REPORT ON

STATISTICAL EVALUATION OF THE CREEP-RUPTURE PROPERTIES OF FOUR HEAT-RESISTANT ALLOYS IN SHEET FORM

By

A. I. Rush

J. W. Freeman

Project 2059

June 1, 1954

Aviation Panel of the ASME-ASTM

Joint Committee on the Effect

of Temperature on the Properties of Metals

STATISTICAL EVALUATION OF THE CREEP-RUPTURE PROPERTIES OF FOUR HEAT-RESISTANT ALLOYS IN SHEET FORM

The rapid increase in the use of materials at increasingly higher temperatures presents the design engineer with the problem of establishing reliable new design values. Each material is expected to have a range in properties which reflects normal production variations in chemical composition, processing conditions, and heat treatment. Thus, sound design values require establishment of the ranges in properties normally to be expected under commercial production conditions.

This paper presents the results of a statistical evaluation of the range in creep-rupture properties of four sheet alloys as commercially produced. The data established were those primarily required by the aviation industry for very high-temperature sheet applications. The alloys were 18-8 Ti (AISI 321), 18-8 Cb-Ta (AISI Type 347), N155 (AMS 5532), and Inconel X (AMS 5542). Ten sheets of each alloys from different heats were included. Attempts were made to obtain samples from several producers. Tests were carried out to establish the stresses for rupture according to the following schedule.

Temp (°F)	Rupture Time (hours)			Type Alloys
1200	20	80	300	321, 347, Inconel X
1350	20	80	300	321, 347, Inconel X, N155
1500	5	20	80	321, 347
1500	20	80	300	Inconel X, N155
1650	5	20	80	N155

In addition, the creep curves from the rupture tests were analyzed for deformations of 0.2, 0.5, 1.0, and 2.0 percent as a function of time.

The investigation was sponsored by the Joint Committee of the ASME-ASTM on the Effect of Temperatures on the Properties of Metals. The program was formulated and supervised by the Aviation Panel of the Joint Committee.

DESCRIPTION OF TEST MATERIAL

The alloys were all furnished gratuitously by several producers as commercial material produced to the following specifications:

Material	Specification	Condition	Finish
AISI 321	MIL-S-6721, comp. Ti	annealed and pickled	Commercial 2-D
AISI 347	MIL-S-6721, comp. Cb-Ta	annealed and pickled	Commercial 2-D
N155	AMS 5532	per AMS 5532	per AMS 5532
Inconel X	AMS 5542	heat treated and aged	per AMS 5532

The heat numbers, number of sources, chemical composition, and other descriptive material supplied by the manufacturers are given in Tables I through IV.

PROCEDURE

The general procedure was to sample each sheet according to a scheme designed to avoid misleading results from possible variations within the individual sheets. Tensile tests were run at room temperature to show normal variation in properties from sheet to sheet and within each sheet. Rupture tests were made by estimating the stress required to give rupture at the intermediate time periods and then adjusting the stresses in subsequent tests to give rupture in the specified time periods. Creep curves, including stress-strain curves during loading, were established for the rupture tests.

No means was available for reliably fastening extensometers to the gage lengths of the specimens during the rupture tests. For this reason, they were fastened to the shoulders of the specimens. This necessitated considerable work to establish reliable means of correcting for strain in the fillets and shoulders of the specimens.

A good deal of care was taken to follow exact procedures as agreed upon with representatives of the Aviation Panel. Because these may influence the results somewhat, they are presented in some detail in the following sections.

1. Sampling

Two methods of sectioning of the sheets were employed, depending upon whether the direction of rolling was parallel to the long or short dimensions of the sheet supplied for testing. The sampling procedures are shown in Figures 1 and 2. Both procedures provided for cutting the sheet in three equal sections from which specimens were obtained with the testing direction transverse to the rolling direction.

Two tensile specimens were obtained from each sheet, one from the outside edge of the sheet and the other from the center. At least one specimen was obtained from each section for each stress-rupture testing temperature. When more than one specimen was taken from the same section, the strips were tested insofar as possible at the two extremes of the stress range. That is, to avoid the possibility of obtaining a false slope to the stress - rupture time curve if a uniform variation existed across the sheet, the specimens from consecutive sections were not tested at consecutive stress increments.

2. Specimen Design

The specimens used for the stress-rupture tests were 22 inches long and 1 inch wide in the shoulder area. The reduced section was 0.500 inches wide by 2.25 inches long and was located in the center of the 22-inch length. The fillet between the reduced section and shoulder area had a 1-inch radius. Holes 5/32 inches in diameter were drilled in the shoulder areas for the attachment of extensometers. Figure 3 is a sketch showing the dimensions of the specimens.

The tensile test specimens were similar, except that they were 1-1/4 inches wide in the shoulder area to provide a large cross section at the pins used to apply the load.

3. Machining

The same machining procedure was employed for all specimens. The specimens were milled to not less than 1/32 inch of finish size on each side and then ground to finish size. Final grinding was done in the longitudinal direction, using a 46 grit, white borlon, medium hard wheel with a vitrified bond (Simond's Wheel WA 46-K5-V1).

4. Testing Procedure

A. Tensile Testing

Duplicate tensile tests were run. All tests were conducted with a free head-speed of 0.05 inches per minute, and strain data were obtained by means of an optical extensometer system. The stress-strain curves plotted from this data were used to establish yield strengths.

B. Stress-Rupture Testing

All stress-rupture tests were conducted in single units of the dead weight-beam loaded type, except when low stresses required the use of a direct load.

The following procedure was used to bring the test specimens to temperature:

(a) Specimens were set up in the testing units and the heat turned on at 4:00 pm, so as to bring the temperature within 50°F of the desired temperature by 5:00 pm.

(b) The specimens were allowed to stand overnight, and the temperature raised to the test temperature between 8:00 am and 9:00 am the next day.

(c) Final temperature adjustments were made so that the stress could be applied at 1:00 pm.

(d) The temperature distribution along the length of the specimen, and the temperature variations with time were within the limits of ASTM Specification E85.

Time-Elongation data were obtained by means of extensometers. Collars were fixed on the upper and lower shoulders of the specimens by means of pins inserted through holes drilled in the specimen shoulder. Extension rods were attached to the collars and extended out of the furnace. Rollers carrying a mirror were inserted between each pair of extension rods. As the specimen deformed, the mirrors were rotated, and the rotation measured by a scale reflected in the mirrors to a telescope. The readings on both sides of the specimens were taken and averaged. The sensitivity of the extensometer system was three-millionths of an inch per inch in the 2-inch gage length. Figure 4 shows the type of extensometer used, as well as the method of attachment to the specimen.

Inasmuch as the extensometers were attached to the shoulders of the specimen, the observed deformations included elongation in the fillet and a portion of the shoulder, as well as in the reduced section. Consequently, it was necessary to establish factors which would correct the total deformation observed to that occurring in the reduced section. That is, the total extension measurements were translated into percent elongation of an "effective gage length." The effective gage length is the hypothetical gage length which would deform the same amount as the total deformation measured by the extensometers.

Two effective gage lengths were determined: one for the loading portion of the creep-rupture tests, and the other for the creep data obtained after the load had been applied. This was necessary because the relations between stress and strain during loading are different than during creep.

(1) On loading, the specimen length covered by the extensometer deforms elastically in accordance with the stresses existing in the gage length, fillets and shoulder lengths.

(2) As the load increases past the proportional limit, if such occurs, a steadily increasing amount of the fillet area deforms plastically. The total elongation measured during this part of the test then becomes a function of the proportional limit, the stress-strain behavior past the proportional limit, and the stress pattern existing in the fillet.

(3) After the load becomes constant, the entire specimen deforms plastically in accordance with the stress - creep rate relationship for the

material and temperature. Therefore, the elongation measured during this period is a function of the stress - creep rate relationship and the stress pattern existing between the points of attachment of the extensometer.

The effective gage length for the loading portion of the creep test was determined at room temperature by several tests run on specimens using both SR4 strain gages applied to the reduced section and the mechanical extensometers attached to the shoulders.

The SR4 gages covered a 1-inch length of the reduced section and it was assumed that they gave accurate stress-strain data for values up to 0.5 percent strain. The stress-strain data obtained from the mechanical extensometers were then adjusted by the use of a suitable correction factor to agree with the data from the SR4 gages.

The continued use of this factor at stresses over the elastic limit resulted in less indicated deformation than that shown by the SR4 gages. However, in the rupture test, the stresses either did not exceed the proportional limit or so far exceeded the elastic limit that deformations in excess of those of interest were obtained. Therefore it is believed that the deviation beyond the elastic limit did not significantly affect the design data. The correction factor was expressed in terms of the effective gage length previously defined. Furthermore, the effective gage length calculated on the basis of the stress distribution in the reduced section, shoulder radius, and shoulders was found to agree remarkably well with the experimental value.

Several independent checks were conducted to determine the effective gage length for creep in the rupture test. Specimens were gage marked in a number of places in both the reduced sections and shoulder areas and carefully measured to 0.0001-inch in the Gage Laboratory of the

Production Engineering Department before and after creep testing. The specimens used for this purpose covered a range of temperatures, stresses, creep rates, and materials. From these data, together with the extensometer readings obtained during the tests, an effective gage length was calculated. In addition, the effective gage length was calculated on the basis of stress distribution and the integration of creep rates in the entire section between the points of attachment of the extensometers. The values obtained for the effective gage length by these calculations agreed exceptionally well with those determined experimentally, as shown in the table on the following page.

RESULTS

Tensile Properties at Room Temperature

The results of the tensile tests are given in Tables V to VIII. It will be noted that tensile properties were uniform. The most notable exception was Inconel X, Heat Y4474X, which had abnormally low strength. If Heat Y4474X were excluded from the values for the ranges reported in Table VII, the low side of the tensile strength range would have been 170,000 psi, instead of the 156,600 psi shown. The other strength values were proportionately low for this heat. The duplicate specimens all agreed well in properties in every case, indicating no large variations within individual sheets.

Period of Test	Material	Temp (°F)	Stress (psi)	Duration of Test (hours)	Total Deformation (%)	Minimum Creep Rate (%/hour)	Effective Gage Length	
							Experimental	Calculated
Loading	321	Room	46,500	--	0.705	--	3.68	3.78
	321	Room	41,000	--	0.595	--	3.68	3.78
	347	Room	43,500	--	0.615	--	3.68	3.78
Creep	N155	1500	14,000	198	1.5	0.0055	2.71	2.61
Creep	321	1200	22,000	31	5.5	0.165	2.78	2.70
		1500	8,000	17	1.7	0.165	3.06	2.90
Creep	347	1200	20,000	700	0.68	0.000624	2.81	2.70

Stress-Rupture Properties

The results of the individual stress-rupture tests are presented in Tables IX to XII, and are plotted on log-stress log-time coordinates in Figures 5 to 8. From these data the stresses for rupture in the specified times were obtained and are given in Tables XIII to XVI. Figures 9 to 12 show the ranges in these stresses as a function of temperature. The approximate ranges in elongations for fracture are also included in the figures. Three or four tests were run on each sheet for each temperature and a stress-rupture curve plotted. The stresses reported were obtained by interpolation on the stress - rupture time curves. In most cases, the stresses were adjusted so that the actual test times were not greatly different from those specified.

In conducting the tests, it was not found possible to test all heats of a given alloy at the same stresses. This was due to the spread in rupture times for a given stress being too wide to enable proper establishment of the specified rupture times. After one test point was available, the stresses were adjusted to give fracture times near those specified. For instance, for N155, the spread in rupture times for the average stress for fracture in 80 hours at 1350°F was 55 to 100 hours. This range is wider than was specified for the investigation. Since N155 alloy gave the least variation in rupture times, the other materials had considerably wider variations in rupture times at a given stress. Several more tests would have been required for each rupture curve to have run tests on all heats at common stresses and also have established the specified rupture times.

When the investigation was initiated, it was believed possible that the number of tests required could be reduced considerably by the use of a time-temperature parameter for correlating stress-rupture data.[1] However, as the work progressed, it became apparent that the data did not fit a single stress-parameter curve sufficiently well to predict the strength of one heat upon the curve obtained from another heat. The individual test points for each alloy are plotted on stress-parameter coordinates in Figures 13 to 16. The time-temperature parameter employed was that developed by Miller and Larson where Parameter = T (C + log t). Temperature, T, is expressed in °R; the time, t, in hours; and the value for the constant, C, is usually taken as 20. It was observed that changing the value of C resulted in better agreement for the values obtained from a single heat, but at the same time increased the disagreement for other heats. However, it is apparent from Figures 13 through 16 that the agreement in rupture strengths between the various heats was not sufficient to warrant its use in the determination of the range in rupture strengths for this investigation from a master curve established from a limited number of heats. It is likewise apparent that using a limited number of tests on each heat to establish a curve would not have been reliable.

Total Deformation Strengths

The available data for total deformations of 0.2, 0.5, 1.0, and 2.0 percent in 1, 5, 20, 80, and 300 hours are given in Tables XIII through XVI. Where the data are sufficiently complete, the ranges are shown as a function of temperature in Figures 17 through 22. To obtain these data, the creep curve for each rupture test was plotted. The available times for

(1) F. R. Larson and James Miller. "A Time-Temperature Relationship for Rupture and Creep Stresses." Trans. of ASME, Vol. 74, No. 5, July 1952.

the total deformations given above were obtained from these curves, Tables IX through XII. Curves were then plotted for stress versus the time for these total elongations for each test temperature on each heat. Values were then interpolated for the stresses for deformations in 1, 5, 20, 80, and 300 hours, depending on what data were available. Figures 23 through 26 illustrate the typical design curves obtained for one heat of each of the four alloys tested.

The deformations reported are the total deformations from loading and creep. Some values were not obtained for the following reasons: (1) deformation during loading exceeded the desired values; (2) the total deformation exceeded those of interest in much less time than 300 hours; (3) in many cases creep rates were so high that deformations of interest were exceeded in less than 1 hour; (4) the total extension to fracture was less than 2 percent.

Statistical Evaluation

The tensile and stress-rupture data were analyzed statistically insofar as it was considered legitimate from the data available.

The range, average, and standard deviation were determined for each alloy for the tensile strength, yield strength, proportional limit, and elongation values obtained from the tensile tests. These values are shown in Table XVII, together with the maximum difference in properties observed for one heat of the alloy.

Similar values, range, average, and standard deviation, were obtained for all the stress-rupture strength data and for total deformation data where it was believed that sufficient data were available to warrant statistical treatment. These values are given in Tables XVIII through XXI, together with the number of heats used in the calculation and the spread in values obtained by using the average plus or minus three times the standard deviation.

In general, the data appeared to follow a rather normal frequency distribution and the agreement between the actual range in values determined and the probable range estimated by the average plus or minus three times the standard deviation was fairly good. Thus it might be expected that the samples was representative of the universe, although a much larger sample would be necesssary to substantiate this statement.

For the tensile data, the major exception to this statement was the properties of the Inconel X sheet. The estimated range indicated that considerably higher strengths might be expected than were actually obtained.

The agreement between the actual and estimated ranges in rupture strengths was quite good, although the estimated range for Inconel X indicated that heats with considerably higher and lower strengths than actually were obtained might be expected, especially at 1200° and 1350°F.

The statistical analysis of the total deformation strengths showed good agreement between actual and estimated ranges when sufficient data were available. However, it should be recognized that the heats for which no values were reported fall outside of the reported ranges and that the actual range in strength would be greater if sufficient data were available to establish these points.

It should be emphasized that the statistical evaluation is based on rupture and total deformation strengths obtained from a plot of stress against time for rupture or given total deformation, and that the values obtained from such plots are subject to statistical variation in themselves.

That is, three to five tests run at a given temperature under different stresses were used to establish the stress-rupture or total deformation strengths, and since some scatter was observed for these points, the individual strengths for a single heat are subject to a plus or minus variation. However, since only three to five tests were run at each temperature and since these tests were obtained from somewhat widely spread locations within a single sheet, it was not thought feasible to attempt a statistical analysis of each heat. Furthermore, the ranges in stress-rupture strengths obtained from the stress-parameter curves of Figures 13 through 16 where all the individual points are plotted were only slightly greater than those obtained using the values taken from the individual rupture strengths.

DISCUSSION

Data are presented on the ranges in rupture and total deformation strengths of commercially produced sheet of 18-8 Ti (Type 321), 18-8 Cb + Ta (Type 347), N155 and Inconel X alloys for three time periods at three temperatures. Sample sheets from 10 separate heats of each alloy were used. In general, these data represent a more complete survey of the high-temperature properties of a given product than is usually available. The additional statistical analysis shows designers rather completely what to expect from the products.

The reasons for the range in properties are not well established. The high-temperature properties of the alloys are known to be influenced by heat-treating temperatures, cold work, and variations in composition. Most studies of variability also indicate that differences arise from working conditions prior to final heat treatment and from unidentified heat to heat variations. In general, the interrelations of these variables make it very difficult to establish specific causes. For these reasons, correlations between properties and compositions or tensile properties were not carried out. Any trends which might be indicated would have to be verified under more closely controlled conditions than were the case for this study.

In general, where test material was obtained from more than one source, the sheets from one source tended to show properties which grouped more closely than the total spread. This would be expected for an established practice in one plant. All of the sheets coming from one producer quite certainly explains the small spread in properties for N155 alloy. On the other hand, all Inconel X sheets were also made by one producer. Inconel X, however, is dependent on precipitation of compounds of nickel with Al + Ti for its high strength. Alloys exhibiting such precipitation reactions might be expected to be considerably more sensitive to prior history than the other alloys. Heat treatments of the other alloys mainly dissolve precipitated carbides and remove cold work. It will be noted that Inconel X, Heat Y4474X, which had the low tensile strength at room temperature had about average properties at 1200°F, and was on the high side of the range at 1500°F.

Due to space limitations, the actual test data are not included. In general, quite good stress - rupture time curves were obtained. There was, however, some scatter which appeared to be related to slight variations in specimens taken from the different locations in the sheets.

The stress - rupture time curves were not parallel to one another, but were at varying angles. This would be expected for the several possible metallurgical variations affecting the properties. The distinct nature of the individual stress - rupture time curves indicated metallurgical variation as the responsible cause of the spread in data, and not sampling or testing variables.

The properties at high temperatures are expressed in every case as the variation in stress for rupture in a given time. It should be recognized, however, that the variation in time for rupture at a fixed stress was considerable. As mentioned previously in the case of least scatter, N155, rupture times at 1350°F would have varied from 55 to 100 hours under the average stress for rupture in 80 hours. In a more extreme case, that of Inconel X tested at 1200°F, the average stress for rupture in 80 hours gave times from 24 to 350 hours. This condition arises from the rather flat slope of the usual log-log stress - rupture time curves. Furthermore, the variation between specimens from an individual sheet run at constant stress would have been considerable, even though the average stress - rupture time curves were quite good.

TABLE I

DESCRIPTION OF 18-8 TI (AISI TYPE 321) SHEET MATERIALS

Supplier	Heat No.	Chemical Composition (%) C	Mn	P	S	Si	Cu	Ni	Cr	Ti	Mo	Gauge (in.)
B	R10356	.042	1.44	.027	.009	.57	--	9.49	17.41	.65	--	.040
B	E02326	.053	1.73	.026	.012	.58	--	9.76	18.01	.49	--	.040
D	E1880(1)	--	--	--	--	--	--	--	--	--	--	.040
C	X25677	.07	1.65	.022	.006	.58	--	10.43	17.84	.55	--	.040
D	E41024(1)	--	--	--	--	--	--	--	--	--	--	.040
A	627967	.078	1.33	.025	.009	.34	.27	9.98	17.75	.57	--	.048
B	R30409	.035	1.50	.030	.015	.66	--	9.36	17.72	.50	--	.040
D	E1869(1)	--	--	--	--	--	--	--	--	--	--	.040
C	X46099	.06	1.56	.021	.005	.84	.24	10.21	17.76	.49	.13	.035/.045
C	X13043	.05	1.43	.029	.005	.94	.24	10.56	17.56	.46	.15	.035/.045

(1) Surface finish and composition not reported -- all other reported to have 2D finish.

TABLE II

DESCRIPTION OF 18-8 CB-TA (AISI TYPE 347) SHEET MATERIALS

Supplier	Heat No.	Chemical Composition (%) C	Mn	P	S	Si	Cu	Ni	Cr	Cb+Ta	Ta	Cb	Mo	Gauge (in.)
A	620809	.08	1.89	.026	.010	.80	.14	10.42	17.66	.96	--	--	--	.040/.050
A	620813	.076	1.78	.024	.010	.53	.16	10.34	17.92	.77	--	--	--	.040/.050
A	636862	.064	1.89	.025	.010	.50	.20	10.76	17.60	.71	--	--	--	.040/.050
D	E40470	.07	1.68	.018	.017	.80	.10	10.44	17.55	--	.25	.57	.12	.040
D	E41286	.06	1.52	.033	.021	.57	.16	10.37	17.55	--	.13	.67	.14	.040
D	E41887	.05	1.67	.028	.019	.98	.18	10.36	17.69	--	.13	.62	.24	.040
D	E41737	.05	1.88	.024	.016	.62	.15	10.33	17.68	--	.10	.63	.18	.031
C	7X7935	.07	1.40	.030	.018	.45	.24	10.29	18.49	--	--	.76	.15	.035/.045
C	X25788	.07	1.83	.016	.005	.73	.26	11.91	17.68	--	--	.94	--	.035/.045
C	3X0005(1)	.04	1.58	.018	.020	.39	.06	11.40	18.24	--	--	.62	.02	.035/.045

(1) 2B finish - all others 2 D finish.

TABLE III

DESCRIPTION OF INCONEL X (AMS 5542) SHEET MATERIALS

Supplier	Heat No.	C	Mn	S	Si	Cu	Ni	Cr	Al	Ti	Cb	Fe	Gauge (in.)
E	Y4474X	.05	.57	.007	.35	.07	73.67	14.70	.84	2.49	.53	6.70	.043
E	Y3166X	.04	.54	.007	.36	.03	73.07	14.73	.80	2.38	1.02	6.94	.043
E	Y4602X	.04	.57	.007	.44	.06	72.56	14.88	.90	2.69	.90	6.97	.043
E	Y4860X	.03	.50	.007	.30	.02	73.46	14.66	.88	2.59	.83	6.70	.043
E	Y4512X	.04	.57	.007	.33	.02	73.16	14.78	.79	2.44	1.03	6.81	.043
E	Y4511X	.03	.56	.007	.31	.02	73.25	14.71	.77	2.35	1.09	6.88	.043
E	Y4847X	.03	.55	.007	.37	.04	73.34	15.14	.76	2.39	.77	6.68	.043
E	Y4984X	.03	.54	.007	.39	.16	72.96	14.93	.85	2.57	.88	6.66	.043
E	253X	.03	.75	.007	.31	.05	72.24	15.31	.78	2.65	.83	7.02	.045

TABLE IV

DESCRIPTION OF N155 (AMS 5532) SHEET MATERIALS

Supplier	Heat No.	Chemical Composition (%)														Gauge (in.)
		C	Mn	P	S	Si	Ni	Cr	Co	Cb	Ta	Cb+Ta	W	Mo	N2	
F	M624	.11	1.45	.028	.013	.41	20.08	21.20	20.05	--	--	.84	2.40	3.08	.12	.044
F	M206	.08	1.32	.022	.020	.50	19.72	21.52	19.81	.66	.23	.89	2.37	3.22	.12	.042
F	M208	.10	1.50	.023	.018	.50	19.26	21.66	19.37	.80	.25	1.05	2.34	3.17	.14	.042
F	M207	.10	1.47	.021	.015	.50	19.88	21.49	19.49	.79	.23	1.02	2.53	3.28	.11	.042
F	M733	.10	1.39	.020	.015	.53	20.18	20.83	20.17	--	--	.81	2.46	2.98	.11	.050
F	M737	.12	1.69	.030	.015	.46	20.36	21.17	19.52	--	--	.81	2.25	3.06	.11	.050
F	M732	.11	1.27	.026	.015	.53	20.04	21.08	20.26	--	--	.82	2.38	2.96	.10	.050
F	M731	.13	1.36	.021	.014	.49	19.75	20.78	19.38	--	--	.79	2.42	2.84	.10	.050
F	M726	.12	1.62	.020	.012	.50	19.37	21.74	20.25	--	--	.81	2.43	3.08	.11	.050
F	M730	.10	1.52	.020	.016	.42	20.12	20.78	19.05	--	--	.76	2.52	2.96	.10	.050

TABLE V

ROOM TEMPERATURE TENSILE DATA FROM TYPE 321 SHEET

Heat No.	Tensile Strength (psi)	Offset Yield Strength (psi) 0.1%	Offset Yield Strength (psi) 0.2%	Proportional Limit (psi)	Elongation (% in 2 in.)
R10356	85,700	31,000	34,000	15,000	62.5
	85,600	31,500	36,000	15,000	63.0
E02326	90,600	31,000	35,000	15,000	67.0
	90,500	33,000	36,000	16,000	68.4
E1880	89,200	33,500	36,000	20,000	67.4
	88,800	30,000	33,000	14,500	62.0
X25677	92,800	32,000	35,500	14,000	58.5
	90,200	31,500	34,500	16,000	62.5
E41024	90,800	27,500	30,000	14,500	74.4
	89,600	32,000	33,500	22,000	74.7
627967	81,500	34,500	37,000	14,000	64.5
	81,600	36,500	39,000	15,500	66.0
R30409	85,400	28,500	30,500	15,500	66.5
	85,700	27,500	31,500	19,000	65.0
E1869	90,300	31,000	34,500	15,000	69.5
	86,300	31,000	34,500	16,500	68.5
X46099	92,200	43,500	45,500	20,000	51.0
	90,600	40,000	43,000	20,000	54.5
X13043	92,700	39,000	41,500	14,000	60.0
	90,800	34,500	39,500	14,000	62.5
Range	81,500/ 92,800	27,500/ 43,500	30,000/ 45,500	14,000/ 22,000	51.0/ 74.7
Average	88,550	32,900	36,000	16,300	64.4
Standard Deviation	3,380	3,960	3,910	2,440	5.65

TABLE VI

ROOM TEMPERATURE TENSILE DATA FROM TYPE 347 SHEET

Heat No.	Tensile Strength (psi)	Offset Yield Strength (psi) 0.1%	Offset Yield Strength (psi) 0.2%	Proportional Limit (psi)	Elongation (% in 2 in.)
620813	94,000	38,500	42,000	16,000	60.0
	94,900	38,000	42,000	14,000	61.5
636862	93,400	39,000	42,000	15,000	60.5
	92,400	39,000	41,500	16,000	64.5
E40470	94,000	35,500	39,500	18,000	61.5
	93,300	36,500	41,000	20,000	58.0
E41286	88,200	36,000	39,500	18,000	61.5
	91,200	34,500	39,000	17,000	61.0
E41887	102,800	40,500	42,500	25,000	63.0
	100,000	45,000	48,500	28,000	57.5
E41737	93,600	42,500	44,000	28,000	59.5
	93,200	32,500	35,500	19,000	60.0
7X7935	99,100	42,500	47,500	19,000	52.0
	97,100	42,500	46,000	19,000	55.5
X25788	97,800	46,500	51,500	21,000	47.0
	95,600	51,000	54,000	21,000	51.5
3X0005	87,500	39,000	41,000	20,000	66.0
	90,500	36,500	40,000	19,000	63.0
Range	87,500/ 102,000	32,500/ 51,000	35,500/ 54,000	14,000/ 28,000	51.5/ 64.5
Average	94,400	39,800	43,300	19,800	59.1
Standard Deviation	3,840	4,490	4,540	3,850	4.74

TABLE VII

ROOM TEMPERATURE TENSILE DATA FROM INCONEL X SHEET

Heat No.	Tensile Strength (psi)	Offset Yield Strength (psi) 0.1%	Offset Yield Strength (psi) 0.2%	Proportional Limit (psi)	Elongation (% in 2 in.)
Y4474X	156,500	99,500	102,000	76,500	32.0
	156,500	100,000	105,000	77,000	30.0
Y3166X	170,700	114,000	118,000	92,000	26.0
	170,700	113,000	115,000	90,000	31.0
Y4602X	179,300	122,000	126,000	91,000	25.0
	177,700	117,000	122,500	92,000	26.0
Y4860X	170,600	115,000	119,000	89,000	31.0
	172,000	118,000	121,000	89,000	27.5
Y4512X	175,400	118,000	122,000	89,000	28.5
	176,800	119,000	124,500	87,000	29.5
Y4511X	174,700	118,000	120,500	85,000	31.0
	171,800	114,500	118,000	86,000	30.5
Y4847X	170,700	114,750	118,000	85,000	29.5
	174,200	120,250	124,000	90,000	30.0
Y4984X	183,800	128,000	131,000	109,000	24.0
	182,500	128,000	132,000	102,000	23.5
253X	185,800	132,500	136,000	110,000	24.0
	184,500	130,000	135,000	100,000	24.0
Range	156,500/ 185,800	99,500/ 132,500	102,000/ 136,000	76,500/ 110,000	23.5/ 32.0
Average	174,000	118,000	121,500	91,100	28.0
Standard Deviation	7,900	8,550	8,725	8,890	2.86

TABLE VIII

ROOM TEMPERATURE TENSILE DATA FROM N-155 SHEET

Heat No.	Tensile Strength (psi)	Offset Yield Strength (psi)		Proportional Limit (psi)	Elongation (% in 2 in.)
		0.1%	0.2%		
M624	117,700	50,400	55,400	20,000	56.0
	117,200	51,500	56,800	29,000	55.5
M206	117,700	48,000	56,600	18,000	52.0
	118,300	47,900	56,500	19,000	52.5
M208	120,200	58,000	64,500	26,000	52.5
	119,700	51,800	59,500	22,000	53.5
M207	118,200	53,500	57,700	28,000	53.6
	119,400	54,700	61,600	26,000	53.6
M733	120,000	54,500	61,800	25,000	54.0
	120,200	51,500	59,500	20,000	52.0
M737	120,500	55,000	59,500	27,000	57.5
	121,200	53,000	60,000	20,000	54.5
M732	119,600	53,000	60,500	22,000	54.0
	119,500	54,000	60,600	22,500	55.0
M731	118,200	51,200	61,500	17,000	51.5
	120,500	52,000	62,600	17,000	52.5
M726	120,200	51,500	58,800	20,000	54.0
	119,300	50,000	57,800	17,500	55.0
M730	116,800	53,000	59,800	17,500	54.5
	116,600	50,500	60,000	18,000	53.0
Range	116,600/ 121,200	47,900/ 58,000	55,400/ 64,500	17,000/ 29,000	51.5/ 57.5
Average	119,050	52,250	59,550	21,575	53.8
Standard Deviation	1,320	2,340	2,230	3,850	1.47

TABLE IX

STRESS-RUPTURE AND TOTAL DEFORMATION DATA FOR TEN HEATS

OF TYPE 321 SHEET TESTED AT 1200°, 1350°, AND 1500°F

Heat No.	Specimen[(a)] Location	Temp (°F)	Stress (psi)	Rupture Time (hours)	Elongation (% in 2 in.)	Deformation on Loading (in./in.)	Time for Indicated Percent Deformation (hours) 0.2	0.5	1.0	2.0
R10356	3	1200	36,000	11.8	17.5	>.02	b	b	b	b
	1		28,500	80.0	34.5	.00910	b	b	0.2	31.6
	2		22,500	338.3	31.0	.00154	5	61.5	86	119
	3	1350	18,000	35.5	23.5	.0012	0.6	3.0	6.0	13.0
	1		14,500	83.5	--(e)	.00097	1.6	7.5	16.6	34.6
	2		10,500	597.8	20.5	.00064	14	48	113	195
	1	1500	11,500	7.6	24.0	.00105	0.1	0.5	1.0	1.7
	3		10,000	23.3	25.0	.00086	0.4	1.5	3.1	5.0
	2		7,000	85.3	25.0	.00051	2.5	6.5	12.5	25
E02326	2	1200	37,500	9.8	10.5	~.040	b	b	b	b
	1		27,000	95.5	11.0	.0073	b	b	0.5	44
	3		22,000	308.1	13.0	.00117	2	45	110	176
	3	1350	16,000	33.3	7.0	.00097	1.5	7.5	14	21.5
	2		13,000	128.0	15.0(e)	.00070	15	30	44	63
	1		11,200	191.0	11.5	.00060	13	31.5	49	78
	3		9,400	584.0	8.5	.00050	27	62	114	203
	1	1500	12,500	6.1	25.5	.00093	0.1	0.5	1.1	2
	2		8,800	30.4	14.5(e)	.00073	0.8	2.6	5.0	8.7
	3		7,400	54.9	3.6(c)	.00061	1.3	5.0	10.5	19.2
E1880	2	1200	34,000	21.5	15.5	~.0220	b	b	b	b
	1		29,000	55.6	12.0	.0137	b	b	b	1.5
	3		22,000	515.0	23.5	.00150	0.5	55	125	214
	3	1350	21,000	23.0	26.5	.00134	0.1	0.4	1.4	5.8
	2		16,000	106.2	14.5	.00092	2.5	14	24	41
	1		13,000	314.0	12.0	.00072	7	28	62	122
	3	1500	15,000	4.5	26.0	.00152	--	0.15	0.4	1.2
	1		12,000	14.7	16.0	.00082	0.3	1.2	2.6	4.5
	3		8,200	91.5	12.0	.00051	2.5	7.6	16	29
	1		6,800	199.3	7.0	.00045	4	17.5	38	72.5
X25677	3	1200	36,000	10.2	11.5	~.024	b	b	b	b
	1		28,500	84.4	24.0	.0080	b	b	0.2	24
	2		23,000	337.2	22.0	.00175	0.5	22	70	127
	3	1350	19,000	31.2	26.0	.00105	0.4	1.7	3.8	8.9
	1		14,500	114.9	17.5(c)	.00070	6	20	32.5	45
	2		12,000	372.0	14.0	.00056	18	40	73	105
	2	1500	14,000	2.9	31.0	.00134	--	0.05	~0.2	~0.4
	1		11,500	20.3	28.5	.00078	0.1	0.4	0.9	1.6
	3		7,500	60.7	30.5	.00056	2	7	15	22
E41024	2	1200	37,500	15.5	12.0	~.04	b	b	b	b
	1		28,500	151.2	10.0	.016	b	b	b	1
	3		25,500	249.5	10.5	.0117	b	b	b	100
	2	1350	23,000	15	10.5	.00508	b	b	0.05	0.7
	1		19,000	84.6	7.0	.00159	--	0.5	3	42
	3		17,500	131.9	14.0	.00094	2	22	59	88
	2		15,500	173.8	8.5	.00083	4	39	88	125
	3	1500	14,000	4.2	27.0	.00150	--	0.1	0.3	0.6
	1		11,500	16.9	14.0	.00111	0.5	1.7	3.9	8
	2		8,000	151.7	6.0	.00068	6	21	43	78

TABLE IX, Continued

Heat No.	Specimen[(a)] Location	Temp (°F)	Stress (psi)	Rupture Time (hours)	Elongation (% in 2 in.)	Deformation on Loading (in./in.)	Time for Indicated Percent Deformation (hours) 0.2	0.5	1.0	2.0
627967	3	1200	33,000	17.1	10.5	~.02	b	b	b	b
	1		28,500	57.5	9.5(d)	.0083	b	b	0.5	25
	2		22,000	342.0	11.0	.00138	30	67	97	146
	3	1350	17,000	45.4	9.5	.00105	--	--	--	--
	1		14,500	151.3	9.0	.00082	3.5	17	42	88
	2		13,000	293.5	9.0	.00071	16	56	100	176
	2	1500	13,000	8.0	21.5	.0011	0.2	1.0	2	3.0
	1		11,500	15.5	21.0	.00092	0.3	1.0	2	4.1
	3		7,500	124.1	12.0	.00062	4	21	50	100
R30409	3	1200	35,000	17.6	12.0	~.04	b	b	b	b
	1		28,500	64.2	5.5	.0132	b	b	b	13
	2		22,000	294.5	18.5	.00490	b	--	73	143
	3	1350	19,000	27.7	18.5	.00130	--	0.3	1.2	7.4
	1		14,500	112.7	16.0	.00078	6.5	19.5	29	45
	2		12,000	240.0	10.0	.00067	13.5	36	67	126
	1	1500	11,500	7.2	12.5(d)	.00090	--	0.2	0.5	1.3
	3		9,400	43.8	13.5	.00076	1.4	5	9.2	15.2
	2		7,000	97.7	6.5(d)	.00055	3.6	10.5	18	30
E1869	3	1200	35,500	21.3	11.5	~.02	b	b	b	b
	1		28,500	127.0	14.0	.0087	b	b	0.5	63
	2		25,000	240.4	9.5	.00413	b	1	65	122
	2	1350	21,000	18.4	27.0	.00161	--	--	--	--
	3		17,500	84.9	22.0	.00106	2.5	10	17	30
	1		14,500	219.5	8.5	.00085	8	28	62	112
	2	1500	14,000	9.6	25.0	.00109	0.1	0.5	1.2	2.3
	1		11,500	31.8	16.5(d)	.00070	0.8	2.7	5.9	9.6
	3		9,500	49.7	18.5	.00060	2.5	8	16.5	29.5
X46099	3	1200	34,000	8.0	21.5	.00979	b	b	--	0.1
	1		28,500	45.9	35.0	.00177	--	0.7	4.0	7.5
	2		21,000	316.3	17.5	.00115	3	27	49	80
	1	1350	22,500	6.9	48.0	.00170	--	--	--	--
	2		17,000	31.0	33.0	.00124	0.2	0.8	2.7	5.2
	3		14,000	116.9	16.5	.00090	1.2	4.8	10.8	23
	1		12,500	160.9	14.5	.00085	2	7.2	19	44
	1	1500	11,500	11.0	28.5	.00125	--	0.2	0.6	1.4
	3		9,400	23.4	17.0	.00108	0.2	0.6	1.6	3.6
	2		7,200	84.6	18.0	.00066	1.4	4.0	9.0	18.0
X13043	1	1200	28,500	25.6	17.5	.00355	b	--	0.2	1.2
	3		23,000	121.8	10.0	.00137	0.5	3.5	11	29
	2		20,000	268.5	17.0	.00108	3	14	35	70
	1	1350	17,000	25.5	29.0	.00131	0.2	1.4	4.4	10.5
	2		13,500	110.6	20.0	.00085	1.4	6.4	14.3	26.0
	3		11,000	242.2	13.0	.00075	3.0	10.7	23	54.0
	1	1500	11,500	10.3	26.0	.00125	0.1	0.6	1	2
	3		9,000	22.9	25.0	.00073	0.3	1	2.4	4.9
	2		6,600	130.1	30.0	.00055	1.4	4.3	9.2	22

(a) Number identifies third of sheet from which specimen was taken.
(b) Exceeded indicated deformation on loading.
(c) Fractured through gage mark.
(d) Fractured outside of gage marks.
(e) Fractured at two places.

TABLE X

STRESS-RUPTURE AND TOTAL DEFORMATION DATA FOR TEN HEATS

OF TYPE 347 SHEET TESTED AT 1200°, 1350°, AND 1500°F

Heat No.	Specimen[(a)] Location	Temp (°F)	Stress (psi)	Rupture Time (hours)	Elongation (% in 2 in.)	Deformation on Loading (in./in.)	Time for Indicated Percent Deformation (hours) 0.2	0.5	1.0	2.0
620809	3	1200	37,000	31.0	10.0	.0356	b	b	b	b
	1		32,500	61.9	6.0	.0158	b	b	b	0.8
	2		28,500	281.4	7.0	.0100	b	b	b	52
	3	1350	22,000	25.3	18.5	.00195	--	0.2	0.7	5.1
	1		18,000	83.6	14.0	.00118	0.7	11	25	44
	2		14,000	288.5	25.0	.00080	8	31	76	114
	3	1500	12,200	12.0	28.0	.0011	--	0.2	0.7	1.7
	1		11,500	19.6	33.0	.00085	0.2	0.6	1.5	2.9
	2		8,200	85.6	18.5	.00058	2.5	7.5	14	23
620813	1	1200	38,000	24.8	12.5[(c)]	.0240	b	b	b	b
	3		32,000	132.1	16.5	.0118	b	b	b	2
	2		28,500	381.4	9.0[(c)]	.00400	b	--	10	137
	2	1350	26,000	11.4	23.0	.00625	b	b	--	0.3
	1		17,500	134.8	26.0	.00111	1	5	25	51
	3		15,500	221.8	17.0[(c)]	.00088	7	40	77	109
	2	1500	15,000	5.2	29.0	.00123	--	--	0.1	0.3
	1		12,000	16.6	40.0	.00091	--	--	0.5	1.2
	3		7,600	118.1	20.5	.00045	5	12	20	32.5
636862	1	1200	36,000	37.5	14.5	.0220	b	b	b	b
	2		32,000	74.1	11.0	.0133	b	b	b	1.5
	3		28,000	268.0	10.5	.0100	b	b	b	44
	1	1350	20,500	42.2	21.5	.00172	--	0.4	1.5	10
	2		16,500	125.5	21.2	.00085	1.3	12	28	46.5
	3		14,000	237.0	30.5	.00078	6	36	68	96
	1	1500	16,000	1.4	35.0	.00264	b	--	--	--
	3		13,000	11.1	42.5	.00118	--	0.2	0.5	1.1
	2		9,700	36.6	18.5	.00058	0.6	2.4	5.0	10.5
	3		7,200	102.2	21.0	.00038	5	11.6	19.0	30
E40470	3	1200	38,000	10.0	20.0	.0250	b	b	b	b
	1		32,500	73.5	21.0	.0140	b	b	b	2
	2		26,000	342.0	9.0	.00212	b	2	15	132
	1	1350	20,000	26.7	27.0	.00173	--	0.4	2.7	6
	1		18,500	47.2	26.5	.00143	--	1	4	12.5
	3		15,500	142.9	7.5	.00097	2	20	34	50
	2		13,500	412.4	29.0	.00080	15	66	96	125
	3	1500	20,000	0.5	54.0	.0134	b	b	b	--
	2		15,000	4.3	31.0	.00145	--	0.1	0.2	0.5
	2		10,000	43.8	23.5	.00075	--	--	--	--
	1		8,000	136.3	--[(d)]	.00050	3	9	18	32
E41286	2	1200	37,000	29.9	8.0	.0240	b	b	b	b
	1		32,500	68.7	7.0	.0180	b	b	b	1
	3		27,000	443.2	4.5	.00491	b	--	156	376
	2	1350	24,000	18.3	8.0	.00190	--	0.2	0.5	4
	1		18,500	100.5	14.0	.00097	2.5	16.5	44	61
	3		15,000	381.1	21.0	.00075	22	105	180	235
	3	1500	15,000	1.8	29.0	.00205	--	--	--	--
	2		12,500	14.6	28.0	.00081	0.2	0.6	1.2	1.9
	1		8,000	174.6	18.5	.00050	5	17	31.5	52

TABLE X, Continued

Heat No.	Specimen[(a)] Location	Temp (°F)	Stress (psi)	Rupture Time (hours)	Elongation (% in 2 in.)	Deformation on Loading (in./in.)	Time for Indicated Percent Deformation (hours) 0.2	0.5	1.0	2.0
E41887	3	1200	43,000	17.0	23.5	~.0300	b	b	b	b
	1		38,500	51.8	24.0	.0270	b	b	b	b
	1		38,000	49.8	25.5	.0264	b	b	b	b
	2		35,000	102.5	22.0	.0169	b	b	b	0.2
	3		30,000	320.0	18.0	.00482	b	--	12	62
	2	1350	23,000	7.8	32.5	.00345	b	--	--	--
	2		21,500	38.4	29.0	.00137	--	0.5	1.5	5.3
	1		18,500	84.2	44.0	.00110	0.5	2	4.5	20
	3		15,000	323.6	18.5	.00073	8	31	62	103
	3	1500	15,000	6.2	23.0	.00148	--	0.1	.4	1.1
	2		13,000	18.4	48.5	.00112	--	--	--	--
	1		8,000	245.7	42.0	.00060	--	2	5	31
E41737	3	1200	37,000	13.3	7.5	.029	b	b	b	b
	1		32,500	48.6	6.5	.0160	b	b	b	1.5
	2		30,500	79.9	9.0	.0127	b	b	b	18
	3		25,000	298.0	6.0	.00492	b	--	100	225
	3	1350	23,000	21.5	9.0	.00184	--	--	--	--
	1		18,500	66.5	8.0	.00107	1	6.5	25	47
	2		14,000	280.7	15.5	.00070	17.5	52	92	127
	1	1500	14,000	5.4	24.0	.00137	--	0.15	0.3	0.5
	2		12,000	12.1	11.5	.00099	--	--	--	--
	1		9,400	64.9	15.0	.00059	0.7	3.7	7	12
	1		8,000	124.0	16.0	.00054	3	9	16.5	30
7X7935	1	1200	32,500	23.3	11.0	.00290	b	0.2	1.0	6.5
	3		28,000	75.1	9.5	.00165	0.1	5.5	21	38.5
	2		23,500	182.0	7.0	.00130	2	45	82	118
	1	1350	18,500	29.1	21.5	.00110	0.6	2.6	5.6	10.5
	2		15,000	75.7	28.0	.00090	1.5	6.5	13	22
	3		11,000	180.0	44.0	.00060	5	21	39	74
	3	1500	12,000	5.1	31.0	.00134	--	--	--	--
	1		8,000	45.1	55.0	.00088	0.2	1	2.3	4.7
	2		6,200	74.8	38.0	.00078	0.4	1.7	4.0	8.7
X25788	2	1200	40,000	18.0	38.5	.00305	b	--	1.0	4
	1		32,500	47.9	23.0	.00174	--	1.2	4.0	10.3
	3		26,000	134.8	24.5	.00148	3	21.5	46	69
	2		22,000	291.1	24.5	.00116	12	56	85	116
	1	1350	18,500	13.0	18.0	.00118	0.4	0.7	1.7	3.0
	3		13,000	105.9	41.5	.00073	1.5	5.4	11	20.5
	2		10,500	241.0	44.0	.00057	3	10	17	30
	2	1500	12,000	4.6	42.0	.00151	--	0.1	0.3	0.6
	1		8,000	28.0	62.5	.00103	--	0.5	1.2	2.5
	3		6,000	68.8	48.0	.00095	--	1	2.4	6
	2		3,900	460.0	24.0	.00058	2	6	18	45
3X0005	3	1200	39,000	7.9		>.04	b	b	b	b
	1		32,500	65.8	8.0	.0340	b	b	b	b
	2		28,000	176.0	4.0	.0127	b	b	b	9
	3		25,000	394.6	6.0	.00675	b	b	2	276
	3	1350	23,000	13.3	18.0	.00448	b	--	0.1	1
	1		18,500	68.3	24.5	.00120	0.6	5	17.5	32
	2		14,000	370.1	18.5	.00080	27	93	135	169
	3	1500	12,000	24.5	32.0	.00107	--	0.2	0.4	1.2
	2		10,000	49.5	21.5	.00096	0.4	1.5	3	6
	1		8,000	146.7	9.0	.00072	2.0	10	27.5	58

(a) Number identifies third of sheet from which specimen was taken.
(b) Exceeded indicated deformation on loading.
(c) Fractured through gage mark.
(d) Fractured outside of gage marks.

TABLE XI

STRESS-RUPTURE AND TOTAL DEFORMATION DATA FOR NINE HEATS

OF INCONEL X SHEET TESTED AT 1200°, 1350°, AND 1500°F

Heat No.	Specimen[(a)] Location	Temp (°F)	Stress (psi)	Rupture Time (hours)	Elongation (% in 2 in.)	Deformation on Loading (in./in.)	Time for Indicated Percent Deformation (hours) 0.2	0.5	1.0	2.0
Y4474X	1	1200	85,000	1.2	0.5	.004	b	--	--	--
	2		71,000	16.6	1.5	.00296	b	--	--	--
	3		63,000	51.3	1.2	.00274	b	--	--	--
	1		52,500	59.6	0.5	.00225	b	--	--	--
	1	1350	55,000	10.4	2.0	.00244	b	--	--	--
	2		47,000	36.8	1.0	.00211	b	--	--	--
	3		41,000	92.9	2.0	.00184	--	--	--	--
	1		34,500	66.1	0.5	.00145	--	--	--	--
	1	1500	32,500	16.5	6.5	.00146	3.2	10	--	--
	2		25,000	75.7	4.5	.00117	29.5	54	--	--
	3		19,000	394	9.0	.00085	196	274	317	--
Y3166X	2	1200	70,000	11.6	1.5	.00300	b	~11	--	--
	3		57,000	37.1	1.5[(c)]	.00228	b	--	--	--
	1		50,000	163.0	1.5	.00218	b	--	--	--
	2	1350	50,000	5.2	1.0	.00242	b	--	--	--
	1		41,000	28.2	1.5[(c)]	.00199	--	--	--	--
	3		35,000	35.6	1.5	.00169	5	--	--	--
	2		26,000	388.3	0.5	.00122	100	--	--	--
	2	1500	32,000	9.5	2.5	.00160	0.5	5.8	7.5	--
	1		22,000	61.9	3.5	.00106	16.5	40	54	--
	3		15,000	295.9	3.5	.00069	140	234	282	--
Y4602X	2	1200	78,000	27.6	2.5	.00355	b	3.7	21	--
	1		68,000	72.3	2.0	.00310	b	10	65	--
	3		57,000	350	2.0	.00244	b	120	--	--
	1	1350	55,000	8.0	1.0	.00251	b	6	--	--
	3		47,000	44.5	2.5	.00230	b	12.5	32	--
	2		39,000	139.3	2.5	.00191	0.1	47	104	~130
	1		33,000	230.5	2.5	.00162	2	87	175	--
	2	1500	28,000	21.4	6.0	.00153	1	5	10	~20
	1		21,000	63.5	8.5	.00106	2.8	14	26.5	--
	3		14,000	241.2	8.5	.00070	20	59	105	160
Y4860X	1	1200	57,000	23.5	1.5	.00288	b	--	--	--
	2		49,000	60.2	0.5[(d)]	.00200	b	--	--	--
	3		43,000	191.2	0.5[(d)]	.00172	6	--	--	--
	2	1350	42,500	18.2	1.5	.00201	b	--	--	--
	3		33,000	110.1	1.0	.00145	6.5	--	--	--
	2		28,000	326.5	1.0	.00132	75	--	--	--
	3	1500	28,000	43.8	1.5	.00129	6.5	30	--	--
	1		21,000	126.0	3.5	.00095	47	104	120	--
	2		17,000	270.8	2.0	.00080	87	184	240	--
Y4512X	2	1200	62,000	40	2.0	.00259	b	--	--	--
	1		57,000	98.4	1.5	.00218	b	--	--	--
	3		50,000	299	1.0	.00205	b	--	--	--
	3	1350	49,000	14.3	0.5	.00210	b	--	--	--
	2		38,000	103.2	1.0	.00171	6	85	--	--
	1		33,000	205.8	3.0	.00134	15	142	--	--
	2	1500	27,000	33.0	3.5	.00123	3	13.3	24.5	~30
	1		23,000	51.7	3.0	.00106	8	25.5	37.0	~50
	3		15,000	340.3	4.0	.00067	53	138	212	286

TABLE XI, Continued

Heat No.	Specimen[(a)] Location	Temp (°F)	Stress (psi)	Rupture Time (hours)	Elongation (% in 2 in.)	Deformation on Loading (in./in.)	Time for Indicated Percent Deformation (hours)			
							0.2	0.5	1.0	2.0
Y4511X	1	1200	75,000	10.4	2.0	.00308	b	6	--	--
	3		72,000	4.4	0.5	.00296	b	--	--	--
	2		63,000	201.5	1.5	.00252	b	178	--	--
	1		57,000	174	2.0	.00240	b	91	--	--
	3	1350	46,000	33.6	2.0	.00218	b	17	--	--
	1		40,000	58.3	2.0	.00191	0.5	35.5	--	--
	2		28,000	720.4	1.5	.00130	33	330	546	--
	1	1500	24,000	29.0	5.0	.00133	2	7	13	--
	3		18,000	116.5	7.5	.00093	14	47	73	105
	2		15,000	202.1	5.5	.00077	24	75	114	158
Y4847X	2	1200	61,000	38.5	1.5	.00268	b	48	--	--
	1		57,000	51.0	1.5	.00240	b	--	--	--
	3		49,000	395.9	1.0	.00207	b	331	--	--
	3	1350	45,000	24.8	2.0	.00215	b	13	--	--
	1		35,000	104.8	2.0	.00160	3	101	--	--
	2		30,000	355.4	1.5	.00123	56	247	~354	
	3	1500	28,000	20.8	6.0	.00151	0.8	4	7.5	--
	1		21,700	56.6	3.5	.00113	6	25	37	48
	2		14,000	346.2	8.0	.00069	43	125	191	249
Y4984X	2	1200	78,000	22.8	1.5	.00315	b	~22	--	--
	1		68,000	55.1	0.5	.00275	b	--	--	--
	3		57,000	356.9	1.5	.00231	b	232	--	--
	2	1350	45,000	69.9	0.5	.00225	b	41.5	--	--
	3		38,000	143.2	1.5	.00168	1	71.5	138	--
	1		30,000	461.2	2.0	.00150	13	260	~420	
	2	1500	29,000	15	2.0	.00163	1	6.5	~14	--
	3		22,500	87.3	3.0	.00121	4	25	33	~45
	1		18,000	127.0	4.0	.00095	15	55	81	110
	1		15,500	208.4	2.5	.00071	29	91	132	190
253X	1	1200	78,000	27.0	2.0	.00344	b	18	--	--
	2		68,000	19.4	0.5	.00300	b	--	--	--
	3		57,000	341.7	2.0	.00252	b	--	--	--
	1	1350	57,000	12.8	0.5	.00250	b	~10	--	--
	2		47,000	53.2	1.5	.00230	b	25	~52	--
	3		33,000	307.9	1.5	.00147	4	196	~300	--
	2	1500	28,000	22.6	1.5	.00142	2	12	--	--
	3		22,500	66.3	2.0	.00110	10	36	52.5	--
	1		16,000	186.7	3.0	.00078	26	86	132	172

(a) Number identifies third of sheet from which specimen was taken.
(b) Exceeded indicated deformation on loading.
(c) Fractured through gage mark.
(d) Fractured outside of gage marks.

TABLE XII

STRESS-RUPTURE AND TOTAL DEFORMATION DATA FOR TEN HEATS

OF N-155 SHEET TESTED AT 1350°, 1500°, and 1650°F

Heat No.	Specimen(a) Location	Temp (°F)	Stress (psi)	Rupture Time (hours)	Elongation (% in 2 in.)	Deformation on Loading (in/in.)	Time for Indicated Percent Deformation (hours) 0.2	0.5	1.0	2.0
M624	2	1350	35,000	21.8	15.0	.00412	b	0.1	1.2	5.5
	3		30,000	56.5	15.5	.00201	b	2	4.5	13
	1		25,000	182.4	13.0	.00135	1	8	22	50
	3		23,000	313.8	9.5	.00125	2.5	15	40	103
	1	1500	22,000	11.5	14.5	.00134	--	0.3	1	2
	3		18,000	70.2	21.0	.00100	0.2	1.7	6.4	17
	2		15,700	165.4	16.0	.00087	2	11	32	61
	3		14,000	266.0	7.5	.00075	5	38	117	192
	3	1650	15,500	5.5	21.5	.00130	--	0.25	0.7	1.3
	2		13,500	14.9	19.0	.00093	0.25	1.3	3	5.5
	1		11,500	39.4	12.0	.00081	0.8	5.5	12	18.5
	3		9,500	124.5	10.0	.00069	4.5	26.5	48	72
M206	2	1350	36,000	20.4	16.0	.00487	b	--	--	--
	3		33,000	46.2	19.0	.00251	b	0.8	3.6	11
	1		29,000	75.4	16.0	.00184	--	2.3	9.2	21
	2		23,000	373.8	9.5	.00125	3	16	46.5	122
	2	1500	21,500	17.2	20.0	.00132	0.1	0.6	1.9	4.2
	1		17,500	94.0	16.5	.00099	0.3	6.2	18.5	39
	3		14,000	366.6	9.5	.00070	5	35	179	264
	2	1650	16,000	6.0	19.0	.00126	0.05	0.4	1.0	2
	3		13,000	18.9	17.5	.00091	0.7	3.5	6.4	9.7
	1		9,800	83.1	15.0	.00077	7	22	40	53.5
M208	2	1350	37,000	17.5	11.5	.00316	b	0.3	1.1	2.6
	2		34,000	42.0	17.0	.00248	b	1.0	3.4	10.4
	1		29,000	81.1	12.5	.00171	0.2	3.2	13.0	29.0
	3		24,000	274.9	9.0	.00123	3.0	19.0	61.0	115.0
	2	1500	21,000	26.3	4.5	.00120	0.1	0.9	2.7	5.5
	1		17,500	85.5	12.5	.00100	0.5	6.5	22	41.5
	3		14,200	324.5	9.0	.00080	4	63	155	225
	2	1650	16,500	5.8	23.0	.00110	0.05	0.4	0.9	2.0
	3		12,500	26.0	15.5	.00070	1.0	5	9.5	12.0
	1		10,000	97.4	7.0	.00060	9	37	53	74
M207	3	1350	38,000	20.3	20.0	.00310	b	0.4	1.6	4.4
	2		36,000	32.5	20.5	.00278	b	0.4	1.7	5
	1		29,000	58.3	9.0	.00157	0.3	2.4	7	21.4
	3		23,500	526.3	9.0	.00126	2	29	91	252
	3	1500	21,000	22.0	16.0	.00129	--	--	--	--
	1		17,500	83.0	19.0	.00110	0.5	5.5	13.3	27.5
	2		16,500	155.0	15.0	.00092	1.5	16.5	52	94
	3		14,200	465.0	8.0	.00078	4	54	208	321
	2	1650	16,500	5.9	28.0	.00129	0.05	0.3	0.8	1.6
	1		13,500	17.1	20.5	.00096	0.2	1.1	2.3	4.5
	3		10,000	121.5	11.0	.00068	8	32	56	79
M733	2	1350	38,000	14.0	22.5	.00365	b	0.2	0.9	2.1
	1		28,500	96.5	19.5	.00152	0.4	2.4	8.1	22
	3		24,000	363.9	18.5	.00123	2.5	14	46	125
	3	1500	21,500	24.0	34.0	.00119	0.1	0.65	1.9	4.5
	1		17,500	86.0	23.0	.00096	0.6	6	17.3	32.3
	2		14,000	404.4	21.0	.00069	11	64	150	233
	2	1650	16,500	7.9	42.0	.00140	--	0.1	0.3	0.9
	3		12,700	15.0	19.5	.00086	0.3	2.1	4.3	7
	1		10,200	75.0	12.0	.00070	2.7	8.7	19.2	23

TABLEXII, Continued

Heat No.	Specimen[a] Location	Temp (°F)	Stress (psi)	Rupture Time (hours)	Elongation (% in 2 in.)	Deformation on Loading (in./in.)	Time for Indicated Percent Deformation (hours) 0.2	0.5	1.0	2.0
M737	2	1350	35,000	32.3	17.0	.00246	b	0.6	2	5.7
	3		28,500	87.2	--(d)	.00154	0.3	3	10	24
	1		23,000	402	7.5(d)	.00117	3	12	41	145
	2		23,000	442	8.5	.00111	4	19	50	133
	3	1500	21,500	23.0	21.5	.00113	0.2	0.9	2.3	5.7
	1		17,500	101.0	19.5	.00095	0.5	3	10	29
	2		14,500	306.0	13.5	.00080	3	24	85	157
	2	1650	16,500	2.5	8.5(d)	.00156	--	0.2	0.4	0.8
	3		12,700	28.7	20.0	.00093	0.6	2.7	6	11
	1		10,200	89.7	23.0	.00068	2.5	12.5	26	45
M732	2	1350	37,000	12.0	14.5	.00445	b	0.1	0.7	2.5
	1		28,500	84.0	15.0	.00152	--	3	9.2	25
	2		23,000	296.0	13.5	.00112	3	14	40	91
	2	1500	21,000	20.0	27.0	.00120	0.1	0.7	1.7	4
	1		17,500	68.1	21.5	.00100	0.5	4	11.5	22.5
	3		14,000	233.0	18.0(c)	.00080	5	21	55	96
	2	1650	16,000	4.4	32.5	.00135	--	0.1	0.3	0.75
	3		12,500	19.0	21.5	.00090	0.2	1	2.3	4.7
	1		10,200	67.8	22.0	.00076	2	13	19	29.4
M731	3	1350	38,000	15.3	14.0	.00315	b	0.4	1.7	3.7
	1		28,500	101.2	13.5	.00160	0.3	4	15.5	34
	2		23,500	559.5	11.0	.00120	2	22	106	260
	3	1500	22,500	16.0	18.0	.00153	--	0.6	2	3.9
	1		17,500	135.7	13.5	.00106	1	16	45	73
	2		14,500	662.1	8.5	.00084	14	82	217	370
	1	1650	17,000	4.7	33.0	.00175	--	0.25	0.6	1.1
	3		13,500	24.7	20.5	.00090	0.5	3.5	7.5	11
	2		10,200	162.9	13.0	.00062	8	30	54	87
M726	3	1350	38,000	14.0	23.5	.00355	b	0.2	2.1	2.7
	1		28,500	97.2	17.0	.00147	0.4	3.5	10.6	24.2
	2		23,500	357.0	14.5	.00115	5	23	51	101
	1	1500	24,000	12.6	19.0	.00150	0.05	0.3	0.75	1.5
	3		17,500	78.2	20.0	.00095	--	--	--	--
	1		15,700	197.6	12.0	.00091	2	15	48	93
	2	1650	16,500	3.9	30.0	.00132	--	0.15	0.4	0.8
	3		13,000	23.5	25.0	.00092	0.2	2	3.9	7.3
	1		10,200	120.1	18.0	.00070	6	26	47	71
M730	3	1350	35,000	28.5	24.5	.00295	b	0.3	1	5
	1		28,500	82.5	11.5(c)	.00148	0.5	2	5.5	19
	2		23,000	575.2	15.5	.00105	1	8.5	42	141
	1	1500	21,000	10.1	46.0	.00117	0.2	0.5	2.3	6
	1		17,500	44.0	13.0	.00093	1	5.3	14.4	29
	2		17,500	87.0	15.5	.00089	1.3	6	15.4	30
	3		14,500	415.0	18.5	.00074	10	51	108	185
	2	1650	16,500	8.0	35.0	.00150	--	0.2	0.5	0.9
	3		13,000	24.6	24.5	.00085	0.3	2.4	5.3	8.8
	1		10,200	87.6	13.0	.00063	4.5	18	35	60

(a) Number identifies third of sheet from which specimen was taken.
(b) Exceeded indicated deformation on loading.
(c) Fractured through gage mark.
(d) Fractured outside of gage marks.

TABLE XIII

RUPTURE AND TOTAL DEFORMATION STRENGTHS OF TEN HEATS OF TYPE 321 SHEET MATERIAL AT 1200°, 1350°, AND 1500°F

Heat No.	Stress for Rupture or Indicated Total Deformation in the Specified Time Period										
	1200°F			1350°F				1500°F			
	20 Hr	80 Hr	300 Hr	5 Hr	20 Hr	80 Hr	300 Hr	1 Hr	5 Hr	20 Hr	80 Hr
					RUPTURE STRENGTH, PSI						
R10356	33,500	28,500	22,500	--	19,000	15,000	11,500	--	12,000	10,000	7,100
E02326	34,000	27,500	22,500	--	17,500	13,500	10,700	--	13,000	9,600	6,600
E1880	33,500	28,000	23,500	--	21,500	16,500	13,000	--	14,800	11,200	8,500
X25677	33,500	29,500	23,500	--	20,500	16,000	12,500	--	13,200	11,500	6,700
E41024	33,500	31,000	24,500	--	22,000	18,500	14,600	--	13,600	11,000	8,800
627967	32,000	27,500	22,500	--	19,000	16,000	13,000	--	14,000	10,800	8,200
R30409	34,500	27,500	22,000	--	20,500	15,500	11,300	--	12,000	10,300	7,500
E1869	36,000	29,500	24,000	--	21,000	17,500	13,500	--	15,500	12,500	7,800
X46099	31,000	26,000	21,000	--	18,000	14,300	11,500	--	13,500	9,900	7,200
X13043	29,500	25,000	19,500	--	17,500	14,000	10,500	--	12,500	9,500	7,200
					2.0% DEFORMATION STRENGTH, PSI						
R10356	29,500	24,000	19,000	--	16,000	12,500	9,700	12,200	10,000	7,400	5,400
E02326	28,000	24,500	20,000	--	16,300	11,700	8,600	14,500	10,000	7,400	5,700
E1880	25,000	23,500	22,000	21,500	17,500	14,200	11,000	15,200	11,700	8,800	6,700
X25677	28,500	25,000	21,000	20,500	17,000	12,800	9,600	12,200	9,800	7,600	--
E41024	26,500	25,500	21,000	21,500	20,000	17,000	14,000	13,500	12,000	9,800	7,900
627967	29,000	24,000	20,000	--	17,500	14,500	12,000	14,000	11,300	9,300	7,800
R30409	27,500	24,000	19,500	--	16,500	13,000	10,200	11,500	10,200	8,300	(4,600)
E1869	29,500	27,000	22,000	--	18,500	15,500	(12,000)	--	12,500	10,500	(6,600)
X46099	25,000	21,000	18,000	17,500	14,000	11,500	(9,600)	12,000	9,000	7,100	--
X13043	23,500	19,500	16,000	--	14,500	10,000	--	--	9,200	6,800	--
					1.0% DEFORMATION STRENGTH, PSI						
R10356	24,000	22,500	--	18,000	14,000	11,000	9,000	11,500	8,800	6,200	--
E02326	25,500	23,000	--	--	14,500	10,500	(7,600)	12,500	8,800	6,400	--
E1880	24,000	22,500	--	19,000	16,500	12,500	(9,300)	14,000	10,300	7,800	5,800
X25677	25,500	23,000	--	18,500	15,500	12,000	(9,000)	11,300	9,000	6,700	--
E41024	--	--	--	19,500	18,500	16,000	13,000	12,500	11,200	9,000	7,200
627967	26,500	22,500	--	--	15,500	13,500	(11,500)	12,500	10,100	8,400	7,000
R30409	24,500	21,500	--	17,000	15,000	11,500	(9,000)	11,000	9,800	6,800	--
E1869	26,000	24,000	--	--	17,000	14,000	--	14,200	11,700	9,000	--
X46099	23,000	20,000	--	15,500	12,500	10,000	--	10,400	8,000	6,400	--
X13043	22,000	17,500	--	16,500	12,000	--	--	11,000	7,600	5,600	--
					0.5% DEFORMATION STRENGTH, PSI						
R10356	23,000	--	--	16,000	12,000	9,500	--	10,500	7,400	(5,600)	--
E02326	22,500	20,500	--	--	13,000	8,700	--	11,000	7,400	(5,300)	--
E1880	22,500	21,000	--	17,500	14,500	(9,600)	--	12,300	8,800	6,600	--
X25677	23,000	(20,000)	--	17,000	14,500	(9,800)	--	9,800	7,700	--	--
E41024	--	--	--	18,000	17,000	14,000	--	12,000	10,300	8,100	--
627967	25,000	21,000	--	16,000	14,300	12,500	--	11,500	9,100	7,500	--
R30409	--	--	--	16,000	14,000	(9,600)	--	10,500	9,300	(5,400)	--
E1869	--	--	--	19,500	15,500	12,500	--	12,800	10,500	(7,200)	--
X46099	21,500	--	--	13,500	11,000	--	--	8,700	7,000	(5,700)	--
X13043	19,000	--	--	14,000	9,200	--	--	9,500	6,300	--	--
					0.2% DEFORMATION STRENGTH, PSI						
R10356	--	--	--	12,500	10,000	--	--	8,300	6,000	--	--
E02326	--	--	--	13,500	10,500	--	--	8,200	5,500	--	--
E1880	--	--	--	14,000	10,500	--	--	10,500	6,600	--	--
X25677	--	--	--	15,000	12,000	--	--	8,700	6,200	--	--
E41024	--	--	--	17,000	16,000	--	--	10,500	8,200	--	--
627967	23,000	--	--	14,500	12,800	--	--	9,000	7,200	--	--
R30409	--	--	--	15,000	11,000	--	--	9,800	6,300	--	--
E1869	--	--	--	15,500	12,500	--	--	11,000	8,600	--	--
X46099	--	--	--	10,300	--	--	--	7,500	6,000	--	--
X13043	--	--	--	9,600	--	--	--	7,200	--	--	--

Note: Parentheses around strength values indicate extrapolated values.

TABLE XIV

RUPTURE AND TOTAL DEFORMATION STRENGTHS OF TEN HEATS

OF TYPE 347 SHEET MATERIAL AT 1200°, 1350°, AND 1500°F

Heat No.	Stress for Rupture or Indicated Total Deformation in the Specified Time Period										
	1200°F			1350°F				1500°F			
	20 Hr	80 Hr	300 Hr	5 Hr	20 Hr	80 Hr	300 Hr	1 Hr	5 Hr	20 Hr	80 Hr
					RUPTURE STRENGTH, PSI						
620809	38,000	32,500	28,000	--	23,000	18,000	14,000	--	13,500	11,500	8,300
620813	38,500	33,500	29,000	--	23,500	19,000	15,000	--	15,000	11,500	8,300
636862	38,000	32,000	28,000	--	24,000	18,000	13,500	--	13,000	10,500	7,700
E40470	36,000	32,000	26,500	--	20,000	17,000	14,000	--	14,200	10,500	9,000
E41286	37,500	32,000	28,000	--	23,500	19,000	15,500	--	13,500	11,800	9,200
E41887	42,000	36,000	30,000	--	22,000	18,500	15,000	--	15,000	12,800	9,800
E41737	36,000	30,000	25,000	--	23,000	18,000	14,000	--	14,000	11,000	8,800
7X7935	33,000	28,000	21,500	--	20,000	14,500	9,000	--	12,000	9,200	6,000
X25788	39,000	29,000	22,000	--	17,000	13,500	10,000	--	12,000	8,400	6,000
3X0005	36,000	31,000	26,000	--	22,000	18,000	14,500	--	(14,000)	12,000	9,000
					2.0% DEFORMATION STRENGTH, PSI						
620809	31,000	27,500	--	20,500	19,000	16,000	(12,000)	13,000	11,000	8,400	--
620813	30,000	29,000	27,000	21,500	20,000	16,500	(13,300)	12,000	9,800	8,200	--
636862	29,000	26,500	--	21,500	19,500	14,500	(11,000)	13,000	10,600	8,100	--
E40470	29,500	27,500	--	20,500	17,500	14,500	(12,000)	13,500	10,500	8,500	--
E41286	30,500	29,000	27,000	23,500	21,500	17,500	14,500	13,500	11,000	9,000	7,600
E41887	--	29,000	--	21,500	18,500	15,500	(13,000)	15,000	11,000	8,600	--
E41737	30.000	28,000	24.000	--	21,500	16,000	(12,500)	12,700	10,400	8,600	--
7X7935	30,500	25,000	(20,000)	--	15,500	10,600	--	--	7,800	--	--
X25788	30,000	24,000	--	17,000	12,500	--	--	10,000	6,600	4,800	--
3X0005	27,000	26,000	24,500	21,000	19,000	16,000	13,000	13,000	10,800	9,000	7,700
					1.0% DEFORMATION STRENGTH, PSI						
620809	--	--	--	20,000	18,000	14,000	--	12,000	10,000	7,600	--
620813	--	--	--	19,000	18,000	15,300	--	11,000	9,000	7,500	--
636862	--	--	--	19,000	17,000	13,500	--	12,000	9,600	7,100	--
E40470	26,000	--	--	19,000	16,500	13,800	--	12,000	9,600	7,800	--
E41286	--	--	--	21,000	19,500	16,800	--	12,800	10,200	8,400	--
E41887	29,500	--	--	19,000	17,000	14,500	--	11,000	8,000	--	--
E41737	--	25,500	--	--	19,000	14,500	--	11,700	9,700	7,800	--
7X7935	28,000	23,000	--	19,500	13,000	9,000	--	--	5,600	--	--
X25788	28,000	22,000	--	14,000	10,500	--	--	7,800	5,300	--	--
3X0005	--	--	--	20,000	18,000	15,000	--	11,600	9,800	8,400	--
					0.5% DEFORMATION STRENGTH, PSI						
620809	--	--	--	19,000	15,500	--	--	11,000	9,000	--	--
620813	--	--	--	17,500	16,000	--	--	--	8,400	--	--
636862	--	--	--	17,500	16,000	--	--	10,500	8,700	--	--
E40470	--	--	--	16,500	15,000	13,000	--	11,000	8,600	--	--
E41286	--	--	--	19,000	18,000	15,500	--	11,500	9,400	7,800	--
E41887	--	--	--	17,500	15,500	--	--	9,200	--	--	--
E41737	--	--	--	19,000	16,500	13,000	--	10,800	9,000	--	--
7X7935	26,000	21,000	--	16,000	11,000	--	--	8,000	--	--	--
X25788	26,000	21,000	--	12,000	9,000	--	--	6,200	4,100	--	--
3X0005	--	--	--	18,000	17,000	14,000	--	10,200	8,600	7,400	--
					0.2% DEFORMATION STRENGTH, PSI						
620809	--	--	--	15,500	--	--	--	9,000	7,500	--	--
620813	--	--	--	16,000	--	--	--	--	7,400	--	--
636862	--	--	--	14,500	--	--	--	9,000	7,200	--	--
E40470	--	--	--	14,500	--	--	--	9,400	7,400	--	--
E41286	--	--	--	17,500	15,000	--	--	9,800	8,000	--	--
E41887	--	--	--	15,500	--	--	--	--	--	--	--
E41737	--	--	--	16,000	14,000	--	--	9,000	7,500	--	--
7X7935	--	--	--	11,000	--	--	--	--	--	--	--
X25788	20,500	--	--	9,400	--	--	--	4,600	--	--	--
3X0005	--	--	--	16,000	14,500	--	--	8,500	7,200	--	--

Note: Parentheses around strength values indicate extrapolated values.

TABLE XV

RUPTURE AND TOTAL DEFORMATION STRENGTHS OF NINE HEATS OF INCONEL X SHEET MATERIAL AT 1200°, 1350°, AND 1500°F

Heat No.	Stress For Rupture or Indicated Total Deformation in the Specified Time Period								
	1200°F			1350°F			1500°F		
	20 Hr	80 Hr	300 Hr	20 Hr	80 Hr	300 Hr	20 Hr	80 Hr	300 Hr
				RUPTURE STRENGTH, PSI					
Y4474X	68,000	55,000	45,500	49,000	38,500	30,000	31,500	25,000	20,000
Y3166X	64,000	53,000	44,000	41,000	33,000	27,000	27,000	20,000	15,000
Y4602X	80,000	68,000	58,000	50,000	42,000	32,000	28,500	19,300	13,000
Y4860X	57,000	47,500	40,000	42,500	34,500	28,000	32,000	23,500	16,500
Y4512X	68,000	58,500	50,000	47,000	38,000	32,000	29,500	21,200	15,500
Y4511X	69,000	64,000	60,000	48,500	39,500	32,500	26,000	19,000	14,000
Y4847X	66,000	57,500	50,000	45,000	37,000	30,500	27,500	20,000	14,500
Y4984X	78,000	67,000	58,000	54,000	42,500	33,000	27,500	20,000	15,000
253X	74,000	65,000	57,000	54,000	42,500	33,000	29,000	21,000	15,000
				2.0% DEFORMATION STRENGTH, PSI					
Y4474X	--	--	--	--	--	--	--	--	--
Y3166X	--	--	--	--	--	--	--	--	--
Y4602X	--	--	--	--	--	--	27,500	17,500	11,500
Y4860X	--	--	--	--	--	--	--	--	--
Y4512X	--	--	--	--	--	--	29,000	20,500	14,800
Y4511X	--	--	--	--	--	--	--	18,000	13,600
Y4847X	--	--	--	--	--	--	25,500	19,000	13,500
Y4984X	--	--	--	--	--	--	27,000	19,500	14,000
253X	--	--	--	--	--	--	--	20,000	(14,200)
				1.0% DEFORMATION STRENGTH, PSI					
Y4474X	--	--	--	--	--	--	--	--	19,500
Y3166X	--	--	--	--	--	--	26,000	19,500	14,700
Y4602X	78,000	66,000	--	48,500	39,000	29,000	22,500	15,000	(10,300)
Y4860X	--	--	--	--	--	--	--	23,000	16,000
Y4512X	--	--	--	--	--	--	27,500	19,200	13,800
Y4511X	--	--	--	--	--	--	22,000	17,000	13,000
Y4847X	--	--	--	--	--	--	23,500	17,500	12,500
Y4984X	--	--	--	--	--	32,000	26,000	18,000	12,500
253X	--	--	--	--	--	--	--	19,000	(13,500)
				0.5% DEFORMATION STRENGTH, PSI					
Y4474X	--	--	--	--	--	--	29,500	23,500	19,000
Y3166X	--	--	--	--	--	--	25,000	19,000	14,200
Y4602X	66,000	59,000	--	44,000	34,000	--	19,000	13,000	--
Y4860X	--	--	--	--	--	--	29,000	21,000	15,000
Y4512X	--	--	--	--	--	--	24,500	17,000	12,500
Y4511X	--	--	--	44,500	35,000	28,500	20,000	15,500	--
Y4847X	64,000	56,000	49,000	42,500	35,000	29,000	22,000	15,500	11,000
Y4984X	--	--	--	49,000	38,000	28,500	23,500	16,000	11,000
253X	--	--	--	49,000	38,500	30,500	24,500	17,000	--
				0.2% DEFORMATION STRENGTH, PSI					
Y4474X	--	--	--	--	--	--	26,000	21,500	18,000
Y3166X	--	--	--	31,500	27,000	--	21,000	16,500	13,200
Y4602X	--	--	--	--	--	--	14,000	--	--
Y4860X	--	--	--	30,500	27,500	--	24,000	17,500	--
Y4512X	--	--	--	--	--	--	18,500	14,000	--
Y4511X	--	--	--	--	--	--	16,500	--	--
Y4847X	--	--	--	31,500	29,500	--	16,500	12,000	--
Y4984X	--	--	--	29,000	--	--	17,000	12,500	--
253X	--	--	--	--	--	--	18,000	(11,500)	--

Note: Parentheses around strength values indicate extrapolated values.

TABLE XVI

RUPTURE AND TOTAL DEFORMATION STRENGTHS OF TEN HEATS

OF N155 SHEET MATERIAL AT 1350°, 1500°, AND 1650°F

Heat No.	Stress for Rupture or Indicated Total Deformation in the Specified Time Period 1350°F 5 Hr	1350°F 20 Hr	1350°F 80 Hr	1350°F 300 Hr	1500°F 5 Hr	1500°F 20 Hr	1500°F 80 Hr	1500°F 300 Hr	1650°F 1 Hr	1650°F 5 Hr	1650°F 20 Hr	1650°F 80 Hr
						RUPTURE STRENGTH, PSI						
M624	--	35,000	28,500	23,000	--	20,500	18,500	14,000	--	16,000	13,000	10,200
M206	--	37,000	29,500	24,000	--	21,000	18,000	14,500	--	16,500	12,800	9,800
M208	--	37,500	29,500	23,500	--	22,000	17,500	14,500	--	16,500	13,000	10,300
M207	--	37,000	31,000	25,500	--	21,000	18,000	15,000	--	17,000	13,500	10,500
M733	--	36,000	29,500	24,000	--	22,000	18,000	14,500	--	17,500	13,500	10,100
M737	--	37,000	30,000	24,500	--	22,000	18,000	14,500	--	16,000	13,000	10,300
M732	--	35,000	28,000	23,000	--	21,000	17,000	13,500	--	16,000	12,500	10,000
M731	--	36,000	30,000	25,000	--	22,000	18,500	16,000	--	17,000	14,000	11,500
M726	--	36,000	29,000	24,000	--	21,500	18,000	14,800	--	16,000	13,200	11,000
M730	--	34,500	28,500	24,000	--	19,500	17,000	15,000	--	17,000	13,300	10,400
						2.0% DEFORMATION STRENGTH, PSI						
M624	35,000	29,000	24,000	(19,500)	20,000	17,500	15,500	(13,500)	16,000	13,500	11,300	9,300
M206	36,000	29,500	24,500	(20,000)	21,500	18,500	16,000	(14,000)	17,500	14,000	11,500	9,200
M208	35,000	30,500	25,000	(21,000)	21,000	18,500	16,200	(14,000)	17,500	14,500	12,000	10,000
M207	35,500	30,500	26,500	23,000	19,500	18,000	16,500	14,500	17,000	14,000	12,000	10,000
M733	34,000	30,500	25,000	(22,000)	21,500	18,500	16,000	13,800	16,500	13,200	11,000	9,100
M737	35,500	29,500	25,000	(21,000)	22,000	18,500	15,500	13,500	16,500	14,000	11,500	9,400
M732	34,000	29,000	24,000	(20,500)	20,500	18,000	14,500	(12,000)	15,000	12,500	10,700	9,200
M731	36,500	31,000	27,000	23,000	22,000	19,500	17,200	15,000	17,000	15,000	12,500	10,300
M726	35,000	29,000	24,000	(20,000)	22,000	19,000	16,000	13,800	16,000	13,500	11,700	10,100
M730	34,000	29,000	24,500	(21,000)	21,500	18,500	16,000	(14,000)	16,300	14,000	11,800	9,800
						1.0% DEFORMATION STRENGTH, PSI						
M624	29,500	25,000	21,500	(18,000)	18,500	16,500	14,500	(13,000)	15,000	12,500	10,500	8,800
M206	31,500	26,000	21,000	(17,500)	20,000	17,500	15,000	(13,500)	16,000	13,300	11,000	8,800
M208	32,500	27,500	23,000	(19,500)	20,000	17,500	15,000	(13,000)	16,500	13,500	11,500	9,500
M207	31,000	27,500	24,000	(21,000)	18,500	17,000	15,500	13,500	15,500	13,000	11,000	9,600
M733	31,000	27,500	23,000	(20,000)	19,500	17,000	15,000	13,000	15,500	12,500	10,000	8,400
M737	31,500	26,000	21,500	(18,500)	19,500	16,800	14,500	(12,800)	15,000	13,000	10,500	8,800
M732	30,000	25,000	21,500	(18,500)	19,000	15,000	13,000	(11,000)	13,500	12,000	10,200	8,800
M731	33,000	28,000	24,000	(21,000)	21,000	18,500	16,200	14,000	16,000	14,000	11,500	9,800
M726	32,500	27,000	22,000	(18,500)	20,000	17,500	15,000	(12,500)	15,000	12,700	11,000	9,700
M730	29,000	25,000	21,500	(18,500)	19,500	17,000	15,000	(13,000)	15,500	13,000	11,000	9,200
						0.5% DEFORMATION STRENGTH, PSI						
M624	26,500	22,000	--	--	16,500	14,500	--	--	13,500	11,500	9,800	--
M206	26,000	22,000	--	--	18,000	15,000	--	--	15,000	12,200	10,000	--
M208	28,000	24,000	--	--	18,500	16,000	--	--	15,000	12,500	10,500	--
M207	27,500	24,000	--	--	17,500	16,000	--	--	14,000	12,000	10,500	--
M733	26,500	24,000	--	--	17,500	15,500	--	--	14,000	11,000	9,100	--
M737	26,500	22,500	--	--	17,000	14,500	--	--	14,000	12,000	9,700	--
M732	26,500	22,000	--	--	17,000	14,000	--	--	12,500	11,000	9,800	--
M731	27,500	24,000	--	--	19,000	17,000	--	--	14,500	13,000	10,800	--
M726	27,000	23,500	--	--	17,500	15,000	--	--	14,000	12,000	10,300	--
M730	25,500	21,000	--	--	17,500	16,000	--	--	14,500	12,000	10,000	--
						0.2% DEFORMATION STRENGTH, PSI						
M624	22,000	--	--	--	14,000	--	--	--	10,000	9,400	--	--
M206	21,500	--	--	--	15,000	--	--	--	12,500	10,200	--	--
M208	22,500	--	--	--	14,000	--	--	--	12,500	10,500	--	--
M207	21,500	--	--	--	14,500	--	--	--	12,000	10,500	--	--
M733	22,000	--	--	--	15,000	--	--	--	12,000	9,400	--	--
M737	22,000	--	--	--	14,000	--	--	--	11,500	9,400	--	--
M732	21,500	--	--	--	14,000	--	--	--	10,500	9,400	--	--
M731	21,000	--	--	--	15,500	--	--	--	12,500	10,800	--	--
M726	23,500	--	--	--	15,000	--	--	--	12,000	10,300	--	--
M730	21,000	--	--	--	15,000	--	--	--	12,000	10,000	--	--

Note: Parentheses around strength values indicate extrapolated values.

TABLE XVII

ROOM TEMPERATURE TENSILE DATA FROM TYPE 321, TYPE 347, INCONEL X AND N155 SHEET MATERIAL

Properties	Type 321[1]	Type 347[2]	Inconel X[2]	N155[1]
	Material			
	TENSILE STRENGTH, PSI			
Range	81,500/ 92,800	87,500/ 102,000	156,500/ 185,800	116,600/ 121,200
Maximum difference for one heat	4,000	3,000	3,500	2,300
Average	85,550	94,400	174,000	119,050
Standard deviation	3,380	3,840	7,900	1,320
	0.1% OFFSET YIELD STRENGTH, PSI			
Range	27,500/ 43,500	32,500/ 51,000	99,500/ 132,500	47,900/ 58,000
Maximum difference for one heat	4,500	10,000	5,500	6,200
Average	32,900	39,800	118,000	52,250
Standard deviation	3,960	4,490	8,550	2,340
	0.2% OFFSET YIELD STRENGTH, PSI			
Range	30,000/ 45,500	35,500/ 54,000	102,000/ 136,000	55,400/ 64,500
Maximum difference for one heat	3,500	8,500	6,000	5,000
Average	36,000	43,300	121,500	59,550
Standard deviation	3,910	4,540	8,725	2,230
	PROPORTIONAL LIMIT, PSI			
Range	14,000/ 22,000	14,000/ 28,000	76,500/ 110,000	17,000/ 29,000
Maximum difference for one heat	7,500	9,000	7,000	9,000
Average	16,300	19,800	91,100	21,575
Standard deviation	2,440	3,850	8,890	3,850
	ELONGATION, % IN 2 INCHES			
Range	51.0/ 74.7	51.5/ 64.5	23.5/ 32.0	51.5/ 57.5
Maximum difference for one heat	5.4	5.5	5.0	3.0
Average	64.4	59.1	28.0	53.8
Standard deviation	5.65	4.74	2.86	1.47

(1) Based on values from 10 heats.
(2) Based on values from 9 heats.

TABLE XVIII

STATISTICAL EVALUATION OF STRESS RUPTURE AND TOTAL DEFORMATION STRENGTHS

OF TEN HEATS OF TYPE 321 SHEET AT 1200°, 1350°, AND 1500°F

Rupture or Total Deformation Time (hours)	Temp (°F)	Number of Heats*	Range in Rupture or Deformation Strength (psi)	Average Strength (psi)	Standard Deviation (psi)	Average ± 3 Times Standard Deviation (psi)
			RUPTURE STRENGTHS			
20	1200	10	29,500/36,000	33,100	1740	27,900/38,300
80		10	25,000/31,000	28,000	1660	23,000/33,000
300		10	19,500/24,500	22,550	1405	18,300/26,800
20	1350	10	17,500/22,000	19,650	1580	14,900/24,400
80		10	13,500/18,500	15,700	1490	11,200/20,200
300		10	10,500/14,600	12,200	1250	8,400/15,900
5	1500	10	12,000/15,500	13,400	1080	10,200/16,600
20		10	9,500/12,500	10,650	900	7,900/13,300
80		10	6,600/ 8,800	7,550	710	5,400/ 9,700
			2.0% TOTAL DEFORMATION STRENGTHS			
20	1200	10	23,500/29,500	27,200	1930	21,400/33,000
80		10	19,500/27,000	23,800	2010	17,800/29,800
300		10	16,000/22,000	19,850	1750	14,600/25,100
20	1350	10	14,000/20,000	16,800	1680	11,800/21,800
80		10	10,000/17,000	13,250	2020	7,200/19,300
300		9	8,600/14,000	10,750	1580	6,000/15,500
1	1500	8	11,500/15,200	13,150	1260	9,400/16,900
5		10	9,000/12,500	10,550	1160	7,100/14,000
20		10	6,800/10,500	8,300	1080	5,100/11,500
80		7	4,600/ 7,900	6,400	1140	3,000/ 9,800
			1.0% TOTAL DEFORMATION STRENGTHS			
20	1200	9	22,000/26,500	24,550	1380	20,400/28,700
80		9	17,500/24,000	21,850	1915	16,100/27,600
5	1350	7	15,500/19,500	17,700	1330	13,700/21,700
20		10	12,000/18,500	15,100	1880	9,500/20,740
80		9	10,000/16,000	12,350	1790	7,000/17,700
300		7	7,600/13,000	9,750	1670	4,700/14,800
1	1500	10	10,400/14,200	12,100	1180	8,600/15,600
5		10	7,600/11,700	9,550	1260	5,800/13,300
20		10	5,600/ 9,000	7,250	1160	3,800/10,800
			0.5% TOTAL DEFORMATION STRENGTHS			
20	1200	7	19,000/25,000	22,350	1680	17,300/27,400
5	1350	9	13,500/19,500	16,400	1590	11,600/21,200
20		10	9,200/17,000	13,500	2130	7,100/19,900
80		8	8,700/14,000	10,750	1800	5,300/16,100
1	1500	10	8,700/12,800	10,850	1310	6,900/14,800
5		10	6,300/10,500	8,400	1400	4,200/12,600
20		8	5,300/ 8,100	6,450	950	3,600/ 9,300
			0.2% TOTAL DEFORMATION STRENGTHS			
5	1350	10	9,600/17,000	13,700	2180	7,200/20,200
20		8	10,000/16,000	11,900	1910	6,200/17,600
1	1500	10	7,200/11,000	9,050	1255	5,300/12,800
5		9	5,500/ 8,600	6,750	1000	3,700/ 9,700

* Number of heats for which data were available for indicated strength value.

TABLE XIX

STATISTICAL EVALUATION OF STRESS RUPTURE AND TOTAL DEFORMATION STRENGTHS

FOR TEN HEATS OF TYPE 347 SHEET AT 1200°, 1350°, AND 1500°F

Rupture or Total Deformation Time (hours)	Temp (°F)	Number of Heats*	Range in Rupture or Deformation Strength (psi)	Average Strength (psi)	Standard Deviation (psi)	Average ± 3 Times Standard Deviation (psi)
			RUPTURE STRENGTHS			
20	1200	10	33,000/42,000	37,400	2250	30,600/44,100
80		10	28,000/36,000	31,600	2160	25,100/38,100
300		10	21,500/30,000	26,400	2700	18,300/34,500
20	1350	10	17,000/24,000	21,800	2080	15,600/28,000
80		10	13,500/19,000	17,350	1770	12,000/22,700
300		10	9,000/15,500	13,450	2070	7,200/19,700
5	1500	10	12,000/15,000	13,620	1005	10,600/16,600
20		10	8,400/12,800	10,920	1250	7,200/14,700
80		10	6,000/ 9,800	8,210	1230	4,500/11,900
			2.0% TOTAL DEFORMATION STRENGTHS			
20	1200	9	27,000/31,000	29,700	1110	26,400/33,000
80		10	24,000/29,000	27,150	1660	22,200/32,100
5	1350	8	17,000/23,500	20,900	1710	15,800/26,000
20		10	12,500/21,500	18,450	2620	10,600/26,300
80		9	10,600/17,500	15,250	1850	9,700/20,800
300		8	11,000/14,500	12,700	980	9,800/15,600
1	1500	9	10,000/15,000	12,900	1265	9,100/16,700
5		10	6,600/11,000	9,950	1420	5,700/14,200
20		9	4,800/ 9,000	8,150	1185	4,600/11,700
			1.0% TOTAL DEFORMATION STRENGTHS			
5	1350	9	14,000/21,500	19,200	2030	13,100/25,300
20		10	10,500/19,500	16,650	2650	8,700/24,600
80		9	9,000/16,800	14,100	1880	8,500/19,700
1	1500	9	7,800/12,800	11,300	1350	7,200/15,300
5		10	5,300/10,200	8,680	1720	3,500/13,800
20		7	7,100/ 8,400	7,800	437	6,500/ 9,100
			0.5% TOTAL DEFORMATION STRENGTHS			
5	1350	10	12,000/19,000	17,200	1990	11,200/23,200
20		10	9,000/18,000	14,950	2540	7,300/22,600
1	1500	9	6,200/11,500	9,800	1635	4,900/14,700
5		8	4,100/ 9,400	8,220	1590	3,400/13,000
			0.2% TOTAL DEFORMATION STRENGTHS			
5	1350	10	9,400/17,500	14,590	2365	7,500/21,700
1	1500	7	4,600/ 9,800	8,470	1625	3,600/13,300
5		7	7,200/ 8,000	7,450	154	7,000/ 7,900

* Number of heats for which data were available for indicated strength value.

TABLE XX

STATISTICAL EVALUATION OF STRESS RUPTURE AND TOTAL DEFORMATION STRENGTHS

FOR NINE HEATS OF INCONEL X SHEET AT 1200°, 1350°, AND 1500°F

Rupture or Total Deformation Time (hours)	Temp (°F)	Number of Heats*	Range in Rupture or Deformation Strength (psi)	Average Strength (psi)	Standard Deviation (psi)	Average ± 3 Times Standard Deviation (psi)
			RUPTURE STRENGTHS			
20	1200	9	57,100/80,000	69,300	6700	49,200/89,400
80		9	47,500/68,000	59,500	6580	39,800/79,200
300		9	40,000/60,000	51,400	6800	31,000/71,800
20	1350	9	41,000/54,000	47,900	4250	35,200/60,600
80		9	33,000/42,500	38,600	3230	28,900/48,300
300		9	27,000/33,000	30,900	2060	24,700/34,100
20	1500	9	26,000/32,000	28,700	1900	23,000/34,400
80		9	19,000/25,000	21,000	1890	15,300/26,700
300		9	13,000/20,000	15,400	1870	9,800/21,000
			2.0% TOTAL DEFORMATION STRENGTHS			
80	1500	6	17,500/20,500	19,100	1060	15,900/22,300
300		5	11,500/14,800	13,600	1030	10.500/16,700
			1.0% TOTAL DEFORMATION STRENGTHS			
20	1500	6	22,000/27,500	24,600	1950	18,800/30,400
80		8	15,000/23,000	18,500	2180	12,000/25,000
300		9	10,300/19,500	14,000	2450	6,700/21,300
			0.5% TOTAL DEFORMATION STRENGTHS			
20	1500	9	19,000/29,500	24,100	3470	13,700/34,500
80		9	15,000/23,500	17,700	2730	9,500/25,900
300		6	11,000/19,000	13,800	2770	5,500/22,100
			0.2% TOTAL DEFORMATION STRENGTHS			
20	1500	9	14,000/26,000	19,100	3660	8,100/30,100
80		7	11,500/21,500	15,100	3370	5,000/25,200

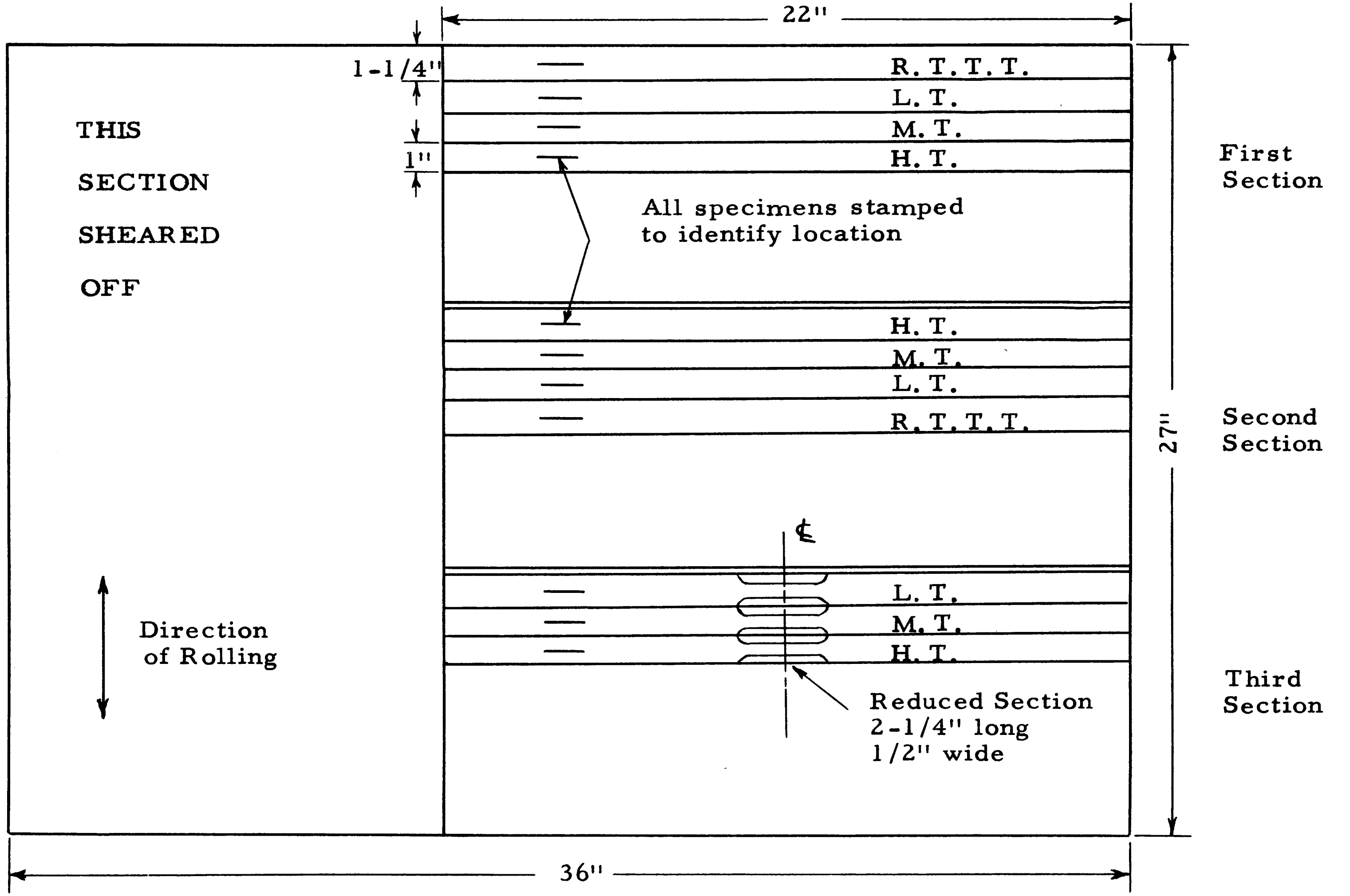
* Number of heats for which data were available for indicated strength value.

TABLE XXI

STATISTICAL EVALUATION OF STRESS RUPTURE AND TOTAL DEFORMATION STRENGTHS FOR TEN HEATS OF N155 SHEET AT 1350°, 1500°, AND 1650°F

Rupture or Total Deformation Time (hours)	Temp (°F)	Number of Heats*	Range in Rupture or Deformation Strength (psi)	Average Strength (psi)	Standard Deviation (psi)	Average ± 3 Times Standard Deviation (psi)
			RUPTURE STRENGTH			
20	1350	10	34,500/37,500	36,100	970	33,200/39,000
80		10	28,000/31,000	29,350	840	26,800/31,900
300		10	23,000/25,500	24,050	757	21,800/26,300
20	1500	10	19,500/22,000	21,250	783	18,900/23,600
80		10	17,000/18,500	17,850	503	16,300/19,400
300		10	13,500/16,000	14,630	627	12,700/16,500
5	1650	10	16,000/17,500	16,550	522	15,000/18,100
20		10	12,500/14,000	13,180	399	12,000/14,400
80		10	9,800/11,500	10,410	476	9,000 / 11,800
			2.0% TOTAL DEFORMATION STRENGTHS			
5	1350	10	34,000/36,500	35,050	819	32,600/37,500
20		10	29,000/31,000	29,750	750	27,500/32,000
80		10	24,000/27,000	24,950	986	22,000/27,900
300		10	19,500/23,000	21,100	1156	17,600/24,600
5	1500	10	19,500/22,000	21,150	840	18,600/23,700
20		10	17,500/19,500	18,450	522	16,900/20,000
80		10	14,500/17,200	15,940	664	13,900/17,900
300		10	12,000/15,000	13,810	739	11,600/16,000
1	1650	10	15,000/17,500	16,530	727	14,300/18,700
5		10	12,500/15,000	13,820	657	11,800/15,800
20		10	10,700/12,500	11,600	496	10,100/13,100
80		10	9,100/10,300	9,640	420	8,400/10,900
			1.0% TOTAL DEFORMATION STRENGTHS			
5	1350	10	29,000/33,000	31,150	1266	27,400/35,000
20		10	25,000/28,000	26,450	1127	23,100/29,800
80		10	21,000/24,000	22,300	1052	19,100/25,500
300		10	17,500/21,000	19,100	1158	15,600/22,600
5	1500	10	18,500/21,000	19,550	723	17,400/21,700
20		10	15,000/18,500	17,030	853	14,500/19,600
80		10	13,000/16,200	14,870	782	12,500/17,200
300		10	11,000/14,000	12,930	758	10,700/15,200
1	1650	10	13,500/16,500	15,350	777	13,000/17,700
5		10	12,000/14,000	12,950	538	11,300/14,600
20		10	10,200/11,500	10,820	482	9,400/12,300
80		10	8,400/ 9,800	9,140	458	7,800/10,500
			0.5% TOTAL DEFORMATION STRENGTHS			
5	1350	10	25,500/28,000	26,700	813	24,300/29,100
20		10	21,000/24,000	22,900	1068	19,700/26,100
5	1500	10	16,500/19,000	17,600	700	15,500/19,700
20		10	14,000/17,000	15,350	839	12,000/18,000
1	1650	10	12,500/15,000	14,100	700	12,000/16,200
5		10	11,000/13,000	11,920	589	10,200/13,700
20		10	9,100/10,800	10,050	467	8,600/11,500
			0.2% TOTAL DEFORMATION STRENGTHS			
5	1350	10	21,000/23,500	21,850	709	19,700/24,000
5	1500	10	14,000/15,500	14,600	538	13,000/16,200
1	1650	10	10,000/12,500	11,750	813	9,300 / 14,200
5		10	9,[illegible]00/10,800	9,900	521	8,400/11,600

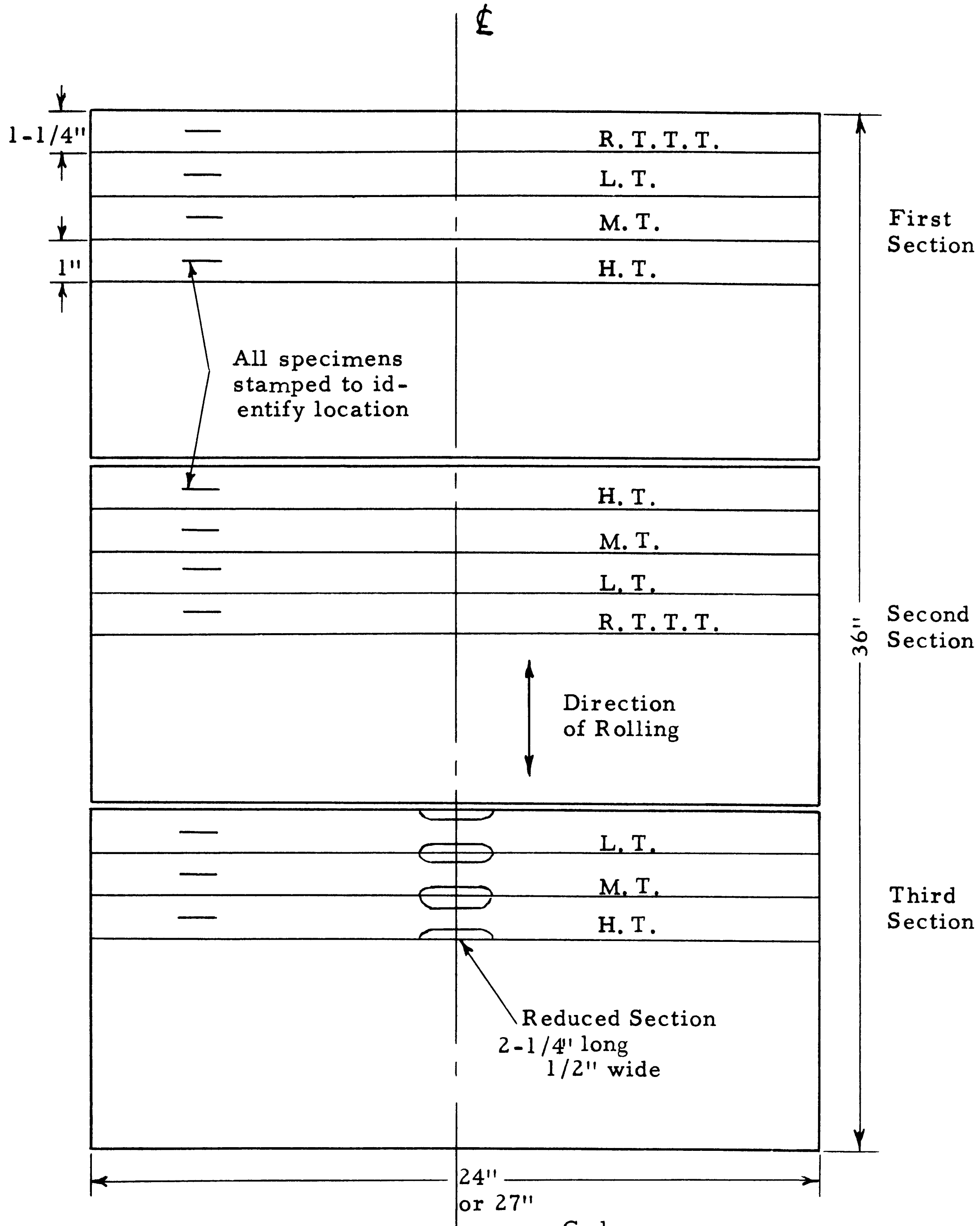
* Number of heats for which data were available for indicated strength value.



Code:

L.T.	= Lowest Temperature
M.T.	= Middle Temperature
H.T.	= Highest Temperature
R. T. T. T.	= Room Temperature Tensile Test

Figure 1. - Sketch Indicating Sampling Procedure of Sheet Materials Submitted with 27-Inch Dimension Parallel to Rolling Direction.



Code:

L.T. = Lowest Temperature
M.T. = Middle Temperature
H.T. = Highest Temperature
R.T.T.T. = Room Temperature Tensile Test

Figure 2. - Sketch Indicating Sampling Procedure of Sheet Materials Submitted with the 36-Inch Dimension Parallel to Direction of Rolling.

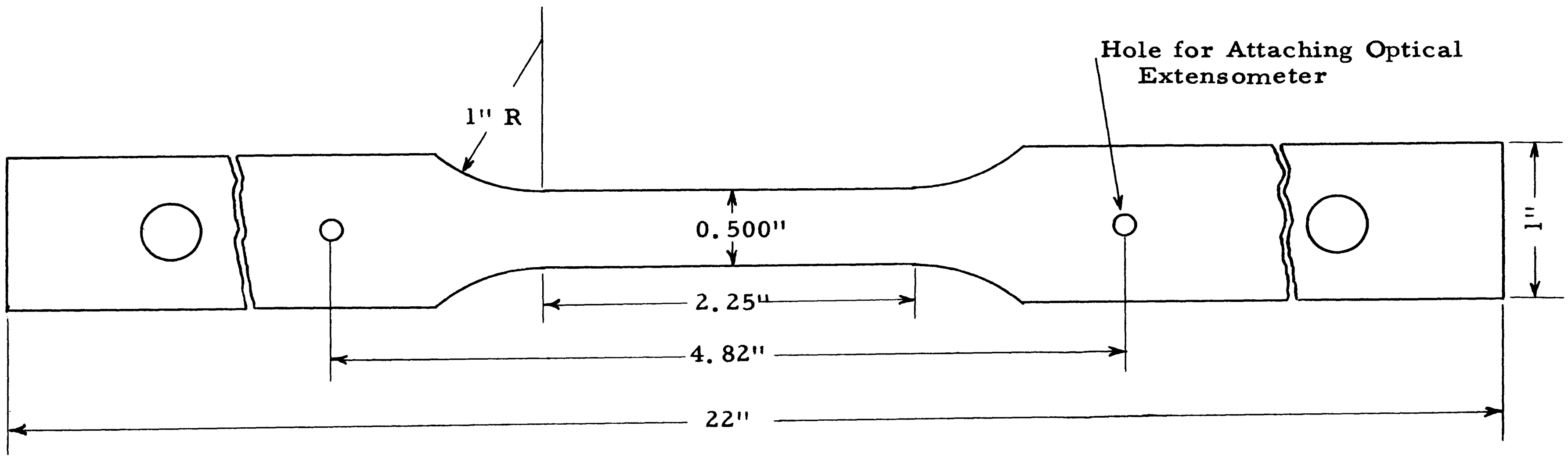


Figure 3. - Dimensions of Creep-Rupture Sheet Specimen.

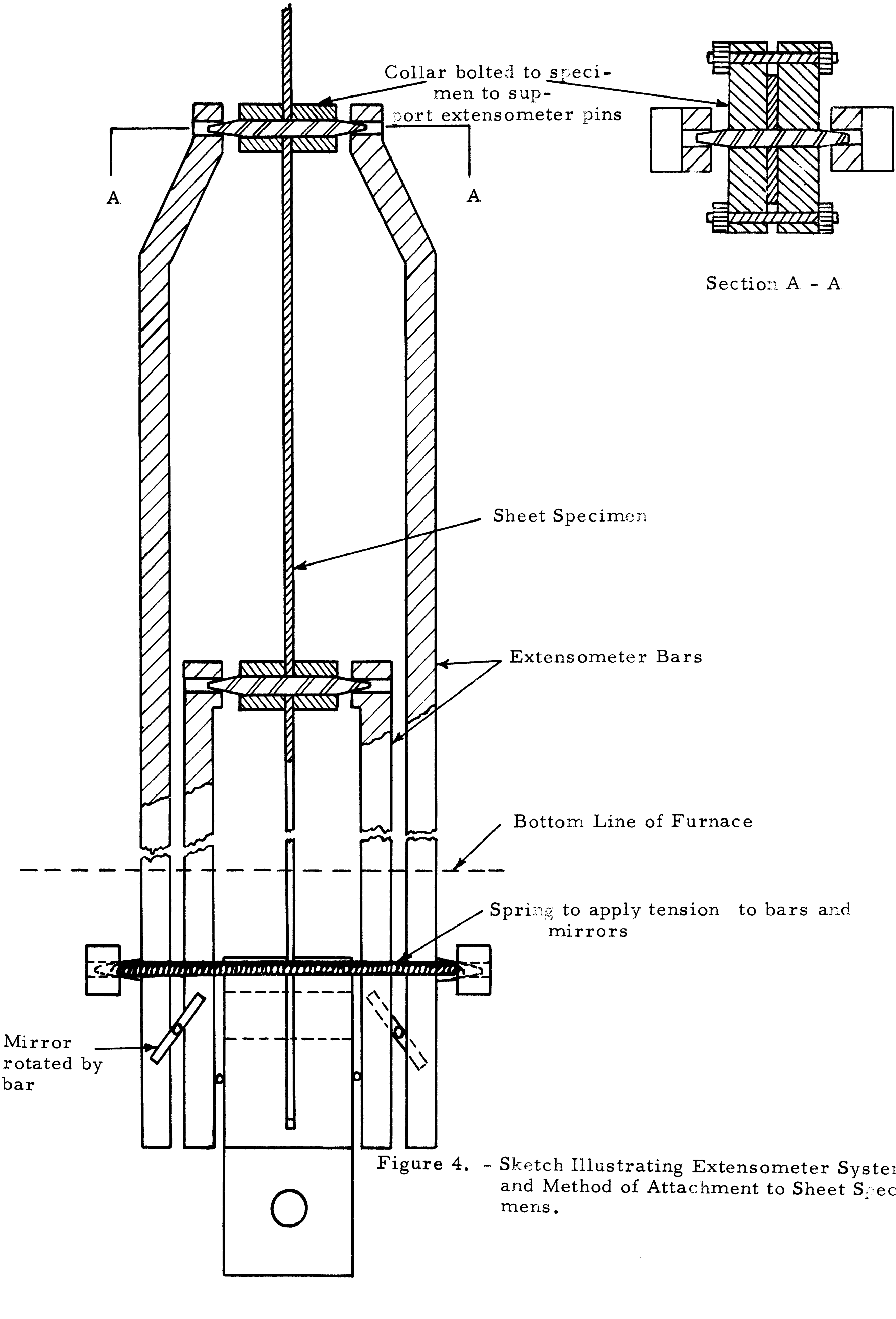


Figure 4. - Sketch Illustrating Extensometer System and Method of Attachment to Sheet Specimens.

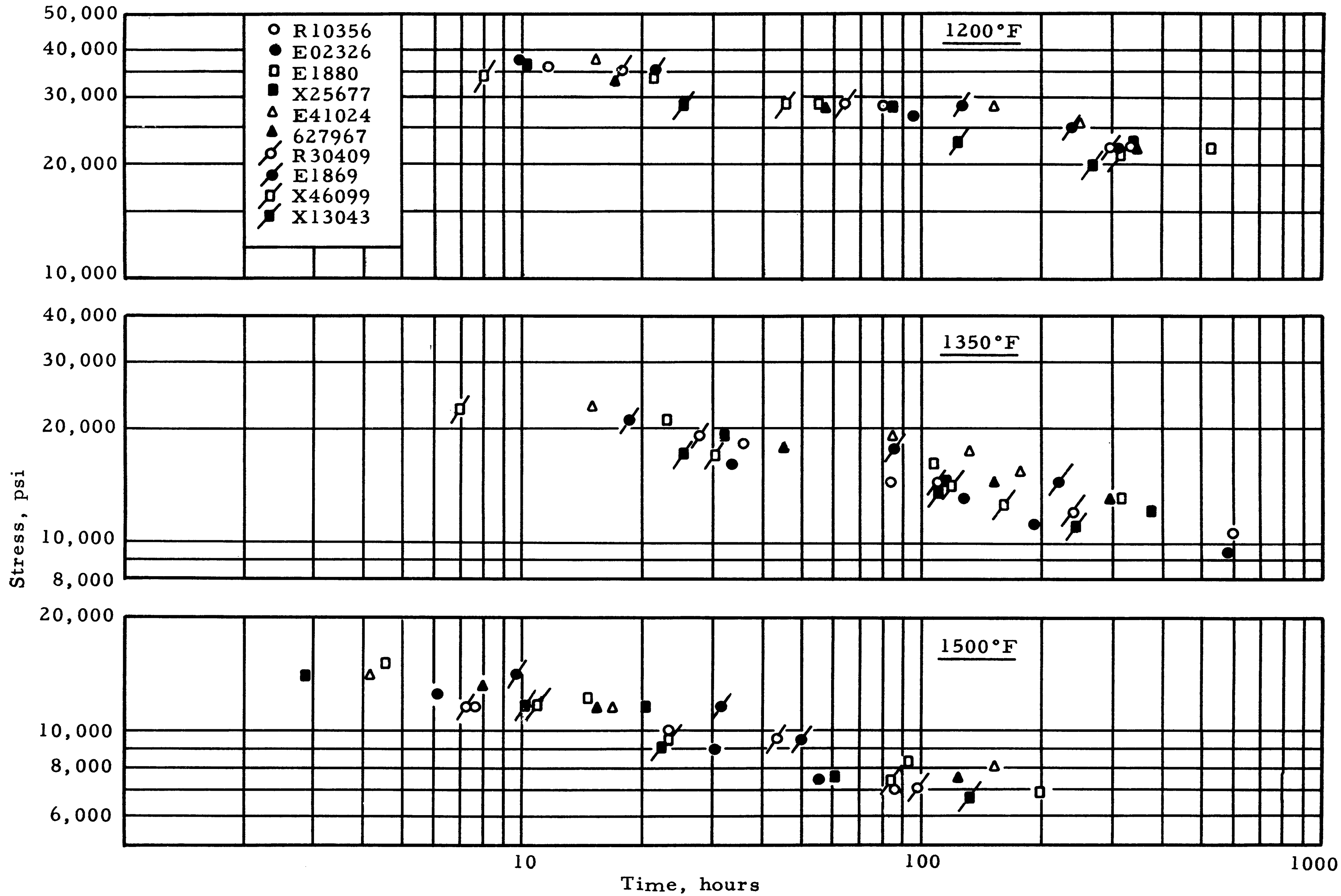


Figure 5. - Stress - Rupture Time Data Obtained from Ten Heats of Type 321 Sheet Material at 1200°, 1350°, and 1500°F.

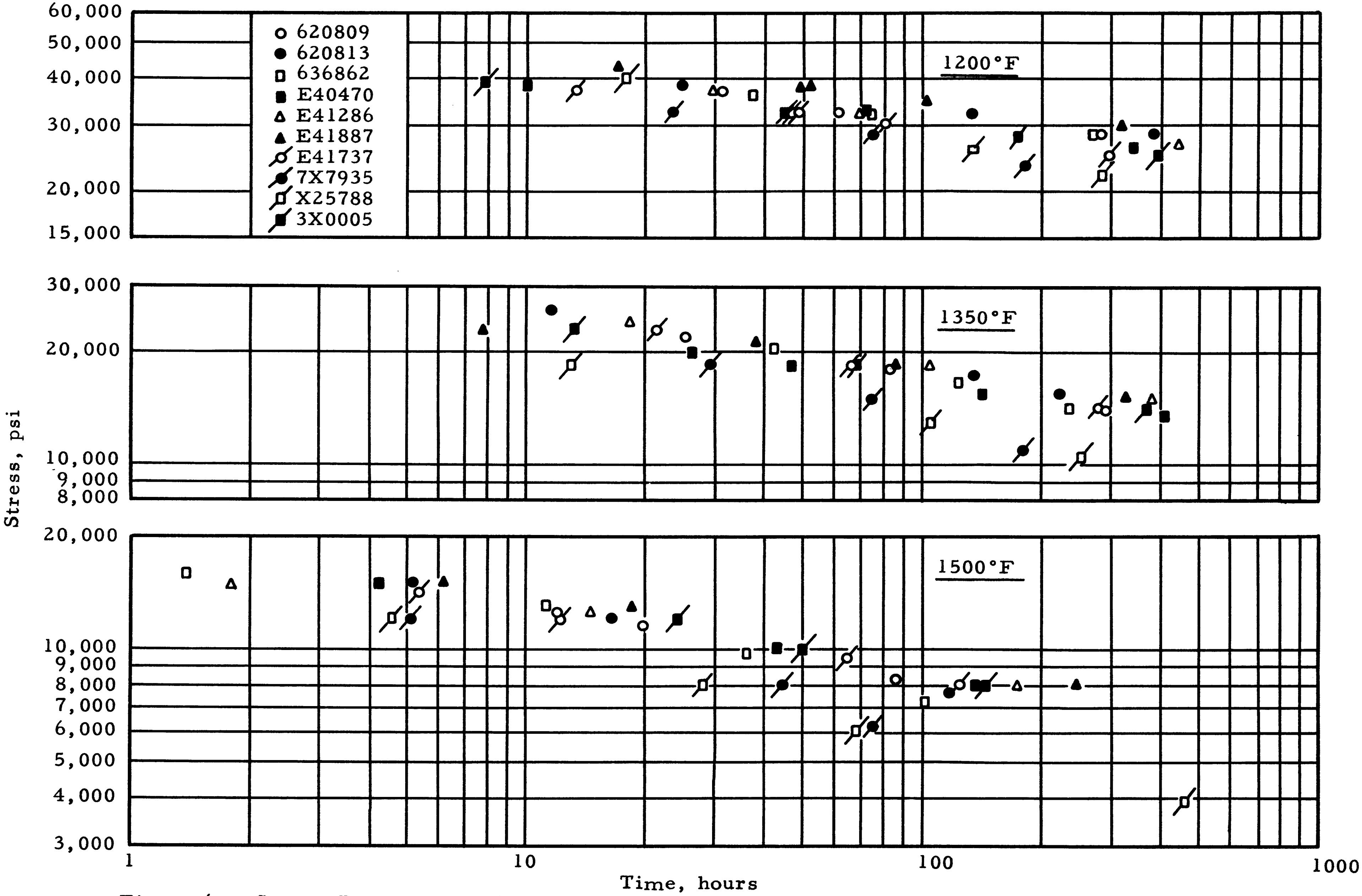


Figure 6. - Stress-Rupture Data Obtained from Ten Heats of Type 347 Sheet Material at 1200°, 1350°, and 1500°F.

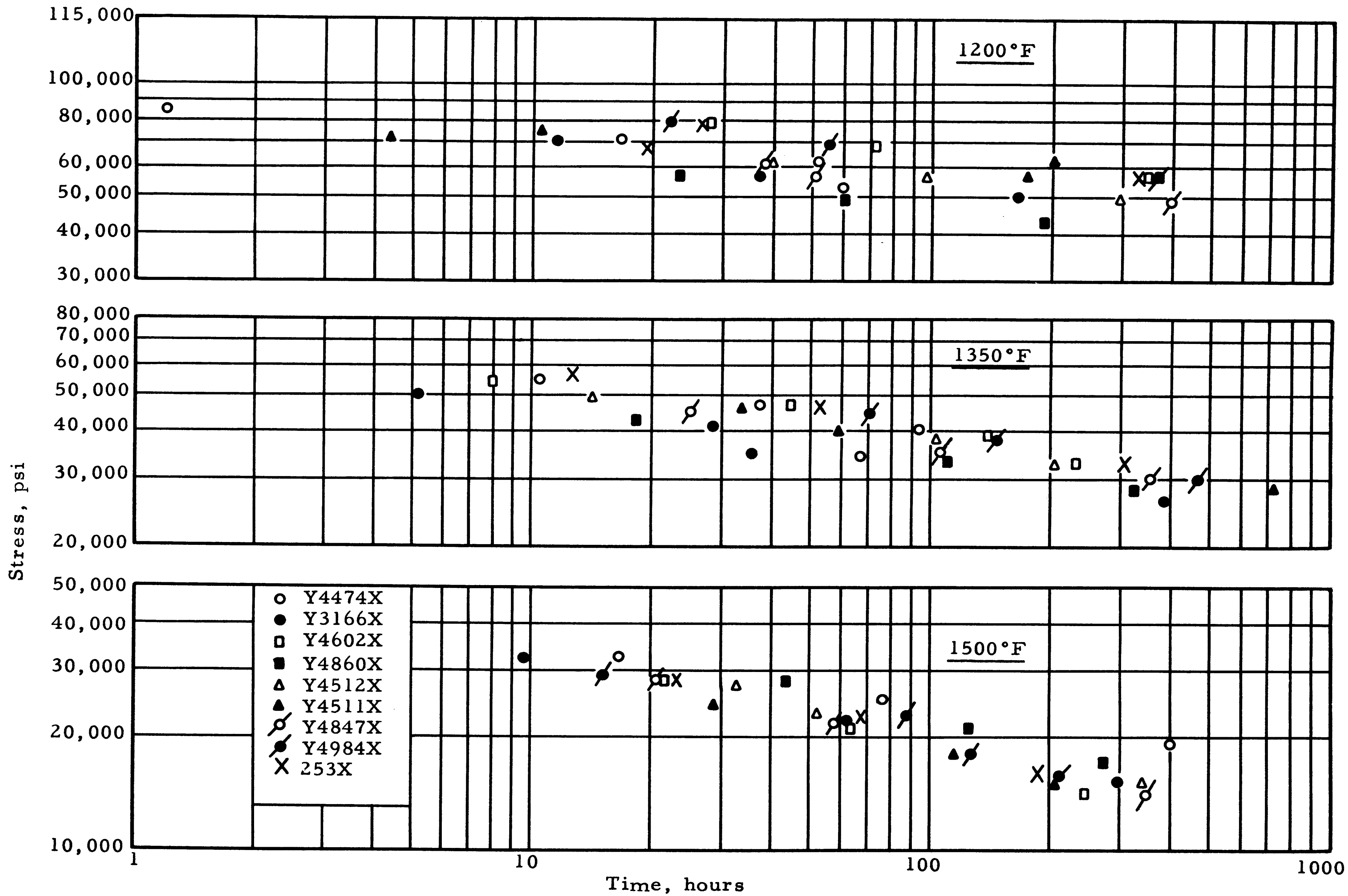


Figure 7. - Stress-Rupture Data Obtained from Nine Heats of Inconel X Sheet Material at 1200°, 1350°, and 1500°F.

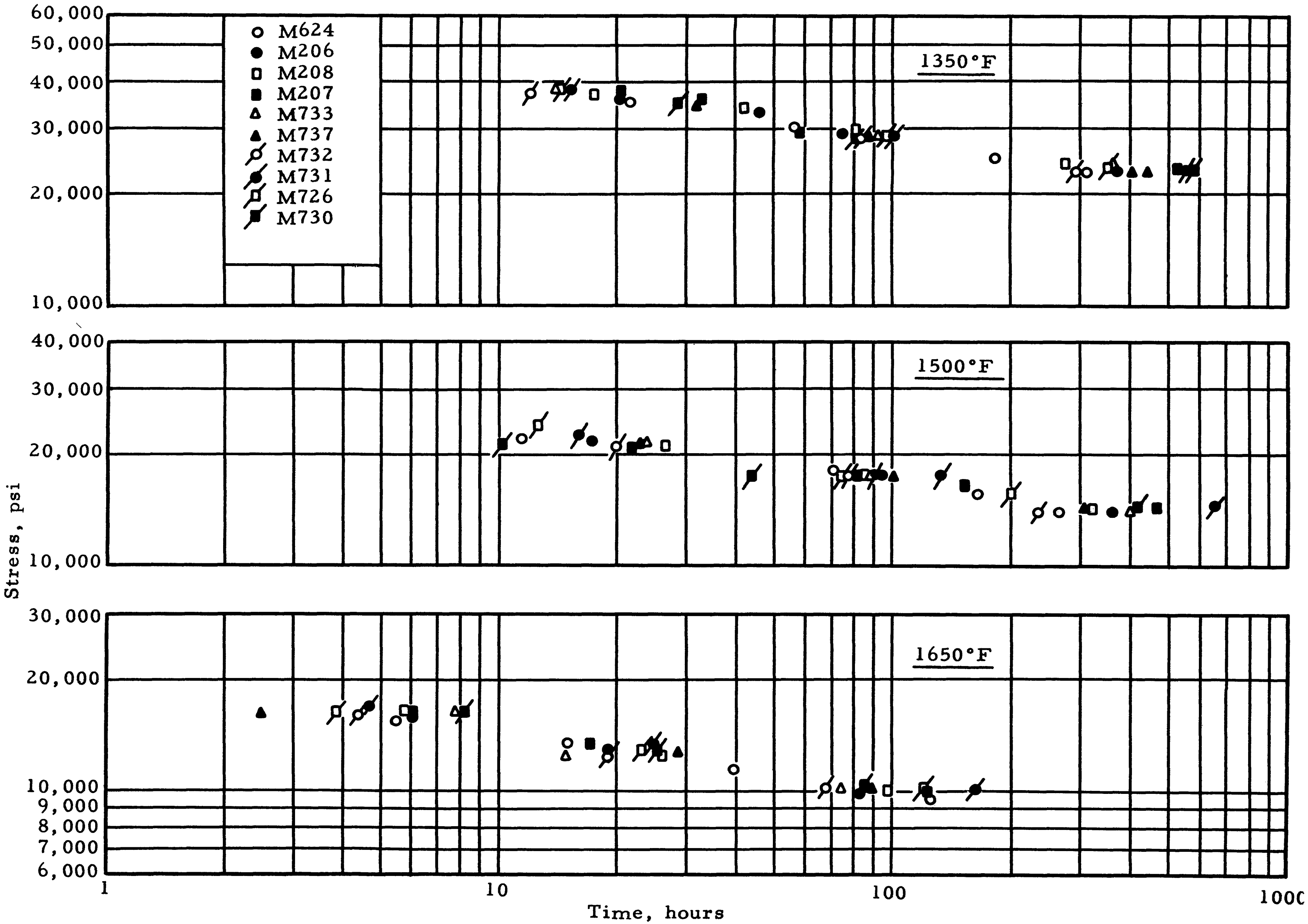


Figure 8. - Stress-Rupture Data Obtained from Ten Heats of N155 Sheet Material at 1350°, 1500°, and 1650°F.

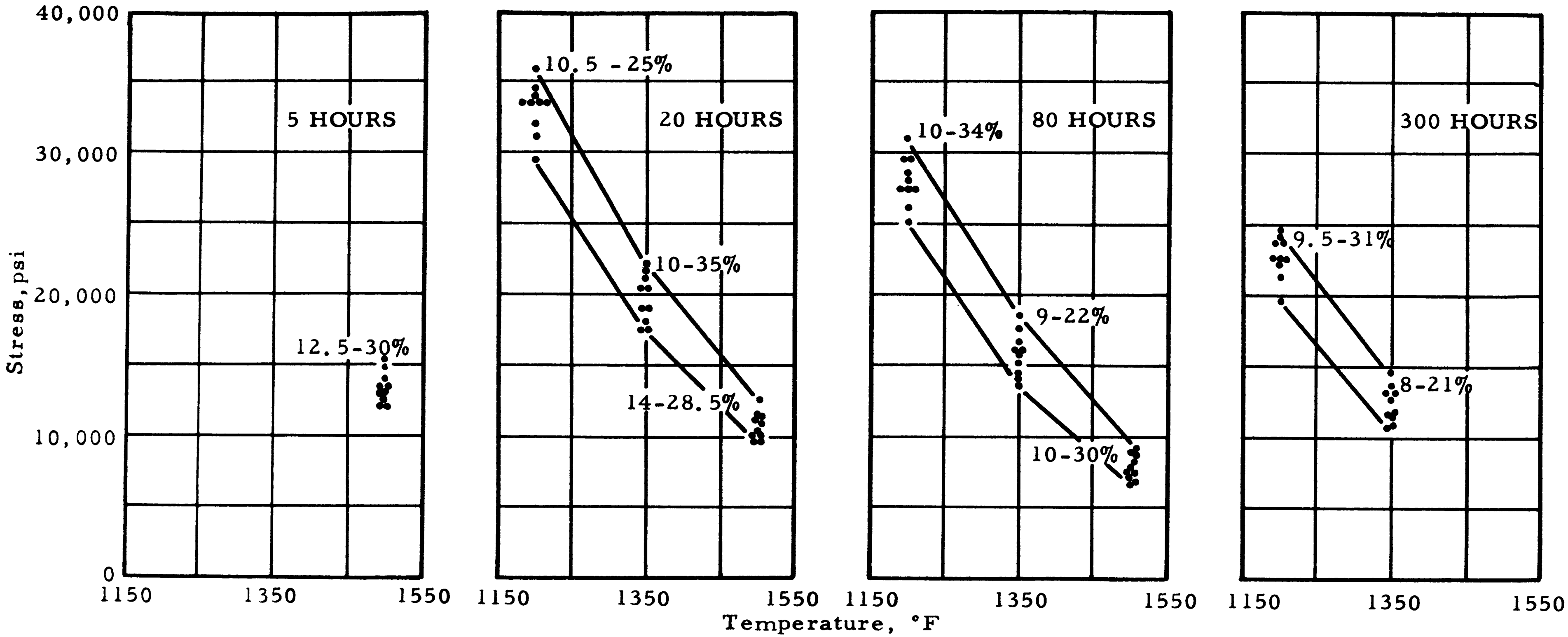


Figure 9. - Summary of Stress-Rupture Strengths for Ten Heats of Type 321 Sheet at 1200°, 1350°, and 1500°F for Time Periods of 5, 20, 80, and 300 Hours. (Note: Percent values shown on graph indicate estimated range in elongation at fracture for specified time period.)

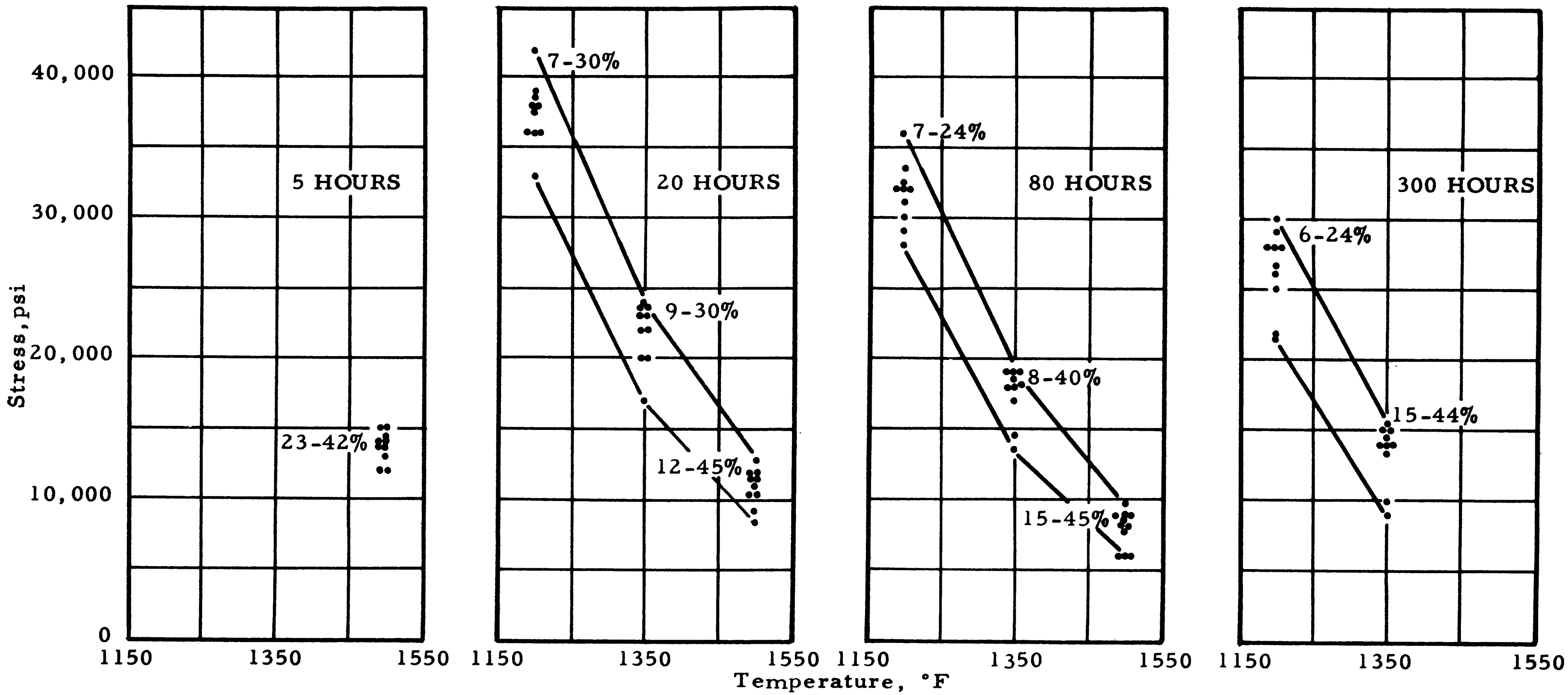


Figure 10. - Summary of Stress-Rupture Strengths for Ten Heats of Type 347 Sheet at 1200°, 1350°, and 1500°F for Time Periods of 5, 20, 80, and 300 Hours. (Note: Percent values shown on graph indicate estimated range in elongation at fracture for specified time period.)

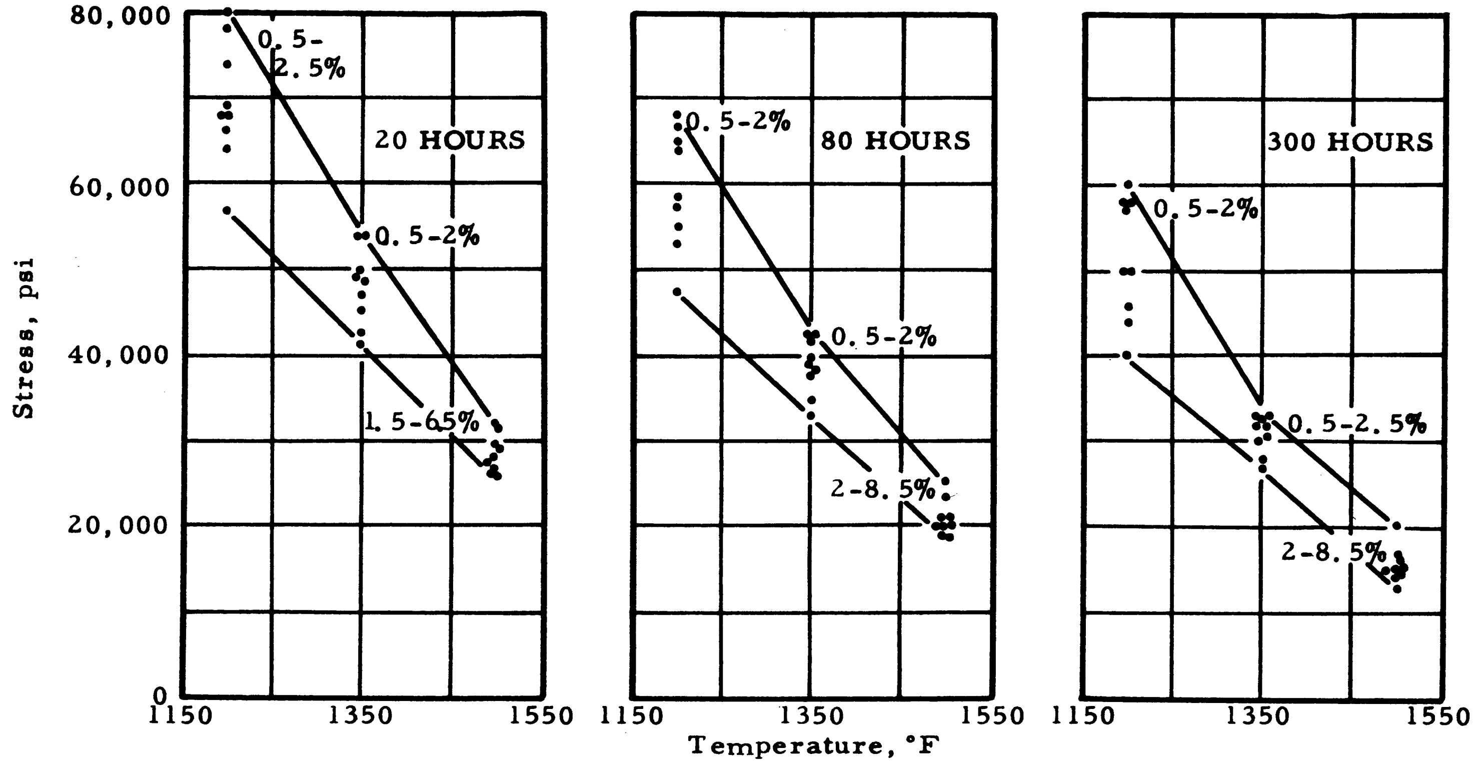


Figure 11. - Summary of Stress-Rupture Strengths for Nine Heats of Inconel X Sheet at 1200°, 1350°, and 1500°F for Time Periods of 20, 80, and 300 Hours. (Note: Percent values shown on graph indicate estimated range in elongation at fracture for specified time period.)

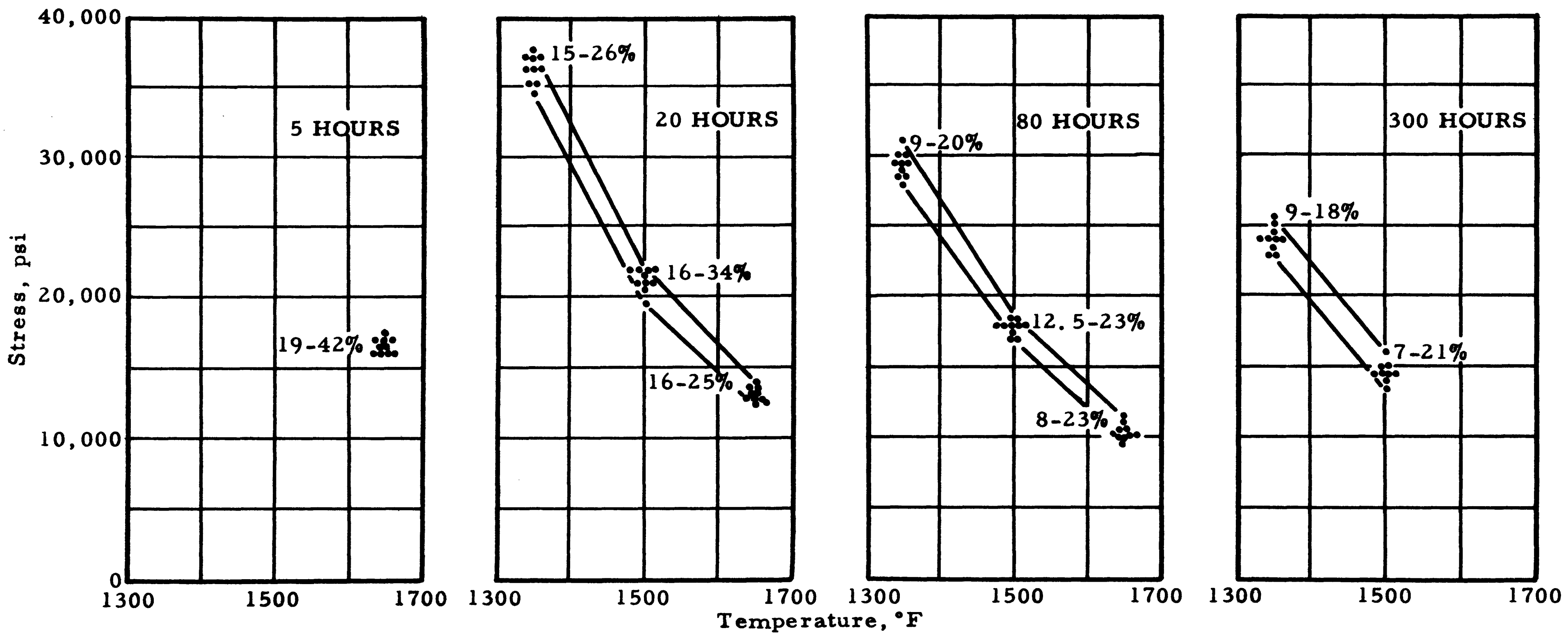


Figure 12. - Summary of Stress-Rupture Strengths for Ten Heats of N155 Sheet at 1350°, 1500°, and 1650°F for Time Periods of 5, 20, 80, and 300 Hours. (Note: Percent values shown on graph indicate estimated range in elongation at fracture for specified time period.)

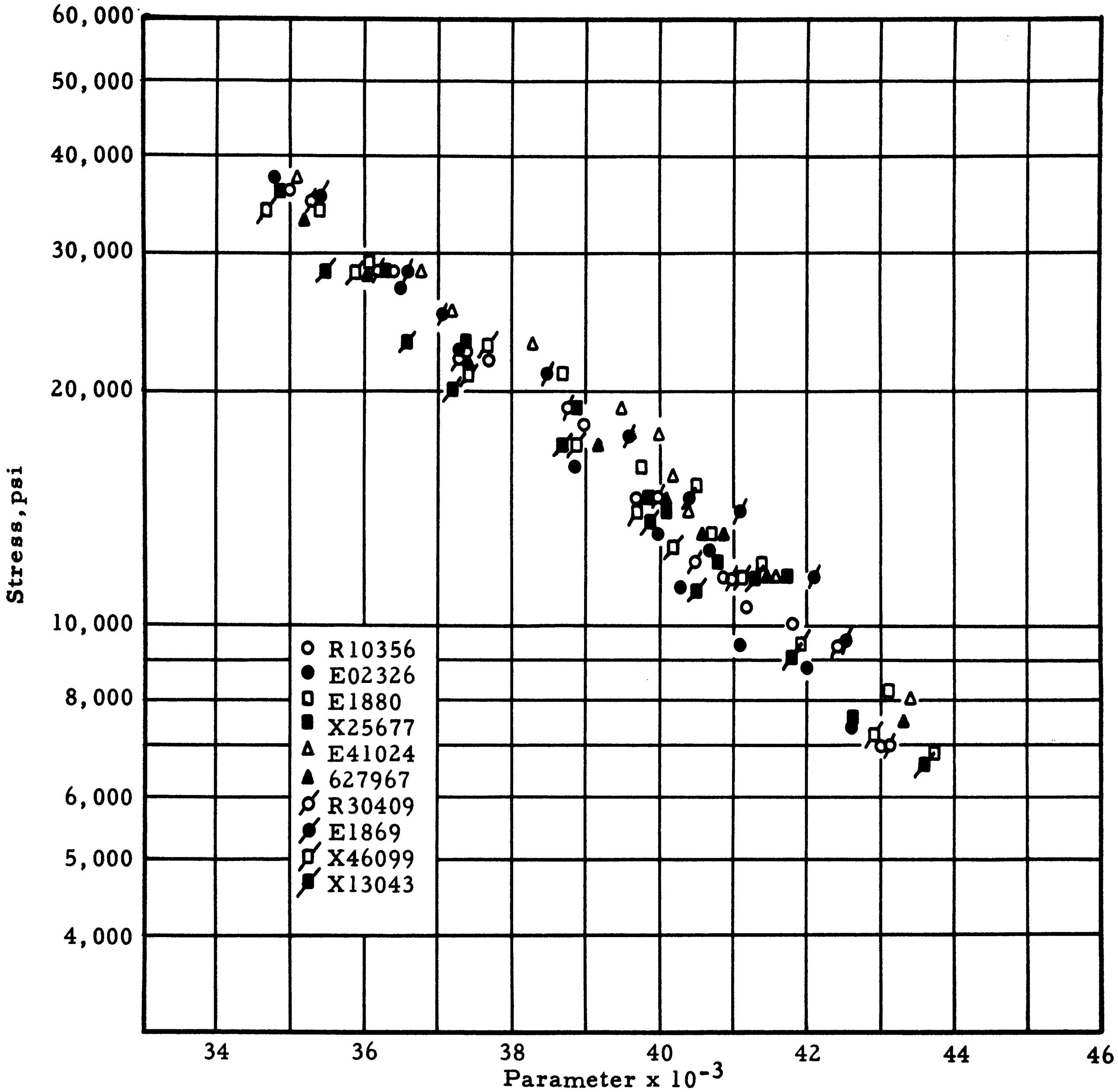


Figure 13. - Graph of Stress Vs. Time-Temperature Parameter, P = T(20 + log t), for the Individual Stress-Rupture Tests on Ten Heats of Type 321 Sheet Material at 1200°, 1350°, and 1500°F.

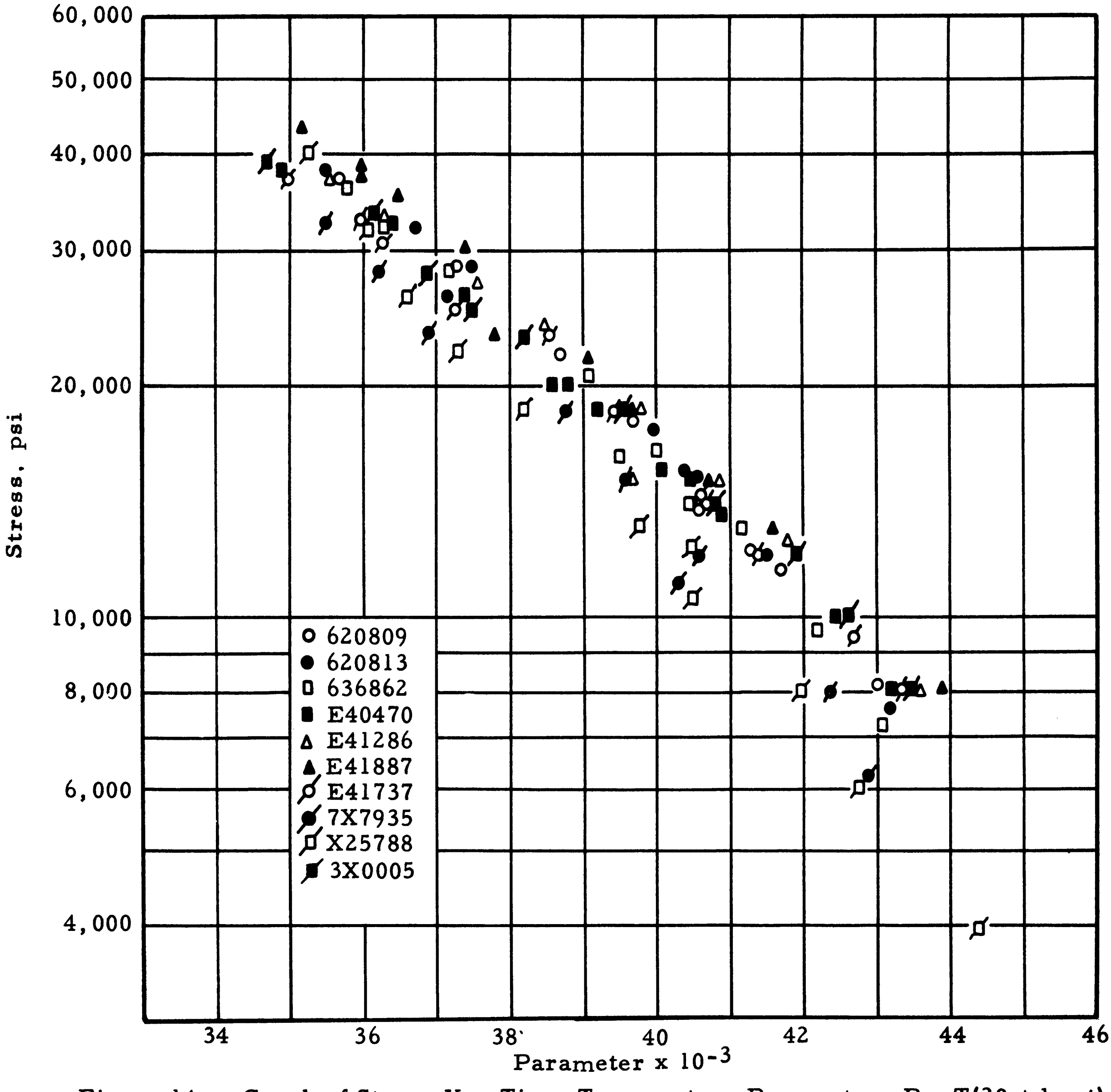


Figure 14. - Graph of Stress Vs. Time-Temperature Parameter, $P = T(20 + \log t)$, for the Individual Stress-Rupture Tests on Ten Heats of Type 347 Sheet Material at 1200°, 1350°, and 1500°F

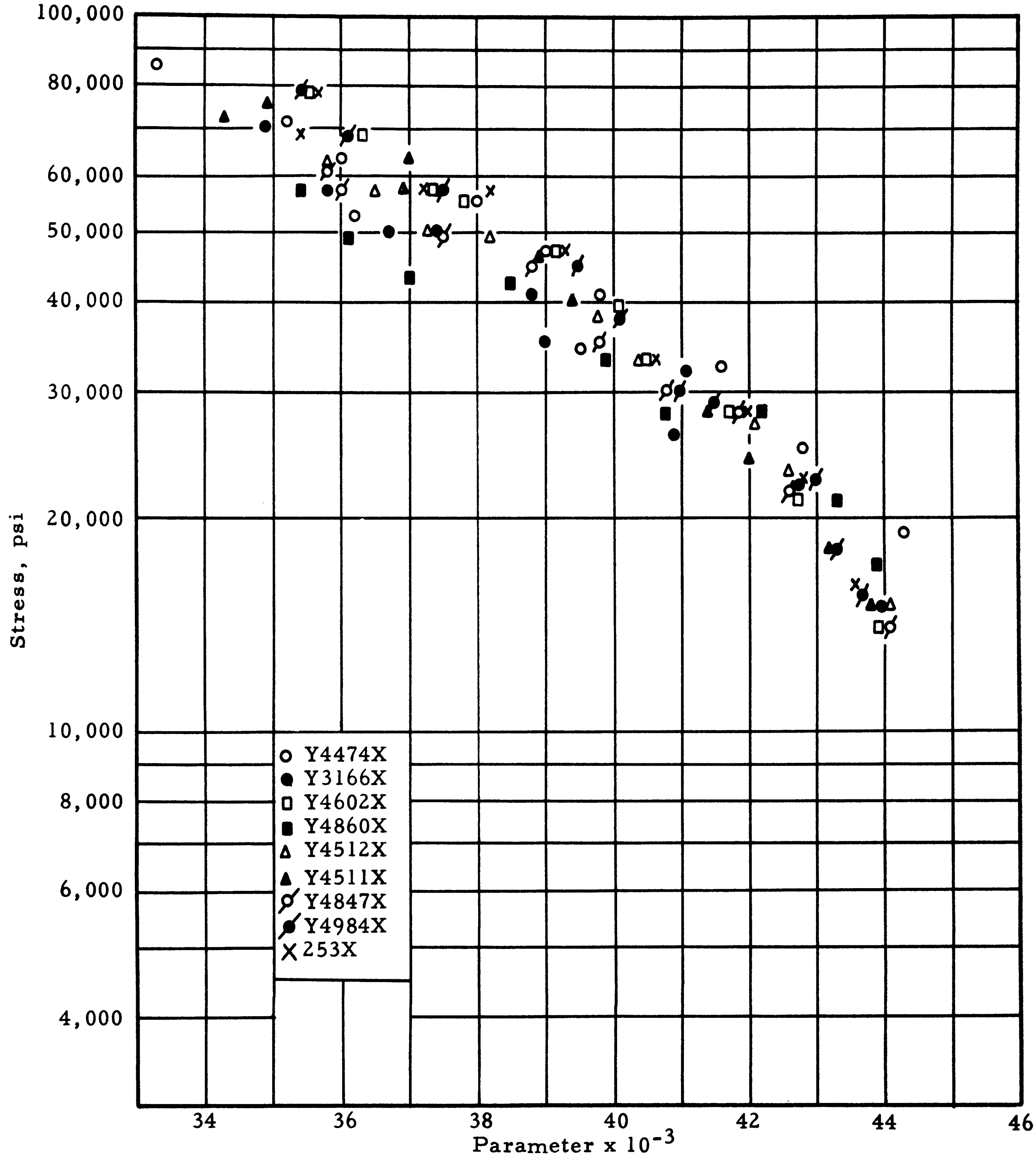


Figure 15. - Graph of Stress Vs. Time-Temperature Parameter, P = T (20 + log t), for the Individual Stress-Rupture Tests on Nine Heats of Inconel X Sheet Material at 1200°, 1350°, and 1500°F.

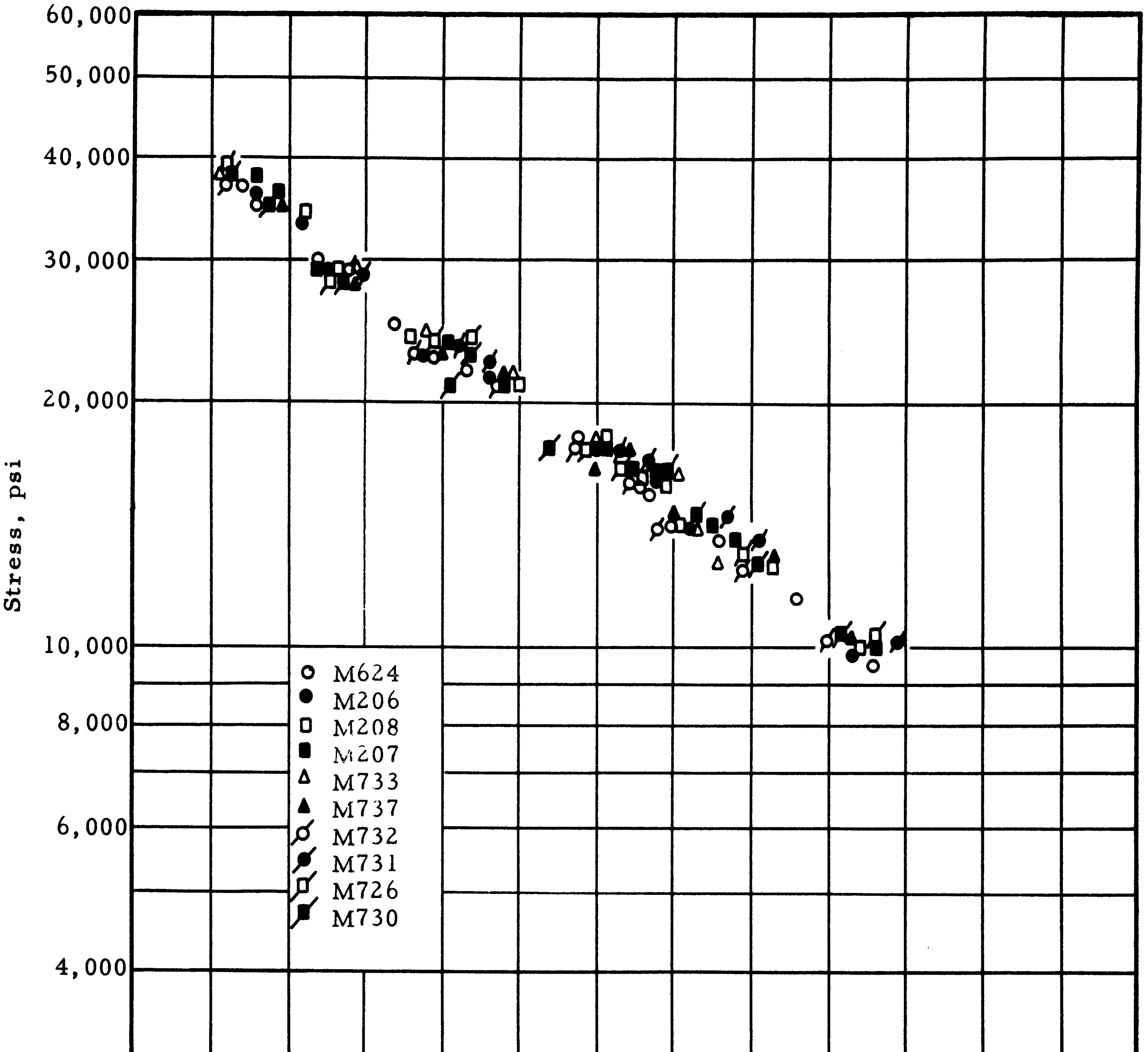


Figure 16. - Graph of Stress Vs. Time-Temperature Parameter, P = T(20 + log t), for the Individual Stress-Rupture Tests on Ten Heats of N155 Sheet Material at 1350°, 1500°, and 1650°F.

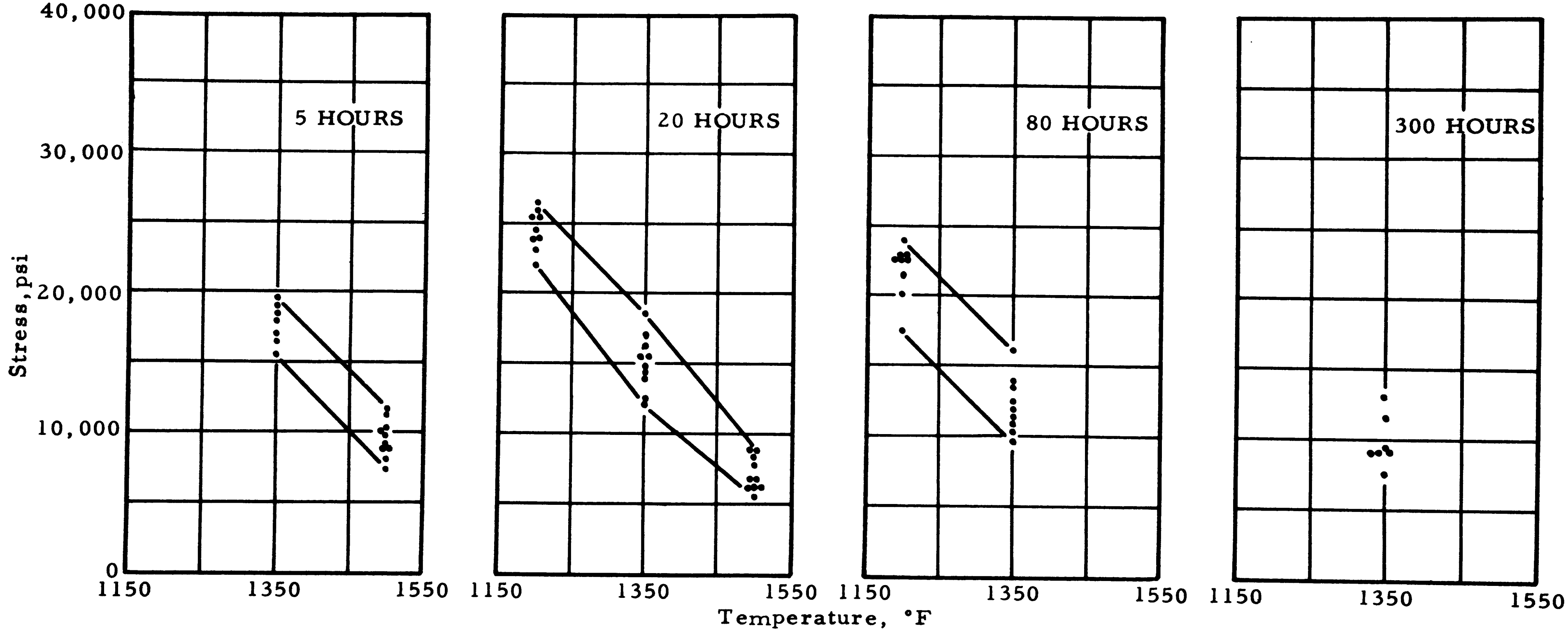


Figure 17. - Summary of 1.0-Percent Total Deformation Strengths for Ten Heats of Type 321 Sheet at 1200°, 1350°, and 1500°F for Time Periods of 5, 20, 80, and 300 Hours.

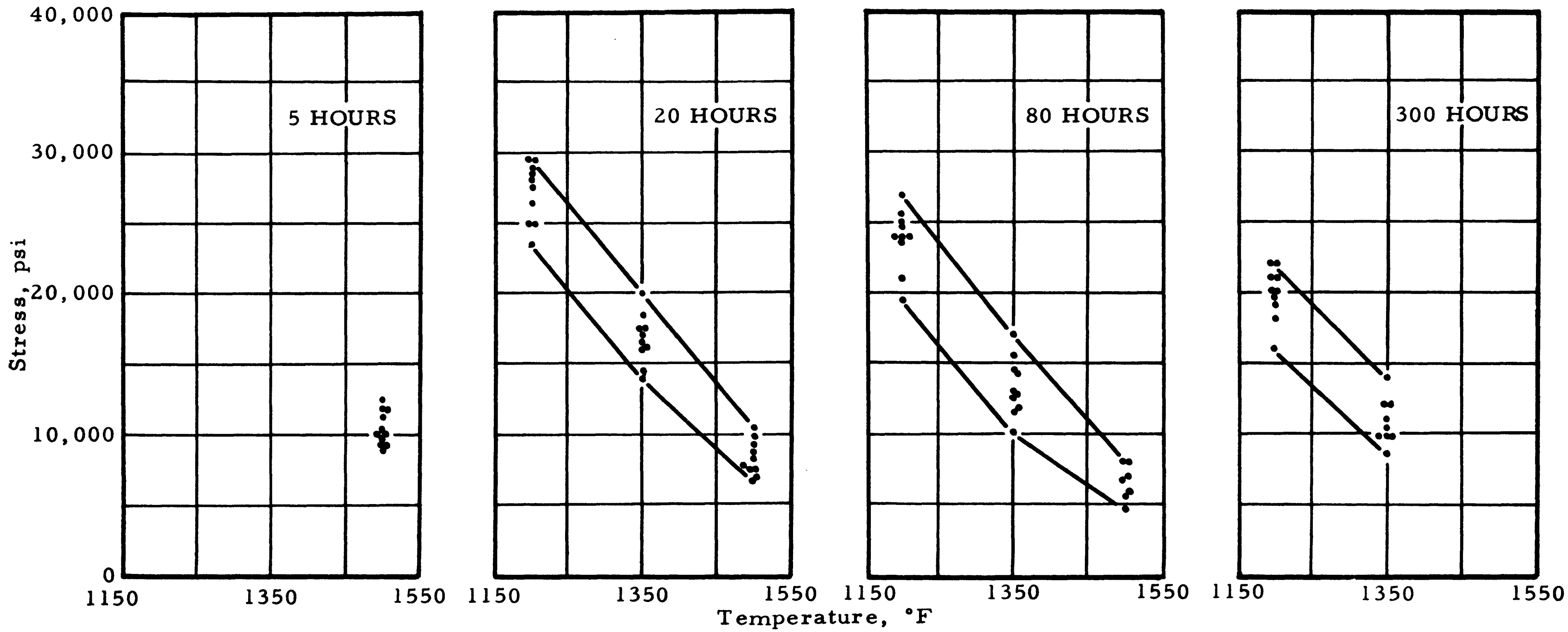


Figure 18. - Summary of 2.0-Percent Total Deformation Strengths for Ten Heats of Type 321 Sheet at 1200°, 1350°, and 1500°F for Time Periods of 5, 20, 80, and 300 Hours.

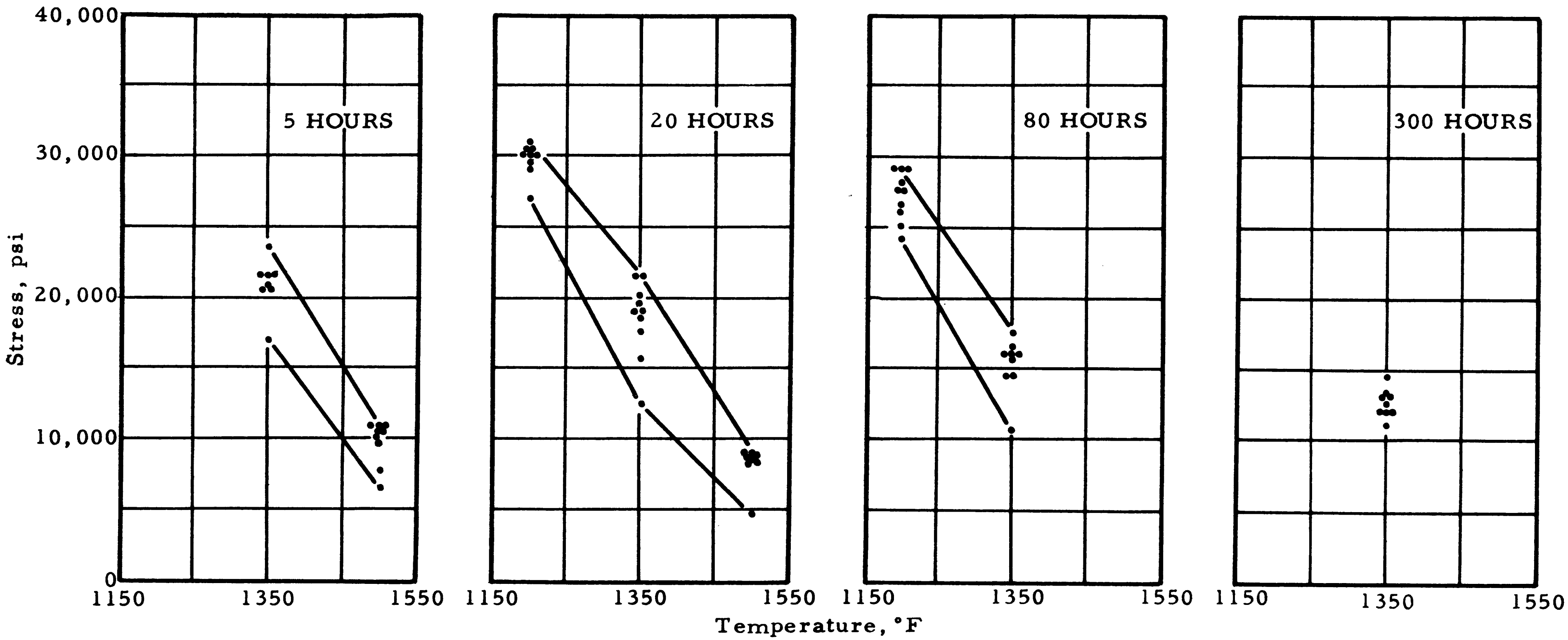


Figure 19. - Summary of 2.0-Percent Total Deformation Strengths for Ten Heats of Type 347 Sheet at 1200°, 1350°, and 1500°F for Time Periods of 5, 20, 80, and 300 Hours.

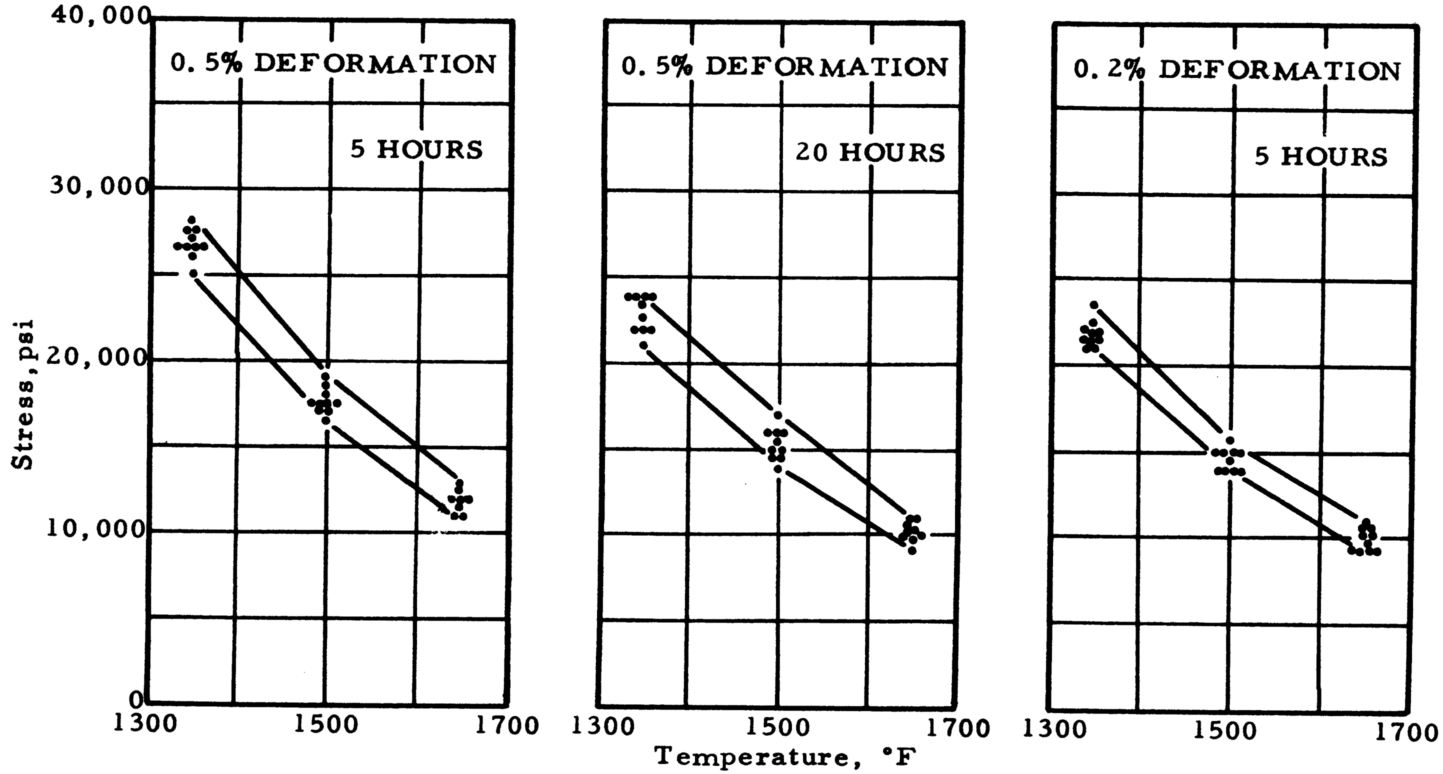


Figure 20. - Summary of 0.5- and 0.2-Percent Total Deformation Strengths for Ten Heats of N155 Sheet at 1350°, 1500°, and 1650°F for Time Periods of 5 and 20 Hours.

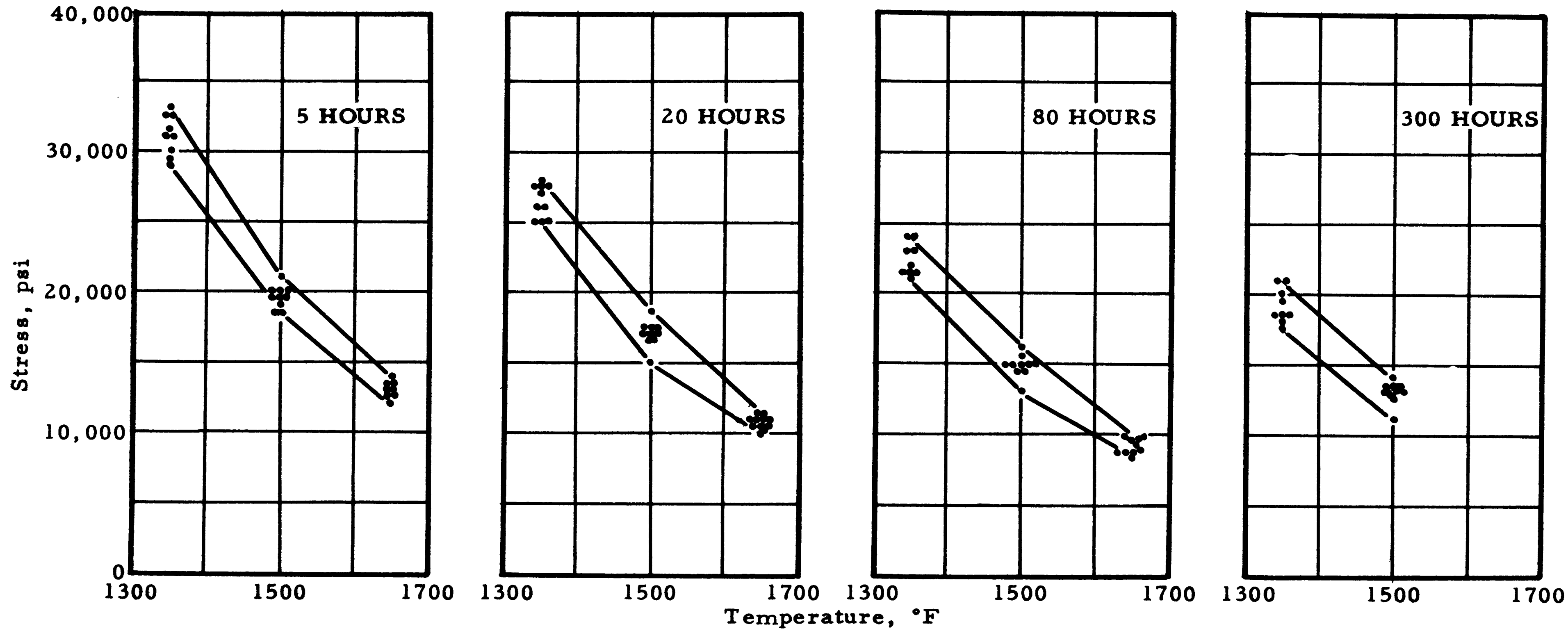


Figure 21. - Summary of 1.0-Percent Total Deformation Strengths for Ten Heats of N155 Sheet at 1350°, 1500°, and 1650°F for Time Periods of 5, 20, 80, and 300 Hours.

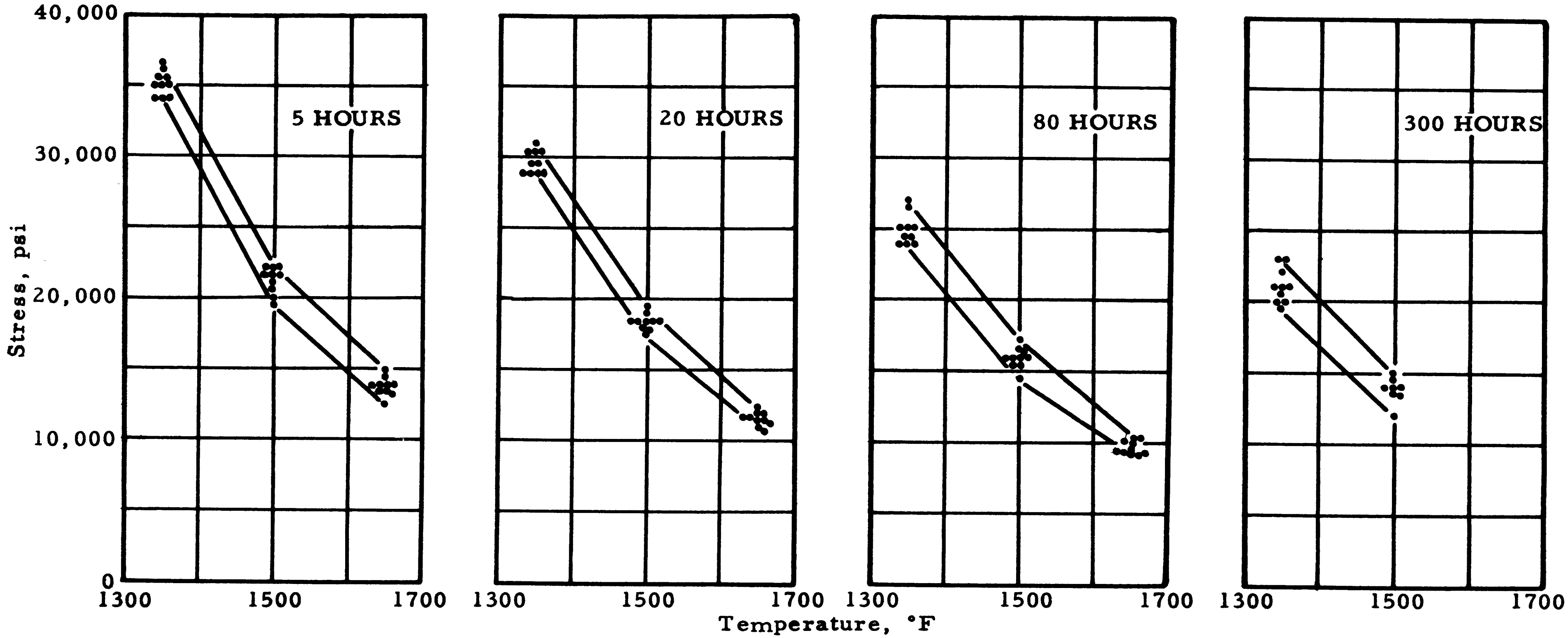


Figure 22. - Summary of 2.0-Percent Total Deformation Strengths for Ten Heats of N155 Sheet at 1350°, 1500°, and 1650°F for Time Periods of 5, 20, 80, and 300 Hours.

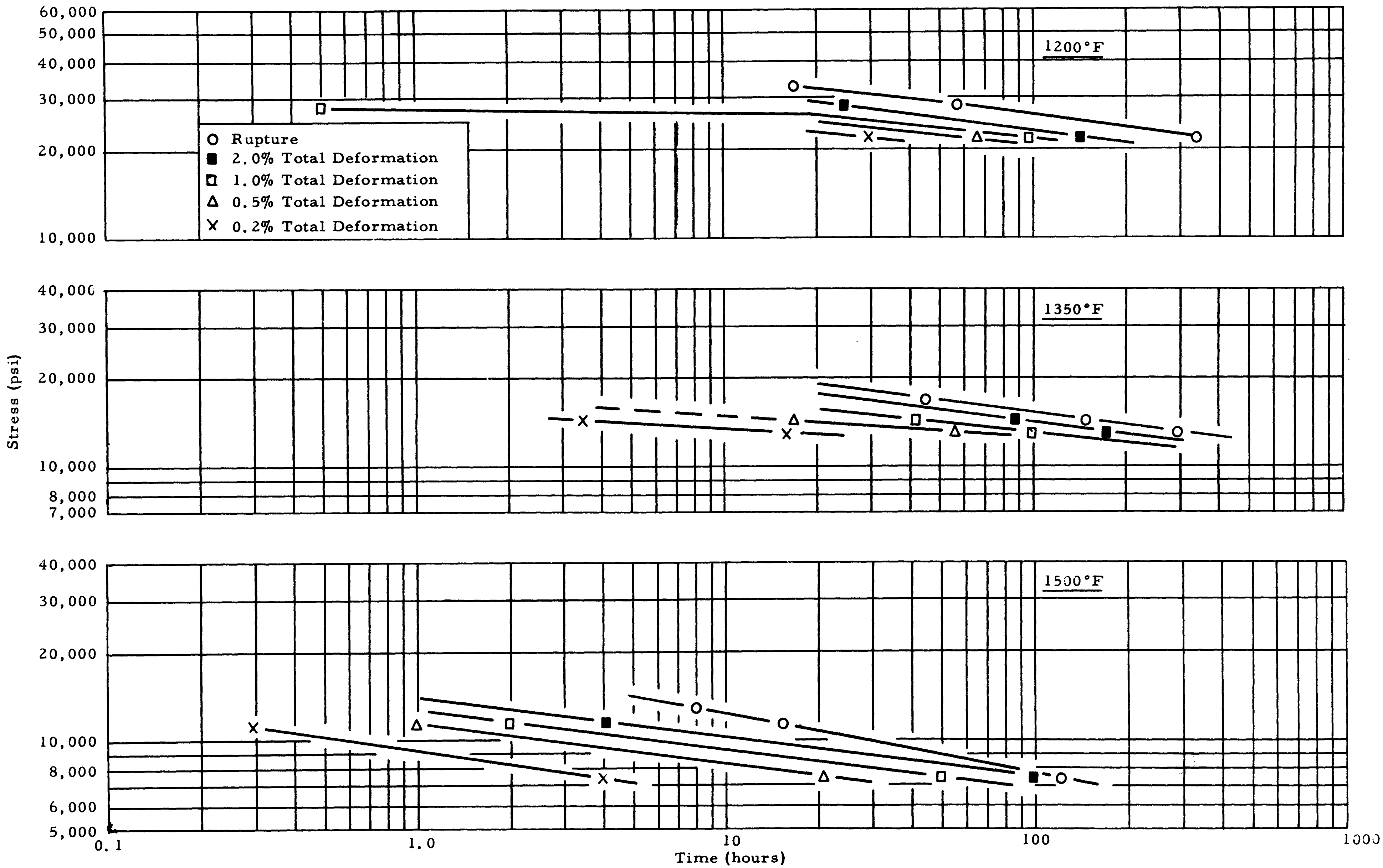


Figure 23. - Design Data Obtained from Stress-Rupture Tests at 1200°, 1350°, and 1500°F on Type 321 Sheet Material (Heat 627967).

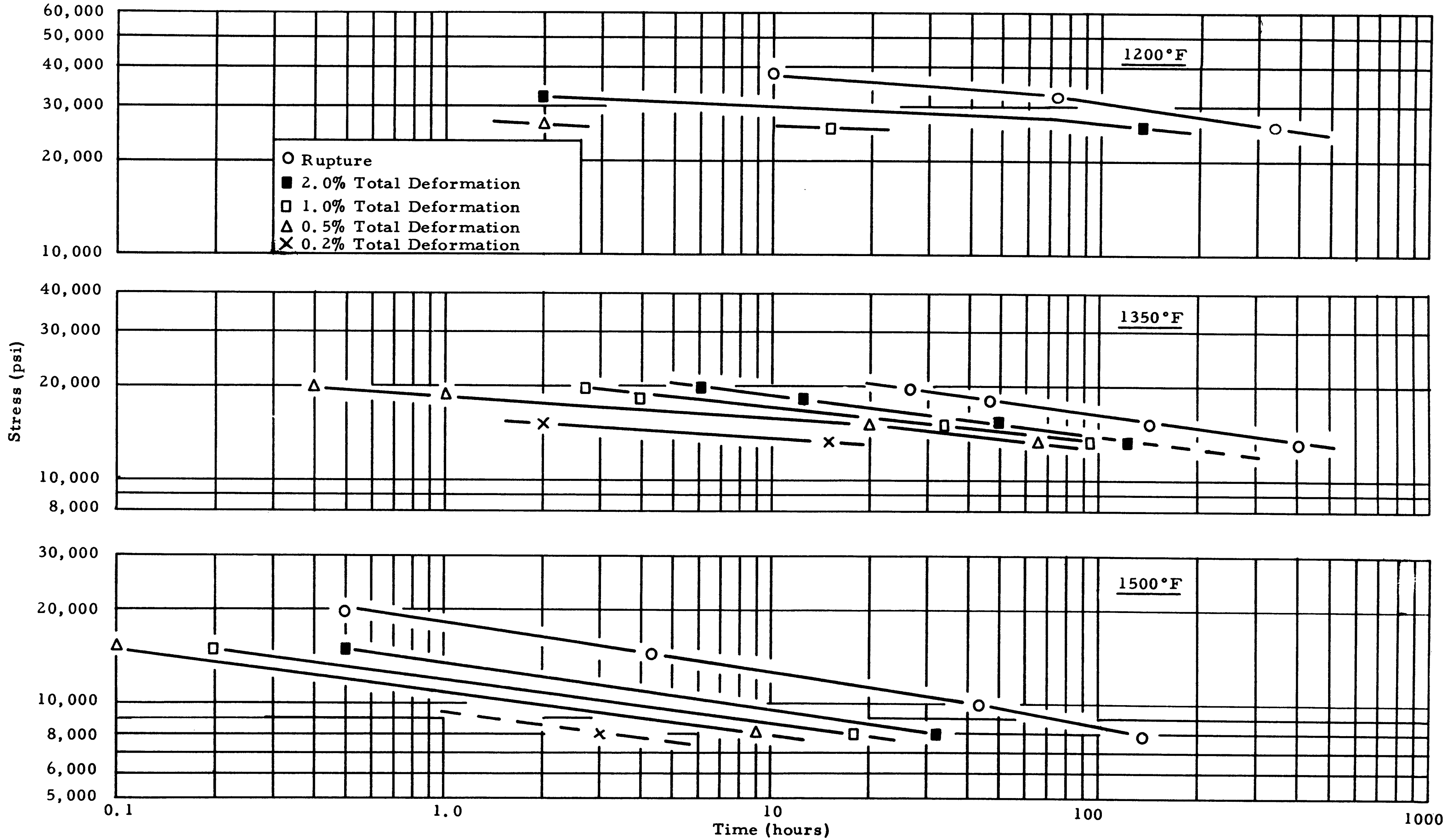


Figure 24. - Design Data Obtained from Stress-Rupture Tests at 1200°, 1350°, and 1500°F on Type 347 Sheet Material (Heat E40470).

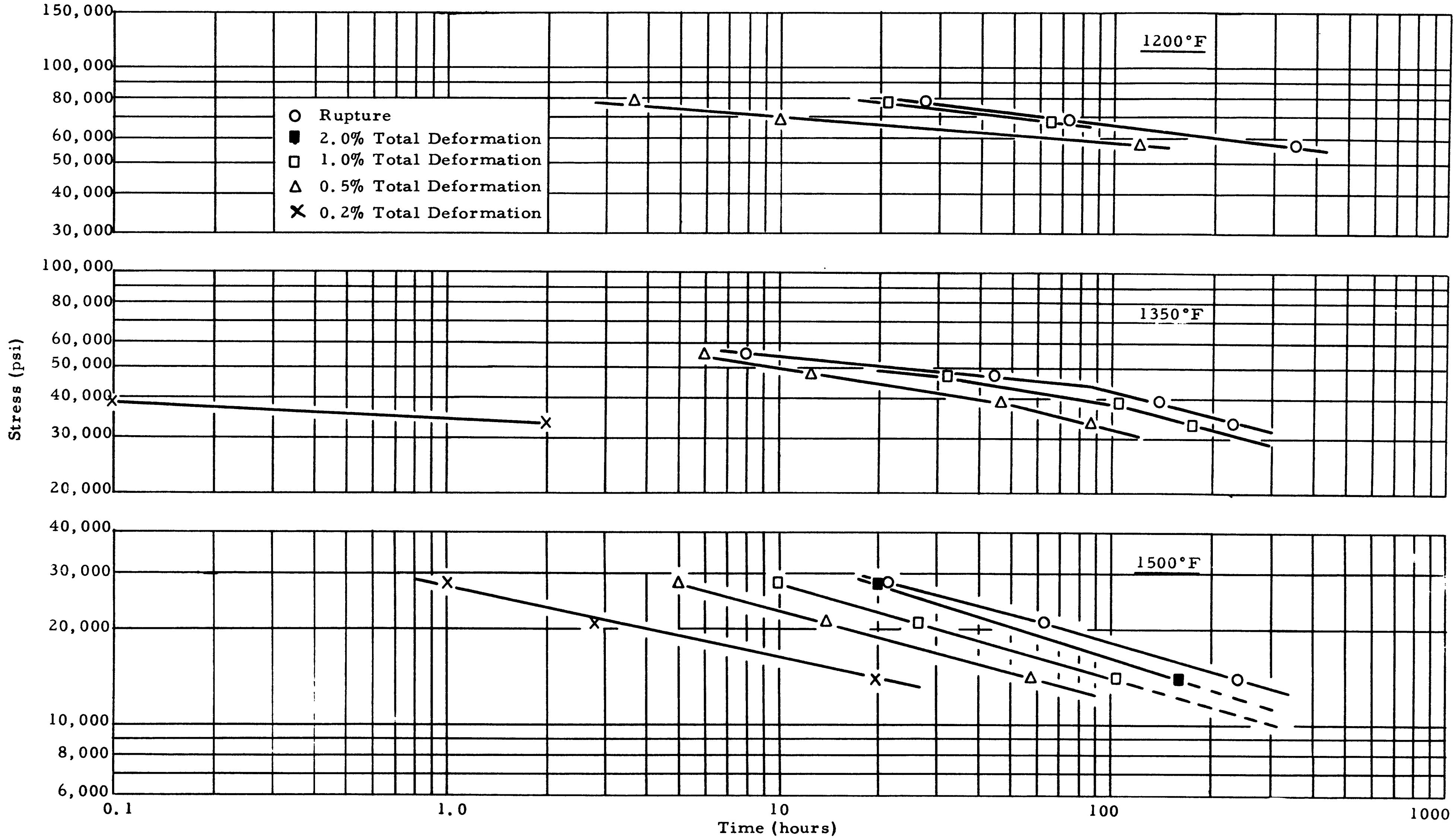


Figure 25. - Design Data Obtained from Stress-Rupture Tests at 1200°, 1350°, and 1500°F on Inconel X Sheet Material (Heat Y4602X).

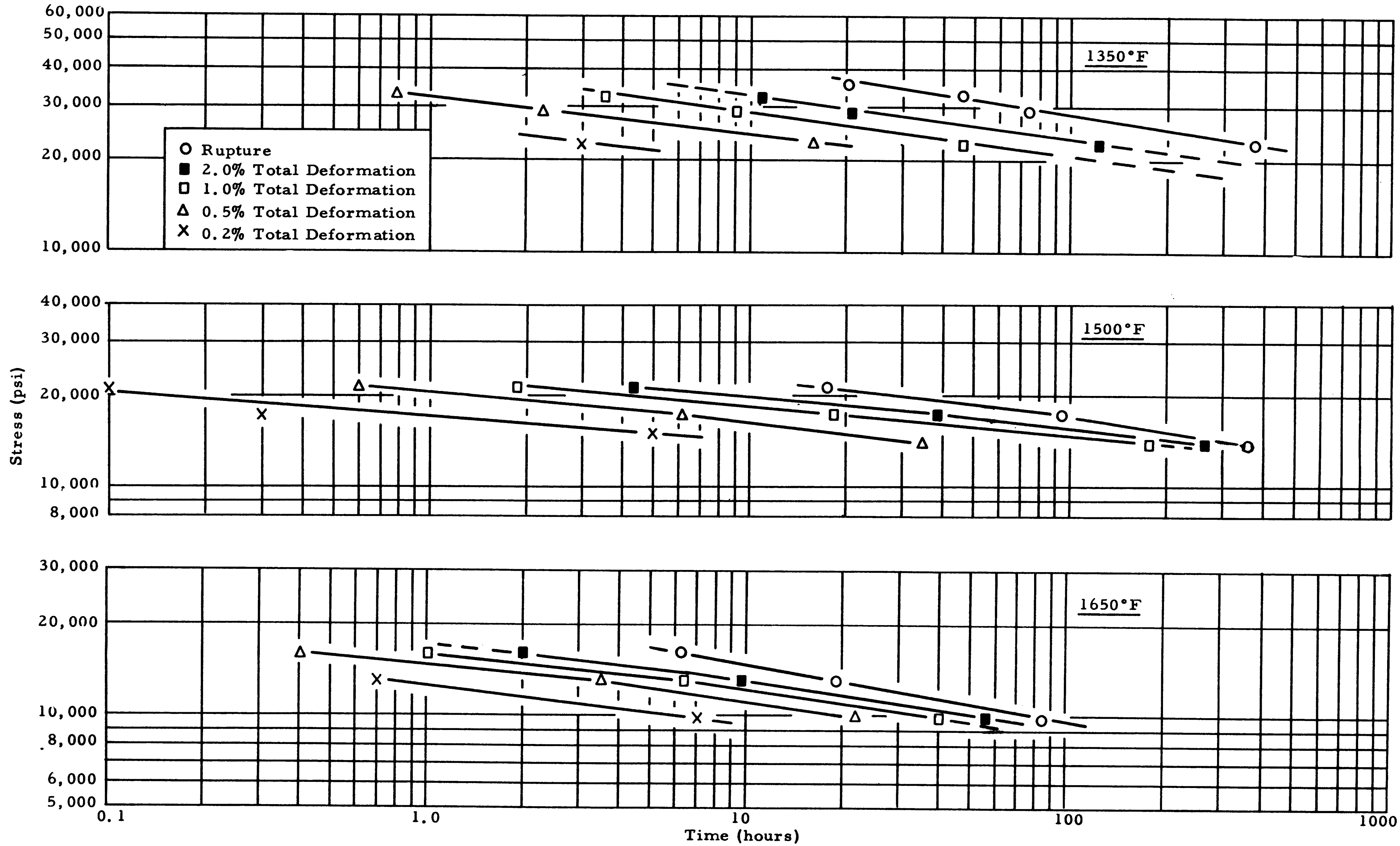


Figure 26. - Design Data Obtained from Stress-Rupture Tests at 1350°, 1500°, and 1650°F on N155 Sheet Material (Heat M206).