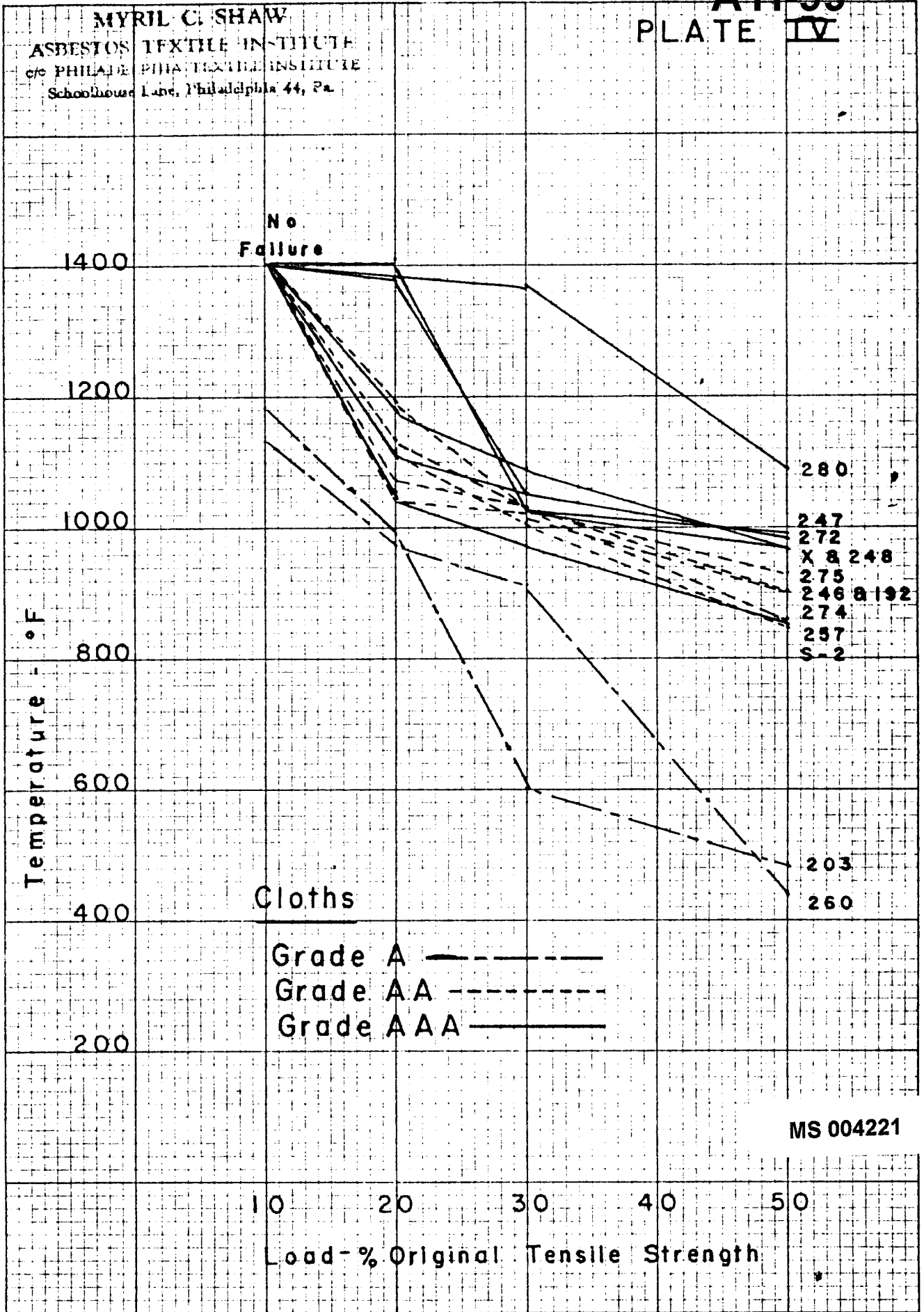
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NO. 316-F
 10 X 10 TO 1 INCH



In many of the higher grade cloths such as sample #246 under Grade AA it will be observed that the 10% figure reads 1410NF/6.8 which indicates that under 6.8 pounds load no failure (NF) was induced at 1410, the limit of the temperature rise.

In this investigation eleven 1" tapes were studied, four in Commercial grade and seven in Underwriters Grade, each tape being identified by the letter T placed before the sample number. The remainder of the samples here studied were cloths in the variety of styles as shown.

The graphic presentation as given in Plates II, III and IV serves to illustrate the similarity in performance of most cloths having like styles and grades.

Analysis of Results

The results of this investigation offer some rather significant points of interest regarding the ability of certain asbestos textiles to resist destruction by stress at temperatures considerably above those normally accepted as the upper limits for elevated temperature serviceability.

Before endeavoring to analyse the specific data as presented, it may be well to consider the magnitude of some of the values to be dealt with in this work. In the first place, the loading schedules established for each of the cloths and tapes here studied have been based upon the original or as received tensile strengths as determined upon samples tested in accordance with the accepted standard practice of having 3" between the jaws of the tensile tester. Under this particular test, however, the samples are subjected to tensile stress over a 19" span between the jaws. Experience gained during this work shows that the tensile strength as obtained over the longer span will be somewhat less than that obtained for the 3" span. A thorough investigation of this condition is to be undertaken, however, to date, nothing of a specific character can be given. It has been found that in some cases the tensile strengths over the longer span may be as much as 10% less than that obtained for the shorter span. It must be realized therefore that when reference is made to the 10% load or other increments as noted, the load in pounds as set forth is, in all probability, actually somewhat greater than the percentage indicated, based upon the 19" span which is used.

In an effort to correlate the applied loads with some characteristic of the materials here tested in order that a basis for comparison may be more apparent, the various loads as related to the unit weight of the cloths have been tabulated and are set forth in Table II. Here it will be seen, for example, that the application of a load of 10% to a 17 ounce per square yard cloth, is equivalent to 340 times the weight of the sample. In other words, developing this data further, a load of 10% per inch applied to a sample of 17P24 cloth would be the equivalent of 360 pounds for a sample of the cloth a yard wide or 340 times the weight of a yard of such a cloth. Likewise, a 22 ounce cloth loaded at 50% is the equivalent to 1310 times the weight of the cloth or 1800 pounds per yard wide sample. Also, a 36 ounce cloth (36P10) loaded at 50% is an equivalent of 800 times the cloth weight or 1800 pounds for a sample one yard wide.

The full range of equivalents for loads versus cloth weights are set forth

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in Table II and the relationships noted serve to indicate to some degree the magnitude of the stress values with which we are here concerned.

Table II

Weight Equivalents in Terms of Cloth Weights

Load Equivalents per Cloth Weight

Loading Weight, Ounces	# 10	# 20	# 30	# 50
17	340	780	1120	
22	262	524	786	1310
24	240	480	720	
26	222	444	666	
36	160	320	480	800
40	144	288	432	720

The test data as presented in Plates II, III and IV provide an opportunity to gain a comparative impression of the characteristics of materials of like grades under the conditions of these tests. Plate II for example, covers the performance data for 1" tapes in Commercial and Underwriters Grades in a variety of thicknesses. It will be seen that, in most cases, the Commercial Grade tapes exhibit somewhat inferior properties compared with the Underwriters Grade over the range studied. Under the maximum stress of 50% of the original strength, the entire range of temperatures of failure is from 375°F to 500°F for the Commercial Grades and from 410°F to 585°F for the Underwriters Grade. Tape T-1 which is in Commercial grade loaded at 105# failed at 375°F while T-24, the heaviest of the tapes in this grade, loaded at 143.5# failed at 500°F. This latter load, incidently, is the equivalent of 1025 pounds per square inch. The Underwriters tapes, under the maximum loading, ranged from 410°F loaded at 89 pounds to 585°F loaded at 158#, the latter tape being the heaviest of the tapes in this grade. It is significant to note that under the minimum loading or stress which will be referred to hereafter as a "perceptable stress" the range of temperature over which failure was induced extended from 705°F to 1060°F for Commercial grades and from 680°F to 1440°F for Underwriters grade. On the other hand the ranges of failure at maximum or "appreciable stress" extended from 375°F to 500°F for Commercial grade and from 410°F to 585°F for Underwriters grade.

Plate III presents the performance characteristics of one Commercial and fifteen Underwriters Grade cloths under the conditions of this test. The Commercial grade cloth, 4OP10, which is identified by the dotted line will be seen to exhibit somewhat inferior properties, compared with the entire group of Underwriters cloths, showing approximately 10% lower failure temperatures than the average for Underwriters grades. The selection of Underwriters grade cloths here covered ranges from 17P24 through 4OP10

For this variety of cloths the performance characteristics will be seen, from the curves, to cover a rather wide range.

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In general, however, the performances of the normal Underwriters grade cloths under the conditions of this test are reasonably well grouped and the demonstration serves to indicate the characteristics which may be expected of such materials under stress at elevated temperatures. Under conditions of "Perceptable stress" (up to 10% load) the serviceability temperatures for this group of cloths ranged from 975°F on sample #250 to 1190°F for sample #278 and for conditions of "appreciable stress" (up to 50% load) the range extended from 385°F for sample #240 to 645°F for sample #243.

Plate IV sets forth the performance data for cloths in various styles and in Grades A, AA and AAA. The grade differences are noted on the graphs by the differences in the continuity of the lines as noted in the legend on the Plate. In this work, two samples of Grade A, 36P10 cloths were studied and it will be seen that the performance characteristics of the two samples are quite similar and, as a matter of fact, close study will further reveal that these cloths fall well within the range of performance for the average Underwriters grade cloths.

Cloths in Grade AA and AAA, however, exhibit elevated temperature performance characteristics which are distinctly significant and which serve to reveal the unique properties of such materials. Under the conditions of these tests and applying the "perceptable stress" of 10% load which ranged from 6.8" to 19.5" per 1" strip, there was no failure at 1410°F after heating for a period of 2 hours and 45 minutes. Under the "appreciable stress", which ranged from 34" to 48.3" for Grade AA the failures ranged from 855°F to 930°F and for Grade AAA under the "appreciable stress" ranging from 36.5" to 97.5" the range of failure was from 855°F to 1085°F. Cloth #280, 48T12 in Grade AAA, exhibited the most outstanding performance, showing no failure after 2 hours and 45 minutes, the time necessary to attain 1410°F under a load of 27.6" and under a stress of 69.1" this material remained in tact up to 1085°F.

Conclusions

The elevated temperature serviceability of an asbestos textile is dependent upon many factors aside from the cloth construction itself, and we are here particularly interested in the one related to the amount and kind of stress or physical abuse to which the material may be subjected. In order to properly service an installation it is necessary to be able to define with reasonable accuracy the several limits of serviceability so that materials capable of meeting the requirements may be properly adopted.

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There are many applications which require materials that will simply resist destruction as a result of high temperature conditions and where there may be very little or no tensile stress. Under such conditions it would appear, on the basis of the preliminary work here reported, that some lower grade cloths will serve as effectively as some of a higher grade materials which might be indicated on the basis of current information. For example, most of the Underwriters grade cloths here studied exhibited reasonable strength and body retention at temperatures above 1000°F under "perceptable stress" conditions. However, under conditions here termed as "appreciable stress", failures were found to range between 400°F and 500°F.

The significance of the data thus far developed in this work would seem to indicate that under conditions requiring minimum strength properties the serviceability temperatures of all grades of asbestos textiles are well above the limits commonly recognized for such grades. As was pointed out earlier, Grades AA and AAA are extremely indestructable under minimum stress, resisting rupture at 1410°F under the conditions noted, although under the "appreciable" stress failure was induced at around 900°F for Grade AA cloths and from 850°F to 1100°F for grade AAA cloths.

In considering the work here reported it must be realized that these results were obtained under conditions of a constantly increasing temperature, with the rise continuing either until failure was achieved or the maximum capabilities of the furnace were reached. In addition, the duration of the tests were for reasonably short periods of time, in no case, exceeding 2-3/4 hours. It is reasonable to assume that subjection of these same materials under constant load and soaking at a constant temperature will bring about somewhat reduced temperatures of serviceability, however, the magnitude of this reduction can only be ascertained through further study.

Further work in this investigation will include the aforementioned soaking heat studies and instantaneous or shock tests wherein the samples under load will be instantaneously inserted into the furnace which has been previously heated to and is being held at a high temperature.

With the accumulation of the data which will be procured from the three series of tests here to be undertaken, it should be possible to rather clearly establish and define the elevated temperature serviceability characteristics of the more universally accepted styles and grades of asbestos textiles presently available.

Acknowledgment:

With the conclusion of this academic year at the Philadelphia Textile Institute we are about to lose the services of Claude A. Kennedy, a student at the Institute, who has served as our laboratory assistant throughout this year. We would like to appreciatively acknowledge his work and assistance in developing much of the data presented in this report for without his help it would not have been possible to have advanced in this investigation to the extent here reported.

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The Technical Committee held its Second Quarter Meeting on June 4th, at the Hotel New Yorker, New York, New York. There were four member companies represented with six members present.

IN ATTENDANCE:

Raybestos-Manhattan, Inc.
H. W. Oliver, Chairman
M. S. Maier

Johns-Manville Corporation
J. L. Tucker
Ed Beale

Keasbey & Mattison Company
R. L. Lanz

Southern Asbestos Company
J. D. McCluer

Philadelphia Textile Institute
M. C. Shaw

Since all members had received a copy of the minutes of the previous meeting, it was moved by Mr. Tucker and seconded by Dr. Maier that the reading of the minutes be dispensed with at this time.

It was recommended by the chairman that the Technical Committee send a proposal to the Board of Governors stating that the Asbestos Textile Institute award a plaque or scroll to Mr. C. R. Frederick, of Keasbey & Mattison Company, in recognition of his many years of service and contributions to the Institute. It was moved by Mr. J. L. Tucker, seconded by Mr. McCluer, and unanimously approved by all members present this action be taken. It was further recommended in the proposal that President Wakem extend an invitation to Mr. C. R. Frederick to attend our next meeting so that the presentation could be made to him at the General Meeting. This would be done if Dr. Shaw could get the scroll in time for our next quarterly meeting in September.

Mr. R. L. Lanz rendered the report of the Sub-Committee on Asbestos Tapes. There was no change in the status of the specification on industrial tapes. This is complete with the exception of after heating tensiles. There will be no action on this until a standard method for testing after heat tensiles of cloth and tapes can be adopted. The action taken to date on industrial tapes is covered in Table I, attached.

During the past quarter, Mr. Lanz submitted a form to each member company to fill out on electrical tapes for the following gauges: .010", .015", .020", .025", and .030". The data submitted on these forms was discussed in detail, however, several large variations were found in total number of ends on the various widths. This was no doubt due to the different style yarns used by the individual companies. As a result of this, it was agreed that we would attempt to standardize on the 1" width of each thickness tape and continue our work from that point. Mr. Lanz will send out forms requesting constructions and yarns to be used in manufacture of 1" tape. He will then use a formula presented by the chairman and compute a nominal ft/lb., showing permissible range of yarns that may be used with reported constructions (total ends and picks/inch). We will then be able to re-evaluate our individual constructions and yarns to see if any change must be made to stay within tolerances. It was tentatively agreed that on 1" tapes the standard total number of ends and picks/inch would be as follows:

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THICKNESS, INCHES:

	.010"	.015"	.020"	.025"	.030"
No. Ends 1" Width	31	33	28	32	33
Picks/inch, All Widths	17	15	13	12	11

FORMULA MENTIONED ABOVE IS AS FOLLOWS:

$$\frac{(1.10 \div 3) \times \text{Total Number Ends}}{\text{yds/lb. (Warp Yarn)}} = \text{Wt/100}^{\circ} \quad \text{Warp}$$

$$\frac{(1.10 \div 3) \times \text{Picks/inch} \times \text{Width}}{\text{yds/lb. (Filling Yarn)}} = \frac{\text{Wt/100}^{\circ}}{\text{Wt/100}^{\circ}} \quad \begin{array}{l} \text{Filling} \\ \text{Tape} \end{array}$$

The above formula is for non-metallic tape, no binders. In the case of binder warp, it is figured separate from ground warp and approximately 60% contraction factor is used on binder warp instead of 10% as is used on ground warp. This formula is to be used only as a guide and is not guaranteed to be 100% accurate.

Brief discussion took place on tolerances in regards to total number of ends, picks/inch, gauge, etc. Since there were different values reported, there will be another discussion on this prior to writing them into A.S.T.M. specification to be recommended at a later date. This concluded the report of the Sub-Committee on Asbestos Tapes, both Industrial and Electrical.

Since there was no activity in the Sub-Committee on Braided Tubing during the last quarter, there was nothing to report, however, a brief discussion took place on the type of gauge to be used in measuring thickness. Mr. Tucker suggested the Cady gauge and it was requested that he send to each member company a detailed description of this gauge and where it could be purchased. It was agreed that even though we may not agree on a specific instrument, that we should set a standard as to the size of the anvil and the amount of weight to be applied. If we can standardize on this, then the Cady gauge, or its equivalent, could be written into the specification on methods of testing braided asbestos tubing. This subject will be on our agenda for the next meeting for further discussion.

Mr. Cutler, Chairman of the Sub-Committee on Asbestos Cloth, was not present. There was no activity within the committee on this subject during the last quarter as we were awaiting results from Dr. Shaw on dynamic testing of asbestos cloths. Our aim in regards to cloth is to standardize on a heat aging method for testing asbestos cloths. We are not in position to make a recommendation at this time due to further work to be conducted by Dr. Shaw. There was a joint meeting with the Sales Promotion Committee in the afternoon at which time Dr. Shaw discussed this subject as a part of his Fellowship Report #37. In the place of dynamic testing, it is now termed "The Elevated Temperature Serviceability of Asbestos Textiles under Constant Stress". Dr. Shaw feels there is additional work to be done whereby cloths may be tested around 2,000°F. for short periods. He is to write and request necessary samples from each member company so that tests can be made on current cloths. This subject is covered in detail in Dr. Shaw's Fellowship Report, therefore, nothing further will be reported here, however, each member company is to carefully digest the data reported by Dr. Shaw in the Fellowship Report as pertains to this subject.

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and will send to him their comments and recommendations. Dr. Shaw presented pictures of testing equipment used so that everyone would have a much better idea of his undertakings in continuing his work on soaking heat studies and shock tests at higher temperatures. A new oven must be constructed in order to reach the high temperatures for shock testing. This will be worked on during the third quarter.

The next topic on the agenda was that of U. S. Government Specifications. In accordance with the request of the Technical Committee at the March meeting, Dr. Shaw contacted the Detroit Arsenal to find out what had happened to our proposed revision of Mil-C-10316, made in 1954. Mr. G. O. Newcomb, Ordnance Tank-Automotive Command, replied on 12 April 1956, as follows:

"Gentlemen:

Since the proposed revision to Specification Mil-C-10316 elicited considerable comment when coordinated with other agencies in the Department of Defense, it was never issued.

These comments are presently being incorporated into a further revised draft which, it is hoped, will be issued without further delay. Six (6) copies of this revised draft will be forwarded to your organization when it is submitted to Washington for issue."

(Signed) G. O. Newcomb
Assistant"

During the past quarter, each member company was to study Mil-I-3053A, dated August 3, 1951, covering Insulation, Electrical, Asbestos Fiber, Treated and Untreated. Special emphasis was to be given to that part dealing with Di-Electric strength. In checking our records it was found that a proposed revision was submitted in 1954. This proposed revision included a deletion of those parts pertaining to Di-Electric strength. Dr. Shaw has been instructed to write appropriate Government agency to determine the status of the proposed revision. Dr. Shaw will also state that we do not approve of Par. 4.5.4.2 on Magnetic Iron Content when required. Since we are not prepared to make a concrete recommendation at the present time, action will be withheld until further consideration is given this subject. Report to be made at next meeting of our committee. This concluded action on U. S. Government Specifications.

It was moved by Mr. J. D. McCluer and seconded by J. L. Tucker, that Dr. Shaw's project list be expanded to include better ways of determining dust in asbestos fiber, better methods of evaluating asbestos fiber, also, use of mild acid to remove impurities prior to making Water of Crystallization determination on asbestos fiber. Since expensive equipment would be required to carry on some of the above activities, it was recommended that the above be presented to the Board of Governors for appropriate action.

It was recommended by Mr. J. L. Tucker that Dr. Shaw's project list be further expanded to include "Development of Metal Detector", for use on asbestos yarns, rovings, etc. Since Raybestos-Manhattan's representative was opposed to such a project for the Secretary, and, stated they would not participate in this project, it will be presented to the Board of Governors for proper disposition.

There being no further business, it was moved by Dr. Maier and seconded by Mr. Tucker that we adjourn.

Respectfully submitted,
M. W. Oliver, Chairman

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ASBESTOS TEXTILE INSTITUTE
Treasurer's Report
August 30, 1956

Balance in Various Funds - May 28, 1956:

Fellowship Fund	\$ 18,288.25	
General Fund	8,406.76	
Petty Cash	<u>57.28</u>	\$ 26,752.29

Receipts:

Exhibit Fund	\$ 3,500.00	
Travel Expense Refund	<u>352.76</u>	\$ 3,852.76

Transfers:

To Exhibit Fund (From General Fund)	\$ 4,000.00	
To Petty Cash (From General Fund)	<u>92.50</u>	\$ 4,092.50
		<u>\$ 34,697.55</u>

Disbursements:Fellowship Fund:

Fellowship Grant (Phila. Tex. Inst.)	\$ 3,000.00	
Fellowship Salary	3,177.33	
Laboratory Expense	<u>74.95</u>	\$ 6,252.28

General Fund:

Secretary's Salary	\$ 1,009.09	
Stenographic Expense	158.00	
Meeting Expense	286.68	
Legal Expense	534.53	
Auditing Expense	3.00	
Ind. Air Hyg. Found. Survey	864.33	
Exhibit Transfer	4,000.00	
Travel Expense Advance	624.64	
Misc. Office Expense	173.67	
Petty Cash Transfer	<u>92.50</u>	\$ 7,746.44

Exhibit Fund:

Art Guild Payments	\$ 3,233.34	\$ 3,233.34
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Petty Cash Fund:

Lab. Assistance	\$ 21.00	
Lab. Supplies	5.22	
Office Supplies	<u>52.72</u>	\$ 78.94
BALANCE ON HAND, AUGUST 30, 1956		\$ 17,311.00
		<u>\$ 17,386.55</u>

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Balance in Various Funds - August 30, 1956:

Fellowship Fund	\$ 12,009.75	
General Fund	1,039.30	
Exhibit Fund	4,266.66	
Petty Cash Fund	<u>70.84</u>	\$ 17,386.55

Respectfully submitted,

J. G. Schoepf

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FELLOWSHIP REPORT

MYRIL C. SHAW
RESEARCH FELLOW
ASBESTOS TEXTILE INSTITUTE

PHILADELPHIA TEXTILE INSTITUTE
PHILADELPHIA, PA.

REPORT #38

September 6, 1956

MS 004230

MT-003636

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THE SERVICEABILITY OF ASBESTOS TEXTILES
UNDER STRESS AT ELEVATED TEMPERATURES

Introduction

The ability of a wide variety of materials of construction to withstand elevated temperatures under varying degrees of stress is causing no small concern throughout many industries, particularly those responsible for the development of the newer aircraft engines and atomic power plant units. Improved metals, cermets and oxides are being developed and investigated in an effort to increase the thermal resistance limitations presently inherent in the materials available.

Asbestos textiles are likewise being called upon to serve in applications that not many years ago would have been considered untenable. The accepted upper limit of 900°F for AAAA Grade cloths and lesser temperatures for lower grade cloths has placed a deterrent in the consideration and application of many asbestos textiles for uses where temperatures in excess of 1000°F are required. However, certain investigators have successfully adapted asbestos textiles to applications where the temperature requirements were well in excess of the indicated maximum serviceability temperatures for those textiles.

Recent work reported by the Fellow has indicated the possibility of higher temperature applications for certain asbestos textile constructions and in an effort to more specifically determine the high temperature capabilities of these materials work has been pursued with investigations conducted at temperatures up to 2650°F.

In considering this problem with its many implications and possibilities it will be appreciated that to endeavor to establish and fix specific temperature versus grade relationships for a range of asbestos textile materials would be impossible and impractical. There are many factors which in combination will serve to determine the serviceability of an asbestos textile, such as the grade of the material, the grade of chrysotile fibers used in fabricating the material and the weight, weave and construction of the material.

Testing Method and Equipment

The work conducted during recent months has been directed, for the most part, in an effort to determine for a few of the highest grade cloths, the maximum temperatures of serviceability under a "sensible stress" for perceptable periods of time. The term "sensible stress" is defined in this case as a load or stress of measurable proportions greater than the load which would be applied were the cloth permitted to hang free wherein the load would be equivalent to the weight of the cloth itself but considerably less than the "as received" breaking strength. For example, a 2.25 lb cloth will exert a stress of 2.25 lb per square yard while hanging free which is the equivalent of approximately 0.9 lb per square inch of supporting area. Likewise, a 2.50 lb cloth will exert a stress of approximately .93 lb per square inch of supporting area. In applying the "sensible stress" an auxiliary load has been added to the test specimens to affect a stress on the 2.25 lb cloth equivalent to approximately 70 lb per square inch of supporting area, and in the case of the 2.50 lb cloth, approximately 65 lb per square inch.

The "sensible stress" here selected bears no relationship to practical application possibilities but was selected to conform with the limitations of the testing equipment adopted for this work.

The test equipment selected for this work was developed primarily for exploratory purposes and was so devised that it might serve to determine whether or not further work along these lines is justified and if so how the stress and temperature applications might be best exerted and controlled.

The test furnace consisted of a vertical, tubular muffle, 3" inside diameter by 3-1/2" deep, said muffle being encased in an insulating brick refractory shell. The furnace muffle was heated by means of an air-gas Meeker burner inserted in the bottom opening of the muffle. A temperature indicating Platinum-Platinum-Rhodium thermocouple, mounted in the top of the muffle opening was so positioned that it would measure the temperature at the surface of the test cloth specimens supported across this opening.

The cloth samples to be tested were supported in a metal bow frame so constructed that the samples, 1" wide by 20" long, could be mounted and, by means of a calibrated spring, be subjected to a known pull or stress. The sample so mounted was positioned that it would span the top of the furnace muffle opening.

With the unit here described it was possible to attain and maintain temperatures up to 2650°F for controllable periods of time and served effectively to provide the information here to follow. However, if an extensive investigation along the lines here pursued is to be undertaken it is recommended that a more substantial unit and one having greater testing capacity be provided.

Test Results

In an effort to explore the scope and possibilities of usefulness for data which might result from the work here to be undertaken, a variety of representative cloths were first investigated at a high temperature and a high stress in order to determine the upper limits of possible serviceability life. The first series of tests were run at 2550°F at a stress exerted by a 20% pull and under these conditions the following results were obtained.

Style	Grade	Duration of test before failure. Seconds	Stress Equivalents in pounds per square inch
22P10G	Und.	12	570
40P10	Und.	12	266
40P10	Und.	13	266
36P10	A	12	286
29P14	AA	11	345
36P10	AA	7	286
40P10	AA	22	266
22P16	AAA	10	392
48T12	AAA	28	266

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It will be observed that the load or stress applied in all of these tests was 20%, however, due to the differences in the thicknesses of the various cloths, the stress equivalents in pounds per square inch of supporting area are different for each construction.

The results of the foregoing studies served to indicate that at the temperatures used a stress considerably less than 20% or 250% per square inch equivalent will be necessary if significant life is to be obtained. The next series of experiments was therefore designed to determine the "sensible strength life" of a group of asbestos textiles at temperatures of 2500°F and 2650°F. The cloths selected for this investigation were 36P10 style in Grades A, AA and AAA and style 40P10 in Grade AA. The "sensible strengths" selected were obtained by applying a 5% load or the equivalent of 71.5% per square inch for the 36P10 and 66.6% per square inch for 40P10. Under these conditions the following results were obtained.

		Time of Failure Minutes	
		<u>2500°F</u>	<u>2650°F</u>
36P10	A	8	less than 1
"	AA	no failure after 30 minutes	less than 1
"	AAA	"	2.25
40P10	AA	"	4.50

Also investigated at this time were samples of Blue Asbestos cloth reasonably comparable to 36P10 in style and failure was found to occur in less than 10 seconds at 2000°F.

In addition to the series of ultra-high temperature tests herebefore described, work was continued using the equipment and techniques as set forth previously, Report #37, wherein studies at moderately high temperatures up to 1475°F were described. In this latest work, samples of 36P10 in Grades AA and AAA were positioned in the electrically heated test furnace under a stress of 8.5% (120% per square inch equivalent) for the Grade AA cloth and 11.0% (155% per square inch equivalent) for the Grade AAA cloth. Under these conditions of stress the test was started at 1000°F and run continuously for one week; there being no failure at the conclusion of this period, the temperature was increased to 1200°F and run for a second week, following which the temperature was increased to 1400°F for a third week, to 1450°F for the fourth week and the test concluded with two additional weeks at 1470°F. The over-all test consumed 6 weeks at temperatures ranging between 1000°F and 1470°F and at the conclusion of this test period there was no failure. However, the samples were permitted to cool down to room temperature in the furnace and under load and at some time during this cooling period failure did occur. The time and temperature of failure was not determined since it occurred during a period of our absence from the laboratory. This cooling failure is however important and more information in this regard is desired. It is undoubtedly a subject for thermo-mineralogical analysis and from such determinations we may be able to establish some fundamental data related to the elevated temperature weaknesses of the chrysotile fiber.

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Analysis of Results

The ability of an asbestos textile to resist destruction due to stress at elevated temperatures is dependent upon a number of factors, including the properties and characteristics of the textile, and the temperatures and stresses to which it may be subjected. In general, however, the results here obtained would indicate that under the conditions of these tests at low or "sensible stress", that is, in the neighborhood of 100 pounds per square inch, Underwriters Grade cloths will normally withstand destruction up to temperatures in the neighborhood of 900°F to 1200°F depending upon weight, weave and construction of the cloth. Increasing the stress to 200 pounds per square inch decreases the temperature range to 600°F to 900°F and at 300 pounds per square inch stress the temperature range is further decreased to 450°F to 650°F.

Cloths in constructions ranging from 29P14 to 40P10 in Grade AA were found to resist failure at a temperature of 1400°F under a "sensible stress" approximating 100% per square inch and additional tests at much higher temperatures revealed that style 36P10 cloth in Grade AA would withstand the "sensible stress" for thirty minutes at 2500°F without destruction. At temperatures of 850° - 900°F failure was induced under stress somewhat greater than 500% per square inch.

Cloths in Grade AAA were found to respond to these tests with proportionately high serviceability characteristics. Under stresses equivalent to from 510% to 1200% per square inch, failures were obtained at temperatures ranging from 800°F to 1085°F.

It will be observed that in every instance, the cloths tested at a minimum load or what we have termed "sensible stress", the temperature of failure far exceeds the generally recognized temperature limits of serviceability for the several asbestos cloths tested. While it is not the intention here to suggest that these tests or the results of the tests should be used at this time to revise our present understanding with regard to the temperature limits of serviceability or to indicate changes in the heat-aging tests currently incorporated as a part of several consumer specifications, it would seem that certain parts of the information here developed might well provide engineering data which would be of interest and service to those engineers presently confronted with high temperature materials problems.

Conclusions

It must be understood that the results here reported are, for the most part, based upon short term tests ranging from a few minutes to two hours, however, one test was conducted for a period of six weeks as indicated. To endeavor to define the limits of the serviceability here being investigated on the basis of the results of these short term tests would be misleading and ill-advised, however, the data here developed does serve to provide basic information upon which a more thorough and extensive investigation is to be pursued.

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We would at this point therefore welcome suggestions from the membership as to the direction to be followed in carrying this investigation further. A clarification as to the temperature ranges of practical interest and the stress or load bearing requirements actually expected would be very helpful in determining the ranges to be covered in further work. It is realized that long term tests will eventually be necessary in order to complete the picture here being developed, however, such tests are time consuming and the results are accumulated very slowly. It would therefore seem desirable at this point to continue to conduct accelerated tests within the limits of practicability in order to definitely define all of the parameters for the full scope of the useful information to be obtained from this work before engaging in the long term tests.

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MINUTES of the General Meeting of
the Asbestos Textile Institute held
March 6, 1950 in Philadelphia, Pa.

IN ATTENDANCE:

F. J. Waken, President
JOHNS-MANVILLE CORP.

AMERICAN ASBESTOS TEXTILE CORP.
J. W. Weber

ASTEN-HILL MANUFACTURING CO.
D. R. Holmes

JOHNS-MANVILLE CORP.
W. C. Seeds
E. A. Schuman
K. Q. Beyard
E. H. Wells
W. S. Hough
H. H. Jackson

KEASBEY & MATTHEWSON CO.
C. R. Frederick
R. L. Lanz
A. E. Whitfield
D. W. Widmayer

RAYBESTOS-MANHATTAN, INC.
J. A. Bettles
J. A. Brown
M. W. Oliver
R. B. Smith

SOUTHERN ASBESTOS CO.
J. T. Griffin
G. J. Harris
R. S. Hulse

CASSIAN ASBESTOS CORPORATION, LTD.
T. T. Tigert

CADWALADER, WICKERSHAM & TAFT
M. I. Ruddeck

ASBESTOS TEXTILE INSTITUTE
M. C. Shaw

Guests:

ASBESTOS TEXTILE COMPANY
Frank Gatke

GARLOCK PACKING COMPANY
G. E. Houghton

1. The meeting was called to order by President Waken and an address of welcome extended to all of the members present. Recognition and welcome was also extended to representatives of two former member companies who attended the meeting of the Air Hygiene Committee held March 7 and were also in attendance at this meeting, namely, Mr. G. E. Houghton, Garlock Packing Company, and Mr. Frank Gatke, Asbestos Textile Company.
2. The Minutes of the last meeting of the Institute were presented for reading, however, since all members had received copies of these minutes and were familiar with the actions there taken, it was moved by J. A. Bettles, seconded by D. R. Holmes and unanimously agreed that the reading of the minutes be omitted at this time.
3. The Treasurer's report was read by the Secretary in the absence of J. G. Schoepf, Treasurer. Following a discussion of the contents of this report, it was moved by D. W. Widmayer, seconded by J. A. Bettles and unanimously agreed that the report be accepted.
4. The Secretary announced that the next General meeting of the Institute would be held at Thetford Mines, Canada, on June 6 and 7, and that the necessary arrangements for accommodation at Thetford and travel facilities to and from the

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meeting were being made by the President and Secretary. As soon as the Secretary can ascertain the number of members who will attend this meeting, this information will be turned over to President Waker who will in turn endeavor to carry the plans forward with some assistance of the traffic department at Johns-Manville Corp.

Since it is unlikely that the full membership will be able to attend these meetings, it is now planned to hold the committee meetings normally held on the day preceeding the General meeting in New York on the day preceeding the Thetford meetings. The results of any actions taken at the committee meetings will be reported at the Thetford meetings by the Chairman of the respective committees.

6. The next report was presented by D. R. Holmes, Chairman of the Air Hygiene Committee. The considerations of this committee in session on March 7 were fully discussed and the specific actions there taken were noted. The comments of Dr. Smith, Johns-Manville Corp., related to the report issued by Dr. Hueper on a subject relating asbestosis with lung and heart diseases was discussed at great length. This latter matter earlier received attention by the Board of Governors and it was announced that this body had appropriated sufficient funds to initiate a preliminary survey to investigate the possibility of more concerted action designed to refute the work of Dr. Hueper. The full report for this committee is attached as a part of the minutes of this meeting.
7. The Sales Promotion Committee report was presented by J. T. Griffis, Chairman. It was reported that this committee has been actively engaged in efforts designed to promote the dissemination of information designed to enlighten and educate the consumer of asbestos textile products regarding their unique characteristics and applications. The placement of Visual Aid Displays and plans for the development of the new asbestos textile exhibit were fully discussed.

In an effort to speed up the development of the new exhibit it was agreed that a part of the necessary funds for its construction should be made available at this time. It was moved by D. W. Widmayer, seconded by D. R. Holmes and unanimously agreed that a sum of \$4,000.00 be transferred from the General Fund

EXHIBIT 10

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