FELLOWSHIP REPORT

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Heat Aging Test on Asbestos Cloths Styles 36P10 and 26P14

Introduction

The subject of heat aging tests for asbestos textiles, the procedures and techniques to be followed and the extent and character of degradation resulting therefrom have been discussed in detail in several previous reports by this writer. It is generally understood that heat aging tests when conducted for control purposes over short periods of time or under unique heating conditions should not be regarded as simulative service tests nor should the results be interpreted in terms of specific ultimate service characteristics.

Heat aging tests do effectively serve to distinguish quality or grade differences between cloths and also may indicate differences in the fiber quality or grades which may have been used in manufacturing cloths of the same grade. Indeed, this latter determination may be one of the most important revelations resulting from such tests.

In an effort to obtain significant data and information that might serve as the basis upon which may be established industry-wide heat aging characteristics for certain asbestos textiles, the Technical and Sales Promotion Committees directed the Fellow to conduct a series of heat aging tests on an industry-wide selection of cloths of styles 36P10 and 26P14, in all available grades. This work has been completed and the results of the tests are here reported.

Test Procedure

Samples. For this work, five member companies submitted materials for test as follows:

26P14 - Underwriters	- 4	samples
26P14 - Grade AA	- 3	"
36P10 - Commercial	- 2	"
36P10 - Underwriters	- 5	"
36P10 - Grade AA	- 3	"
36P10 - Grade AAA	- 4	"

Sample Preparation. Tests were run only in the warp direction using eight warp-grab samples of each cloth for each test. The results, as reported, are the average of eight determinations for each sample.

Cloth Characteristics. The characteristics of each of the samples as related to weight, thickness and construction are set forth in Table I. Certain of these characteristics are noted with an asterick and + or - which serves to indicate that the property so noted is either in excess of or less than the tolerable limits as presently accepted by the industry.

Heat Aging Test Procedure. The test procedure followed in this work was in conformance with the practice as recommended on previous occasions by the writer. That is, an air circulating oven was used, the test samples were laid in a single layer on a wire mesh screen within the oven, and the samples were permitted to condition under room conditions for 30 minutes following the test before the tensile strength determinations were made. The duration of each test was 2 hours. The temperatures at which these tests were conducted were 300°F, 400°F, 500°F, 600°F, 700°F and 800°F.

Investigational Data

The results of the tests here conducted are set forth in Table II, wherein the breaking strength, in pounds, is given; in Table III, wherein the percentage strength retentions are presented; and in Plates I, II, III and IV which graphically presents the data contained in Tables II and III.

Plates I and III set forth the data in terms of pounds breaking strength and Plates II and IV present the same data in terms of percent strength retention.

It will be observed that the cloths are grouped according to style and grade in both the tables and the graphs.

26P14. The selection of four Underwriters Grade and three Grade AA cloths in style 26P14 show ranges in tensile strength, as received, of from 84 to 110 pounds for Underwriters Grade and from 91 to 113 for Grade AA. Plates III and IV graphically present this information and, in addition, show the increased differences between maximum and minimum values as a result of heat aging. For example, the Underwriters Grade cloth at 400°F shows a range of from 57 to 87 pounds and at 600°F from 22 to 52 pounds. The same style cloth in Grade AA exhibits even more marked differences, ranging from 91 to 113 pounds as received, 86 to 122 pounds at 300°F and 54 to 98 pounds at 500°F.

Plotted on each of the graphs are lines connecting the bar plots, the dotted line representing the range average or medium value and the solid line the average or arithmetic mean value. For the most part, the two values are not greatly different, being not more than two pounds apart for Grade AA and five pounds apart in two instances for Underwriters Grade. However, it will be seen that the difference between the maximum and minimum values and the average values is considerably greater than tolerance provisions would permit. For example, in Underwriters Grade, the "as received" tensile strength will be found to range from 84 to 110 pounds with an average of 96 pounds. This would require a specification of 96 ± 12# or 12.5%. As the temperatures increase the tolerance requirements also increase, for example, Underwriters Grade at 600°F has a range of from from 23 pounds to 53 pounds and would require a specification of 35 ± 18 pounds or 51%. The same relative relationships exist for the Grade AA cloths.

36P10. The cloths in style 36P10 fall within much closer tensile strength ranges with only the Grade AAA materials exhibiting excessive ranges of values. Plates I and II graphically present this data.

The Commercial grade cloths in this style are represented by only two cloths and it is perhaps unwise to consider this data as representative of the industry's production of this material. However, the "as received" tensile strength values of the cloths submitted exceed the presently accepted values of 95 pounds by from 20 to 45 pounds. As the temperatures of test increase the range of strengths decreases to ± 4 pounds from the average of approximately 21 pounds at temperatures above 500°F. It will also be observed that the strength characteristics of the Commercial grade and Underwriters grade cloths are quite similar over the entire range and not greatly different with the average values being approximately 21.5 and 33.0 pounds respectively.

Table I

Cloth Construction Data

Sample #	Style	Grade	Weight	Thickness	Construction
301	26P14	Und.	1.70	0.059	15 x 13.7
308	"	"	1.56	0.054	14.6 x 13.3
313	"	"	1.47*(-)	0.055	14 x 14
319	"	"	1.73	0.057	15 x 14
302	26P14	AA	1.82*(+)	0.057	14.6 x 13.3
318	"	"	1.73	0.056	15 x 14.3
322	"	"	1.67	0.050	15 x 14
303	36P10	Comm.	2.23	0.075	18.7 x 9
309	"	"	2.29	0.076	18 x 9
304	36P10	Und.	2.35	0.071	18.3 x 9.3
307	"	"	2.45*(+)	0.084*(+)	18.6 x 8.8
310	"	"	2.30	0.076	18.3 x 8.7
314	"	"	2.21	0.080	18.3 x 9
317	"	"	2.24	0.077	18.6 x 9
305	36P10	AA	2.29	0.072	18.7 x 9
311	"	"	2.30	0.072	18.3 x 9
320	"	"	2.30	0.088*(+)	18.3 x 9.3
306	36P10	AAA	2.33	0.073	18.3 x 9.3
312	"	"	2.19	0.068	18 x 9
316	"	"	2.21	0.076	18 x 9
321	"	"	2.44*(+)	0.078	18.3 x 9.7

Table II

Tensile Strength - Pounds

	#	As Received	300°F	400°F	500°F	600°F	700°F	800°F
26P14 Und.	301	85.8	79.5	57.0	25.62	22.6	23.62	26.0
	308	106.2	98.75	87.75	52.80	52.5	50.6	51.7
	313	84.2	80.8	64.25	38.9	30.5	28.0	29.12
	319	110.0	102.9	70.5	42.1	32.2	29.25	30.4
	Avr.	96.55	90.5	69.87	39.85	34.45	32.87	34.3
26P14 AA	302	91.2	86.9	73.1	54.0	53.4	54.62	53.0
	318	95.4	96.4	80.9	73.25	70.0	71.60	72.0
	322	113.8	121.9	98.0	98.10	94.1	85.40	81.6
	Avr.	100.1	102.0	84.0	75.12	72.5	70.54	68.9
36P10 Comm.	303	114.8	103.5	63.56	20.0	17.5	17.12	17.6
	309	139.4	138.5	107.7	39.62	26.75	26.0	24.9
	Avr.	127.1	121.0	85.63	29.81	22.12	21.56	21.2
36P10 Und.	304	127.0	117.63	68.75	28.6	28.6	29.75	28.8
	307	144.8	144.0	102.5	44.4	36.25	34.4	33.6
	310	143.2	142.0	107.7	49.5	37.12	35.0	33.6
	314	139.0	125.5	82.62	39.8	26.5	24.9	25.4
	317	136.4	124.75	89.3	55.0	45.0	43.25	41.6
	Avr.	138.1	130.77	90.2	43.46	34.69	33.46	32.6
36P10 AA	305	128.2	121.25	99.12	80.5	80.3	82.0	79.0
	311	124.4	124.30	108.1	80.25	66.5	70.8	67.37
	320	136.2	136.1	109.0	89.87	86.62	87.6	86.9
	Avr.	129.6	127.22	105.41	83.54	77.81	80.1	77.2
36P10 AAA	306	134.2	126.5	121.25	104.1	103.3	107.0	100.6
	312	168.0	169.8	156.1	152.3	147.4	159.4	150.5
	316	162.6	161.0	160.1	157.5	145.0	152.39	152.4
	321	163.6	170.1	140.7	136.0	132.9	138.90	130.0
	Avr.	157.1	156.85	144.54	137.5	132.2	139.42	133.4

Table III

Percent Tensile Strength Retention

	#	300°F	400°F	500°F	600°F	700°F	800°F
26P14 Und.	301	93.5	66.5	29.8	26.3	27.6	30.3
	308	92.6	82.3	49.6	49.3	47.5	48.5
	313	96.0	76.2	46.1	36.2	33.2	34.5
	319	93.5	64.1	38.2	29.3	26.6	27.6
	Avr.	93.9	72.3	40.9	35.3	33.7	35.2
26P14 AA	302	95.2	80.0	59.2	58.6	60.0	58.1
	318	100.5	84.8	76.8	73.5	75.2	75.5
	322	107.0	86.2	86.5	83.0	75.0	71.7
	Avr.	100.9	83.7	74.2	71.7	70.0	68.4
36P10 Comm	303	90.2	55.5	17.4	15.2	14.9	15.3
	309	99.5	77.1	28.4	19.3	18.3	17.8
	Avr.	94.9	66.3	22.9	17.2	16.6	16.5
36P10 Und	304	92.5	54.1	22.40	22.40	23.4	22.7
	307	99.5	71.0	30.60	25.00	23.8	23.2
	310	99.0	75.0	34.50	25.80	24.4	23.4
	314	97.6	59.5	28.60	19.20	17.9	18.2
	317	91.5	65.5	40.40	33.00	31.6	30.5
	Avr.	96.0	65.0	31.3	25.1	24.2	23.6
36P10 AA	305	94.5	77.2	62.7	62.5	63.8	61.5
	311	99.9	87.0	64.5	53.4	57.0	54.0
	320	99.9	80.0	65.8	63.0	64.2	63.0
	Avr.	98.1	81.4	64.3	59.7	61.7	59.5
36P10 AAA	306	94.0	90.3	77.5	76.5	79.7	74.9
	312	101.0	92.8	90.5	87.8	94.8	89.5
	316	99.0	98.5	96.5	89.2	93.8	93.5
	321	104.0	86.0	83.0	81.0	85.0	79.5
	Avr.	99.5	91.9	86.9	83.6	88.4	84.4

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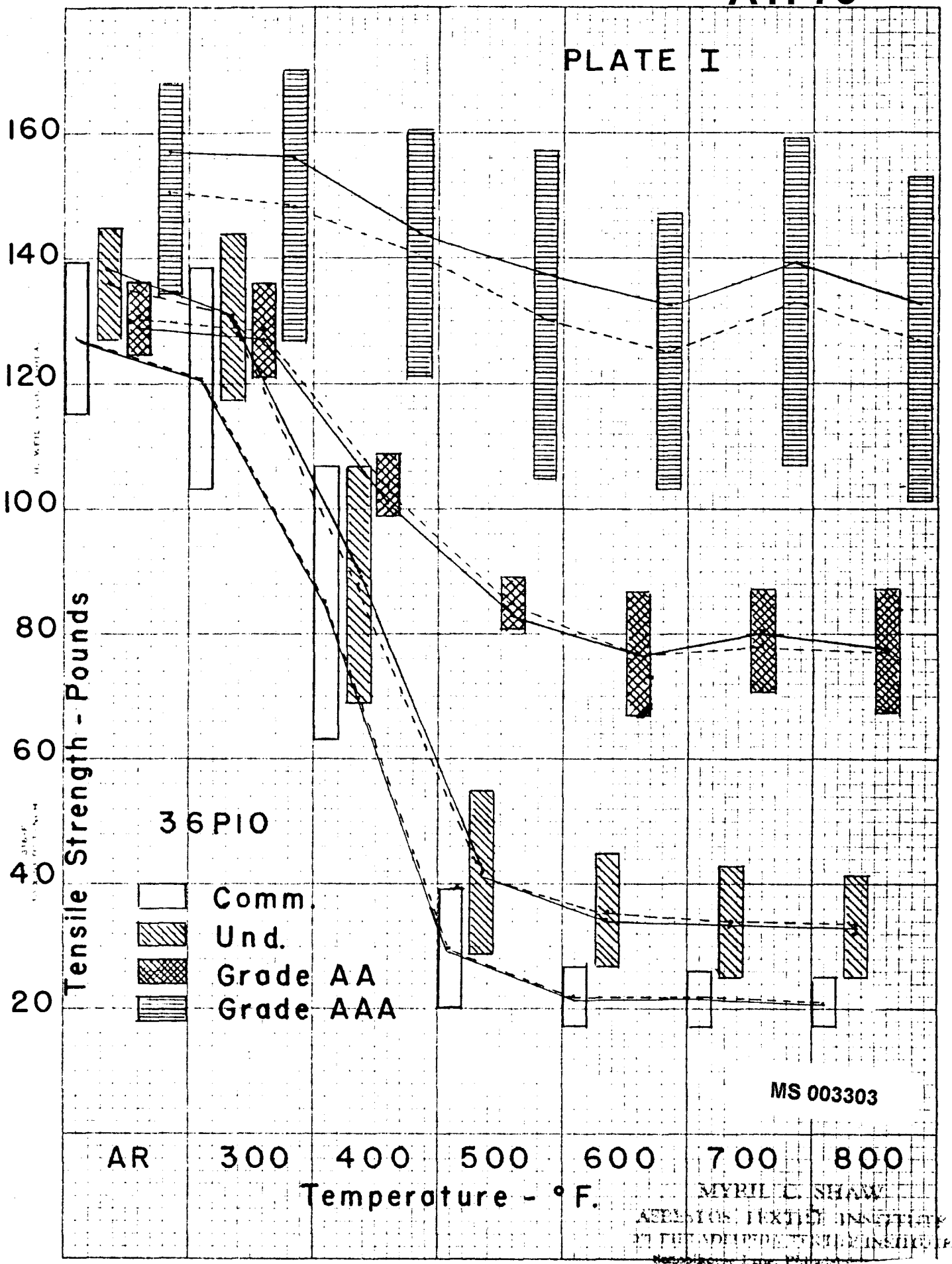

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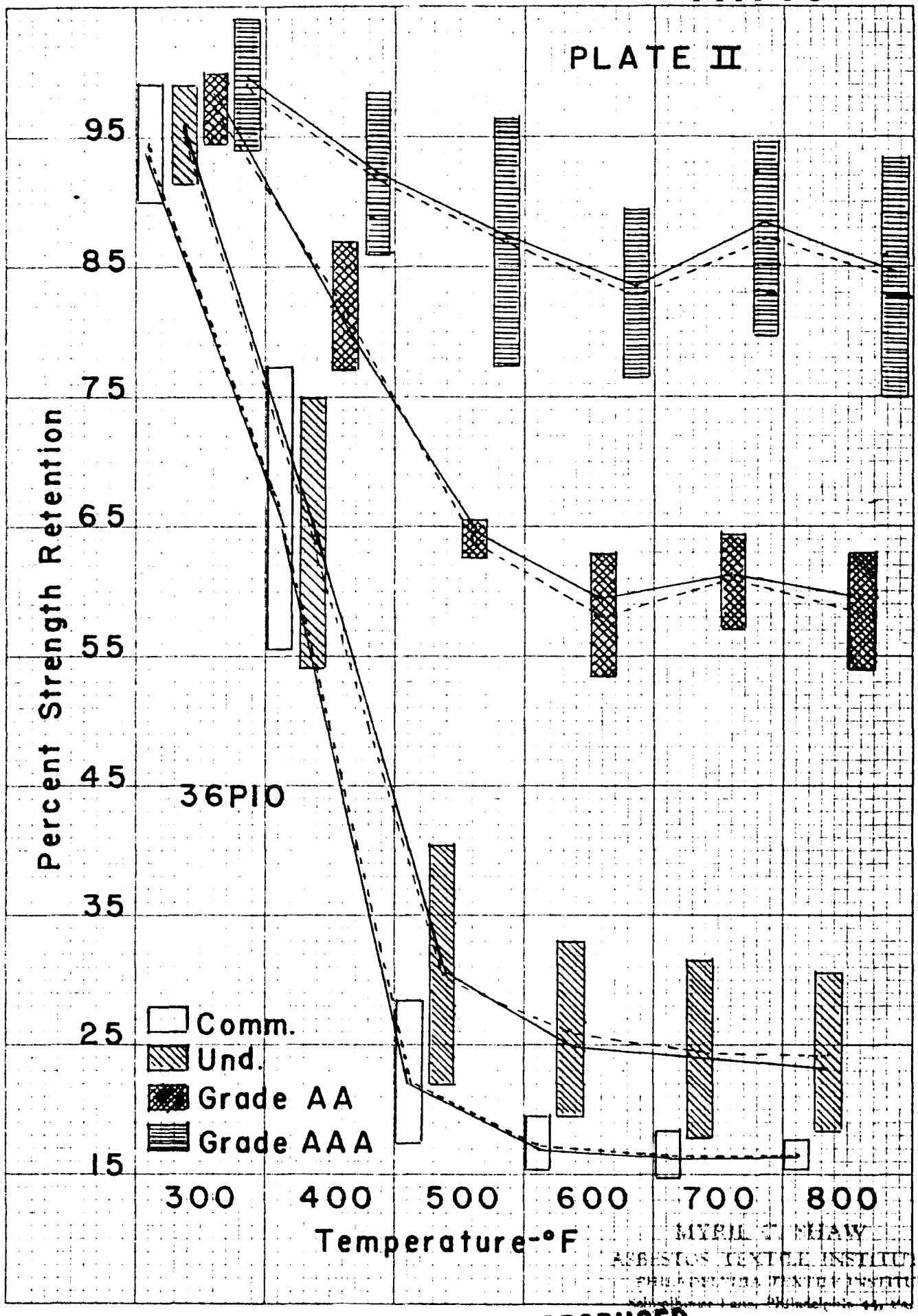

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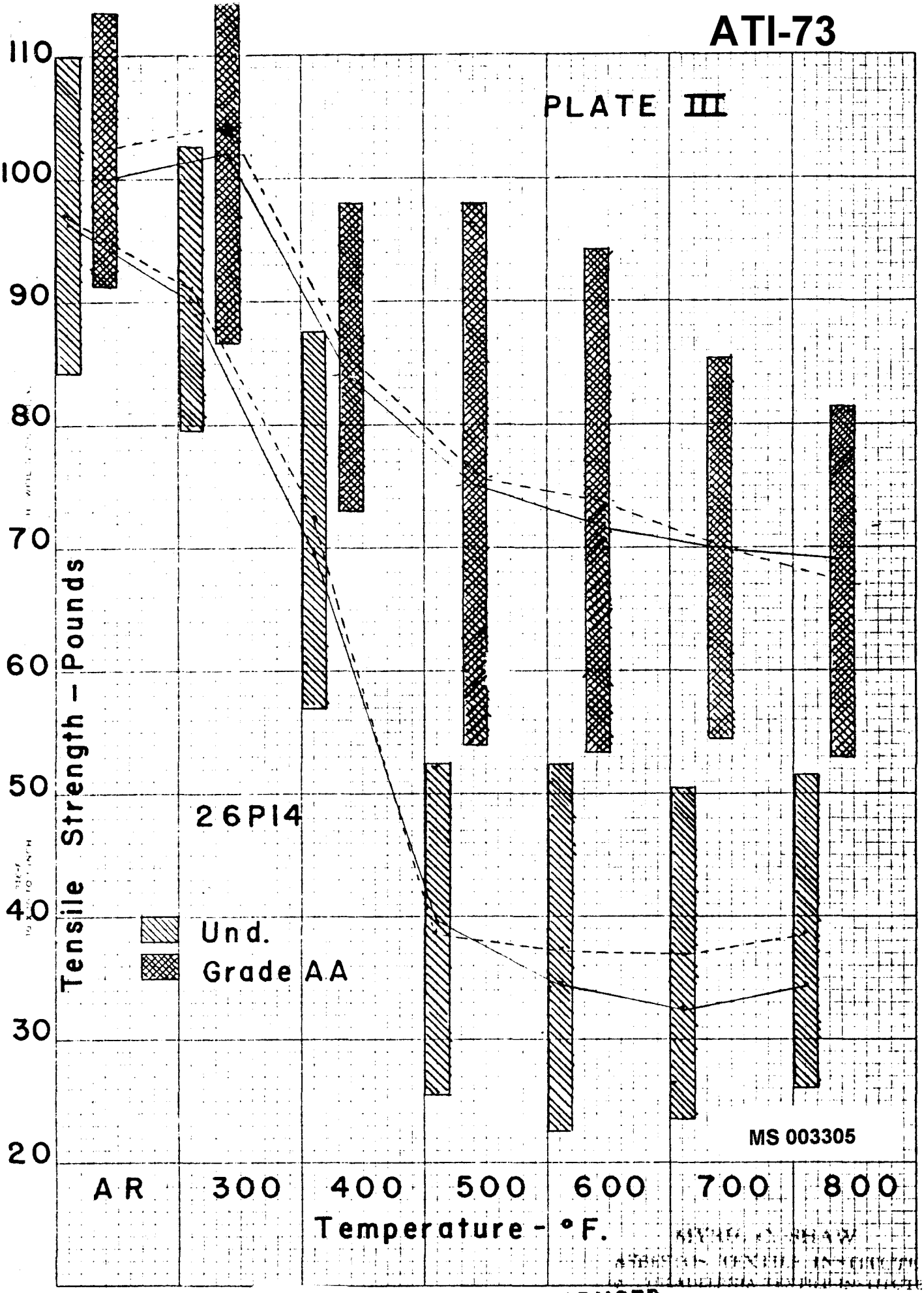
PLATE III



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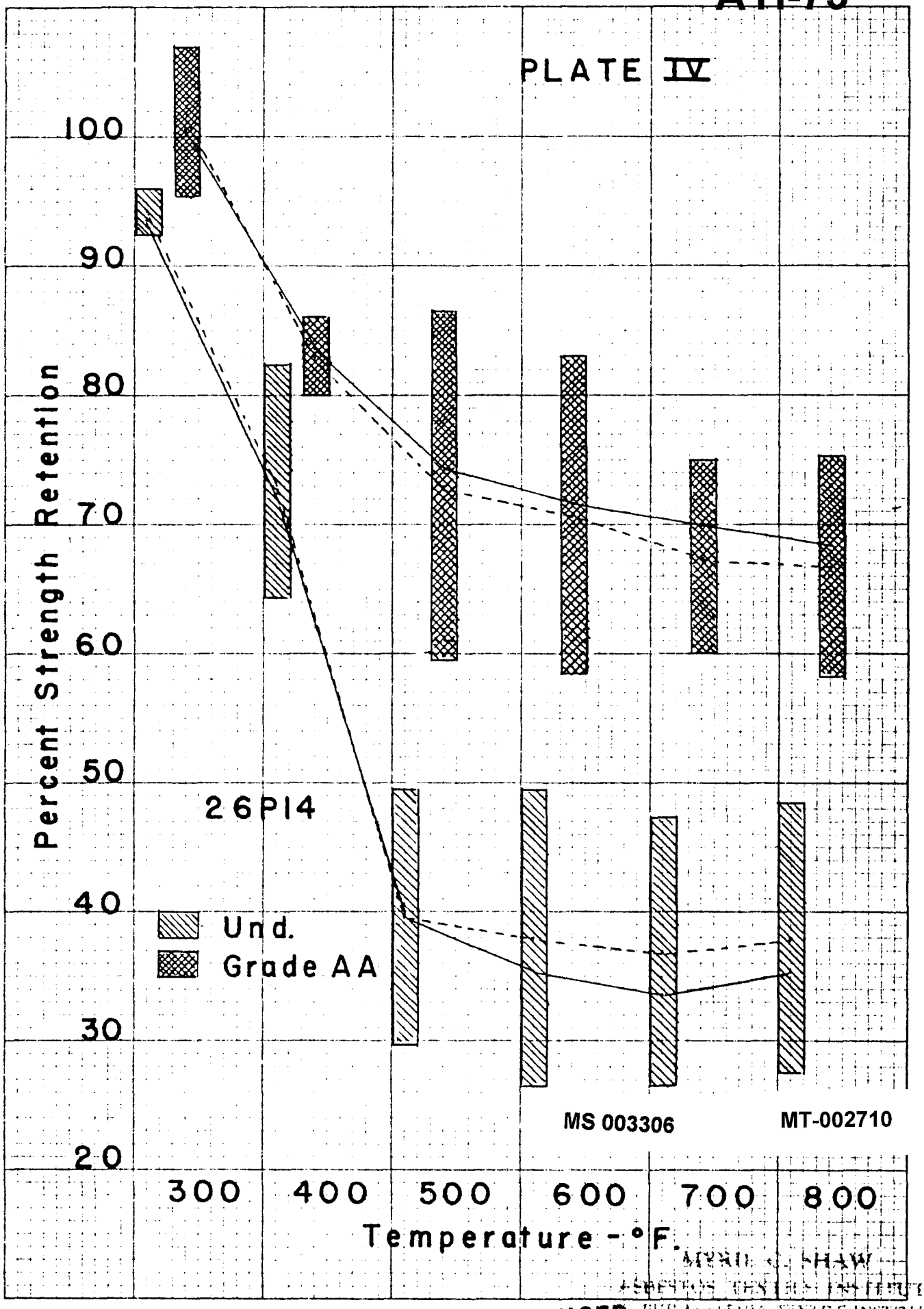

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Cloths in both Grades AA and AAA exhibit relatively good strength retention characteristics over the temperature range here used, reaching minimum strengths at 600°F and exhibiting properties as good or better than minimum at temperatures of 700°F and 800°F. The Grade AA cloth reaches a minimum value of approximately 77 pounds or 59.5% of the original strength and Grade AAA shows a minimum value of 132 pounds or 83% of the original strength.

Analysis of Results

An analysis of the results of the tests conducted during this investigation reveals several significant facts. First, the range of tensile strength values for the style 26P14 in grades Underwriters and AA are in excess of tolerable limitations both "as received" and "after heat aging" at temperatures up to 800°F. The tensile strength of the cloths "as received" ranges from 84 to 110 pounds for Underwriters grade and from 91 to 114 pounds for Grade AA, which is the equivalent of approximately ± 13% variation for Underwriters and ± 14% for Grade AA.

These variations become even more pronounced as the heat aging temperatures are increased. It would seem that an effort should be made to reduce or resolve this wide range in tensile strength values before an attempt is made to write specifications in this instance.

Secondly, the tensile strength characteristic of the cloths in style 36P10 appear to be within tolerable limits for consideration of the problem at hand. All of the tensile strength values obtained for 36P10 in all grades "as received" exceeded the presently accepted industry-wide standards and the average values for each group were considerably in excess of the standard.

Thirdly, the minimum tensile strength values resulting from heat aging were obtained, in most cases, at 600°F and heat treatment at higher temperatures did not appear to materially reduce this figure, in fact, in two cases, an increase was obtained at 700°F over that obtained at 600°F. This latter phenomenon occurred in 36P10 style cloths in Grades AA and AAA and is undoubtedly attributable to the loss of moisture by the asbestos fibers with the resultant contraction within the fiber bundles with increased frictional resistance between the individual fibers resulting.

Conclusions

The writer has made an effort to point out in reporting the results of earlier extensive investigations covering heat aging tests ranging in time periods of from five minutes up to seven days and over temperatures of from 200°F to over 2500°F, that the results to be obtained are dependent upon factors of cloth construction and composition as well as the time and temperature of test. To endeavor to define a time-temperature relationship for a grade of material irrespective of the weight, weave and construction can be quite misleading. To ideally meet the requirements, each cloth construction should be considered as a group within itself and the full range of grade-temperature-tensile strength relationships within this group should be used to provide information of significance. Such tabulations for the two styles of cloth here investigated have been set up based upon the results of this work and are presented in Tables IV and V. It will be noted that in Table IV, wherein the data is presented in terms of pounds, tensile strength, the strengths