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A STUDY OF THE TENSILE AND CREEP-RUPTURE PROPERTIES OF FIFTEEN HEATS OF C-110M TITANIUM ALLOY SHEET

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Foreword

This report was prepared by the Cornell Aeronautical Laboratory, Inc., Buffalo, New York, under USAF Contract No. AF 33(616)-2342. The contract was initiated under Project No. 7360, "Materials Analysis and Evaluation Techniques", Task No. 73605 "Design Data for Metals", formerly RDO No. 614-13 "Design and Evaluation Data for Structural Metals", and was administered under the direction of the Materials Laboratory, Directorate of Research, Wright Air Development Center, with Mr. W. H. Rector acting as project engineer.

This report covers work conducted from January 15, 1954 to March 15, 1955.

ABSTRACT

Fifteen heats of titanium alloy RC-130-A (C110-M) have been sampled and tested at room and elevated temperatures. These data are analyzed for reproducibility and relationships between the room temperature and high temperature properties at 500°F and 700°F. The results indicate that a correlation exists between the room temperature strength properties and the yield and ultimate strengths at 500 and 700°F. However, the creep and rupture properties appear to be independent of the short time tensile strength results even at 700°F, which was the temperature used for creep testing.

PUBLICATION REVIEW

THIS REPORT HAS BEEN REVIEWED AND IS APPROVED.

FOR THE COMMANDER

M. R. WHITMORE
Technical Director
Materials Laboratory
Directorate of Research

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INTRODUCTION

At the high operating speeds of supersonic aircraft, aerodynamic heating becomes a significant factor which must be dealt with from the structural design standpoint. In this respect, titanium and its alloys appear to have potential value because of their combination of light weight with high-temperature strength.

Because titanium alloys have been supplied commercially for only the past few years, limited information exists concerning their load-carrying ability at elevated temperatures. While such data may be determined for individual lots of material, the question arises as to the scatter of results that might be expected from heat to heat of titanium alloys of the same nominal composition. It would be convenient to be able to appraise the high-temperature strength of each heat of a titanium alloy from the room temperature tensile properties normally provided with each batch of material by the producer.

This report summarizes the work done on a Wright Air Development Center contract which had for its objective the correlation of the mechanical properties of the structural titanium alloy C-110M (RC-130-A) at room and elevated temperatures. The purpose of this comparison was to establish whether or not the room-temperature mechanical properties could be used as a basis for predicting the high-temperature mechanical properties.

The work program included tensile tests conducted at both room and elevated temperatures and creep and rupture tests at 700°F. The results have been tabulated and examined for consistence and relationships between the various mechanical properties.

TEST PROGRAM

Random samples were taken from fifteen production heats of varying thicknesses of the RC-130-A (C110-M) titanium alloy. The samples were supplied by Rem-Cru Titanium, Inc. from their regular production in the form of 24" x 48" sheets in thicknesses between 0.025 inch and 0.100 inch. Tensile tests were made in both the longitudinal and transverse directions at room temperature, 500°F and 700°F. Creep and rupture tests were made in one direction only. This direction was chosen on the basis of the weaker direction as determined by the yield strength of the room temperature tensile tests. The creep-rupture tests were all conducted at 700°F to give creep, total deformation, and rupture values from 1 to 100 hours.

TEST PROCEDURES

The room-temperature tensile tests were conducted on a 60,000 lb. Southwark-Emery hydraulic tensile testing machine at a strain rate of 0.5% per minute. Elevated-temperature tensile tests were conducted on the same equipment by surrounding the specimen with an electric resistance furnace. Three thermocouples were attached, one each, to the top, middle, and bottom of the 2-inch gage length. Temperature distribution over the gage length was held to within ± 3°F at the start of each test and maintained as long as practicable during the test. Strain was measured by clamping extensometer arms to each end of the gage length. These arms extended out of the furnace and engaged a cantilever strain gage(1). The output of the strain gage was fed into an SR-4 strain indicator and an Esterline Angus recorder with a fixed-speed chart drive. Sensitivity of the system was equal to 0.00090 units of strain per readable recorder division. A predetermined slope of the recorded time vs. deformation line was maintained by manually adjusting the controls on the tensile machine. The strain rate was maintained constant throughout the full duration of the test.

Creep tests were conducted in lever type creep test machines. Temperature control was the same as in the high-temperature tensile tests. Strain was also measured using the same type cantilever strain gage, the output of which was recorded on a Foxboro strain recorder. Sensitivity of the system was 0.000070 units of strain per recorder division with a long-time accuracy of 0.00070.

(1) Guarnieri, G and Miller, J. Strain gage for testing sheet metal at high temperature Metal Progress 54, No. 5, (November 1948) p. 692-694

TEST RESULTS AND DISCUSSION

Tensile tests were made on fifteen heats of material in both the longitudinal and transverse directions as related to the direction of rolling. Two sheets taken from different locations in the ingot were tested for two of the heats that were sampled. One of these heats was in stock at Cornell Aeronautical Laboratory, Inc. at the time the project was started. Tensile tests were made on both sheets of material at room temperature and 500°F to indicate possible variations in the properties of the two sheets. From the data in Table I, a difference in strength is evident. The room-temperature difference in strength carries over to the 500°F tests, and the spread increases somewhat at the higher temperatures. Due to a shortage of material from sheet 1 of this heat, creep tests and 700°F tensile tests were made only on sheet 2. Two of the sample sheets received from Rem-Cru Titanium, Inc. were also from different locations in the same ingot. The room temperature and 500°F tensile test data for these two sheets of material are given in Table II. A comparison of the data in Tables I and II shows that the heat which was received more recently (Rem-Cru Heat No. A 30649) has less spread in the tensile properties. There was a lapse of about 1-1/2 years between the production of the two heats. Although the two heats by themselves are by no means a representative sample of production at the two different periods, one might infer an indication of improved production practice.

The room-temperature tensile test data for all of the heats tested are summarized in Table III. The tensile test data for 500°F and 700°F are given in Tables IV and V. In order to make comparison of the data easier, the tensile strengths, yield strengths, and elongation values for room temperature, 500°F and 700°F are retabulated separately. The yield strengths are given in Table VI, ultimate tensile strengths in Table VII, and elongation values in Table VIII.

An examination of the yield strength values given in Table VI shows some definite trends:

(1) The yield strength at room temperature is always higher in the transverse direction.

(2) At 500°F and 700°F, the spread between the longitudinal and transverse yield strengths decreases with increase in sheet thickness, and in a few cases, the longitudinal strength is greater than the transverse.

(3) There is an apparent trend of increasing yield strength with thickness, but this will be shown to be only minor.

The ultimate strength values given in Table VII follow the same trends as the yield strengths. The elongation results contained in Table VIII are not as consistent as the yield strength and ultimate strength results. However, the following general trends are apparent:

(1) The elongation tends to be greater in the longitudinal direction at room temperature.

(2) The 500°F and 700°F tests show a decrease in the elongation values which is undoubtedly associated with a precipitation reaction that occurs in this temperature range for the RC-130-A alloy.

(3) The elongation values for both directions tend to equalize in the elevated temperature tests.

Table IX summarizes the test report data obtained at room temperature by Rem-Cru Titanium, Inc. on the same heats of material. These results are in general agreement with those obtained at Cornell Aeronautical Laboratory, Inc.

The fifteen heats of material were creep-rupture tested at 700°F in the longitudinal direction. This was the weakest direction as determined by the tensile yield strength at room temperature. In addition, three of the heats representing the thinnest sheet (0.025 inch), an intermediate thickness, (0.064 inch), and the thickest sheet (0.100 inch) were tested in the transverse direction. The total deformation and creep-rupture data for the above tests are given in Tables X through XXVIII. These data are also plotted as stress vs. time curves in Figures 1 through 19.

The stresses to produce given amounts of creep, total deformation and rupture in 10 and 100 hours were taken from the curves in Figures 1 through 19. This information is tabulated in Tables XXIX, XXX, and XXXI.

Inspection of the tabulated data failed to reveal any definite trends other than those enumerated regarding yield strength and tensile strength.

Plots of the frequency distribution of the tensile strengths at room temperature, yield strengths at room temperature, 500°F and 700°F and 1% creep in 10 hours and 100 hours at 700°F were made as shown in Figure 20. These plots show a tendency toward a normal statistical grouping in all cases with the greatest deviations occurring in the yield strength at 700°F. The spread in these latter data is even more accentuated when one considers the difference between the highest and lowest reading as a percentage of the highest reading. This amounts to 20% in the case of the room temperature ultimate strength, 29% for the room temperature yield strength, 36% for the yield strength at 500°F, 49% for the yield strength at 700°F, 41% for the 1.0% creep in 100 hours and 21% for the 1.0% creep in 10 hours. It is also evident that those heats that display the highest and lowest room-temperature tensile strengths remain close to these positions in the tabulations of other strength characteristics.

The data were compared on the basis of increasing manganese content and individual and total carbon and nitrogen contents as reported in the Rem-Cru test reports, Table IX, and no correlation could be found with the mechanical properties. Neither could a correlation be found with the bend values or elongation.

The only basis for comparison that brought out any definite trends was that of the yield strength at room temperature. In order to make the comparisons more apparent and easily cross referenced, the data for the various tests were plotted in the form of bar charts in Figure 21. The room-temperature yield strength was plotted in the order of increasing strength and all other charts in this figure were plotted with the C.A.L. H.T. numbers in the same relative order. It can be readily seen that the longitudinal yield strengths at 500°F and 700°F and the longitudinal ultimate tensile strengths at room temperature, 500°F and 700°F show the same tendency toward increasing in the same order as the room-temperature yield strength. The elongation values show no correlation with this property. The transverse yield and ultimate strengths at room temperature, 500°F and 700°F also display a tendency toward increasing in the same order as the room-temperature longitudinal yield strength. The latter correlation with the transverse tensile strength properties is not as pronounced as that with the longitudinal tensile strength properties, but it exists. The transverse elongation values show no correlation with the strength properties.

There is a tendency toward a slight inverse relationship between the room-temperature longitudinal yield strength and the stress to produce 1.0% creep in 100 hours at 700°F. The stresses to produce 1.0% creep in 10 hours and that to produce rupture in 100 hours at 700°F appear to be relatively independent of the room-temperature yield strength tendencies.

When the first few tests were run on this project, it was pointed out in an interim report that the strength appeared to be related to the thickness. This conclusion was arrived at due to the fact that the first few heats tested included the thinnest and thickest material and several intermediate thicknesses. A comparison of longitudinal yield and ultimate tensile strengths at room temperature on the basis of increasing yield strength and increasing thickness is shown in Figure 22. The thinnest material has a relatively low strength, while the thickest material has the highest strength. Except for these two thicknesses, and several of the intermediate thicknesses, the correlation is not too good. When the first and last heats are disregarded, the ultimate tensile strength correlation with thickness is practically non-existent.

The stresses to produce 1% creep and rupture in 100 hours were plotted against the longitudinal yield strengths for room temperature and 700°F in Figure 23. The objective of these plots was to bring out any possible correlations between the room-temperature and high-temperature properties. With the exception of a slight tendency toward an inverse correlation between the stress for 1% creep in 100 hours and both the room temperature and 700°F yield strengths and a slight tendency toward a direct correlation of the stress for rupture in 100 hours with the same values, the points fall in a random distribution. These same tendencies are shown in Figure 21.

CONCLUSIONS

The spread in room-temperature properties of the fifteen heats that were tested is sufficiently great, in fact, some of the values fall below specification minimums, to insure that the data cover the typical spread encountered in production. The frequency distribution appears to be fairly normal within this spread. These factors lend weight to the reliability of the conclusions drawn from the data and it is felt that they are applicable to the titanium alloy C-110M (RC-130-A) that is presently being produced. The conclusions drawn from the data may be summarized as follows:

(1) The fifteen heats of material showed a spread in properties typical of those encountered in production.

(2) The room-temperature yield strength shows a direct correlation with the yield strengths obtained at 500°F and 700°F. This holds true for both the longitudinal and transverse directions.

(3) A correlation also exists between the yield and ultimate strengths at room temperature, 500°F and 700°F. The ultimate strengths increase with increasing yield strength.

(4) The transverse yield and tensile strengths increase almost directly with the longitudinal properties.

(5) The transverse room-temperature, 500°F and 700°F yield and tensile strengths are higher than the longitudinal.

(6) The elongations do not appear to be related to strength in either the transverse or longitudinal directions.

(7) The creep and rupture properties at 700°F do not appear to bear any distinct relationship to the yield and tensile strengths at any of the three tensile test temperatures.

(8) While it appears to be safe to estimate short-time high-temperature properties based on those obtained at room temperature, it is also evident that creep and rupture properties cannot be predicted on this basis.

TABLE I

COMPARISON OF TENSILE TEST DATA
FOR TWO SHEETS OF RC-130-A FROM SAME HEAT
(C.A.L. H.T. 274) (REM-CRU HEAT NO. A-3723) 0.065-INCH SHEET

	Sheet No.	Transverse Direction		Longitudinal Direction	
		Room Temperature	500°F	Room Temperature	500°F
Ultimate Strength PSI	1	153,000	>133,800	150,000	132,500
	1	151,000	>131,000	150,500	136,900
	2	143,000	112,200	141,000	105,500
	2	146,000	112,100	142,000	107,200
Yield Strength PSI (0.2% Offset)	1	131,000	108,000	137,300	102,800
	1	135,000	111,800	137,000	95,500
	2	134,000	90,600	120,000	80,200
	2	134,000	86,300	128,000	86,600
% Elongation in Two Inches	1	19.5	Fractured at pin	21.5	16.0
	1	21.0	" "	19.6	17.0
	2	7.0*	13.0	19.0	13.0
	2	23.0	13.0	22.0	12.0

*Fractured outside two-inch gage length.

TABLE II

COMPARISON OF TENSILE TEST DATA
FOR TWO SHEETS OF RC-130-A FROM SAME HEAT
(C.A.L. H.T. 355 AND 375) (REM-CRU HEAT NO. A 30649) 0.050-INCH SHEET

	C.A.L. H.T. NO.	TRANSVERSE DIRECTION ROOM TEMPERATURE	TRANSVERSE DIRECTION 500°F	LONGITUDINAL DIRECTION ROOM TEMPERATURE	LONGITUDINAL DIRECTION 500°F
Ultimate Strength PSI	355	145,200	113,500	142,500	108,300
	355	145,900	115,200	143,100	111,200
	375	148,600	120,100	146,900	118,100
	375	147,200	119,500	145,800	117,100
Yield Strength PSI (0.2% Offset)	355	137,900	93,500	130,100	81,100
	355	136,000	93,700	124,900	83,200
	375	140,900	97,200	129,600	86,200
	375	140,900	96,200	129,500	86,600
% Elongation in Two Inches	355	12.0	11.0	21.0	13.0
	355	18.0	16.0	16.0	15.0
	375	20.0	15.0	21.0	19.0
	375	20.0	15.0	21.0	15.0

TABLE III

ROOM TEMPERATURE TENSILE TEST DATA

Heat Identification		Sheet Thickness	LONGITUDINAL				TRANSVERSE			
CAL	Rem-Cru	Ins.	Yield Strength psi	Ultimate Strength psi	% Elong. In 2 In.	E x 10^{-6}	Yield Strength psi	Ultimate Strength psi	% Elong. In 2 In.	E x 10^{-6}
341	A 30633-1	.025	107,000	132,000	18.0	16.2	128,000	140,000	10.0*	18.4
			119,000	141,000	10*	18.1	124,000	138.000	21.0	17.5
340	A 30635B-3	.035	125,000	146,000	18.0	15.0	135,000	147,000	15.0	16.0
			129,000	148,000	21.0	15.6	136,000	149,000	17.0	17.8
342	A 30637T-13	.041	120,700	135,500	21.0	15.3	122,900	136,900	17.0	14.4
			118,700	141,600	18.0	16.8	121,300	137,800	17.0	15.5
376	A 43037-19	.041	109,400	132,800	20.0	15.9	138,000	138,200	5.0	16.1
			109,700	132,300	22.0	16.3	135,000	143,200	12.0	16.5
353	A 4C013T-4	.042	118,400	136,700	8.0	18.1	139,600	147,500	6.0	18.2
			119,600	137,000	12.0	19.3	139,200	140,000	1.5	16.9
373	A 41097-23	.042	106,000	126,800	20.0	14.6	108,900	124,200	6.0	15.3
			108,300	129,800	20.0	13.1	108,900	121,000	8.0	13.2
375	A 30649-3	.050	129,600	146,900	21.0	14.6	140,900	148,600	20.0	17.8
			129,500	145,800	21.0	14.3	140,900	147,200	20.0	16.4
378	A 30559-11	.050	103,000	131,000	20.0	14.2	129,600	138,400	22.0	16.3
			107,400	131,300	21.0	13.6	130,000	139,800	22.0	17.6
354	A 32219-4	.051	116,500	138,500	22.0	13.5	133,200	138,900	4.0	16.9
			115,000	137,200	19.0	16.4	132,700	145,000	5.0	15.6
355	A 30649B-1	.052	130,100	142,500	21.0	15.5	137,900	145,200	12.0	17.1
			124,900	143,100	16.0	15.4	136.000	145,900	18.0	19.1
377	A 41064-12	.060	118,000	135,700	24.0	14.8	131,200	141,600	19.0	16.0
			113,000	128,000	24.0	13.4	133,700	142,300	19.0	14.9
274-2	A 3723-29	.064	120,000	141,000	19.0	16.7	134,000	143,000	7.0*	16.9
			128,000	142,000	22.0	16.6	134,000	146,000	23.0	17.3
374	A 31292-8	.065	136,100	150,900	22.0	16.7	142,900	149,700	11.0	16.3
			129,100	143,300	23.0	15.4	142,700	148,700	22.0	16.0
356	A 41059M-11	.066	129,300	146,900	21.0	15.2	145,200	153,100	19.0	16.5
			126,600	143,800	23.0	16.6	149,800	152,800	22.0	17.5
357	A 42010T-25	.080	132,600	151,100	19.0	15.7	150,100	151,100	1.5	17.1
			133,100	149,200	21.0	16.6	149,600	152,800	3.0	16.7
343	A 30676T-8	.100	145,400	157,900	14.0	13.2	151,100	167,200	12.0	16.6
			145,900	159,200	14.0	16.9	151,100	164,200	8.0	15.7

* Broke outside 2 inch gage length

TABLE IV

TENSILE TEST DATA AT 500°F

Heat Identification		Sheet Thickness	LONGITUDINAL				TRANSVERSE			
CAL	Rem-Cru	Ins.	Yield Strength psi	Ultimate Strength psi	% Elong. In 2 In.	E x 10^{-6}	Yield Strength psi	Ultimate Strength psi	% Elong. In 2 In.	E x 10^{-6}
341	A 30633-1	.025	67,000	102,000	13.0	11.6	93,300	115,200	9.0	14.0
			64,700	99,000	13.0	11.8	87,700	113,000	15.0	14.1
340	A 30635B-3	.035	80,700	111,200	8.0	15.9	88,800	110,400	10.0	17.3
			86,000	113,600	9.0	16.6	84,000	106,900	8.0	15.1
342	A 30637T-13	.041	79,300	113,000	17.0	13.9	82,700	119,900	11.0	17.5
			81,600	112,500	17.0	13.4	80,000	116,800	7.0	17.0
376	A 43037-19	.041	66,100	98,800	13.0	11.5	88,100	110,100	14.0	15.8
			74,400	99,500	14.0	10.9	89,800	112,000	13.0	16.8
353	A 4C013T-4	.042	82,600	106,800	10.0	12.1	103,000	129,000	10.0	13.8
			83,500	105,300	10.0	13.5	102,300	127,700	10.0	13.5
373	A 41097-23	.042	74,100	106,900	15.0	11.5	73,500	107,300	17.0	11.9
			70,600	103,800	15.0	11.3	74,100	108,400	16.0	13.3
375	A 30649-3	.050	86,200	118,100	19.0	12.4	97,200	120,100	15.0	13.2
			86,600	117,100	15.0	13.4	96,200	119,500	15.0	13.8
378	A 30559-11	.050	71,400	99,400	12.0	12.8	89,700	109,900	11.0	15.5
			73,100	101,000	12.0	13.4	86,200	110,900	10.0	15.9
354	A 32219-4	.051	69,300	104,000	13.0	13.9	87,500	115,400	13.0	11.4
			71,300	107,300	9.0	9.3	108,700	116,100	5.0	11.9
355	A 30649B-1	.052	81,100	108,300	13.0	14.5	93,500	113,500	11.0	12.7
			83,200	111,200	15.0	17.8	93,700	115,200	16.0	14.6
377	A 41064-12	.060	76,000	108,000	16.0	13.7	87,800	114,000	13.0	16.7
			77,100	109,900	17.0	14.4	86,700	100,800	13.0	15.6
274-2	A 3723-29	.064	80,200	105,400	13.0	13.8	90,600	112,200	13.0	26.3
			86,600	107,200	12.0	17.1	86,300	112,100	13.0	13.4
374	A 31292-8	.065	91,600	119,100	17.0	13.4	98,600	121,200	15.0	14.4
			89,400	117,300	17.0	14.3	94,500	121,400	16.0	13.8
356	A 41059M-11	.068	86,300	115,300	14.0	15.9	101,800	122,000	12.0	17.9
			84,200	113,100	13.0	13.8	98,200	122,300	12.0	15.7
357	A 42010T-25	.080	100,000	121,600	16.0	10.6	114,800	130,500	9.0	11.5
			99,600	124,800	16.0	13.5	109,300	125,100	11.0	14.1
343	A 30676T-8	.100	95,700	122,800	13.0	13.3	89,000	118,800	10.0	14.5
			92,000	122,400	14.0	16.9	91,700	121,800	11.0	15.8
			97,700	120,700	10.0	15.6				

TABLE V

TENSILE TEST DATA AT 700°F

Heat Identification		Sheet Thickness Ins.	LONGITUDINAL				TRANSVERSE			
CAL	Rem-Cru		Yield Strength psi	Ultimate Strength psi	% Elong. In 2 In.	E x 10^{-6}	Yield Strength psi	Ultimate Strength psi	% Elong. In 2 In.	E x 10^{-6}
341	A 30633-1	.025	52,000	77,000	14.0	8.3	93,300	112,200	6.0	23.7
			61,600	91,000	14.0	10.4	87,000	110,500	12.0	12.7
340	A 30635B-3	.035	80,600	102,000	15.0	12.3	86,200	100,800	9.0	11.1
			76,400	99,300	15.0	9.0	79,600	100,000	8.0	12.2
342	A 30537T-13	.041	75,600	102,400	19.0	12.6	80,000	99,400	12.0	10.3
			72,100	100,000	18.0	15.8	81,400	101,400	14.0	11.4
376	A 43037-19	.041	64,000	90,200	14.0	10.4	81,700	99,400	10.0	12.6
			64,500	93,700	13.0	12.4	84,000	101,200	12.0	14.7
353	A 4C013T-4	.042	79,000	94,000	11.0	10.2	94,000	113,900	13.0	13.2
			78,000	95,100	11.0	9.6	101,200	115,200	11.0	12.8
373	A 41097-23	.042	71,400	101,100	21.0	11.2	71,700	94,500	17.0	8.1
			71,400	97,800	19.0	10.9	71,700	93,500	16.0	8.7
375	A 30649-3	.050	78,200	103,700	18.0	10.4	86,200	108,700	15.0	12.5
			80,400	103,000	18.0	9.6	86,700	108,000	19.0	13.1
378	A 30559-11	.050	66,200	89,700	13.0	9.9	81,400	97,000	11.0	11.9
			65,400	90,200	15.0	9.8	83,800	98,000	13.0	12.6
354	A 32219-4	.051	66,500	93,500	12.0	11.8	84,000	105,200	13.0	11.4
			70,500	92,500	17.0	10.9	80,500	102,300	5.0	11.9
355	A 30649B-1	.052	77,800	98,600	15.0	10.4	86,800	103,200	13.0	12.0
			77,000	99,200	17.0	10.5	86,700	103,900	14.0	14.2
377	A 41064-12	.060	71,000	94,700	14.0	13.1	75,400	100,800	12.0	14.0
			69,700	95,500	18.0	11.2	81,200	100,900	14.0	14.1
272-2	A 3723-29	.064	68,500	92,800	12.0	14.1	76,400	96,800	16.0	15.9
			50,000	93,000	13.0	16.4	77,000	98,000	19.0	14.9
374	A 31292-8	.065	80,500	107,400	28.0	11.5	88,900	106,600	18.0	11.5
			82,300	106,100	25.0	10.7	87,800	106,000	21.0	11.0
356	A 41059M-11	.068	98,500	98,600	16.0	10.6	107,600	131,900	10.0	14.8
			73,800	98,900	16.0	12.7	97,100	130,000	26.0	14.9
357	A 42010T-25	.080	90,200	108,100	16.0	9.5	109,000	126,700	9.0	12.3
			92,200	111,200	17.0	10.0	102,500	118,100	12.0	12.7
343	A 30676T-8	.100	83,500	109,700	8.0	12.8	83,200	113,100	10.0	14.0
			88,700	110,300	9.0	12.5	83,700	110,000	16.0	10.2

TABLE VI

COMPARISON OF TENSILE YIELD STRENGTHS (0.2% OFFSET) AT ROOM TEMPERATURE, 500°F AND 700°F

Heat Identification		Sheet Thickness	ROOM TEMPERATURE		500°F		700°F	
CAL	Rem-Cru	Ins.	Longitudinal psi	Transverse psi	Longitudinal psi	Transverse psi	Longitudinal psi	Transverse psi
341	A 30633-1	.025	107,000	128,000	67,000	93,300	52,000	93,300
			119,000	124,000	64,700	87,700	61,600	87,000
340	A 30635B-3	.035	125,000	135,000	80,700	88,800	80,600	86,200
			129,000	136,000	86,000	84,000	76,400	79,600
342	A 30637T-13	.041	120,700	122,900	79,300	82,700	75,600	80,000
			118,700	121,300	81,600	80,000	72,100	81,400
376	A 43037-19	.041	109,400	138,000	66,100	88,100	64,000	81,700
			109,700	135,000	74,400	89,800	64,500	84,000
353	A 4C013T-4	.042	118,400	139,600	82,600	103,000	79,000	94,000
			119,600	139,200	83,500	102,300	78,000	101,200
373	A 41097-23	.042	106,000	108,900	74,100	73,500	71,400	71,700
			108,300	108,900	70,600	74,100	71,400	71,700
375	A 30649-3	.050	129,600	140,900	86,200	97,200	78,200	86,200
			129,500	140,900	86,600	96,200	80,400	86,700
378	A 30559-11	.050	103,000	129,600	71,400	89,700	66,200	81,400
			107,400	130,000	73,100	86,200	65,400	83,800
354	A 32219-4	.051	116,500	133,200	69,300	87,500	66,500	84,000
			115,000	132,700	71,300	108,700	70,500	80,500
355	A 30649B-1	.052	130,100	137,900	81,100	93,500	77,800	86,800
			124,900	136,000	83,200	93,700	77,000	86,700
377	A 41064-12	.060	118,000	131,200	76,000	87,800	71,000	75,400
			113,000	133,700	77,100	86,700	69,700	81,200
274-2	A 3723-29	.064	120,000	134,000	80,200	90,600	68,500	76,400
			128,000	134,000	86,600	86,300	50,000	77,000
374	A 31292-8	.065	136,100	142,900	91,600	98,600	80,500	88,900
			129,100	142,700	89,400	94,500	82,300	87,800
356	A 41059M-11	.068	129,300	145,200	86,300	101,800	98,500	107,600
			126,600	149,800	84,200	98,200	73,800	97,100
357	A 42010T-25	.080	132,600	150,100	100,000	114,800	90,200	109,000
			133,100	149,600	99,600	109,300	92,200	102,500
343	A 30676T-8	.100	145,400	151,100	95,700	89,000	83,500	83,200
			145,900	151,100	92,000	91,700	88,700	83,700
					97,700			

TABLE VII

COMPARISON OF ULTIMATE TENSILE STRENGTHS AT ROOM TEMPERATURE, 500°F AND 700°F

Heat Identification		Sheet Thickness	ROOM TEMPERATURE		500°F		700°F	
CAL	Rem-Cru	Ins.	Longitudinal psi	Transverse psi	Longitudinal psi	Transverse psi	Longitudinal psi	Transverse psi
341	A 30633-1	.025	132,000	140,000	102,000	115,200	77,000	112,200
			141,000	138,000	99,000	113,000	91,000	110,500
340	A 30635B-3	.035	146,000	147,000	111,200	110,400	102,000	100,800
			148,000	149,000	113,600	106,900	99,300	100,000
342	A 30637T-13	.041	135,500	136,900	113,000	119,900	102,400	99,400
			141,600	137,800	112,500	116,800	100,000	101,400
376	A 43037-19	.041	132,800	138,200	98,800	110,100	90,200	99,400
			132,300	143,200	99,500	112,000	93,700	101,200
353	A 4C013T-4	.042	136,700	147,500	106,800	129,000	94,000	113,900
			137,000	140,000	105,300	127,700	95,100	115,200
373	A 41097-23	.042	126,800	124,200	106,900	107,300	101,100	94,500
			129,800	121,000	103,800	108,400	97,800	93,500
375	A 30649-3	.050	146,900	148,600	118,100	120,100	103,700	108,700
			145,800	147,200	117,100	119,500	103,000	108,000
378	A 30559-11	.050	131,000	138,400	99,400	109,900	89,700	97,000
			131,300	139,800	101,000	110,900	90,200	98,000
354	A 32219-4	.051	138,500	138,900	104,000	115,400	93,500	105,200
			137,200	145,000	107,300	116,100	92,500	102,300
355	A 30649B-1	.052	142,500	145,200	108,300	113,500	98,600	103,200
			143,100	145,900	111,200	115,200	99,200	103,900
377	A 41064-12	.060	135,700	141,600	108,000	114,000	94,700	100,800
			128,000	142,300	109,900	110,800	95,500	100,900
274-2	A 3723-29	.064	141,000	143,000	105,400	112,200	92,800	96,800
			142,000	146,000	107,200	112,100	93,000	98,000
374	A 31292-8	.065	150,900	149,700	119,100	121,200	107,400	106,600
			143,300	148,700	117,300	121,400	106,100	106,000
356	A 41059M-11	.068	146,900	153,100	115,200	122,000	98,600	131,900
			143,800	152,800	113,100	122,300	98,900	130,000
357	A 42010T-25	.080	151,100	151,100	121,600	130,500	108,100	126,700
			149,200	152,800	124,800	125,100	111,200	118,100
343	A 30676T-8	.100	157,900	167,200	122,800	118,800	109,700	113,100
			159,200	164,200	122,400	121,800	110,300	110,000
					120,700			

TABLE VIII

COMPARISON OF ELONGATION (% IN 2 INS.) AT ROOM TEMPERATURE, 500°F AND 700°F

Heat Identification		Sheet Thickness	ROOM TEMPERATURE		500°F		700°F	
CAL	Rem-Cru	Ins.	Longitudinal %	Transverse %	Longitudinal %	Transverse %	Longitudinal %	Transverse %
341	A 30633-1	.025	18.0	10.0*	13.0	9.0	14.0	6.0
			10.0*	21.0	13.0	15.0	14.0	12.0
340	A 30635B-3	.035	18.0	15.0	8.0	10.0	15.0	9.0
			21.0	17.0	9.0	8.0	15.0	8.0
342	A 30637T-13	.041	21.0	17.0	17.0	11.0	19.0	12.0
			18.0	17.0	17.0	7.0	18.0	14.0
376	A 43037-19	.041	20.0	5.0	13.0	14.0	14.0	10.0
			22.0	12.0	14.0	13.0	13.0	12.0
353	A 4C013T-4	.042	8.0	6.0	10.0	10.0	11.0	13.0
			12.0	1.5	10.0	10.0	11.0	11.0
373	A 41097-23	.042	20.0	6.0	15.0	17.0	21.0	17.0
			20.0	8.0	15.0	16.0	19.0	16.0
375	A 30649-3	.050	21.0	20.0	19.0	15.0	18.0	15.0
			21.0	20.0	15.0	15.0	18.0	19.0
378	A 30559-11	.050	20.0	22.0	12.0	11.0	13.0	11.0
			21.0	22.0	12.0	10.0	15.0	13.0
354	A 32219-4	.051	22.0	4.0	13.0	13.0	12.0	13.0
			19.0	5.0	9.0	5.0	17.0	5.0
355	A 30649B-1	.052	21.0	12.0	13.0	11.0	15.0	13.0
			16.0	18.0	15.0	16.0	17.0	14.0
377	A 41064-12	.060	24.0	19.0	16.0	13.0	14.0	12.0
			24.0	19.0	17.0	13.0	18.0	14.0
274-2	A 3723-29	.064	19.0	7.0*	13.0	13.0	12.0	16.0
			22.0	23.0	12.0	13.0	13.0	19.0
374	A 31292-8	.065	22.0	11.0	17.0	15.0	28.0	18.0
			23.0	22.0	17.0	16.0	25.0	21.0
356	A 41059M-11	.068	21.0	19.0	14.0	12.0	16.0	10.0
			23.0	22.0	13.0	12.0	16.0	26.0
357	A 42010T-25	.080	19.0	1.5	16.0	9.0	16.0	9.0
			21.0	3.0	16.0	11.0	17.0	12.0
343	A 30676T-8	.100	14.0	12.0	13.0	10.0	8.0	10.0
			14.0	8.0	14.0	11.0	9.0	16.0
					10.0			

* Broke outside 2 in. gage length

TABLE IX

REM-CRU TEST REPORT DATA

Heat Identification		Sheet Thickness	Ultimate Strength	Yield Strength	% Elong.	Bend	Chemistry		
Rem-Cru	CAL	Ins.	psi	psi	In 2 In.	Value	%C	%N	%Mn
A 3723-29	274	.064	146,900	137,200	16.0	2.6T	<0.1	0.027	6.76
A 30559-11	378	.050	139,100	133,000	16.0	2.5T	0.12	0.02	7.10
A 30633-1	341	.025	135,200	128,900	17.0	1.2T	<0.10	0.02	7.4
A 30637T-13	342	.041	132,900	118,300	14.5	2.3T	<0.1	0.02	7.60
A 30635B-3	340	.035	149,100	135,200	16.0	1.2T	<0.1	0.02	7.60
A 30649-3	375	.050	140,400	136,500	14.0	1.9T	.16	0.02	8.7
A 30649B-1	355	.052	144,000	136,500	16.1	0.9T	0.10	0.02	8.3
A 30676T-8	343	.100	145,700	137,200	16.5	2.5T	<0.1	0.02	7.10
A 31292-8	374	.065	146,300	141,300	14.0	1.9T	0.16	0.02	8.10
A 32219-4	354	.051	139,600	127,100	13.1	2.5T	<0.10	0.03	8.0
A 41059M-11	356	.068	153,800	147,400	11.5	2.0T	<0.1	0.02	8.0
A 41064-12	377	.060	139,700	134,300	17.0	2.1T	0.17	0.03	7.80
A 41097-23	373	.042	135,300	123,200	13.0	2.3T	<0.1	0.02	8.10
A 42010T-25	357	.080	153,200	147,400	10.5	2.0T	<0.1	0.02	8.0
A 43037-19	376	.041	146,700	140,500	15.5	2.5T	0.12	0.04	6.3
A 4C013T-4	353	.042	147,600	140,500	17.5	1.5T	<0.10	0.02	7.2

TABLE X

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES OF
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL DIRECTION
(C.A.L. H.T. 274) (REM-CRU HEAT NO. A-3723) (SHEET NO. 2)

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	% Elong. in 2 In.	Min. Creep Rate % Per Hour	Hardness RC Before Test	Hardness RC After Test	Specimen
20,000	0.18	12.8	OL	63.5	1.0	180.0	20.0		210.0								306.	1.0	0.0009	31	33	274-55A
30,000	0.23	3.5	OL	20.0	OL	48.0	0.5	125.0	35.0	320.0	234.0						497.	1.5	0.0013	31	31	274-53A
50,000	0.50	2.0	OL	8.0	OL	16.0	OL	30.0	OL	66.0	30.0	124.0	95.9				161.0	2.78	0.0140	31	36	274-51A
60,000	0.64	0.7	OL	2.0	OL	5.0	OL	12.0	OL	30.0	6.5	59.0	41.8	121.0	108.5	298.0	298.0	45.0	0.0272	31	36	274-48A
70,000	0.81	0.5	OL	1.5	OL	3.0	OL	6.0	OL	15.0	1.3	28.0	17.8	55.5	49.5	122.5	122.5	49.0	0.0520	32	34	274-47A
80,000	1.15	<0.1	OL	<0.1	OL	0.35	OL	1.2	OL	3.2	OL	6.3	2.7	14.0	11.4	27.5	27.5	24.0	0.222	32	37	274-46A
90,000	2.71	<0.1	OL	<0.1	OL	<0.1	OL	<0.1	OL	0.14	OL	0.45	OL	1.35	0.54	2.75	2.75	17.0	0.330	30	35	274-45A

TABLE XI

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES OF
RC-130-A TITANIUM SHEET AT 700°F
TRANSVERSE DIRECTION
(C.A.L. H.T. 274) (REM-CRU HEAT NO. A-3723) (SHEET NO. 2)

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	% Elong. in 2 In.	Min. Creep Rate % Per Hour	Hardness RC Before Test	Hardness RC After Test	Specimen
40,000	0.23	3.9	OL	11.0	OL	54.1	5.0	144.8	47.0								210.0	1.5	0.0011	31	35	274-64A
60,000	0.47	1.2	OL	5.0	OL	11.2	OL	28.0	0.2	73.3	33.0	146.0	118.0	262.5	249.0		354.0	9.0	0.0011	31	34	274-61A
70,000	0.52	1.6	OL	3.7	OL	5.9	OL	14.0	OL	32.4	12.0	65.2	49.0	140.0	126.0	194.5	194.5	44.5	0.0213	32	38	274-63A
80,000	0.70	0.4	OL	1.2	OL	2.6	OL	4.5	OL	13.2	2.7	24.3	17.3	46.5	42.8	82.0	82.0	31.5	0.0490	31	39	274-62A
90,000	0.97	0.1	OL	0.3	OL	0.6	OL	1.1	OL	2.2	0.1	5.5	2.2	16.2	12.9	27.3	27.3	21.0	0.2700	32	39	274-66A

TABLE XII

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
(C.A.L. H.T. 341) (REM-CRU HEAT NO. A 30633-1) (.025 IN. THICK)

Stress P.S.I.	% Elong. on Loading	Time in Hours for Deformation of 0.1 C	0.1 TD	0.2 C	0.2 TD	0.3 C	0.3 TD	0.5 C	0.5 TD	1.0 C	1.0 TD	2.0 C	2.0 TD	5.0 C	5.0 TD	Fracture Hours	Time of Test Hours	Perm. % Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness RC Before Test	Hardness RC After Test	Specimen
10,000	0.027	58.0	42.0	192.0	176.0	218.0	210.0									-	260.0	0.27	0.000470	23	31	341-20
15,000	0.14	39.0	OL	126.0	3.5	205.0*	100.0									-	186.0	0.28	0.00130	25	27	341-13
25,000	0.22	21.0	OL	80.0	OL	110.0	8.0	165.0	103.0	297.0	245.0					-	330.0	1.12	0.00160	23	28	341-12
30,000	0.28	11.8	OL	57.0	OL	74.0	2.5	100.0	63.0	160.0	122.0	306.0	252.0	-	-	-	310.0	2.30	0.00180	23	30	341-19
40,000	0.44	6.4	OL	17.8	OL	25.4	OL	40.0	1.5	68.0	45.3	120.0	97.3	-	-	-	168.0	3.06	0.00500	23	32	341-18
50,000	0.55	4.4	OL	11.2	OL	16.5	OL	23.7	OL	38.2	22.0	67.7	51.0	165.5	142.0	-	210.0	6.05	0.00800	23	33	341-17
70,000	0.98	0.5	OL	2.3	OL	3.9	OL	5.6	OL	9.6	0.1	16.8	9.4	38.5	31.4	177.5	177.5	41.0	0.0400	23	30	341-16
80,000	3.32	<0.1	OL	<0.1	OL	<0.1	OL	<0.1	OL	<0.1	OL	0.85	OL	8.8	0.33	44.0	44.0	20.0	0.310	25	30	341-21
90,000	5.40	<0.1	OL	<0.1	OL	<0.1	OL	<0.1	OL	<0.1	OL	0.4	OL	2.55	OL	20.0	20.0	30.0	0.420	27	31	341-22

OL = On loading
* = Extrapolated

TABLE XIII

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
TRANSVERSE
C.A.L. H.T. 341 REM-CRU HEAT NO. 30633-1 .025 IN. THICK

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	Total % Elong. in 2 In.	Min. Creep Rate % Per Hour	Hardness "RC" Before Test	Hardness "RC" After Test	Specimen
20,000	0.11	85	OL	202	80	283	196	455	368	-	-	-	-	-	-	disct'd	472	0.63	0.000850	27	31	341-27
40,000	0.34	10	OL	30	OL	55	OL	90	20	161	112	-	-	-	-	"	212.5	1.72	0.00350	28	31	341-29
60,000	0.49	1	OL	7	OL	13	OL	23.5	0.05	43.5	24	75	60	-	-	"	90.6	3.06	0.0131	27	32	341-28
80,000	0.75	0.10	OL	0.50	OL	2	OL	4.3	OL	9.5	1.3	17	11.5	39.3	33.8	101.25	101.25	13	0.137	27	31	341-24
95,000	1.53	0.01	OL	0.15	OL	0.5	OL	1.2	OL	2.7	OL	5.1	1.1	12.5	8.7	35.5	35.5	16	0.410	27	35	341-25

OL = On Loading
C = Creep
TD = Total Deformation

TABLE XIV

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
(C.A.L. H.T. 340) (REM-CRU HEAT NO. A 30635B-3) (.035 IN. THICK)

Stress P.S.I.	% Elong. on Loading	Time in Hours for Deformation of 0.1 C	0.1 TD	0.2 C	0.2 TD	0.3 C	0.3 TD	0.5 C	0.5 TD	1.0 C	1.0 TD	2.0 C	2.0 TD	5.0 C	5.0 TD	Fracture Hours	Time of Test Hours	Perm. % Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness RC Before Test	Hardness RC After Test	Specimen
10,000	0.06	350*0	30.0	-	-											-	306.0	0.098	0.000150	29	32	340-20
20,000	0.14	1.5	OL	40.0	3.0	175.0	16.0	-	280*0							-	247.0	0.35	0.000300	30	32	340-18
30,000	0.19	3.0	OL	17.0	0.3	110.0	8.0	160.0	112.0								238.0	0.55	0.00160	29	32	340-19
40,000	0.31	4.2	OL	7.8	OL	26.0	OL	72.0	6.0	205*0	147.5	-	-	-	-	-	200.0	0.88	0.00400	30	33	340-15
60,000	0.63	2.7	OL	10.3	OL	22.0	OL	32.1	OL	52.0	26.9	81.0	63.8	172.0	152.0	-	187.0	5.37	0.00630	30	35	340-9
70,000	0.72	1.5	OL	5.2	OL	10.5	OL	21.0	OL	36.0	9.2	56.5	42.6	128.5	101.0	377.0	377.0	46.0	0.0130	29	36	340-14
80,000	0.75	0.6	OL	3.9	OL	6.3	OL	12.7	OL	26.0	4.5	36.7	29.0	68.0	60.3	163.0	163.0	37.5	0.0235	30	34	340-16
90,000	2.05	0.1	OL	0.3	OL	0.7	OL	2.0	OL	5.7	OL	12.6	OL	24.0	17.8	44.0	44.0	31.0	0.124	29	35	340-17
100,000	5.48	<0.1	OL	<0.1	OL	<0.1	OL	<0.1	OL	<0.1	OL	<0.1	OL	0.23	OL	0.3	0.3	14.0	-	30	32	340-25

OL = On loading
* = Extrapolated

TABLE XV

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES RC-130-A TITANIUM SHEET AT 700°F LONGITUDINAL (C.A.L. H.T. 342) (REM-CRU HEAT NO. A 30637T-13) (.041 IN. THICK)

Stress P.S.I.	% Elong. on Loading	Time in Hours for Deformation of 0.1 C	0.1 TD	0.2 C	0.2 TD	0.3 C	0.3 TD	0.5 C	0.5 TD	1.0 C	1.0 TD	2.0 C	2.0 TD	5.0 C	5.0 TD	Fracture Hours	Time of Test Hours	Perm. % Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness RC Before Test	Hardness RC After Test	Specimen
10,000	0.09	79.0	2.0	129.0	81.0											-	285.0	0.15	0.000700	30	34	342-20
20,000	0.17	12.5	OL	126.0	1.0	215.0	71.0	-	180.0							-	212.0	0.29	0.000350	30	35	342-19
30,000	0.22	9.0	OL	50.0	OL	80.0	7.0	176.0	74.0	-	320.0*					-	260.0	0.66	0.00210	32	33	342-24
40,000	0.40	4.1	OL	8.5	OL	23.5	OL	58.5	3.0	160.0	92.0	-	-	-	-	-	189.0	1.20	0.00250	31	33	342-16
50,000	0.43	1.9	OL	5.5	OL	18.0	OL	39.2	1.0	88.7	45.4	169.0	136.0	-	-	-	257.0	3.32	0.00580	30	36	342-18
60,000	0.55	1.6	OL	4.8	OL	8.6	OL	20.0	OL	52.0	16.0	93.0	72.5	178.8	163.8	-	260.5	8.22	0.0125	30	36	342-15
80,000	0.82	1.2	OL	3.2	OL	5.5	OL	10.5	OL	21.0	3.0	33.4	23.5	61.0	53.0	152.0	152.0	38.5	0.0402	30	37	342-14
90,000	1.60	0.2	OL	0.4	OL	0.9	OL	2.0	OL	4.5	OL	8.6	1.4	16.3	12.8	45.5	45.5	34.0	0.170	30	38	342-17
100,000	3.81	<0.1	OL	<0.1	OL	<0.1	OL	0.12	OL	0.33	OL	0.95	OL	4.18	0.45	12.0	12.0	24.0	0.788	31	40	342-25

OL = On loading
* = Extrapolated

TABLE XVI

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
C.A.L. H.T. 376 REM-CRU HEAT NO. A 43037-19 .041 IN. THICK

Stress PSI	% Elong. on Load-ing	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Frac-ture Hours	Time of Test Hours	Total % Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness "RC" Before Test	Hardness "RC" After Test	Speci-men
20,000	0.14	190	OL	363	90	570	315	-	660	-	-	-	-	-	-	NF	670	0.51	0.00047	31	31	376-6
40,000	0.38	3.6	OL	13	OL	27	OL	61	3.2	154	88	-	-	-	-	NF	180	1.55	0.0054	31	33	376-4
60,000	0.66	13	OL	25	OL	34	OL	48	OL	70	37	106	83	-	192*	NF	158	4.07	0.0058	30	35	376-3
80,000	1.30	0.20	OL	1.1	OL	2.9	OL	6.5	OL	13	OL	23	8	50	37	157	157	26.5	0.055	30	36	376-1
85,000	2.47	0.15	OL	0.80	OL	2.1	OL	3.3	OL	7	OL	13	OL	33	16	100.5	100.5	28	0.108	31	37	376-5
90,000			On Loading													0.2	0.2	12	-	31	34	376-2

OL = On Loading
C = Creep
TD = Total Deformation
* = By Extrapolation
NF = Not Fractured

TABLE XVII

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES OF
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
C.A.L. H.T. 353 REM-CRU HEAT NO. A 4C013T-4 .042 IN. THICK

Stress PSI	% Elong on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	Perm. % Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness RC Before Test	Hardness RC After Test	Specimen
20,000	0.14	71.0	OL	-	20.0	-	194.0*									-	188.0	0.16	0.000410	33	34	353-16
30,000	0.27	36.0	OL	144.0	OL	233.0*	2.0	-	167.0							-	224.5	0.29	0.000890	33	34	353-15
50,000	0.52	19.0	OL	48.5	OL	61.0	OL	84.5	OL	123.0	82.0	172.0	149.0	-	-	-	211.5	2.7	0.00230	34	37	353-14
60,000	0.57	1.2	OL	7.0	OL	14.0	OL	28.5	OL	65.0	23.0	127.0	98.0	-	-	-	149.0	2.45	0.0130	33	36	353-19
70,000	0.92	0.4	OL	2.2	OL	5.2	OL	11.5	OL	23.0	0.2	35.5	24.3	57.0	50.7	144.5	144.5	44.0	0.0300	32	36	353-13
80,000	1.31	0.2	OL	0.7	OL	1.5	OL	3.3	OL	8.0	OL	17.0	5.0	32.0	26.6	67.5	67.5	21.0	0.104	34	38	353-17
90,000	3.24	<0.1	OL	<0.1	OL	0.11	OL	0.22	OL	0.7	OL	2.23	OL	8.5	1.95	20.0	20.0	19.0	0.460	33	37	353-18

OL - On Loading
* - By extrapolation
C - Creep
TD - Total Deformation

TABLE XVIII

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
C.A.L. H.T. 373 REM-CRU HEAT NO. A 41097-23 .042 IN. THICK

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	% Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness "RC" Before Test	Hardness "RC" After Test	Specimen
20,000	0.17	121	OL	192	20	-	140	-	-	-	-	-	-	-	-	NF	204	0.39	0.000460	30	35	373-6
40,000	0.36	18	OL	50	OL	70	OL	105	38	171	125	-	-	-	-	NF	186.8	1.48	0.00240	30	34	373-9
60,000	0.69	5	OL	13	OL	19	OL	30	OL	59	19	100	72	-	-	NF	118.3	3.43	0.0107	30	37	373-1
70,000	0.78	6	OL	10	OL	13.5	OL	19	OL	30	11	46	34	85*	75*	182.8	182.8	16.5	0.0174	31	36	373-8
80,000	1.87	0.22	OL	1.4	OL	2.8	OL	5.8	OL	10.7	OL	18.5	0.5	34	25	67.3	67.3	18	0.0590	30	38	373-5
85,000	2.46	0.10	OL	0.40	OL	1	OL	2.5	OL	5.9	OL	11	OL	2.3	13.5	44.9	44.9	16	0.125	30	39	373-4
95,000	-		R u p t	u r e d	o n	L o a d	i n g											14		29	31	373-2

OL = On Loading
C = Creep
TD = Total Deformation
* = By Extrapolation
NF = Not Fractured

TABLE XIX

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
C.A.L. H.T. 375 REM-CRU HEAT NO. A 30649-3 .050 IN. THICK

Stress PSI	% Elong. on Load-ing	Time in Hours for Deformation of														Frac-ture Hours	Time of Test Hours	Total % Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness "RC"		Speci-men
		0.1%		0.2%		0.3%		0.5%		1.0%		2.0%		5.0%						Before Test	After Test	
		C	TD	C	TD	C	TD	C	TD	C	TD	C	TD	C	TD							
41,500	0.27	10	OL	41	OL	67.5	0.3	98	50	159	128	-	-	-	-	NF	185.0	1.50	0.00310	-	41	375-4
60,000	0.60	13	OL	25	OL	34	OL	48	OL	72	42	110	87	276	243	NF	310.0	6.15	0.00590	-	41	375-1
80,000	0.99	0.8	OL	4.5	OL	6.6	OL	9.7	OL	15.2	0.1	23	15.3	47.8	38.7	202	202	38	0.0230	-	42	375-2
90,000	2.39	0.3	OL	0.7	OL	1.4	OL	3.4	OL	6	OL	10.5	OL	26	13.2	90	90	-	0.190	-	46	375-3

OL = On Loading
C = Creep
TD = Total Deformation
NF = Not Fractured

TABLE XX

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
C.A.L. H.T. 378 REM-CRU HEAT NO. A 30559-11 .050 IN. THICK

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	% Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness "RC" Before Test	Hardness "RC" After Test	Specimen
20,000	0.15	58	OL	174	7	-	122	-	-	-	-	-	-	-	-	NF	201.9	0.38	0.00070	30	31	378-8
40,000	0.36	18	OL	45	OL	72	OL	117	27	195	139	-	-	-	-	NF	251	1.73	0.0030	30	32	378-7
60,000	0.64	7	OL	20	OL	25	OL	47	OL	77	36	125	96	-	-	NF	137.5	2.92	0.0062	31	33	378-5
75,000	1.08	0.30	OL	2	OL	5.5	OL	14	OL	24	OL	37.2	23	66.4	56	147.1	147.1	31	0.020	30	35	378-6
80,000	1.53		OL	0.09	OL	0.37	OL	1.8	OL	8.7	OL	17.7	1.6	36.6	27.2	88.0	88.0	23	0.053	30	36	378-1
85,000	3.07		OL	0.05	OL	0.11	OL	0.33	OL	1.6	OL	6.4	OL	16.7	6	38.8	38.8	18	0.21	29	37	378-3
95,000				Ruptured on Loading														12		30	31	378-2

OL = On Loading
C = Creep
TD = Total Deformation
NF = Not Fractured

TABLE XXI

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
C.A.L. H.T. 354 REM-CRU HEAT NO. A-32219-4 .051 IN. THICK

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	% Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness RC Before Test	Hardness RC After Test	Specimen
20,000	0.14	60	OL	235	14	-	170	-	-	-	-*	-	-	-	-	Discont'd	235	0.20	0.00057	34	34	354-17
30,000	0.27	21	OL	73	OL	107	1.5	195	79	-	284	-	-	-	-	"	224	0.59	0.0020	35	35	354-14
50,000	0.54	9	OL	24	OL	34	OL	54	OL	104	50	191	151	-	-	"	199	2.12	0.0072	34	35	354-13
70,000	0.92	0.95	OL	2	OL	3	OL	7	OL	19.5	0.6	39	22	74	64	171	171	34	0.039	37	36	354-16
80,000	1.39	0.43	OL	0.86	OL	1.45	OL	3.9	OL	9	OL	18	5	36	29.5	87	87	26	0.098	35	37	354-18
90,000	1.99	0.2	OL	0.36	OL	0.52	OL	0.87	OL	2.4	OL	6.3	0.1	15.7	10	32.5	32.5	21.5	0.250	34	41	354-22
100,000		Ruptured During Loading																11.5		32	35	354-21

OL - On Loading
* - By Extrapolation
C - Creep
TD - Total Deformation

TABLE XXII

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
C.A.L. H.T. 355 REM-CRU HEAT NO. A 30649B-1 .052 IN. THICK

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	Total % Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness "RC" Before Test	Hardness "RC" After Test	Specimen
10,000	0.08	245	3	-	260	-	-	-	-	-	-	-	-	-	-	NF	340	0.27	0.000050	34	38	355-17
20,000	0.13	24	OL	178	8	-	143	-	-	-	-	-	-	-	-	NF	234	^.38	0.00060	35	36	355-16
30,000	0.21	32	OL	72	OL	108	29	190	110	-	-	-	-	-	-	NF	186	0.70	0.0028	34	37	355-15
40,000	0.27	43	OL	77	OL	110	2.3	160	80	258	207	-	-	-	-	NF	259	1.28	0.0014	36	37	355-20
50,000	0.47	0.99	OL	3.5	OL	7.5	OL	32	0.30	98	40	185	146	-	-	NF	191	2.56	0.0062	36	38	355-14
70,000	0.81	0.97	OL	9	OL	12.5	OL	21	OL	33	8	50	37	109	91	413	413	45	0.025	35	40	355-18
80,000	1.09	0.75	OL	3	OL	5.9	OL	9	OL	14.6	OL	22	13.5	46	37	188	188	34	0.038	35	41	355-19
85,000	1.35	0.45	OL	3.8	OL	6.5	OL	10.2	OL	16.6	OL	25.5	1.5	50	38.5	172	172	36	0.040	35	41	355-26
95,000	4.78	0.10	OL	0.18	OL	0.30	OL	0.80	OL	2.2	OL	4.5	OL	10.3	0.30	47	47	27	0.43	33	41	355-28
100,000			Ruptured on Loading															14		34	36	355-27

OL = On Loading
C = Creep
TD = Total Deformation
NF = Not Fractured

TABLE XXIII

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
C.A.L. H.T. 377 REM-CRU HEAT NO. A 41064-12 .060 IN. THICK

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	% Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness "RC" Before Test	Hardness "RC" After Test	Specimen
20,000	0.14	64	OL	168	24	-	124	-	-	-	-	-	-	-	-	NF	201.3	0.37	0.00105	32	34	377-8
40,000	0.36	45	OL	100	OL	150	OL	202	65	291	230	-	-	-	-	NF	308	1.48	0.00149	33	35	377-7
60,000	0.65	6	OL	14	OL	33	OL	59	OL	95	41	148.5	117	-	-	NF	160.5	2.96	0.00630	32	37	377-2
81,000	1.35	-	OL	1.2	OL	3	OL	7	OL	14.5	OL	23.2	9.5	42	35.2	118.0	118.0	34	0.0412	33	41	377-1
90,000	3.22	-	OL	0.03	OL	0.08	OL	0.23	OL	1	OL	5.2	OL	15.6	4.1	48.3	48.3	36	0.208	33	41	377-5

OL = On Loading
C = Creep
TD = Total Deformation
NF = Not Fractured

TABLE XXIV

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
C.A.L. H.T. 374 REM-CRU HEAT NO. A 31293-8 .065 IN. THICK

Stress PSI	% Elong. on Load-ing	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Frac-ture Hours	Time of Test Hours	Total % Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness "RC" Before Test	Hardness "RC" After Test	Speci-men
20,000	0.15	44	OL	106	4	148	78	-	*162	-	-	-	-	-	-	NF	151	0.48	0.00120	35	41	374-8
40,000	0.32	24	OL	45	OL	63	OL	95	20	164	122	-	-	-	-	NF	187.6	1.51	0.00400	38	43	374-5
60,000	0.53	5	OL	15.5	OL	25	OL	38.5	OL	64	37	101.5	81	-	-	NF	113.3	2.84	0.00940	38	45	374-3
80,000	0.77	1.5	OL	3.5	OL	5.2	OL	7.8	OL	13	4	21	14.8	46	38.5	213.3	213.3	43	0.0400	35	45	374-7
90,000	0.92	1.2	OL	2.7	OL	3.8	OL	5.5	OL	9.0	0.8	15.4	9.5	33.8	27.8	112.5	112.5	29	0.0600	36	46	374-1
105,000	1.93	0.03	OL	0.2	OL	0.55	OL	1.4	OL	2.8	OL	4.8	0.02	*11.2	7	31.5	31.5	21	0.280	36	47	374-2

OL = On Loading
C = Creep
TD = Total Deformation
* = By Extrapolation
NF = Not Fractured

TABLE XXV

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES RC-130-A TITANIUM SHEET AT 700°F LONGITUDINAL C.A.L. H.T. 356 REM-CRU HEAT NO. A-41059M-11 .068 IN. THICK

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	% Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness RC Before Test	Hardness RC After Test	Specimen
10,000	0.066	140	47	-	212	-	-	-	-	-	-	-	-	-	-	Discont'd	312	0.23	0.00023	36	41	356-19
20,000	0.16	40	OL	102	5	168	64	-	184	* -	-	-	-	-	-	"	235	0.56	0.0014	38	38	356-15
30,000	0.22	35	OL	72	OL	104	26	153	100	*285	224	-	-	-	-	"	260	1.2	0.0018	34	38	356-14
40,000	0.33	10	OL	29	OL	55	OL	89	22	148	100	256	225	-	-	"	330	2	0.0033	36	42	356-17
50,000	0.47	7	OL	19	OL	26	OL	37	2.5	58	38	97	78	-	-	"	190	3.95	0.024	35	41	356-13
70,000	0.80	2	OL	7	OL	11	OL	16.5	OL	26	7	40	30	84	71	"	121	8	0.038	38	41	356-16
80,000	0.89	1	OL	1.95	OL	2.85	OL	4.2	OL	6.8	1.3	11	7.2	32	24	190	190	34.5	0.110	37	45	356-18
90,000	1.10	0.65	OL	1.2	OL	1.55	OL	2	OL	3	OL	5	2.8	14.5	9.6	94.5	94.5	30.5	0.150	36	46	356-20
100,000		On loading														0.1	0.1	14		34	36	356-25

* - By Extrapolation
OL - On Loading
C - Creep
TD - Total Deformation

TABLE XXVI

TOTAL DEFORMATION AND CREEP RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
LONGITUDINAL
C.A.L. H.T. 357 REM-CRU HEAT NO. A 42010T-25 .080 IN. THICK

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	Total % Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness "RC" Before Test	Hardness "RC" After Test	Specimen
20,000	0.15	150	OL	-	78	-	176	-	-	-	-	-	-	-	-	NF	163.1	0.28	0.000500	35	41	357-19
30,000	0.23	54	OL	88	OL	118	38	177	110	-	-	-	-	-	-	NF	188	0.75	0.000780	34	41	357-16
50,000	0.44	10	OL	21	OL	31.5	OL	52	2	89	58	149	123	-	-	NF	136	2.21	0.00570	33	43	357-13
60,000	0.50	5	OL	13	OL	18.5	OL	29	OL	50	29	84	68	-	-	NF	90	2.70	0.0102	33	43	357-15
70,000	0.60	3	OL	7	OL	9	OL	12.8	OL	19.2	11	30.6	24	76.5	65	433.2	433.2	62	0.0241	35	46	357-20
80,000	0.77	1	OL	4	OL	5.3	OL	8.7	OL	14.5	4.0	22.5	16.5	40.5	36.8	147.0	147.0	41	0.0440	34	45	357-14
90,000	0.90	0.8	OL	2.3	OL	3.1	OL	4.1	OL	6.4	0.8	10.3	6.6	22	18.7	112.3	112.3	29	0.0560	36	46	357-17
100,000	1.95	0.08	OL	0.55	OL	1.05	OL	1.7	OL	2.9	OL	4.7	0.02	12	6.5	51.9	51.9	29	0.167	36	46	357-18
105,000	3.37		OL		OL	0.04	OL	0.09	OL	0.28	OL	1.75	OL		1	24.3	24.3	30	0.433	35	46	357-25

OL = On Loading
C = Creep
TD = Total Deformation
NF = Not Fractured

TABLE XXVII

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES RC-130-A TITANIUM SHEET AT 700°F LONGITUDINAL C.A.L. H.T. 343 REM-CRU HEAT NO. A-30676T-8 .100 IN. THICK

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of 0.1% C	0.1% TD	0.2% C	0.2% TD	0.3% C	0.3% TD	0.5% C	0.5% TD	1.0% C	1.0% TD	2.0% C	2.0% TD	5.0% C	5.0% TD	Fracture Hours	Time of Test Hours	% Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness Rc Before Test	Hardness Rc After Test	Specimen
10,000	0.07	58	1.5	209	82	-	*250	-	-	-	-	-	-	-	-	Discont'd	237	0.22	0.00028	37	42	343-30
20,000	0.13	24.8	OL	64	22	171	46	-	*220	-	-	-	-	-	-	"	174	0.306	0.0005	34	41	343-26
30,000	0.23	3	OL	24	OL	51	0.5	104	45	-	180	-	-	-	-	"	186	0.79	0.0033	37	42	343-29
50,000	0.43	3.5	OL	12	OL	21	OL	38	1.4	72	43	139	106	-	-	"	175	2.4	0.0113	34	42	343-25
70,000	0.60	0.35	OL	0.9	OL	6	OL	13.5	OL	29	10	54	39	142	123	"	209	6.9	0.0190	34	42	343-23
80,000	0.80	1.3	OL	3	OL	5	OL	9	OL	16	3	28.3	18.2	70.5	59	135.5	135.5	27	0.508	34	43	343-24
90,000	0.99	0.3	OL	0.8	OL	1.7	OL	3.3	OL	7	0.1	13.3	7	29	24.3	87.25	87.25	31.5	0.130	36	44	343-38

OL - On Loading
* - By extrapolation
C - Creep
TD - Total Deformation

TABLE XXVIII

TOTAL DEFORMATION AND CREEP-RUPTURE PROPERTIES
RC-130-A TITANIUM SHEET AT 700°F
TRANSVERSE
C.A.L. H.T. 343 REM-CRU HEAT NO. A 30676T-8 .100 IN. THICK

Stress PSI	% Elong. on Loading	Time in Hours for Deformation of														Fracture Hours	Time of Test Hours	Total % Elon. in 2 In.	Min. Creep Rate % Per Hour	Hardness "RC"		Specimen
		0.1%		0.2%		0.3%		0.5%		1.0%		2.0%		5.0%						Before Test	After Test	
		C	TD	C	TD	C	TD	C	TD	C	TD	C	TD	C	TD							
20,000	0.18	27	OL	70	2.7	112	32	225	124	*670	480	-	-	-	-	NF	620	1.1	0.0014	34	39	343-19
40,000	0.27	15	OL	39	OL	70	OL	122	44	286	194	-	-	-	-	NF	310	1.3	0.0034	35	39	343-16
60,000	0.50	2.3	OL	10	OL	17	OL	27	OL	50	29	106	77	264	240	NF	285	5.9	0.021	33	41	343-14
80,000	0.71	1.5	OL	4.2	OL	6.5	OL	11	OL	18.6	6	31	22.5	*68	*60	150.5	150.5	33	0.037	34	43	343-15
90,000	1.11	0.7	OL	1.5	OL	2.7	OL	4.8	OL	8.2	OL	14	7.3	30	24	74.8	74.8	36.5	0.088	31	43	343-13

OL = On Loading
C = Creep
TD = Total Deformation
* = By Extrapolation
NF = Not Fractured

TABLE XXIX

STRESSES TO PRODUCE 0.1, 0.5, 1.0 AND 5.0% CREEP IN 10 AND 100 HOURS AT 700°F

Heat Identification		Sheet Thickness	10 Hours				100 Hours			
CAL	Rem-Cru	Ins.	0.1% psi	0.5% psi	1.0% psi	5.0% psi	0.1% psi	0.5% psi	1.0% psi	5.0% psi
341	A 30633-1	.025L*	32,000	60,000	68,000	80,000	------	30,000	35,000	56,000
341	A 30633-1	.025T	40,000	63,000	79,000	100,000	19,000	38,000	46,000	------
340	A 30635B-3	.035	30,000	80,000	85,000	92,000	11,000	35,000	49,000	74,000
342	A 30637T-13	.041	28,000	78,000	85,000	93,000	8,000	35,000	48,000	70,000
376	A 43037-19	.041	46,000	74,000	82,000	------	24,000	34,000	50,000	72,000
353	A 4C013T-4	.042	52,000	70,000	82,000	88,000	12,000	41,000	53,000	------
373	A 41097-23	.042	50,000	75,000	80,000	------	23,000	41,000	49,000	68,000
375	A 30649-3	.050	58,000	80,000	84,000	------	------	41,000	51,000	71,000
378	A 30559-11	.050	51,000	76,000	80,000	88,000	------	42,000	54,000	70,000
354	A 32219-4	.051	46,000	68,000	78,000	92,000	14,000	31,000	50,000	66,000
355	A 30649B-1	.052	------	40,000	68,000	86,000	------	35,000	44,000	68,000
377	A 41064-12	.060	54,000	76,000	82,000	94,000	------	50,000	59,000	73,000
274-2	A 3723-29	.064 L*	20,000	62,000	72,000	81,000	------	32,000	44,000	62,000
274-2	A 3723-29	.064 T	------	42,000	72,000	92,000	------	------	44,000	72,000
374	A 31293-8	.065	50,000	78,000	86,000	105,000	------	39,000	50,000	------
356	A 41059M-11	.068	42,000	76,000	81,000	94,000	12,500	40,000	44,000	68,000
357	A 42010T-25	.080	50,000	74,000	82,000	105,000	23,000	38,000	48,000	66,000
343	A 30676T-8	.100L	27,000	60,000	85,000	------	------	30.000	45.000	75.000
343	A 306767-8	.100T	44,000	80,000	87,000	------	------	42,000	52,000	74,000

*L = Longitudinal direction
T = Transverse direction

TABLE XXX

STRESSES TO PRODUCE 0.1, 0.5, 1.0 AND 5.0% TOTAL DEFORMATION IN 10 AND 100 HOURS AT 700°F

Heat Identification		Sheet Thickness	10 Hours				100 Hours			
CAL	Rem-Cru	Ins.	0.1% psi	0.5% psi	1.0% psi	5.0% psi	0.1% psi	0.5% psi	1.0% psi	5.0% psi
341	A 30633-1	.025L*	12,000	35,000	52,000	74.000	------	25,000	32,000	54,000
341	A 30633-1	.025T	------	42,000	61,000	85,000	------	27,000	41,000	------
340	A 30635B-3	.035	11,000	38,000	70,000	90,000	------	30,000	44,000	70,000
342	A 30637T-13	.041	------	38,000	64,000	90,000	------	26,000	40,000	67,000
376	A 43037-19	.041	------	35,000	------	84,000	------	25,000	37,000	67,000
353	A 4C013T-4	.042	------	------	62,000	84,000	------	32,000	48,000	------
373	A 41097023	.042	------	------	70,000	86,000	------	------	42,000	67,000
375	A 30649-3	.050	------	------	64,000	92,000	------	------	44,000	68,000
378	A 30559-11	.050	------	------	65,000	84,000	------	------	44,000	73,000
354	A 32219-4	.051	------	35,000	56,000	83,000	------	28,000	41,000	63,000
355	A 30649B-1	.052	40,000	82,000	86,000	95,000	16,000	42,000	50,000	70,000
377	A 41064-12	.060	------	------	65,000	86,000	------	37,000	49,000	77,000
274-2	A 3723-29	.064 L*	------	------	56,000	80,000	------	23,000	37,000	60,000
274-2	A 3723-29	.064 T	------	44,000	71,000	92,000	------	------	------	77,000
374	A 31293-8	.065	------	44,000	70,000	100,000	------	23,000	43,000	------
356	A 41059M-11	.068	------	43,000	65,000	89,000	------	30,000	40,000	67,000
357	A 42010T-25	.080	------	41,000	70,000	96,000	------	30,000	42,000	64,000
343	A 30676T-8	.100 L	------	38,000	70,000	100,000	10.000	25,000	37,000	72.000
343	A 30676T-8	.100T	------	------	72,000	100,000	------	23,000	46,000	72,000

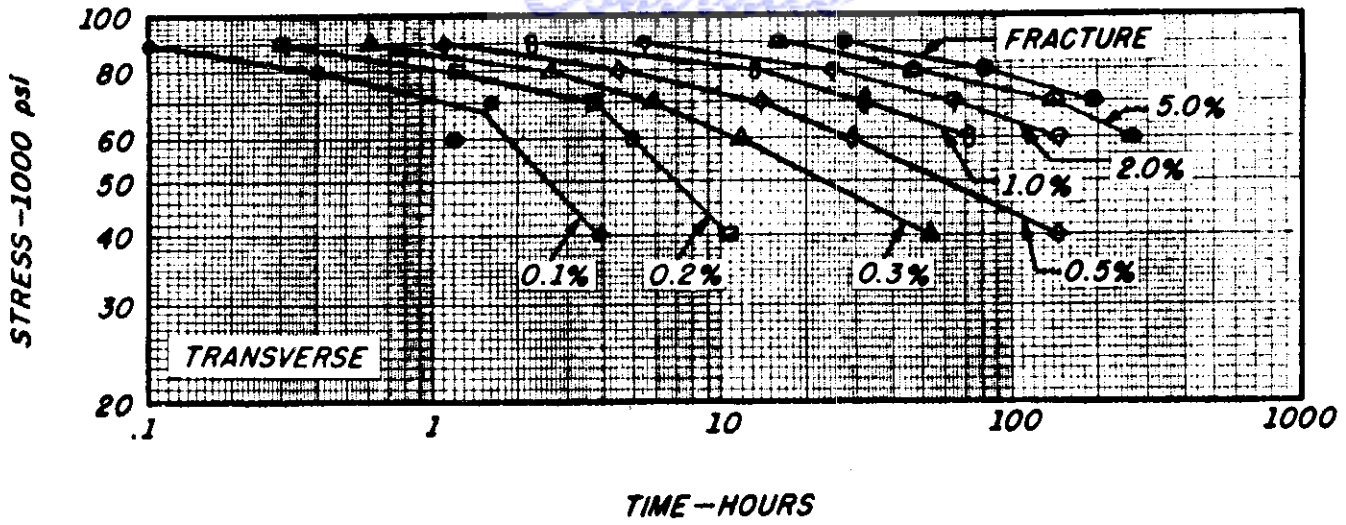
*L = Longitudinal direction
T = Transverse direction

TABLE XXXI

STRESSES TO PRODUCE RUPTURE IN 10 AND 100 HOURS AT 700°F

Heat Identification		Sheet Thickness	10 Hours	100 Hours
CAL	Rem-Cru	Ins.	psi	psi
341	A 30633-1	.025L*	95,000	74,000
341	A 30633-1	.025T	115,000	80,000
340	A 30635B-3	.035	95,000	84,000
342	A 30637T-13	.041	100,000	83,000
376	A 43037-19	.041	87,000	85,000
353	A 4C013T-4	.042	95,000	74,000
373	A 41097-23	.042	-------	76,000
375	A 30649-3	.050	-------	88,000
378	A 30559-11	.050	95,000	79,000
354	A 32219-4	.051	95,000	88,000
355	A 30649B-1	.052	-------	88,000
377	A 41064-12	.060	-------	82,000
274-2	A 3723-29	.064 L*	84,000	70,000
274-2	A 3723-29	.064 T	100,000	77,000
374	A 31293-8	.065	101,000	90,000
356	A 41059M-11	.068	-------	88,000
357	A 42010T-25	.080	110,000	90,000
343	A 30676T-8	.100 L	-------	86,000
343	A 30676T-8	.100T	-------	85,000

*L = Longitudinal direction
T = Transverse direction



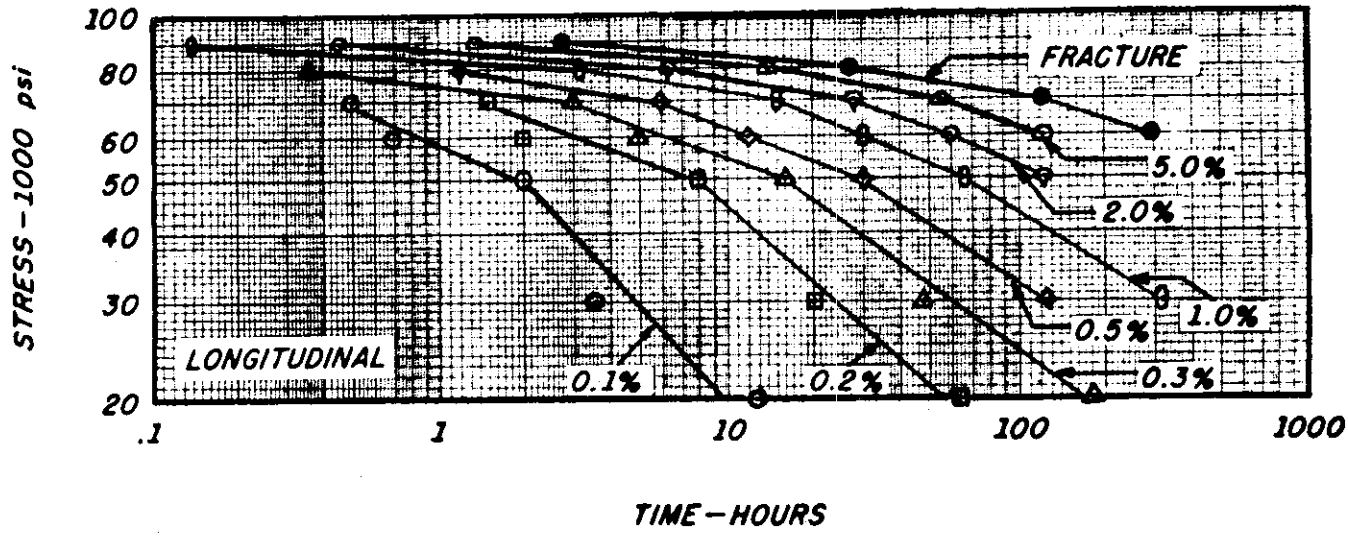


FIGURE 1 COMPARISON OF CREEP-RUPTURE PROPERTIES OF 0.064 INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F - TRANSVERSE VS. LONGITUDINAL DIRECTION. C.A.L. HT 274 SHEET NO. 2

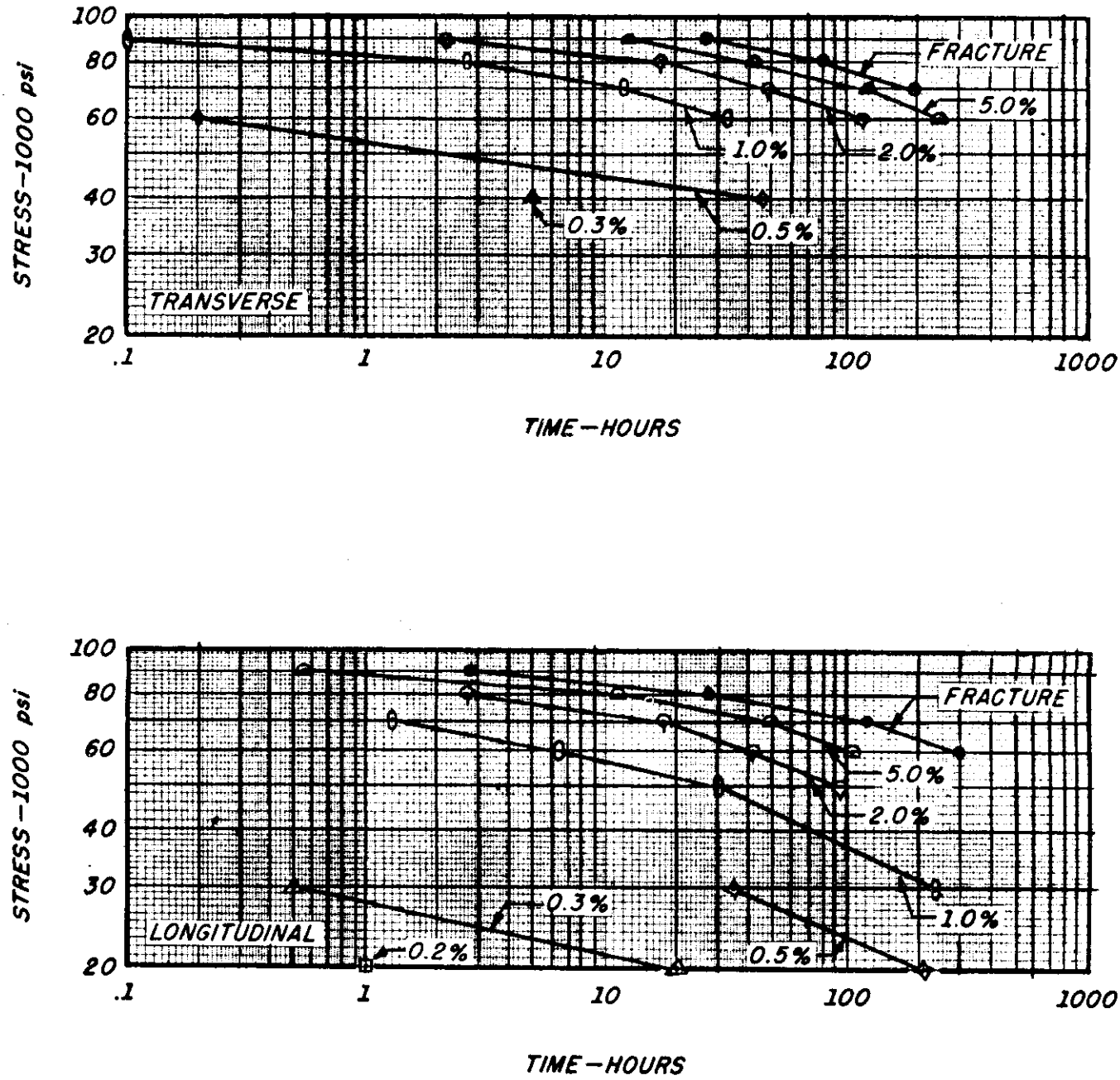


FIGURE 2 COMPARISON OF TOTAL DEFORMATION PROPERTIES OF 0.064 INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F - TRANSVERSE VS. LONGITUDINAL DIRECTION. C.A.L. HT 274 SHEET NO. 2

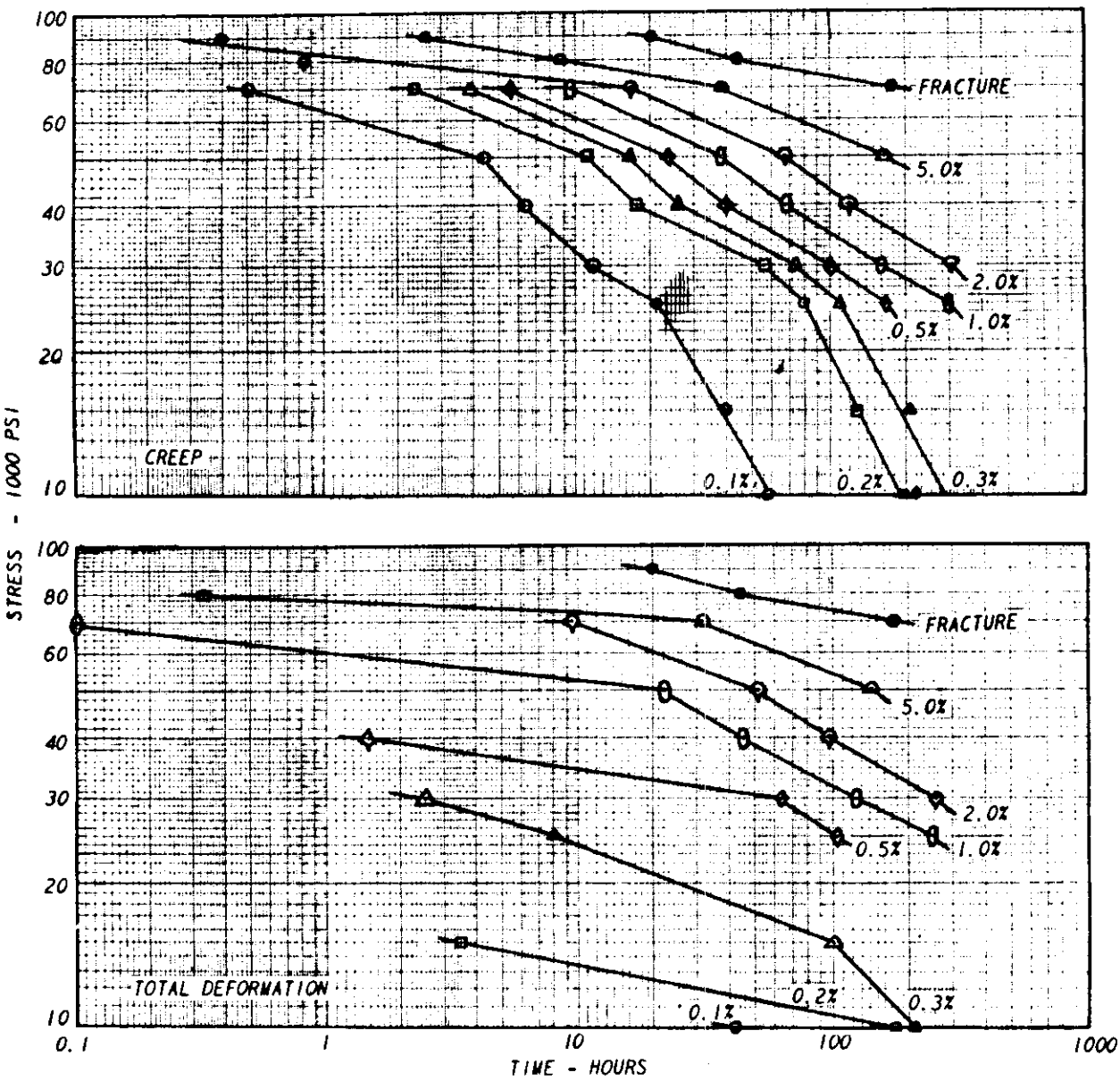


Figure 3 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.025-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700° F-LONGITUDINAL DIRECTION. CAL HT 341

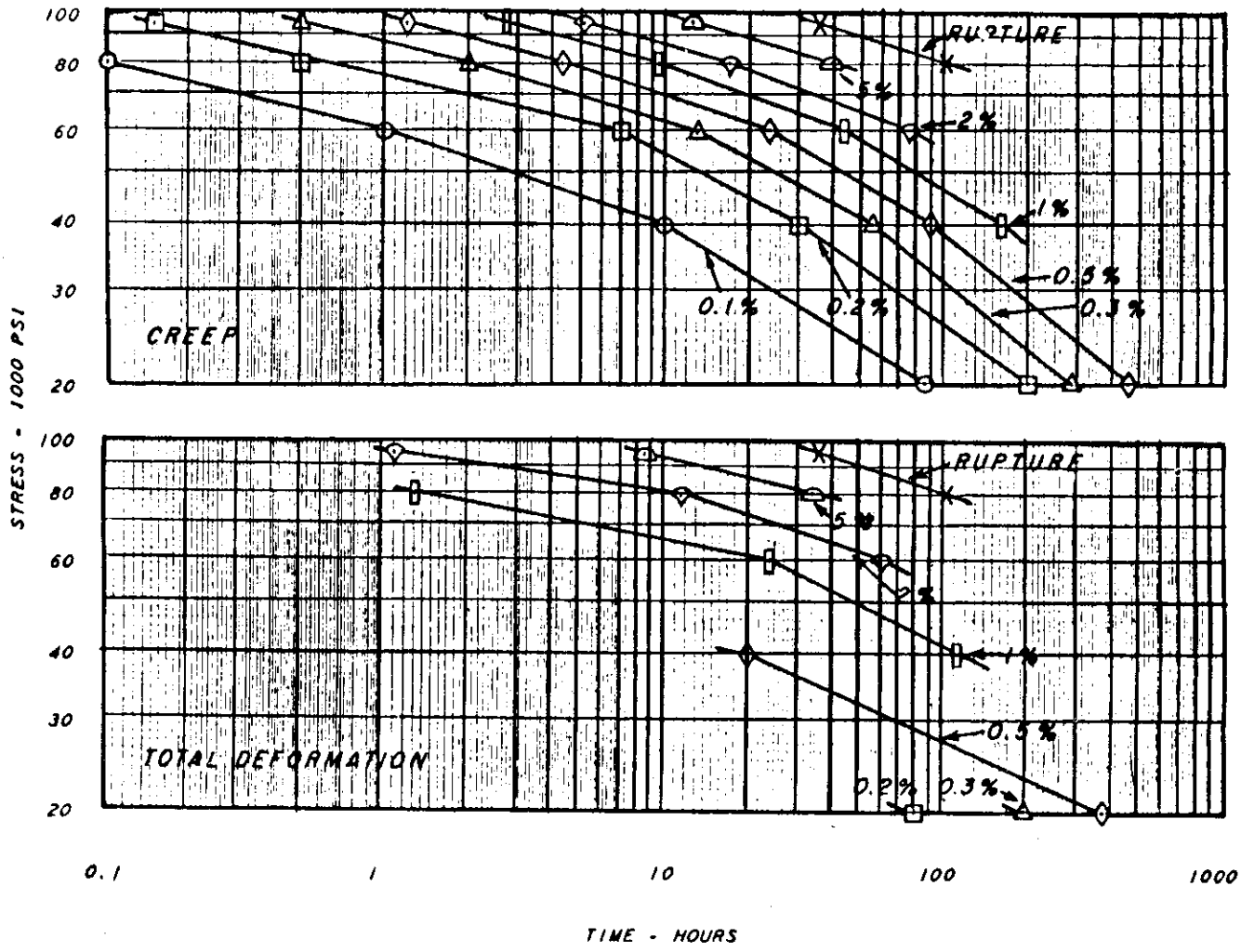


Figure 4 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.025-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-TRANSVERSE DIRECTION. CAL HT341

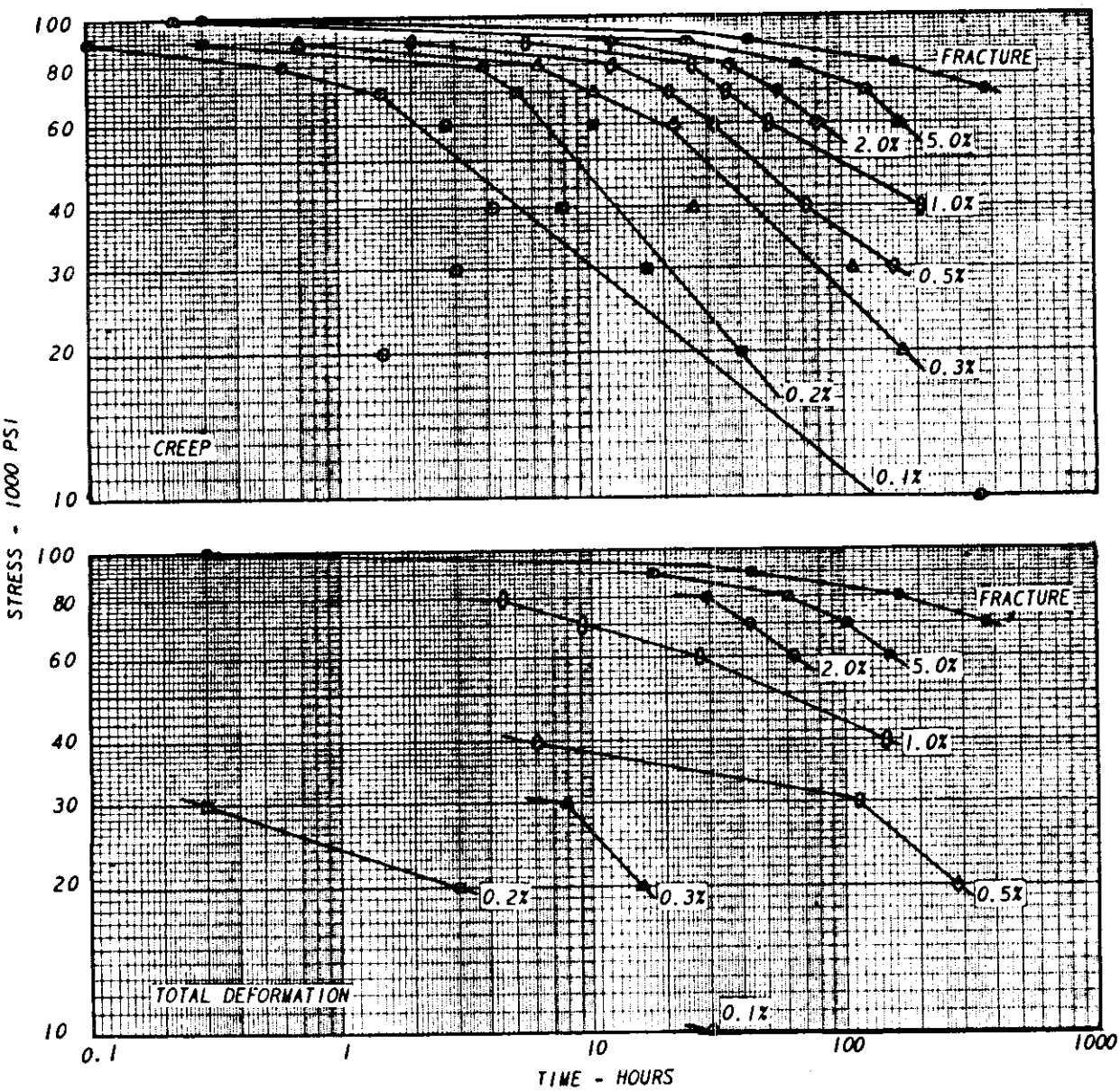


Figure 5 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.035-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT 340

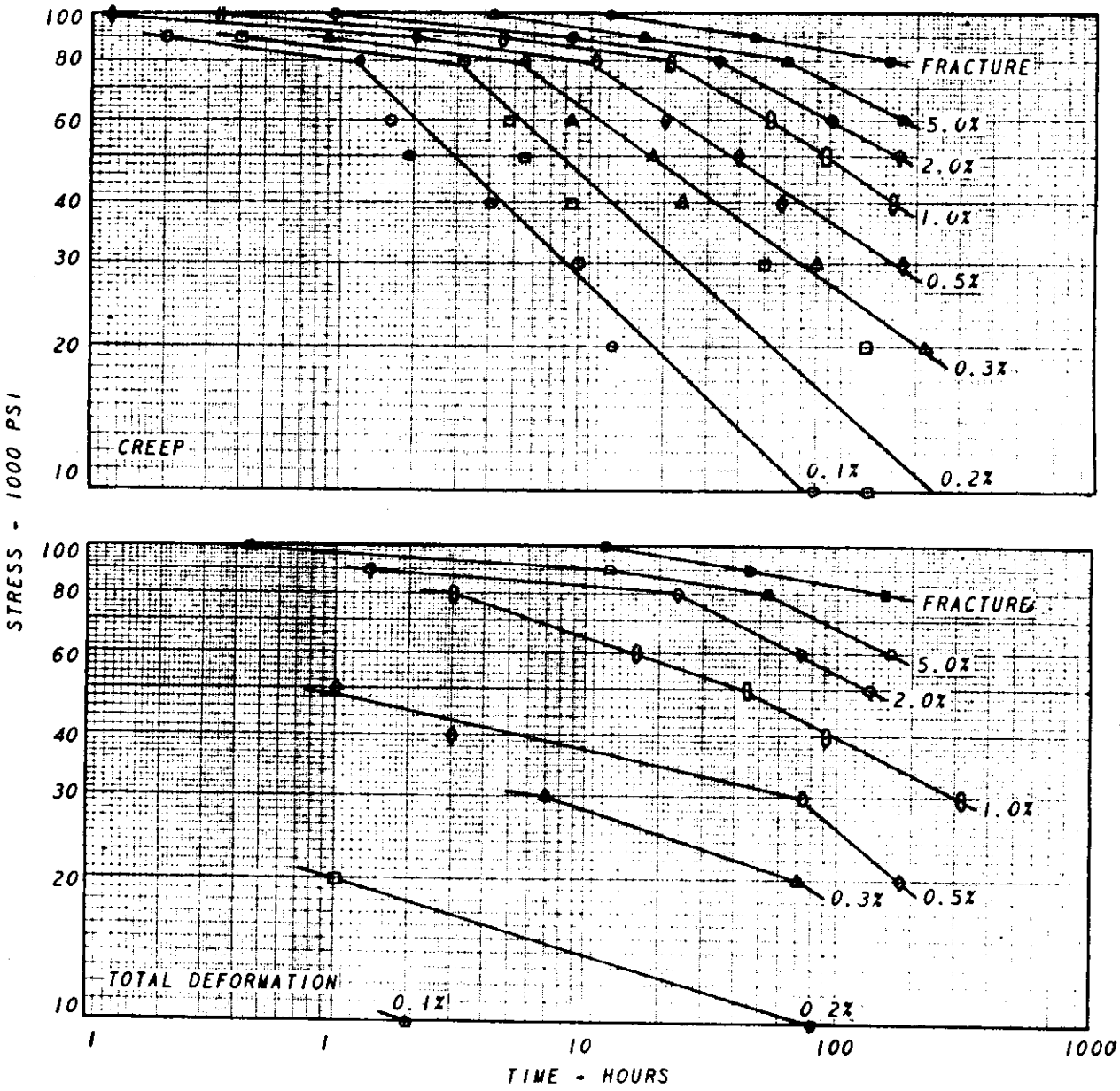


Figure 6 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.041-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT 342

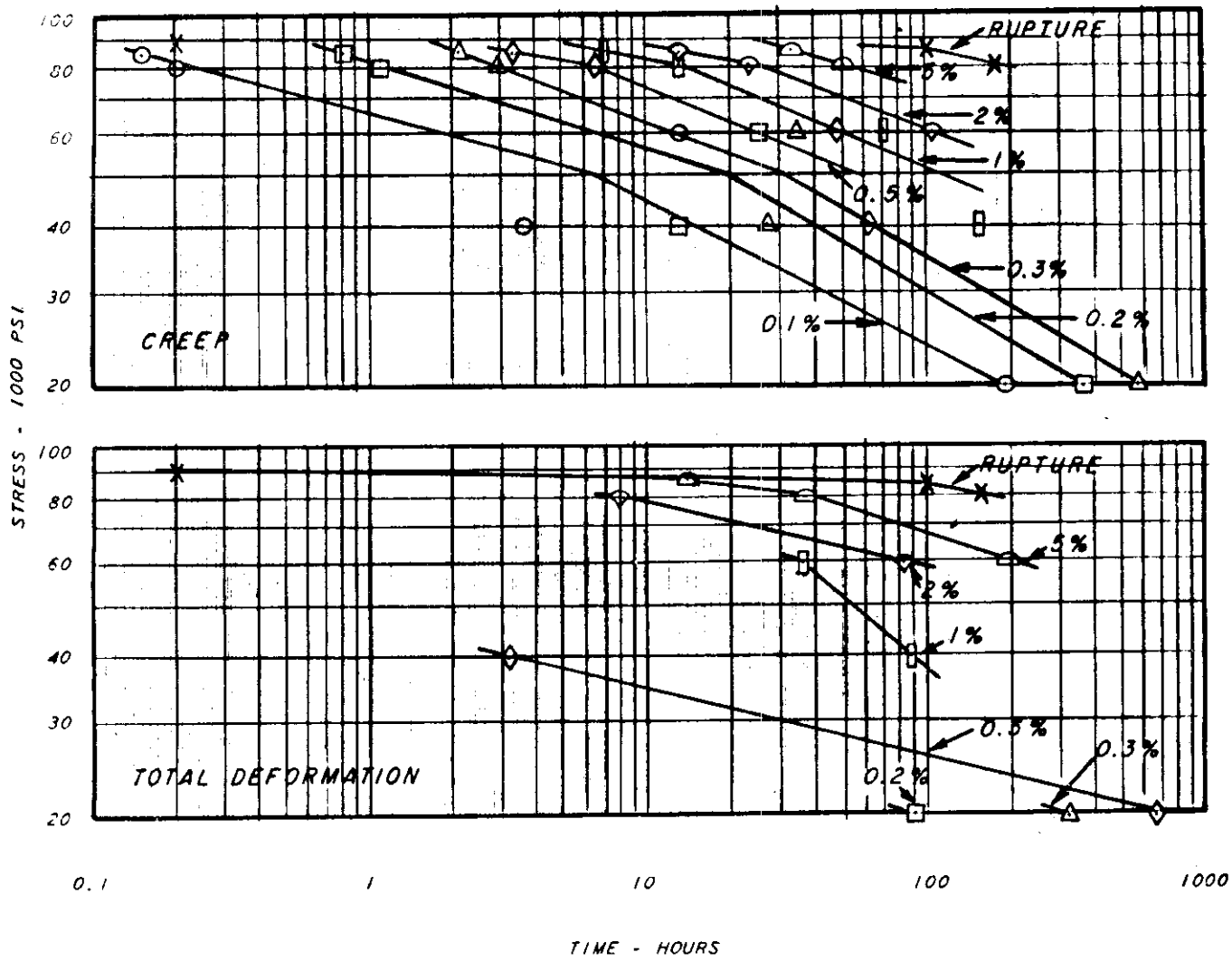


Figure 7 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.041-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT376

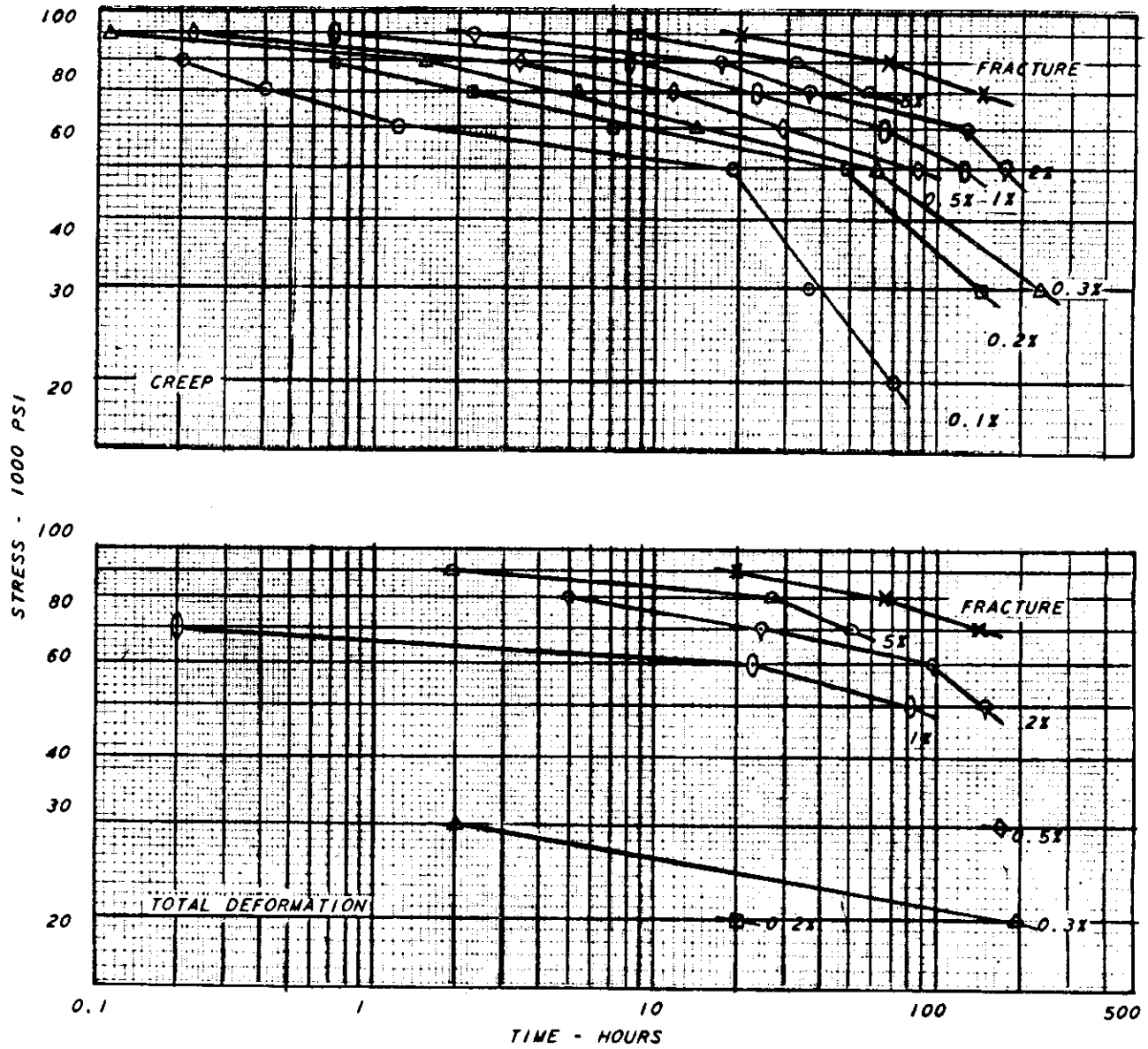


Figure 8 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.042-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT 353

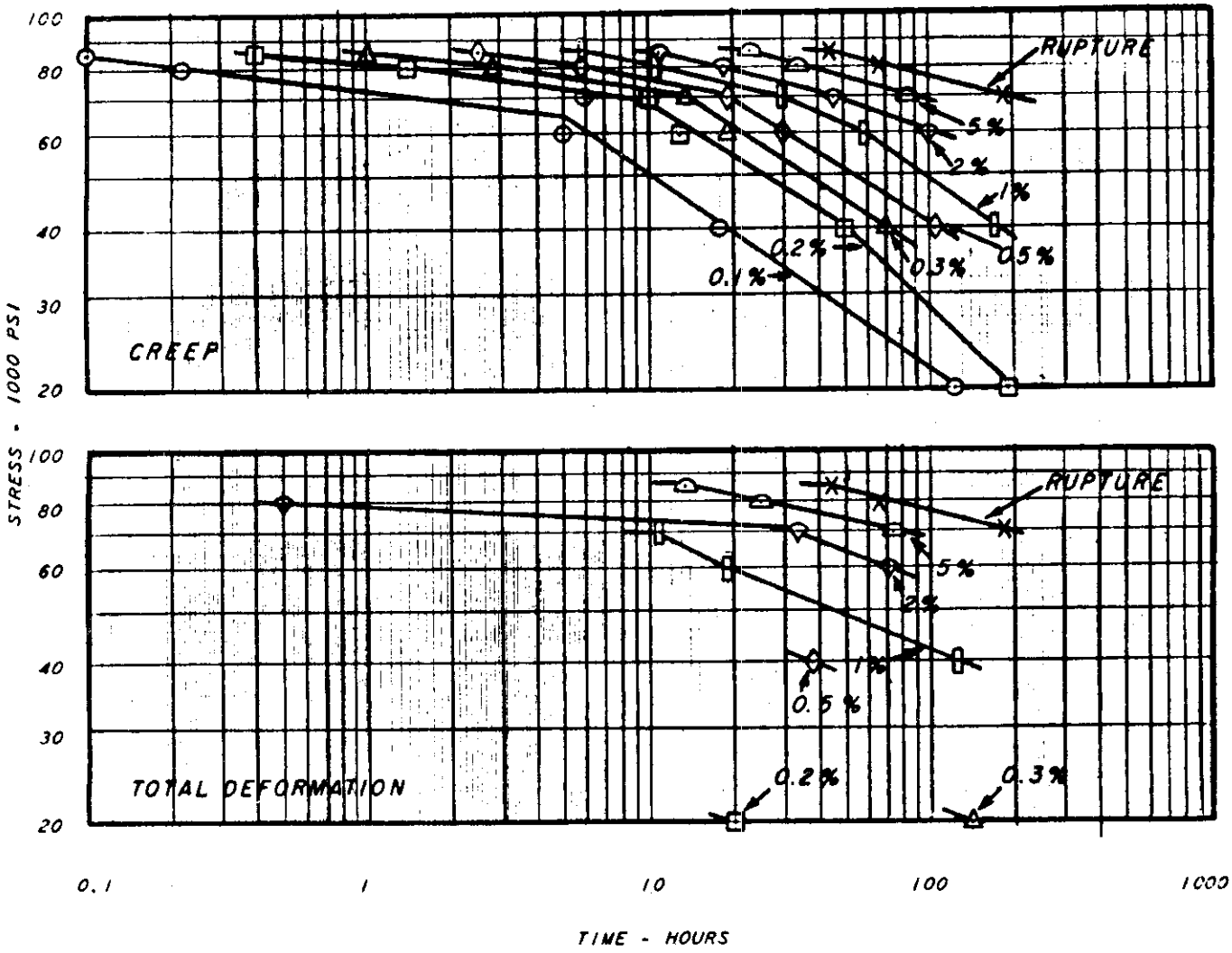


Figure 9 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.042-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT373

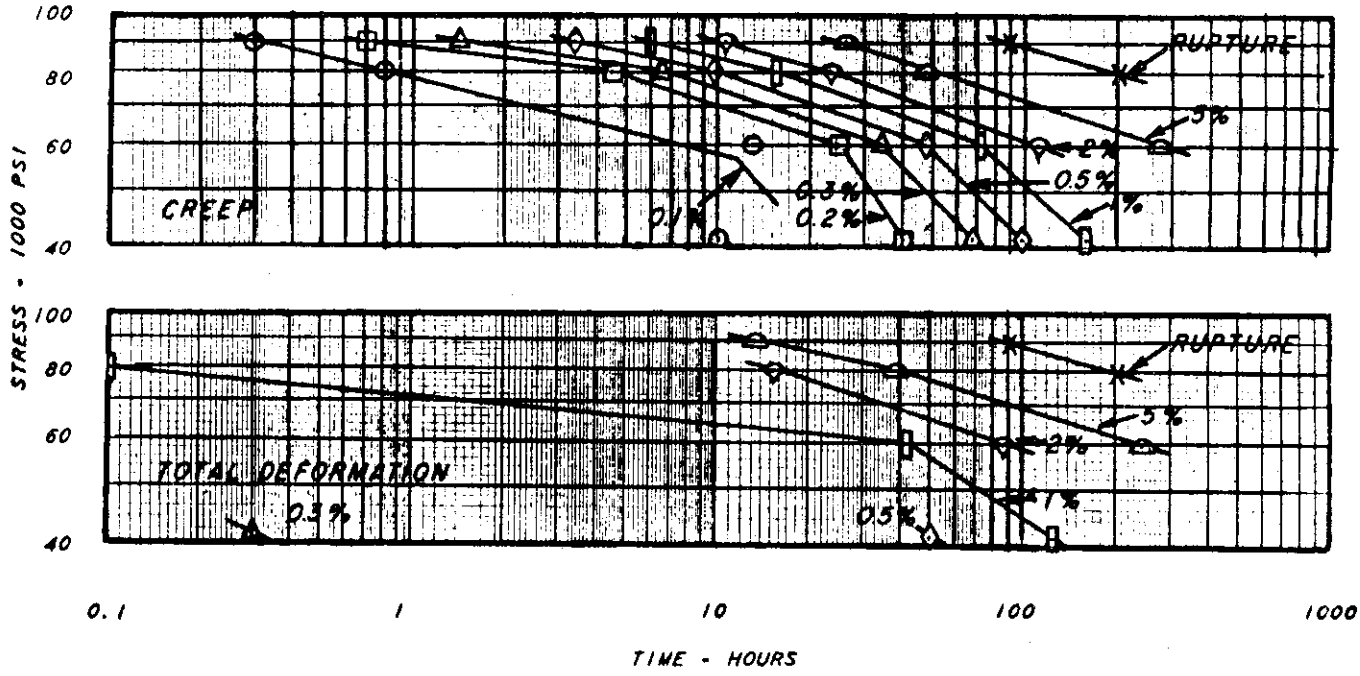


Figure 10 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.050-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT375

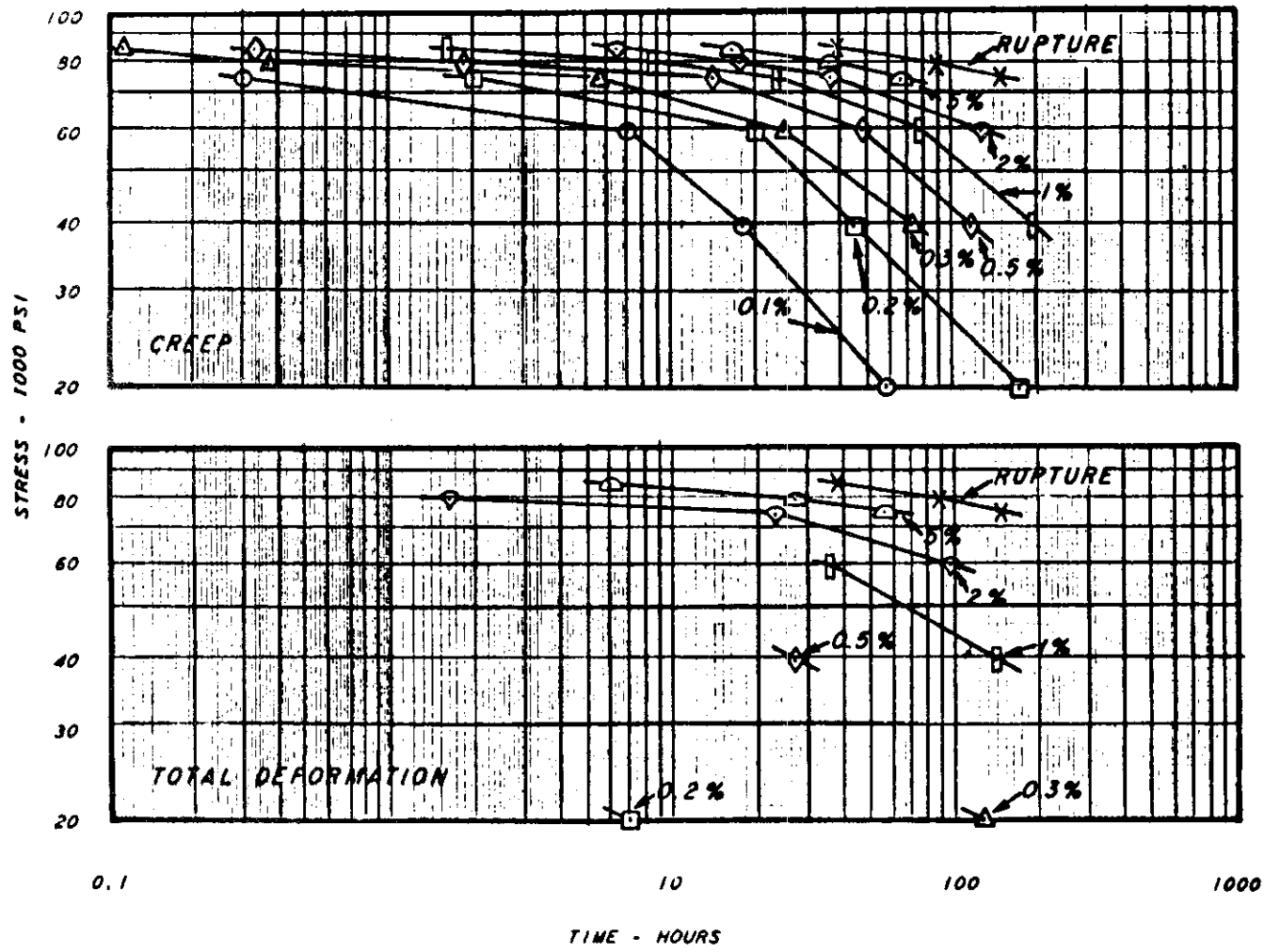


Figure 11 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.050 INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT378

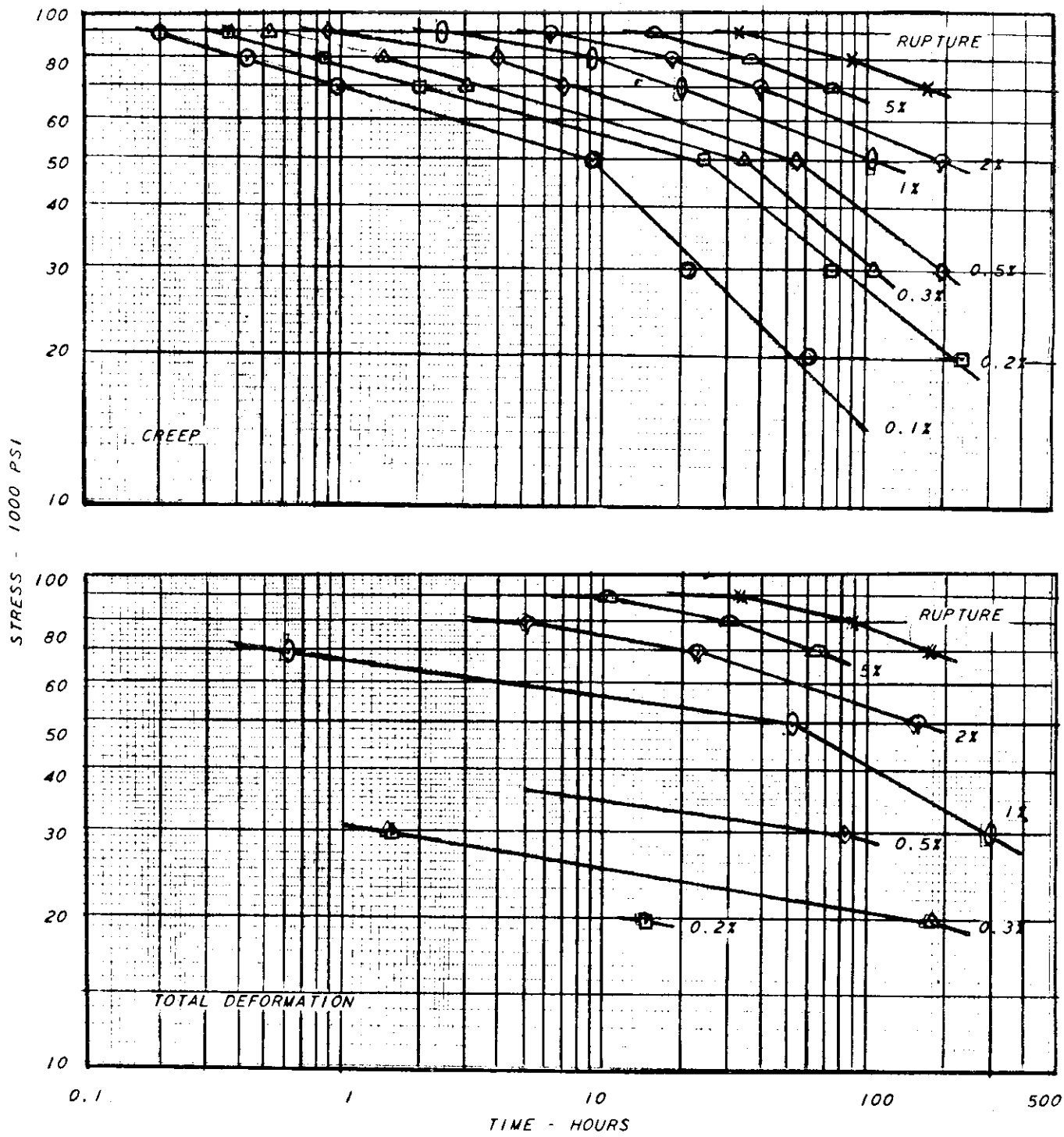


Figure 12 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.051-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT 354

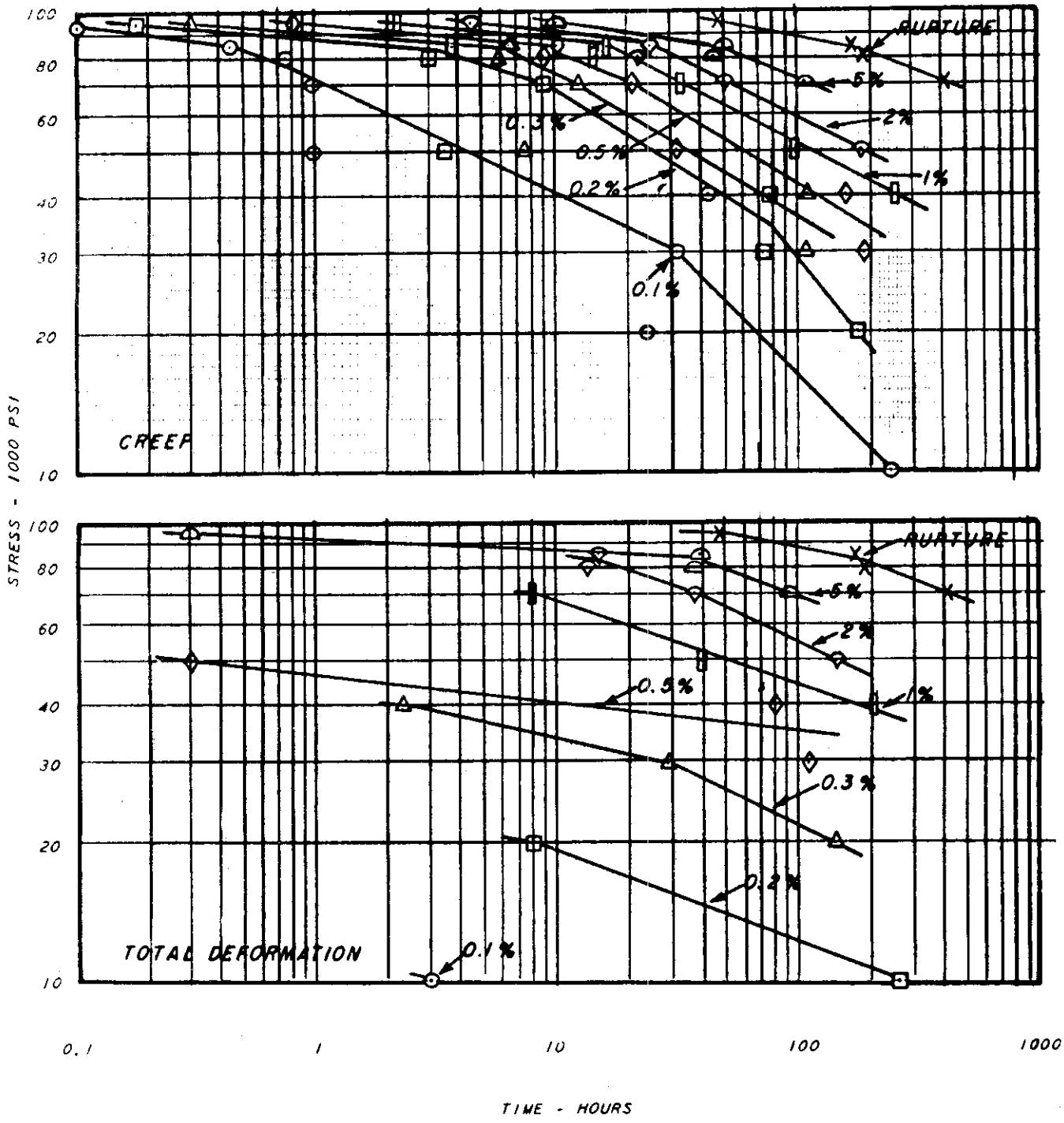


Figure 13 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.052 INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F - LONGITUDINAL DIRECTION. CAL HT355

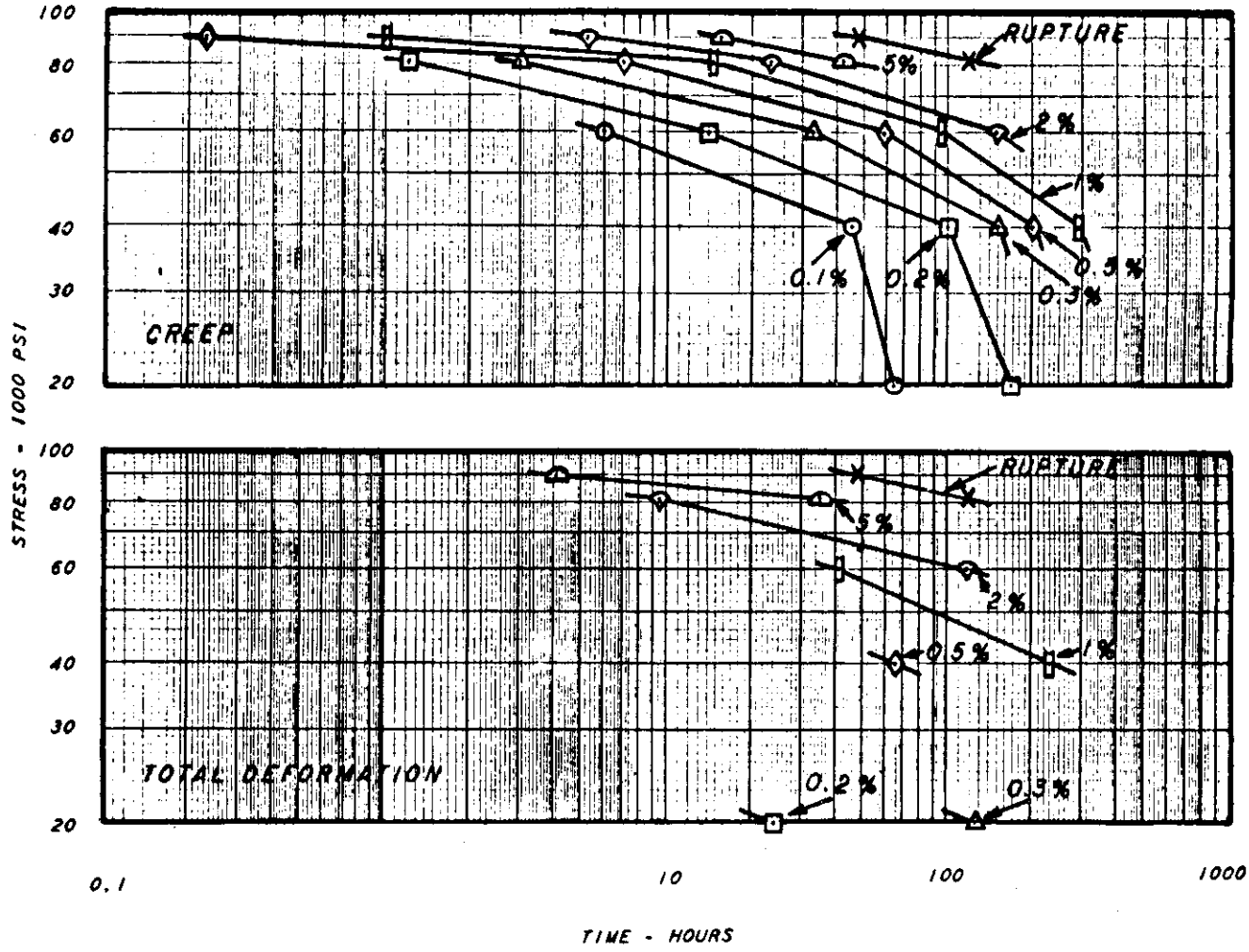


Figure 14 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.060-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT377

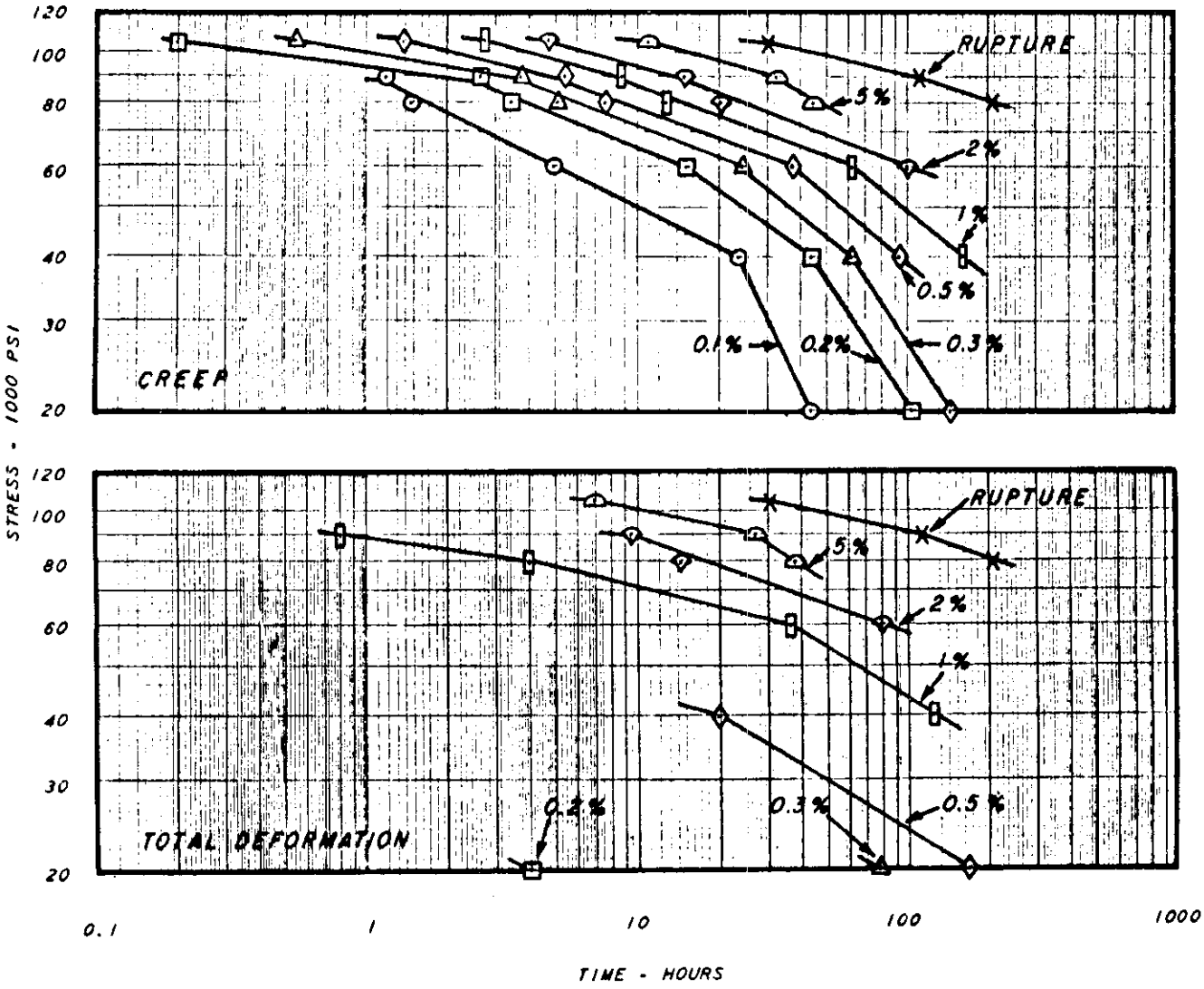


Figure 15 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.065-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT374

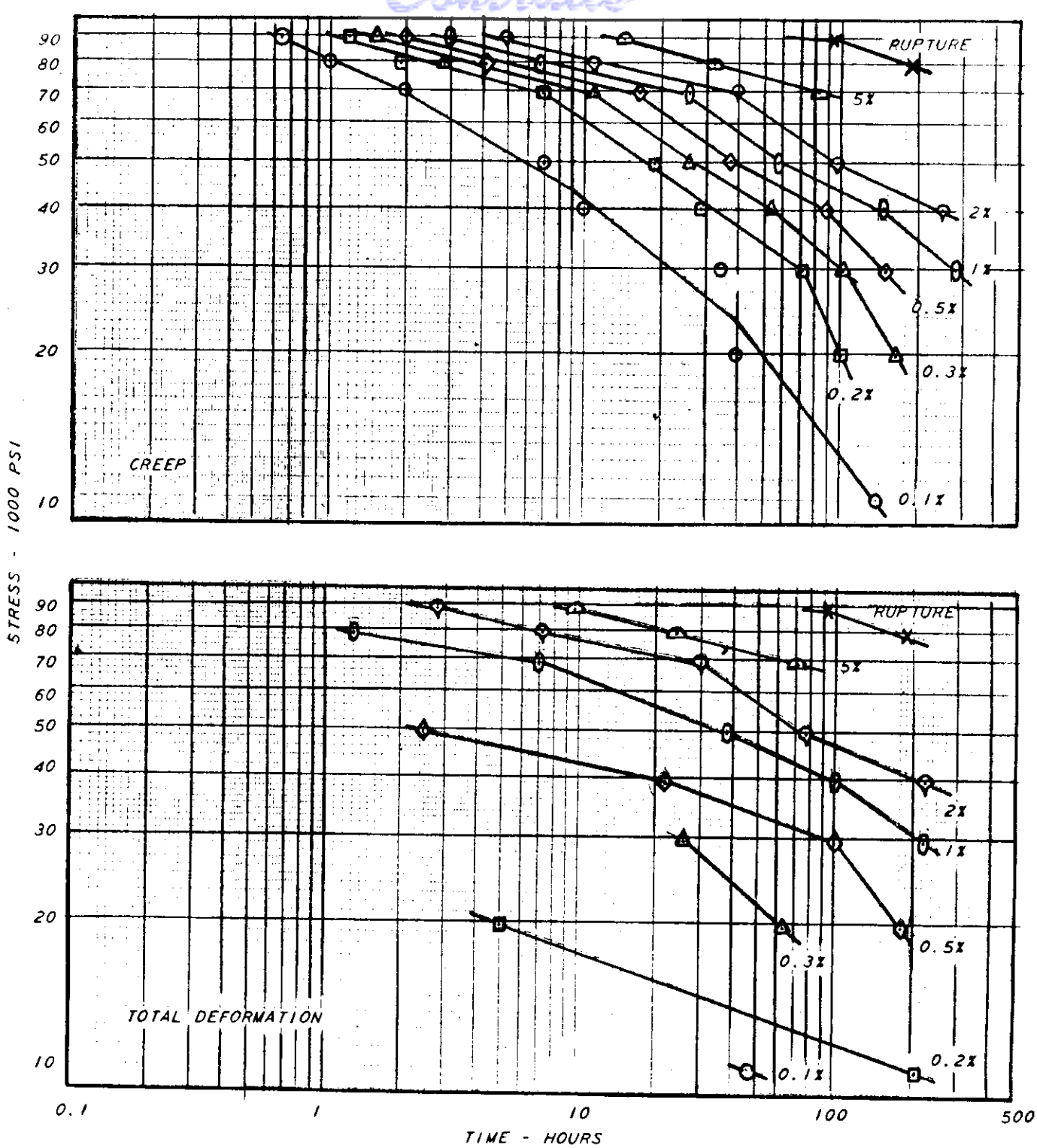


Figure 16 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.068-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT 356

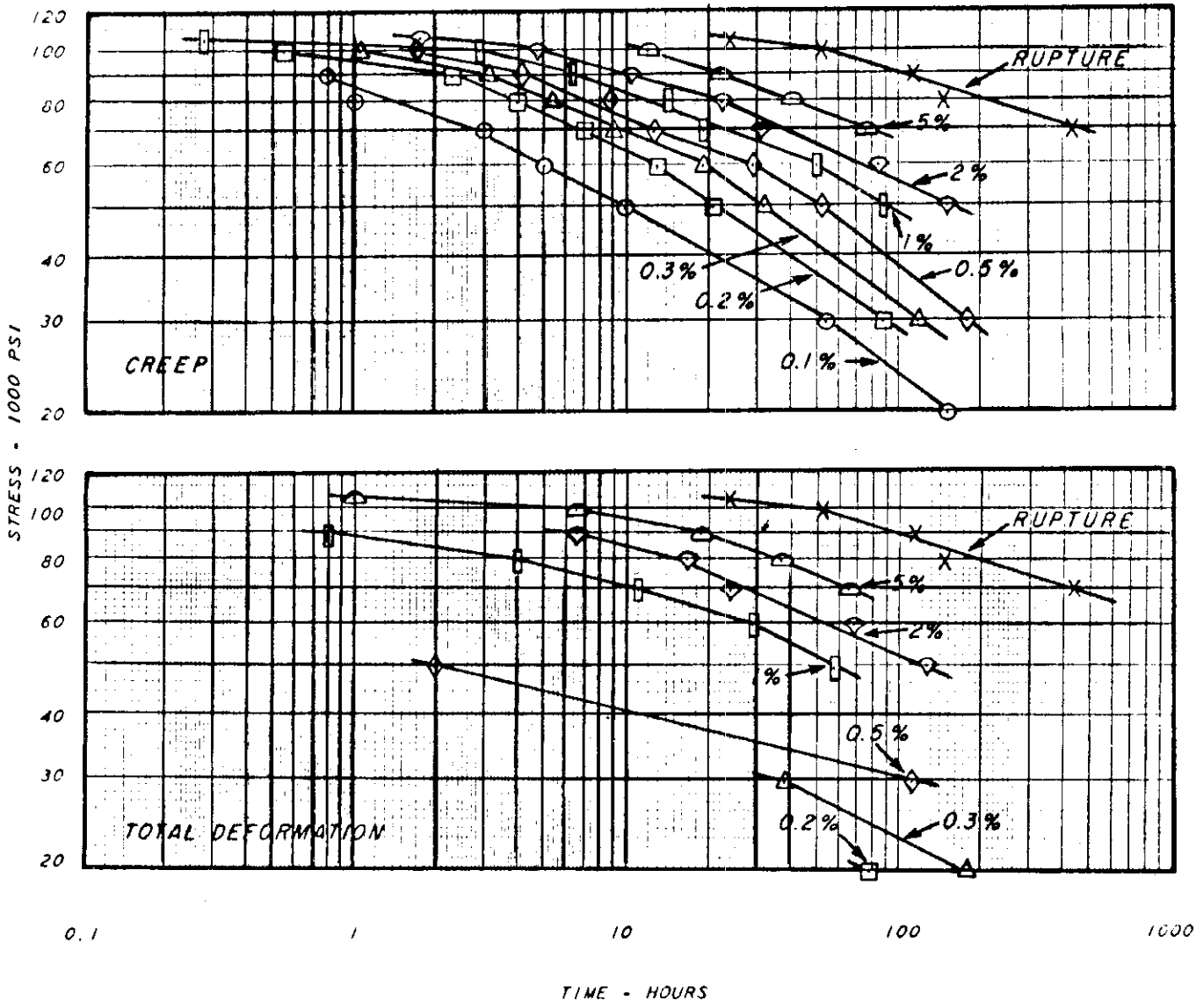


Figure 17 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.080-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F- LONGITUDINAL DIRECTION CAL HT357

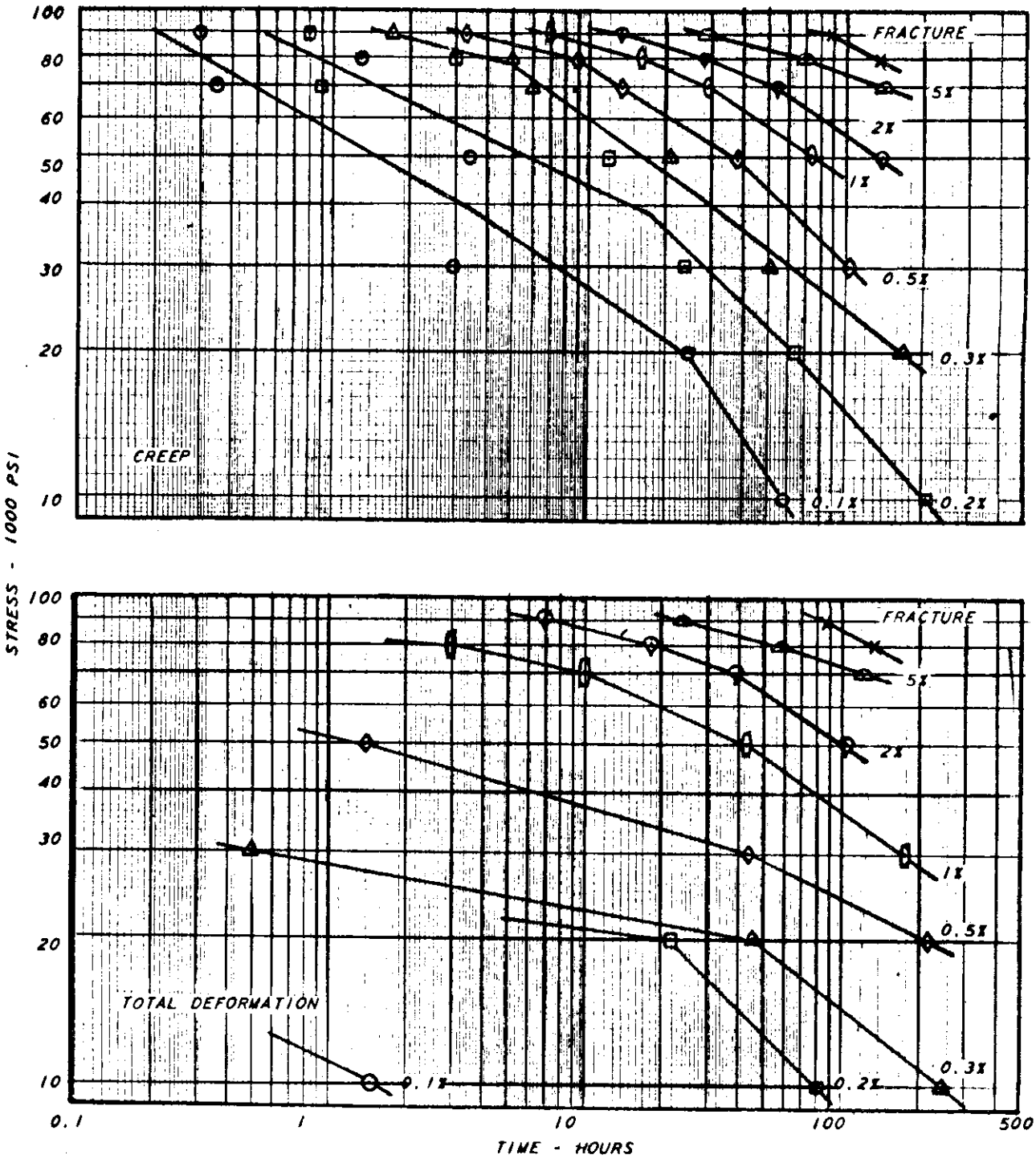


Figure 18 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.100-INCH THICK RC-130-A TITANIUM ALLOY SHEET AT 700°F-LONGITUDINAL DIRECTION. CAL HT 343

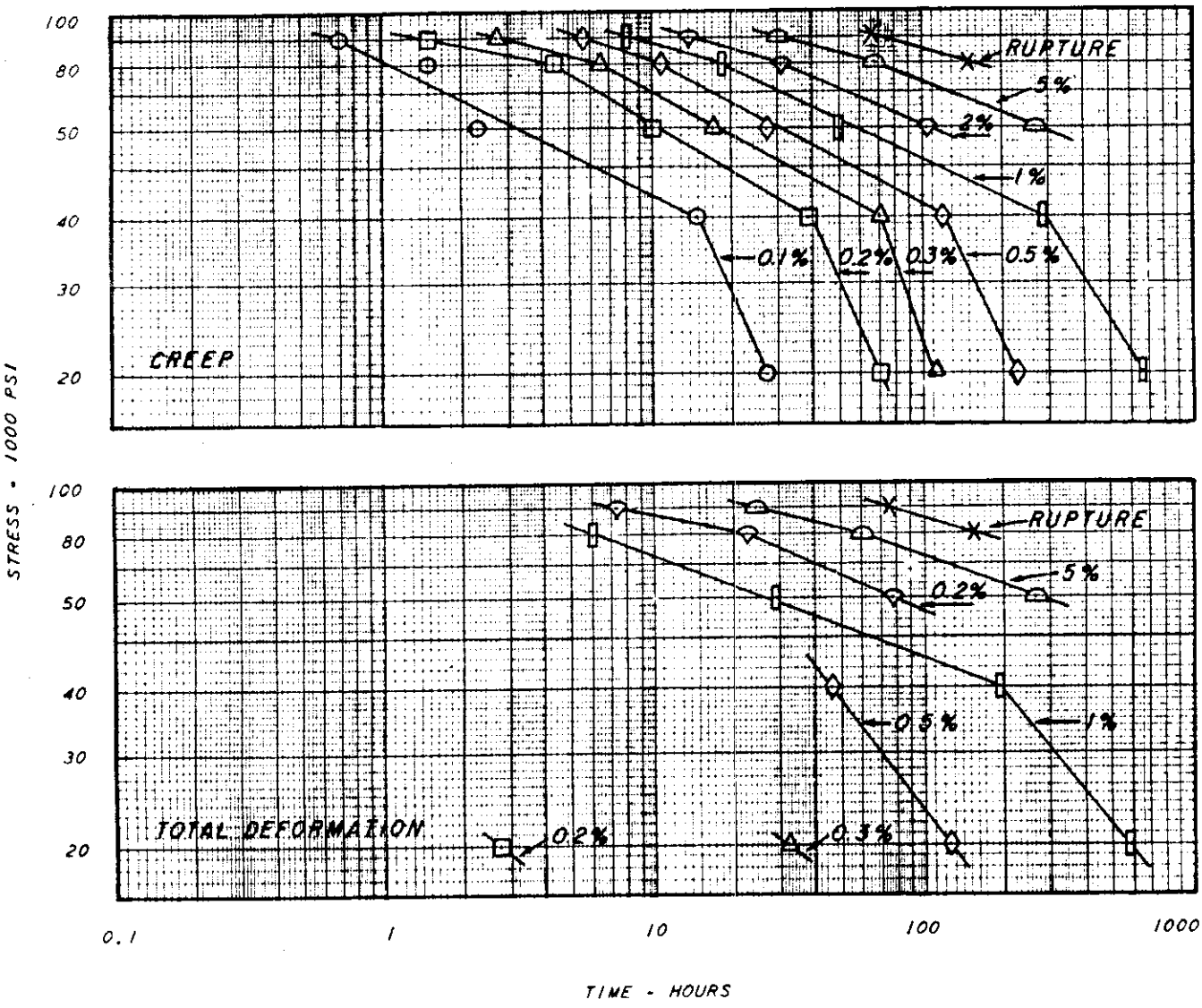


Figure 19 CREEP-RUPTURE AND TOTAL DEFORMATION PROPERTIES OF 0.100-INCH RC-130-A TITANIUM ALLOY SHEET AT 700°F - TRANSVERSE DIRECTION CAL HT 343

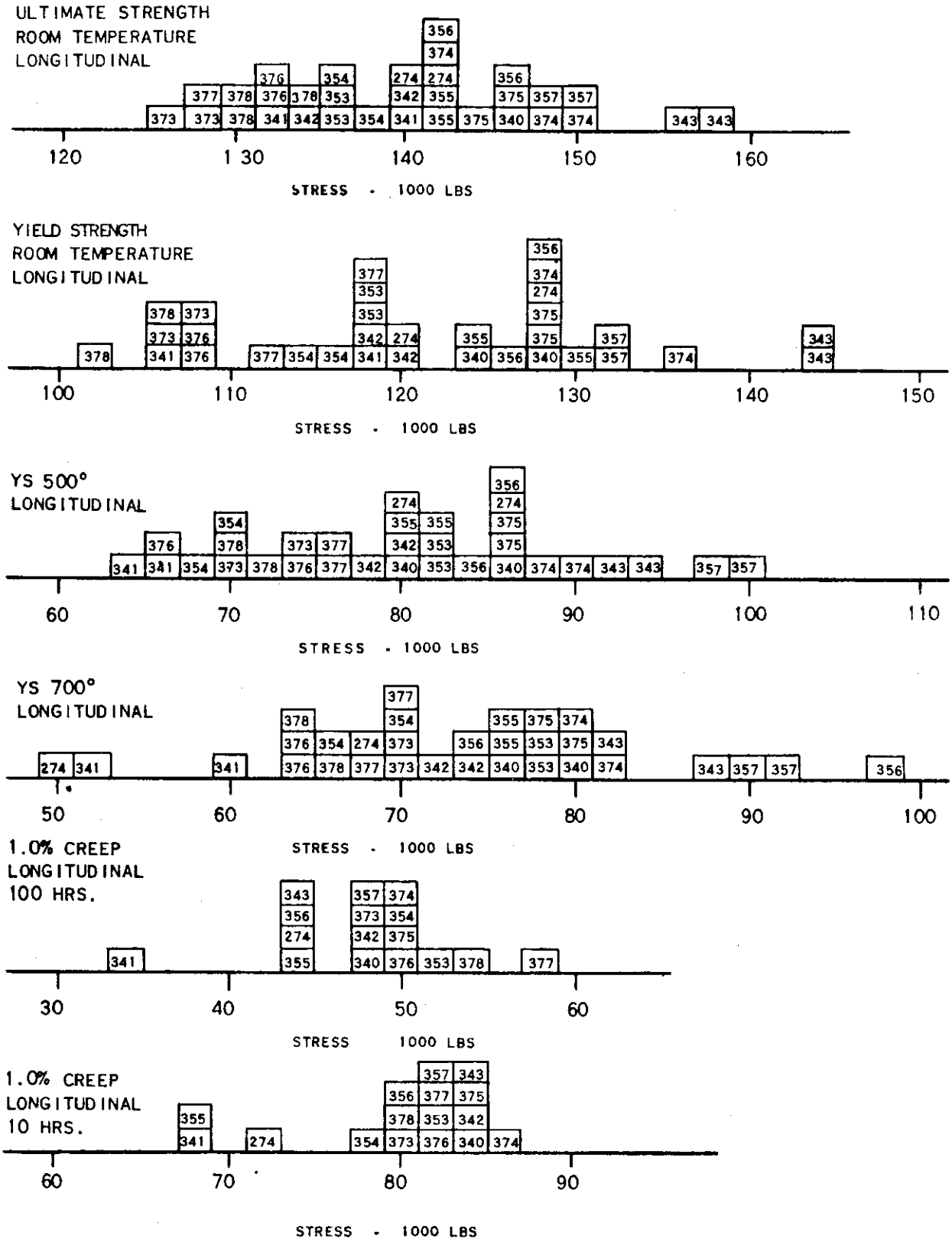
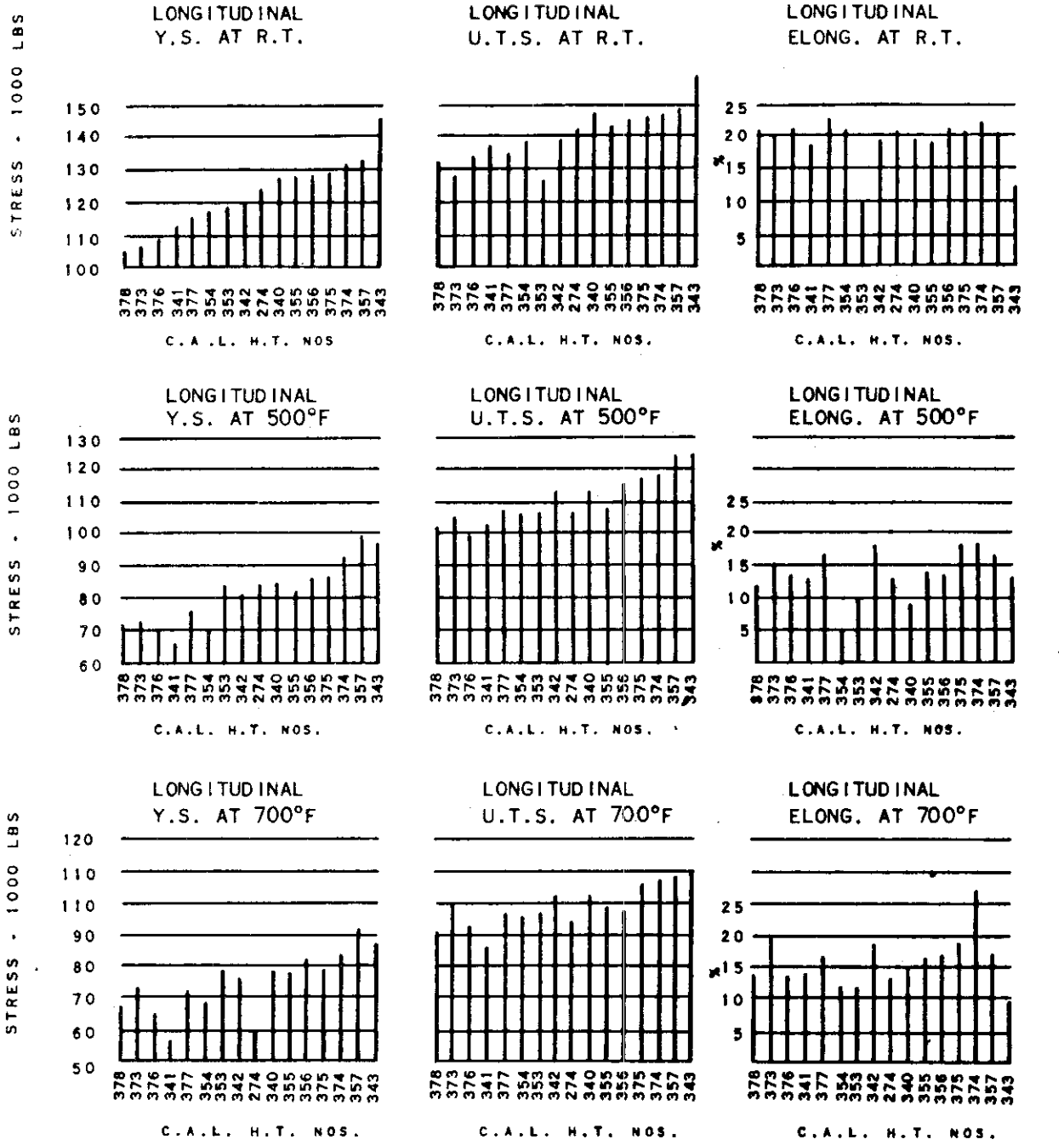


FIG. 20 - FREQUENCY DISTRIBUTION OF TENSILE STRENGTHS AT ROOM TEMPERATURE, YIELD STRENGTH AT ROOM TEMPERATURE, 500°F AND 700°F, AND 1% CREEP IN 10 HOURS AND 100 HOURS AT 700°F



NOTE: ALL VALUES SHOWN ARE THE AVERAGE OF THE TWO VALUES REPORTED IN THE TABLES.

FIG. 21 - COMPARISON OF ROOM TEMPERATURE AND ELEVATED TEMPERATURE PROPERTIES OF FIFTEEN HEATS OF RC-130-A TITANIUM ALLOY ON THE BASIS OF INCREASING ROOM TEMPERATURE YIELD STRENGTH.

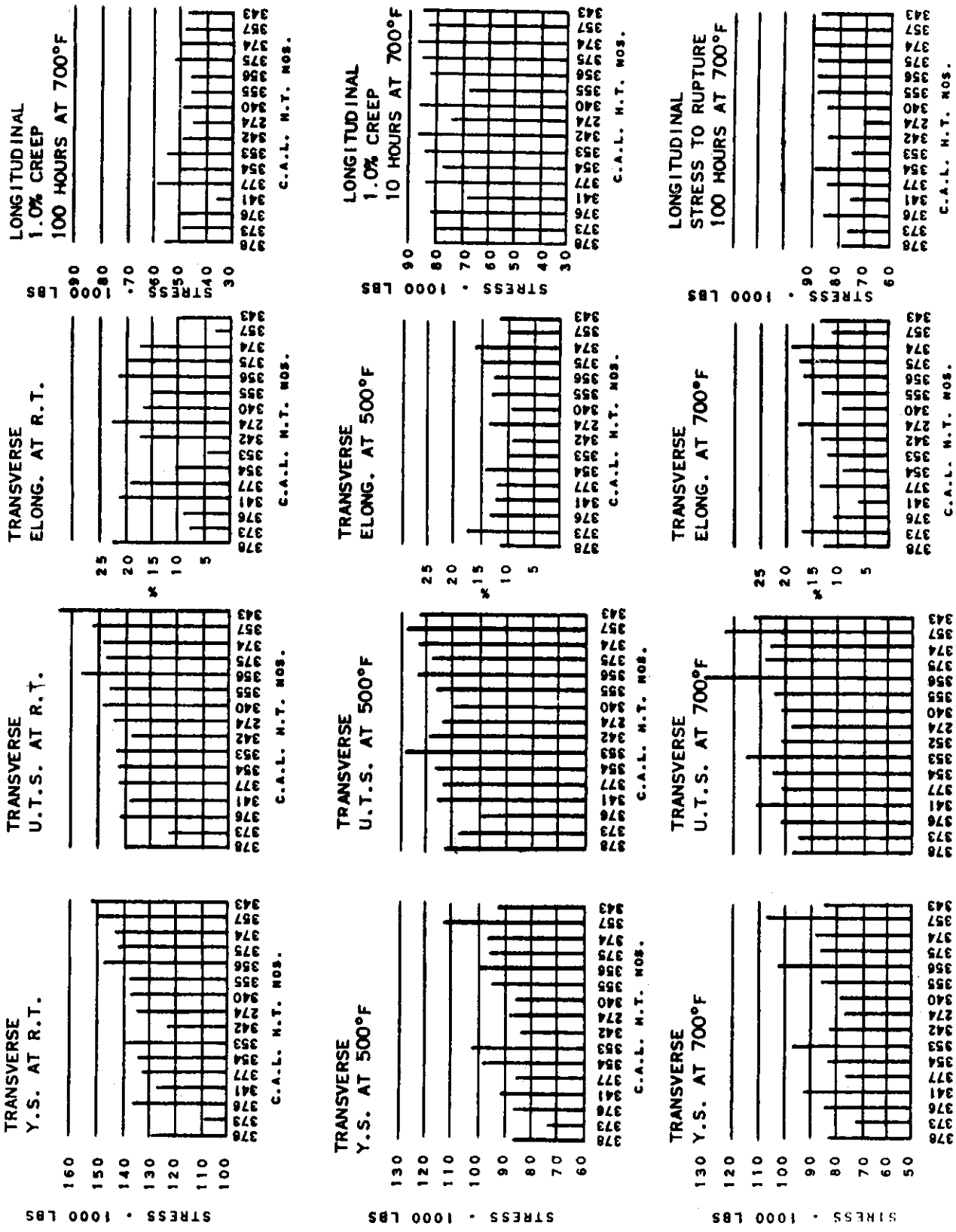


FIG. 21 CONTINUED

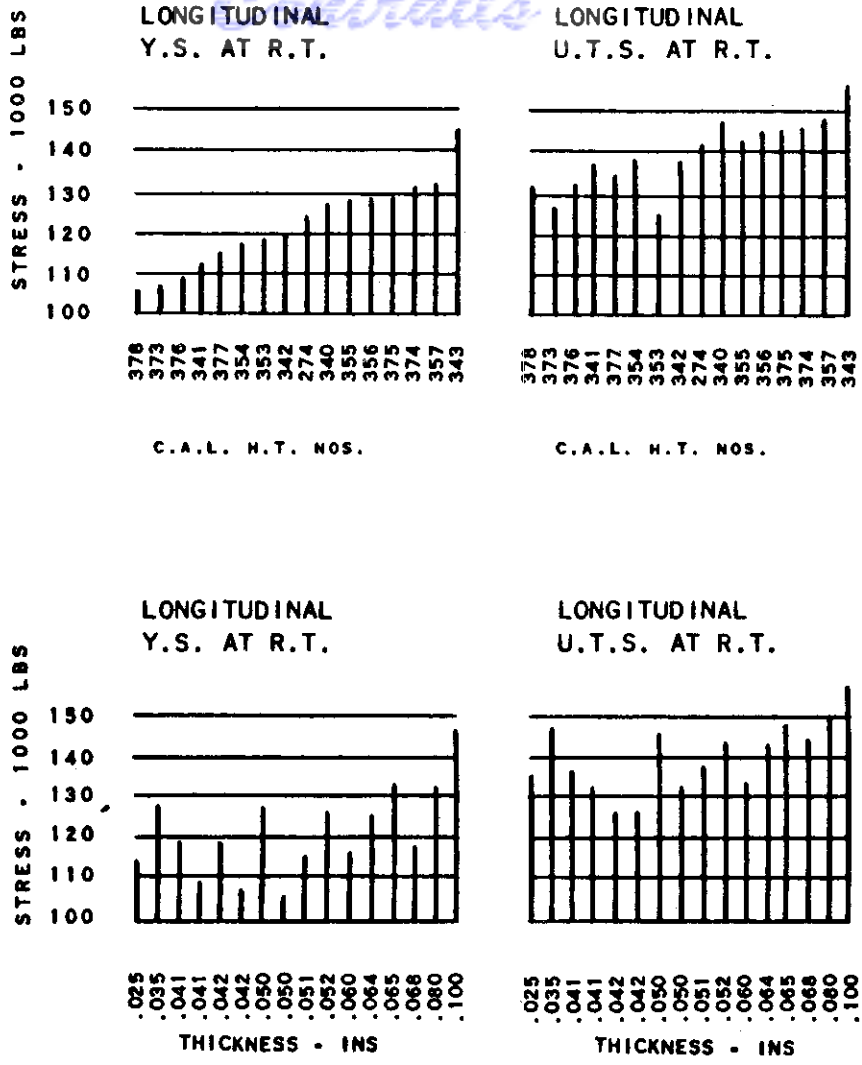


FIG. 22 - COMPARISON OF LONGITUDINAL YIELD AND ULTIMATE TENSILE STRENGTHS AT ROOM TEMPERATURE ON THE BASIS OF INCREASING YIELD STRENGTH AND INCREASING THICKNESS.

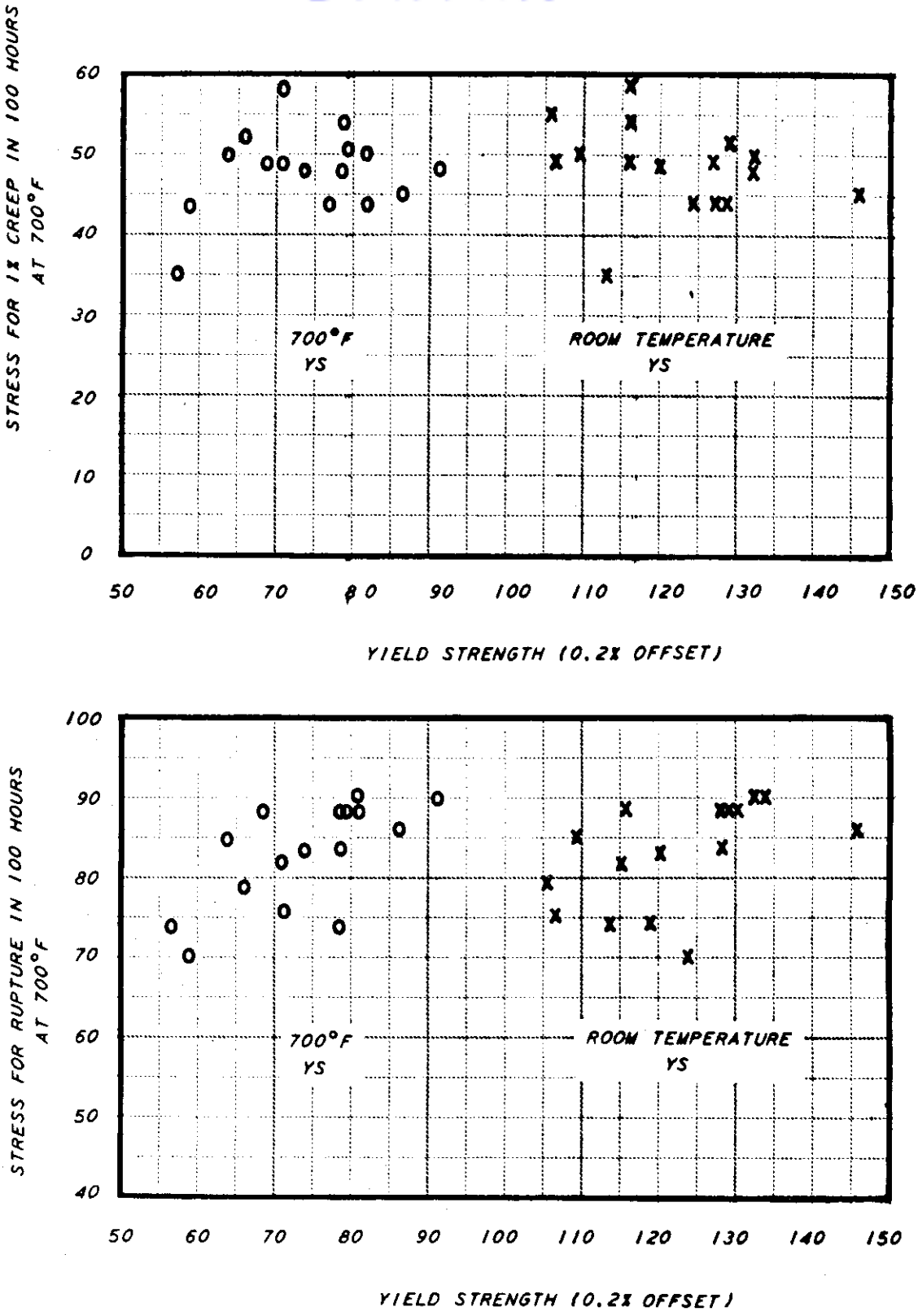


Fig. 23 - PLOTS OF STRESS FOR 1% CREEP AND RUPTURE IN 100 HOURS VERSUS 0.2% OFFSET YIELD STRENGTH ROOM TEMPERATURE AND 700°