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FINAL REPORT
June 1962

MATERIAL EVALUATION FOR A SUPERSONIC TRANSPORT PLANE

by

V. Weiss
R. Sell
C. Chave

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SYRACUSE UNIVERSITY RESEARCH INSTITUTE

DEPARTMENT OF CHEMICAL ENGINEERING AND METALLURGY

Approved by:

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ABSTRACT

4630 The screening program of materials being considered for a Supersonic Transport Plane conducted at Syracuse University during the period April 1961 through April 1962 is summarized in this report. The materials investigated are shown in Table I. Experimental results are shown in the form of graphs where the tensile strength, 0.2% yield strength, modulus of elasticity, elongation in percent, notch strength and the notch strength ratio are shown as a function of the test temperature. Evaluation of the alloys is also presented on the basis of notch strength ratio versus strength to density ratio. The titanium alloy Ti-6Al-4V annealed appears to be the most promising in this representation.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

This final report represents a summary of all data obtained to date at Syracuse University in the Screening Program of Materials being considered for a MACH III Transport Plane. During the course of this investigation three (3) quarterly progress reports have been submitted. (1, 2, 3) To date, data on five materials listed below have been investigated:

AISI-301 Stainless, 34%, 51% and 60% - Cold Reduction

PH 15-7 Mo, RH 1050 and CH 900

Ti-6Al-4V (RS 120A) Annealed, Solution Treated and Aged

Ti-4Al-3Mo-1V (RS-115) Annealed

Ti-5Al-2.75Cr-1.25Fe (RS-140) Annealed, Solution Treated and Aged

The heat treating conditions and the chemical composition of these materials are listed in Tables I and II respectively.

The test program was primarily designed to provide a comparative evaluation of materials on the basis of tensile and notch tensile properties prior and subsequent to a 1,000 hour exposure under stress at 650F.(4) The exposure stress was chosen on the basis of preliminary design information on the expected service loads of the airplane. Steels and super-alloys were exposed under a stress of 40 ksi, titanium alloys under a stress of 25 ksi. The test specimens are illustrated in Fig. 1. All sheet materials had a thickness of 0.025 in. The tensile specimen had a width of .375 in., the notch tensile specimen had a gross section width of 1 in. and a net section width of 0.705 in., the notch root radius being less than .001 in.

P1

In addition, edge cracked specimens were tested for selected conditions in order to evaluate the influence of notch sharpness. Tensile tests and notch tensile tests were conducted at -110F, 75F, 350F, 650F and 800F, prior to exposure and at -110F, 75F and 650F subsequent to the above described 1,000 hour exposure under stress.

The tensile and notch tensile tests were conducted on a 60,000 lbs. capacity Baldwin Universal Testing Machine equipped with a micro-former stress-strain recorder. For the tests at -110F specimens were immersed in a solution of dry ice and acetone, room temperature (75F) tests were conducted in air, for elevated temperature tests the specimen was tested inside a Marshall furnace. Stress-strain curves were obtained for all tests on smooth specimens to permit the determination of the modulus of elasticity and the .2% yield strength as a function of test temperature and exposure treatment.

The exposure treatment was conducted in stress rupture machines converted for this purpose to accommodate two or three specimens within the constant temperature zone of the furnace.

In the preparation of notch tensile specimens special attention was given to an exact measurement of the root radii both prior and subsequent to exposure. All specimens having notch root radii in excess of .001 in. were rejected. A Sonntag Universal Fatigue Testing Machine was converted to allow the manufacture of edge cracked specimens from a 10% starter notch. With the exception of Ti-5Al-2.75Cr-1.25Fe (RS 140) in the solution treated and aged condition all materials were suitable to fatigue cracking by this method.

The following discussion of the experimental results includes all data obtained to date. Additional tests under the same program are now in progress on some materials contained in this report. The results will be discussed at a later date. In general the future effort consists of a continuation and amplification of the screening program. In the latter phase transition temperature studies are under way on Ti-6Al-4V, (Annealed, Solution Treated and Aged), PH 115-7 Mo, (RH 1050, CH 900) and Ti-8Al-1Mo-1V in the duplex annealed condition. The effect of exposure under stress on the ductile-to-brittle transition temperature will also be investigated on the more promising alloys. In addition a follow-on program is being initiated on wider specimens for the more promising alloys. A study on the effect of stress concentration factor in which specimens having various stress concentration factors between 1.5 and that corresponding to a natural crack has also been initiated.

EXPERIMENTAL RESULTS

In the following discussion of the experimental results each alloy will be discussed separately. An overall comparison of the relative rating of all alloys will be given in the Conclusions. The data are presented as a function of test temperature and fall generally in two categories: properties obtained from smooth specimens such as tensile strength, 0.2% offset yield strength, elongation in 2 in. and modulus of elasticity, and the properties obtained from notched specimens namely notch strength (on notched and cracked specimens) and notch strength ratio (notch strength/tensile strength, both taken at the test temperature indicated.) Longitudinal properties are represented by open symbols, transverse properties by solid symbols, properties prior to exposure by circles, properties subsequent to exposure by triangles. In some cases crack data were obtained and are represented by squares. Whenever data were obtained from an exposure treatment in which the specimen was subjected to the exposure temperature of 650F only and not simultaneously subjected to a load (no-load exposure) the data are represented by inverted triangles.

AISI-301 (Tables IV through IX)

Three strength levels of this alloy were investigated as obtained by a 34%, a 51% and a 60% cold reduction, namely 175 ksi, 220 ksi and 225 ksi respectively. The results are presented in Figs. 2 to 7.

Fig. 2 shows the smooth properties of AISI-301 cold reduced 34%. The tensile and yield strengths show a slight increase at all heat temperatures

P4

of directionality causing lower transverse properties at all test temperatures, but particularly at -110F and at 75F. The elongation drops rapidly with increasing test temperature from approximately 18% at -110F to less than 4% at and above 350F. Adverse transverse properties are again observed below 350F. The exposure treatment causes a considerable loss in elongation at -110 and 75F in the transverse direction and at 75F in the longitudinal direction. Specimens subjected to a no-load exposure gave the same results as those exposed under stress.

The notch properties of AISI-301, cold reduced 34% are illustrated in Fig. 3. The notch strength continuously decreases with increasing test temperature. The transverse notch strength is generally 10% below the longitudinal notch strength. At -110F and at 75F exposure causes an increase in notch strength. No effect of exposure is observed at 650F and 800F. (No-load exposure yielded approximately the same results as exposure under stress. The results obtained from fatigue cracked specimens are identical to those obtained from sharply notched specimens. The notch strength ratio increases from -110F to 75F and subsequently decreases with increasing test temperature. Exposure generally causes a loss in notch strength ratio except at -110F where the reverse effect is observed. A minimum notch strength ratio of 0.6 was observed at 650F subsequent to exposure in the transverse direction.

Fig. 4 shows the smooth properties of AISI-301 cold reduced 51%. Tensile, yield strength and elongation decrease with increasing test

P5

yield strength at all test temperatures both in the longitudinal and in the transverse direction. This increase is approximately 20%. The elongation again drops rapidly from 18% at -110F in the longitudinal direction to less than 4% at 75F in both the longitudinal and the transverse direction. The exposure treatment causes a more than 50% loss in the elongation at -110F. The tensile strength in the transverse direction is slightly higher at -110F but no effect of directionality is observed on the tensile strength for other test temperatures. The yield strength in the transverse direction is below that in a longitudinal direction at -110F and 75F. The elongation and the transverse direction at -110F is also considerably below that for the longitudinal direction.

The notch properties are illustrated in Fig. 5. Transverse properties are always considerably below longitudinal properties, particularly at -110F and 75F where the notch strength in the transverse direction is almost 40% below the notch strength in the longitudinal direction. The notch strength ratio versus test temperature plot reflects the effect of the exposure treatment on the smooth properties. In all instances the notch strength ratio is decreased by the exposure treatment. The minimum notch strength ratio of .35 is observed at 650F subsequent to exposure in the transverse direction. →

Fig. 6 shows the smooth properties of AISI-301 cold reduced 60%. The experimental results are similar to those obtained on AISI-301 cold reduced 51% in that both tensile and yield strength are increased by the exposure treatment, particularly at -110F and room temperature. The elongation in 2% at room temperature. The elongation in the transverse direction and in both test directions subsequent to exposure never exceeds 4% for any test temperature investigated.

The notch properties, Fig. 8, decrease with increasing test temperature. Exposure has little effect but a marked difference exists between longitudinal and transverse properties, the latter being approximately 25% lower. The notch strength ratio also decreases with increasing test temperature and reflects the tensile properties as well as the directionality. Minimum notch strength ratios of 0.5 are observed at -110 and +650F subsequent to exposure when tested in the transverse direction. All test results obtained on fatigue cracked specimens of 301 stainless 34, 51 and 60% cold reduced agree with those obtained from machined notches

PH 15-7 Mo (Tables X through XIII)

The results on PH 15-7 Mo in the condition RH 1050 are illustrated in Figs. 8 and 9. Both tensile and yield strength continuously decrease with increasing test temperature. Exposure as well as direction of testing seem to have little effect on the tensile and yield properties. The elongation decreases from approximately 5% at -110 to a minimum of less than 3% at 350F then increases with test temperature to approximately 4%. Elongation shows both the effect of directionality as well as of exposure. In the region between 75F and 650F the elongation in the transverse direction is below that in the longitudinal direction. Exposure under stress seems to cause a slight increase in elongation of -110F and at 650F in the longitudinal direction while a loss is observed in the trans- → 8

P 6

P 7

exposure indicate a loss in elongation at -110F in both directions and in the transverse direction at 75F.

The notch properties of PH 15-7 Mo, RH 1050, are illustrated in Fig. 9. Both the effects of exposure and directionality are observed, the notch strength in the transverse direction being always considerably below that in the longitudinal direction. A sharp drop in notch strength due to exposure is observed at 75F. Notch strength data from fatigue cracked specimens lie slightly above those for machined notches at -110 and 75F. No load exposure points were obtained at -100F and 75F. There appears to be little difference between the notch strength obtained prior to exposure and subsequent to a no load exposure. The notch strength ratio versus test temperature curves reflect the complexity of the notch strength versus test temperature curves and show a minimum at -110F of approximately 0.4. This low notch strength ratio was observed at -110F in the transverse direction prior to exposure and subsequent to exposure, the longitudinal direction subsequent to exposure and the transverse direction subsequent to a no load exposure.

The smooth properties of PH 15-7 Mo, in the condition CH 900 are represented in Fig. 10. To date only data prior to exposure are available. Both tensile strength and yield strength decrease with increasing testing temperature. Little effect of directionality is observed except a slight increase in the transverse elongation at -110F. Over the entire range of testing temperature the elongation did not exceed 4%. The notch data on PH 15-7 Mo in the condition of CH 900 are represented in Fig. 11. Again sharply with increasing testing temperature. Considerably lower notch strength values are observed in the transverse direction. This is reflected in the notch strength ratio values obtained namely .7 to .8 for the longitudinal direction and .35 to .45 for the transverse direction over the entire range of test temperatures investigated.

Specimens of PH 15-7 Mo both in the condition RH 1050 and CH 900 are now being exposed and the results on the effect of exposure on both notched and smooth qualities will be reported in the near future.

Ti-6Al-4V (RS-120A) (Tables XIV through XVII)

The experimental results of Ti-6Al-4V (RS-120A) in the annealed condition are illustrated in Figs. 12 and 13. Little effect of exposure treatment and directionality is noted on the tensile strength and the yield strength. The elongation within the range of test temperatures is between 6 and 13% showing a minimum of approximately 6% in the longitudinal direction prior to exposure at -110 and in the transverse direction prior to exposure at 800F. The notch strength, Fig. 13, decreases nearly linearly with increasing test temperature and again shows little effect of directionality or exposure. The notch strength ratio increases from approximately 0.8 at -110F to 1.0 at room temperature. The apparent susceptibility of this material to fatigue cracks should be emphasized. A minimum notch strength ratio .6 was observed on a fatigue crack specimen tested at -110F in the transverse direction.

Figs. 14 and 15 show the smooth and notch properties of Ti-6Al-4V (RS-120A) in the solution treated and aged condition. Tensile and yield strength decreases with increasing test temperature showing no effect of exposure or directionality. Exposure causes a significant loss in → 10

P8

P9

elongation of specimens tested in the transverse direction, especially at -110F and 75F, where the elongation is reduced from approximately 7% prior to exposure to approximately 2% subsequent to exposure. No-load exposure data fall between the data obtained prior to exposure and subsequent to exposure under stress.

The notch properties, Fig. 15, show an increase in notch strength and notch strength ratio with testing temperature between -110F and 350F with a subsequent decrease with further increase in temperature. The effect of exposure and test direction is negligible, especially with respect to the notch strength ratio, as compared to the effect of test temperature. The minimum notch strength ratio .4 was observed on a fatigue crack specimen tested at -110F in the transverse direction.

Ti-4Al-3Mo-1V (RS-115) (Tables XVIII and XIX)

Figs. 16 and 17 show the smooth and notched properties obtained on Ti-4Al-3Mo-1V (RS-115) in the annealed condition. To date tests have only been performed on the material prior to exposure. Both tensile and yield strength gradually decrease with increasing test temperature. No effect of directionality is observed. The elongation increases from 4% to -110 to approximately 9% at 200F and subsequently decreases again to approximately 3% at 800F. The elongation measured in the transverse direction is lower than that measured in the longitudinal direction at 350F and 800F.

The notch properties, Fig. 17, increase between -110 and 200F and subsequently decrease with increasing testing temperature. Little effect of directionality is observed. The notch strength ratio increases through-

→ 11

beyong unity at and above 200F. Specimens of this alloy are now being exposed and the results will be reported in the near future.

Ti-5Al-2.75Cr-1.25Fe (RS-140) (Tables XX through XXIII)

Figs. 18 and 19 show the smooth and notch properties of Ti-5Al-2.75Cr-1.25Fe (RS-140) in the annealed condition. The tensile strength and the .2% yield strength, Fig. 18, continuously decrease with increasing test temperature and show little effect of directionality and exposure. The elongation varies between 6 and 14% having a minimum at -110F and 600F in the longitudinal direction.

The notch strength, Fig. 19, increases between -110F and 75F where it reaches a maximum and then decreases nearly linearly as the test temperatures increase to 800F. The effect of directionality only observed at 75F, where the specimens tested in the transverse direction show slightly higher notch strength values. The exposure treatment seems to have little effect on the notch strength. The notch strength ratio increases from approximately .7 to 1.0 between -110F and 75F and remains nearly constant or above 1.0 as the test temperature is further increased to 800F. Little effect of exposure is noted.

Figs. 20 and 21 show the tensile and notch tensile properties obtained on RS-140 in the solution treated and aged condition. A general decrease in tensile and yield strength coupled with a slight increase in elongation is observed with increasing testing temperature from -110F to 800F, Fig. 20. No effect of exposure or directionality is observed on the tensile strength or yield strength. Minimum elongation values of approximately 2% are observed both in the longitudinal and transverse direction prior to sub-

→ 12

sequent to exposure at -110F. The gradual increase in elongation with increasing test temperature is less for specimens subjected to the exposure treatment.

The notch properties between -110 and 800F are shown in Fig. 21. The notch strength increases continuously with increasing testing temperature. Exposure causes a considerable reduction in notch properties at -110 and 75F. Minumum notch strength ratio of .2 observed on specimens tested both in the longitudinal and transverse direction subsequent to exposure at -110F. Only at testing temperatures above 350F does a notch strength ratio exceed .6 for all conditions tested.

NOTCH ROOT RADIUS CHANGES DURING EXPOSURE

The effect of the exposure treatment on the notch geometry was determined on selected specimens of Ti-6Al-4V, solution treated and aged and PH 15-7 Mo, RH 1050. The results are shown in Table III. A slight increase in notch root radius was observed in one Ti-6Al-4V (transverse) specimen and both PH 15-7 Mo specimens. This increase is between 0.00015 and 0.00025 in. reflecting a maximum plastic strain at the notch root of 40 (Ti-6Al-4V transverse) and 25 (PH 15-7 Mo) percent. One specimen of Ti-6Al-4V tested in the longitudinal direction showed no measurable change in notch root radius during exposure.

P 12

CONCLUSIONS

A summary of all experimental data is presented in Figs. 22 and 23 with the notch strength ratio plotted as a function of the strength to density ratio. This presentation facilitates an easy interpretation of the data with respect to aircraft desirability as expressed by the strength to density ratio and fracture toughness as expressed by the notch strength ratio. Of the materials tested subsequent to exposure the titanium alloy Ti-6Al-4V in the annealed condition seems to be the most promising. Other alloys that warrant further studies at the present time are RS-140 in the annealed condition and RS-115 in the annealed condition. Recent communication with TMCA has indicated that the titanium alloy Ti-8Al-8Mo-1V in the duplex annealed condition might show promising results with respect to the tentative selection criteria indicated. This alloy will be included in the screening program at Syracuse University.

On the basis of poor notch strength values the following alloys investigated to date must be considered unacceptable (these alloys show notch strength ratio of .4 or less in any of the conditions investigated) AISI-301 - 51%, PH 15-7 Mo - CH 900, RS-140, solution treated and aged.

end

P 13

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3. Sell, R. J., Chave, C. and Weiss, V., "Material Evaluation For a Mach III Transport Plane", Report No. 873-622-QP3, NASA (1962).

4. Minutes of First Meeting, Special Committee on Materials Research for Supersonic Transports, NASA, Washington, D. C., May 1961.

TABLE I

MATERIALS

LOY	CONDITION
SI-301	Cold Reduced 34%
SI-301	Cold Reduced 51%
SI-301	Cold Reduced 60%
15-7 Mo	RH 1050 (1750F for 10 minutes air cooled to 75F in 1 hour, -110F for 22 hours, air warmed to 75F. 1050F for 1 hour, air cooled)
15-7 Mo	CH 900 (Solution treated, aged 1 hour at 900F, air cooled)
6Al-4V (RS-120A)	Annealed
6Al-4V (RS-120A)	Solution treated and aged 4 hours at 925F, air cooled
4Al-3Mo-1V (RS-115)	Annealed
5Al-2.75Cr-1.25Fe (RS-140)	Annealed
5Al-2.75Cr-1.25Fe (RS-140)	Solution treated and aged 900F for 6 hours, air cooled

CHEMICAL ANALYSIS

SUPPLIER / HEAT NUMBER	CARBON	MANGANESE	PHOSPHORUS	SULPHUR	SILICON	NICKEL	CHROMIUM	MOLYBDENUM	VANADIUM	ALUMINUM	NITROGEN	HYDROGEN	IRON	TITANIUM
AMERICAN STEEL & WIRE 3V0065	0.06	1.34	0.029	0.013	0.56	7.31	17.72						BALANCE	
REPUBLIC 3330522	0.07	0.52	0.015	0.016	0.30	7.20	15.34	2.24		1.15	0.01		BALANCE	
REPUBLIC 3930269	0.034								4.10	6.10	0.012		0.18	BALANCE
REPUBLIC 3930265	0.031							3.16	1.05	4.30	0.004	0.003		BALANCE
REPUBLIC 3930017	0.030						3.10			5.10	0.011		1.30	BALANCE

TABLE III

Notch Root Radius Changes During Exposure

MATERIAL	BEFORE EXPOSURE	AFTER EXPOSURE	CHANGE
Ti-6Al-4V (RS-120A)			
Solution Treated and Aged			
Spec. No. AYL28B (Long.)	0.0005	0.0005	—
Spec. No. AYT32B (Trans.)	0.0005	0.0007	0.0002
Ph 15-7 Mo			
Condition RH 1050			
Spec. No. EYL7A (Long.)	0.0010	0.00125	0.00025
Spec. No. EYT8A (Trans.)	0.0011	0.00125	0.00015

TABLE IV

Material-AISI-301
34% Cold Reduction

SMOOTH SPECIMENS

Direction	CONDITION Unex-posed	Exposed 650°F 1000 Hrs. 40 KSI	Exposed 650°F 1000 Hrs. No Load	Test Temp °F	Tensile Strength KSI	0.2% Yield Strength KSI	Elong. Percent (in 1.5")	Mod. of Elas. E-10^{6}PSI	Strength/Density -10^3 in (Density = 0.286 lbs/in^3)
	X			-110	211.5	-	21.2	24.0	739.5
	X			-110	211	155.5	21.0	27.7	737.8
	X			75	173.4	166.7	20.4	23.9	606.3
	X			75	166.5	-	2[illegible].2	-	582.2
	X			75	177.8	161	21.2	24.5	621.7
	X			350	166.5	151.5	2.4	22.2	582.2
	X			650	153	132.5	3.0	21.8	535.0
	X			800	134.5	121.5	3.3	18.3	470.3
		X		-110	234	186	23.2	27.0	818.2
		X		75	204	184	9.0	25.0	[illegible]13.3
		X		650	163.6	149	3.1	25.0	572.0
			X	75	218	179.5	12.95	26.3	[illegible]62.2
	X			-110	212.5	127	20.1	25.0	743.0
	X			75	182.6	143.7	13.9	25.7	638.5
	X			350	171	149	3.4	23.4	597.9
	X			650	152.5	-	3.3	-	533.2
	X			650	158.5	126.5	2.6	21.8	544.2
	X			800	142	117	3.0	22.8	496.5
		X		-110	210.1	187.7	9.7	29.3	734.6
		X		75	201	171	7.6	27.0	702.8
		X		650	169.2	140	3.1	25.0	591.6
			X	-110	216	179.5	9.39	25.65	[illegible]55.2
			X	75	195	177	8.68	30.2	681.8

TABLE V

Material-AISI-301
34% Cold Reduction

NOTCH SPECIMENS

Rolling Direction	CONDITION Unex-posed	Exposed 650°F 1000 Hrs. 40 KSI	Exposed 650°F 1000 Hrs. No Load	Notch <0.001	Natural Crack	Test Temp °F	Notch Strength KSI	Notch Strength Ratio
L	X			X		-110	183	0.865
L	X			X		75	187.4	1.087
L	X			X		350	172.6	1.036
L	X			X		650	137.5	0.899
L	X			X		800	117.5	0.884
L	X				X	75	194.5	1.128
L		X		X		-110	220	0.940
L		X		X		75	209	1.023
L		X		X		650	126	0.771
L			X	X		-110	210	1.149
L			X	X		75	206	0.945
T	X			X		-110	164.5	0.774
T	X			X		-110	164	0.772
T	X			X		75	167.5	0.917
T	X			X		75	164	0.898
T	X			X		350	146	0.654
T	X			X		350	130	0.760
T	X			X		650	102.9	0.662
T	X			X		650	110.5	0.710
T	X			X		800	108	0.761
T	X			X		800	98	0.690
T	X				X	75	172	0.942
T		X		X		-110	187.4	0.892
T		X		X		-110	193	0.904
T		X		X		75	190	0.945
T		X		X		75	187	0.930
T		X		X		650	96.2	0.569
T		X		X		650	102	0.603
T			X	X		-110	178	0.824
T			X	X		75	186	0.964

TABLE VI
Material-AISI-301
51% Cold Reduction

SMOOTH SPECIMENS

Direction	CONDITION Unex-posed	Exposed 650°F 1000 Hrs. 40 KSI	No Load	Test Temp °F	Tensile Strength KSI	0.2% Yield Strength KSI	Elong. Percent (in 1.5")	Mod. of Elas. E-10^6 PSI	Strength / Density -10^3 in (Density = 0.286 lbs/in^3)
	X			-110	223.5	215	18.0	22.9	781.5
	X			75	216	211.5	2.3	23.4	755.2
	X			350	208	188.5	2.0	24.5	727.3
	X			650	191	167	2.6	25.1	667.8
	X			800	165	153.8	2.6	19.7	576.9
		X		-110	260	253.5	6.35	24.8	909.1
		X		75	260	254	1.47	27.35	909.1
		X		650	219	201.5	1.67	24.8	765.7
			X	-110	280	245.5	10.0	29.6	979.0
			X	75	265	245.5	2.34	27.4	926.4
	X			-110	238	196.5	11.4	26.1	832.2
	X			75	214	194	3.6	26.3	748.3
	X			350	210.5	187.5	2.4	25.7	736.0
	X			650	204	178	2.4	24.5	713.3
	X			800	173	145.2	2.3	22.3	604.9
		X		-110	275	251	5.68	32.3	961.5
		X		75	266	246.5	-	28.1	930.1
		X		650	225	208.5	1.67	25.4	786.7
			X	-110	278	246.5	6.35	30.5	972.0
			X	75	267	244	1.67	31.4	933.4

TABLE VII

Material-AISI-301
51% Cold Reduction

NOTCH SPECIMENS

Rolling Direction	CONDITION Unex-posed	Exposed 650°F 1000 Hrs. 40 KSI	No Load	Notch <0.001	Natural Crack	Test Temp °F	Notch Strength KSI	Notch Strength Ratio
L	X			X		-110	237	1.060
L	X			X		75	214.5	0.993
L	X			X		350	152	0.731
L	X			X		650	123	0.644
L	X			X		800	121.1	0.734
L	X				X	75	207	0.958
L		X		X		-110	237	0.912
L		X		X		75	221	0.850
L		X		X		650	103	0.470
L			X	X		-110	240	0.857
L			X	X		75	229	0.864
T	X			X		-110	176	0.739
T	X			X		-110	171	0.718
T	X			X		75	163	0.762
T	X			X		75	153	0.715
T	X			X		350	128.5	0.610
T	X			X		350	129	0.613
T	X			X		650	103	0.505
T	X			X		650	95.6	0.469
T	X			X		800	104.2	0.602
T	X			X		800	104	0.601
T	X				X	75	165.1	0.771
T		X		X		-110	153	0.556
T		X		X		-110	147.5	0.536
T		X		X		75	146	0.549
T		X		X		75	170.5	0.641
T		X		X		650	75.7	0.336
T		X		X		650	78.2	0.348
T			X	X		-110	150	0.540
T			X	X		75	165.5	0.620

TABLE VII

Material-AISI-301
60% Cold Reduction

SMOOTH SPECIMENS

Direction	Condition: Unexposed	Condition: Exposed 650°F 1000 Hrs. 40 KSI	Condition: Exposed 650°F 1000 Hrs. No Load	Test Temp. °F	Tensile Strength KSI	0.2% Yield Strength KSI	Elong. Percent (in 1.5")	Mod. of Elas. E-10^6PSI	$\frac{\text{Strength}}{\text{Density}}$ 10^3in (Density = 0.286 $\frac{\text{lbs}}{\text{in}^3}$)
	X			-110	231	206	10.7	25.1	807.7
	X			75	223.5	222.5	2.4	25.7	781.5
	X			350	213.5	207.5	2.4	22.5	746.5
	X			650	194.5	180	2.6	22.9	680.1
	X			800	174.5	166.7	3.3	20.9	610.1
		X		-110	278	276.3	3.0	26.3	972.0
		X		75	269	272.5	1.67	25.65	940.6
		X		650	216	-	1.33	-	755.2
			X	-110	284	276	4.68	27.15	993.0
			X	75	258	251	2.01	27.9	902.1
	X			-110	240	205.5	4.5	27.9	839.2
	X			75	222	210	2.7	29.5	776.2
	X			350	225	203.5	2.0	29.5	786.7
	X			650	190	175.5	1.4	25.8	664.3
	X			650	208.5	181	3.0	25.8	729.0
	X			800	183.8	160	3.0	25.0	642.7
	X			800	183.8	-	3.0	-	642.7
		X		-110	290	280	1.34	30.15	1014.0
		X		75	269	259.5	1.3	30.15	940.6
		X		650	204	-	0.99	-	713.3
			X	-110	288	270	4.0	32.2	1007.0
			X	75	281	264	1.67	31.25	982.5

TABLE IX

Material-AISI-301
60% Cold Reduction

NOTCH SPECIMENS

Rolling Direction	Unex-posed	Ex[illegible] 0°F 40 KSI	Ex[illegible] 0°F [illegible] Load	Notch <0.001	Natural Crack	Test Temp °F	Notch Strength KSI	Notch Strength Ratio
L	X			X		-110	226.5	0.981
L	X			X		75	206.5	0.924
L	X			X		350	159	0.745
L	X			X		650	128.5	0.661
L	X			X		800	135	0.774
L	X				X	-110	232	1.004
L	X				X	-110	231.5	1.002
L	X				X	75	206.2	0.923
L		X		X		-110	248.5	0.894
L		X		X		75	218	0.810
L		X		X		650	122	0.565
L			X	X		-110	263	0.915
L			X	X		75	235	0.911
T	X			X		-110	184.5	0.769
T	X			X		-110	173.5	0.723
T	X			X		75	167.2	0.753
T	X			X		75	148.2	0.668
T	X			X		350	121.5	0.540
T	X			X		350	114	0.507
T	X			X		650	106.2	0.534
T	X			X		650	106	0.533
T	X			X		800	62.4	0.339
T	X			X		800	93.1	0.507
T	X			X		800	109.5	0.596
T	X				X	-110	167.5	0.698
T	X				X	-110	167	0.696
T	X				X	75	159.5	0.718
T		X		X		-110	135	0.466
T		X		X		-110	134.2	0.463
T		X		X		75	153	0.569
T		X		X		75	132	0.491
T		X		X		650	97.5	0.478
T		X		X		650	90.5	0.444
T			X	X		-110	177	0.615

TABLE X

Material-PH 15-7 Mo
Heat Treatment RH 1050

SMOOTH SPECIMENS

Condition: Unexposed	Condition: Exposed 650°F 1000 Hrs. 40 KSI	Condition: Exposed 650°F 1000 Hrs. No Load	Test Temp. °F	Tensile Strength KSI	0.2% Yield Strength KSI	Elong. Percent (in 1.5")	Mod. of Elas, E-10⁶PSI	Strength/Density -10³in (Density = 0.286 lbs/in³)
X			-110	218	212	5.47	30.2	787.0
X			75	201	196.5	4.34	27.1	723.6
X			350	184	180	3.01	24.5	664.3
X			650	169	159.5	3.34	25.7	610.1
X			800	143.5	139	2.01	21.0	518.1
	X		-110	232	226.5	6.35	32.1	837.5
	X		75	214	211	4.01	27.8	772.6
	X		650	178	167	4.01	29.35	642.6
		X	-110	232	227	4.68	28.6	837.5
		X	75	215	211	4.01	26.4	776.2
X			-110	224.5	219	5.95	29.35	810.5
X			75	204	197.5	3.68	28.55	736.5
X			350	186.5	182.5	2.34	27.75	673.3
X			650	170	161	2.68	33.1	613.7
X			800	152	141	5.35	24.5	548.7
	X		-110	230	224.5	3.68	29.4	830.3
	X		75	214	209	3.01	30.2	772.6
	X		650	176.8	172	2.68	29.35	638.3
		X	-110	234	225	4.68	31.2	844.8
		X	75	217	210	2.68	29.4	783.4

TABLE XI

Material-PH 15-7 Mo
Heat Treatment RH 1050

NOTCH SPECIMENS

Rolling Direction	Condition: Unexposed	Condition: Exposed 650°F 1000 Hrs 40 KSI	Condition: Exposed 650°F 1000 Hrs No Load	Notch <0.001	Natural Crack	Test Temp °F	Notch Strength KSI	Notch Strength Ratio
L	X			X		-110	139	0.638
L	X			X		75	185.2	0.921
L	X			X		350	155	0.842
L	X			X		650	154	0.911
L	X			X		800	150	1.045
L	X				X	-110	180	0.826
L	X				X	-110	121.5	0.557
L	X				X	75	196.5	0.976
L		X		X		-110	105.2	0.453
L		X		X		75	173	0.808
L		X		X		650	167.5	0.941
L			X	X		-110	138.5	0.596
L			X	X		75	178	0.827
T	X			X		-110	116	0.517
T	X			X		-110	87	0.388
T	X			X		-110	84	0.374
T	X			X		75	152	0.745
T	X			X		75	144	0.706
T	X			X		350	143	0.768
T	X			X		350	149	0.799
T	X			X		650	110	0.647
T	X			X		650	120	0.706
T	X			X		800	137	0.901
T	X			X		800	134	0.882
T	X				X	-110	144.5	0.644
T	X				X	-110	145	0.646
T	X				X	75	169.5	0.831
T		X		X		-110	98	0.426
T		X		X		-110	100	0.434
T		X		X		75	122	0.570
T		X		X		75	118	0.551
T		X		X		650	116.5	0.658
T		X		X		650	111.3	0.629
T			X	X		-110	92.5	0.395
T			X	X		75	144.4	0.665

TABLE XII

Material-PH 15-7 Mo
Heat Treatment CH 900

SMOOTH SPECIMENS

Condition: Unexposed	Condition: Exposed 650°F 1000 Hrs. — 40 KSI	Condition: Exposed 650°F 1000 Hrs. — No Load	Test Temp. °F	Tensile Strength KSI	0.2% Yield Strength KSI	Elong. Percent (in 1.5")	Mod. of Elas. E-10^{6}PSI	Strength/Density -10^{3}in (Density = 0.286 lbs/in^3)
X			-110	304	305	2.0	28.9	1097.4
X			75	283.9	279	1.0	28.9	1024.9
X			350	248	-	1.34	-	895.3
X			650	224	217.5	1.34	25.9	808.6
X			800	201	-	2.34	-	725.6
X			-110	307	294	3.67	32.[illegible]	1108.3
X			75	292	278	0.67	32.4	1054.1
X			350	257	230	1.34	-	927.[illegible]
X			650	236	206	2.34	33.4	851.9
X			800	220	205.5	2.0	30.6	794.2

TABLE XIII

Material-PH 15-7 Mo
Heat Treatment CH900

NOTCH SPECIMENS

Rolling Direction	Condition: Unexposed	Condition: Exposed 650°F 1000 Hrs — 40 KSI	Condition: Exposed 650°F 1000 Hrs — No Load	Notch <0.001	Natural Crack	Test Temp °F	Notch Strength KSI	Notch Strength Ratio
L	X			X		-110	236	0.776
L	X			X		75	229	0.807
L	X			X		75	225	0.[illegible]93
L	X			X		350	1[illegible]7	0.714
L	X			X		650	166	0.741
L	X			X		800	156	0.776
T	X			X		-110	126.3	0.411
T	X			X		-110	127.5	0.415
T	X			X		75	126	0.438
T	X			X		75	128	0.438
T	X			X		350	114	0.444
T	X			X		350	10[illegible].5	0.422
T	X			X		650	96	0.407
T	X			X		650	[illegible]9.5	0.337
T	X			X		800	95.5	0.434
T	X			X		800	82.4	0.3[illegible]4

TABLE XIV

Material-Ti-6Al-4V (RS-120A)
Heat Treatment Annealed

SMOOTH SPECIMENS

CONDITION			Test Temp. °F	Tensile Strength KSI	0.2% Yield Strength KSI	Elong. Percent (in 1.5")	Mod. of Elas. E-10^6 PSI	Strength/Density -10^3 in (Density = 0.160 lbs/in^3)
Unex-posed	Exposed 650°F 100 Hrs. 25 KSI	Exposed 650°F 100 Hrs. No Load						
X			-110	170.5	163.5	6.35	20.1	1065.6
X			75	135	124.5	9.7	15.8	843.7
X			350	115.5	102.5	11.36	16.55	721.9
X			650	101	76	8.7	14.2	631.3
X			800	91.4	75.4	10.03	13.5	571.3
	X		-110	173	163	11.3	16.55	1081.3
	X		75	146.8	135	10.0	17.1	917.5
	X		650	100.5	80.5	9.05	16.8	628.1
X			-110	169.5	159	12.6	17.7	1059.4
X			75	146	136	13.0	18.3	912.5
X			350	123.5	110.5	10.38	17.4	771.9
X			650	107.8	89.7	6.35	15.1	673.[illegible]
X			800	100	83.6	5.35	15.3	625.0
	X		-110	175	166.3	11.0	19.35	1093.7
	X		75	152	140	12.5	14.05	950.0
	X		650	111.2	93.8	7.03	13.85	695.0

TABLE XV

Material-Ti-6Al-4V (RS-120A)
Heat Treatment Annealed

NOTCH SPECIMENS

Rolling Direction	CONDITION			Notch <0.001	Natural Crack	Test Temp °F	Notch Strength KSI	Notch Strength Ratio
	Unex-posed	Exposed 650°F 1000 Hrs 25 KSI	Exposed 650°F 1000 Hrs No Load					
L	X			X		-110	136.6	0.801
L	X			X		75	137.2	1.016
L	X			X		350	118	1.022
L	X			X		650	99	0.980
L	X			X		800	94.5	1.034
L	X				X	-110	137	0.804
L	X				X	-110	123	0.721
L	X				X	75	118	0.874
L		X		X		-110	134.5	0.777
L		X		X		75	137.6	0.937
L		X		X		650	102.5	1.020
T	X			X		-110	131.2	0.774
T	X			X		-110	134.6	0.794
T	X			X		75	137.2	0.940
T	X			X		75	142.9	0.979
T	X			X		350	132	1.069
T	X			X		350	127	1.028
T	X			X		650	109.6	1.017
T	X			X		650	107.5	0.997
T	X			X		800	110	1.100
T	X			X		800	105.8	1.058
T	X				X	-110	106	0.625
T	X				X	-110	133	0.785
T	X				X	75	129	0.884
T		X		X		-110	142.8	0.816
T		X		X		-110	140.5	0.803
T		X		X		75	143	0.941
T		X		X		75	139.5	0.918
T		X		X		650	106	0.953
T		X		X		650	112.5	1.012

TABLE XVI

Material-Ti-6Al-4V (RS-120A)
Heat Treatment Solution Treated,
Aged 4 Hrs. 935F

SMOOTH SPECIMENS

CONDITION			Test Temp. °F	Tensile Strength KSI	0.2% Yield Strength KSI	Elong. Percent (in 1.5")	Mod. of Elas, E-10⁶PSI	Strength/Density -10³in (Density = 0.160 lbs/in³)
Unex-posed	Exposed 650°F 1000 Hours. 40 KSI	No Load						
X			-110	197.5	182.5	7.03	15.8	1234.4
X			75	171	155	6.01	18.0	1068.7
X			350	145.8	118.5	7.7	15.55	911.3
X			650	126.3	97.4	5.35	15.3	789.4
X			800	121	92.9	5.67	16.3	756.3
	X		-110	199	165.5	2.68	17.7	1243.7
	X		75	171.5	-	5.02	-	1071.9
	X		650	131.3	101	5.01	14.25	820.6
		X	75	165	151.5	6.02	15.6	1031.3
		X	75	162	152.5	6.02	15.3	1012.5
X			-110	208	194.5	7.0	17.7	1300.0
X			75	164.2	151.5	8.36	17.7	1026.3
X			350	143.8	120	6.02	15.1	898.7
X			650	135.2	104.7	5.30	17.4	845.0
X			800	127.3	95.9	5.01	18.3	795.6
	X		-110	206	190	2.0	17.7	1287.5
	X		75	165	162	0.67	18.3	1031.3
	X		650	133.2	105	4.68	13.5	832.5
		X	-110	197	182.5	4.68	17.1	1231.3
		X	75	[illegible]	-	6.35	-	1118.7

TABLE XVII

Material-Ti-6Al-4V (RS-120A)
Heat Treatment Solution Treated, aged 4 Hrs. 935F

NOTCH SPECIMENS

Rolling Direction	CONDITION			Notch <0.001	Natural Crack	Test Temp °F	Notch Strength KSI	Notch Strength Ratio
	Unex-posed	Exposed 650°F 1000 Hrs. 25 KSI	No Load					
L	X			X		-110	111.5	0.565
L	X			X		75	130	0.760
L	X			X		350	135	0.926
L	X			X		650	117	0.926
L	X			X		800	103.8	0.858
L	X				X	-110	116.5	0.590
L	X				X	-110	111.5	0.564
L	X				X	75	122	0.714
L		X		X		-110	112.5	0.565
L		X		X		75	119.5	0.697
L		X		X		650	126.8	0.966
T	X			X		-110	103.5	0.498
T	X			X		-110	100.5	0.483
T	X			X		75	127	0.773
T	X			X		75	119.1	0.725
T	X			X		350	141	0.981
T	X			X		350	142	0.987
T	X			X		650	124	0.917
T	X			X		650	123	0.910
T	X			X		800	116.4	0.914
T	X			X		800	115.5	0.907
T	X				X	-110	90.5	0.435
T	X				X	-110	93	0.447
T	X				X	75	120	0.731
T		X		X		-110	100.5	0.488
T		X		X		-110	104	0.505
T		X		X		75	125	0.758
T		X		X		75	116.5	0.706
T		X		X		650	124.8	0.937
T		X		X		650	130	0.976
T			X	X		-110	103.8	0.527
T			X	X		75	111	0.620

TABLE XVIII

Material-Ti-4Al-3Mo-1V (RS-115)
Heat Treatment Annealed

SMOOTH SPECIMENS

CONDITION			Test Temp. °F	Tensile Strength KSI	0.2% Yield Strength KSI	Elong. Percent (in 1.5")	Mod. of Elas. E-10^6PSI	Strength-10^3in / Density (Density = 0.163 $\frac{lbs}{in^3}$)
Unex-posed	Exposed 650°F 1000 Hrs							
	25 KSI	No Load						
X			-110	164	154.5	5.02	16.4	1006.1
X			75	134.5	127	8.7	15.05	825.2
X			350	115.5	97.7	8.7	14.6	708.6
X			650	95.5	76.2	4.69	14.05	585.9
X			800	86.5	73.1	4.35	12.25	530.7
X			-110	164.5	158	4.10	16.2	1009.2
X			75	135	128	8.38	15.9	828.2
X			350	114	105	6.02	17.2	699.4
X			650	93.5	79.4	4.69	11.85	573.6
X			800	88	72	2.68	16.2	539.9

TABLE XIX

Material-Ti-4Al-3Mo-1V (RS-115)
Heat Treatment Annealed

NOTCH SPECIMENS

Rolling Direction	CONDITION			Notch <0.001	Natural Crack	Test Temp °F	Notch Stre KSI	Notch Strength Ratio
	Unex-posed	Exposed 650°F 1000 Hrs						
		25 KSI	No Load					
L	X			X		-110	124	0.756
L	X			X		75	128	0.951
L	X			X		350	125	1.082
L	X			X		650	104	1.089
L	X			X		800	97	1.121
L	X				X	-110	104	0.634
L	X				X	-110	121	0.737
L	X				X	75	115.6	0.859
T	X			X		-110	101	0.613
T	X			X		-110	124	0.753
T	X			X		75	132	0.977
T	X			X		75	138	1.022
T	X			X		350	118.5	1.039
T	X			X		350	119	1.043
T	X			X		650	98.5	1.053
T	X			X		650	104	1.112
T	X			X		800	97	1.102
T	X			X		800	98	1.113
T	X				X	-110	113.6	0.686
T	X				X	-110	104.6	0.632
T	X				X	75	127	0.940

TABLE XX

Materiul-Ti-5Al-2.75Cr-1.25 Fe (RS-140)
Heat Treatment Annealed

SMOOTH SPECIMENS

CONDITION Unex-posed	CONDITION Exposed 650°F 1000 Hrs. 25 KSI	CONDITION Exposed 650°F 1000 Hrs. No Load	Test Temp. °F	Tensile Strength KSI	0.2% Yield Strength KSI	Elong. Per-cent (in 1.5")	Mod. of Elas. E-10^6PSI	$\frac{\text{Strength}}{\text{Density}}$-$10^3$in (Density = 0.163 $\frac{\text{lbs}}{\text{in}^3}$)
X			-110	169	165.5	6.0	16.85	1036.8
X			75	146	132	13.6	17.15	895.7
X			350	118.3	100.8	9.38	15.55	725.8
X			650	109	85.3	7.68	15.35	668.7
X			800	95.2	79.7	12.85	12.4	584.0
X			-110	164	153	[illegible]	16.6	1006.1
X			75	143	132.5	13.05	15.8	877.3
X			350	120.5	99.7	11.7	14.5	739.3
X			650	106	85.9	8.7	15.6	650.3
X			800	95.6	73.5	13.18	15.6	586.5
	X		75	147	133.5	11.5	17.1	901.8

TABLE XXI

Material-Ti-5Al-2.75Cr-1.25Fe (RS-140)
Heat Treatment Annealed

NOTCH SPECIMENS

Rolling Direction	CONDITION Unex-posed	CONDITION Exposed 650°F 1000 Hrs. 25 KSI	CONDITION Exposed 650°F 1000 Hrs. No Load	Notch <0.001	Natural Crack	Test Temp °F	Notch Strength KSI	Notch Strength Ratio
L	X			X		-110	130	0.804
L	X			X		75	136	0.931
L	X			X		350	127.4	1.076
L	X			X		650	113.5	1.041
L	X			X		800	100	1.050
L	X				X	-110	125.5	0.742
L	X				X	-110	115	0.680
L	X				X	75	129	0.883
L		X		X		75	131	
L		X		X		650	113	
T	X			X		-110	124	0.756
T	X			X		-110	132.2	0.806
T	X			X		75	146	1.020
T	X			X		75	144.5	1.010
T	X			X		350	122	1.012
T	X			X		350	128.5	1.062
T	X			X		650	117.6	1.109
T	X			X		650	118.2	1.115
T	X			X		800	112.5	1.176
T	X			X		800	114	1.192
T	X				X	-110	106	0.646
T	X				X	-110	116.4	0.709
T	X				X	75	145	1.013
T		X		X		75	144.8	0.985
T		X		X		75	154	1.048
T		X		X		650	109	
T		X		X		650	119	

TABLE XXII

Material-Ti-5Al-2.75Cr-1.25Fe (RS-140)
Heat Treatment Solution Treated, Aged 900F 6hrs.

SMOOTH SPECIMENS

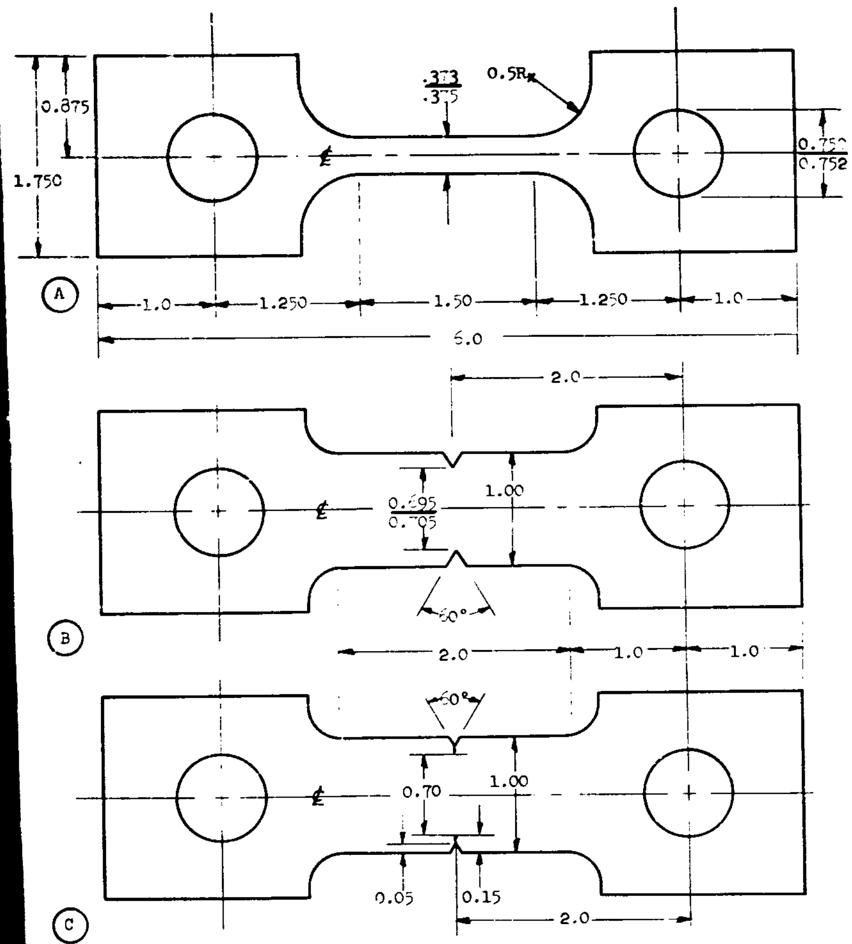
Rolling Direction	CONDITION Unex-posed	Exposed 650°F 1000 Hrs. 25 KSI	Exposed 650°F 1000 Hrs. No Load	Test Temp. °F	Tensile Strength KSI	0.2% Yield Strength KSI	Elong. Percent (in 1.5")	Mod. of Elas. E-10^6PSI	Strength/Density -10^3in (Density = 0.163 lbs/in^3)
	X			-110	206	179.5	1.67	16.3	1263.8
	X			75	171	143.5	4.35	15.0	1049.0
	X			350	158	118.5	6.22	17.75	969.3
	X			350	151	115.5	6.0	14.15	926.3
	X			650	148.5	102	6.0	16.9	911.0
	X			800	110.5	83	9.03	12.6	677.9
			X	-110	205	170.5	4.01	16.9	1257.6
			X	75	177.5	146.5	4.68	16.65	1088.9
		X		-110	196	183	2.01	19.1	1202.4
		X		75	172.8	145.5	3.01	15.4	1060.1
		X		650	145	99	5.35	14.15	889.5
	X			-110	206	181	3.34	17.4	1263.8
	X			75	176.5	153	5.35	16.9	1082.8
	X			350	150	118.5	6.22	20.6	920.2
	X			650	134	94.2	6.48	20.6	822.0
	X			800	113.6	86.1	9.38	11.0	696.9
			X	-110	213	182	3.01	17.5	1306.7
			X	75	184	154	6.36	16.9	1128.8
		X		-110	202	180.5	2.34	17.5	1239.3
		X		75	176.5	153.5	2.34	17.2	1082.8
		X		650	142	100	5.35	15.4	871.2

TABLE XXIII

Material-Ti-5Al-2.75Cr-1.25Fe (RS-140)
Heat Treatment Solution Treated, Aged 900F 6Hrs.

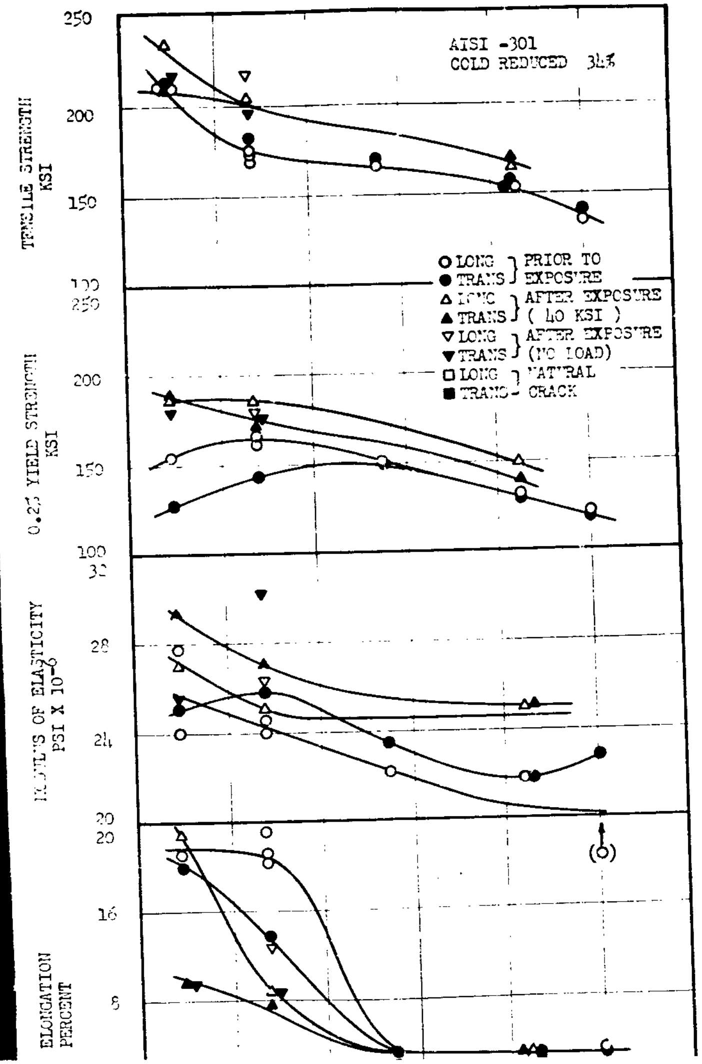
NOTCH SPECIMENS

Rolling Direction	CONDITION Unex-posed	Exposed 650°F 1000 Hrs 25 KSI	Exposed 650°F 1000 Hrs No Load	Notch <0.001	Natural Crack	Test Temp °F	Notch Strength KSI	Notch Strength Ratio
L	X			X		-110	90	0.437
L	X			X		75	93.4	0.546
L	X			X		350	116.5	0.737
L	X			X		650	131	0.882
L	X			X		800	129.5	1.172
L			X	X		-110	39	0.190
L			X	X		75	58	0.326
L		X		X		-110	42.3	0.216
L		X		X		75	65.4	0.378
L		X		X		650	112.5	0.776
T	X			X		-110	90	0.437
T	X			X		-110	87.5	0.425
T	X			X		75	93.4	0.529
T	X			X		75	94.5	0.535
T	X			X		350	114	0.760
T	X			X		350	115	0.767
T	X			X		650	131.5	0.981
T	X			X		650	118	0.880
T	X			X		800	131.5	1.157
T	X			X		800	123.5	1.131
T			X	X		-110	52	0.244
T			X	X		75	61.3	0.333
T		X		X		-110	49	0.243
T		X		X		-110	61	0.302
T		X		X		75	79.9	0.453
T		X		X		75	77.8	0.441
T		X		X		650	122.5	0.863
T		X		X		650	125.6	0.885



THICKNESS 0.025

FIG. 1 A-SMOOTH SPECIMEN
B-EDGE NOTCHED SPECIMEN



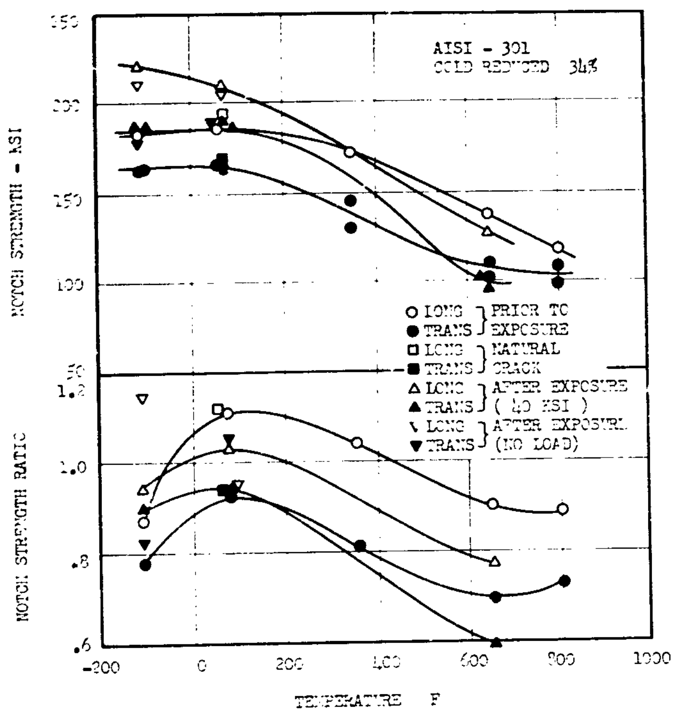
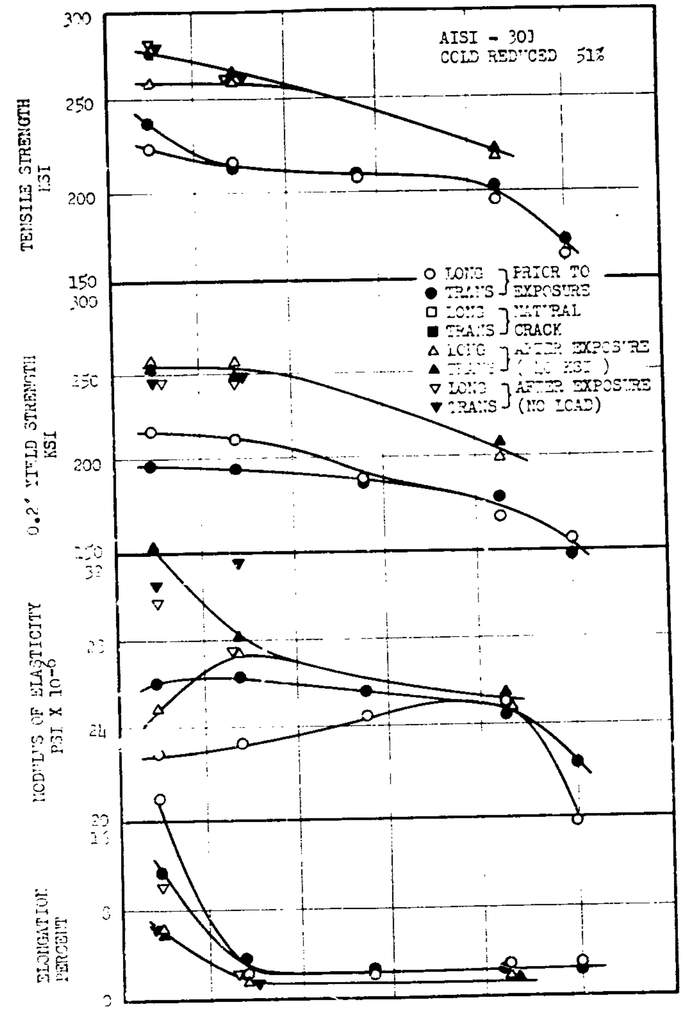
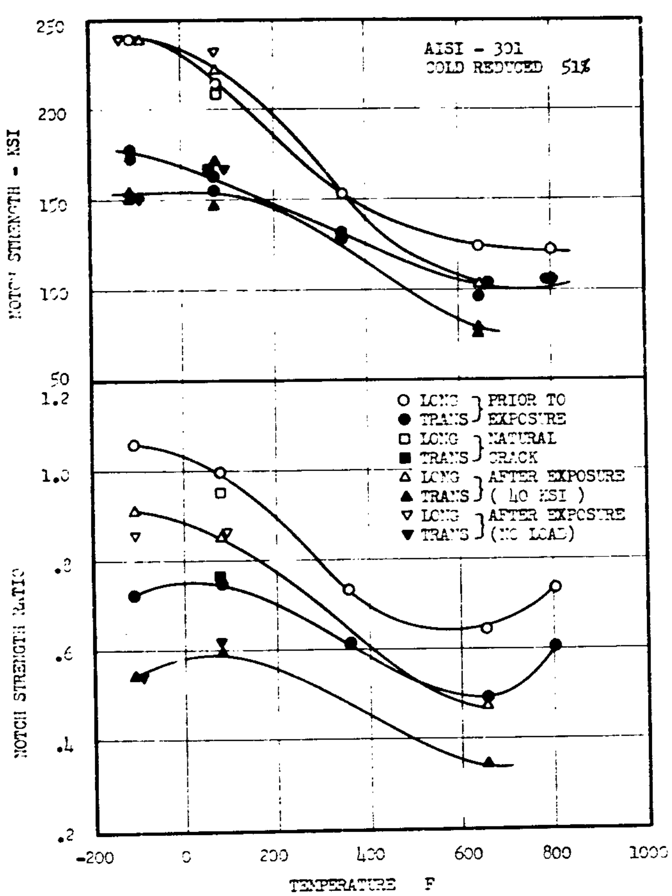
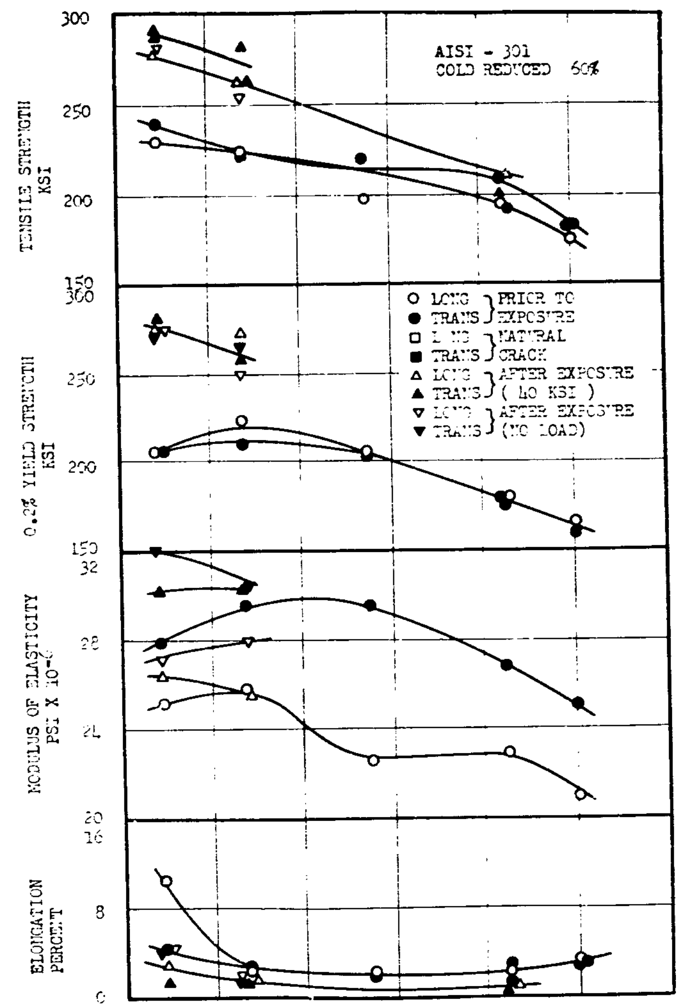


FIG. 3 THE EFFECT OF TESTING TEMPERATURES ON THE NOTCH STRENGTH AND NOTCH STRENGTH RATIO OF AISI - 301 COLD REDUCED 34%. MATERIAL TESTED PRIOR TO EXPOSURE AND IN THE EXPOSED CONDITION.




AISI - 301
COLD REDUCED 51%
NOTCH STRENGTH - KSI
NOTCH STRENGTH RATIO
LONG } PRIOR TO
TRANS } EXPOSURE
LONG } NATURAL
TRANS } CRACK
LONG } AFTER EXPOSURE
TRANS } (40 KSI)
LONG } AFTER EXPOSURE
TRANS } (NO LOAD)
TEMPERATURE F


AISI - 301
COLD REDUCED 60%
TENSILE STRENGTH KSI
0.2% YIELD STRENGTH KSI
MODULUS OF ELASTICITY PSI X 10-6
ELONGATION PERCENT
LONG } PRIOR TO
TRANS } EXPOSURE
LONG } NATURAL
TRANS } CRACK
LONG } AFTER EXPOSURE
TRANS } (40 KSI)
LONG } AFTER EXPOSURE
TRANS } (NO LOAD)

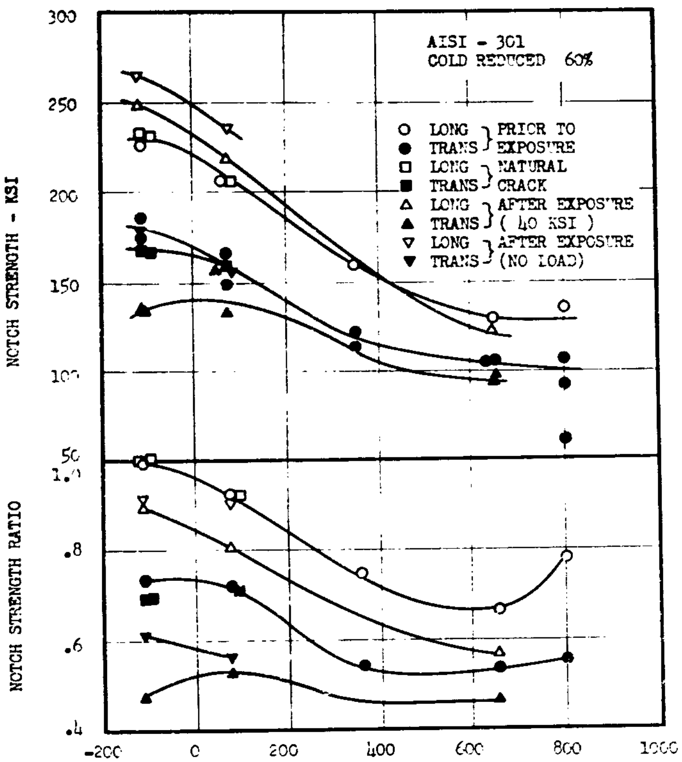
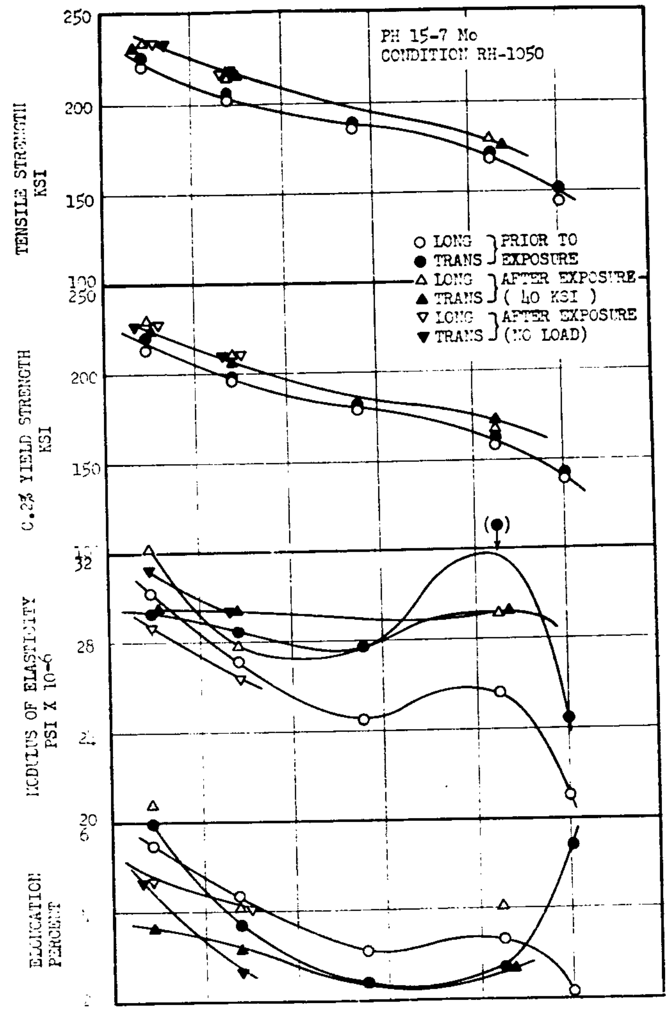
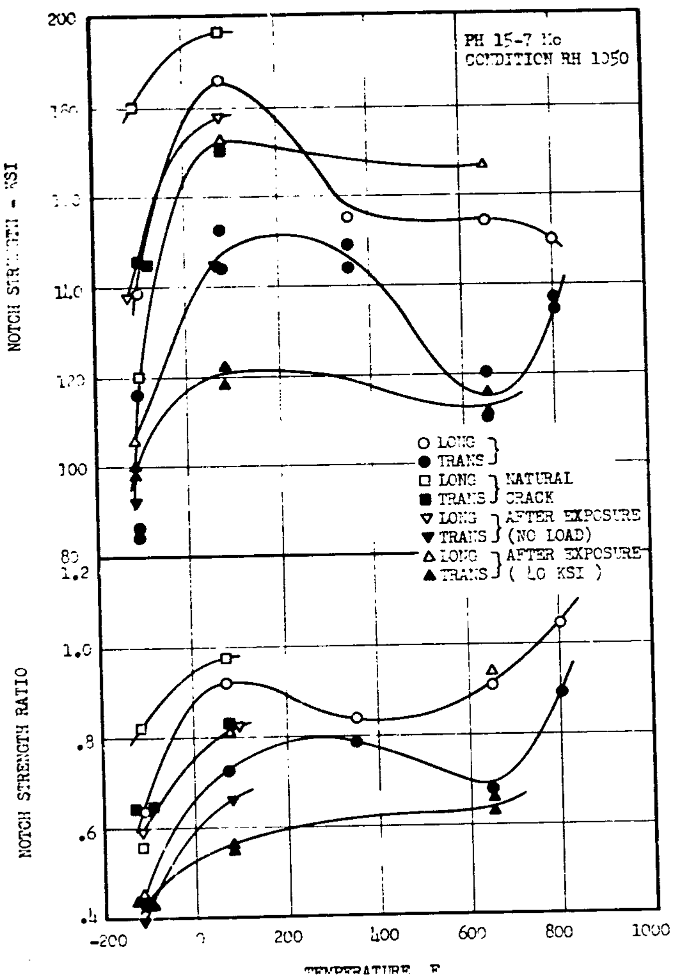
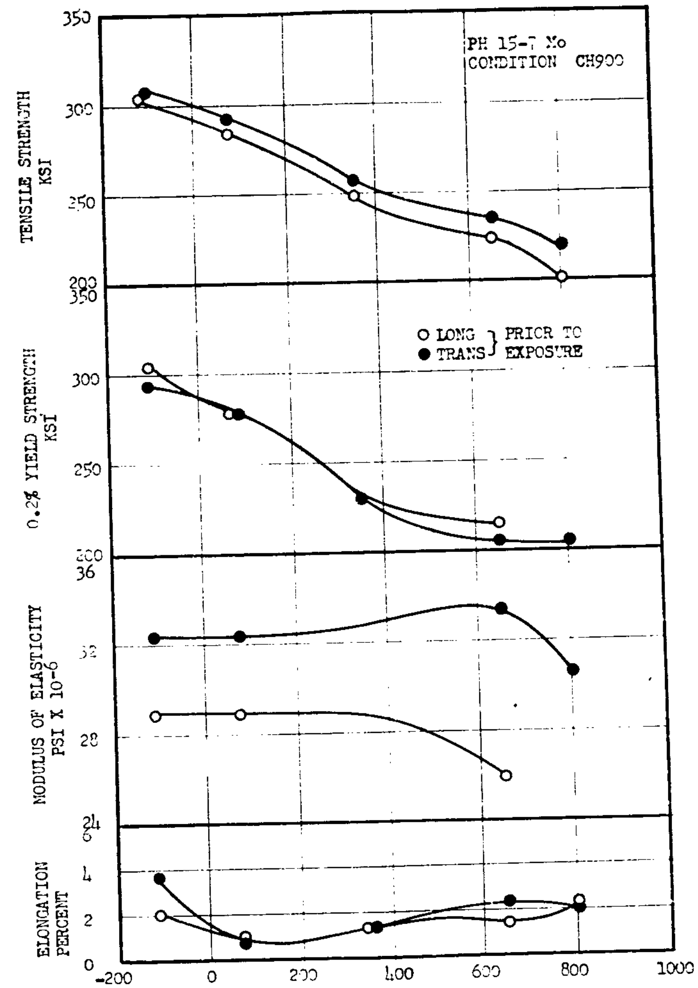
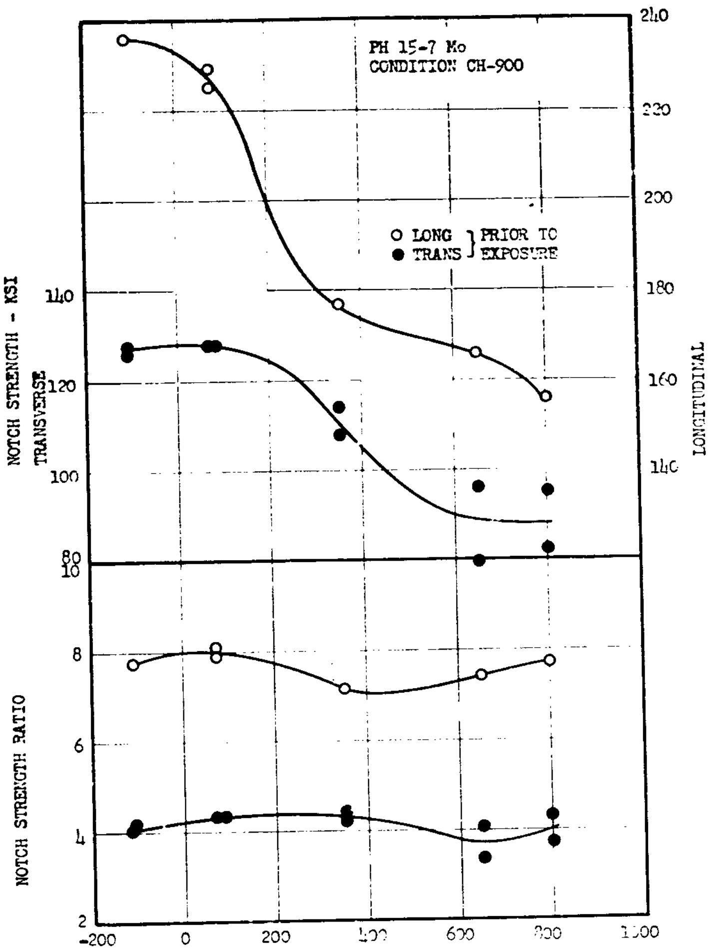


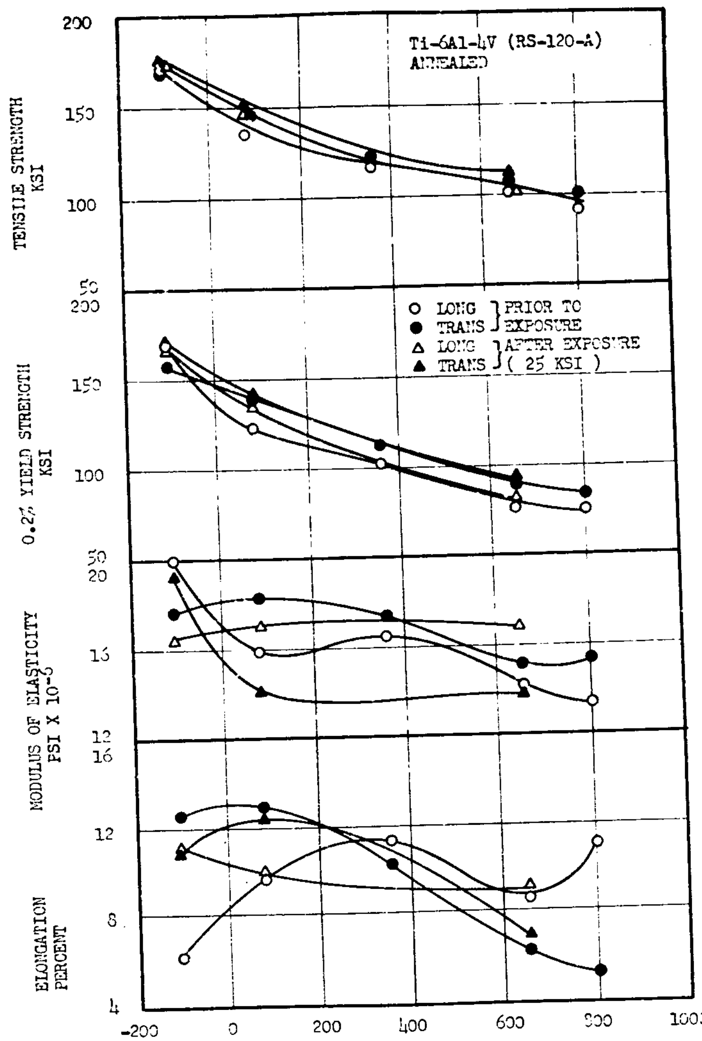
FIG. 7 THE EFFECT OF TESTING TEMPERATURES ON THE NOTCH STRENGTH AND NOTCH STRENGTH RATIO OF AISI - 301 COLD REDUCED 60%.




PH 15-7 Mo
CONDITION RH 1050
NOTCH STRENGTH - KSI
NOTCH STRENGTH RATIO
○ LONG
● TRANS
□ LONG
■ TRANS NATURAL CRACK
▽ LONG
▼ TRANS AFTER EXPOSURE (NO LOAD)
△ LONG
▲ TRANS AFTER EXPOSURE (40 KSI)
200
100
80
1.2
1.0
.8
.6
.4
-200
200
400
600
800
1000


PH 15-7 Mo
CONDITION CH900
○ LONG
● TRANS PRIOR TO EXPOSURE
TENSILE STRENGTH KSI
0.2% YIELD STRENGTH KSI
MODULUS OF ELASTICITY PSI X 10-6
ELONGATION PERCENT
350
300
250
200
36
28
24
6
4
2
0
-200
0
200
400
600
800
1000


PH 15-7 Mo
CONDITION CH-900
○ LONG } PRIOR TO
● TRANS } EXPOSURE
NOTCH STRENGTH - KSI
TRANSVERSE
LONGITUDINAL
NOTCH STRENGTH RATIO
TEMPERATURE F
140
120
100
80
10
8
6
4
2
240
220
200
180
160
140
-200
0
200
400
600
800
1000


Ti-6Al-4V (RS-120-A)
ANNEALED
○ LONG } PRIOR TO
● TRANS } EXPOSURE
△ LONG } AFTER EXPOSURE
▲ TRANS } (25 KSI)
TENSILE STRENGTH
KSI
0.2% YIELD STRENGTH
KSI
MODULUS OF ELASTICITY
PSI X 10-6
ELONGATION
PERCENT
200
150
100
50
200
150
100
50
20
16
12
16
12
8
4
-200
0
200
400
600
800
1000

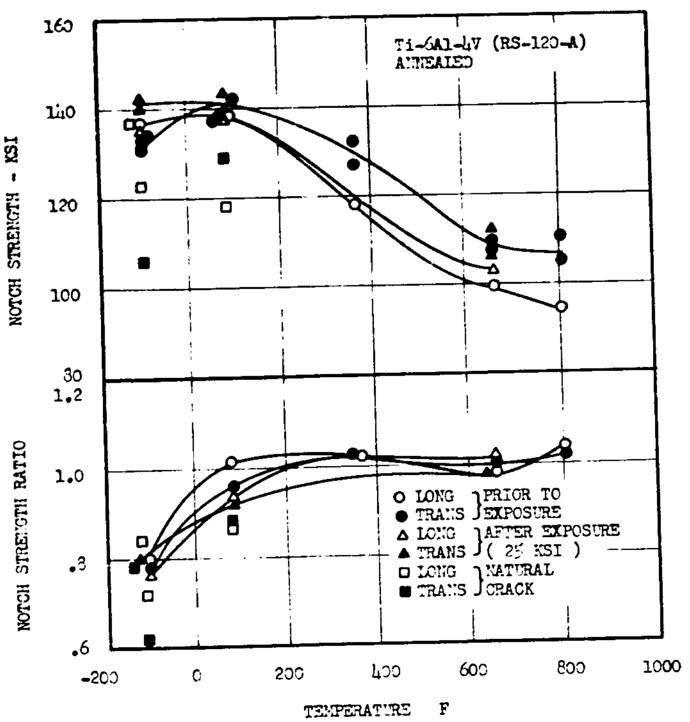


FIG.13 THE EFFECT OF TESTING TEMPERATURES ON THE NOTCH STRENGTH AND NOTCH STRENGTH RATIO OF Ti-6Al-4V (RS-120-A) ANNEALED. MATERIAL TESTED PRIOR TO EXPOSURE AND IN THE EXPOSED CONDITION.

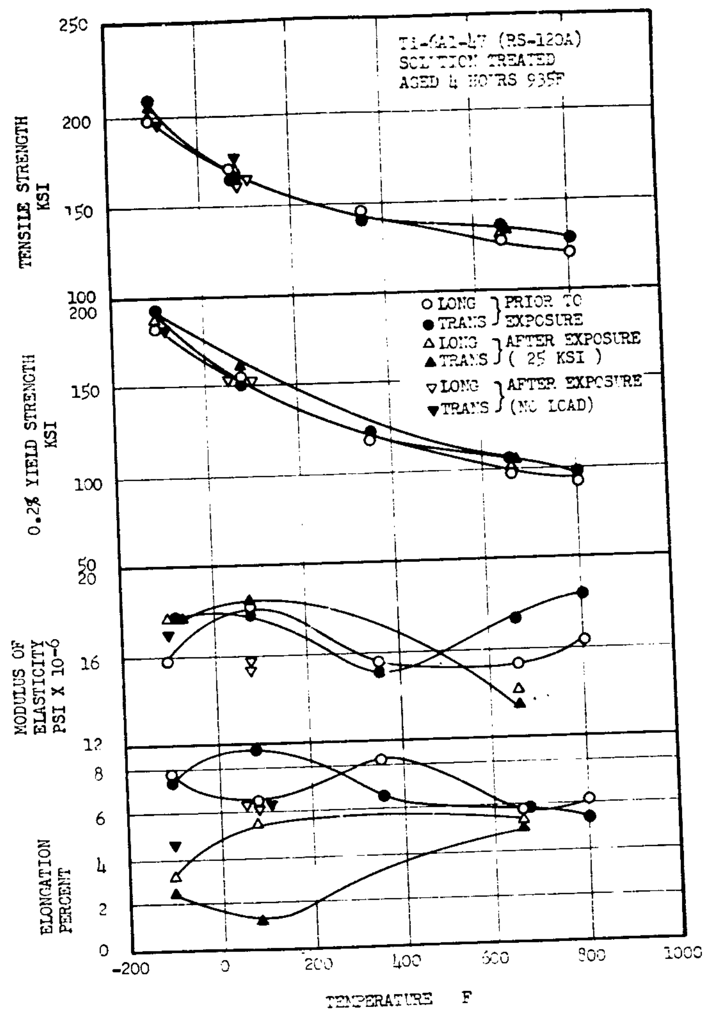


FIG.14 THE EFFECT OF TESTING TEMPERATURES ON THE TENSILE STRENGTH, THE YIELD STRENGTH, THE MODULUS OF ELASTICITY AND THE ELONGATION IN PERCENT OF Ti-6Al-4V (RS-120A) SOLUTION

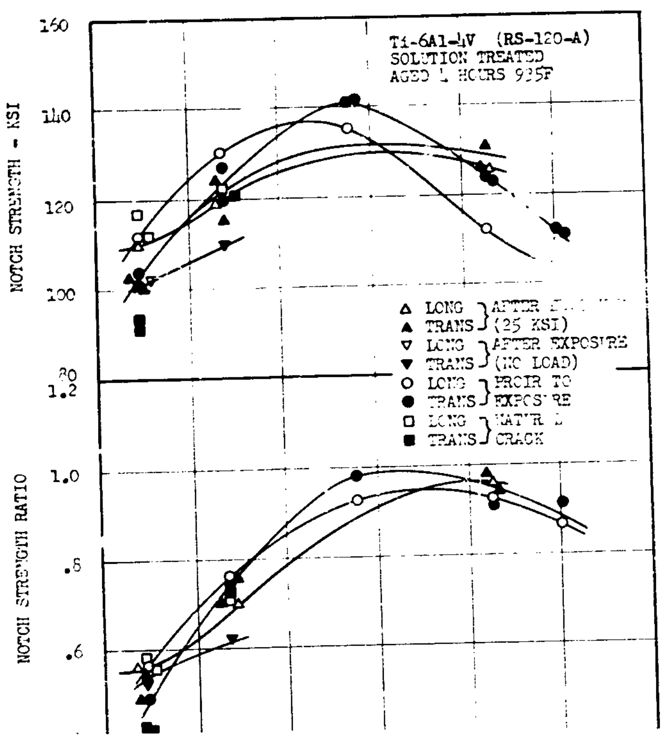
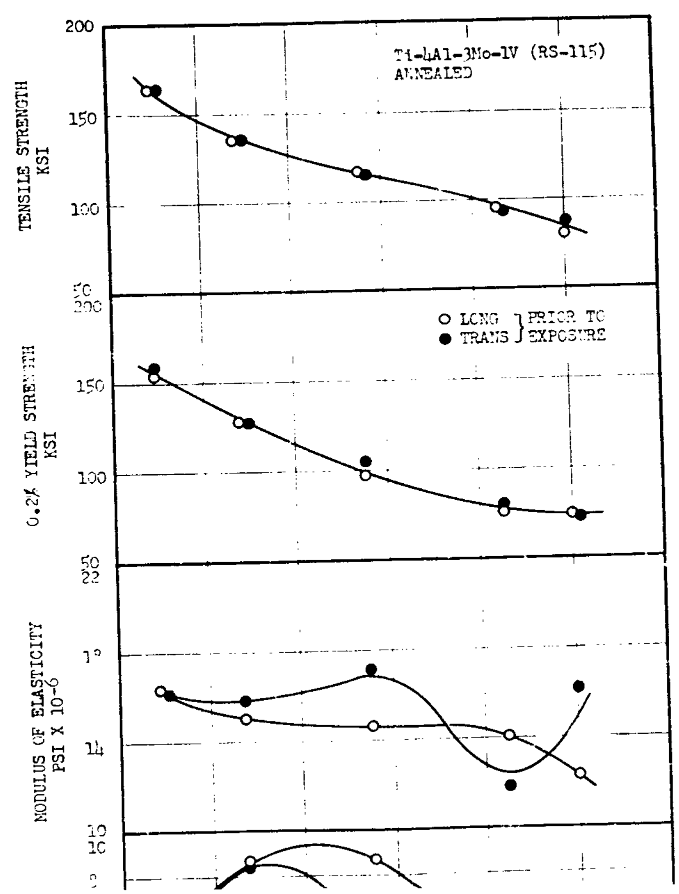


FIG. 4 THE EFFECT OF TESTING TEMPERATURES ON THE TENSILE STRENGTH, THE YIELD STRENGTH, ... OF ELASTICITY AND THE ELONGATION IN PERCENT OF AISI - 301 COLD REDUCED 51%. MATERIAL TESTED PRIOR TO EXPOSURE AND IN THE EXPOSED CONDITION.



CONDITION.

FIG. 6 THE EFFECT OF TESTING TEMPERATURES ON THE TENSILE STRENGTH, THE YIELD STRENGTH, THE MODULUS OF ELASTICITY AND THE ELONGATION IN PERCENT OF AISI - 301 COLD REDUCED 60%. MATERIAL TESTED PRIOR TO EXPOSURE AND IN THE EXPOSED CONDITION.

ERRATA SHEET

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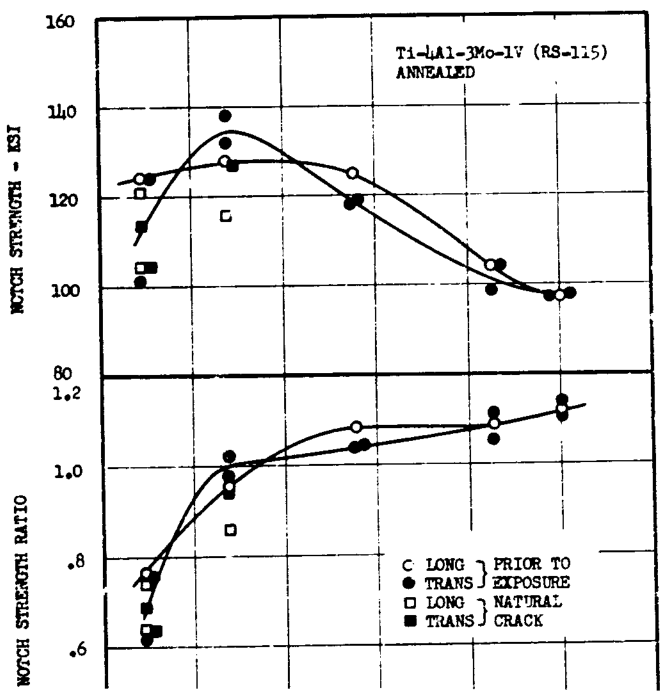
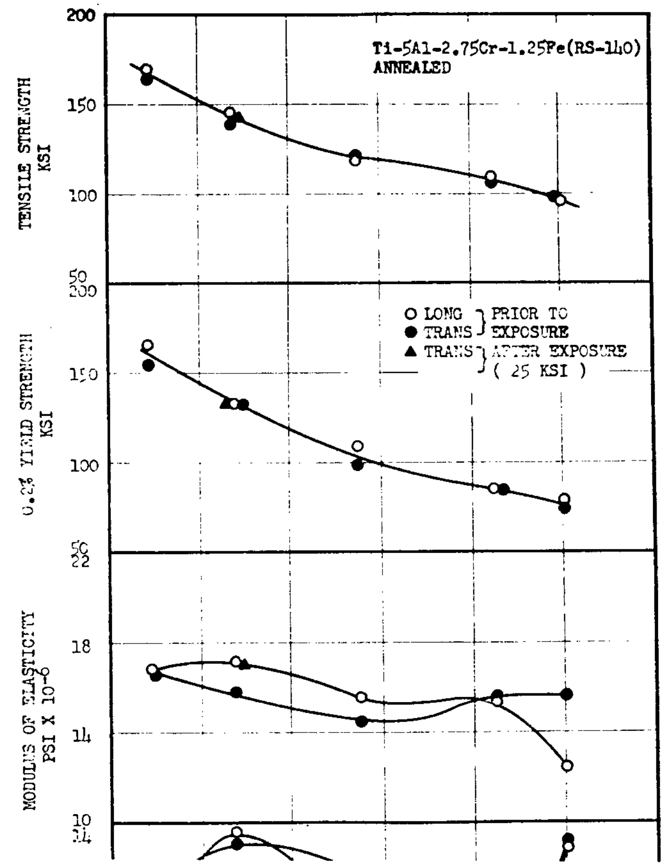
CONTRACT NO. NASr-43





ERRATA SHEET

FINAL REPORT ~~- JUNE 62~~
NASA
CONTRACT NO. NASr-43

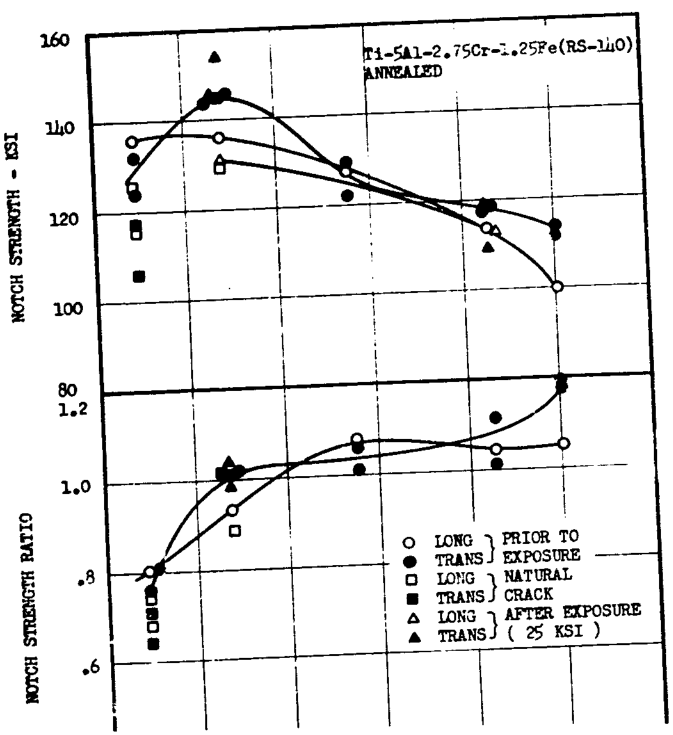
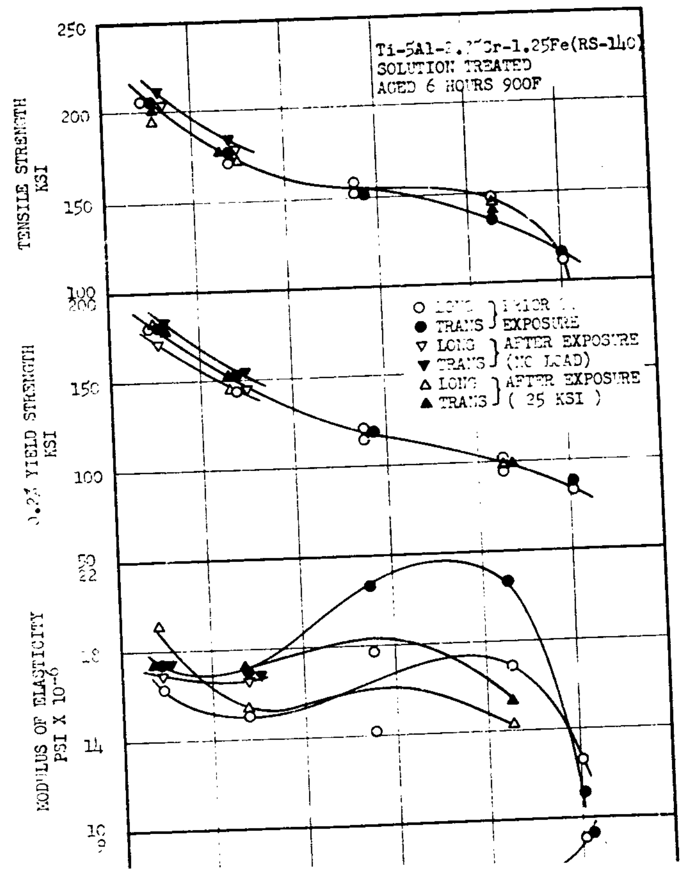
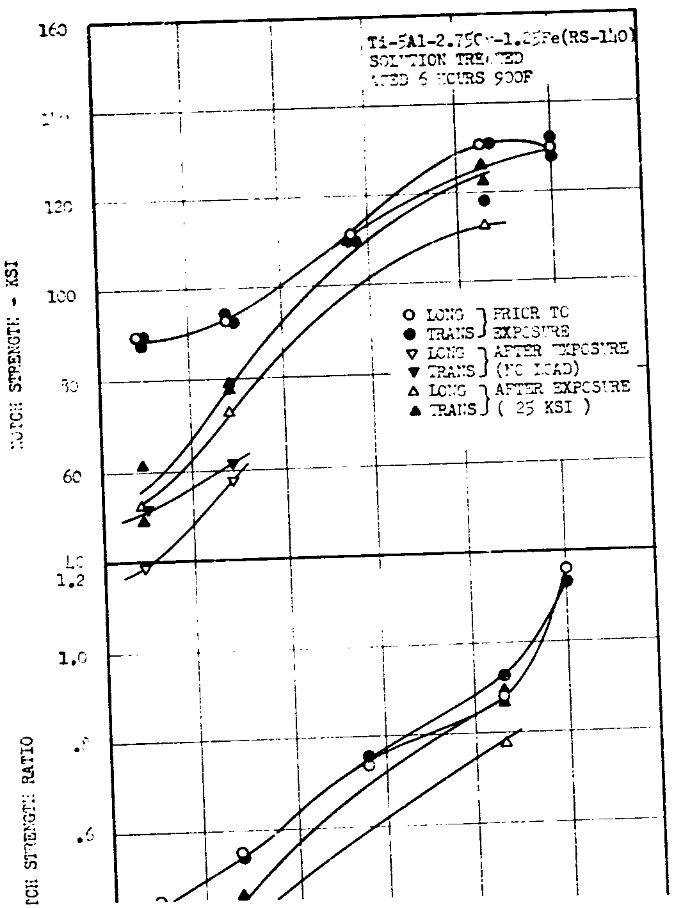


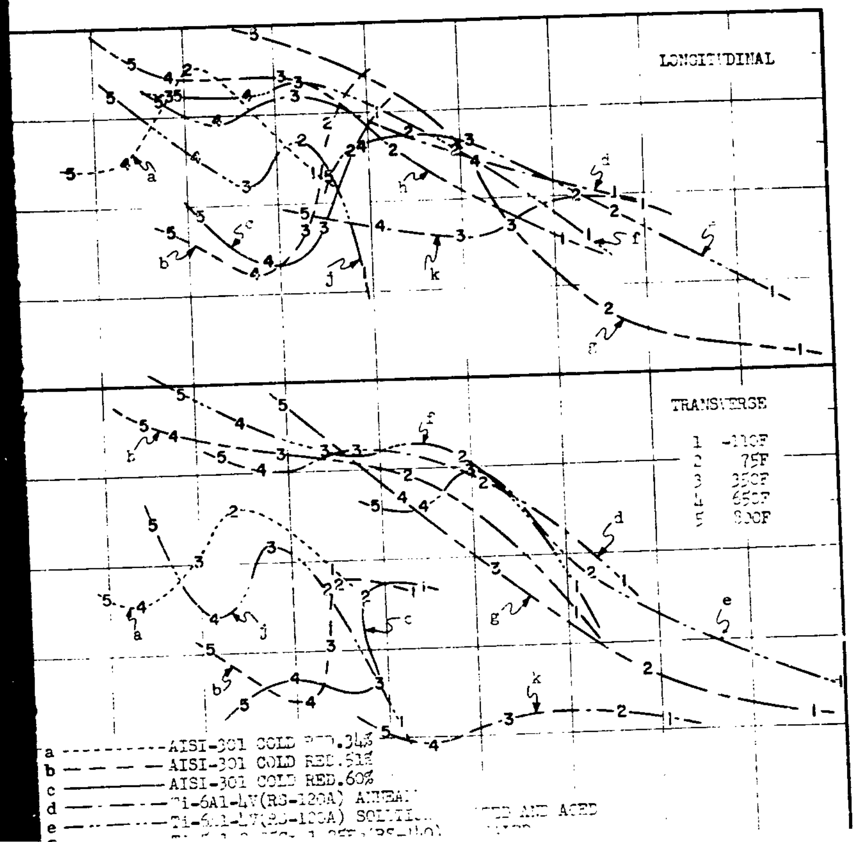
FIG. 8 [illegible] THE YIELD STRENGTH, THE MODULUS OF ELASTICITY AND THE ELONGATION IN PERCENT OF [illegible] 15-7 Mo, CONDITION RH 1050. MATERIAL TESTED PRIOR TO EXPOSURE AND IN THE EXPOSED CONDITION.

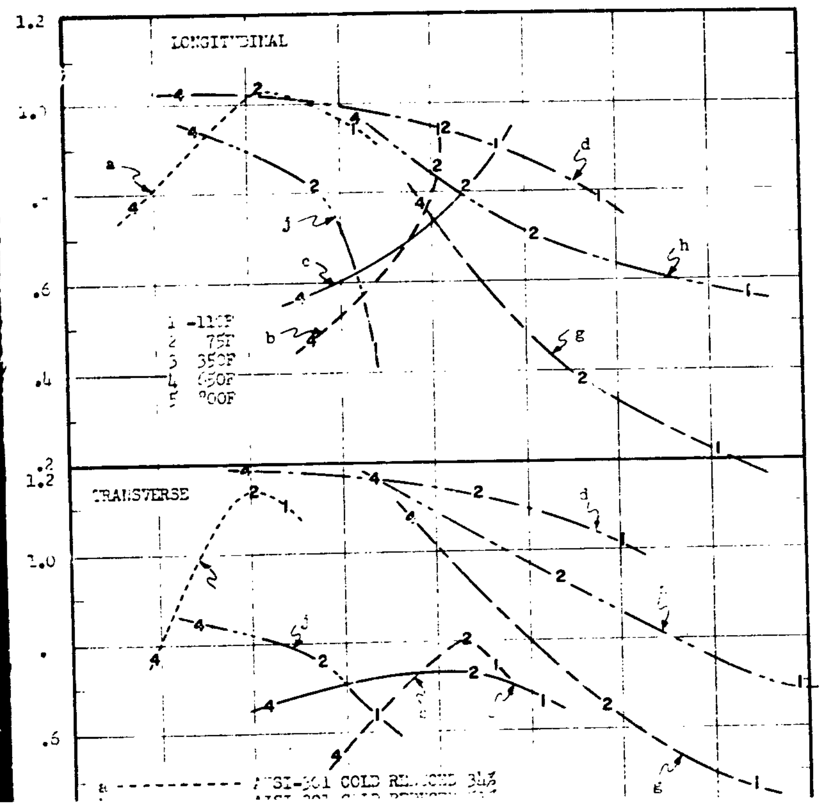


RH 1050. MATERIAL TESTED PRIOR TO EXPOSURE AND IN THE EXPOSED CONDITION.



ELONGATION IN PERCENT OF PH 15-7 Mo IN CONDITION CH-900. MATERIAL TESTED PRIOR TO EXPOSURE.





THE YIELD STRENGTH, THE MODULUS OF ELASTICITY AND THE ELONGATION IN PERCENT OF Ti-6Al-4V (RS-120-A) ANNEALED. MATERIAL TESTED PRIOR TO EXPOSURE AND IN THE EXPOSED CONDITION.

END