FINAL REPORT
on
A METHOD FOR CORRELATING ELEVATED TEMPERATURE FATIGUE DATA

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ABSTRACT

The results of a research program to develop a method for correlating elevated temperature fatigue data is reported.

Temperature parameter correlations are presented for 31 alloys at elevated temperatures and 7 alloys at low temperatures. The linear correlation is well demonstrated in the elevated and low temperature regions. Temperature ranges are included from 75°F to 1650°F and from 75°F to -423°F.

The temperature correlation method is outlined for convenient application and a tabulation of elevated temperature fatigue data for approximately 250 alloys is presented. A comprehensive bibliography of references containing elevated temperature fatigue data is included.

ACKNOWLEDGEMENT

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A. INTRODUCTION

Most of the intuitive efforts to derive a theory of fatigue, based on experimental observation, are in good agreement with the observed phenomena up to a certain point. However, in most cases the theories are not entirely satisfactory because assumptions are made that cannot be justified experimentally.(A-42)

Establishing the fatigue properties of a material is a very lengthy process requiring two to three months of testing time to obtain a creditable S-N curve. Many short time tests for predicting fatigue properties have been proposed; however, the fatigue properties obtained by short time methods have yet to be proven reliable.(A-153) Consequently, many thousands of hours have been expended in the collection of fatigue data and a great amount of fatigue data has been accumulated in the past 10 years. However, in the area of elevated temperature fatigue testing relatively little useful S-N data is available.

The design engineer working with mechanical and structural applications at elevated temperature finds meagre information about the behavior of materials in fatigue. The existing elevated temperature fatigue data for the alloys in high temperature applications is very sparse and in many cases the designer makes an "educated guess" about fatigue behavior. When new materials are developed for elevated temperature applications the designer can only estimate the fatigue behavior from other elevated temperature mechanical property data.

Fatigue testing at elevated or low temperatures is expensive and particularly time consuming. The different design considerations generally impose a large number of test conditions that cannot be satisfied without a comprehensive fatigue test program. Since time is usually the principal consideration, fatigue properties are often superficially examined to establish design criteria. The end result is the non-optimum design or application of materials and structures.

Most of the information available about elevated temperature fatigue behavior has been derived from experimental test programs. The S-N curve, usually obtained in test programs in material evaluation and determining effects of a variable, provides the means by which the correlation of elevated temperature fatigue data is attempted herein.

An examination of elevated temperature fatigue data for any alloy reveals that the shape of the S-N curve consistently changes with temperature. It will be noted that the shape of the S-N curve is occasionally changed by other test conditions also, however, holding all test conditions constant except temperature, a correlation is possible.

The mechanism of the correlation depends on the mathematical expression selected to describe the S-N curve. The exponential form ($Y = Ae^{-k(x)^m} + d$), describes a family of curves similar to straight lines or rectangular hyperbolas, depending on the values of the parameters, A, k, m and d. Describing two parameters from short-time mechanical property tests, the others are evaluated by a simple method of curve fitting and represent temperature dependent parameters which describe the S-N curve.

B. SCOPE OF INVESTIGATION

The scope of the investigation is primarily limited by the amount of elevated temperature fatigue data that was uncovered in the literature and data survey. The correlations developed in this paper are limited to the temperature parameters and do not account for or include other variables such as stress concentrations, testing methods, physical changes, etc., in the correlation. The correlation may be applied successfully to any set of fatigue data that will hold constant the following:

1. specimen geometry
2. testing method and speed
3. loading conditions (mean stress, stress ratio)
4. heat treatment, mechanical working
5. environment (other than temperature)
6. physical properties
7. surface treatment (cladding, shot peening, etc)

No rigid criterion for a useful data set is established because of the relatively small amount of elevated temperature fatigue data accumulated. S-N data with as few as five data points have been correlated. The value of the correlation is valid and may be used to the same extent in design, as the five data point S-N curve.

Elevated temperature parameter correlations have been developed for 31 alloys of 9 different base metals. (including contract identified and substitute alloys) Test temperatures as high as 0.640 of the absolute melting point temperature have been examined. It is important to note that no comprehensive data set was uncovered, that contained a complete elevated temperature mechanical property analysis, from a single experimental investigation.

Low temperature parameter correlations have been developed for 7 alloys of 3 base metals. (including one contract identified alloy) Test temperatures as low as 37°R have been examined and correlated. It is also important to note, that no data set of fatigue or other mechanical properties containing low to high temperature information was uncovered.

The exponential equation presented in Section III and IV

$$S = (TS' - E')\, e^{-k(\log_{10}N)^m} + E'$$

is used to describe the S-N curve. The parameters TS' and E' are obtained from the elevated temperature tensile strength, the parameters k and m are obtained by the "method of least squares" and correlated with temperature. Once the correlation of the parameters m and k with temperature is established, an S-N curve for any temperature may be predicted by interpolating values of m in the following manner:

1. values for the parameters m and k are determined from the linear correlation,
2. the elevated temperature tensile strength and elastic modulus are determined at the temperature selected from a stress-strain diagram.(short-time test)
3. The equation is then solved for values of S by selecting values for N.
4. The resulting S and N values are plotted to obtain the predicted S-N curve.

The entire approach to this correlation method; data analyses, selecting the S-N equation and developing the correlation with temperature has been functional from beginning to end. The method is based only on the phenomenological evidence of fatigue and is developed in a functional manner.

C. OBJECTIVES OF THE RESEARCH PROGRAM

1. To provide linear elevated temperature correlations for fatigue data of a significant representation of metal alloys.

2. To examine the feasability of extending the correlation method to predict fatigue properties at cryogenic temperatures.

3. To develop a reliable method for correlating elevated temperature fatigue data and to apply this method to predict elevated temperature fatigue properties.

4. To develop a mathematical relationship for the S-N curve that would describe the experimental S-N curve with the same degree of accuracy as existing statistical methods.

5. To accumulate a comprehensive bibliography and compilation of elevated temperature fatigue data.

D. RESULTS AND DISCUSSION

1. Linear elevated temperature parameter correlations are presented in Figures I-1 through I-31 in section I. The indirect correlation of the temperature parameters **m** (slope) and b ($\log_e$ intercept) by using the elevated temperature tensile strength, and elevated temperature elastic modulus to obtain a linear relation with absolute temperature is demonstrated very well for all alloys.

On each Figure and Table of the elevated and low temperature parameter correlations, there is identified a group of tabulation sheet numbers. The tabulation sheets are located in section V and contain the original S-N data, the S-N curve and mechanical property information useful in the correlation procedure.

The following Figures show certain variations that are noteworthy of discussion:

a. Figures I-2, 3, 4, have shown a single point far below the correlation curve. This point (in each Figure) was obtained at room temperature using a different testing method. The material was the same, however specimen geometry was different. This demonstrates the effect of varying other parameters with temperature.

b. Figures I-10, 11, 13, are plotted with two points, meaning that elevated temperature fatigue data was available for these materials at two temperatures only. No useful information regarding the validity of the correlation can be obtained from these data. The information was included because the alloys were identified in the research contract.

c. Figure I-12, 16, 24, 29, contain a considerable amount of deviation from a linear correlation. The data used to obtain the original S-N curves for Figures I-16, 24, were limited to 5 to 7 data points. With an expected data scatter of 10 to 1 at any stress level, the true S-N curve could not be obtained from such data, the correlation is also not anticipated.

   In Figure I-12, the original S-N data were obtained from variety of test and specimen conditions. A good elevated temperature parameter correlation was not

anticipated.

Figure I-29 is difficult to analyze because the original S-N curve was obtained from a fairly large population of data points. The correlating mechanical property data was obtained by request letter and little explanation can be given. By comparison, Figure I-30 was obtained from the same reference under similar laboratory conditions and the degree of agreement is excellent.

The remaining correlations, with individual exceptions for single points, illustrate that the linear correlations of temperature parameters is fairly well defined.

2. The linear correlations of low temperature parameters presented in Figures II-1 through II-7 illustrate that the correlation method is applicable to the low temperature region. Figure II-4 describes a good linear correlation for 7075-T6 Aluminum down to $37^{\circ}R$ ($-423^{\circ}F$). The low temperature fatigue data is well correlated using the method outlined in section III.

No fatigue data was available, in a temperature range from cryogenic to elevated temperatures, with the same test conditions that would permit a good test of the correlation method.

3. The correlation method, as outlined in section III, is applied to the data set for 6Al-4V Titanium (Figure I-27) to illustrate how the S-N curve may be predicted for a material that has been correlated. The procedure is regimented to insure an objective analysis of the data.

4. The mathematical relationship for the S-N curve

$$\left[\frac{TS' - E'}{S' - E'}\right] = e^{k(\log_{10} N)^m}$$

is shown to describe the S-N curve adequately to permit convenient evaluation of all temperature parameters. The comparison of the S-N equation with the mean S-N curve for the 6Al-4V Titanium alloy demonstrates the

accuracy of the equation. (Section IV)

5. The bibliography and tabular compilation of elevated temperature fatigue data in section V represent a comprehensive survey of the literature for elevated temperature fatigue information. Although more than 3,000 references to fatigue testing were uncovered and examined, only 114 of these references contained elevated temperature fatigue data. The data available in many of the references (and particularly the data provided the research effort by industrial concerns) was of little use to the correlation because no S-N curves were established. Many of the tests were conducted at one stress level to establish a finite lifetime for a material or component to experience a particular load spectrum. Such information was of little value and could not be correlated with other test programs.

It was quite surprising to discover the sparsity of elevated temperature fatigue data about alloys developed for elevated temperature applications. The manufacturers and fabricators using the stainless steels in particular, were quick to advise that little or no elevated temperature fatigue data was available.

A tabular list of technical publications examined, and industrial concerns that provided elevated temperature data of some form is presented in Section V with the data compilation.

E. RECOMMENDATIONS

One of the implicit objectives of the research effort was to obtain a comprehensive data set of S-N curves. Although this objective was not achieved, the ideal data set would have included the following information:

1. 40 to 50 data points per S-N curve
2. S-N curves for 6 or more temperatures
3. A temperature range from approximately -300°F to 1000°F
4. Mechanical property data (F_{tu}, E, etc.) obtained at the same test temperatures from the same melt or heat of material.

The value of such a data set to the correlation is obvious, a linear correlation of such data would confirm the method for the most skeptical reader.

The linear correlations obtained in this effort are too consistent to be accidental, and cover too many alloys of different base metals to be restricted in application.

It is therefore, recommended that a comprehensive program, similar to the one stated above, be undertaken for at least 2 base metal alloys to confirm the method of correlating temperature parameters. The program would provide additional useful information if the materials selected for testing were recent developments that had not been evaluated in fatigue or other mechanical properties at low and elevated temperatures.

I. ELEVATED TEMPERATURE CORRELATION OF FATIGUE DATA

A. Index of Materials Correlated at Elevated Temperatures

Material	Alloy	Temperature Range °F	Tabulation Sheets	Figure
Aluminum	2014-T	RT-400	87-89	I-1
	2014-T	RT-500	25-28	I-2
	2014-T6	RT-500	127-130	I-3
	2024-T4	RT-500	131-134	I-4
	5052-H36	RT-500	139-141	I-5
	6053-T6	RT-500	142-144	I-6
	6061-T6	RT-500	135-138	I-7
	7075-T	RT-400	90-92	I-8
	7074-T6	RT-500	123-126	I-9
Beryllium	QMV	RT-1100	33-34	I-10
Magnesium	HK31A-H24	RT-400	44-45	I-11
Inconel	"X"	RT-1500	1-5	I-12
	"X"	1350-1500	145-146	1-13
	700	RT-1500	52-56	I-14
	718	RT-1400	6-9	I-15
Steel	Cr-Mo	RT-932	79-84	I-16
	4130	RT-800	93-95	I-17
	4340	RT-1000	35-38	I-18
Stainless Steel	403	RT-900	102-105	I-19
Nickel Base	Udimet 500	RT-1650	57-59	I-20
	N-155	RT-1500	10-14	I-21
	GMR-235	RT-1500	76-78	I-22
	Hastelloy	RT-1500	63-65	I-24
Cobalt Base	S-816	RT-1500	60-62	I-23
	Stellite 31	RT-1600	111-114	I-25
Titanium	2.5Al-16V	RT-900	66-70	I-26
	6Al-4V	RT-900	20-24	I-27
	4Al-3Mo-IV	RT-900	15-19	I-28
	3Al-5Cr	RT-1000	46-51	I-29
	3Mn-Complex	RT-1000	115-120	I-30
Cast Iron	Austenitic	RT-1160	39-43	I-31

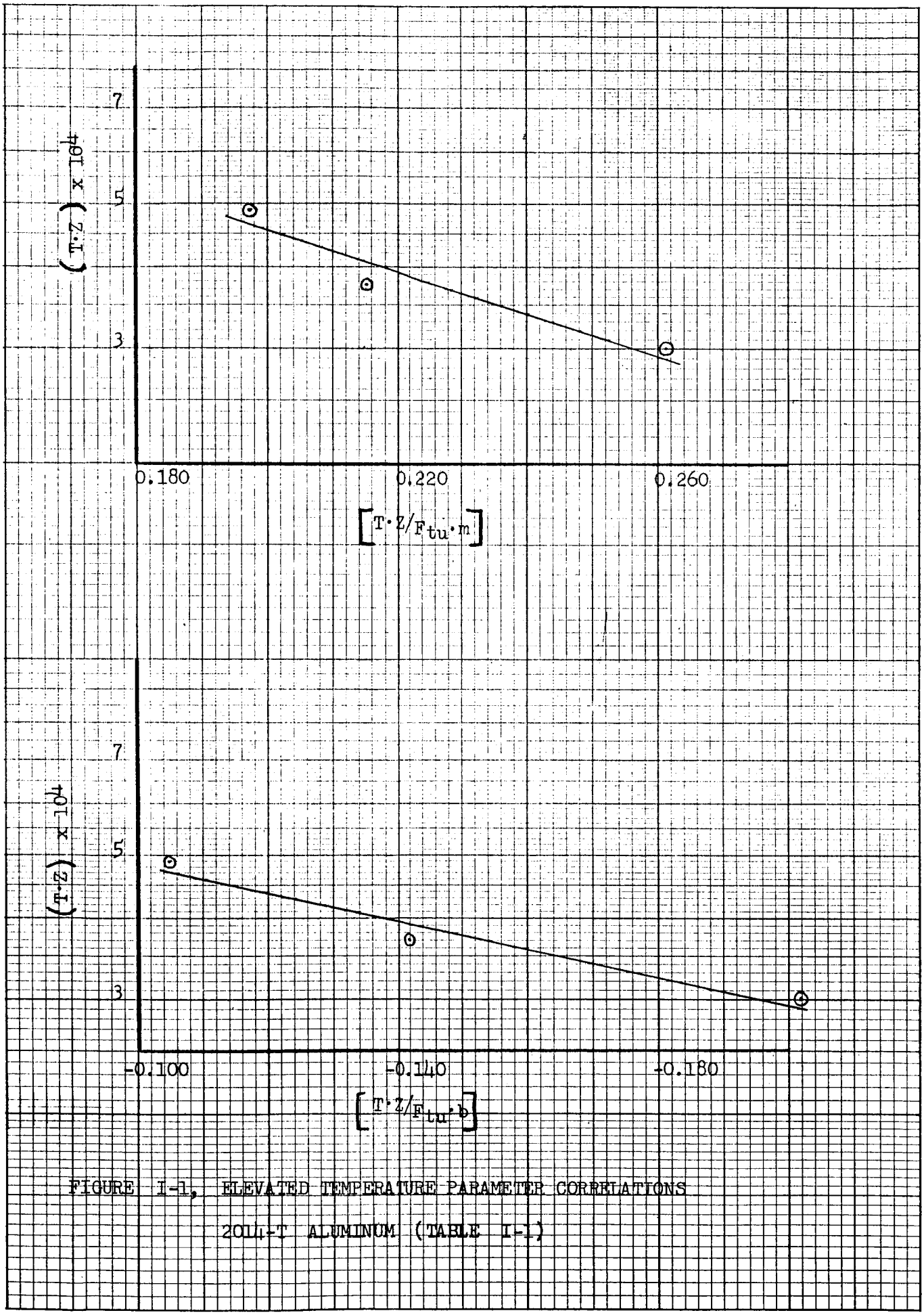


FIGURE I-1, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

2014-T ALUMINUM (TABLE I-1)

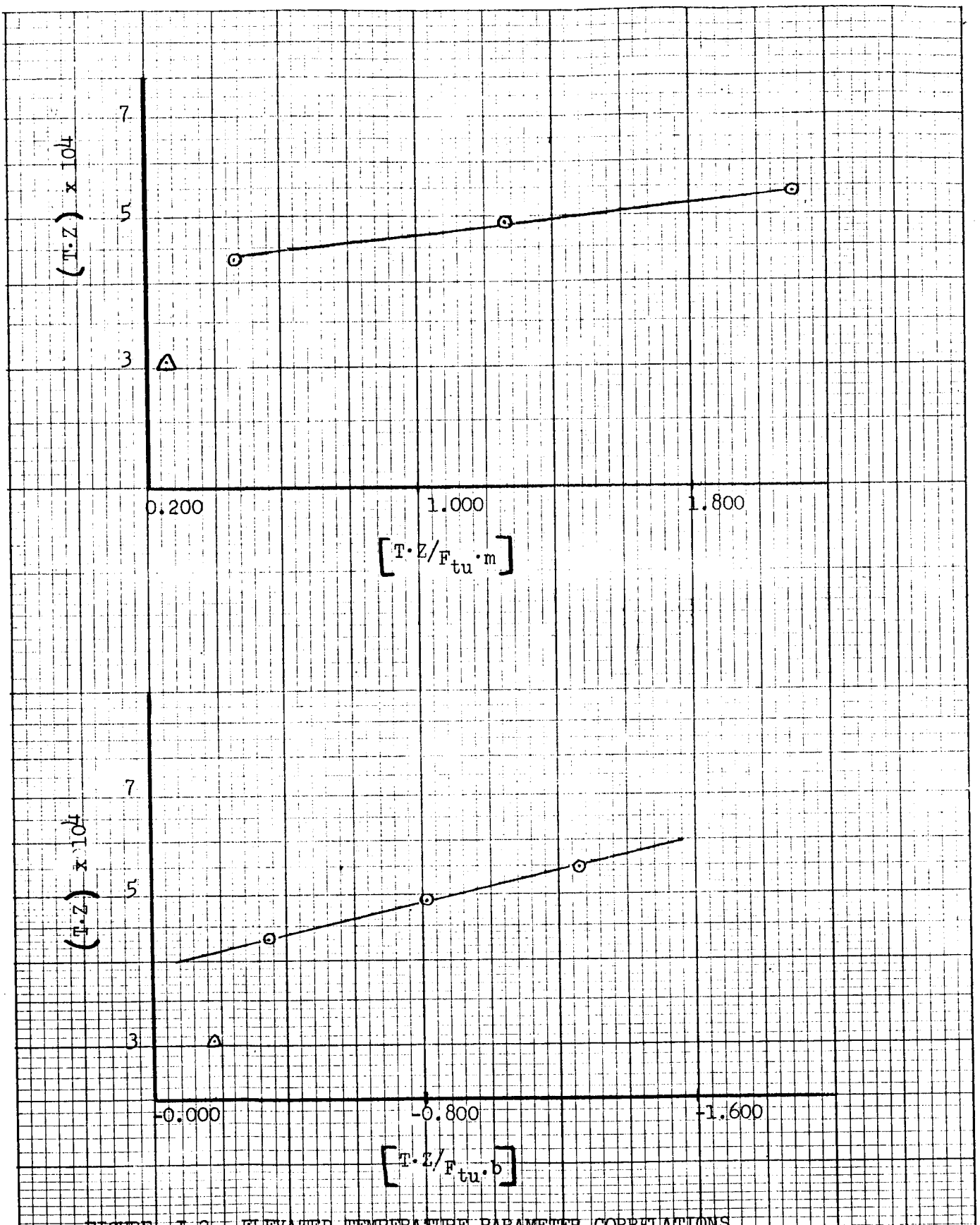


FIGURE I-2, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

2014-T ALUMINUM (TABLE I-2)

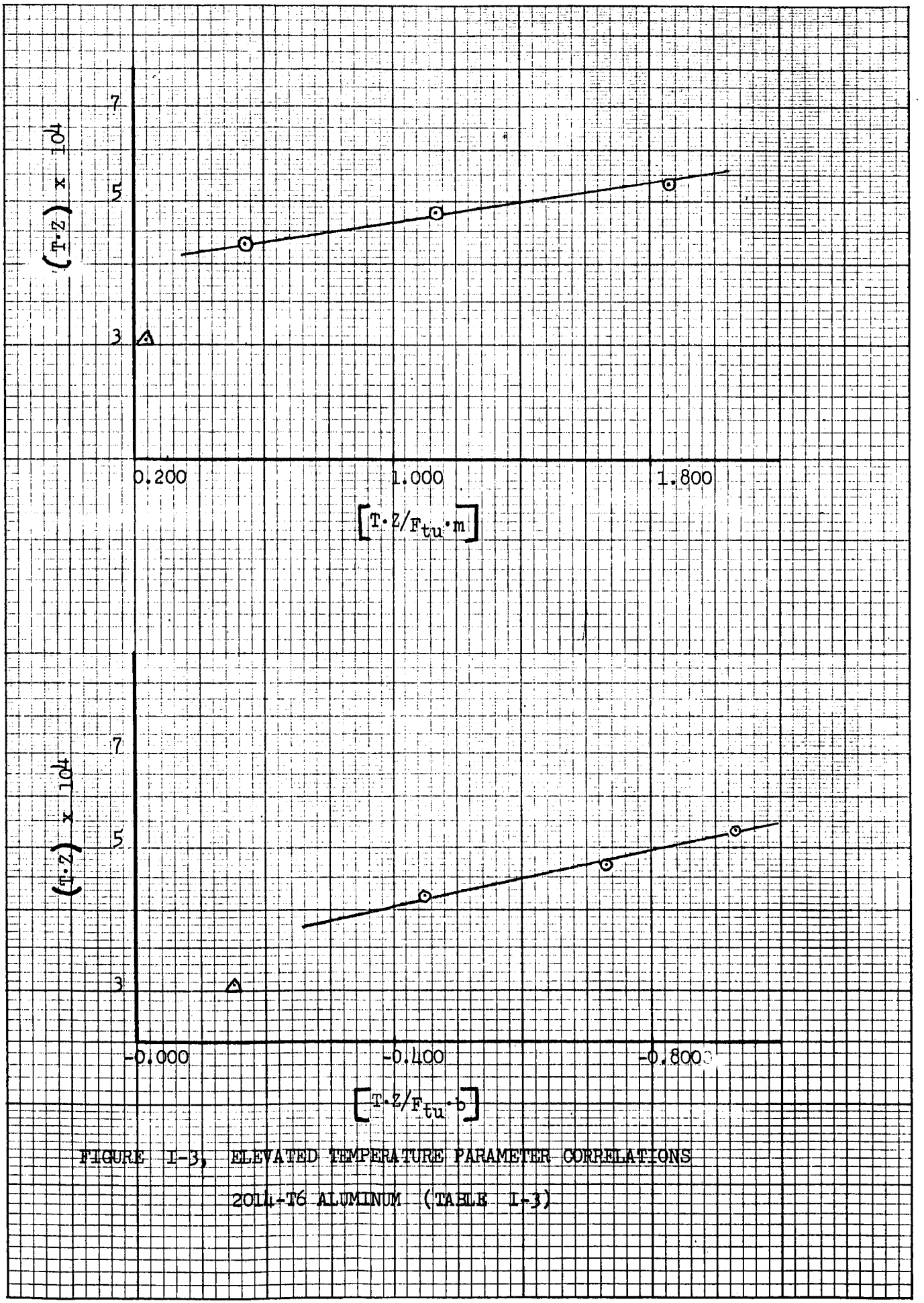


FIGURE I-3, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

2014-T6 ALUMINUM (TABLE I-3)

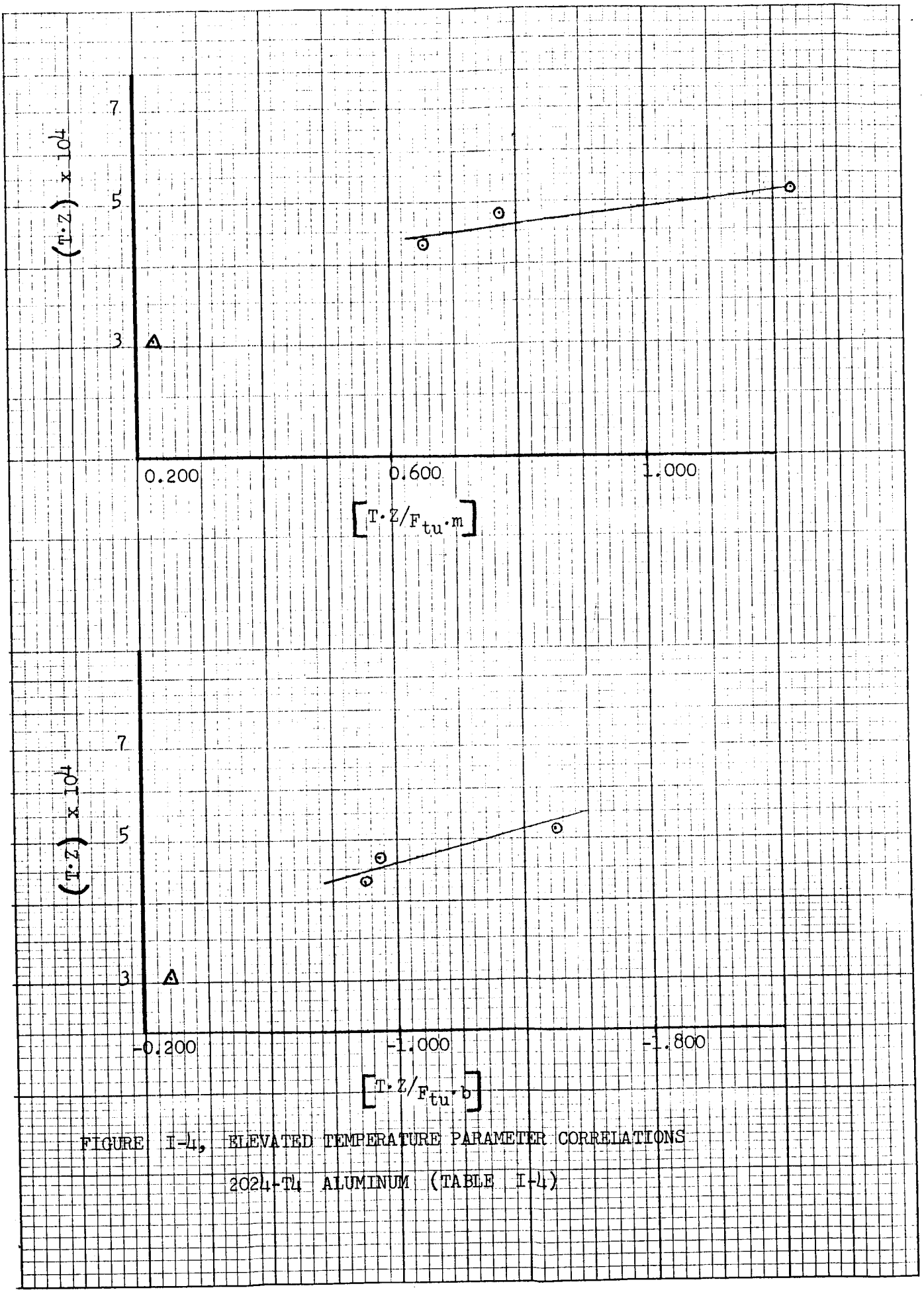


FIGURE I-4, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

2024-T4 ALUMINUM (TABLE I-4)

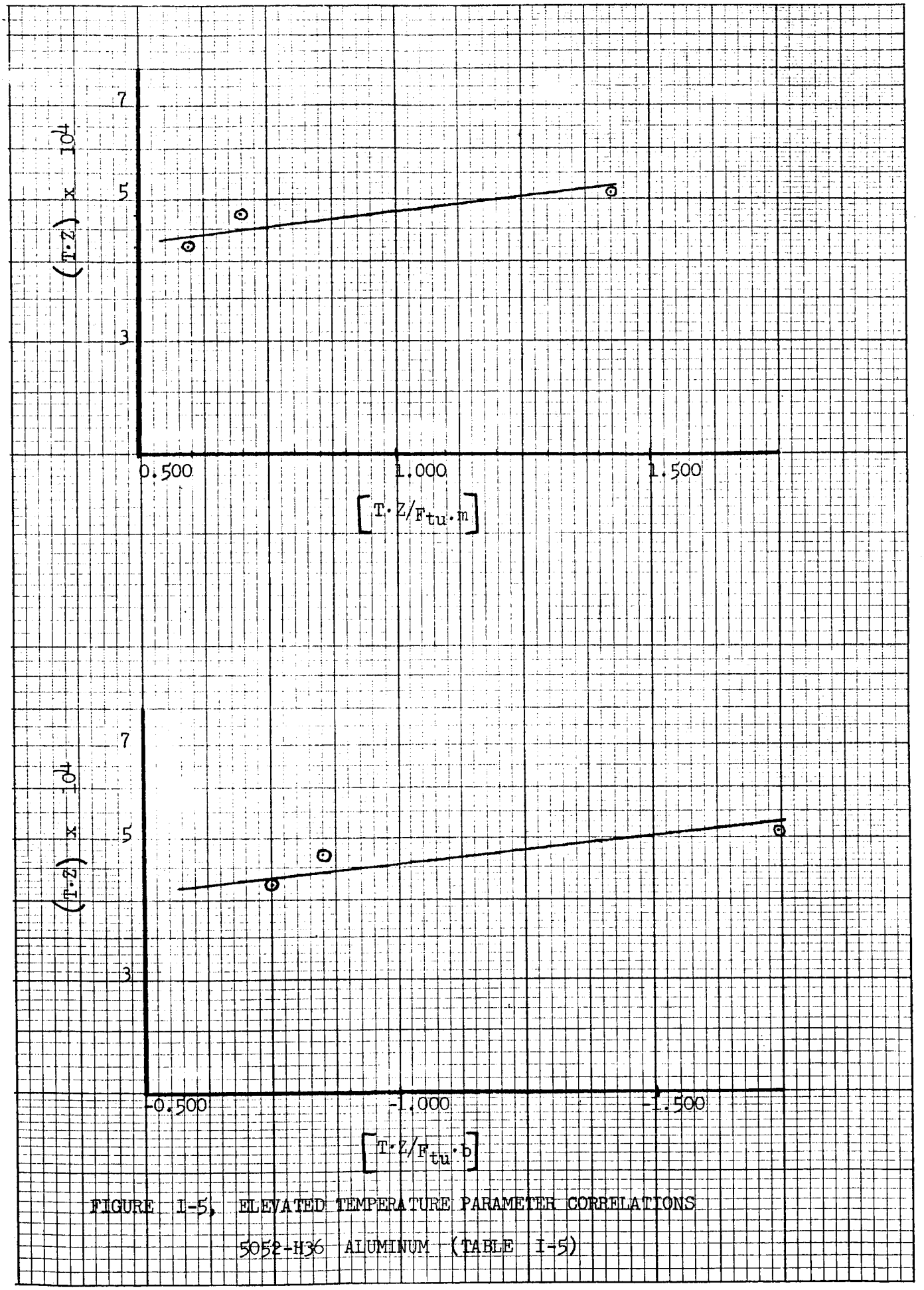


FIGURE I-5, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

5052-H36 ALUMINUM (TABLE I-5)

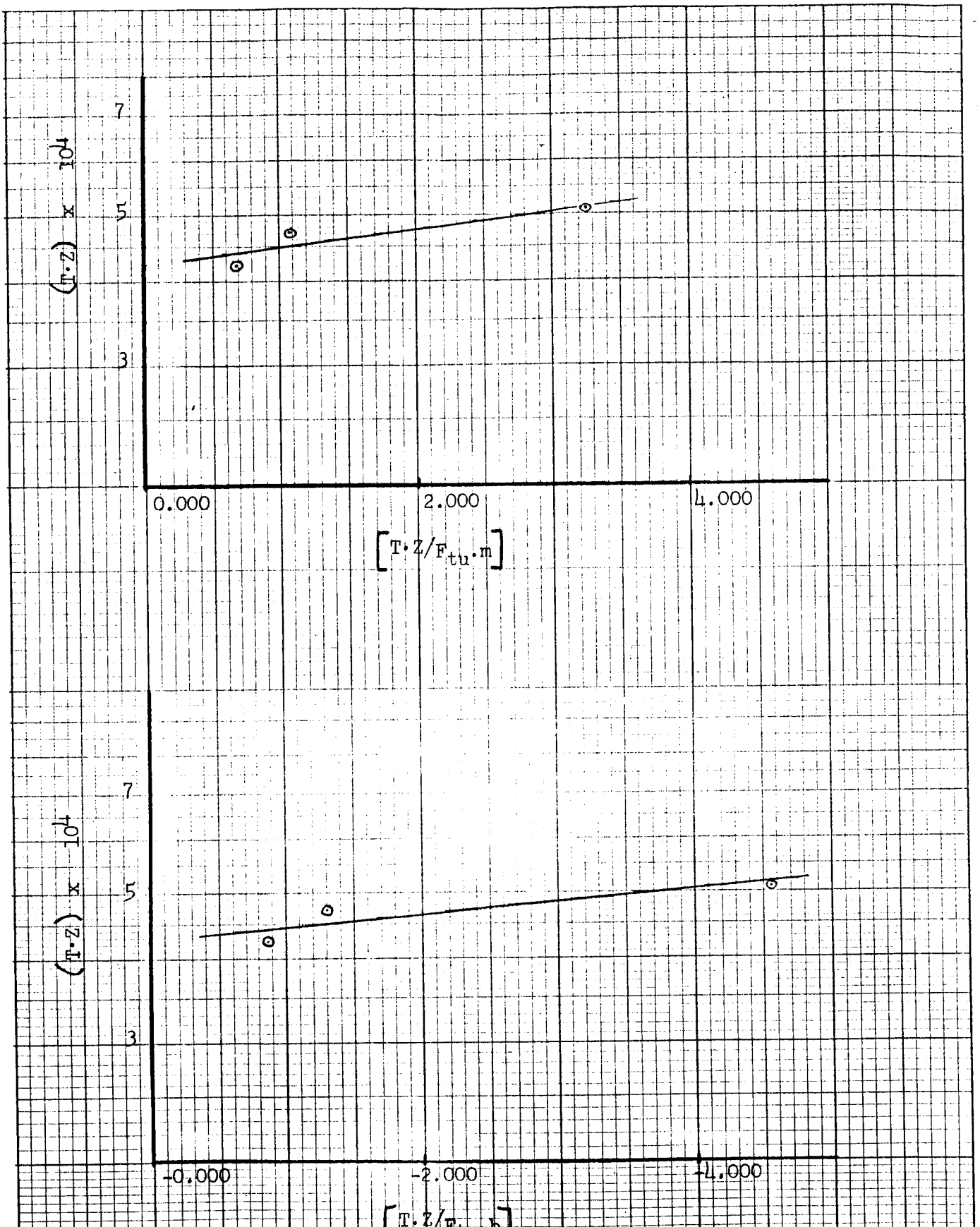


FIGURE I-6, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

6053-T6 ALUMINUM (TABLE I-6)

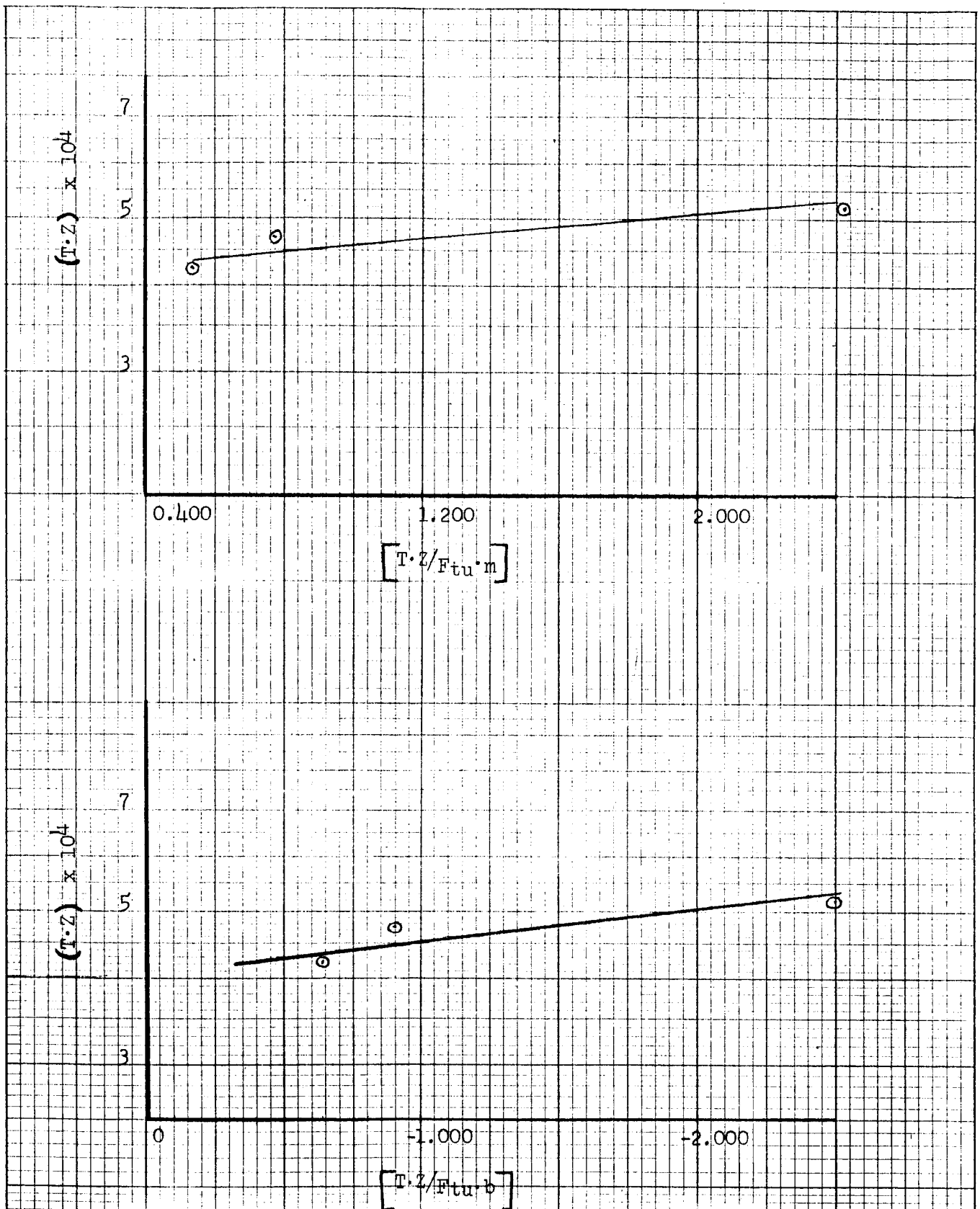


FIGURE I-7, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

6061-T6 ALUMINUM (TABLE I-7)

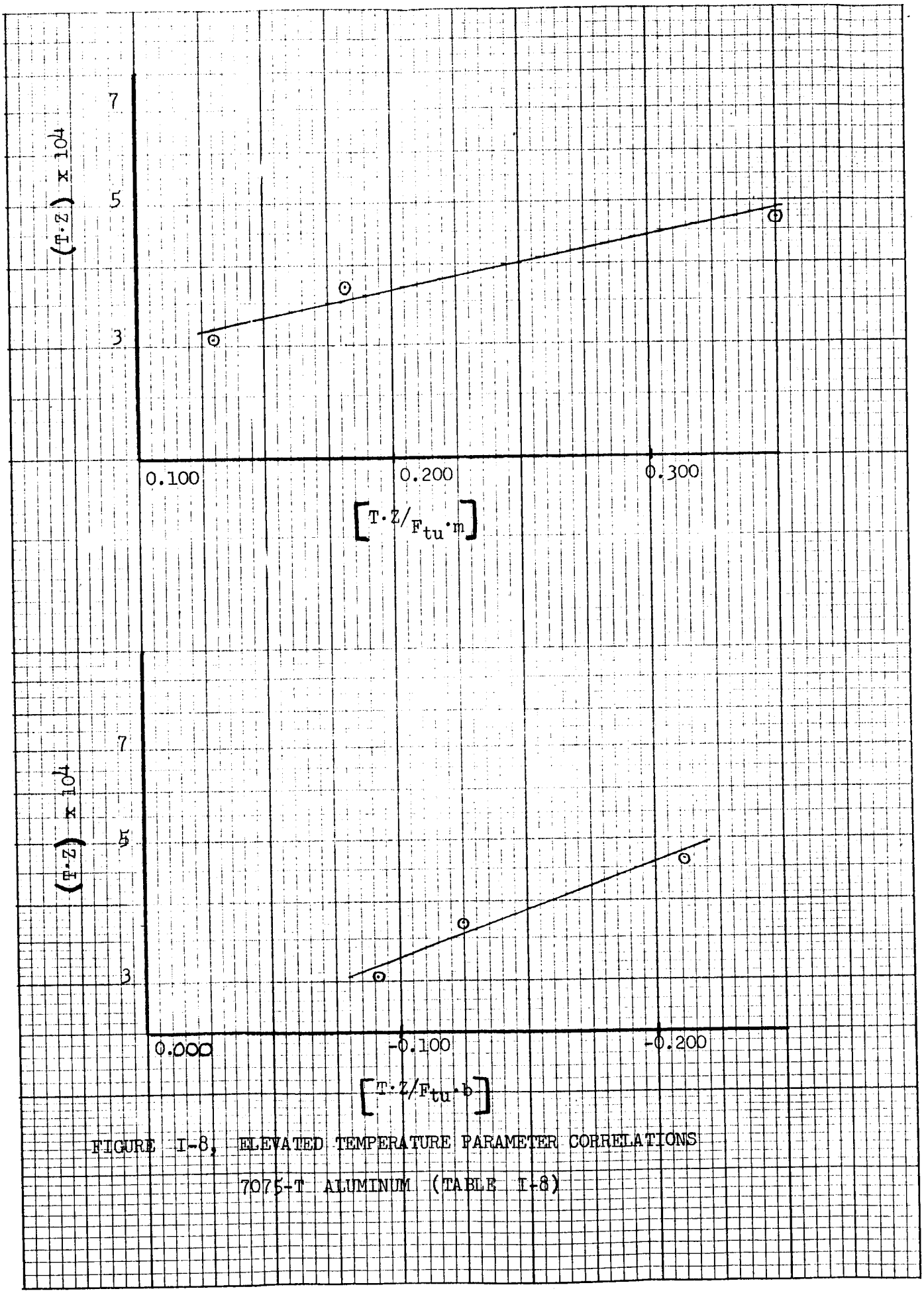


FIGURE I-8, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

7075-T ALUMINUM (TABLE I-8)

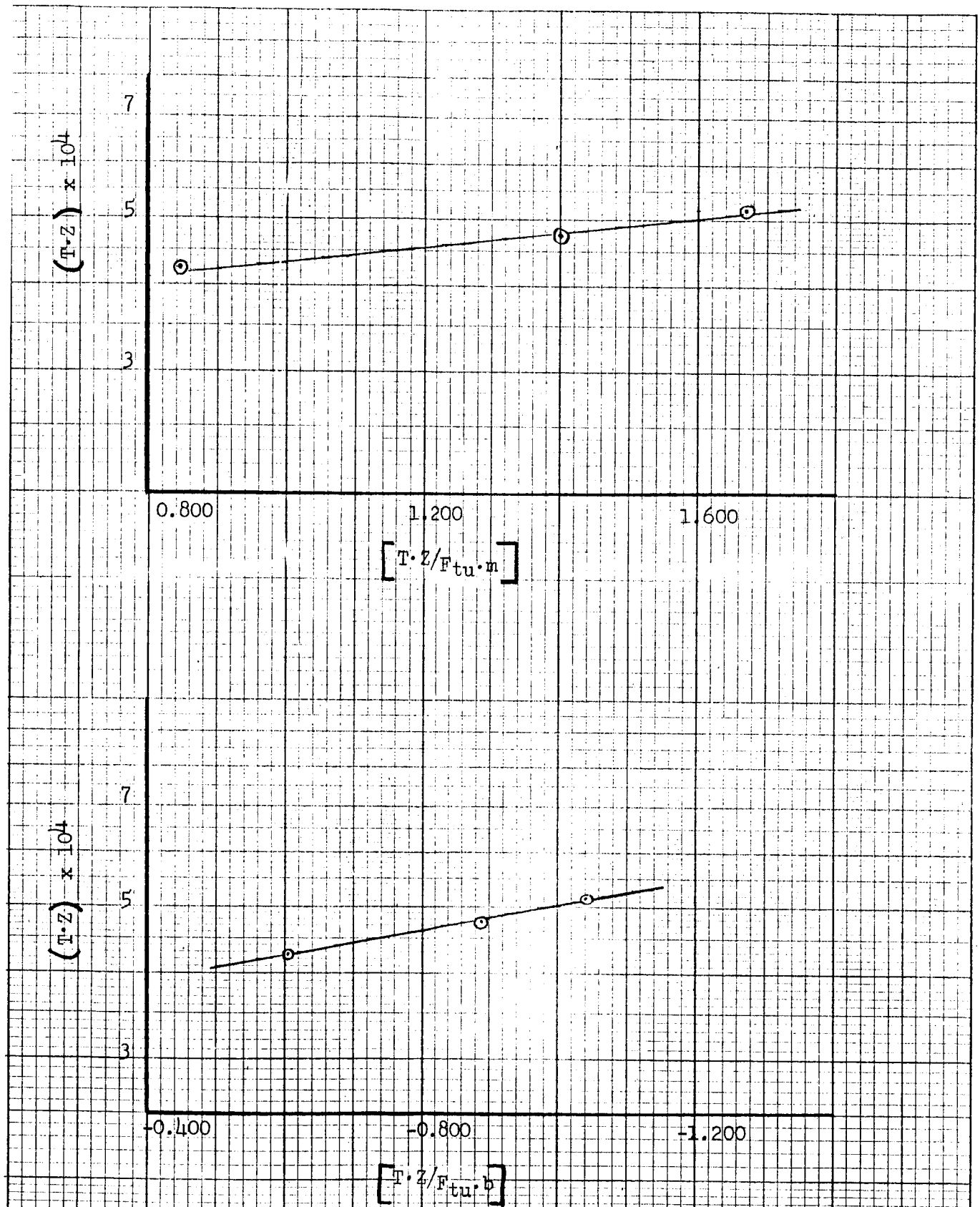


FIGURE I-9, ELEVATED TEMPERATURE PARAMETER CORRELATIONS 7075-T6 ALUMINUM (TABLE I-9)

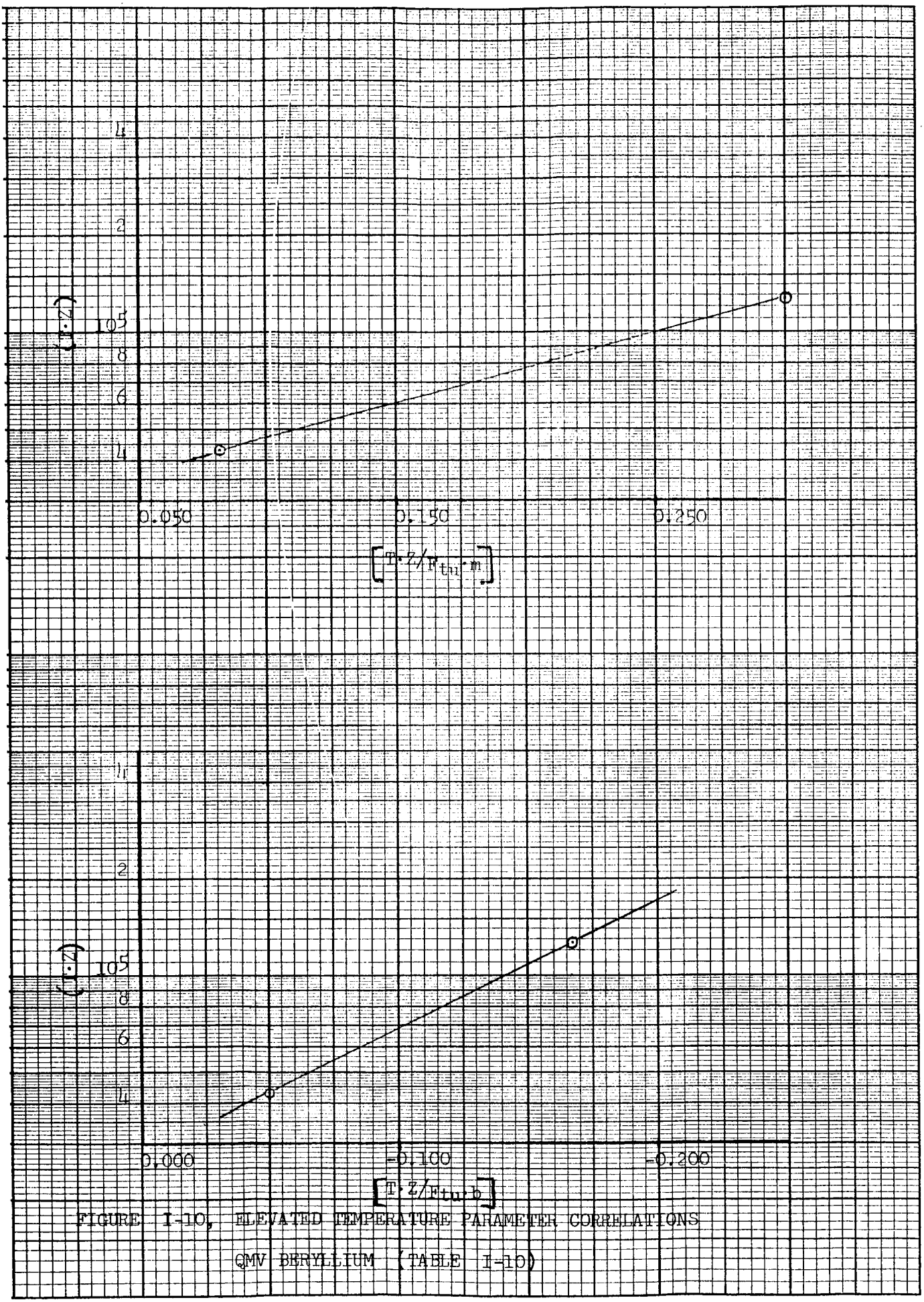


FIGURE I-10, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

QMV BERYLLIUM (TABLE I-10)

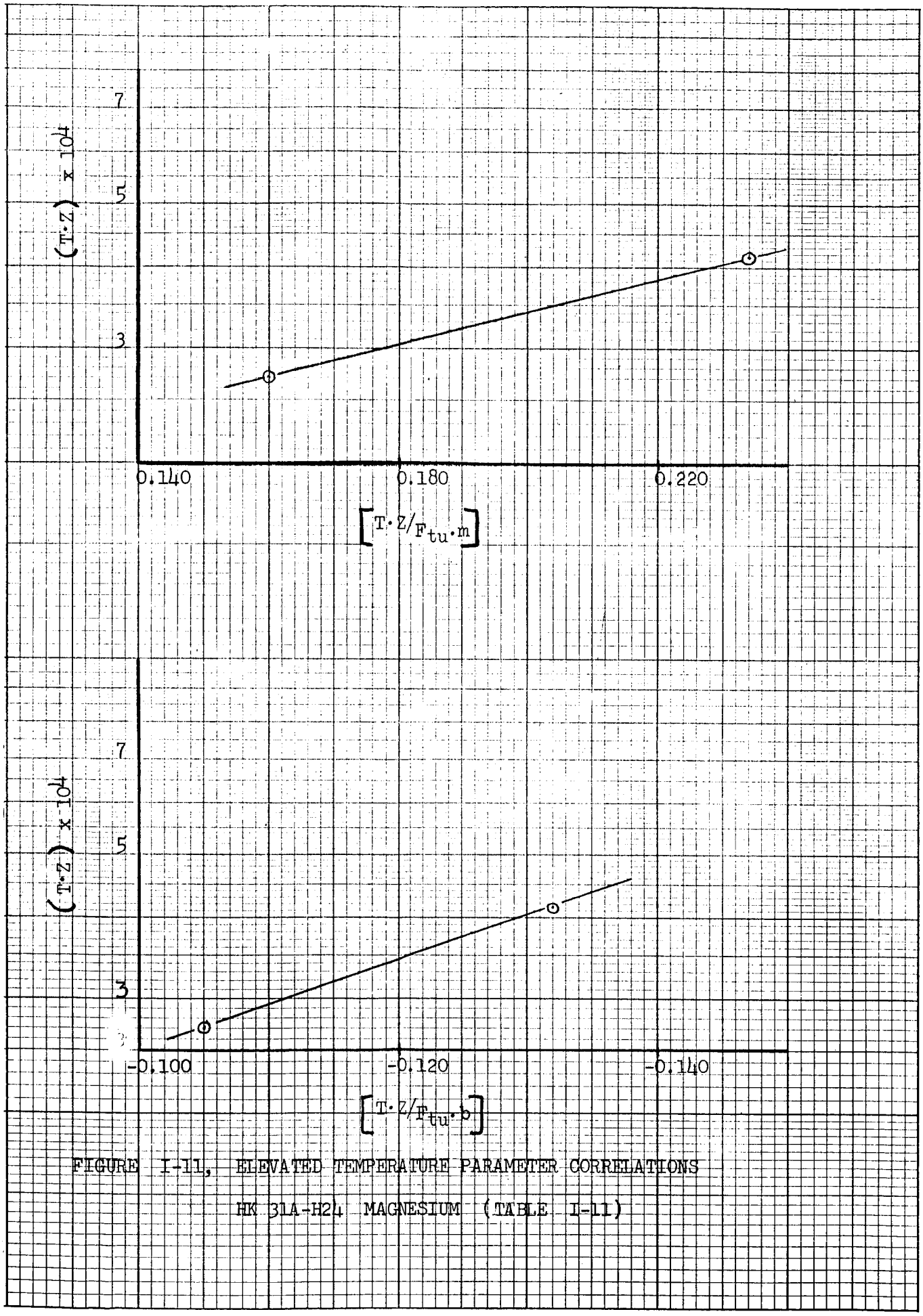


FIGURE I-11, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

HK 31A-H24 MAGNESIUM (TABLE I-11)

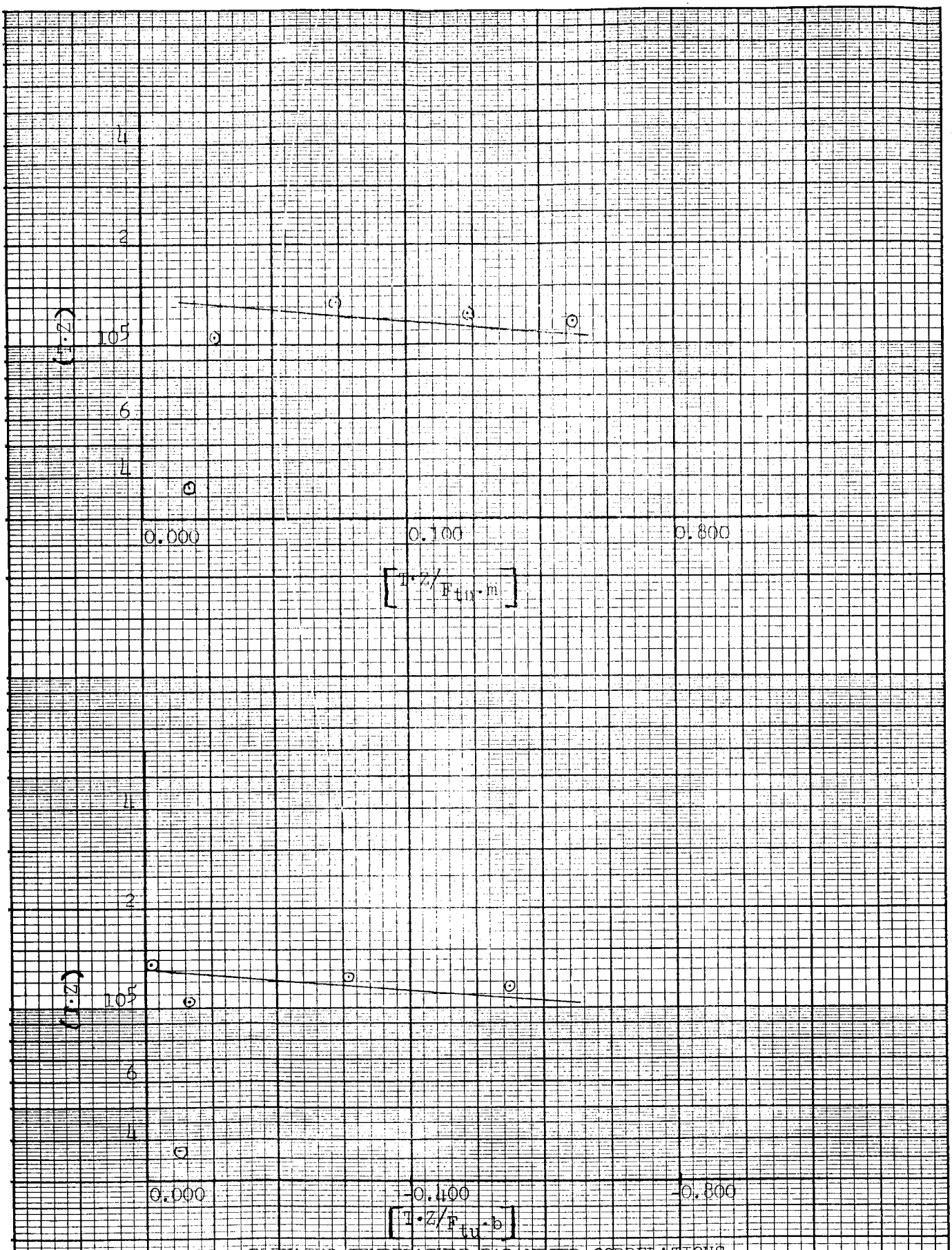


FIGURE I-12, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

INCONEL "X" (TABLE I-12)

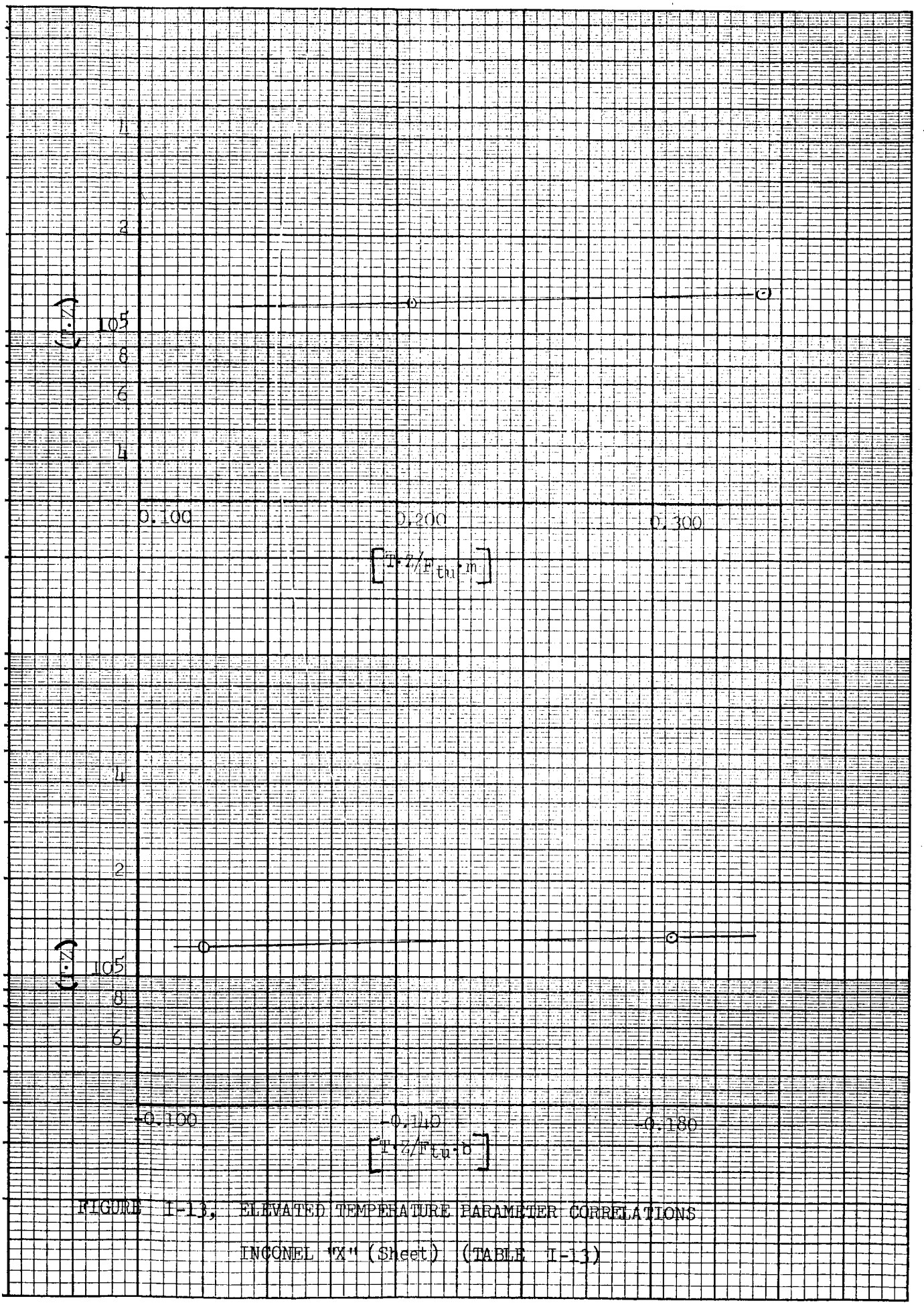


FIGURE I-13, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

INCONEL "X" (Sheet) (TABLE I-13)

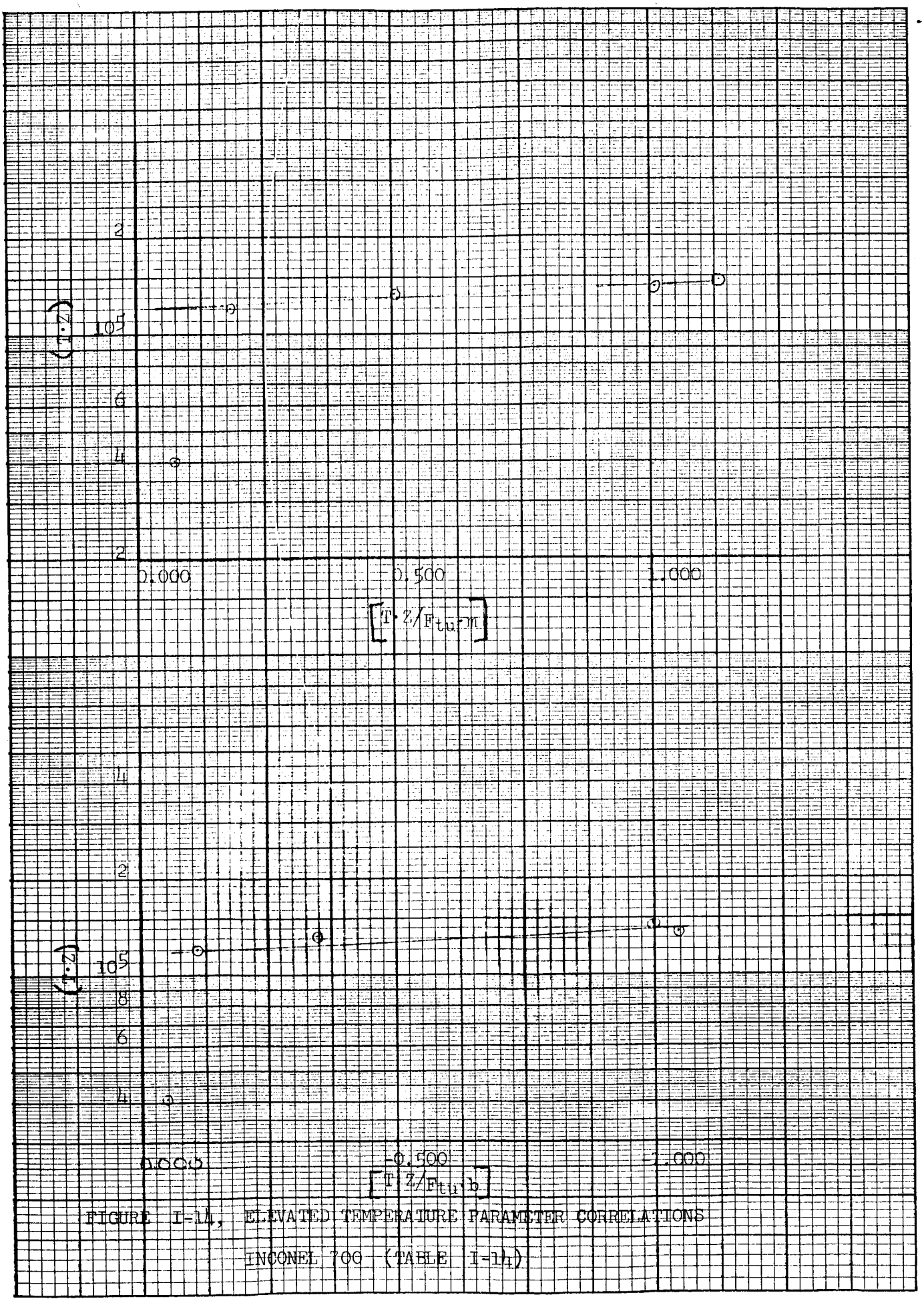


FIGURE I-14, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

INCONEL 700 (TABLE I-14)

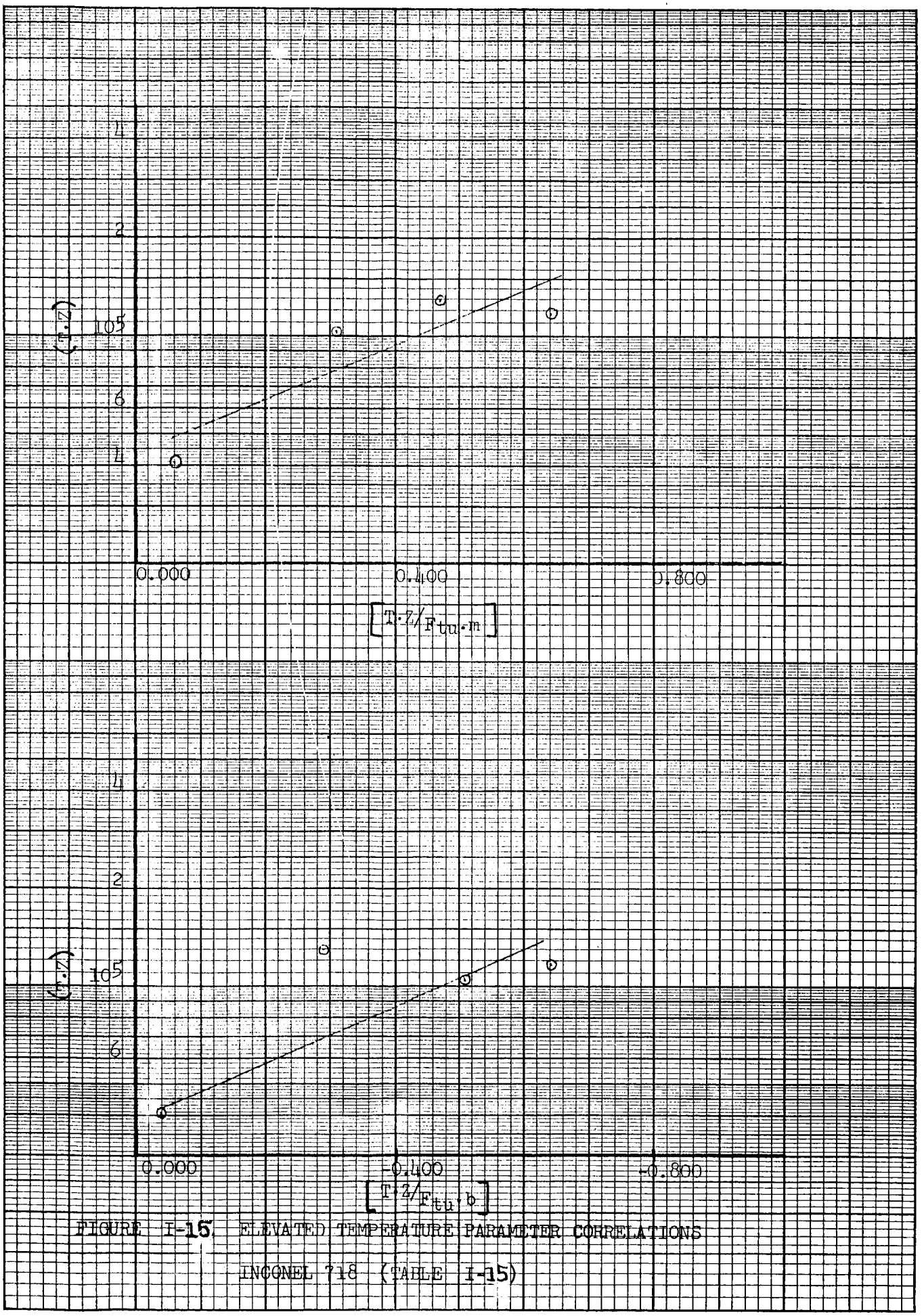


FIGURE I-15. ELEVATED TEMPERATURE PARAMETER CORRELATIONS

INCONEL 718 (TABLE I-15)

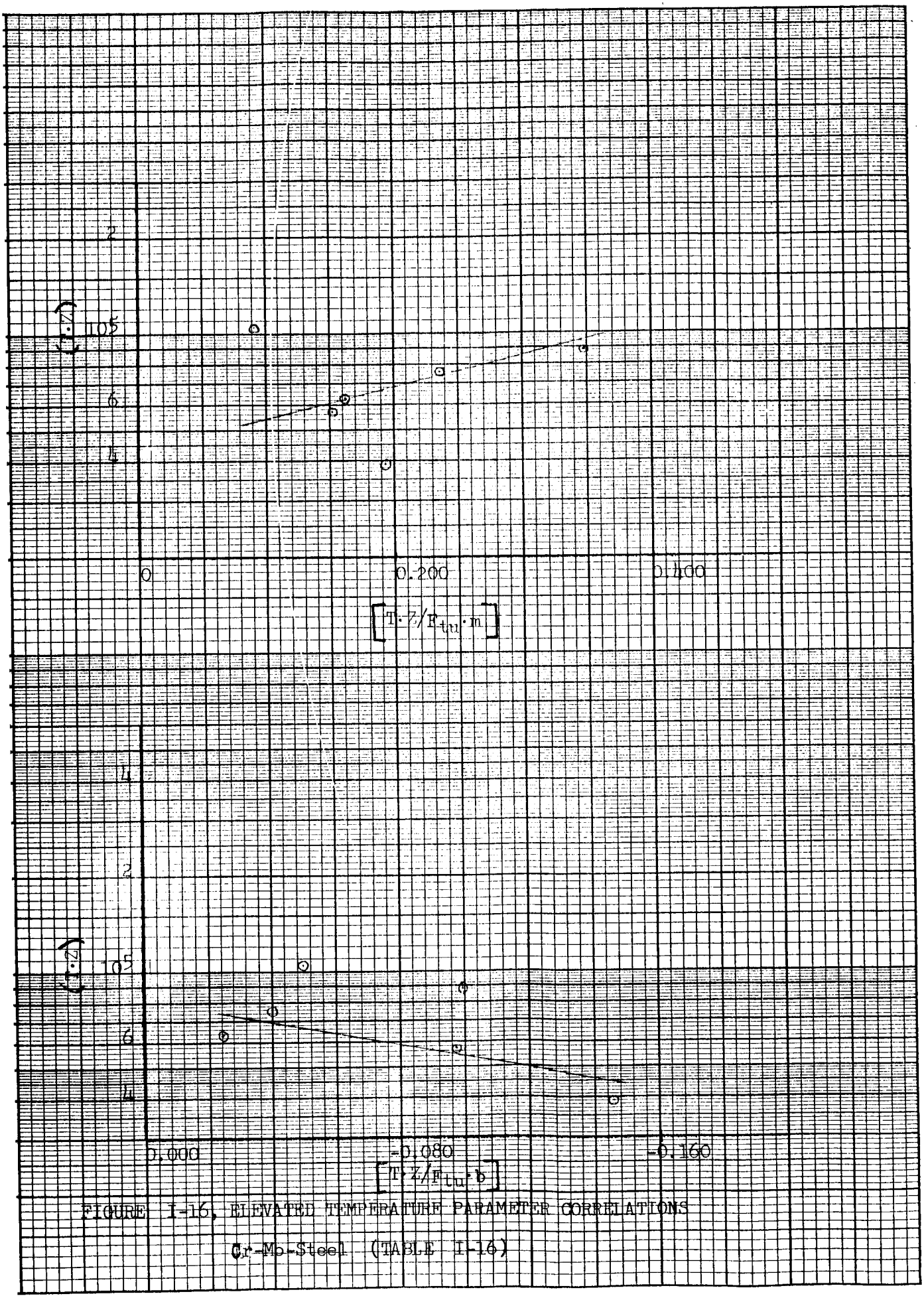


FIGURE I-16, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

Cr-Mo-Steel (TABLE I-16)

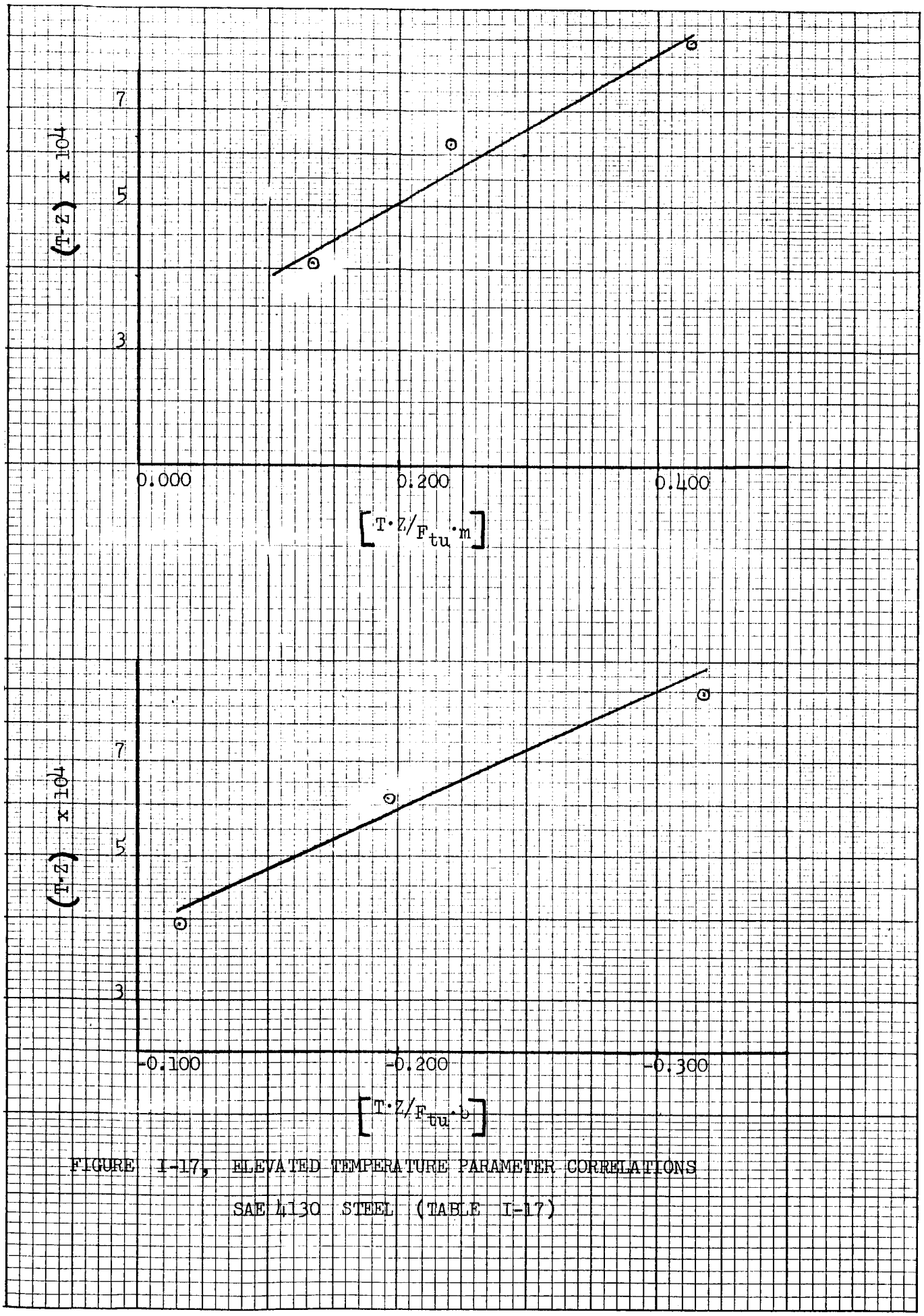


FIGURE I-17, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

SAE 4130 STEEL (TABLE I-17)

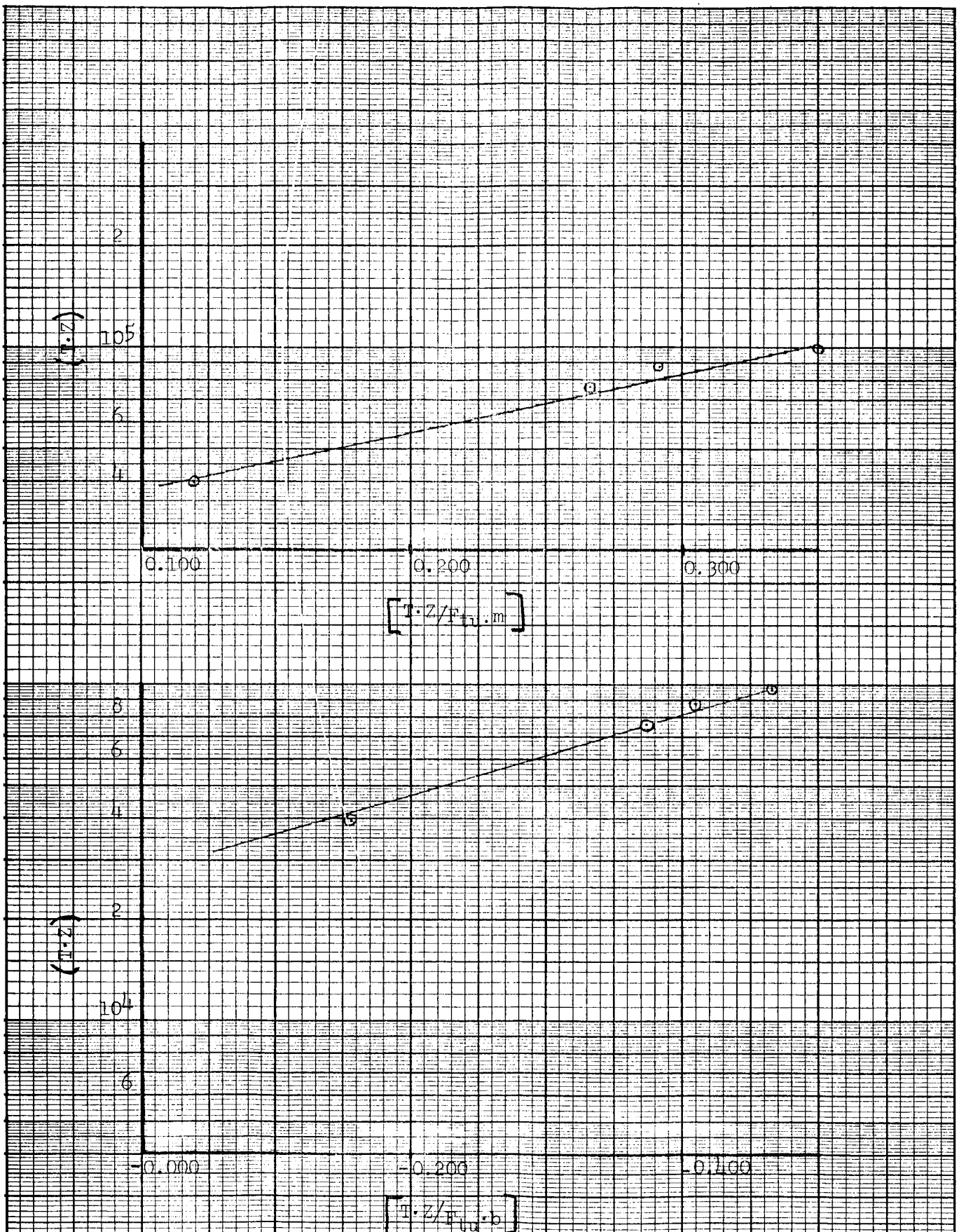


FIGURE I-18, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

SAE 4340 STEEL (TABLE I-18)

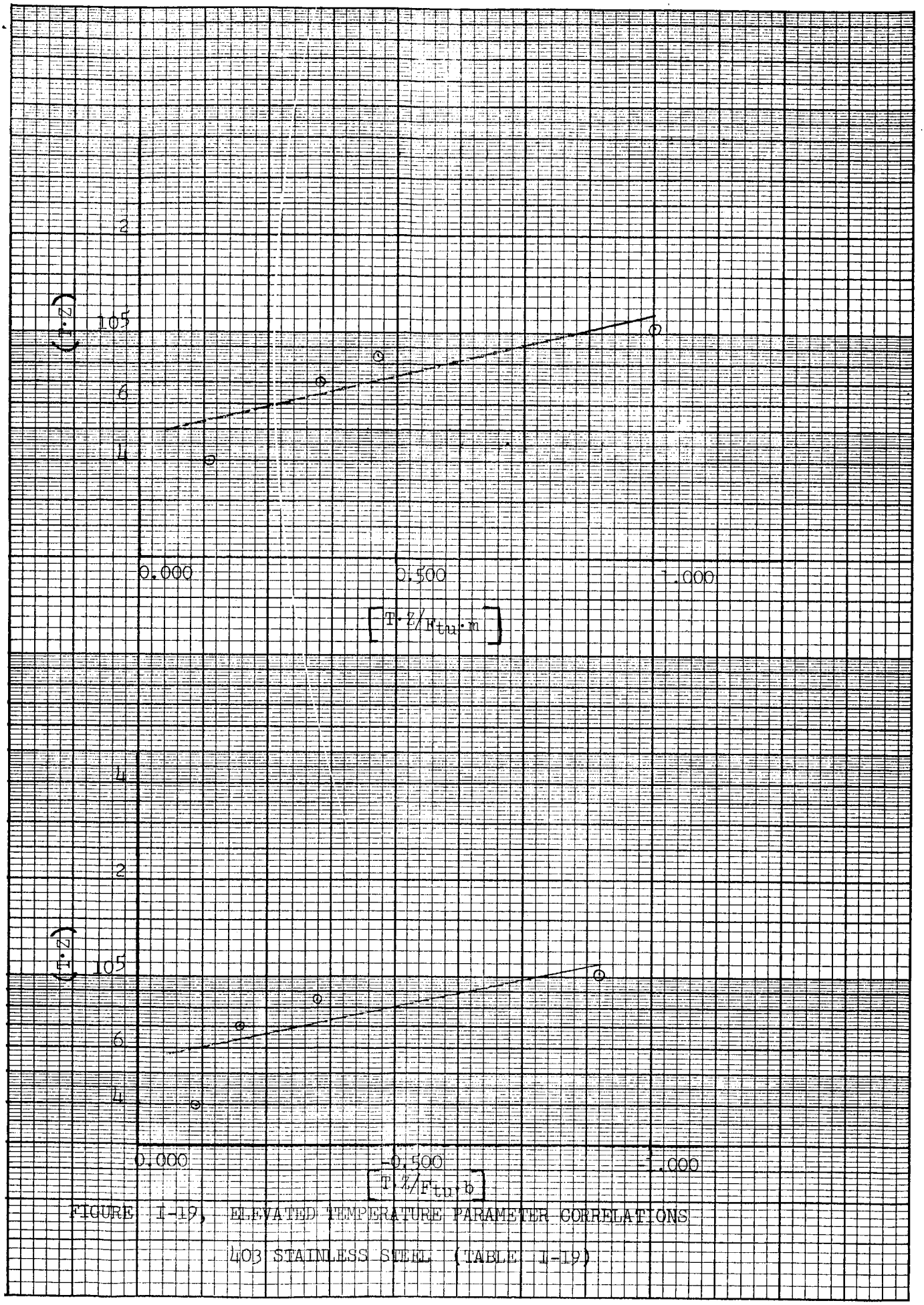


FIGURE I-19, ELEVATED TEMPERATURE PARAMETER CORRELATIONS 403 STAINLESS STEEL (TABLE I-19)

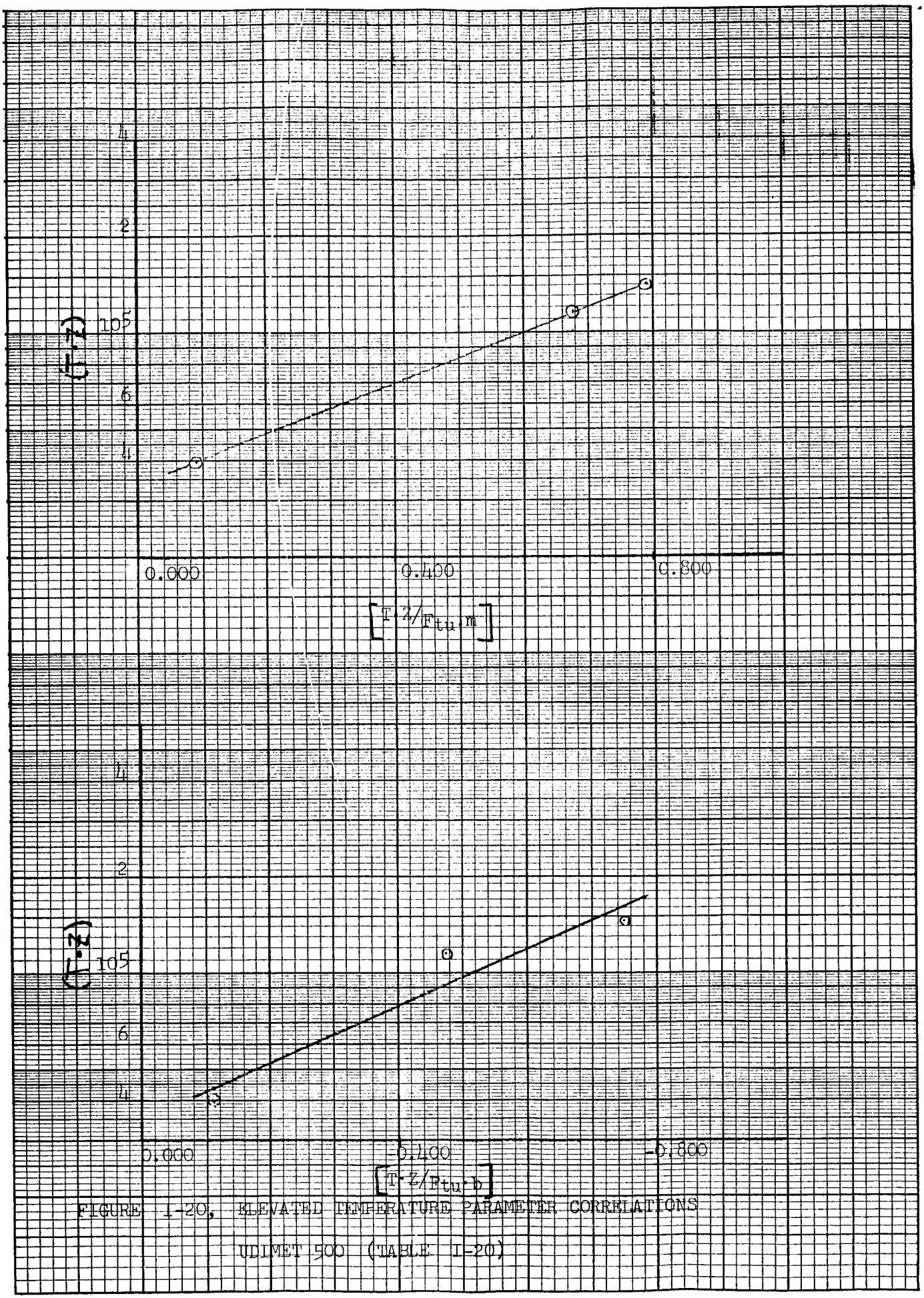


FIGURE I-20, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

UDIMET 500 (TABLE I-20)

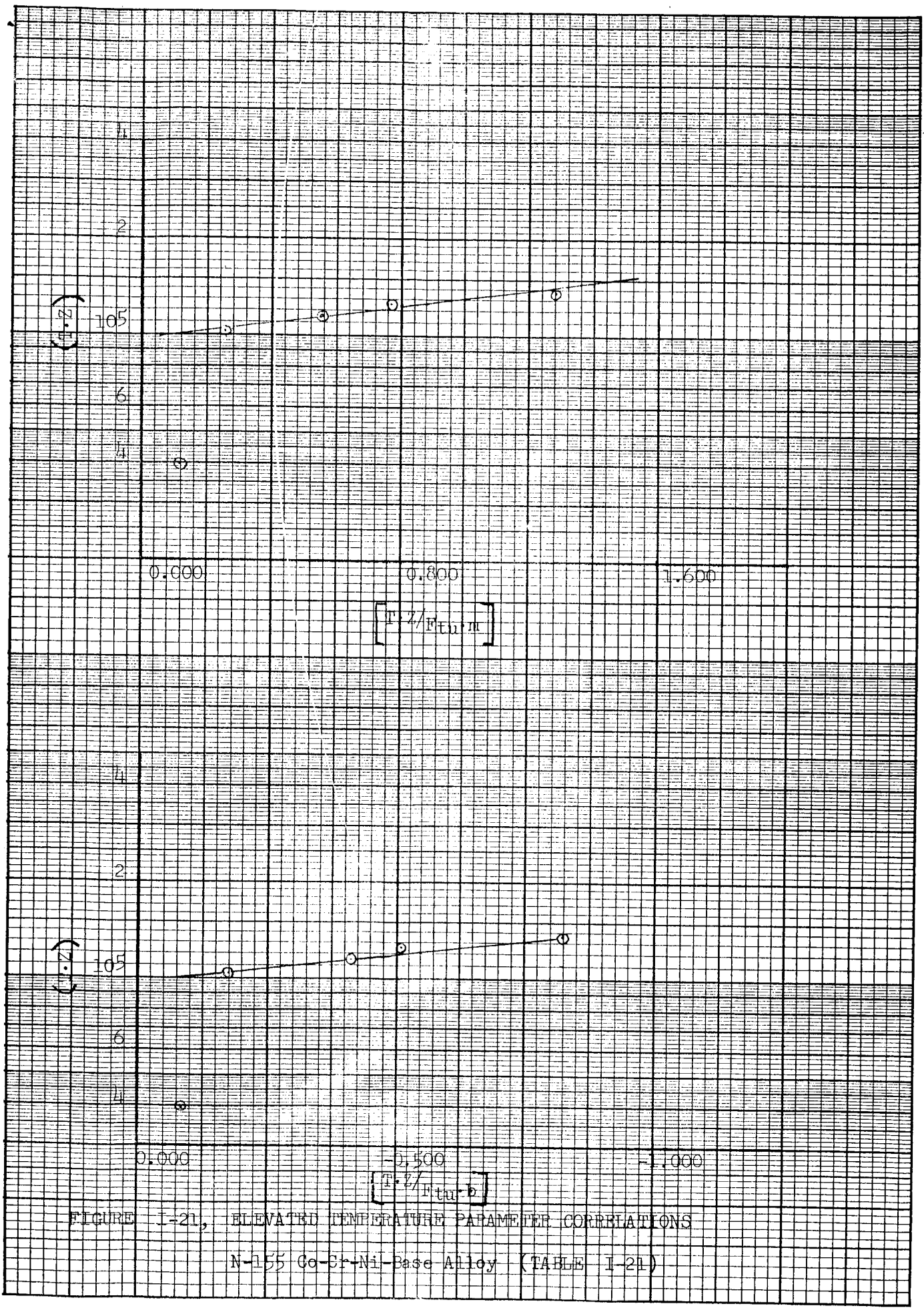


FIGURE I-21, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

N-155 Co-Cr-Ni-Base Alloy (TABLE I-21)

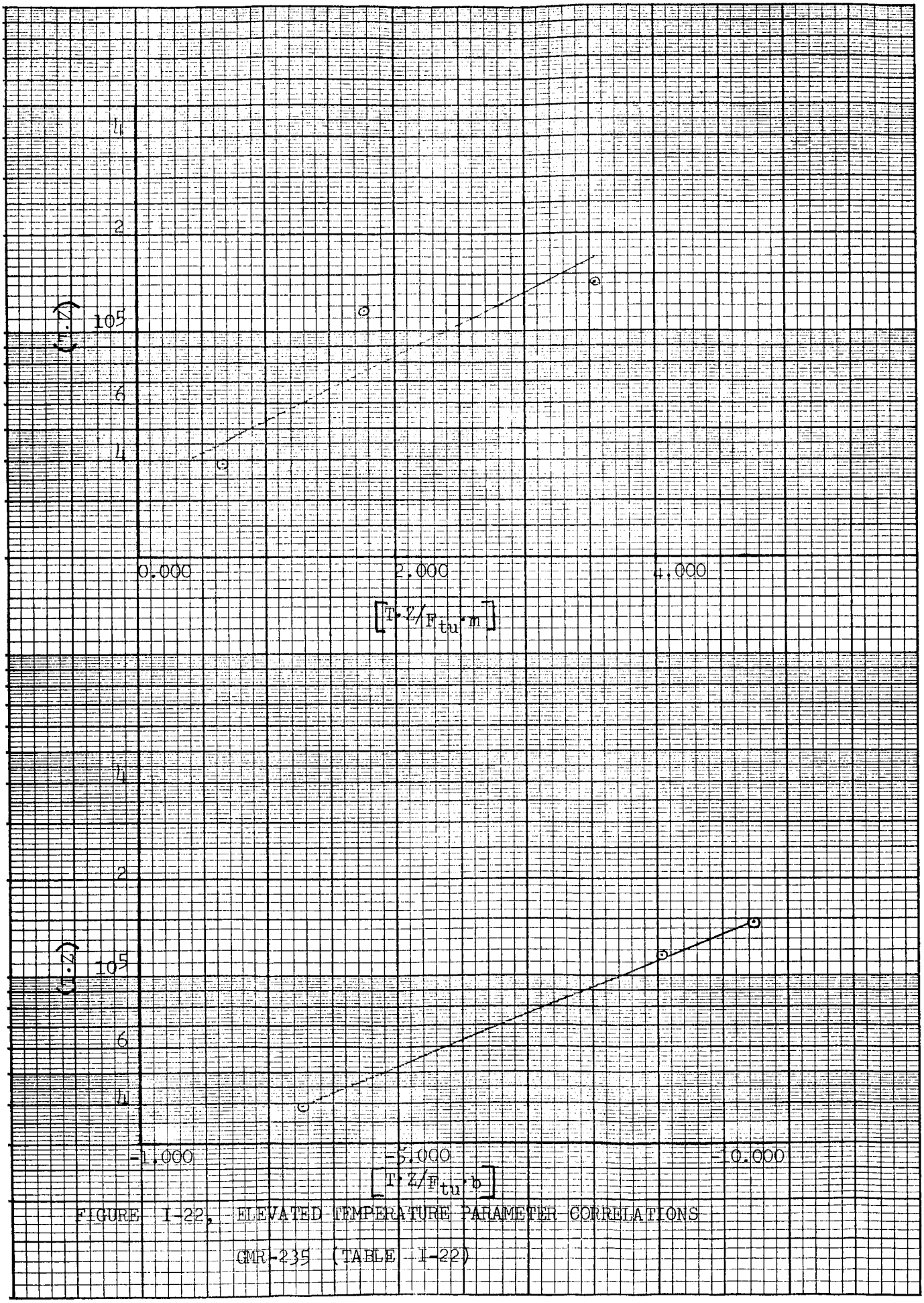


FIGURE I-22, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

GMR-235 (TABLE I-22)

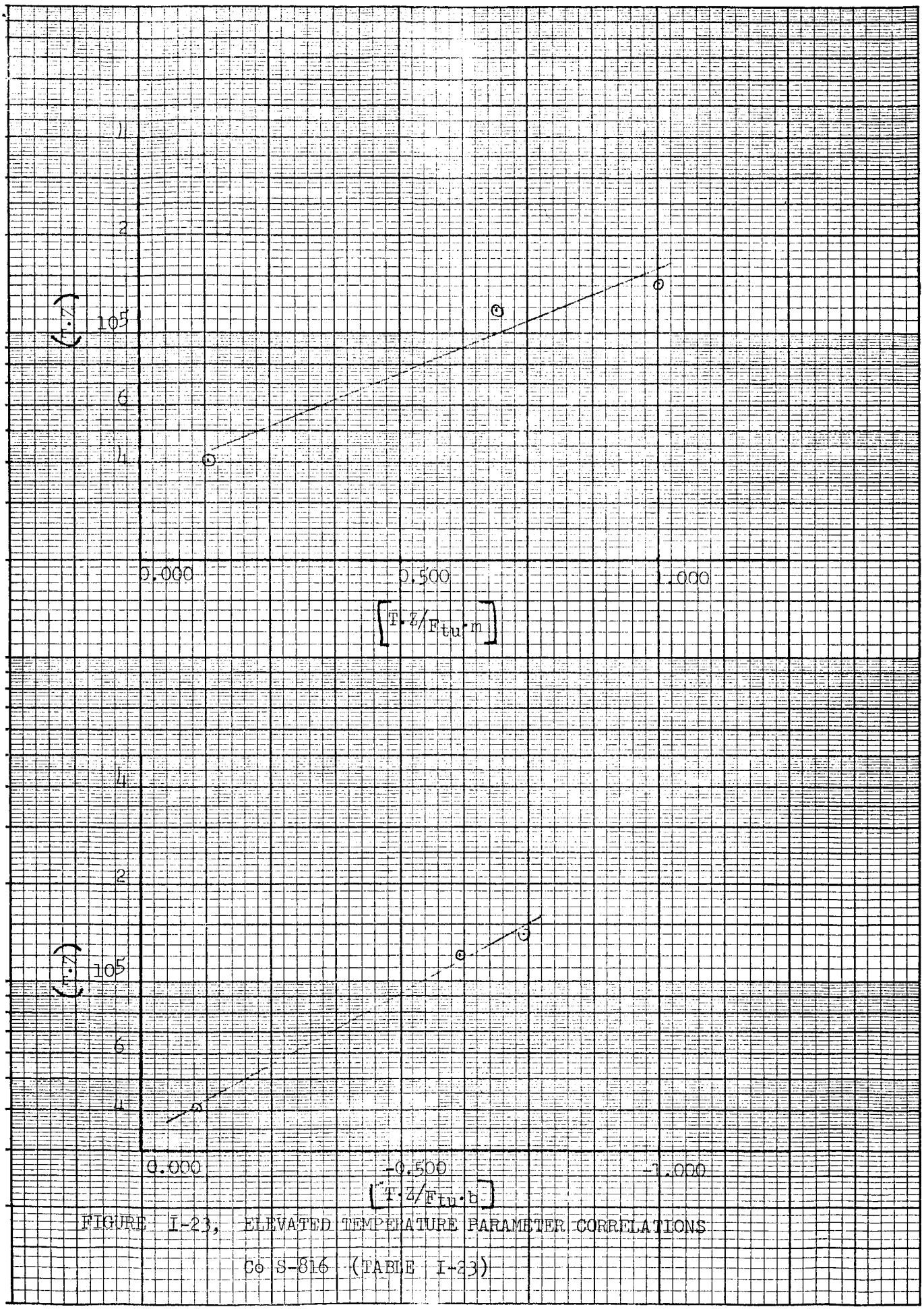


FIGURE I-23, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

Co S-816 (TABLE I-23)

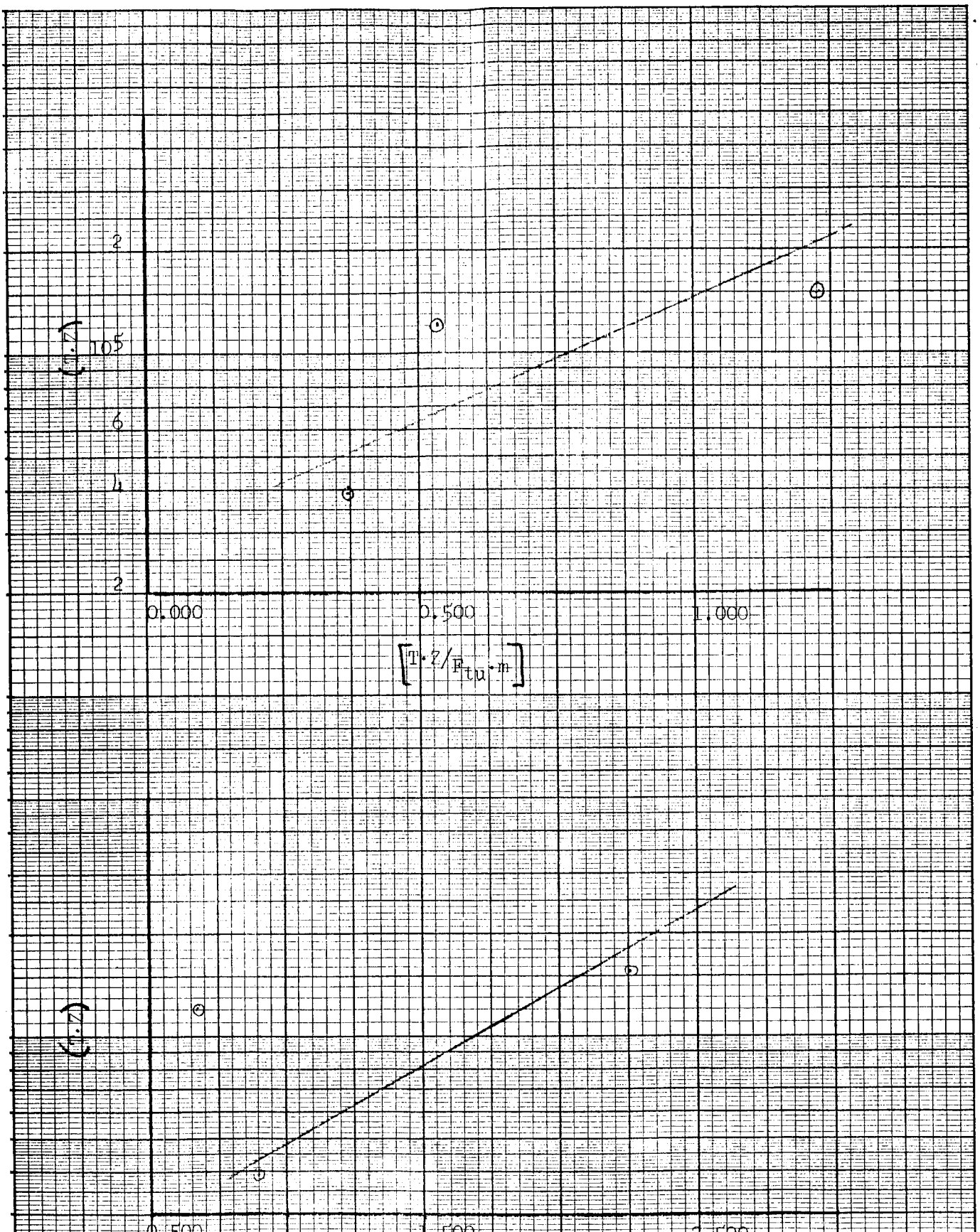


FIGURE I-24, ELEVATED TEMPERATURE PARAMETER CORRELATIONS HASTELLOY R235 (TABLE I-24)

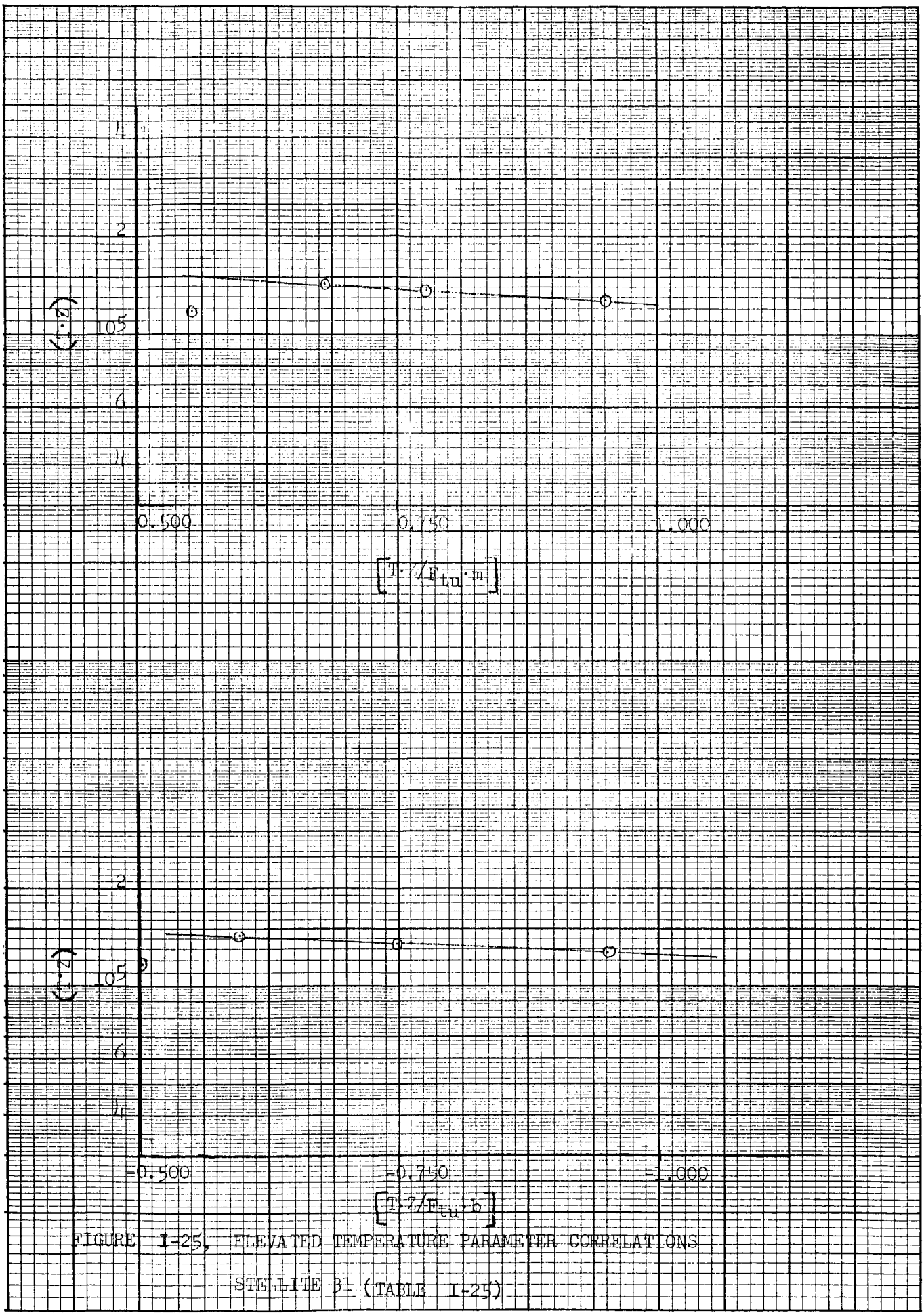


FIGURE I-25, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

STELLITE 31 (TABLE I-25)

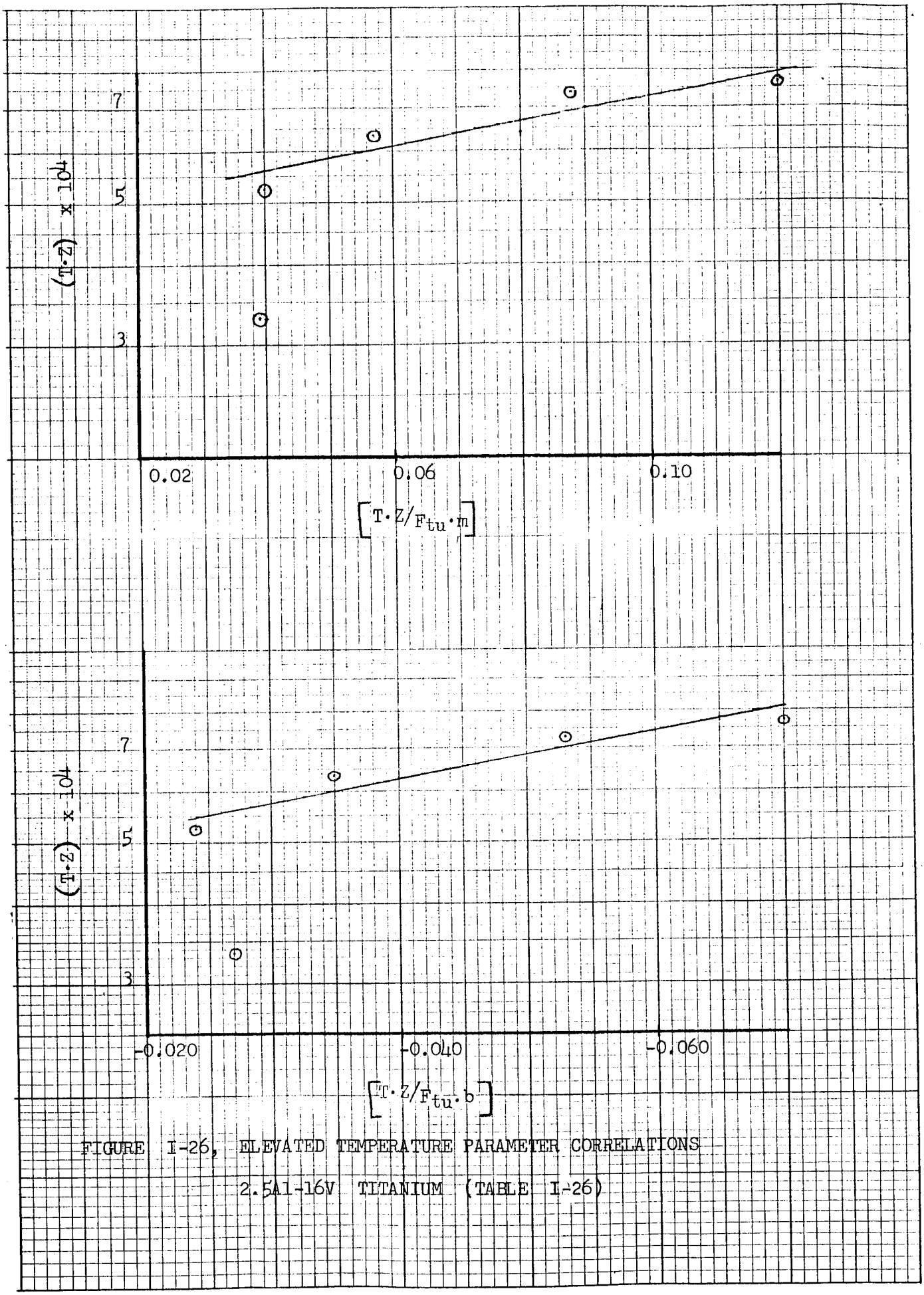


FIGURE I-26, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

2.5Al-16V TITANIUM (TABLE I-26)

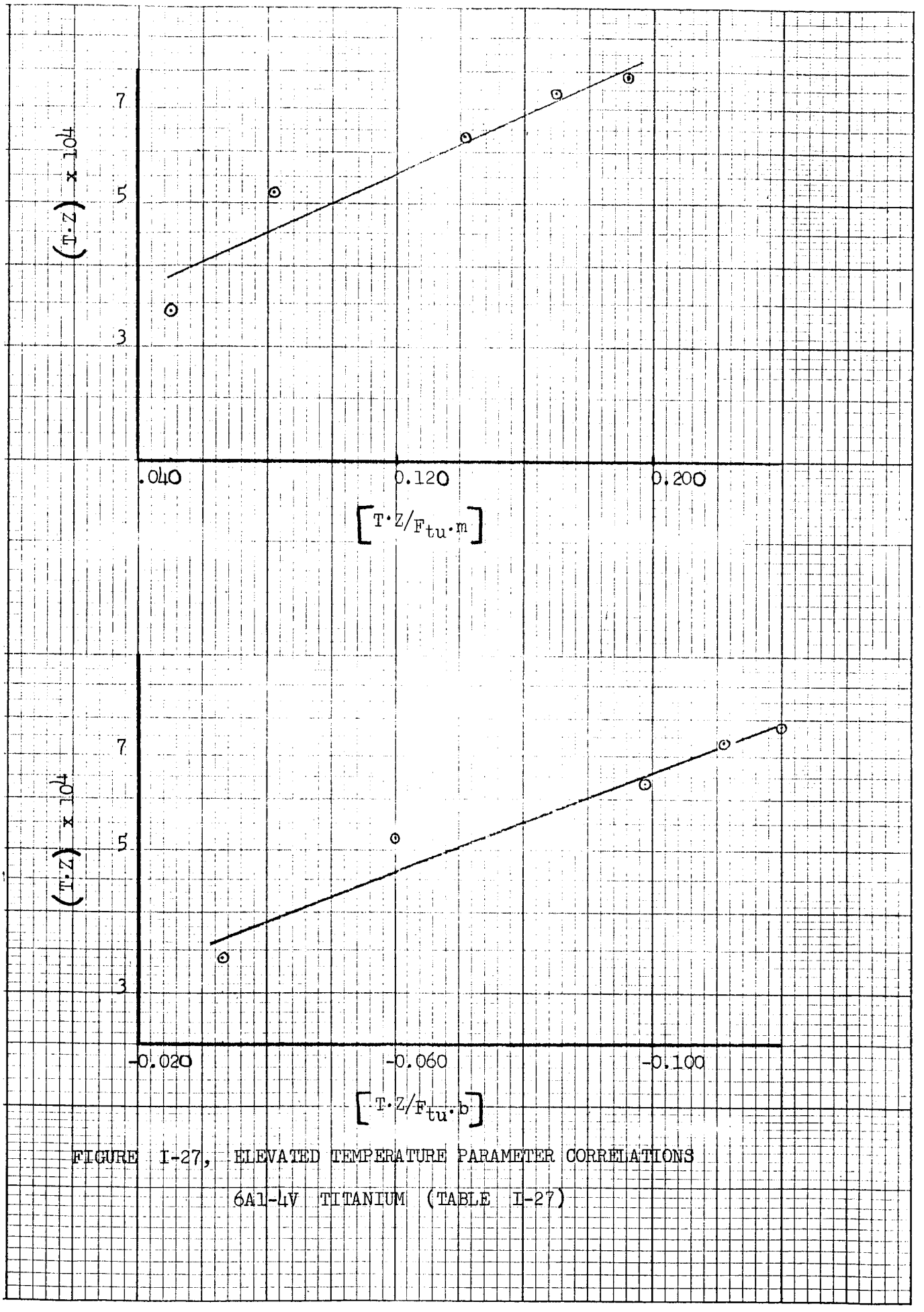
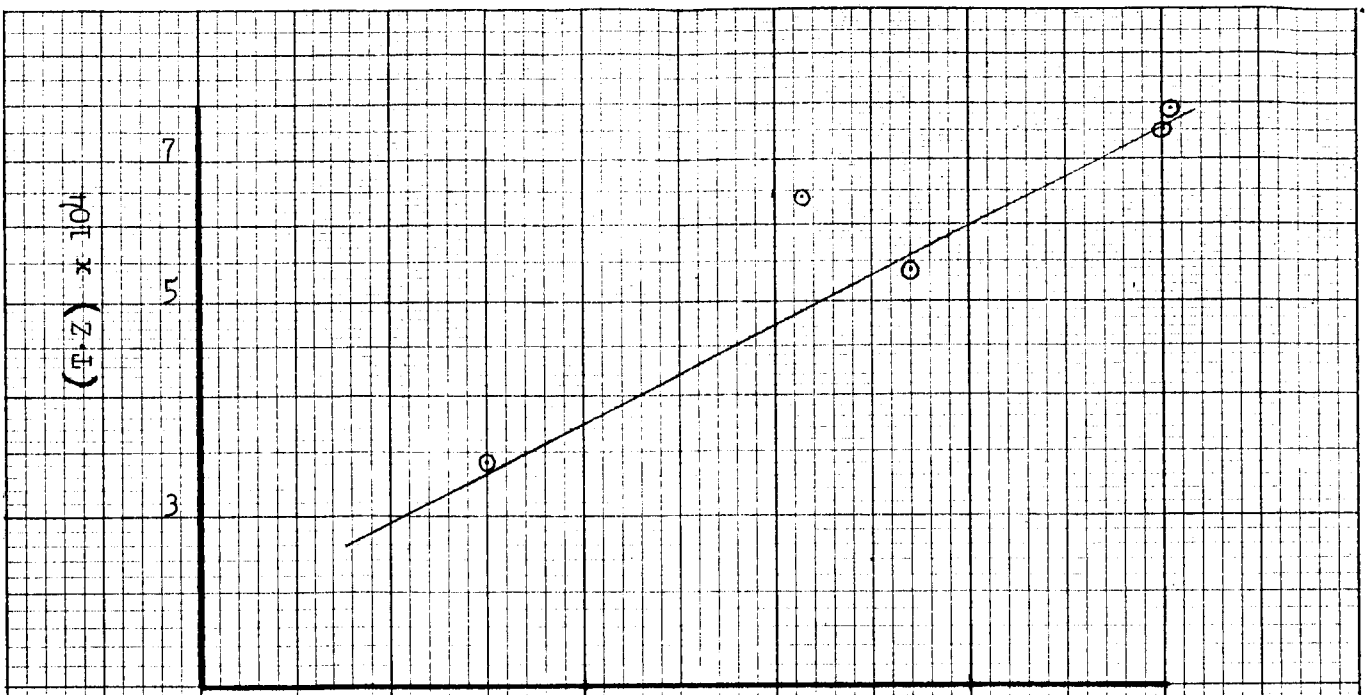


FIGURE I-27, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

6Al-4V TITANIUM (TABLE I-27)



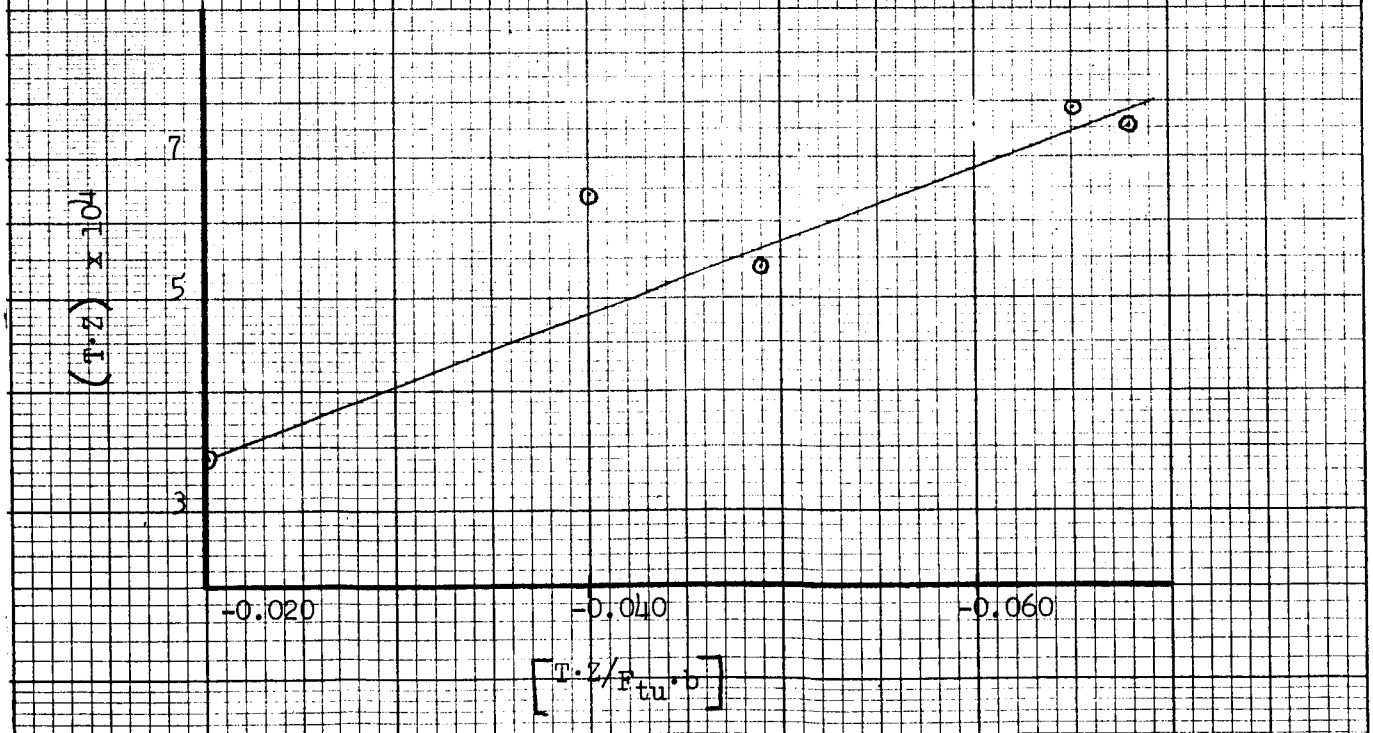


FIGURE I-28, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

4Al-3Mo-IV TITANIUM (TABLE I-28)

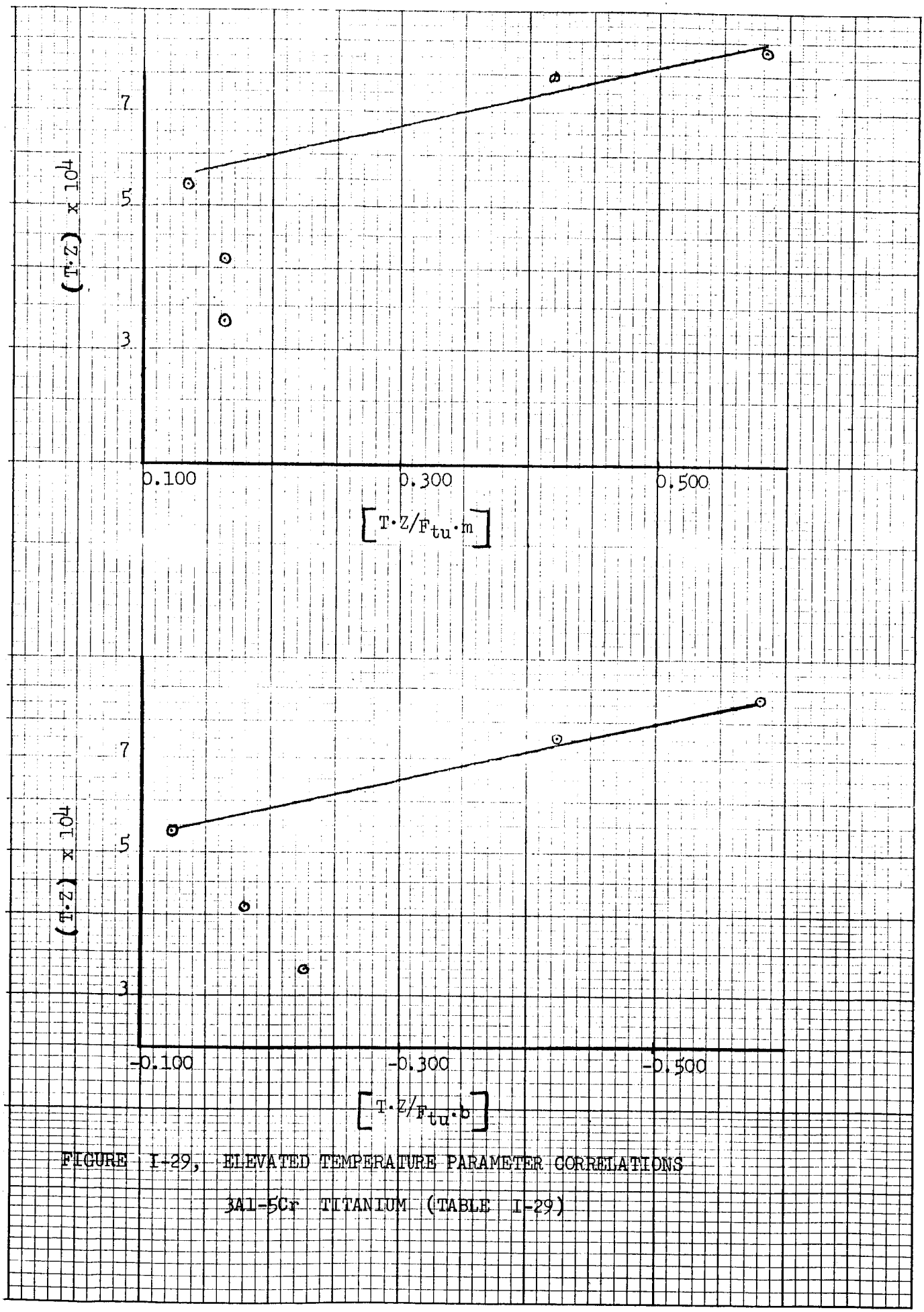
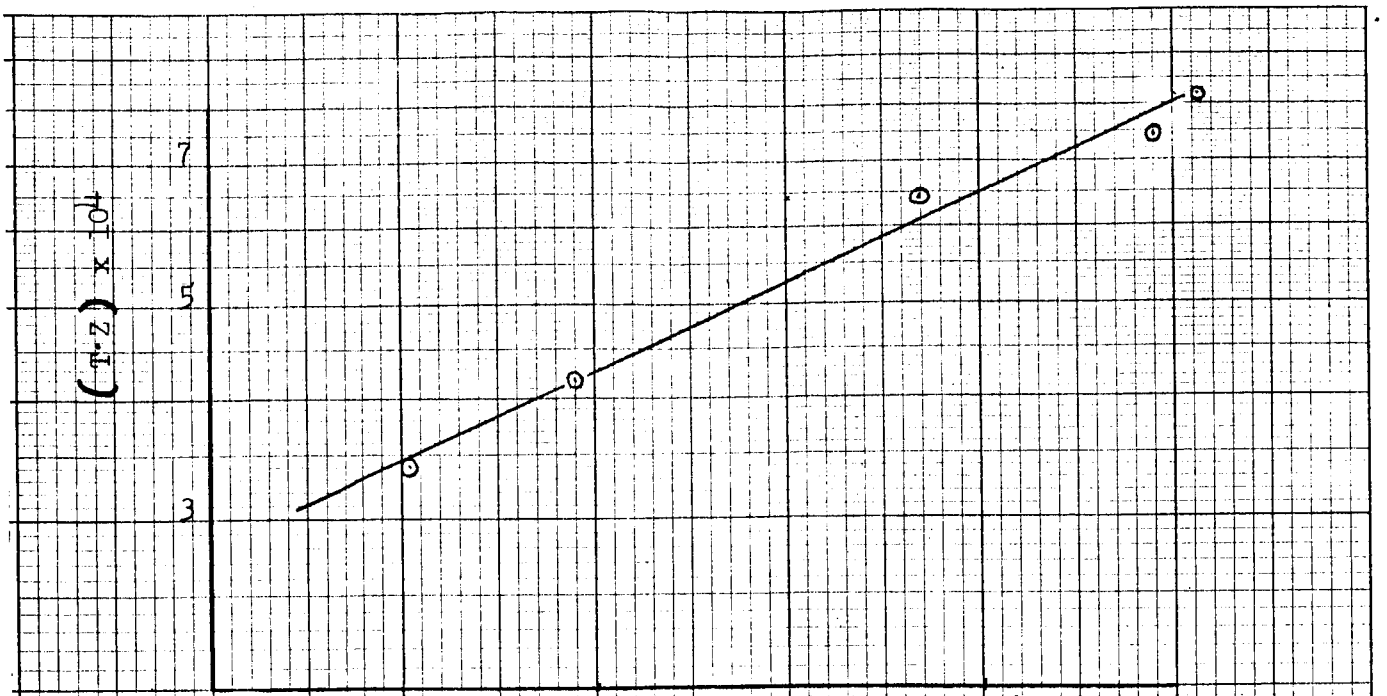


FIGURE I-29, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

3A1-5Cr TITANIUM (TABLE I-29)



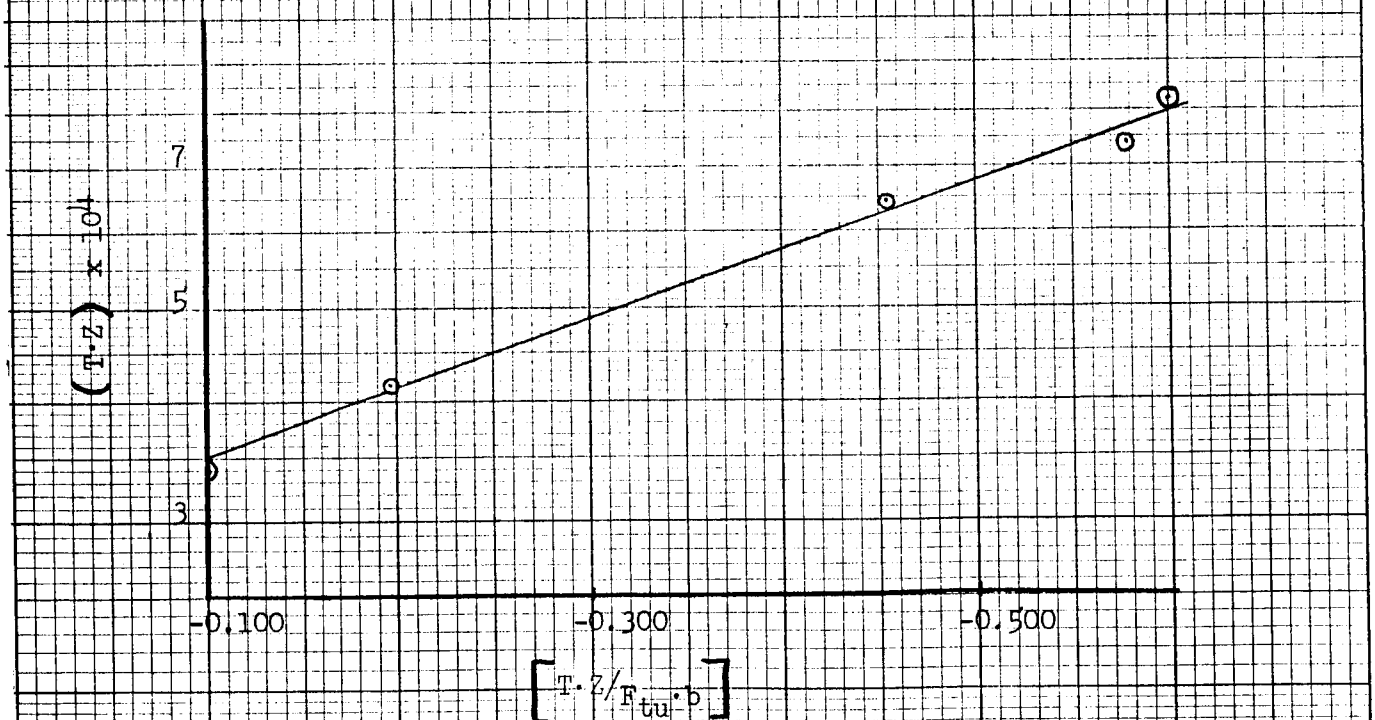


FIGURE I-30, ELEVATED TEMPERATURE PARAMETER CORRELATIONS

$3M_n$ COMPLEX TITANIUM (TABLE I-30)

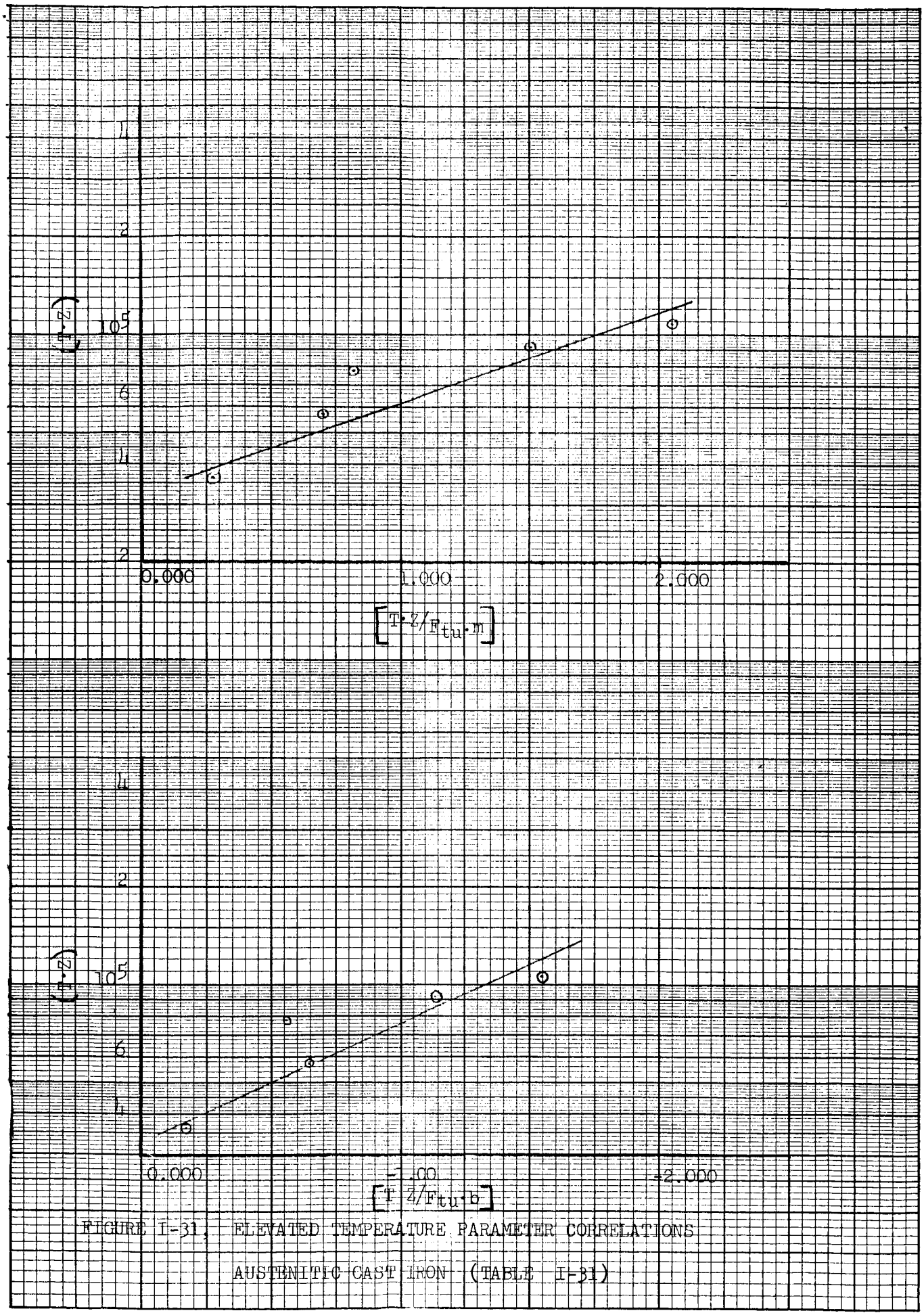


FIGURE I-31. ELEVATED TEMPERATURE PARAMETER CORRELATIONS AUSTENITIC CAST IRON (TABLE I-31)

SECTION I - TABLES
of
TEMPERATURE AND CORRELATION PARAMETERS,

FIGURE AND TABULATION SHEET REFERENCES

Symbols

T = Absolute Temperature, degrees Rankine

Z = $\sqrt[4]{\text{Elevated Temperature Elastic Modulus}}$

F_{tu} = Elevated Temperature Tensile Strength

AX = Axial Load Data

RB = Rotating Beam Data

CB = Rotating Cantilever Beam Data

SB = Sheet Bending Data

m = Temperature Parameter (slope)

b = Temperature Parameter $\left[\log_e \text{(intercept value)}\right]$

TABLE I-1

MATERIAL - 2014 T Aluminum, (Melting Temperature 1100°F)
Temperature Range (535° to 860°R) - Type Test RB

References:
Figure I-1
Tabulation Sheets 87-89
Bibliographical Entry A-85

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	62.0	*57.056	1.881	-2.439	3.053	0.262	-0.202
660	54.0		3.238	-4.910	3.766	0.215	-0.142
860	18.0		13.786	-25.980	4.907	0.198	-0.105

TABLE I-2

MATERIAL - 2014 T-Aluminum, (Melting Temperature 1180°F)
Temperature Range (530° to 960°R) - Type Test RB

References:
Figure I-2
Tabulation Sheets 25-28
Bibliographical Entry A-111

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**530	70.0	*57.056	1.734	-2.418	3.024	0.249	-0.179
760	45.0		2.034	-2.652	4.336	0.474	-0.363
860	17.0		2.277	-3.525	4.907	1.268	-0.819
960	10.5		2.469	-4.174	5.477	2.113	-1.250

** Data obtained at room temperature, assumed to be 535°R
* No elevated temperature values for Elastic modulus available, room temperature value used.

TABLE I-3
MATERIAL - 2014 - T6 Aluminum, (Melting Temperature 1180°F)
Temperature Range (535° to 960°R) - Type Test RB

References:
Figure I-3
Tabulation Sheets 127-130
Bibliographical Entry A-49

T °R	F ksi	$\sqrt[4]{Z/E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
535	70.0	57.06	1.951	-2.814	3.052	0.223	-0.155
760	47.0	56.32	1.605	-2.029	4.281	0.567	-0.449
860	18.0	55.58	2.321	-3.632	4.790	1.144	-0.731
960	11.0	55.40	2.608	-5.192	5.318	1.853	-0.931

TABLE I-4
MATERIAL - 2024 - T4 Aluminum, (Melting Temperature 1100°F)
Temperature Range (535° to 960°R) - Type Test CB and RB

References:
Figure I-4
Tabulation Sheets 131-134
Bibliographical Entry A-49

T °R	F_{tu} ksi	$\sqrt[4]{Z/E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
535	68.0	57.06	1.975	-1.616	3.053	0.227	-0.278
760	43.0	56.40	1.512	-1.192	4.286	0.659	-0.836
860	26.0	55.61	2.378	-2.005	4.782	0.773	-0.917
960	14.0	54.00	2.856	-2.469	5.184	1.297	-1.499

TABLE I-5
MATERIAL - 5052-H36 Aluminum, (Melting Temperature - 2100°F)
Temperature Range (760° to 960°R) - Type Test RB
References:
Figure I-5
Tabulation Sheets 139-141
Bibliographical Entry A-49

T °R	F_{tu} ksi	$Z/\sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
760	36.0	55.561	1.977	-1.554	4.223	0.589	-0.755
860	28.0	54.801	2.431	-1.988	4.713	0.692	-0.847
960	15.0	53.211	2.390	-1.956	5.108	1.425	-1.741

TABLE I-6
MATERIAL - 6053-T6 Aluminum, (Melting Temperature - 2100°F)
Temperature Range (760° to 960°R) - Type Test RB
References:
Figure I-6
Tabulation Sheets 142-144
Bibliographical Entry A-49

T °R	F_{tu} ksi	$Z/\sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
760	28.0	55.561	2.178	-1.792	4.223	0.692	-0.842
860	23.0	54.801	1.909	-1.567	4.713	1.074	-1.308
960	15.0	53.211	1.053	-0.744	5.108	3.235	-4.576

TABLE I-7
MATERIAL - 6061 - T6 Aluminum, (Melting Temperature - 2100°F)
Temperature Range (535° to 960°R) - Type Test RB and CB
References:
Figure I-7
Tabulation Sheets 135-138
Bibliographical Entry A-49

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
535	45.0	56.20	2.291	-1.860	3.007	0.292	-0.359
760	34.0	55.60	2.370	-1.940	4.226	0.524	-0.641
860	19.0	54.85	3.204	-2.769	4.717	0.775	-0.896
960	7.5	53.30	2.805	-2.301	5.117	2.432	-2.965

TABLE I-8
MATERIAL - 7075-T Aluminum, (Melting Temperature 1100°F)
Temperature Range (535° to 860°R) - Type Test RB
References:
Figure I-8
Tabulation Sheets 90-92
Bibliographical Entry A-85

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	82.0	56.781	2.867	-4.020	3.038	0.129	-0.092
660	72.0	56.234	2.831	-4.147	3.711	0.182	-0.124
860	38.0	54.038	3.470	-5.772	4.647	0.352	-0.212

** Data obtained at room temperature, assumed to be 535°R

TABLE I-9
MATERIAL - 7075-T6 Aluminum, (Melting Temperature 1180°)
Temperature Range (535° to 960°R) - Type Test RB
Reference:
Figure I-9
Tabulation Sheets 123-126
Bibliographical Entry A-49

T °R	F_{tu} ksi	Z $\sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	82.0	56.781	1.835	-2.455	3.038	0.202	-0.151
760	25.0	56.066	2.018	-2.822	4.261	0.844	-0.604
860	14.0	55.310	2.243	-3.826	4.757	1.400	-0.888
960	11.0	53.703	2.799	-4.470	5.155	1.674	-1.048

TABLE I-10
MATERIAL - QMV Beryllium, (Melting Temperature 2332°F)
Temperature Range (535° to 1560°R) - Type Test AX
References:
Figure I-10
Tabulation Sheets 33-34
Bibliographical Entry A-78

T °R	F_{tu} ksi	Z $\sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	77.17	*81.433	6.830	-11.187	4.316	0.082	-0.050
1560	20.10	81.433	20.531	-37.866	12.700	0.308	-0.167

** Data obtained at room temperature, assumed to be 535°R
* No elevated temperature values for Elastic modulus available, room temperature value used.

TABLE I-11
MATERIAL - HK 31A-H24 Magnesium, (Melting Temperature 1100°F)
Temperature Range (535° to 860°R) - Type Test AX

References:
Figure I-11
Tabulation Sheets 44-45
Bibliographical Entry A-6

T °R	F_{tu} ksi	$Z/\sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
535	37.0	50.49	4.565	-6.924	2.701	0.160	-0.105
860	24.0	48.32	7.401	-13.072	4.155	0.234	-0.132

TABLE I-12
MATERIAL - Inconel "X", (Melting Temperature 2600°F)
Temperature Range (530° to 1960°R) - Type Test RB

References:
Figure I-12
Tabulation Sheets 1-5
Bibliographical Entry A-2

T °R	F_{tu} ksi	$Z/\sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	172.5	70.861	2.917	-4.224	3.756	0.075	-0.051
1460	130.1	70.861	7.324	-12.667	10.350	0.109	-0.063
1660	104.0	69.984	1.714	-2.011	11.620	0.652	-0.555
1810	83.0	68.486	3.055	-4.826	12.390	0.497	-0.309
1960	60.1	67.858	7.400	-13.971	13.300	0.299	-0.016

** Data obtained at room temperature, assumed to be 535°R

TABLE I-13
MATERIAL - Inconel "X" (Sheet), (Melting Temperature 2600°F)
Temperature Range (1810° to 1960°R)

References:
Figure I-13
Tabulation Sheets 145-146
Bibliographical Entry A-113

T °R	Ftu ksi	Z $\sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
1810	83.0	68.486	7.272	-13.543	12.396	0.205	-0.110
1960	60.0	67.858	6.608	-12.128	13.300	0.335	-0.183

TABLE I-14
MATERIAL - Inconel 700, (Melting Temperature 2600°F)
Temperature Range (535° to 2060°R) - Type Test RB

References:
Figure I-14
Tabulation Sheets 52-56
Bibliographical Entry A-3

T °R	Ftu ksi	Z $\sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	171.0	*75.214	3.302	-5.194	4.024	0.071	-0.045
1660	145.5		4.475	-7.144	12.042	0.185	-0.116
1810	135.0		1.917	-2.803	13.130	0.507	-0.347
1960	106.5		1.270	-1.232	13.717	1.014	-1.045
2060	83.5		1.522	-1.732	14.417	1.134	-0.997

** Data obtained at room temperature, assumed to be 535°R
* No elevated temperature values for Elastic modulus available, room temperature value used.

TABLE I-15
MATERIAL - Inconel 718, (Melting Temperature 2600°F)
Temperature Range (545° to 1860°R) - Type Test RB

References:
Figure I-15
Tabulation Sheets 6-9
Bibliographical Entry A-1

T °R	Ftu ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{Ftu \cdot m}$	$\frac{T \cdot Z}{Ftu \cdot b}$
545	191.0	73.757	3.548	-5.327	4.020	0.059	-0.039
1460	170.0	71.056	1.948	-1.263	10.374	0.313	-0.507
1660	153.0	70.345	1.187	-1.187	11.679	0.643	-0.643
1860	96.8	69.327	2.845	-4.577	12.895	0.468	-0.291

TABLE I-16
MATERIAL - Cr-Mo-Steel,(Melting Temperature 2500°F)
Temperature Range (535° to 1392°R) - Type Test AX

References:
Figure I-16
Tabulation Sheets 79-84
Bibliographical Entry A-42

T °R	Ftu ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{Ftu \cdot m}$	$\frac{T \cdot Z}{Ftu \cdot b}$
**535	110.0	*74.012	1.867	-2.478	3.960	0.193	-0.145
672	96.0		3.940	-6.159	5.714	0.151	-0.097
852	94.0		4.158	-6.281	6.306	0.161	-0.026
1032	96.0		3.337	-5.037	7.638	0.238	-0.047
1212	101.0		3.547	-3.511	8.970	0.349	-0.099
1392	89.0		12.608	-22.909	10.302	0.092	-0.050

** Data obtained at room temperature, assumed to be 535°R
* No elevated temperature values for Elastic modulus available, room temperature value used.

TABLE I-17
MATERIAL - SAE 4130 Steel, (Melting Temperature 2600°F)
Temperature Range (535° to 1260°R) - Type Test RB
Reference:
Figure I-17
Tabulation Sheets 93-95
Bibliographical Entry A-76

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
545	133.8	74.012	2.189	-2.552	4.033	0.135	-0.116
860	127.8	72.310	2.080	-2.544	6.220	0.239	-0.196
1260	92.6	70.654	2.267	-3.026	8.902	0.424	-0.318

TABLE I-18
MATERIAL - SAE 4340 Steel, (Melting Temperature 2600°F)
Temperature Range (535° to 1460°R) - Type Test AX
Reference:
Figure I-18
Tabulation Sheets 35-38
Bibliographical Entry A-4

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	158.5	74.012	2.233	-1.591	3.960	0.119	-0.157
1060	152.8	71.746	1.862	-1.333	7.605	0.267	-0.373
1260	125.0	69.984	2.404	-1.720	8.818	0.293	-0.410
1460	80.7	66.865	3.307	-2.596	9.762	0.365	-0.466

** Data obtained at room temperature, assumed to be 535°R

TABLE I-19
MATERIAL - 403 Stainless Steel, (Melting Temperature 2790°F)
Temperature Range (535° to 1360°R) - Type Test AX
Reference:
Figure I-19
Tabulation Sheets 102-105
Bibliographical Entry A-105

T °R	F ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	141.0	*73.689	2.057	-2.754	3.942	0.136	-0.109
960	98.0		2.602	-3.753	7.074	0.350	-0.192
1160	87.0		2.088	-2.806	8.548	0.470	-0.350
1360	70.0		1.417	-1.602	10.020	1.010	-0.894

TABLE I-20
MATERIAL - Udimet 500, (Melting Temperature 2500°F)
Temperature Range (535° to 2110°R) - Type Test AX
Reference:
Figure I-20
Tabulation Sheets 57-59
Bibliographical Entry A-102

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	175.0	73.689	2.519	-2.061	3.942	0.089	-0.109
1660	175.0	70.356	0.983	-0.140	11.680	0.679	-0.477
2110	84.0	69.247	2.200	-2.316	14.610	0.791	-0.751

** Data obtained at room temperature, assumed to be 535°R
* No elevated temperature values for Elastic modulus available, room temperature value used.

TABLE I-21
MATERIAL - N-155 (Co-Cr-Ni-Base Alloy) (Melting Temperature 2500°F)
Temperature Range (535° to 1960°R) - Type Test RB

References:
Figure I-21
Tabulation Sheets 10-14
Bibliographical Entry A-71

T °R	F_{tu} ksi	$Z = \sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	119.1	74.012	3.001	-4.085	3.960	0.111	-0.081
1460	93.1	70.275	4.315	-6.333	10.260	0.255	-0.174
1660	80.4	69.406	2.601	-3.461	11.521	0.551	-0.414
1810	60.19	68.834	2.694	-4.071	12.460	0.768	-0.508
1960	44.6	67.936	2.316	-3.631	13.315	1.289	-0.822

TABLE I-22
MATERIAL - GMR-235 (High Temperature Alloy), (Melting Temperature 2300°F)
Temperature Range (535° to 2110°R) - Type Test AX

References:
Figure I-22
Tabulation Sheets 76-78
Bibliographical Entry A-102

T °R	F_{tu} ksi	$Z = \sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	106.0	74.012	0.556	-0.105	3.950	0.672	-3.557
1660	95.0	69.904	0.686	-0.135	11.604	1.780	-9.048
2110	64.0	67.703	0.632	-0.214	14.285	3.532	-10.430

** Data obtained at room temperature, assumed to be 535°R

TABLE I-23
MATERIAL - Co S-816 (Cobalt Base Alloy),(Melting Temperature 2700°F)
Temperature Range (540° to 1960°R) - Type Test CB

References:
Figure I-23
Tabulation Sheets 60-62
Bibliographical Entry A-32

T °R	Ftu ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
540	150.0	76.366	2.142	-2.662	4.124	0.128	-0.103
1660	110.0	72.079	1.580	-1.730	11.965	0.688	-0.629
1960	70.0	70.713	1.944	-2.692	13.860	1.018	-0.735

TABLE I-24
MATERIAL - Hastelloy R235,(Melting Temperature 2400°F)
Temperature Range (535° to 2110°R) - Type Test AX

References:
Figure I-24
Tabulation Sheets 63-65
Bibliographical Entry A-102

T °R	Ftu ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	120.0	*72.744	0.870	-0.364	3.892	0.373	-0.891
1660	105.0		2.154	-1.763	12.076	0.584	-0.652
2110	70.1		1.774	-0.969	15.349	1.236	-2.263

** Data obtained at room temperature, assumed to be 535°R
* No elevated temperature values for Elastic modulus available, room temperature value used.

TABLE I-25

MATERIAL - Stellite 31, (Melting Temperature)
Temperature Range (1660° to 2060°R) - Type Test RCB

References:
Figure I-25
Tabulation Sheets 111-114
Bibliographical Entry A-75

T °R	F_{tu} ksi	$\frac{Z}{\sqrt[4]{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
1660	92.0	72.078	2.330	-2.618	11.965	0.558	-0.497
1810	80.0	71.203	1.700	-1.679	12.888	0.948	-0.949
1960	68.5	70.421	2.475	-2.718	13.803	0.777	-0.747
2060	65.0	69.775	3.268	-3.730	14.374	0.677	-0.593

TABLE I-26

MATERIAL - 2.5Al-16V Titanium, (Melting Temperature 3000°F)
Temperature Range (535° to 1360°R) - Type Test AX

References:
Figure I-26
Tabulation Sheets 66-70
Bibliographical Entry A-50

T °R	F_{tu} ksi	$\frac{Z}{\sqrt[4]{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
535	174.0	62.130	4.917	-7.123	3.324	0.039	-0.027
860	151.0	61.165	8.695	-14.422	5.260	0.040	-0.024
1060	142.0	59.924	7.865	-12.723	6.352	0.057	-0.035
1260	128.0	58.614	6.573	-10.821	7.385	0.088	-0.053
1360	107.0	56.520	5.669	-9.751	7.687	0.127	-0.074

TABLE I-27
MATERIAL - Ti-6Al-4V Titanium, (Melting Temperature 3045°F)
Temperature Range (535° to 1360°R) - Type Test AX

References:
Figure I-27
Tabulation Sheets 20-24
Bibliographical Entry

T °R	F_{tu} ksi	$Z/\sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	177.0	63.826	3.853	-5.779	3.383	0.050	-0.033
860	143.0	61.376	4.517	-6.197	5.278	0.082	-0.060
1060	132.1	59.811	3.350	-4.870	6.340	0.143	-0.099
1260	123.0	58.479	3.554	-5.196	7.368	0.169	-0.115
1360	111.0	57.597	4.054	-5.868	7.833	0.193	-0.120

TABLE I-28
MATERIAL - Ti-4Al-3Mo.-IV Titanium, (Melting Temperature 3000°F)
Temperature Range (535° to 1360°R) - Type Test AX

References:
Figure I-28
Tabulation Sheets 15-19
Bibliographical Entry A-50

T °R	F_{tu} ksi	$Z/\sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	193.0	63.93	5.913	-8.923	3.388	0.030	-0.020
960	161.1	62.75	4.501	-6.870	5.396	0.074	-0.049
1060	149.0	60.62	6.879	-10.581	6.425	0.063	-0.041
1260	138.8	59.92	5.442	-7.973	7.550	0.100	-0.068
1360	126.0	58.24	6.200	-9.688	7.920	0.101	-0.065

** Data obtained at room temperature, assumed to be 535°R

TABLE I-29
MATERIAL - 3Al-5Cr Titanium, (Melting Temperature 3000°F)
Temperature Range (535° to 1460°R) - Type Test RB

References:
Figure I-29
Tabulation Sheets 49-51
Bibliographical Entry A-77

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	140.8	62.748	1.458	-1.035	3.326	0.162	-0.228
660	140.8	62.748	1.780	-1.635	4.141	0.162	-0.180
860	135.0	62.748	2.973	-3.261	5.396	0.134	-0.123
1060	117.5	61.277	0.208	-0.551	6.495	2.658	-1.003
1260	111.0	60.048	1.706	-1.612	7.566	0.418	-0.423
1460	106.0	60.048	1.423	-1.250	8.767	0.581	-0.662

TABLE I-30
MATERIAL - $3M_n$ Complex Titanium, (Melting Temperature 3020°F)
Temperature Range (535° to 1460°R) - Type Test RB

References:
Figure I-30
Tabulation Sheet 115-120
Bibliographical Entry A-77

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	147.9	63.636	2.211	-2.347	3.404	0.104	-0.098
660	142.0	63.242	1.546	-1.491	4.174	0.190	-0.197
860	131.0	62.230	0.629	-0.196	5.352	0.645	-2.084
1060	119.0	60.618	1.461	-1.188	6.425	0.370	-0.454
1260	101.0	58.857	1.472	-1.267	7.416	0.488	-0.579
1460	72.0	56.234	2.227	-2.850	8.210	0.512	-0.400

** Data obtained at room temperature, assumed to be 535°R

TABLE I-31

MATERIAL - Austenitic Cast Iron, (Melting Temperature 2100°F)
Temperature Range (535° to 1620°R) - Type Test AX

References:
Figure I-31
Tabulation Sheets 39-43
Bibliographical Entry A-42

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	35	*66.86	3.727	-5.957	3.577	0.274	-0.171
860	31		2.617	-2.878	5.750	0.709	-0.644
1160	30		3.153	-4.559	7.756	0.820	-0.567
1360	26		2.322	-3.052	9.094	1.506	-1.146
1620	20		2.638	-3.489	10.832	2.053	-1.552

** Data obtained at room temperature, assumed to be 535°R

* No elevated temperature values for Elastic modulus available, room temperature value used.

II. LOW TEMPERATURE CORRELATION OF FATIGUE DATA

A. Index of Materials Correlated at Low Temperatures

Material	Alloy	Temperature Range °F(-)	Tabulation Sheets	Figure
Aluminum	2024-T	RT-320	99-101	II-1
	5456-H321	RT-320	85-86	II-2
	7075-T	RT-320	121-122	II-3
	7075-T6	RT-423	29-32	II-4
	7075-T6	RT-320	96-98	II-5
Steel	4340	RT-320	106-107	II-6
Titanium	RC130-B	RT-320	108-110	II-7

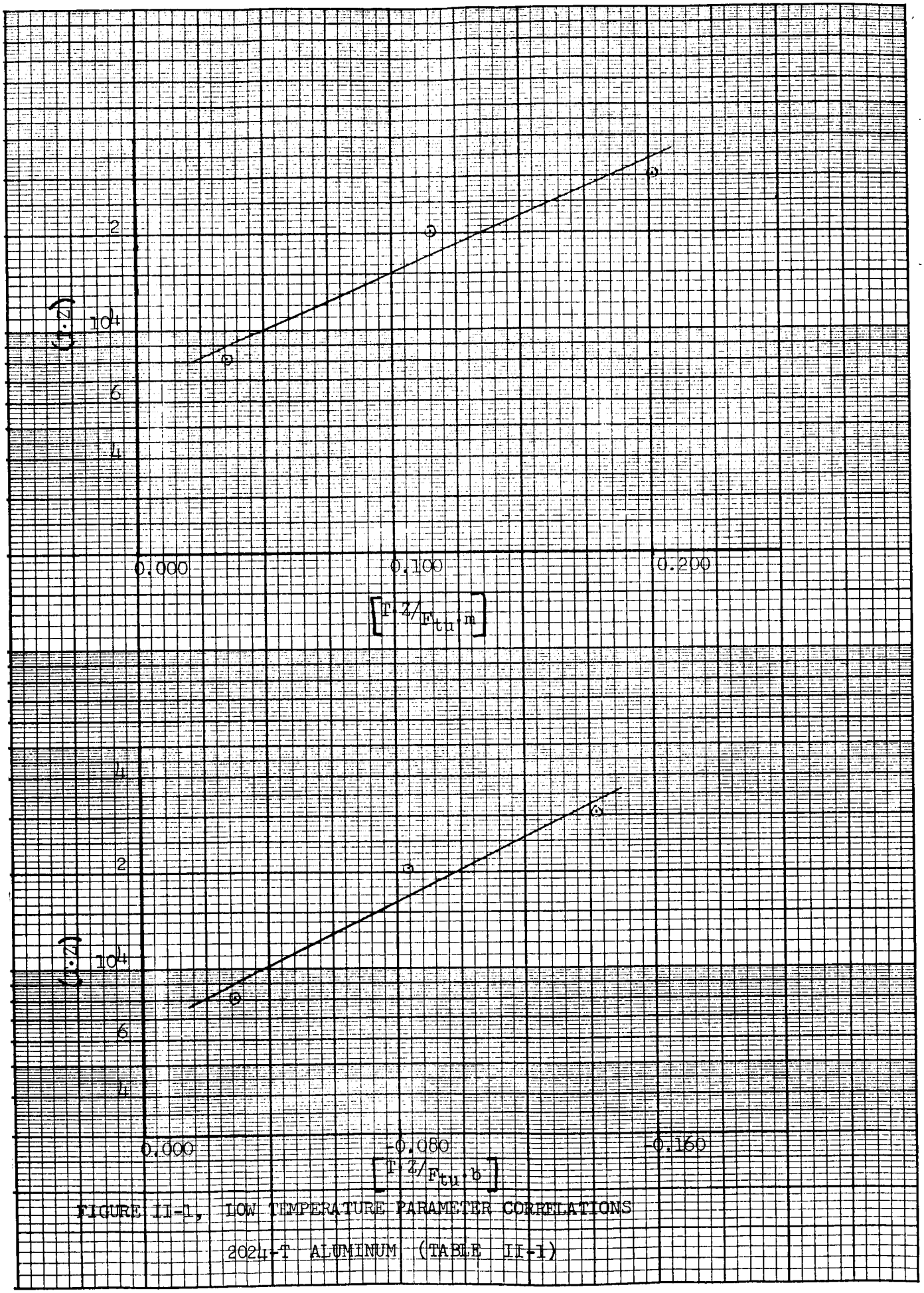


FIGURE II-1, LOW TEMPERATURE PARAMETER CORRELATIONS

2024-T ALUMINUM (TABLE II-1)

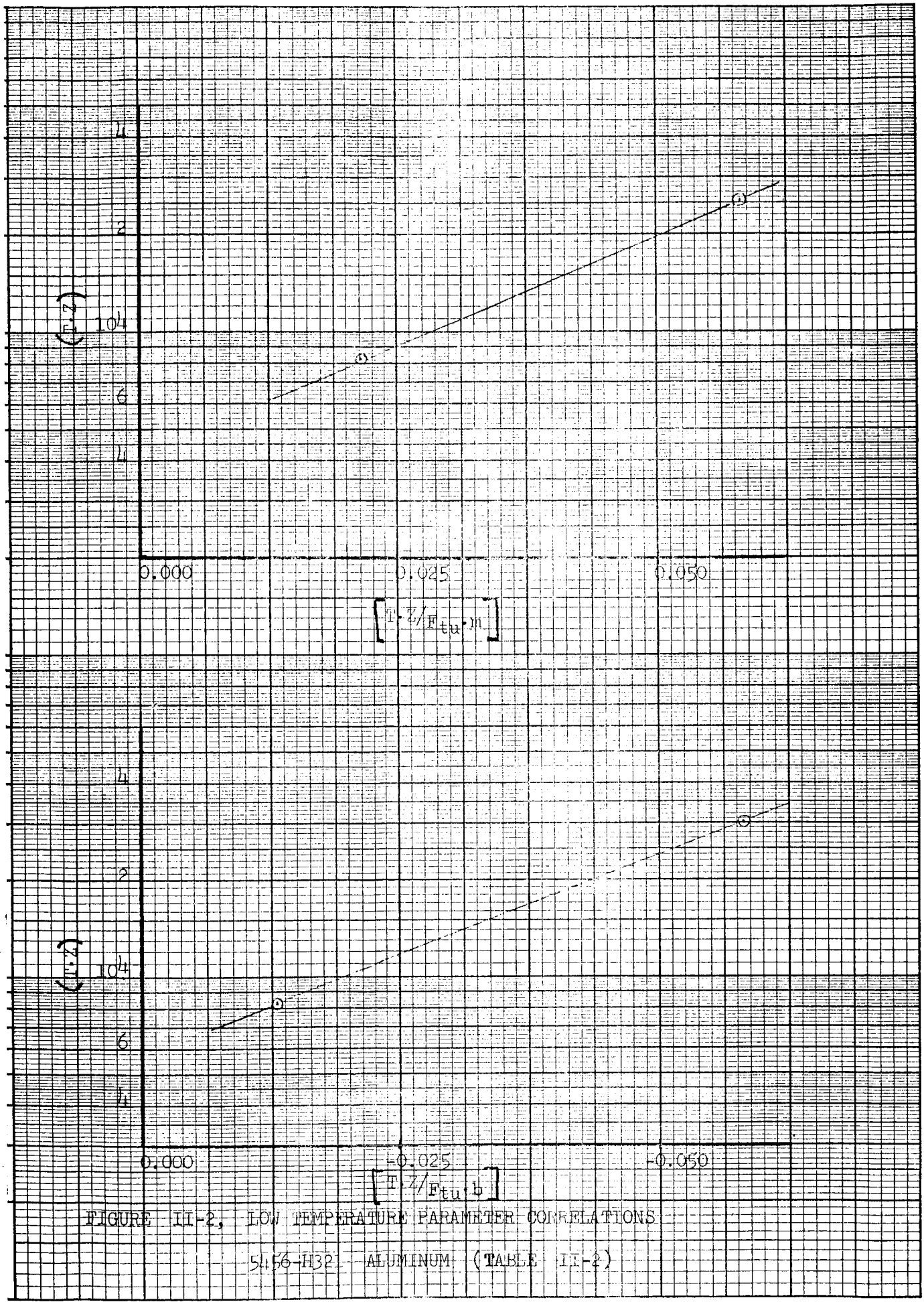


FIGURE II-2, LOW TEMPERATURE PARAMETER CORRELATIONS

5456-H32 ALUMINUM (TABLE II-2)

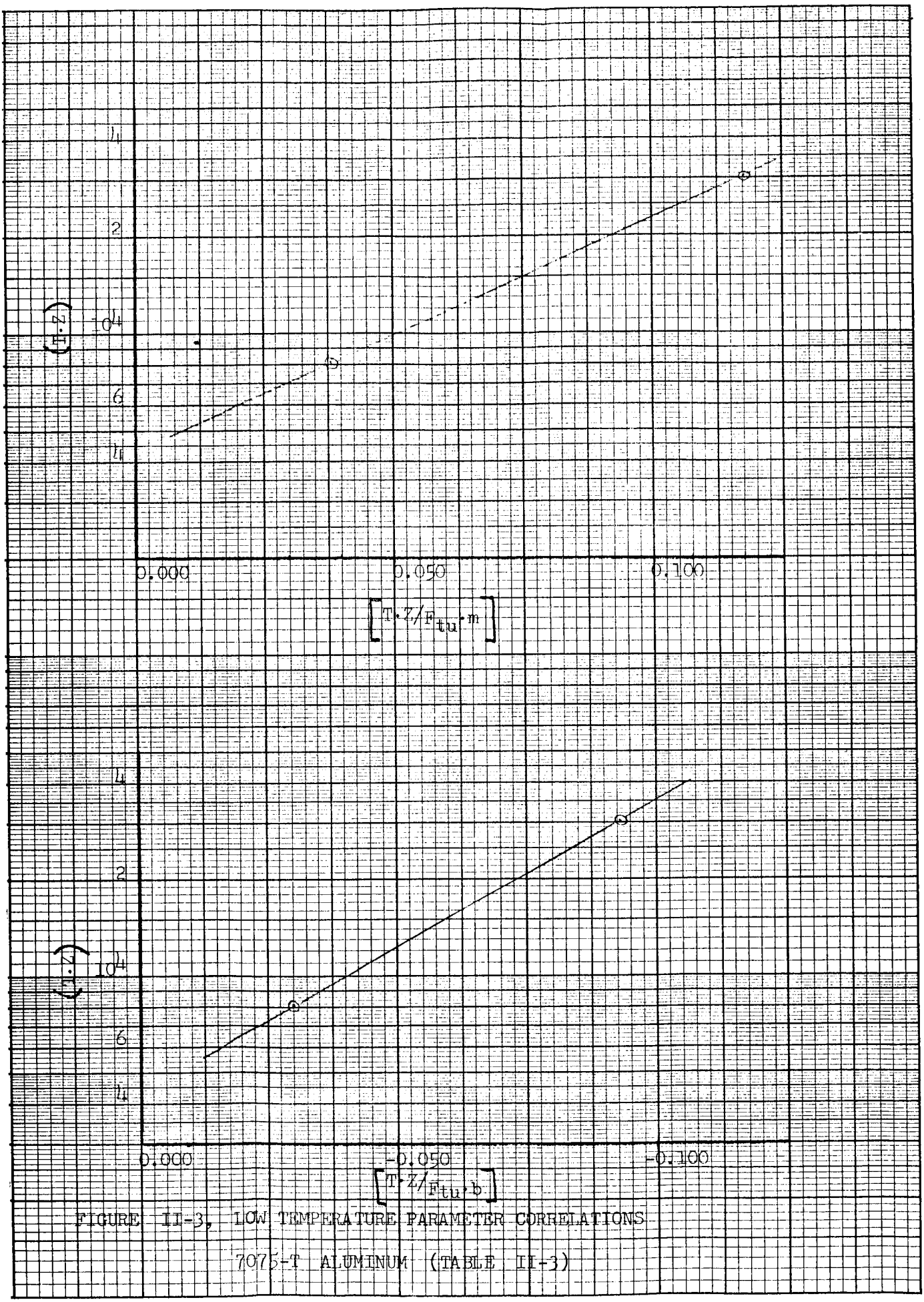


FIGURE II-3, LOW TEMPERATURE PARAMETER CORRELATIONS

7075-T ALUMINUM (TABLE II-3)

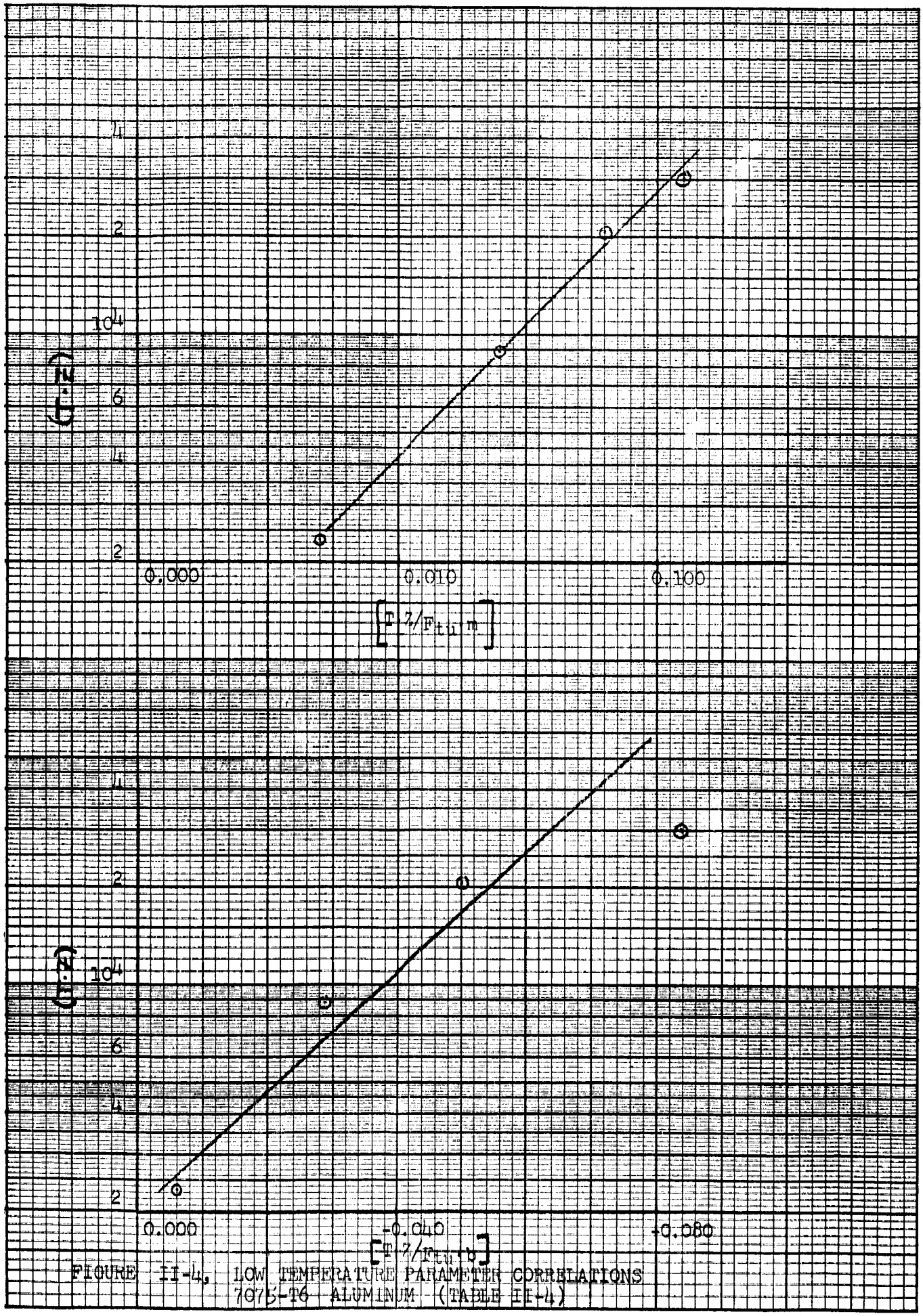


FIGURE II-4, LOW TEMPERATURE PARAMETER CORRELATIONS
7075-T6 ALUMINUM (TABLE II-4)

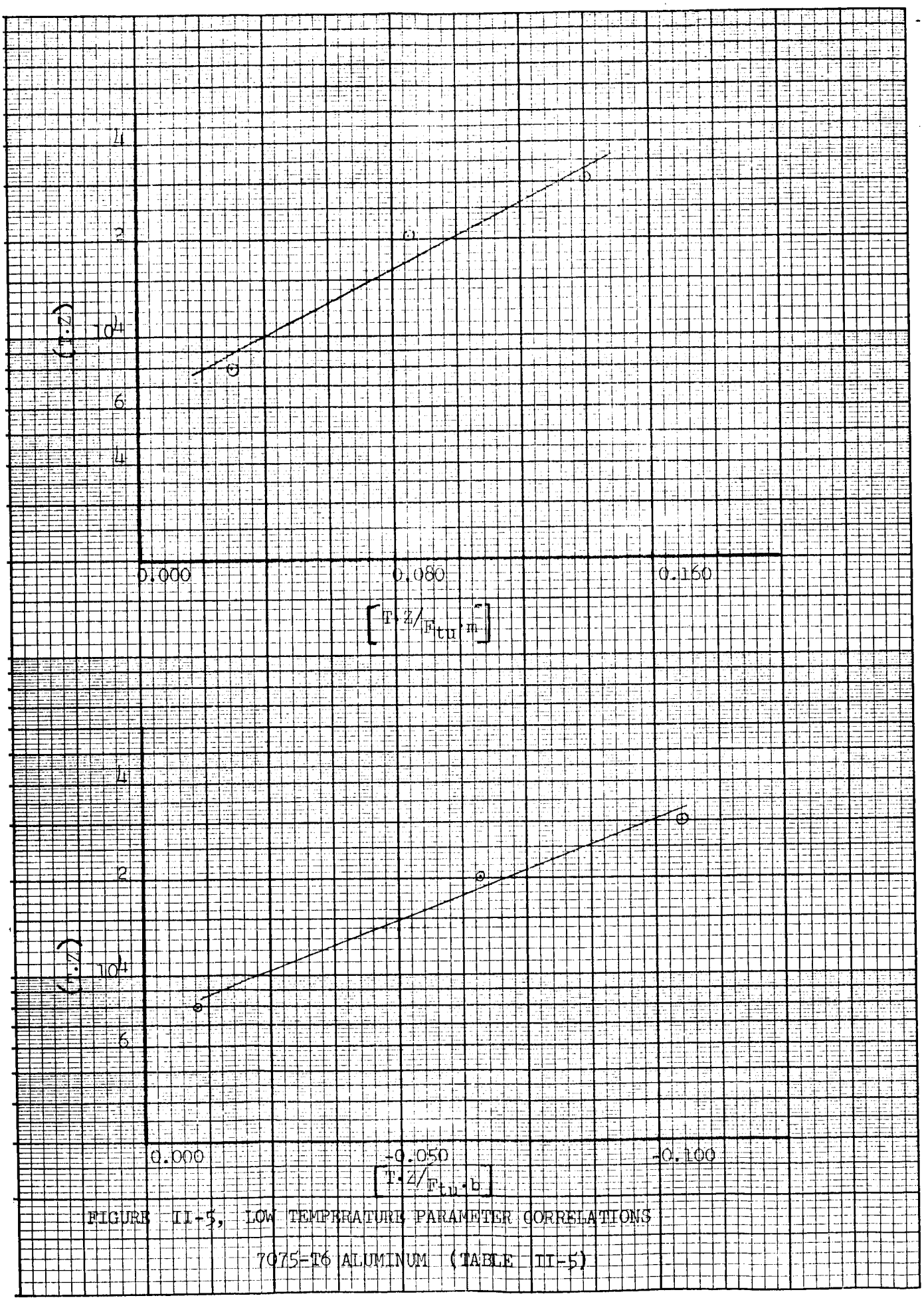


FIGURE II-5, LOW TEMPERATURE PARAMETER CORRELATIONS

7075-T6 ALUMINUM (TABLE II-5)

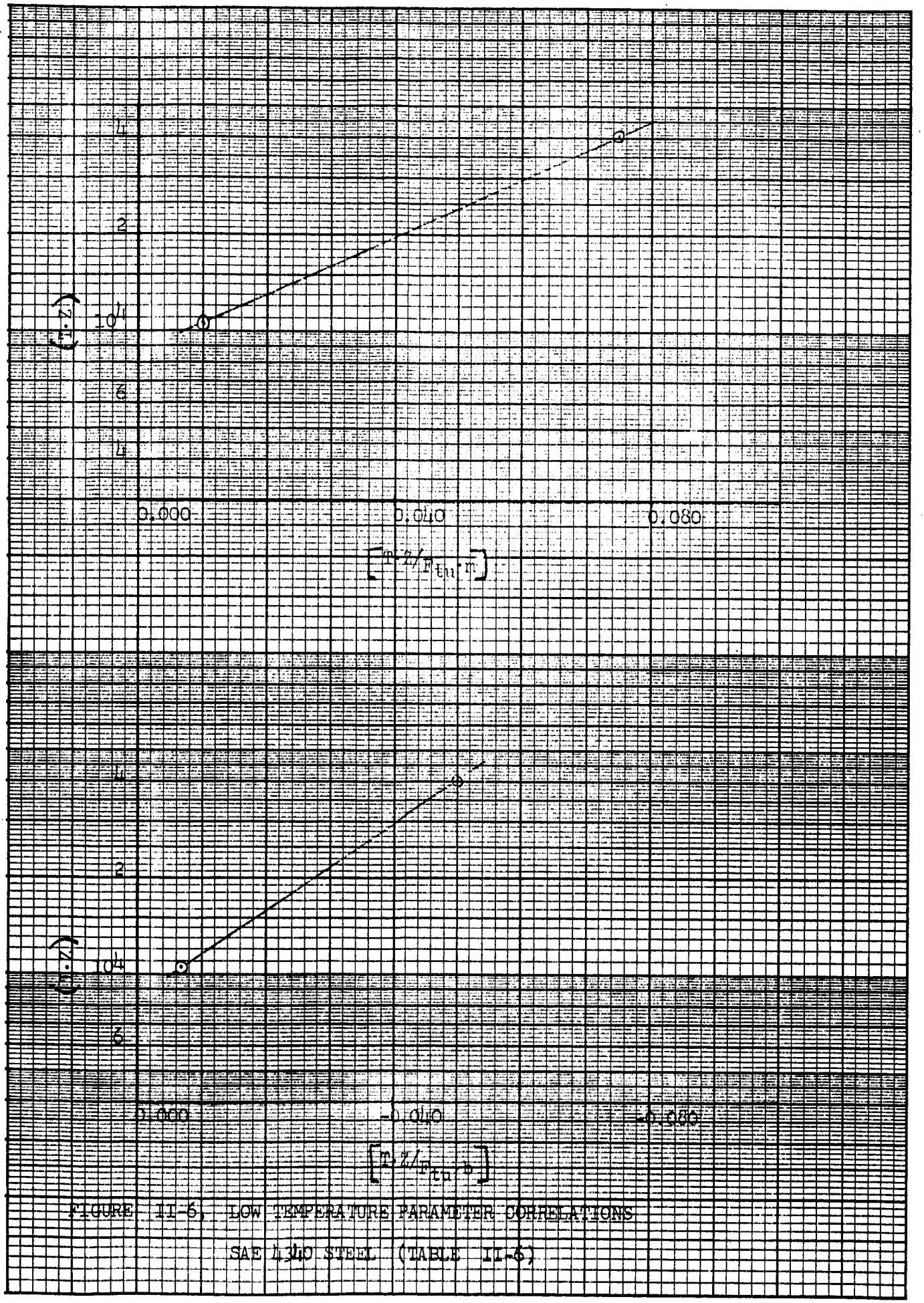


FIGURE II-6, LOW TEMPERATURE PARAMETER CORRELATIONS

SAE 4340 STEEL (TABLE II-6)

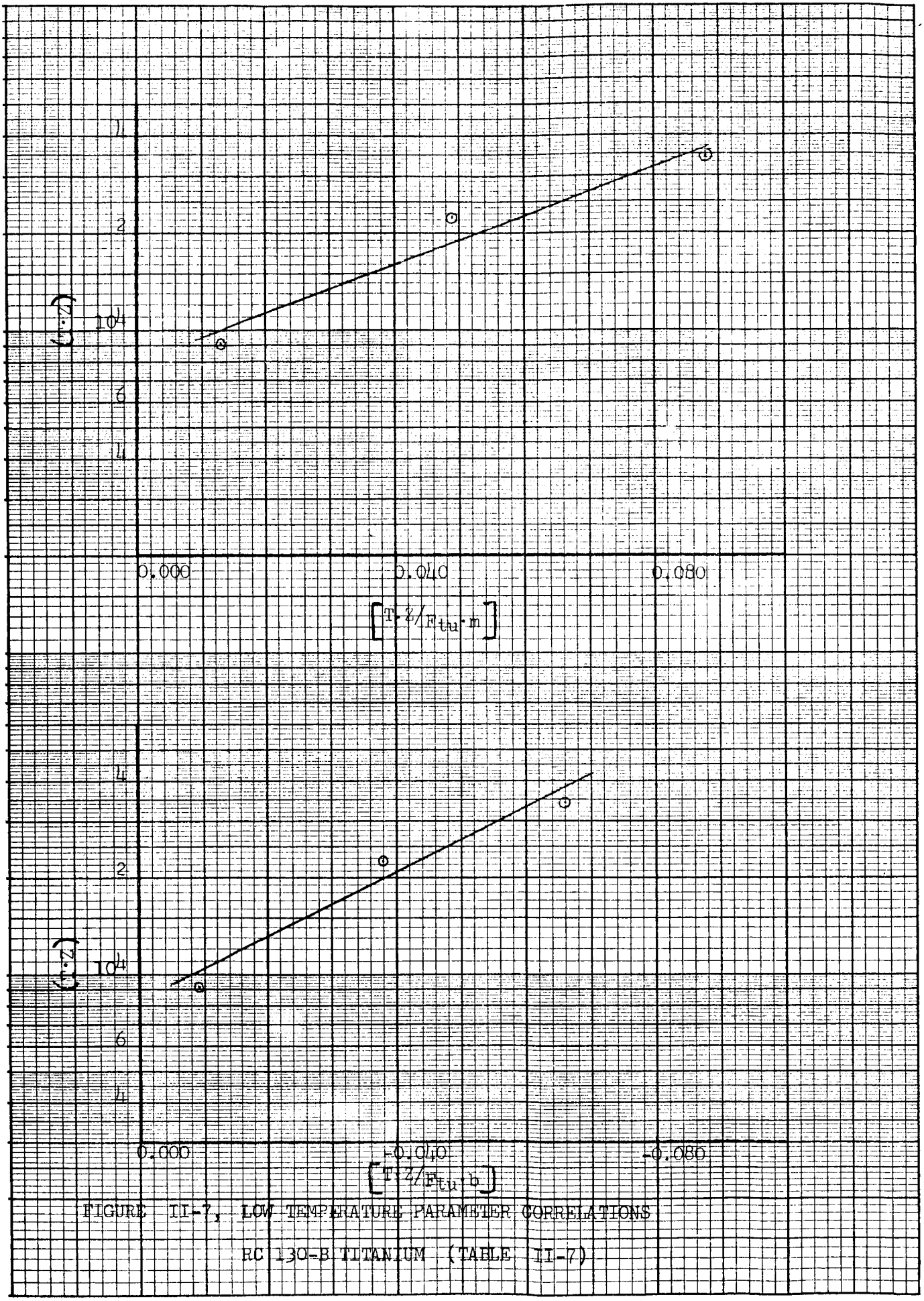


FIGURE II-7, LOW TEMPERATURE PARAMETER CORRELATIONS

RC 130-B TITANIUM (TABLE II-7)

SECTION II - TABLES
of
LOW TEMPERATURE AND CORRELATION PARAMETERS,

FIGURE AND TABULATION SHEET REFERENCES

Symbols

T = Absolute Temperature, degrees Rankine

Z = $\sqrt[4]{\text{Elevated Temperature Elastic Modulus}}$

F_{tu} = Elevated Temperature Tensile Strength

AX = Axial Load Data

RB = Rotating Beam Data

CB = Rotating Cantilever Beam Data

SB = Sheet Bending Data

m = Temperature Parameter (slope)

b = Temperature Parameter $\left[\log_e \text{ (intercept value)}\right]$

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TABLE II-1
MATERIAL - 2024-T Aluminum At Low Temperatures,(Melting Temperature 1100°F)
Temperature Range (537° to 139°R) - Type Test RB
References:
Figure II-1
Tabulation Sheets 99-101
Bibliographical Entry A-7

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	$T \cdot Z$ (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
537	68.0	57.056	2.231	-3.148	3.064	0.202	-0.143
352	75.5	57.597	2.330	-3.217	2.025	0.115	-0.083
139	97.0	58.358	2.297	-2.968	0.812	0.036	-0.028

TABLE II-2
MATERIAL - 5456-H321 Aluminum at Low Temperatures,(Melting Temperature 1100°F)
Temperature Range (140° to 535°R) - Type Test AX
References:
Figure II-2
Tabulation Sheets 85-86
Bibliographical Entry A-58

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	$T \cdot Z$ (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
140	68.9	59.58	5.718	-9.408	0.834	0.021	-0.013
535	52.7	56.23	6.139	-9.818	3.008	0.058	-0.058

TABLE II-3
MATERIAL - 7075-T Aluminum, (Melting Temperature 1100°F)
Temperature Range (535° to 139°R) - Type Test RB
References:
Figure II-3
Tabulation Sheets 121-122
Bibliographical Entry A-84

T °R	F_{tu} ksi	$Z = \sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
**535	83.9	56.650	2.981	-3.893	3.031	0.121	-0.093
139	99.5	58.358	2.123	-2.698	0.812	0.038	-0.030

TABLE II-4
MATERIAL - 7075-T6 Aluminum At Low Temperatures, (Melting Temperature 1180°F)
Temperature Range (537° to 37°R) - Type Test RB
References:
Figure II-4
Tabulation Sheets 29-32
Bibliographical Entry A-34

T °R	F ksi	$Z = \sqrt[4]{E}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
537	74.0	56.781	3.173	-4.703	3.049	0.130	-0.084
352	85.5	59.620	3.112	-4.536	2.096	0.079	-0.050
139	97.1	63.593	2.352	-3.120	0.885	0.039	-0.029
37	113.4	63.593	2.761	-3.459	0.233	0.007	-0.006

** Data obtained at room temperature, assumed to be 535°R

TABLE II-5
MATERIAL - 7075-T6 Aluminum,(Melting Temperature 1100°F)
Temperature Range (537° to 136°R) - Type Test RB
References:
Figure II-5
Tabulation Sheet 96-98
Bibliographical Entry A-74

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	$\frac{T \cdot Z}{(x\ 10^{-4})}$	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
537	87.0	56.781	2.494	-3.316	3.049	0.140	-0.106
352	98.2	57.451	2.435	-3.113	2.020	0.084	-0.066
136	118.0	58.358	2.381	-2.914	0.971	0.028	-0.023

TABLE II-6
MATERIAL - SAE 4340 Steel at Low Temperatures,(Melting Temperature 2600°F)
Temperature Range (537° to 139°R) - Type Test AX
References:
Figure II -6
Tabulation Sheets 106-107
Bibliographical Entry A-84

T °R	F_{tu} ksi	$\sqrt[4]{\frac{Z}{E}}$	m	b	$\frac{T \cdot Z}{(x\ 10^{-4})}$	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
537	146.0	74.56	3.676	-5.511	4.004	0.075	-0.050
139	208.0	75.09	4.783	-6.916	1.045	0.010	-0.007

TABLE II-7

MATERIAL - RC 130-B Titanium At Low Temperatures,(Melting Temperature 3000°F)

Temperature Range (537° to 139°R) - Type Test AX

References:
Figure II-7
Tabulation Sheets 108-110
Bibliographical Entry A-11

T °R	F_{tu} ksi	$\frac{Z}{\sqrt[4]{E}}$	m	b	T·Z (x 10^{-4})	$\frac{T \cdot Z}{F_{tu} \cdot m}$	$\frac{T \cdot Z}{F_{tu} \cdot b}$
537	149.0	64.018	2.621	-3.468	3.438	0.088	-0.066
351	172.0	64.491	2.665	-3.446	2.267	0.049	-0.038
139	256.0	65.933	2.835	-3.751	0.918	0.013	-0.009

III. CORRELATION PROCEDURE

In order to apply the correlation procedure to elevated temperature fatigue data certain criteria should be established for useful data sets. The American Society for Testing Materials has recommended that fifty test specimens be used to establish the S-N curve. (B-169) By this criterion no data set available at elevated temperatures could be used to evaluate the fatigue properties of a material.

Although a large amount of fatigue data at elevated temperatures was compiled much of this data is of little use in the correlation effort because incomplete information was presented. The correlation procedure is applied to all data for which the temperature parameters could be established. To correlate the temperature parameters and the fatigue characteristics at elevated temperatures the following information should be available.

1. A creditable S-N curve for a minimum of 2 temperatures
2. The S-N curves should hold all known variables that effect the fatigue life of the material constant. (Such as, stress ratio, mean stress, notches, surface finish, type of test, physical properties and mechanical properties of the material)
3. The short-time elevated temperature stress-strain diagram, or elevated temperature tensile strength and elastic modulus
4. Specimen geometry
5. Reasonable approximations for item 3 can be obtained by substitution of room temperature values for these mechanical properties.

With this information, the correlation method may be applied to data sets and be expected to yield information of the same level as the data used for obtaining the temperature parameters.

A. DATA ANALYSIS

Two forms of fatigue data lend themselves conveniently to the

correlation procedure, design data and laboratory test data.

1. Design data

Design data generally appears as an S-N curve or in tabular form. The S-N curve is frequently drawn with no data points appearing on the figure, the curve is then assumed to be the mean S-N curve. Design data is also frequently presented in tabular form as a particular stress value for a finite lifetime such as 10^4, 10^5, 10^6 etc. (Example, Table 2.3.1 p.52 Reference A-4) These data are assumed to represent points from the mean S-N curve, and the S-N curve reproduced from tabular design data should pass through each point.

2. Laboratory test data

Laboratory fatigue test data are available in tabular form and as S-N curves drawn through data points which appear on a figure. In many instances the data points used to obtain the S-N curve are too few to apply a statistical method in analysis. In such instances it is suggested that the mean S-N curve is drawn by eye, for the entire data set (for a given material), by the same individual.

Laboratory fatigue data with 20 or more data points can be objectively analyzed to obtain the mean S-N curve by following the method proposed in the Aircraft Fatigue Handbook. This method for presentation of laboratory fatigue data has the advantages of being objective, statistically sound and capable of reproducing the same S-N curve consistently.

"Method for Presentation of Laboratory Fatigue Test Data": Aircraft Fatigue Handbook, Volume III, Materials (Reference A-7)

Using a set of typical experimental data points the method for obtaining the mean S-N curve is demonstrated.

An estimated mean line is first drawn by "inspection" for the data plotted on the usual semi-logarithmic scale, as line 1, Figure III-1.

In Figure III-2, we see how the data may be divided into groups, each of which includes 5 or more test points within a ten to one life ratio. Any one of these groups now constitutes a valid group of data to analyze.. Do not, however, include in calculations any data representing specimens which had a fatigue life equal to or greater than the shortest life of an unbroken sample. If portions of a curve cannot be included within any group, represent that portion by estimated dashed lines.

Figures III-3 and III-4 show how to average the data within a group to arrive at a more accurate mean curve than the "eye-estimated" curve. A veritical line is drawn through the center of the group, S-T in Figure III-3. This is the mean-log-life line.

Then measure with a KSI scale the stress by which each test point deviates from the eye-estimated curve. Those points below the curve are negative, those above, positive. To average these deviations, compute their algebraic sum and mean. As an example, in Group B, Figure III-3, the average is -1/2 KSI. In Figure III-4 this is plotted on the mean-log-life line S-T at point "W". If the sign is negative, "W" will fall below the eye-estimated curve; if positive, it will fall above.

Repeat this averaging for each group. In Figure III-5 is shown how a line 2 through the "W" points would represent a conversion from the eye-estimated mean S-N curve to a calculated mean curve. If the calculated line deviates from the original estimate by more than 2 stress

percent, repeat the calculation and revise the location of the calculated line accordingly. For that portion of the S-N curve where the group does not include 5 or more test points within a ten to one life ratio, an eye-estimated dashed line should be used for the mean curve.

All fatigue test data with more than 20 data points should be reduced in the manner described and a mean S-N curve should be replotted in each instance.

B. FITTING THE S-N EQUATION TO THE MEAN S-N CURVE

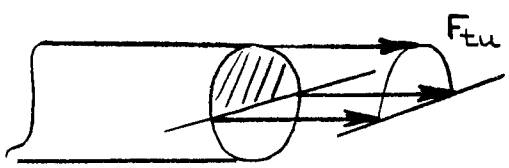
Assuming the mean S-N curve has been determined from the experimental data, the S-N equation is now fitted to the mean S-N curve in order to evaluate the temperature parameters. The mathematical form to be used is given in section IV as

$$S = (TS' - E')\, e^{-k(\log_{10}N)^m} + E' \qquad \text{Equation I}$$

1. Temperature Parameters

The value for the parameter TS' is determined as the elevated temperature ultimate strength (F_{tu}) when being applied to axial load fatigue data.

An equivalent modulus of rupture must be calculated when the correlation is being applied to bending fatigue tests. Illustrating the calculation of equivalent modulus of rupture for a specimen of circular cross-section, a simplified stress distribution is assumed over the portion of the specimen in tension. It is assumed that the F_{tu} is developed uniformly as shown, the force acting through



the centroid of this area is $F = F_{tu}\left(\frac{\pi r^2}{2}\right)$, the internal moment is expressed as

$$M = F_{tu}\left(\frac{\pi r^2}{2}\right)(4r/3\pi)(2) = F_{tu}\left(\frac{4r3}{3}\right).$$

Using this value for moment in the Flexure formula yields the equivalent modulus of rupture

$$TS' = \frac{My}{I} = F_{tu}\,(4r^3/3)(r)\left(\frac{4}{\pi r^4}\right) = F_{tu}\,(16/3\pi)$$

$$TS' = 1.695\ F_{tu}$$

The value for the parameter E' is determined by consulting the data and selecting the lowest value of stress for which a specimen failure has occurred in fatigue. Identifying this value as S_{min}, E' is calculated as

$$E' = S_{min} - \frac{TS'}{100}$$

When using the correlated parameters to predict an S-N curve, the value for E' is conservatively estimated as $E' = 0.30\ (F_{tu})$

The parameters m and k are the remaining temperature parameters which describe the shape of the S-N curve.

S and N represent the maximum stress and cycles to failure respectively.

2. Evaluating the Temperature Parameters by the Method of Least Squares.

The equation for the S-N curve (Equation 1) is rewritten for convenience in the following linear form:

$$\ln \ln \left[\frac{TS' - E'}{S - E'}\right] = (\ln k) + m \ln (\log_{10} N)$$

Expressing the modified linear form more simply as

$$y' = mx' + b$$

where $m = m$ $\qquad b = (\ln k)$

$$y' = \ln \ln \left[\frac{TS' - E'}{S - E'}\right] \text{ and } x' = \ln (\log_{10} N)$$

it can be demonstrated that the parameter m may be determined from the slope m and the parameter k may be determined from the intercept $b = (\ln k)$ of the linear form. The S-N equation is illustrated in linear form as Figure III-6 from the data obtained for 6Al-4V Titanium at 900°F.

The S-N equation (Equation 1) may also be expressed in linear form using logarithms to the base 10 in a similar manner.

The values for the slope (m) and intercept $b = (\ln k)$ are determined in the following manner:

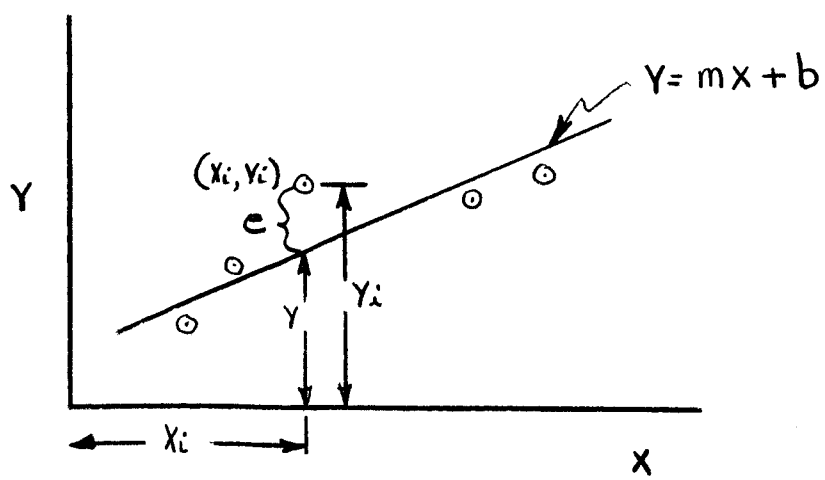
a. Individual values of Stress (S) and Cycles to Failure (N) are obtained from the mean S-N curve. The points should not necessarily be selected at uniform intervals of S or N, but should be selected in such a manner as to be placed in equal increments along the path of the curve.

b. The values of TS' and E' are calculated.

c. The calculation of $\left[\frac{TS' - E'}{S - E'}\right]$, and the subsequent evaluation of $\ln \ln \left[\frac{TS' - E'}{S - E'}\right]$, and $\ln (\log_{10} N)$ is made

d. The following derivation for the least square determination of slope and intercept is simplified by expressing the variable $\ln \ln \left[\frac{TS' - E'}{S - E'}\right]$ as Y and $\ln (\log_{10} N)$ as X.

e. Assume the following:



$$e = (y_i - y) = y_i - mx_i - b$$

$$e^2 = y_i^2 + m^2 x_i^2 + b^2 + 2mbx_i - 2 mx_iy_i - 2by_i$$

$$\Sigma e^2 = \Sigma y_i^2 + m^2 \Sigma x_i^2 + \Sigma b^2 + 2mb\Sigma x_i - 2m\Sigma x_iy_i - 2b\Sigma y_i$$

(Σb^2 represented by Nb^2 , where N = total number of data points)

f. Taking the derivative of Σe^2 first with respect to m and then with respect to b, we obtain two equations. Setting the two equations equal to zero yields the slope and intercept for which Σe^2 is minimum. It is of interest to note that by inspection the slope and intercept for which Σe^2 would be a maximum is ∞.

g. The resulting equations, when solved simultaneously for the slope m and intercept b, yield:

$$m = \frac{\Sigma x_iy_i - \frac{\Sigma x_i \Sigma y_i}{N}}{\Sigma x_i^2 - \frac{\Sigma x_i \Sigma x_i}{N}}$$

$$b = \frac{\Sigma y_i \Sigma x_i^2 - \Sigma x_i \Sigma x_i y_i}{N\Sigma x_i^2 - \Sigma x_i \Sigma x_i}$$

h. The solution for m, and b can be conveniently determined with a hand calculator or be easily reduced by digital computer.

Expressing the parameters in terms of the original variables

$$m = \frac{\sum\left[\ln(\log_{10}N)\right] \cdot \left[\ln \ln \left(\frac{TS' - E'}{S - E'}\right)\right] - \frac{\sum\left[\ln(\log_{10}N)\right] \cdot \sum\left[\ln \ln\left(\frac{TS' - E'}{S - E'}\right)\right]}{N}}{\sum\left[\ln(\log_{10}N)\right]^2 - \frac{\sum\left[\ln(\log_{10}N)\right] \cdot \sum\left[\ln(\log_{10}N)\right]}{N}}$$

$$b = (\ln k) = \frac{\sum\left[\ln \ln \left(\frac{TS' - E'}{S - E'}\right)\right] \cdot \sum\left[\ln(\log_{10}N)\right]^2 - \sum\left[\ln(\log_{10}N)\right] \cdot \sum\left[\ln(\log_{10}N)\right] \cdot \left[\ln \ln\left(\frac{TS' - E'}{S - E'}\right)\right]}{N\sum\left[\ln(\log_{10}N)\right]^2 - \sum\left[\ln(\log_{10}N)\right] \cdot \sum\left[\ln(\log_{10}N)\right]}$$

C. CORRELATING THE TEMPERATURE PARAMETERS

1. Short-time Mechanical Properties

The mechanical properties selected to provide the indirect temperature correlation are the elevated temperature elastic modulus and the elevated temperature ultimate tensile strength. The tensile strength and elastic modulus are mechanical properties most frequently evaluated in material evaluation programs. A simple stress-strain diagram will provide this information for a material at the desired temperature.

When the elevated temperature values of tensile strength and elastic modulus are not available a reasonable approximation to the correlation can be obtained by using the room temperature values for these properties in the calculations.

2. Correlation Form

Using the absolute value for the testing temperature (T' in ^{o}R to simplify elevated and low temperature data analysis) and the fourth root of the elevated temperature elastic modulus ($Z = \sqrt[4]{\text{Elastic Modulus} = E}$), the correlation term log $(T \cdot Z)$ is plotted against $(T \cdot Z/F_{tu} \cdot m)$ and against $(T \cdot Z/F_{tu} \cdot b)$ to obtain the linear temperature correlation. The actual form of the relationship between the variables m, k, T', Z and F_{tu} is

$$\log_{10} \left[T \cdot Z \right] = (\text{Constant}) \left[T \cdot Z/F_{tu} \cdot m \right] + \log \left[T \cdot Z \right]_{o}$$

The temperature parameters (m) and (b = ln k) are correlated reasonably well with temperature in this form. This linear form has been established by cut and trying many different combinations of mechanical properties and forms (relationships). It is highly possible that certain other forms could provide better linear agreement with

certain alloy parameters and temperature; however, the form selected is in best agreement with all the alloys considered.

Tables I-1 to I-31 and Tables II-1 to II-7 illustrate the calculation of the correlation terms. In order to maintain 3 decimal accuracy the fourth roots were evaluated with log tables. The term b (intercept value = lnk) is correlated directly in order to reduce the number of calculations.

D. OBTAINING THE S-N CURVE AT ANY TEMPERATURE USING THE CORRELATED PARAMETERS

The method for using the correlated parameters to obtain an S-N curve for a material at any temperature is best explained by illustration. Selecting the data and parameter correlation of the Titanium alloy (6Al-4V) in Figure I-27, the mean S-N curve at a temperature of 700°F will be predicted in the following manner.

1. The short-time mechanical properties F_{tu} = 135,000 psi and E = 11.5 x 10^6 psi are determined from available mechanical property data. (A stress-strain diagram obtained at 700°F would also provide this information)

2. The value of the parameter term (T·Z) is calculated and the value of the parameters m and b are determined from Figure I-27

$$(T \cdot Z) = (1160)(58.35) = 6.768 \times 10^4$$

From Fig. I-27, $(T \cdot Z/F_{tu} \cdot m) = 0.157$

$(T \cdot Z/F_{tu} \cdot b) = -0.103$

$$m = (T \cdot Z)/(0.157\ F_{tu}) = 3.194$$

$$b = (T\ Z)/(-0.103\ F_{tu}) = -4.869$$

3. The parameter k is evaluated from

$$b = \ln(k) = -4.869$$

in the following manner since the logarithms of numbers less than one were expressed with a negative sign.

$$\ln(k) = -4.869 = (0.131 - 5.000)$$

$$k = \frac{\text{anti-log}_e\ (0.131)}{\text{anti-log}_e\ (5.000)} = 0.00765$$

4. The value for TS' is determined. (TS' = F_{tu} = 135,000 psi) The data from which the correlation parameters were evaluated was obtained from axial load fatigue tests, therefore the equivalent modulus of rupture is not calculated.

5. The value for E' must be approximated since no fatigue data exists to evaluate E' as (S_{min} - TS'/100).

   A conservative value of E' = 0.30 TS' will provide a reasonable value for E'. This figure is an approximation for the endurance stress.

   E' = 40,500 psi

6. The S-N equation for the 6Al-4V Titanium is therefore described at 700°F as

$$S = (94,500)e^{-(0.00765)(\log_{10}N)^{3.194}} + 40,500$$

7. The S-N curve is then plotted by selecting values for N and solving the equation for corresponding values of S.

8. Another method may be used to establish the value of E' by performing a number of fatigue tests at a high stress level in order to establish a point on the S-N curve. The mean value of N and the appropriate value for S inserted in the equation would evaluate the parameter E'.

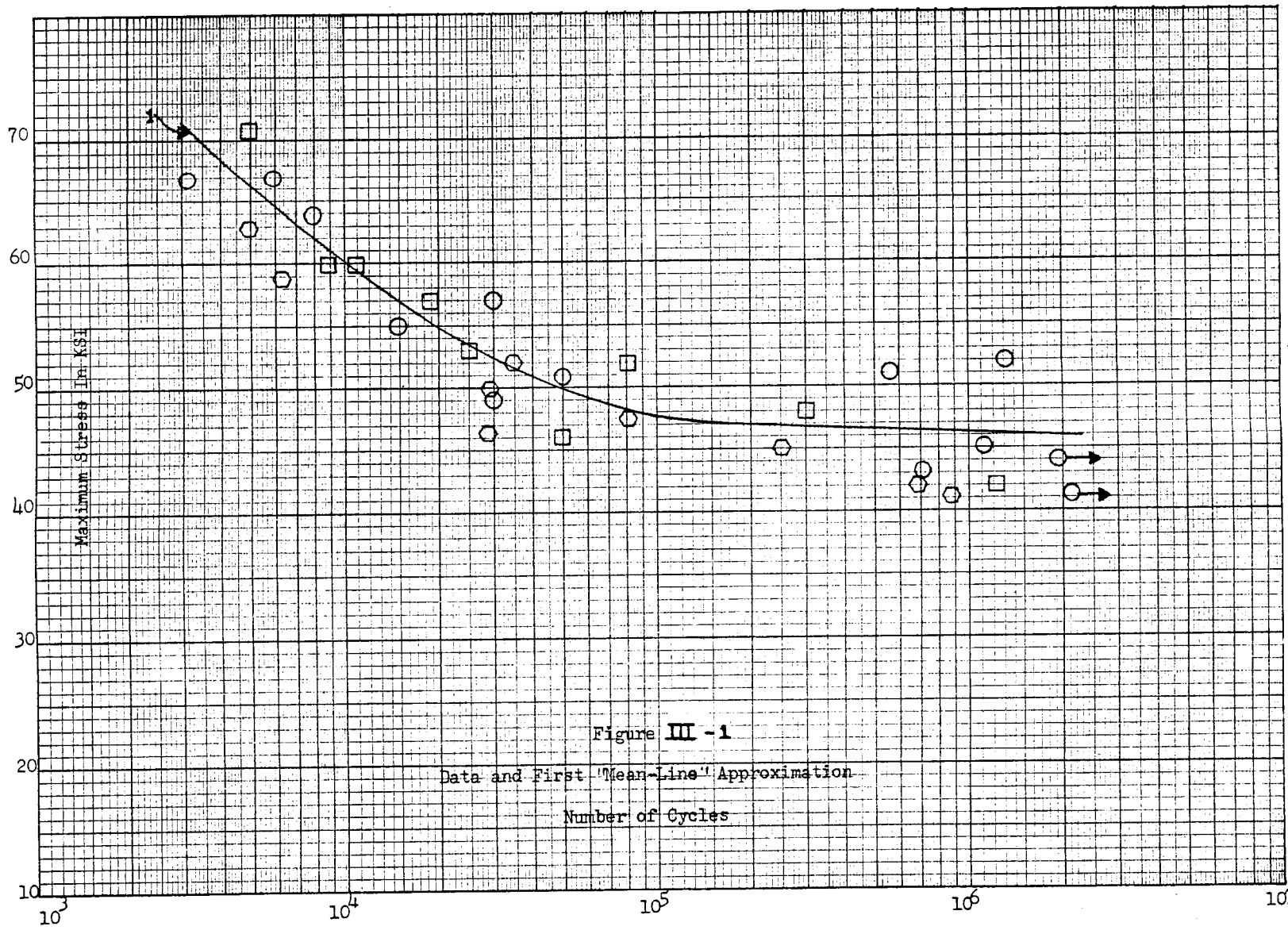
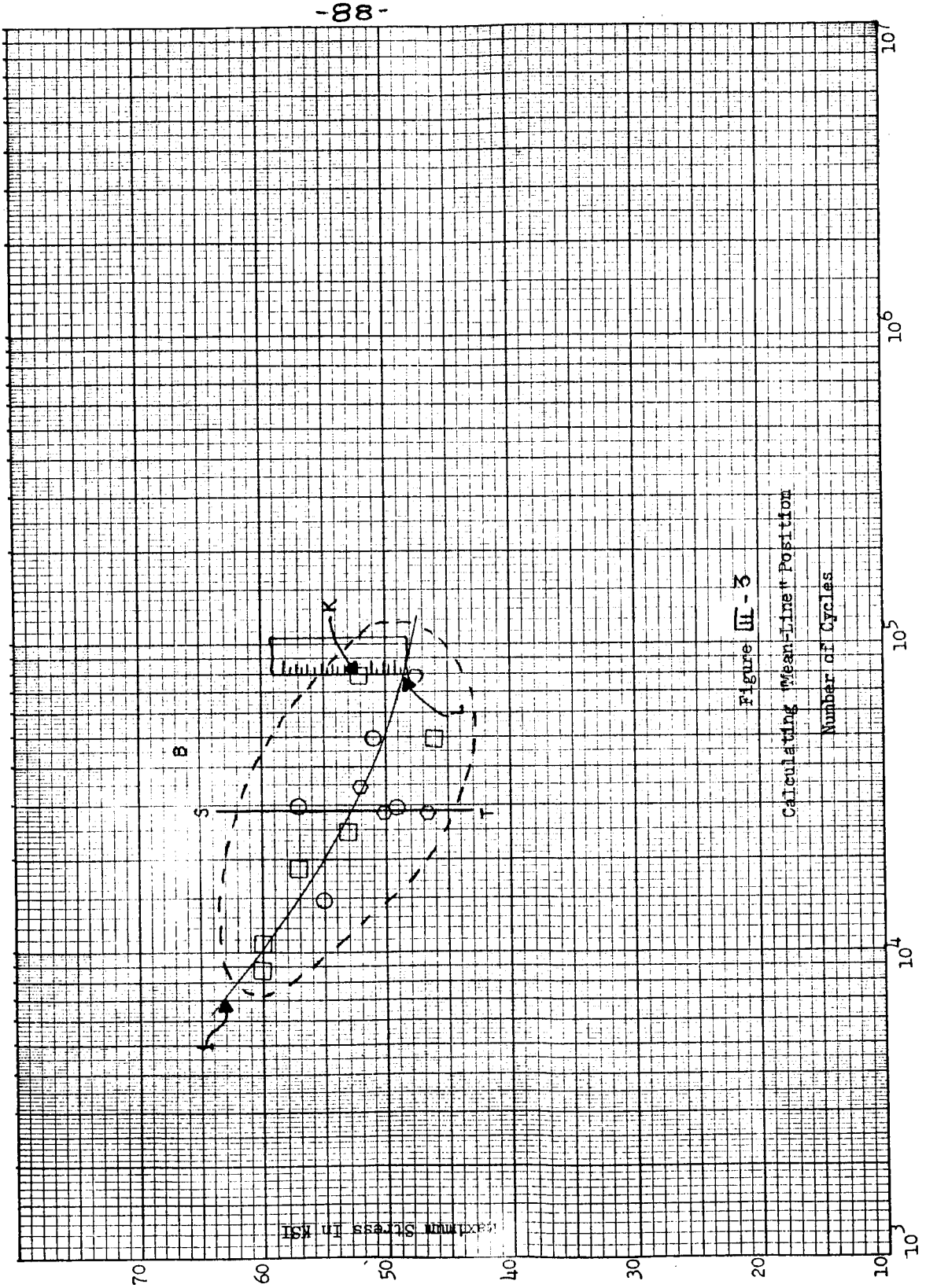


Figure III -1

Data and First "Mean-Line" Approximation

Maximum Stress in KSI
70
60
50
40
30
20
10
10^3
10^4
10^5
10^6
10^7
Number of Cycles
Division Into Groups
A
B
C

Figure III-2


Maximum Stress In KSI
70
60
50
40
30
20
10
10^3
10^4
10^5
10^6
10^7
Number of Cycles
Calculating Mean-Line Position
Figure III - 3
K
B
S
T

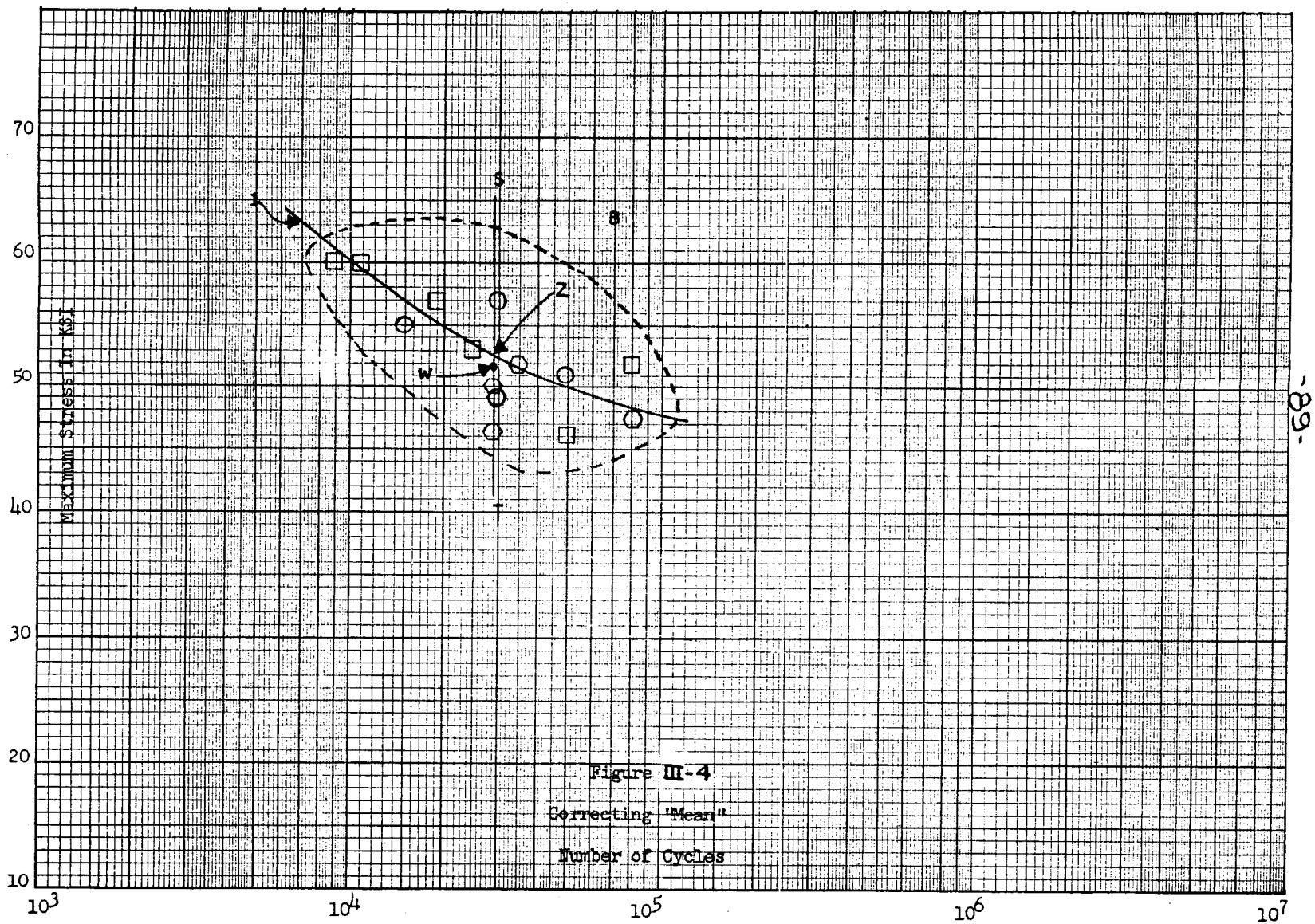


Figure III-4

Correcting "Mean"

Number of Cycles

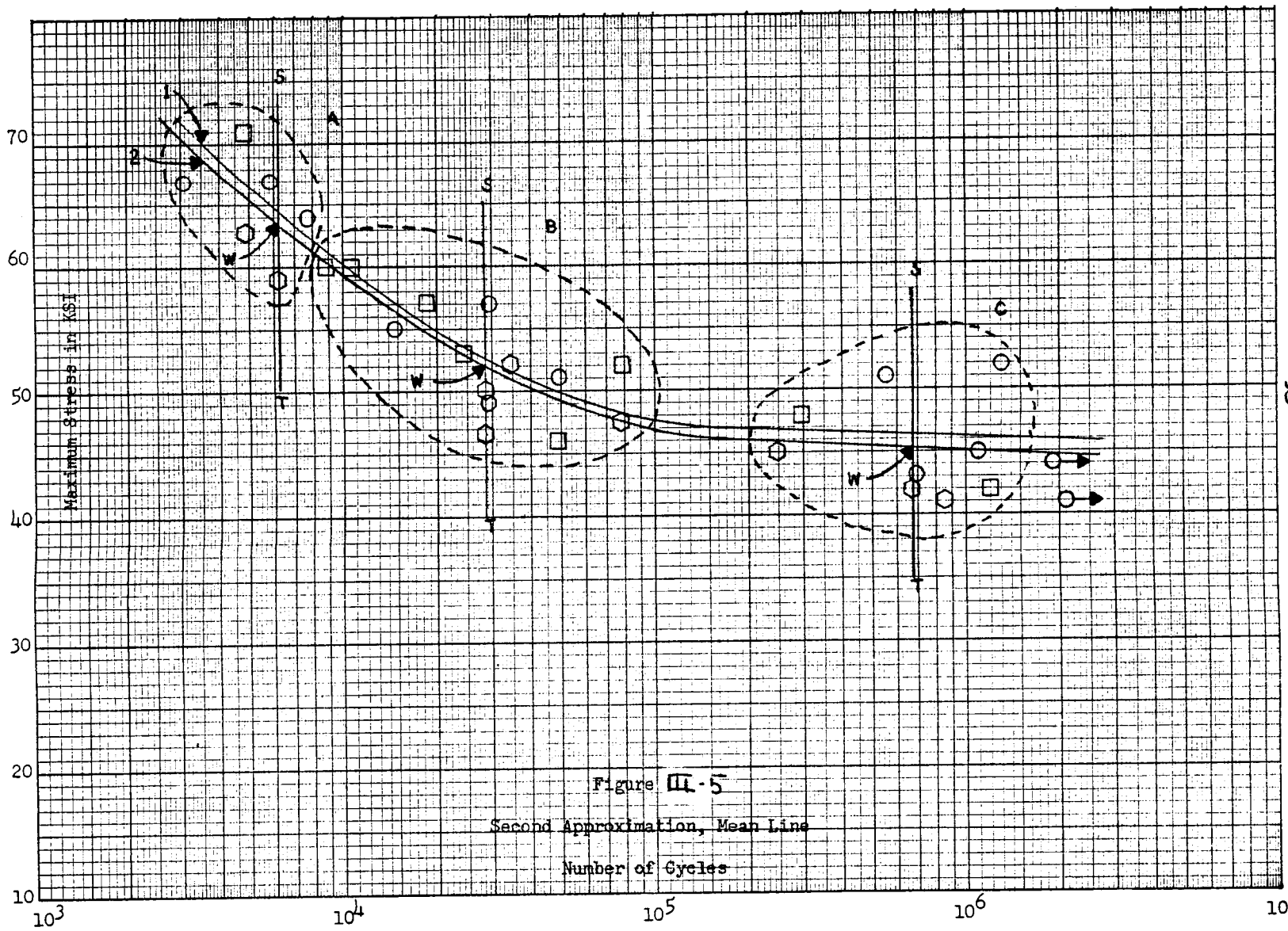


Figure III-5

Second Approximation, Mean Line

Number of Cycles

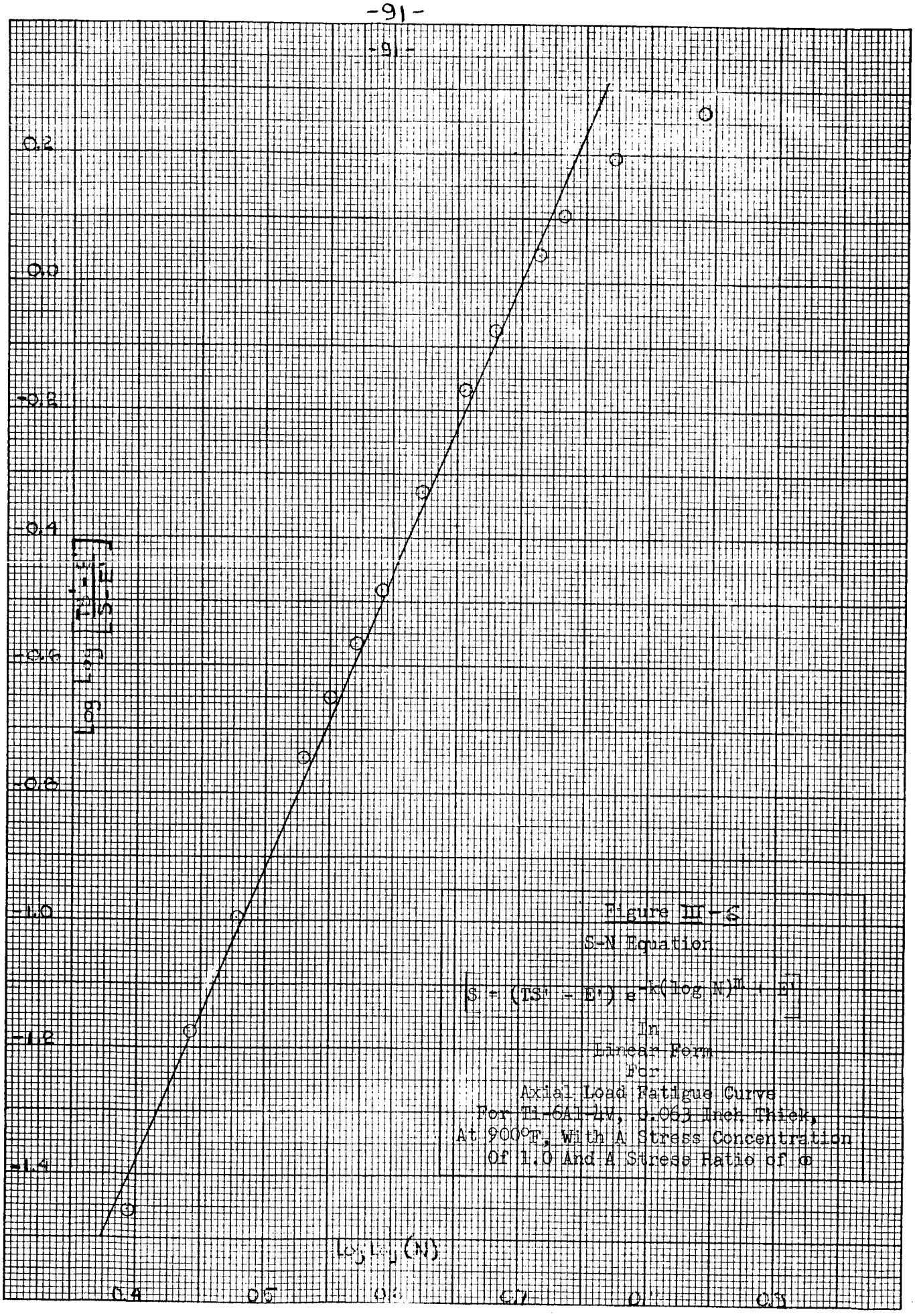


Figure III-6

S-N Equation

$$S = (TS' - E')\, e^{-k(\log N)^m} + E'$$

In

Linear Form

For

Axial Load Fatigue Curve

For Ti-6Al-4V, 0.063 Inch Thick,

At 900°F, With A Stress Ratio of 0

IV - MATHEMATICAL RELATIONSHIP FOR THE S-N CURVE

A. FUNCTIONAL RELATIONSHIP

The exponential form used for the S-N equation is:

$$S = (TS' - E') e^{-k(\log_{10} N)^m} + E' \qquad \text{(Equation 1)}$$

The parameters in this equation have been described in detail in section III-1. This exponential form was selected to describe the mean S-N curve for the following reasons:

1. This form of exponential equation is capable of describing a family of curves similar to straight lines or rectangular hyperbolas depending on the values assumed for the parameters.

2. Two of the parameters TS' and E' are conveniently and quite accurately evaluated from short-time elevated temperature mechanical property tests.

3. The basic form of this exponential equation was used by W.Wiebull to describe the S-N relationship for room temperature tests of steel quite successfully. (B-170)

4. The exponential form of the S-N equation was compared with several other equations that have been used to describe the S-N curve. (all of the hyperbolic form) Among the equations examined and compared were,

   $S = (E \cdot c / 2N^{1/a}) + S_e$, proposed by Tavernelli (B-145),

   $S = (k/N) + E$, proposed by D.L. Henry (A-76) and

   $S = (b/N^c) + E$, proposed by Palmgren (B-56) .

   In each case the exponential form for the S-N equation presented in this paper was in better agreement with the mean S-N curve.

B. DESCRIBING A MEAN S-N CURVE WITH THE EXPONENTIAL S-N EQUATION

The mean S-N curve for the 6Al-4V Titanium alloy was obtained in Tabulation Sheet V-24 using the statistical method (that makes no pre-determined assumption for the shape of the curve) described in section III.

The mean S-N curve (from Figure V-24) has been re-drawn for Figure IV-1

and is represented by the solid line passing through the data points.

The linear form of the S-N equation described in Figure III-6 for this particular mean S-N curve was obtained by fitting the exponential equation to the mean S-N curve to establish the parameters m and k. The parameters TS' and E' were evaluated from the mechanical properties and existing fatigue data to obtain the S-N equation for this temperature.

The S-N equation is shown on Figure IV-1 as a broken line and the degree of agreement is described very well.

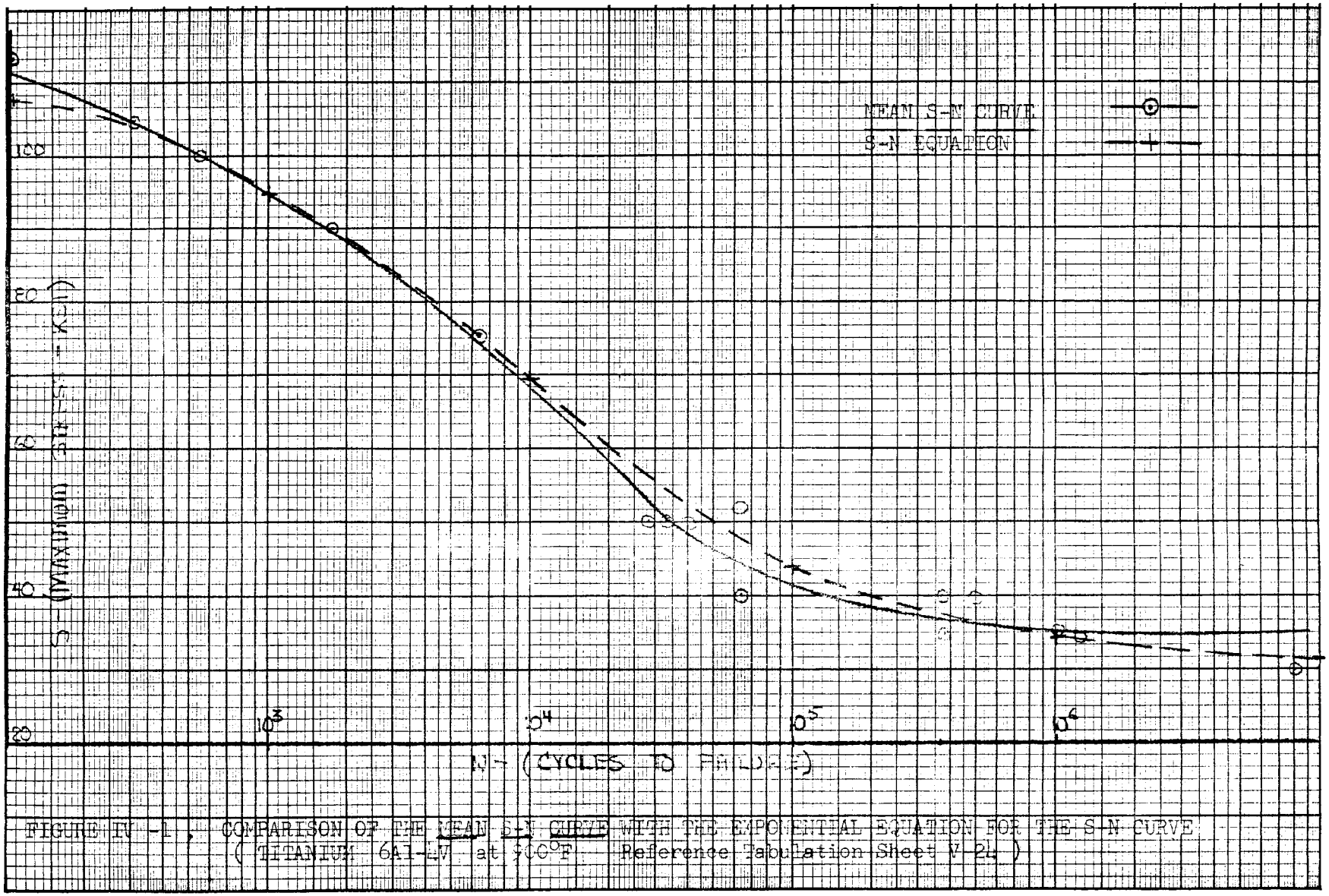


FIGURE IV -1 , COMPARISON OF THE MEAN S-N CURVE WITH THE EXPONENTIAL EQUATION FOR THE S-N CURVE
(TITANIUM 6Al-4V at 700°F Reference Tabulation Sheet V-24)

V. ELEVATED TEMPERATURE FATIGUE DATA COMPILATION

TABLE V-1, Elevated Temperature Fatigue Data Compilation Reference

TABLE V-2, Information Sources

Bibliography

A. References Containing Elevated Temperature Fatigue Data
B. References Containing No Elevated Temperature Fatigue Data

Tabulation Sheets and S-N Curves For Materials Used in Elevated and Low Temperature Correlations

Symbols

DD	Design Data
PPC	Data Points Per S-N Curve

TABLE V-1
ELEVATED TEMPERATURE FATIGUE DATA COMPILATION

Alloy	Testing Temperature Range °F	Type Data	Tabulation Sheets	Bibliography
Aluminum				
1100	75-600	Torsional		A-101
	70-423	DD		A-28
3003	75-500	DD		A-49
2014	75-500	DD	127-130	A-49
	75-600	DD		A-27
	75-500	DD	26-28	A-111
	75-110	3PPC		A-35
	RT-400	10PPC	87-89	A-85
185	RT-500	2PPC		A-55
	RT-500	DD		A-111
2024	RT-500	6PPC		A-25
	RT-700	3PPC		A-55
	75-500	DD	131-134	A-49
	25-196 (-)	6PPC		A-84
	75-600	DD		A-27
	RT-500	DD		A-112
	300-500	6PPC		A-26
	500	5PPC		A-102
	253 (-)	5PPC		A-34
	25-196 (-)	6PPC		A-74
	70-473 (-)	DD		A-28
2618	75-600	DD		A-27
3032	RT-800	1PPC		A-55
	RT-500	DD		A-112
A51S-T	RT-500	DD		A-112
5052	RT-500	DD	139-141	A-49
	RT-500	DD		A-112
5086	RT-320	7PPC		A-57
5083	RT-320	7PPC		A-58
5454	RT-320	7PPC		A-58
5456	RT-320	7PPC	85-86	A-58
6053	75-500	DD		A-49
	RT-500	DD		A-112
6061	75-500	DD	135-138	A-49
	77-320	5PPC		A-58
	70-423	DD		A-29
7075	75-500	DD	123-126	A-49
	25-196 (-)	5PPC	121-122	A-84
	75-500	DD		A-27
	300	7PPC		A-103
	RT-400	12PPC	90-92	A-85
	253 (-)	5PPC	29-32	A-34
	RT-198 (-)	6PPC	96-98	A-74
	70-423	DD		A-29

V-1 ELEVATED TEMPERATURE FATIGUE DATA COMPILATION

Alloy	Testing Temperature Range °F	Type Data	Tabulation Sheets	Bibliography
Aluminum				
A142	RT-600	DD		A-93
214	RT-600	DD		A-94
319	RT-600	DD		A-94
355	RT-600	DD		A-94
A355	RT-600	DD		A-94
142-T	RT-500	DD		A-111
	RT-600	DD		A-94
112	RT-600	DD		A-94
122	RT-600	DD		A-94
A132	RT-600	DD		A-94
D132	RT-600	DD		A-94
Pure	60-80 (-)	6PPC		A-108
	RT-250	11PPC		A-23
Al-3Mg	60-80 (-)	6PPC		A-108
Al-1Mg	60-80 (-)	6PPC		A-108
X2219	400-600	DD		A-27
XB185	RT-800	3PPC		A-55
Beryllium				
QMV	RT-1100	4PPC	33-34	A-78
	80-100 (-)	DD		A-28
Cobalt				
L605	1500-1800	6PPC		A-41
S-816	RT-1500	6PPC	60-62	A-32
	RT-1650	10PPC		A-75
	75-1650	10PPC		A-104
	75-1650	8PPC		A-105
	1500	16PPC		A-106
	1400-1800	10PPC		A-40
Stellite 21	1500	7PPC		A-106
Stellite 23-61	1200-1500	6PPC		A-96
Stellite 31	RT-1600	10PPC	111-114	A-75
	75-1500	10PPC		A-106
Vitallium	1200-1500	5PPC		A-97
V-36	1500-1800	6PPC		A-41
WF-31	1500-1800	8PPC		A-41
X-40	1200-1500	6PPC		A-98
	1200-1600	3PPC		
Special Alloys	750	20PPC		A-44
Brass				
Alpha Brass	RT-1000	3-10PPC		A-12

V-1 ELEVATED TEMPERATURE FATIGUE DATA COMPILATION

Alloy	Testing Temperature Range °F	Type Data	Tabulation Sheets	Bibliography
Steel				
SAE1018	RT-700	10PPC		A-62
SAE1020	RT-1200	4PPC		A-69
SAE1050	RT-1200	DD		
1075	RT-423	DD		A-28
1113	20-180 (-)	8-17PPC		A-59
SAE2330	25-196 (-)	5PPC		A-84
2800	RT-423	DD		A-29
SAE4130	RT-800	40PPC	93-95	A-76
4340	RT-1000	6PPC	35-38	A-4
	25-196 (-)	5PPC	100-107	A-84
	80-50 (-)	5PPC		A-86
	RT-423	DD		A-28
8630	25-196 (-)	5PPC		A-84
	253 (-)	5PPC		A-34
52100	350	8PPC		A-80
GTA	1200-1500	5PPC		A-96
GT-45	1200	5PPC		A-96
K-42-B	1200-1500	5PPC		A-96
M1	RT-500	8-20PPC		A-80
MV1	RT-500	8-20PPC		A-80
Gamma Columbian	1200-1500	5PPC		A-96
Halmo	RT-500	8-20PPC		A-80
Hoskins 502	1200	5PPC		A-96
HyTuf	25-196 (-)	5PPC		A-84
Timken Alloy #2	1200	5PPC		A-96
Fe-12Cr	RT-100	8PPC		A-109
STAINLESS STEEL				
301	RT-423	DD		A-28
302	RT-40	11PPC		A-46
	RT-423	DD		A-28
304	RT-423	DD		A-28
314	1200-1800	10PPC		A-40
321	1350-1500	4-5PPC		A-113
347	RT-423	DD		A-28
403	RT-900	13PPC		A-75
	75-900	6PPC		A-102
	700-900	5PPC	102-105	A-105
422	900-1100	7PPC		A-102
15-7PH	RT-800	10PPC		A-8
17-7PH	RT-423	DD		A-28
A-286	75-1600	10PPC		A-16
	70-1200	DD		A-7
AM355	RT-800	5PPC		A-28
	RT-600	10PPC		A-8
HS-88	1000-1200	6PPC		A-41
N-153	1500	7PPC		A-96
N-155	RT-1500	5PPC		A-24
	RT-1500	6PPC		A-31
	RT-1500	4PPC		A-31
	1350-1500	3PPC		A-47

V-1 ELEVATED TEMPERATURE FATIGUE DATA COMPILATION

Alloy	Testing Temperature Range °F	Type Data	Tabulation Sheets	Bibliography
Stainless Steel				
N-155	RT-1500	6-20PPC		A-71
	RT-1500	8-14PPC		A-72
	1200-1500	5PPC		A-96
	1500	6PPC		A-102
	1300-1500	5-6PPC		A-113
	RT-1000	4PPC		A-61
S-495	1200-1500	5PPC		A-96
S-497	1200	4PPC		A-96
S-590	1200-1350	5PPC		A-96
S-816	1200-1500	5PPC		A-96
	RT-1200	4-7PPC		A-56
	1500	7PPC		A-102
Cyclops 17-W	1200-1500	5PPC		A-96
Discaloy	1000-1350	6PPC		A-41
Lapelloy	RT-900	10PPC		A-75
	700-1200	5PPC		A-102
Refractaloy 26	RT-1600	4PPC		A-96
	1200	5PPC		A-96
	1200-1500	6PPC		A-96
Timken	1200	8PPC		A-91
Timken	1000-1200	7PPC		A-41
	1200-1500	5PPC		A-95
	RT-1200	4-7PPC		A-56
	75-1200	10PPC		A-102
	1200	5PPC		A-102
	1200	6PPC		A-102
Tinidur	1000-1350	5PPC		A-41
13Cr.Steel	450	4PPC		A-88
	450-600	8PPC		A-89
18Cr-8Ni	RT-1200	4-6PPC		A-20
	253	5PPC		A-34
25Cr-20Ni	1200	5PPC		A-96
25Ni-12Cr	1200	5PPC		A-96
18-8-W-Mo	1200	5PPC		A-96
19-9-W-Mo	1200	5PPC		A-96
25-20-W-Mo	1500	5PPC		A-96
19-9DL(DL)	1000-1200	6PPC		A-41
19-9DL(D)	1200-1500	5PPC		A-96
234A5	1200	5PPC		A-96
Magnesium				
A263	RT-400	6PPC		A-64
AZ80X	RT-400	6PPC		A-64
C	150-275	2PPC		A-111
CM2	150-275	2PPC		A-111
CM22	150-275	2PPC		A-111
CM42	150-275	2PPC		A-111

V-1 ELEVATED TEMPERATURE FATIGUE DATA COMPILATION

Alloy	Testing Temperature Range °F	Type Data	Tabulation Sheets	Bibliography
Magnesium				
CM62	150-275	2PPC		A-111
EK31	RT-600	12PPC		A-43
EM51	RT-400	6PPC		A-64
EM61	RT-400	6PPC		A-64
FS-1	25-196 (-)	5PPC		A-84
	150-275	2PPC		A-111
G	150-275	2PPC		A-111
H	150-275	2PPC		A-111
J-1	150-275	2PPC		A-111
M1	RT-400	6PPC		A-64
	150-275	2PPC		A-111
O-1	150-275	2PPC		A-111
R	150-275	2PPC		A-111
ZT1	RT-662	2PPC		A-9
HK31A-H24	RT-400	10PPC		A-6
Molybdenum				
Unalloyed	40-1800 (-)	8PPC		A-68
	RT-1100	10PPC		A-14
Nickel				
AMS 5735	RT-1200	6PPC		A-36
6059	1200-1500	5PPC		A-96
GMR 325	RT-1650	6PPC	76-78	A-102
Hastelloy B	1200-1500	4PPC		A-96
Hastelloy R235	RT-1650	6PPC	63-65	A-102
M-252	1500	3PPC		A-102
Inconel	1200-1800	8PPC		A-40
Incoloy 901	RT-1300	6PPC		A-36
Inconel 80-20	1200	7PPC		A-96
Inconel "x"	1200-1500	6PPC		A-96
	1350-1500	5-6PPC	145-146	A-113
	RT-1500	6-10PPC	1-5	A-2
Inconel"x-550"	75-1500	4PPC		A-102
	RT-1350	4PPC		A-2
Inconel W	1200	7PPC		A-96
Inconel 700	RT-1500	6PPC	52-56	A-36
Inconel 713c	1700			A-16
	1200-1500	6PPC		A-7
Nimonic-80	1200-1500	6PPC		A-96
	600-800	6PPC		A-92
	20-800	6PPC		A-33
	750-875	10PPC		A-10
Nimonic-90	RT-1000	20PPC		A-60
	RT-975	8PPC		A-73
Nimonic 95	950-900	10PPC		A-10
Udimet 700-300	1350-1500	DD		A-7
	RT-1650	6PPC		A-102
	RT-1650	6PPC		A-36

V-1 ELEVATED TEMPERATURE FATIGUE DATA COMPILATION

Alloy	Testing Temperature Range °F	Type Data	Tabulation Sheets	Bibliography
Nickel				
7Mo-Waspalloy	75-1500	6PPC		A-102
Waspalloy	1500	3PPC		A-47
	1500	3PPC		A-102
Waspalloy	1500	3PPC		A-47
Magnesium				
Special Alloys	600-800	6PPC		A-92
	500-800	6PPC		A-33
Titanium				
RC55	RT-600	10PPC		A-75
RC-130-B	25-196 (-)	13PPC	108-110	A-11
	RT-600	13PPC		A-75
Ti-150A	25-196 (-)	13PPC		A-11
304 18-8	25-196 (-)	5PPC		A-84
Ti-8Al-2Cb-1Ta	75-1000	12PPC		A-16
Ti-7Al-3Mo	75-1000	10PPC		A-16
Ti-4Al-3Mo-IV	RT-900	20PPC	15-19	A-50
3Al-5Cr	RT-1000	20PPC	46-51	A-77
	RT-500	7PPC		A-110
3MnComplex	RT-1000	20PPC		A-77
Ti-2.5Al-16V	RT-900	20PPC	66-70	A-50
Ti-6Al-4V	RT-900	20PPC	20-24	A-50
	RT-1000	4-16PPC		A-17
	500-750	4-20PPC		A-82
	RT-1000			A-110
	RT-423			A-28
B120VCA	RT-900	20PPC		A-50
Special Alloys	RT-600	4PPC		A-63
	77-321	DD		A-39
	253	5PPC		A-34
	60-600 (-)			A-110
	60-600			A-110
	RT-600			A-110
	RT-800			A-110
	RT-600			A-110
Zinc				
	20-196 (-)	2-6PPC		A-87

TABLE V-2

INFORMATION SOURCES

Publications	Issue Years Examined
Aerospace Engineering (Aeronautical Engineering Review)	1945-1961
AGARD- Materials Properties Handbook	1960
Aircraft Fatigue Handbook	1957
Armed Service Technical Information Agency	(Subscriber)
ASM-Transactions	1945-1961
ASTM-Proceeding	1941-1961
ASTM-References on Fatigue	1951-1961
Battelle Technical Review	1952-1961
British Journal of Metals (Metallurgia)	1950-1961
Defense Metals Information Center	(Subscriber)
Journal of Aerospace Sciences	1945-1961
Journal of Welding	1945-1960
Journal of Applied Mechanics	1945-1961
Mechanical Engineering	1945-1961
Metalurgical Abstracts	1945-1960
Metal Progress	1940-1961
Metals Review	1950-
NASA (Including NACA) Technical Publications	(1915-1961)
OSRD Reports	(1942-1946)
Review of Metal Literature	(1945-1961)
Society for Experimental Stress Analysis (Proceedings)	(1945-1961)
WADC/WADD Technical Publications	(1951-1961)

Literature surveys were undertaken in support of the research effort by ASTIA, and the Technical Library of the General Electric Corporation.

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Industrial, Institutional and Research Organization Contributors

Aerospace Industries Association of America, Inc.
7660 Beverly Blvd.
Los Angeles 36, California

Aluminum Company of America
ALCOA Research Laboratories
New Kensington, Pennsylvania

ASTIA
Arlington, Virginia

Allegheney Ludlum Steel Corporation
Pittsburgh 22, Pennsylvania

Allison Division
General Motors Corporation
Indianapolis 6, Indiana

Armco Steel Corporation
Middleton, Ohio

Battelle Memorial Institute
Columbus 1, Ohio

Beryllium Corporation
Reading, Pennsylvania

Boeing Airplane Company
Witchita, Kansas

Boeing Airplane Company
Vertol Division
Morton, Pennsylvania

Brush Beryllium Company
Cleveland 3, Ohio

Convair-Astronautics
Division of General Dynamics Corporation
San Diego 12, California

Crucible Steel Company of America
Pittsburgh 30, Pennsylvania

Dow Chemical Company
Applications Research
Metallurgical Laboratories
Midland, Michigan

Defense Metals Information Center
Battelle Memorial Institute
Columbus, Ohio

TABLE V-2, INFORMATION SOURCES (continued)

Editorial Services Unit
Research Laboratory, General Electric Company
Schenectady, New York

General Electric Company (GEL)
Schenectady 5, New York

General Electric Company (Metallurgical Products)
Detroit 32, Michigan

Huntington Alloy Products Division
The International Nickel Company, Inc.
Huntington 17, West Virginia

International Nickel Company, Inc.
New York 5, New York

Jones and Laughlin Steel Corporation
Stainless and Strip Division
Los Angeles 22, California

Lockheed Aircraft Corporation
Structures Test Laboratory
Marietta, Georgia

Lockheed Aircraft Corporation
Missiles and Space Division
Sunnyvale, California

Mallory-Sharon Metals Corporation
Niles, Ohio

The Martin Company
Manufacturing Research and Development
Baltimore 3, Maryland

North American Aviation, Inc.
Materials
Los Angeles, California

Reactive Metals, Inc.
Niles, Ohio

Rem-Cru Titanium, Inc.
Midland, Pennsylvania

Timken Roller Bearing Co.
Canton 6, Ohio

Titanium Metals Corporation of America
New York 7, New York

TABLE V-2, INFORMATION SOURCES (continued)

U. S. Department of Commerce
Civil Aeronautics Administration
Washington 25, D. C.

U. S. Steel Corporation
Pittsburgh 30, Pennsylvania

Vought Aeronautics
Manufacturing Research and Development
Dallas, Texas

Wright Air Development Division
Air Research and Development Command
Wright Patterson Air Force Base, Ohio

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B-168. McClintock, M. R. and Gibbons, H. P.: Mechanical Properties of Structural Materials at Low Temperatures, National Bureau of Standards Monograph 13, Washington, D.C., June, 1960.

B-169. _____: Manual on Fatigue Testing, STP No. 91, American Society for Testing Materials, Philadelphia, 1949

B-170. Murray, William M.,: Editor, Fatigue and Fracture of Metals, The Technology Press of The Massachusetts Institute of Technology and John Wiley and Sons Inc., New York 1952.

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel X Condition 2100°F/2hrs plus 1500°F/24hr
Reference INCO (Private communication) plus 1200°F/25hrs
Reference No. 2 Code No. 42

Date of Tabulation
Tabulated by CHB
Checked by RMA

Test Temperature RT Environment Air
Type of Test Rotating beam Specimen Data .35" dia
Type of Data Numerical Surface Finish —
Stress Ratio -1 Stress Concentration Factor 1
Mean Stress — Notch Description —

Fatigue Data Source:
Author Private communications with INCO
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
INCO

	1	2	3	4	5	6	7	8	9	10
S	72000	55000	50000	45000	40000	42000	40000	38000	38000	35000
N	393000	1235000	1360000	5173000	14522000	11250000	14964000	11725800	14042000	12542000
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: -9.229 = b, 2.917 = m } C

Comments: Too few data points

Mechanical Properties:

			Other Properties:
F_{tu}	172.5 ksi	at RT	
F_{ty}	ksi	at	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ	0.29	at	
% E	30.7	at RT	
% RA	47.4	at RT	
Hardness		at	

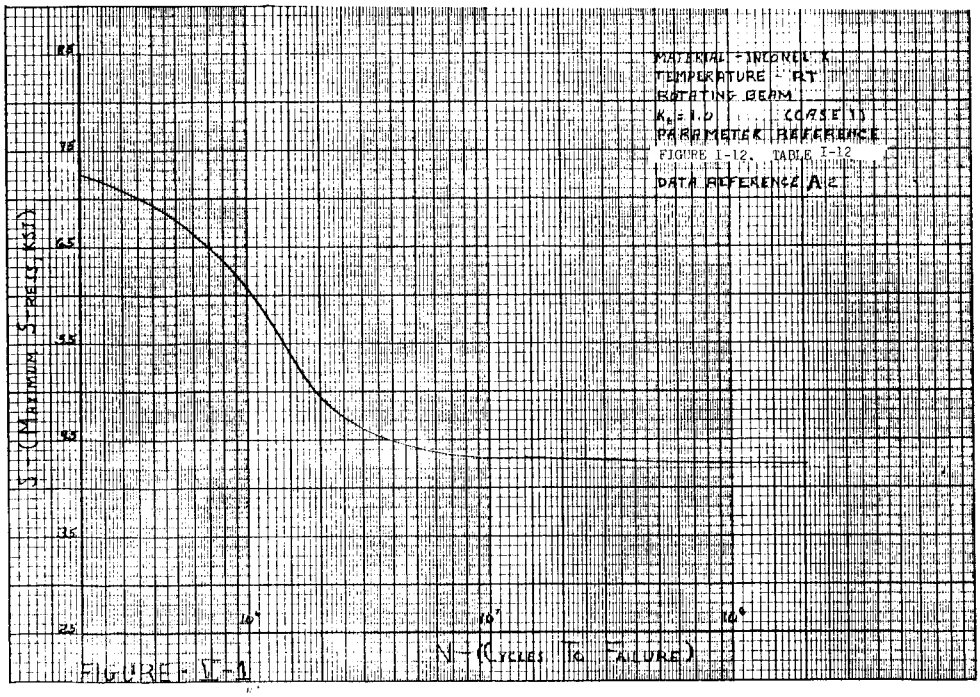


FIGURE I-A

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel X Condition [illegible]
Reference INCO (Private Communication) plus [illegible]
Reference No. 2 Code No. 42

Date of Tabulation
Tabulated by CHB
Checked by RHO

Test Temperature 1000°F Environment Air
Type of Test Rotating beam Specimen Data [illegible]
Type of Data Numerical Surface Finish —
Stress Ratio -1 Stress Concentration Factor 1
Mean Stress — Notch Description —

Fatigue Data Source:
Author INCO (Private communication)
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
INCO [illegible] 40-5
p. 2

	1	2	3	4	5	6	7	8 -	9	10
S	[illegible]	55000	52500	51000	47500	45000				
N	[illegible]	9771000	4,260,000	4,230,000	3,960,000	118,250,000				
S										
N										
S										
N										
S										
N										
S										
N				(Ult. Cumulative Cycles)						
S	46.0	57.5	[illegible]	[illegible]	[illegible]	[illegible]	4.0	[illegible]	[illegible]	[illegible]
N	[illegible]	[illegible]	[illegible]	4.1 x 10⁶	[illegible]	[illegible]	[illegible]	4.18 x 10⁶	[illegible]	[illegible]
S	[illegible]									
N										
S										
N										
S										
N										
S										
N										

b unbroken

Parameters: m = 7.324
b = -12.667
C

Comments: Too few data points

Mechanical Properties:

				Other Properties:
F_{tu}	130.1	ksi	at 1000°F	[illegible]
F_{ty}	77.1	ksi	at [illegible]	[illegible]
E	25.2	10^3 ksi	at [illegible]	
G		10^3 ksi	at	
μ			at	
% E	14.75		at [illegible]	
% RA			at	
Hardness			at	

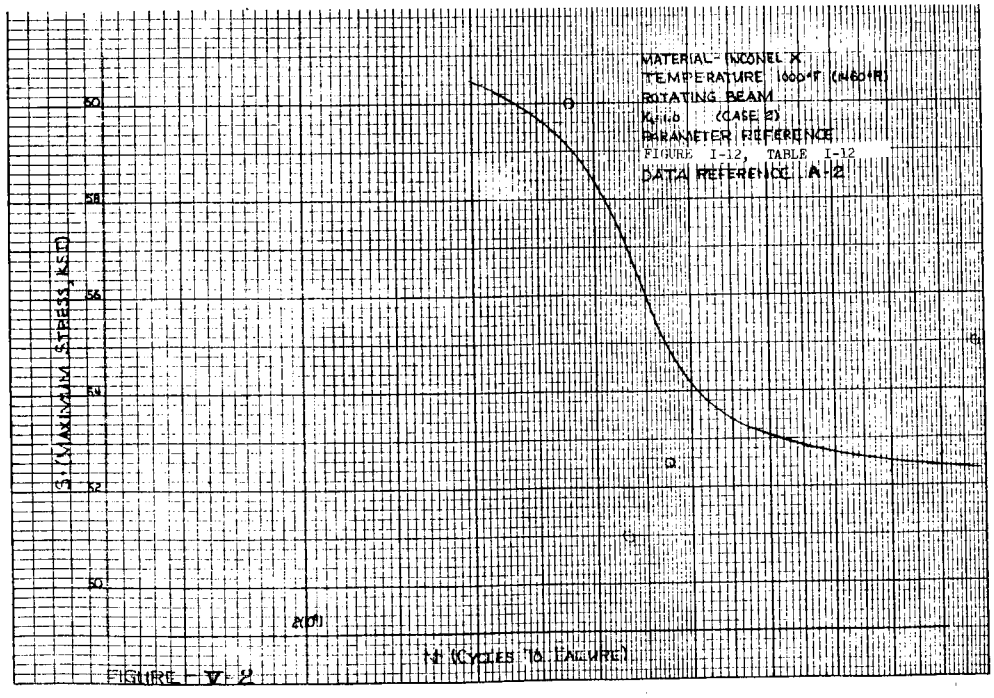


FIGURE V-2

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel X Condition [illegible]

Reference INCO [illegible]

Reference No. 2 Code No. 42

Test Temperature 1200°F Environment Air

Type of Test Rotating beam Specimen Data 3/8" dia. bar

Type of Data Numerical Surface Finish —

Stress Ratio -1 Stress Concentration Factor 1.0

Mean Stress — Notch Description —

Date of Tabulation

Tabulated by CHB

Checked by

Fatigue Data Source:

Author INCO (Private communication)

Publication

No. References

Principal Investigator

Affiliation

Comments

Mechanical Properties Source:

[illegible]

Mechanical Properties:

				Other Properties:
F_{tu}	104.4	ksi	at 1200°F	75°F [illegible]
F_{ty}	75.3	ksi	at [illegible]	E = 5[illegible]
E	24.0	10^3 ksi	at [illegible]	
G		10^3 ksi	at	
μ			at	
% E	4.3		at [illegible]	
% RA			at	
Hardness			at	

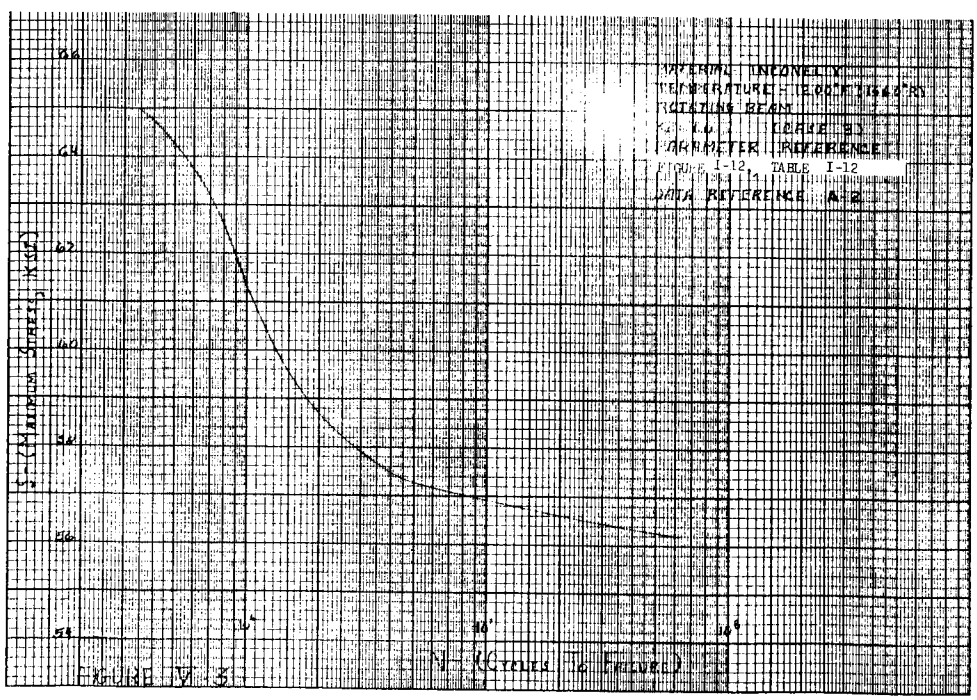
Data Correlation (1% cycles)

	1	2	3	4	5	6	7	8	9	10
S	65.00	[illegible]	55.000	[illegible]	55.000					
N	546,000	[illegible]	603,000	[illegible]	[illegible]					
S										
N										
S										
N										
S										
N										
S										
N										
S	57.0	64.0	62.0	[illegible]	1.0	60.6	57.0	58.0	57.0	56.5
N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
S	56.									
N	[illegible]									
S										
N										
S										
N										
S										
N										

b vibration

Parameters: m = 1.714, b = -2.011 } c

Comments: Too few data points



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel X — Condition 2102°F/4 hrs. plus 1550°F/24 hours plus 1300°F/20 hrs.

Reference INCO

Reference No. 2 — Code No. 42

Test Temperature 1350°F — Environment Air

Type of Test Rotating beam — Specimen Data 5/8 in. dia. bar

Type of Data Numerical — Surface Finish —

Stress Ratio −1 — Stress Concentration Factor 1.0

Mean Stress — — Notch Description —

Date of Tabulation

Tabulated by CHB

Checked by RMH

Fatigue Data Source:

Author INCO (Private communication)

Publication

No. References

Principal Investigator

Affiliation

Comments

Mechanical Properties Source:

NACA TN 4022.5

p. 13, 14

S	52000	52000	54,000	52,000	52000					
N	2,871,000	2,718,000	2,812,000	1,652,000	1,528,000					
S										
N										
S										
N										
S										
N										
S										
N										
S					Data Correlation		(SKG cycles)			
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

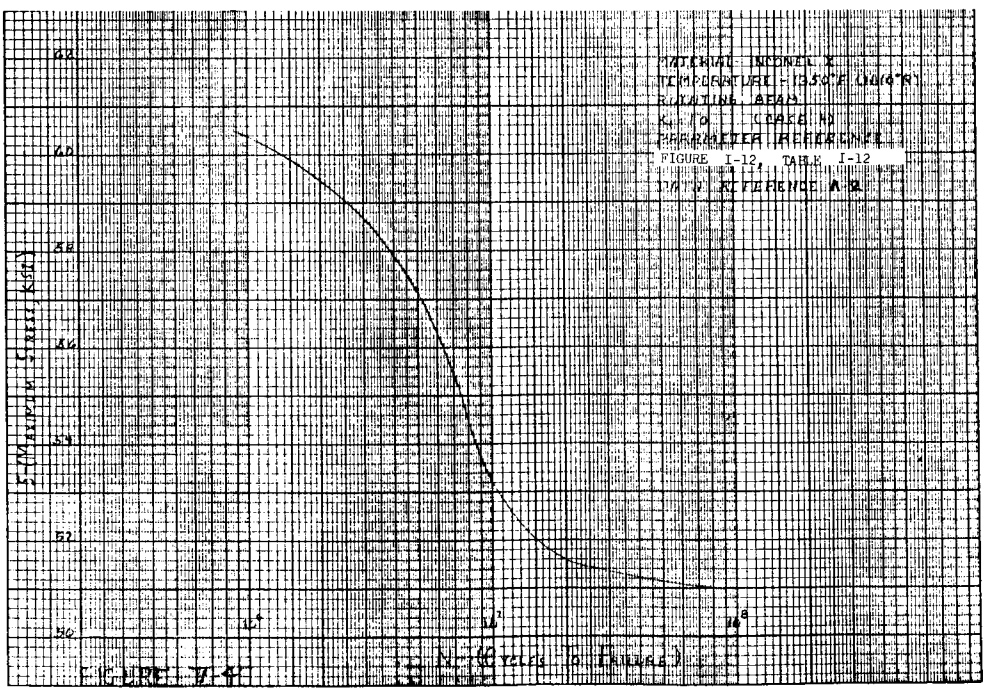
b unbroken

Parameters: m = 3.055, b = −4.826 } C

Comments: Too few data points

Mechanical Properties:

				Other Properties:
F_{tu}	83.0	ksi	at 1350°F	T_s = [illegible] ksi
F_{ty}	83.0	ksi	at 1350°F	E' = 97.727 ksi
E	22.0	10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material: Inconel X — Condition: 2100°F/2 hrs/plus 1550°F/4 hrs/air plus 1300°F/20 hrs.
Reference: INCO
Reference No. 2 — Code No. 42

Date of Tabulation:
Tabulated by: CHB
Checked by:

Test Temperature: 1500°F — Environment: Air
Type of Test: Rotating beam — Specimen Data: 5/8 in. dia. bar
Type of Data: Numerical — Surface Finish: —
Stress Ratio: — — Stress Concentration Factor: 1.0
Mean Stress: — — Notch Description: —

Fatigue Data Source:
Author: INCO (Private communication)
Publication:
No. References:
Principal Investigator:
Affiliation:
Comments:

Mechanical Properties Source:
NACA TN 4065
p. 8

Mechanical Properties:

				Other Properties:
F_{tu}	60.0	ksi	at 1500°F	T_S' = 76.0 Ksi
F_{ty}	60.0	ksi	at 1500°F	E' = 33.29 Ksi
E	21.2	10^3 ksi	at 1500°F	
G		10^3 ksi	at	
μ			at	
% E	40		at 1500°F	
% RA			at	
Hardness			at	

	1	2	3	4	5	6	7	8	9	10
S	40,000	35,000	34,000	33,000						
N	21,048	69,382	85,455	112,206						
S										
N										
S										
N										
S										
N										
S										
N										
	Data correlation (ΔS, cycles)									
S	40.0	37.9	31.0	28.6	26.2	24.0	22.0	20.0	18.6	17.2
N	2.15×10^7	2.96×10^7	$5.\times 10^7$	1.14×10^8	$2.\times 10^8$	$4.\times 10^8$	$7.\times 10^8$	1.1×10^9	2.1×10^9	$3.\times 10^9$
S										
N										
S										
N										
S										
N										
S										
N										

b unbroken

Parameters: m = 7.400 } C
b = -13.971 }

Comments: Too few data points

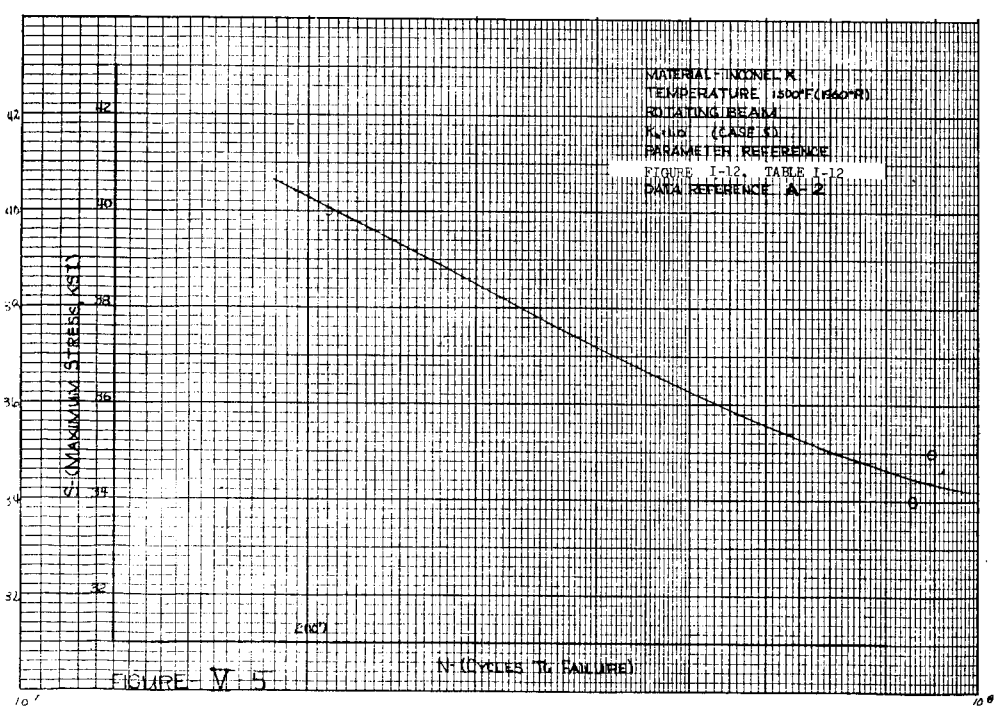


FIGURE V-5

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel 718 Condition [illegible]
Reference INCO [illegible]
Reference No. 1 Code No. 115 [illegible]

Date of Tabulation
Tabulated by
Checked by BV

Test Temperature 65°F Environment Air
Type of Test Rotating beam Specimen Data
Type of Data Numerical Surface Finish
Stress Ratio Stress Concentration Factor
Mean Stress Notch Description

Fatigue Data Source:
Author INCO (private communication)
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
INCO

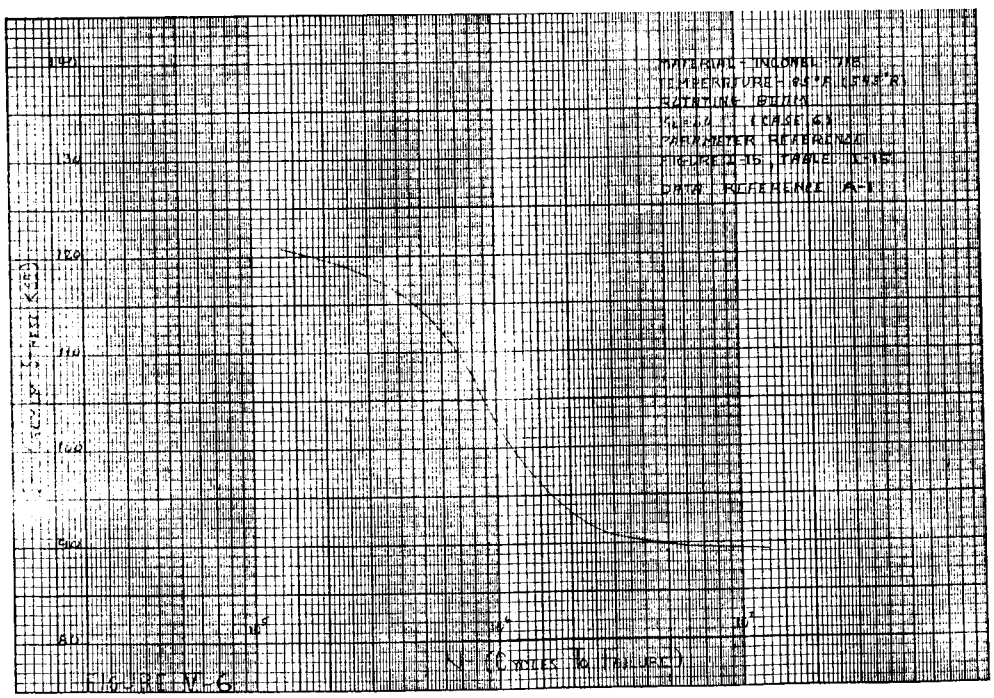
	1	2	3	4	5	6	7	8	9	10
S	120,000	110,000	105,000	100,000	95,000	90,000	85,000	80,000		
N	157,000	210,000	275,000	365,000	480,000	655,000	870,000	1,150,000		
S										
N										
S										
N										
S										
N										
S										
N			Data	Correlation	(INCO, cycles)					
S	120	118	116	114	112	107	103	100	95	91
N	1.5×10⁵	2×10⁵	3.1×10⁵	5.1×10⁵	6.0×10⁵	8.2×10⁵	1.0×10⁶	1.2×10⁶	1.7×10⁶	2.8×10⁶
S	130									
N	1.0×10⁵									
S										
N										
S										
N										
S										
N										

Parameters: m: 3.548, b = -5.327 } C

Comments:

Mechanical Properties:

			Other Properties:
F_{tu}	191 ksi	at 65°F	15' = 329.70 ksi
F_{ty}	151 ksi	at 65°F	E' = 86.253 × 10³ ksi
E	10³ ksi	at	
G	10³ ksi	at	
μ		at	
% E	24	at 65°F	
% RA	38	at 65°F	
Hardness		at	



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel 718 Condition Aged No Weld Specs
Reference INCO annealed 1700°F/1hr, W.Q.,
Reference No. 115 Code No. aged 1325°F/8hr, A.C.

Test Temperature 1000°F Environment Air
Type of Test Rotating beam Specimen Data
Type of Data Numerical Surface Finish
Stress Ratio Stress Concentration Factor
Mean Stress Notch Description

Date of Tabulation
Tabulated by BF
Checked by BM

Fatigue Data Source:
Author INCO (private communication)
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:

Mechanical Properties:

F_{tu}	170.0 ksi	at	1000°F
F_{ty}	134.5 ksi	at	1000°F
*E	25.5 10^3 ksi	at	1000°F
G	10^3 ksi	at	
μ		at	
% E	17.0	at	1000°F
% RA	34.0	at	1000°F
Hardness		at	

Other Properties:
TS' = 2.890
E' = 87.11

S	112,000	105,000	100,000	95,000	75,000	90,000	85,000	80,000		
N	540,000	1,526,000	4,103,000	11,406,000	1437,000	10,617,000	114,225,000	151,290,000		
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S			Data Correlation (KSI, cycles)							
S	111	110	108	106	109	102	100	98	96	94
N	1.7×10^5	9.8×10^5	7.2×10^5	1.5×10^6	2.25×10^6	3.3×10^6	4.75×10^6	6.9×10^6	1.0×10^7	1.5×10^7
S	72	71	70							
N	2.4×10^7	3.2×10^7	5.6×10^7							
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

a Specimen unbroken
b Specimen fractured

Parameters:
m = 1.948
b = 4.263
C

Comments: * 1. Dynamic E

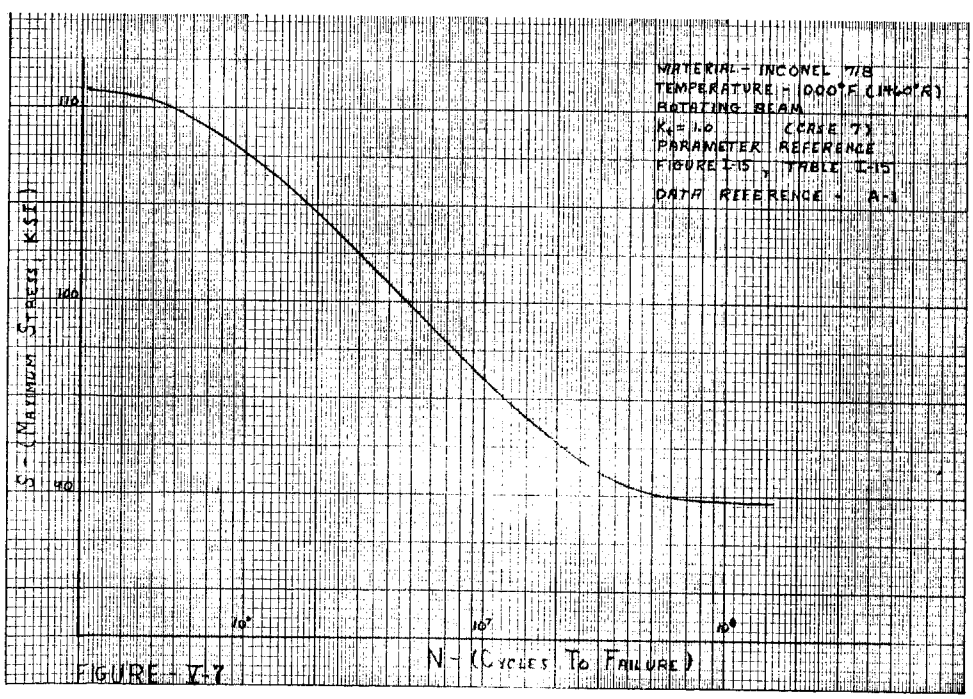


FIGURE V-7

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Incone/ 718 Condition Melt Ue. VSD23 bar-extruded
Reference INCO 1 hr/1200°F/air, A.C.
Reference No. 115 Code No. aged 1325°F/16hr, A.C.

Test Temperature 1200°F Environment Air
Type of Test Rotating beam Specimen Data .5 inch bar stock
Type of Data Numerical Surface Finish
Stress Ratio Stress Concentration Factor
Mean Stress Notch Description

Fatigue Data Source:
Author INCO (private communication)
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:

Mechanical Properties:

				Other Properties:
F_{tu}	153.0	ksi	at 1200°F	T = 240.1 Ksi
F_{ty}	132.8	ksi	at 1200°F	E' = 82.397 Ksi
*E	24.5	10^3 ksi	at 1200°F	
G		10^3 ksi	at	
μ			at	
% E	12.0		at 1200°F	
% RA	12.0		at 1200°F	
Hardness			at	

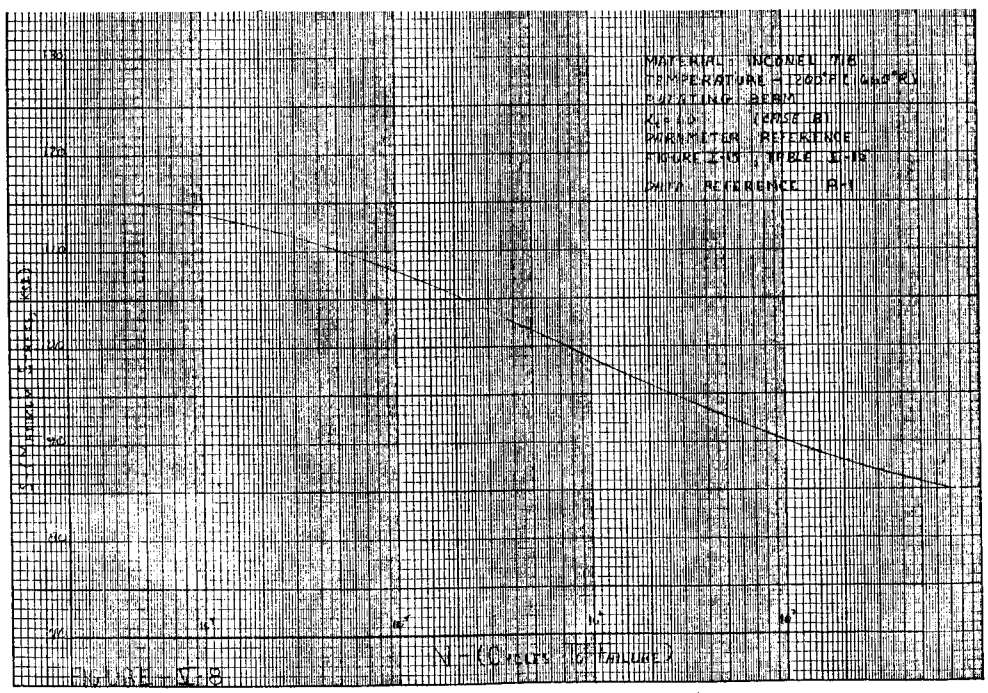
Date of Tabulation
Tabulated by JB
Checked by

	1	2	3	4	5	6	7	8	9	10
S	153,333	142,333	135,333	122,333	122,333	85,333	89,000	120,000	85,000	91,333
N	3,333	66,333	55,333	2,333,000	3,118,333	3,333,333	1,654,000	13,774,000	2,505,000	12,113,333
S	73,333	73,333								
N	5,738,333	6,738,333								
S										
N										
S										
N										
S										
N			Data Correlation (Ksi/cycles)							
S	115.0	112.5	110.0	107.5	105.0	102.5	100.0	97.5	95.0	92.5
N	4.7×10^3	1.95×10^4	5.0×10^4	1.1×10^5	2.2×10^5	4.2×10^5	7.9×10^5	1.46×10^6	2.7×10^6	5 x 10^6
S	90.0	87.5	85.0							
N	1.1×10^7	2.45×10^7	4.5×10^7							
S										
N										
S										
N										
S										
N										

2 specimens unbroken

Parameters: m = 1.187, b = -1.187 } C

Comments: * 1. dynamic E



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel 718 Condition Melt No. Y5272 Lot [illegible]
Reference INCO annealed 1700°F/1hr, A.C.
Reference No. 115 Code No. aged 1325°F/16hr, A.C.

Date of Tabulation
Tabulated by JB
Checked by RM

Test Temperature 1400°F Environment Air
Type of Test Rotating beam Specimen Data 5/16 inch bar stock
Type of Data Numerical Surface Finish
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author INCO (private communication)
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:

S/N	1	2	3	4	5	6	7	8	9	10
S	75,000	75,000	60,000	55,000	50,000	45,000	42,000	40,000		
N	42,000	3/35,000	4/35,000	4/52,500	1/37,500	5/32,000	6/35,000	4/40,000[a]		
S										
N										
S										
N										
S										
N										
S										
N										
S	75	74	75	72	71	70	65	60	55	50
N	4.2×10^5	2.35×10^5	4.15×10^5	5.8×10^5	6.5×10^5	7.2×10^5	2.2×10^6	9.9×10^6	8.6×10^6	1.77×10^6
S	98	96	94	93						
N	2.9×10^7	3.5×10^7	5.6×10^7	7.6×10^7						
S										
N										
S										
N										
S										
N										

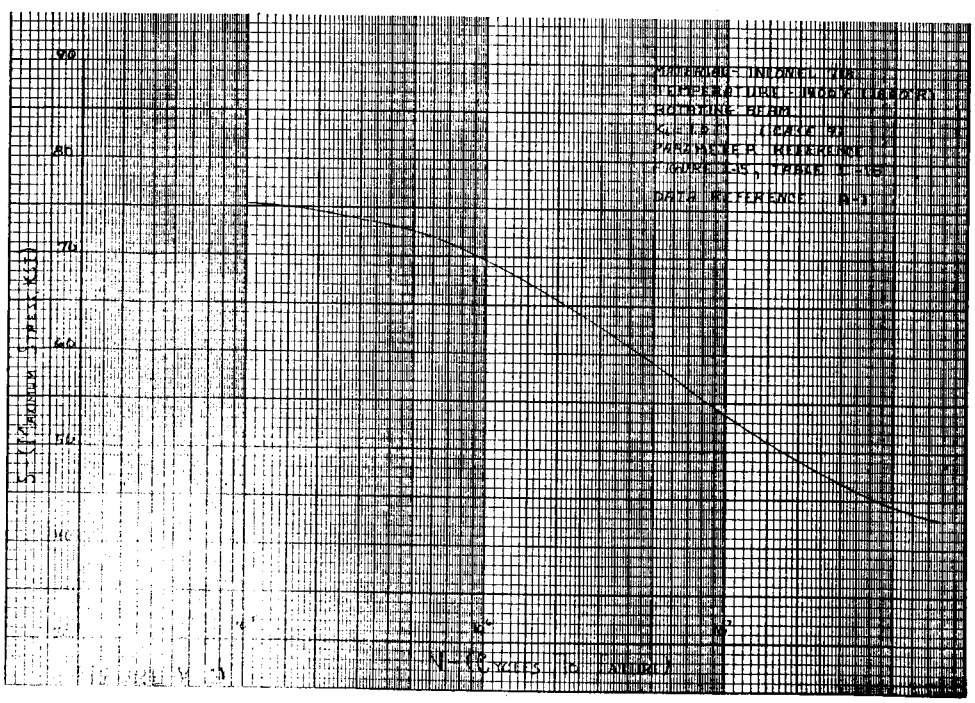
[a] specimen run broken

Parameters: m = 2.845, b = -4.577 } C

Comments: * 1. Dynamic E

Mechanical Properties:

				Other Properties:
F_{tu}	96.8	ksi	at 1400°F	75' = 164.56 Ksi
F_{ty}	84.0	ksi	at 1400°F	E' = 41.354 Msi
*E	23.1	10^3 ksi	at 1900°F	
G		10^3 ksi	at	
μ			at	
% E	33.0		at 1400°F	
% RA	45.5		at 1400°F	
Hardness			at	



10/10

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Wrought N-155 Alloy Condition Wrought

Reference NACA Report 1288, pp2,3

Reference No. 91 Code No. 165

Test Temperature RT Environment Air

Type of Test Reverse Bending, Westinghouse Specimen Data 0.550 in. dia.

Type of Data Numerical Surface Finish

Stress Ratio* -1 Stress Concentration Factor 1.0

Mean Stress 0 Notch Description —

Fatigue Data Source: *2

Author NACA Subcommittee on Power-Plant Materials

Publication NACA RT 1288 p. 32 Table VIII

No. References 5

Principal Investigator Author

Affiliation

Comments

Mechanical Properties Source:

NACA Subcommittee on Power-Plant Materials, p. 30

Mechanical Properties:

F_{tu}	119.1 ksi	at RT	
F_{ty}	60.5 ksi	at RT	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	43.75	at RT	
% RA	45.95	at RT	
Hardness		at	

Other Properties:

K_T=1

75°: 20-97 KSI

E' = 29.115 KSI

Date of Tabulation

Tabulated by DS

Checked by RH

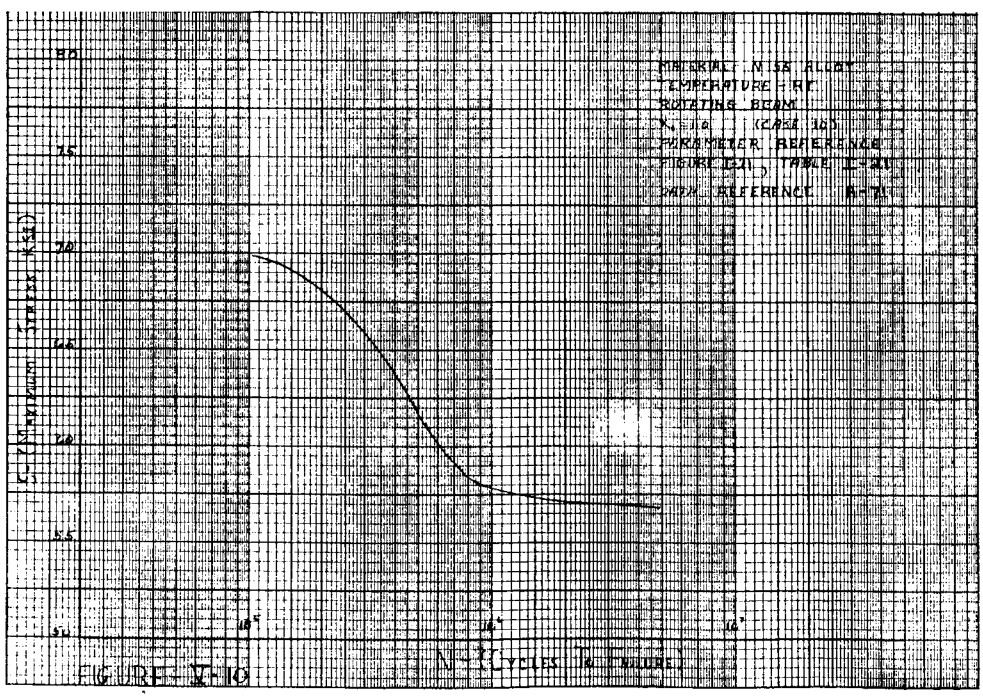
	1	2	3	4	5	6	7	8	9	10
S	69,000	61,000	57,500	57,000	56,000	55,500	54500			
N	193,000	379000	1,100,000	1,100,000	6990000	[a] $711(10)^4$	[a] $1,58(10)^6$			
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation, KSI						
S	69.5	67.0	68.0	66.0	63.0	60.0	[illegible]	58.0	51.5	52.0
N	1.2×10^5	1.5×10^5	3.1×10^5	3.0×10^5	3.8×10^5	9.9×10^5	6.1×10^5	8.9×10^5	1.1×10^6	$3.3\times$
S										
N										
S										
N										
S										
N										
S										
N										

[a] Test discontinued

Parameters: m = 3.001, b = -4.085 } C

Comments: * 1 stress ratio = max. alt. stress / min. alter. stress

2 Table VIII gives a greater no. of points than any of the others.



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Wrought N-155 Alloy Condition Wrought
Reference NACA RT 1288, pp. 2, 3
Reference No. 71 Code No. 165

Test Temperature 1000°F Environment Air
Type of Test Reverse Bending, Westinghouse Specimen Data 0.550 in. dia.
Type of Data Numerical Surface Finish
Stress Ratio *1 -1 Stress Concentration Factor 1.0
Mean Stress 0 Notch Description —

Fatigue Data Source:*
Author NACA Subcommittee on Power Plant Materials
Publication NACA RT 1288 p. 33
Table VIII
No. References 5
Principal Investigator Author
Affiliation
Comments

Mechanical Properties Source:
NACA Subcommittee on Power-Plant Materials, p. 30

Mechanical Properties:

				Other Properties:
F_{tu}	93.13	ksi	at 1000°F	K_f=1
F_{ty}	32.85	ksi	at 1000°F	$T3' = 158.32$
E		10^3 ksi	at	$E' = 98.917$
G		10^3 ksi	at	
μ			at	
% E	42.00		at 1000°F	
% RA	42.37		at 1000°F	
Hardness			at	

Date of Tabulation
Tabulated by DS
Checked by AMT

	1	2	3	4	5	6	7	8	9	10
S	57,000	51,000	50,500	49,000	48,500					
N	198,000	352,000	730,000	1220000	2160(a)*					
S										
N										
S										
N										
S										
N										
S										
N					Data Correlation					
S	60.0	59	58	57	56	55	54	53	52	51
N	1.35×10^5	1.71×10^5	2.3×10^5	2.8×10^5	3.2×10^5	3.7×10^5	4.2×10^5	4.8×10^5	5.7×10^5	7.0×10^5
S	50									
N	1.0×10^6									
S										
N										
S										
N										
S										
N										

(Cycles)

a Test discontinued.

Parameters: $M = 4.315$, $K = -6.333$ } C

Comments: 1 stress ratio: max. alt. stress / min. alt. stress
2 Table VIII gives more points per curve than the others given.

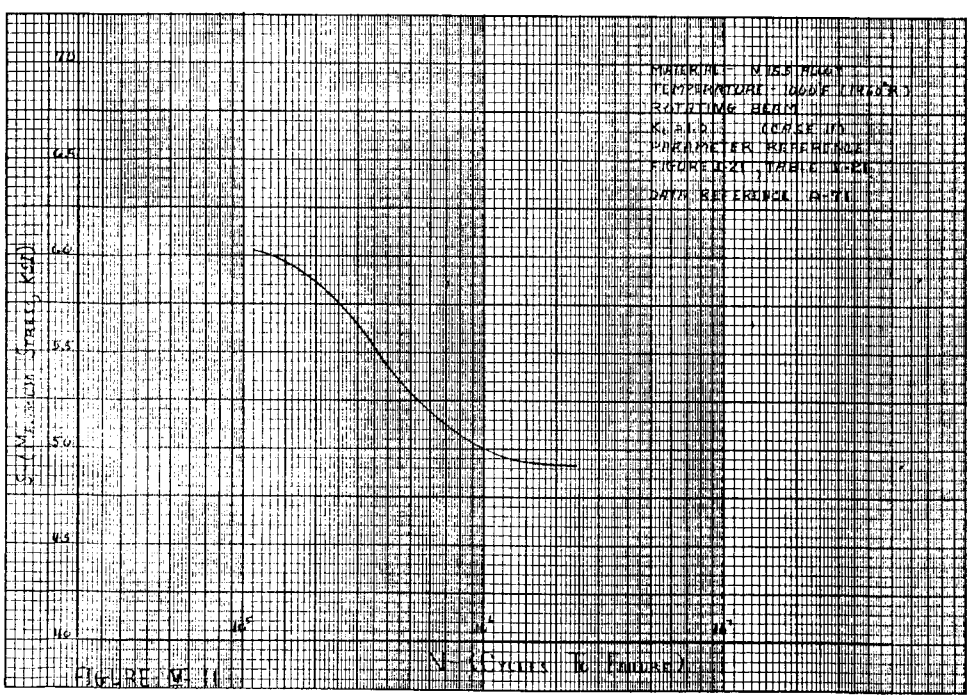


FIGURE VI-11

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Wrought N-155 Alloy Condition Wrought
Reference NACA RT 1283, pp 2.3
Reference No. 71 Code No. 165

Test Temperature 1200°F Environment Air
Type of Test Reverse Bending (Westinghouse) Specimen Data 0.550 in. dia.
Type of Data Numerical Surface Finish
Stress Ratio*1 -1 Stress Concentration Factor 1.0
Mean Stress 0 Notch Description ——

Fatigue Data Source:*2
Author NACA Subcommittee on Power Plant Materials
Publication NACA RT 1288 p.3.3 Table VIII
No. References 5
Principal Investigator Author
Affiliation
Comments

Mechanical Properties Source:
NACA Subcommittee on Power Plant Materials p.3.2

Mechanical Properties:

F_{tu}	60.4 ksi	at 1200°F	
F_{ty}	35.52 ksi	at 1200°F	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	34.00	at 1200°F	
% RA	36.25	at 1200°F	
Hardness		at	

Other Properties:
$K_T = 1$
$TS' = 136.68$ 1
$E' = 15.433$

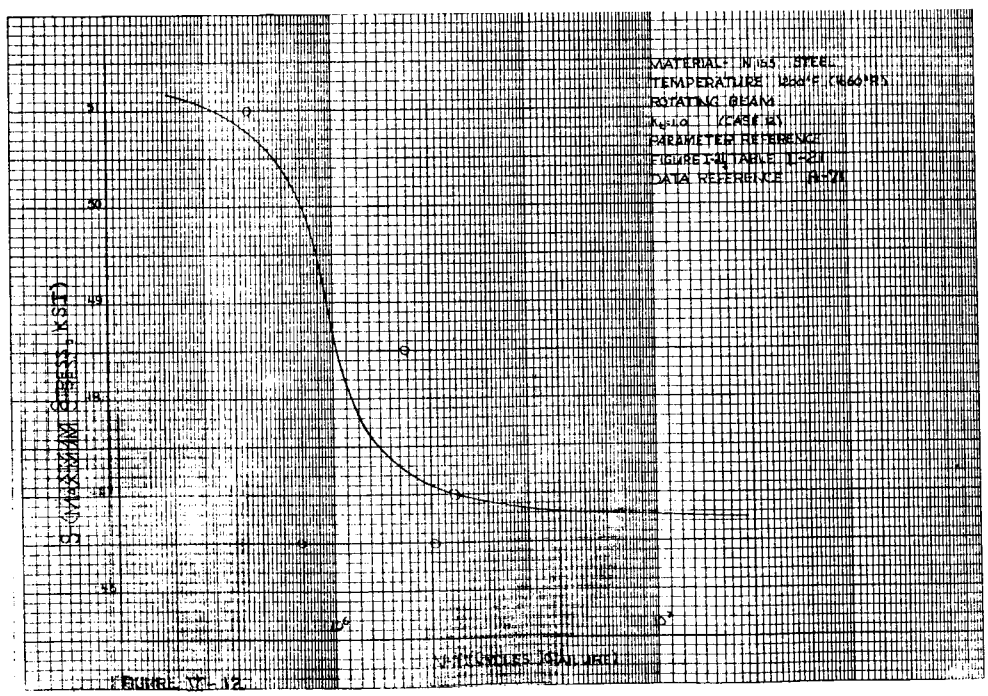
Date of Tabulation
Tabulated by DS
Checked by RH

	1	2	3	4	5	6	7	8	9	10
S	51,000	47,000	43,500	46,000	48,500	46,500	45,000			
N	550000	2350000	790000	200(0)[b]	1770000	2050000	509(10)[b]			
S										
N										
S										
N										
S										
N										
S				Data Correlating (1551 cycles)						
N										
S	51.1	51.0	50.5	50.0	49.5	49.0	48.0	47.5	47.2	47.0
N	3.6×10^5	1.2×10^5	6.6×10^5	8.0×10^5	9.0×10^5	9.6×10^5	1.15×10^6	1.32×10^6	1.75×10^6	2.35×10^6
S	96.7	96.8								
N	5.2×10^5	6.0×10^6								
S										
N										
S										
N										
S										
N										

a Test discontinued
b Specimens machined by ordinary shop practice.

Parameters:
$m = 2.601$
$b = -3.461$ } c

Comments: 1 Stress ratio = max. alt. stress / min. alt. stress
2 Table VIII gives more points per cure than the others given.



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Wrought N-155 Alloy Condition Wrought
Reference NACA RT 1288, pp. 2, 3
Reference No. 71 Code No. 165

Test Temperature 1350°F Environment Air
Type of Test Reverse Bending (Westinghouse) Specimen Data 2.550 in. dia bar
Type of Data Numerical Surface Finish
Stress Ratio* -1 Stress Concentration Factor 1.0
Mean Stress 0 Notch Description —

Fatigue Data Source:*2
Author NACA Subcommittee on Power Plant Materials
Publication NACA RT 1288, p. 33 Table VIII
No. References 5
Principal Investigator Author
Affiliation
Comments

Mechanical Properties Source:
NACA Subcommittee on Power Plant Materials p. 22

Mechanical Properties:

F_{tu}	60.19 ksi	at 1350°F	
F_{ty}	36.85 ksi	at 1350°F	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	27.00	at 1350°F	
% RA	28.50	at 1350°F	
Hardness		at	

Other Properties:
K_T=1
TS=102.32
E'=31,277

Date of Tabulation
Tabulated by DS
Checked by

	1	2	3	4	5	6	7	8	9	10
S	46,000	44,000	43,500	41,500	37,500	37,500	39,000	38,500		
N	1,509,000	1,750,000	1,880,000	4,400,000	64,000,000	430(10)⁶	115.8(10)⁶	52,000,000		
S										
N										
S										
N										
S										
N										
S										
N					Axis Correction					
S	99.9	99.0	93.0	92.0	91.0	90.0	37.6	37.2	37.0	38.9
N	1.2×10^6	2.0×10^6	3.2×10^6	4.6×10^6	6.4×10^6	1.1×10^7	1.5×10^7	2.6×10^7	4.0×10^7	7.0×10^7
S										
N										
S										
N										
S										
N										
S										
N										

*1 Discontinued

Parameters: m=2.694, b=-4.071 } C

Comments: 1. stress ratio = max. alternating stress / min. alt. stress
2. Table VIII gives more points per curve than the other tables.

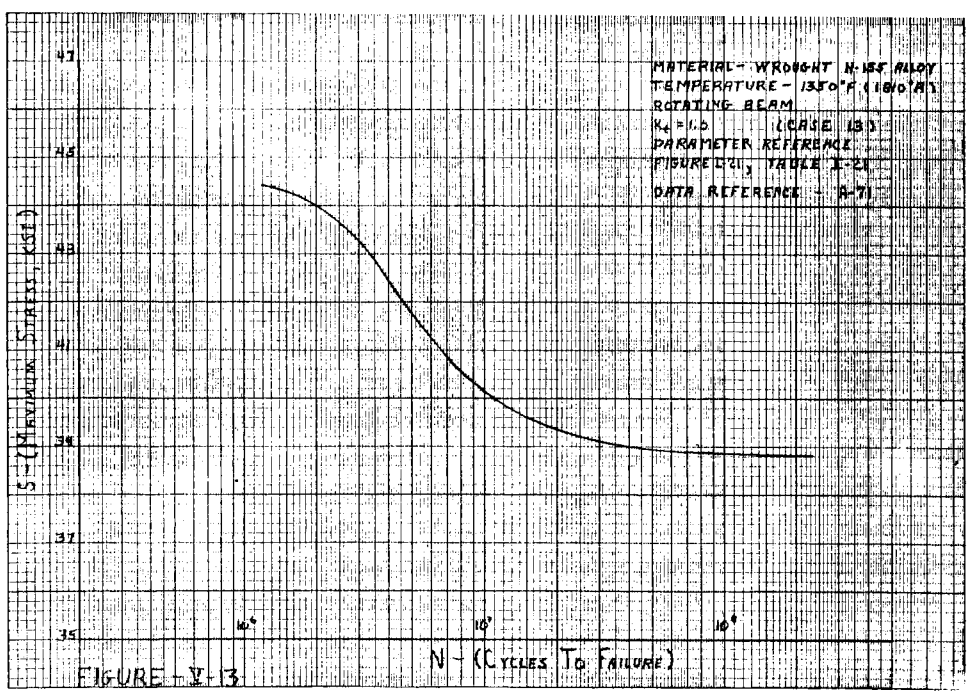


FIGURE - V-13

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Wrought N-155 Alloy Condition Wrought
Reference NACA RT 1288, pp. 2,3
Reference No. 71 Code No. 165

Test Temperature 1500°F Environment Air
Type of Test Reverse Bending (Westinghouse) Specimen Data 0.55 in. dia. bar
Type of Data Numerical Surface Finish
Stress Ratio* -1 Stress Concentration Factor 1.0
Mean Stress 0 Notch Description —

Fatigue Data Source: *

Author NACA Subcommittee on Power Plant Materials
Publication NACA RT 1288, p.33
Table VIII
No. References 5
Principal Investigator Author
Affiliation
Comments

Mechanical Properties Source:

Mechanical Properties:

				Other Properties:
F_{tu}	44.6	ksi	at 1500°F	K_t=1
F_{ty}	35.8	ksi	at 1500°F	T_3=75.82 kips
E		10^3 ksi	at	E'=25.092 Ksi
G		10^3 ksi	at	
μ			at	
% E	22.5		at 1500°F	
% RA	27.0		at 1500°F	
Hardness			at	

Date of Tabulation
Tabulated by DS
Checked by

	1	2	3	4	5	6	7	8	9	10
S	35000	33,500	31,500	30,500	28000	26,500	25,500	[b] 30,500	[b] 27,000	[b] 26,000
N	430000	5700000	4900000	$20.5(10)^6$	$12.8(10)^6$	$10.1(10)^6$	$19.0(10)^6$	7,200,000	$13.8(10)^6$	32,498,000
S										
N										
S										
N										
S										
N										
S										
N				Data Correlations (KSI, Cycles)						
S	39.6	34.0	33.0	32.0	31.0	30.0	29.0	28.0	27.0	26.5
N	9.3×10^5	9.9×10^5	2.9×10^6	9.8×10^6	8.8×10^6	1.56×10^7	2.65×10^7	9.9×10^7	8.0×10^7	1.5×10^8
S	26.2	26.0	25.8							
N	1.8×10^8	2.5×10^8	8.0×10^8							
S										
N										
S										
N										
S										
N										

[b] Specimens machined by ordinary shop practice.

Parameters: m = 2.316, b = -3.631 } C

* **Comments:** 1 stress ratio = max. alt. stress / min. alt. stress
2 Table VIII gives more points per curve than the other tables.

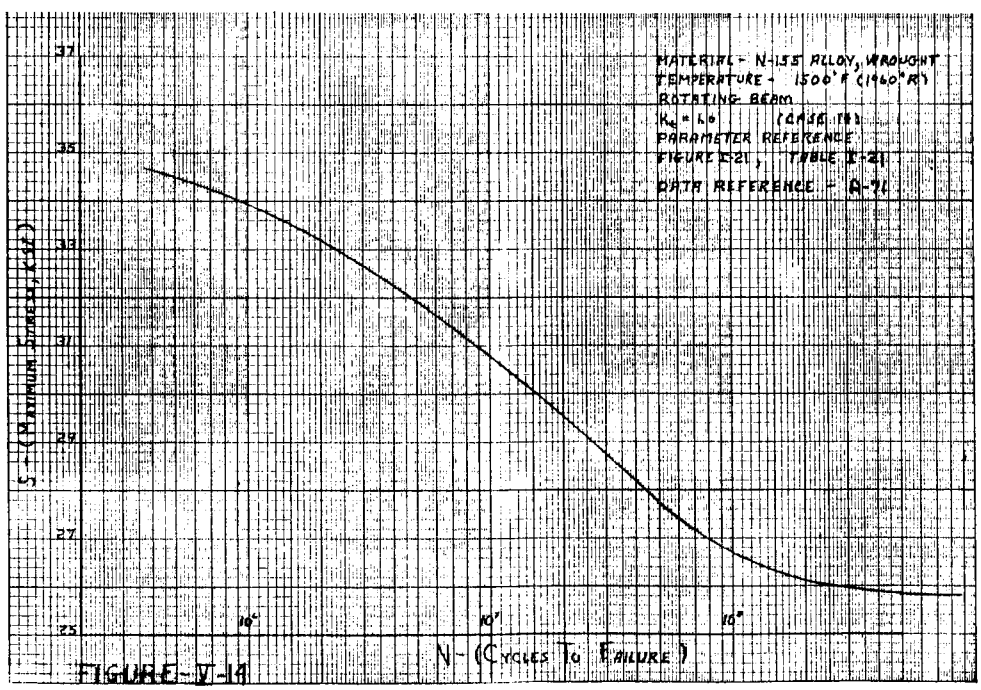


FIGURE-V-14

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-4Al-3Mo-1V Condition

Reference

Reference No. 50 Code No. 39

Test Temperature RT Environment Air

Type of Test Axial Load Specimen Data

Type of Data Numerical Surface Finish

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author

Publication

No. References

Principal Investigator

Affiliation

Comments

Mechanical Properties Source:

Mechanical Properties:

F_{tu}	ksi	at	
F_{ty} 161	ksi	at 80°F	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:

T_S = 173 Ksi

E = 13.5(10)⁶ Psi

Date of Tabulation

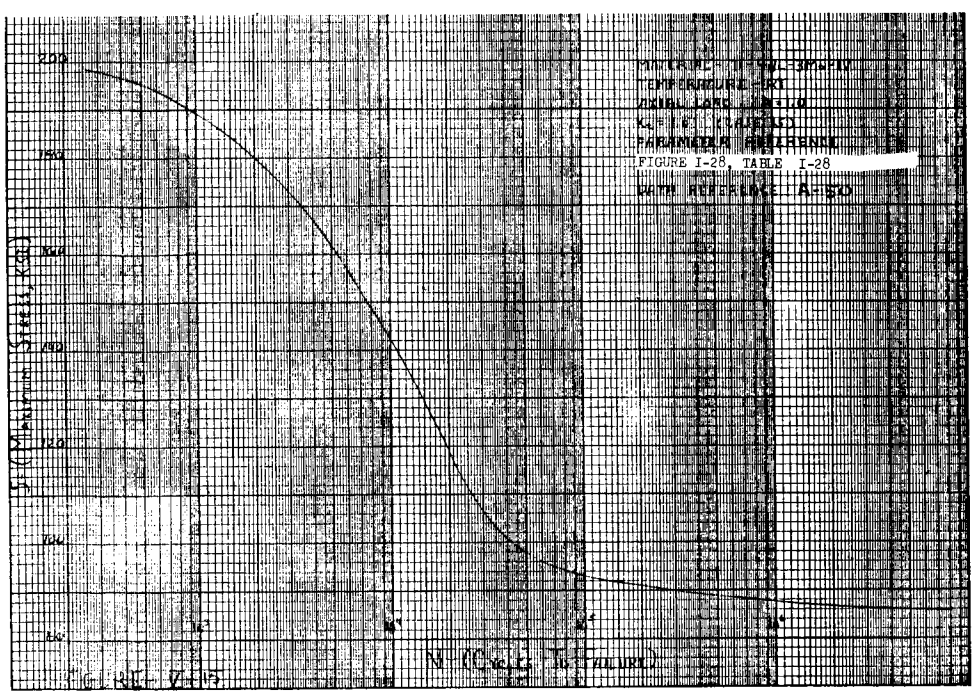
Tabulated by DS

Checked by

	1	2	3	4	5	6	7	8	9	10
S					1,500	110,000			110,000	
N					9,311		17,210	32,000		
S						95,000		85,000	80,000	80,000
N			46,000	122,000	1,110,000	237,000	760,000	5,591,000	13,000,000	
S										
N										
S										
N										
S										
N				Data	Correlation	Ksi				
S	190.0	185.0	180.0	170.0	160.0	150.0	140.0	130.0	120.0	110.0
N	7.9×10^3	1.93×10^3	2.0×10^3	3.4×10^3		1.8×10^3	1.1×10^4	1.5×10^4	1.96×10^4	2.6×10^4
S	105.0	100.0	95.0	92.5	70.0	87.5	85.5			
N	3.2×10^4	4.2×10^4	7.3×10^4	1.4×10^5	3.0×10^5	7.0×10^5	8.0×10^6			
S										
N										
S										
N										
S										
N										

Parameters: m = 5.913 } C
b = -8.924 }

Comments: 1 Poor, 2 Poor, 3 Good data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-4Al-3Mo-1V Condition [illegible]

Reference [illegible]

Reference No. 20 Code No. 39

Test Temperature 400°F Environment [illegible]

Type of Test Axial load Specimen Data [illegible]

Type of Data Nominal Surface Finish [illegible]

Stress Ratio -1 Stress Concentration Factor 1.0

Mean Stress [illegible] Notch Description [illegible]

Fatigue Data Source:

Author Hyler, W. S., McGee, W. M.

Publication [illegible]

No. References [illegible]

Principal Investigator W. S. Hyler

Affiliation Lockheed

Comments [illegible]

Mechanical Properties Source:

[illegible]

Mechanical Properties:

				Other Properties:
F_{tu}	161	ksi	at [illegible]	70°=161 ksi
F_{ty}	[illegible]	ksi	at [illegible]	E = 17.39 10^3 ksi
E	[illegible]	10^3 ksi	at 400°F	
G	[illegible]	10^3 ksi	at [illegible]	
μ	[illegible]		at [illegible]	
% E	7.2		at [illegible]	
% RA	[illegible]		at [illegible]	
Hardness	[illegible]		at [illegible]	

Date of Tabulation [illegible]

Tabulated by DS

Checked by RMJ

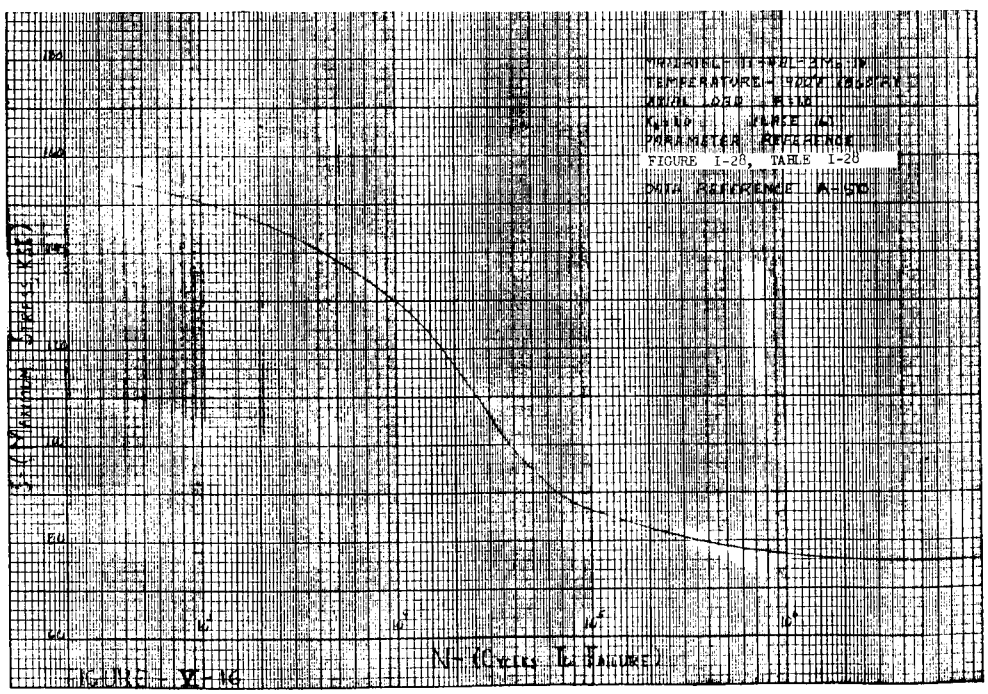
	1	2	3	4	5	6	7	8	9	10
S	[illegible]	[illegible]	[illegible]	150,000	140,000	[illegible]	[illegible]	100,000	85,000	[illegible]
N	[illegible]	[illegible]	1,161	1	3,526	3,193	5,000	[illegible]	41,000	47,000
S	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	70,000
N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	3,530	1,411,000	[illegible]	[illegible]	[illegible]
S	[illegible]	[illegible]								
N	[illegible]	[illegible]								
S										
N										
S										
N										
S	155.0	150.0	140.0	120.0	120.0	110.0	100.0	90.0	80.0	78.0
N	[illegible]	1.12×10^3	4.5×10^3	1.0×10^4	1.73×10^4	2.1×10^4	3.8×10^4	6.9×10^4	4.8×10^5	6.0×10^5
S	[illegible]					7.6×10^4				
N	1.1×10^5									
S										
N										
S										
N										
S										
N										

Data Correlation Age

Parameters: m = 4.501, b = -6.870 } C

Comments: [illegible]

3. Good data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-6Al-3Mo-1V Condition Solution treated and Aged

Reference Lockheed Prog. Rept. #7 p.A-112

Reference No. 52 Code No. 39

Date of Tabulation

Tabulated by DS

Checked by

Test Temperature 600°F Environment Air

Type of Test Axial Load Specimen Data .060 in thick sheet

Type of Data Numerical Surface Finish

Stress Ratio *1 1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Hughes White, G.L., McGee, W.M.

Publication Prog. Rept. #7 (Lockheed) Contract AF33(616)-6396

No. References

Principal Investigator W.M. McGee

Affiliation Lockheed

Comments

Mechanical Properties Source:

Prog. Rept. #3 (Lockheed) Contract AF33(616)-6396 p.A-125

Mechanical Properties:

F_{tu}	199 ksi	at 600°F	
F_{ty}	106 ksi	at 600°F	
E	13.5 (10^3 ksi)	10^3 ksi at 600°F	
G		10^3 ksi at	
μ		at	
% E	6.0	at 600°F	
% RA		at	
Hardness		at	

Other Properties:

75°: 17.0 Ksi

E' = 58.51 Ksi

S *1	160,000	115,000	130,000	147,500	145,000	140,000	110,000	90,000	70,000	70,000
N	12	69	317	58	83	2,759	13,590	18,000	31,000	86,000
S	80,000	80,000	80,000	70,000	70,000	70,000 *2	60,000	60,000	60,000	60,000
N	97,000	64,000	259	230,000	255,000	10,007,000	132,000	181,000	251,000	1,118,000
S	50,000 *3	50,000 *3	50,000 *3							
N	10,000,000	10,000,000	10,000,000							
S										
N										
S										
N				Data Correlation Ksi						
S	195.0	190.0	135.0	130.0	120.0	110.0	100.0	90.0	85.0	80.0
N	1.45×10^3	1.8×10^3	9.4×10^3	6.2×10^3	9.2×10^3	1.9×10^9	2.00×10^9	3.0×10^9	3.7×10^9	5.7×10^9
S	75.0	70.0	65.0	60.0						
N	9.9×10^9	1.7×10^5	3.1×10^5	1.3×10^6						
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Parameters: m = 6.879, b = -10.581 } C

Comments: 1. Max. A.F. Stress / Mean Stress

2. 50% cycles

3. Good data

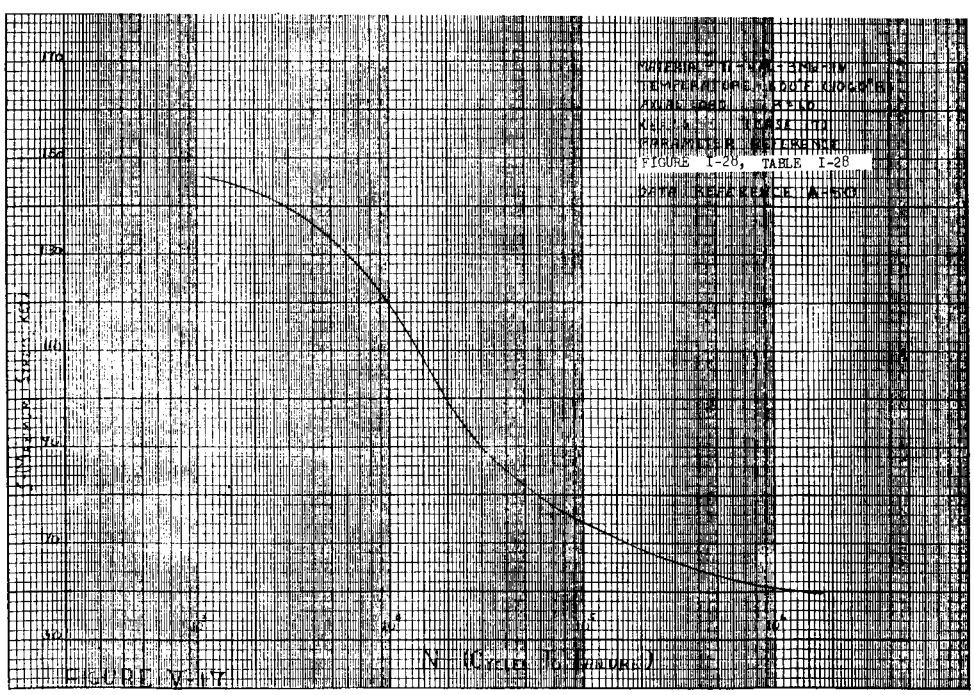


FIGURE V-17

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-4Al-3Mo-1V Condition Solution Treated and Aged

Reference Lockheed Prog. Rept. #7 pA 112

Reference No. 50 Code No. 39

Date of Tabulation

Tabulated by DS

Checked by RMH

Test Temperature 800F Environment Air

Type of Test Axial Load Specimen Data 0.063 in thick sheet

Type of Data Numerical Surface Finish

Stress Ratio *1 1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Hughes, White, E.L., McGee, W.M.

Publication Prog. Rept. #9 (Lockheed) Contract AF 33(616)-6396

No. References

Principal Investigator W.M. McGee

Affiliation Lockheed

Comments

Mechanical Properties Source:

Prog. Rept. #8 (Lockheed) Contract AF 33(616)-6396 pA-125

Mechanical Properties:

F_{tu}	139 ksi	at 70°F	
F_{ty}	100 ksi	at 70°F	
E	12.9 ($F_{GL} \times 10^{-6}$) 10^3 ksi	at 800°F	
G	10^3 ksi	at	
μ		at	
% E	6.8	at 70°F	
% RA		at	
Hardness		at	

Other Properties:

$T_S' = 139$

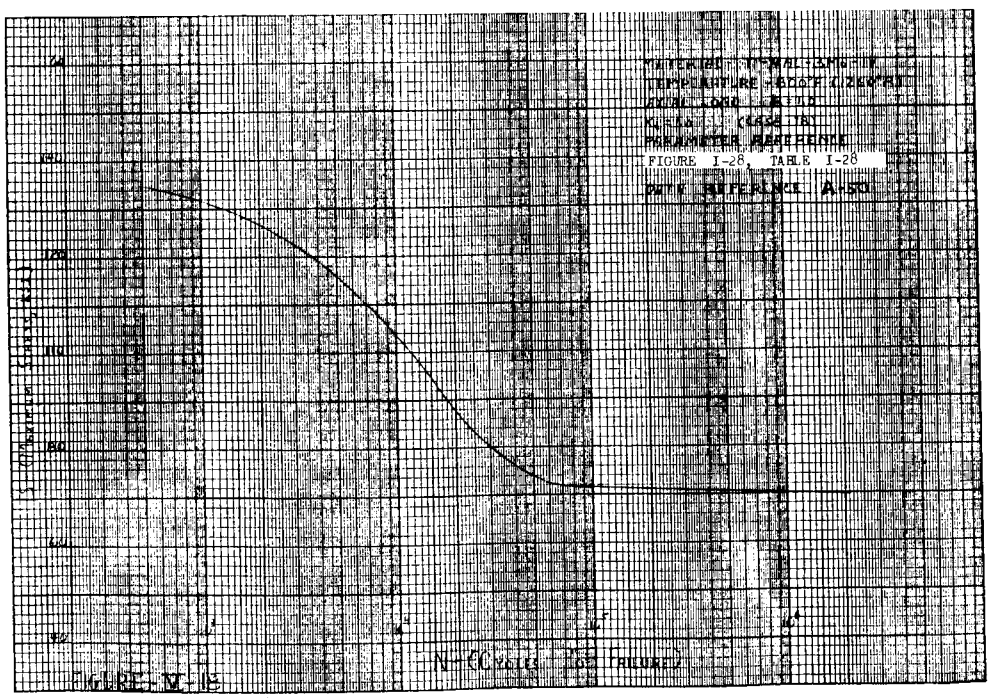
$E' = 68.61$

	1	2	3	4	5	6	7	8	9	10
S	111,500	121,000	109,000	121,000	121,000	102,000	80,000	83,000	83,000	15,000
N	171	317	316	2,185	3,762	8,112	19,000	56,000	172,000	151,000
S	76,000	80,000	80,000	16,000	32,000	60,000	60,000	60,000	60,000	60,000
N	16,000	1,146,000	1,170,000	1,196,000	1,276,000	8,121,000	10,000,000	10,000,000	10,000,000	10,000,000
S	50,000									
N	10,000,000									
S										
N										
S										
N				Data Correlation Ke						
S	135.0	130.0	125.0	120.0	110.0	100.0	90.0	80.0	75.0	73.0
N	5.2×10^2	1.3×10^3	2.9×10^3	3.7×10^3	7.2×10^3	1.2×10^4	1.8×10^4	3.2×10^4	9.5×10^4	8.2×10^4
S	71.0	72.0								
N	9.0×10^5	2.0×10^6								
S										
N										
S										
N										
S										
N										

Parameters: $m = 5.442$, $b = -7.923$ } C

Comments: 1 Max. Init. Stress / Mean Stress

3 Good data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-4Al-3Mo-1V Condition Solution treated and Aged

Reference Lockheed Progress Rept #7, pp 112

Reference No. 50 Code No. 39

Date of Tabulation

Tabulated by DS

Checked by AHA

Test Temperature 900°F Environment Air

Type of Test Axial load Specimen Data 0.25 in. thick sheet

Type of Data Min. val. Surface Finish

Stress Ratio* 1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Hughes, White, D.L., McGee, W.M.

Publication Prog. Rept #7 (Lockheed) Contract AF 33(616)-6346

No. References

Principal Investigator McGee

Affiliation Lockheed

Comments

Mechanical Properties Source:

Prog. Rept #8 (Lockheed) Contract AF 33(616)-6346 pA-125

Mechanical Properties:

F_{tu} 126	ksi	at 900°F	
F_{ty} 93.8	ksi	at 900°F	
E 11.5	10^3 ksi	at 900°F	
G	10^3 ksi	at	
μ		at	
% E 5.6		at 900°F	
% RA		at	
Hardness		at	

Other Properties:

~~T_S = 126.00 ksi~~

~~E' = 58.74 ksi~~

T_S = 126.00 } Rms

E' = 58.74 }

	1	2	3	4	5	6	7	8	9	10
S	[illegible]	130,000	125,000	125,000	122,000	117,500	100,500	80,000	80,000	70,000
N	170	1	05	122	1,209	2,549	9,222	45,000	60,000	112,000
S	80,000	70,000	70,000	70,000	65,000	65,000	60,000	60,000	52,000	50,000
N	170,000	221,000	111,000	200,000	1,122,000	3,165,000	3,295,000	10,000,000	9,751,000	17,000,000
S	90,000*	90,000								
N	10,000,000	16,000,000								
S										
N										
S										
N										
S	125.0	120.0	115.0	110.0	100.0	90.0	80.0	70.0	65.0	60.0
N	6.6×10^2	1.5×10^3	2.8×10^3	4.6×10^3	1.1×10^4	2.6×10^4	6.0×10^4	1.5×10^5	2.8×10^5	5.6×10^5
S	60.0									
N	2.1×10⁷									
S										
N										
S										
N										
S										
N										

Data Correlation Table

continued

Parameters: m = 6.200, b = -9.688 } C

Comments: Max. Alt. Stress / Mean Stress

2 1:1 cycles

3. Good data

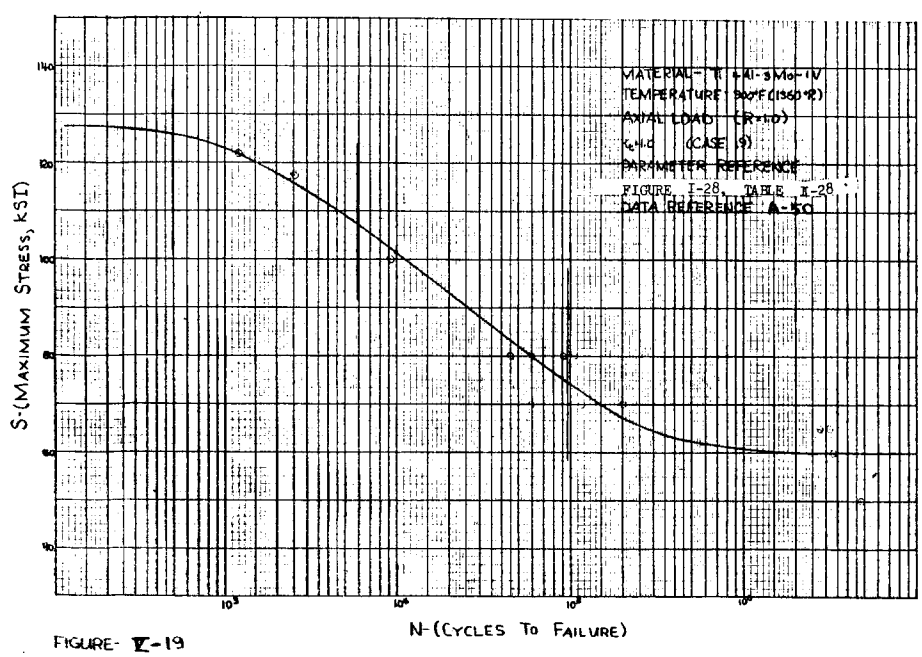


FIGURE- E-19

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-6Al-4V Condition Solution Treated and Aged

Reference Lockheed Prog. Report #2 pp 5-7

Reference No. 50 Code No. 39

Date of Tabulation

Tabulated by DS

Checked by RM

Test Temperature RT Environment Air

Type of Test Axial Specimen Data 0.063 in thick sheet

Type of Data Numerical Surface Finish

Stress Ratio* -1 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Hughes, W. M. McGee, H. A.

Publication Prog. Rept. #1 thru 6 Lockheed Missiles & Space Co.

No. References

Principal Investigator W. M. McGee

Affiliation Lockheed

Comments

Mechanical Properties Source:

Lockheed Prog. Rept. #2 Contract AF 33(657)-7936

pp 5-6

Mechanical Properties:

F_{tu}	177.0 ksi	at RT	
F_{ty}	167.0 ksi	at RT	
E	16.6 10^{-6} psi	at RT	
G	10^3 ksi	at	
μ		at	
% E	8.6	at RT	
% RA		at	
Hardness		at	

Other Properties:

F_{cy} = 177.0 Ksi

E' = 55.23 Ksi

S N	1	2	3	4	5	6	7	8	9	10
S	165.0	140.0	120.0	100.0	90.0	80.0	75.0	70.0	65.0	60.0
N	5.0×10^2	9.1×10^3	9.9×10^3	1.9×10^5	3.1×10^5	6.1×10^5	1.05×10^6	2.2×10^6	6.9×10^6	2.3×10^7
S	51.0									
N	7.0×10^7									

Data Correlation, Ksi

Parameters: m = 3.853, b = -5.279 } C

Comments: 1. Maximum alternating stress - see Mean Stress

2. 10^7 cycles

3. Good data

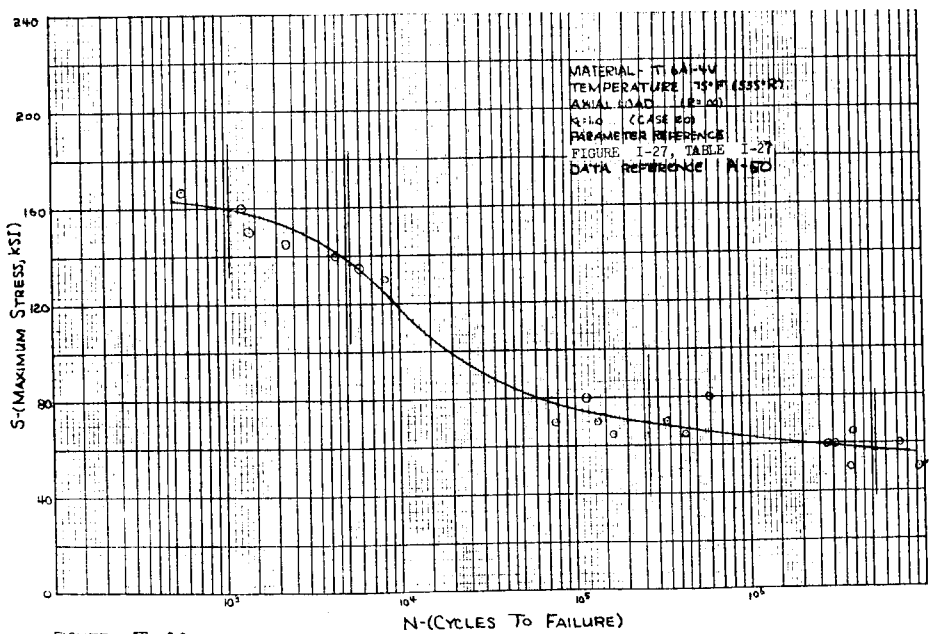


FIGURE - V - 20

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-6Al-4V Condition

Reference

Reference No. 50 Code No. 39

Date of Tabulation

Tabulated by DS

Checked by

Test Temperature 400°F Environment

Type of Test Axial Specimen Data

Type of Data Smooth Surface Finish

Stress Ratio Stress Concentration Factor

Mean Stress Notch Description

Fatigue Data Source:

Author Ott, C.C., Mc Gee, W.M.

Publication Proc. Nat. Aerospace Elect. Conf. AFOSR(6616)-C-916

No. References

Principal Investigator W.M. McGee

Affiliation Lockheed

Comments

Mechanical Properties Source:

/ /

Mechanical Properties:

F_{tu}	145 ksi	at	
F_{ty}	120 ksi	at	
E	(Psi) 10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:

Tc = 493.0 °F

E' = 5157 ksi

S-N	1	2	3	4	5	6	7	8	9	10
S	135.0	130.0	125.0	120.0	115.0	110.0	105.0	100.0	95.0	90.0
N	1.5×10^2	3.6×10^2	7.7×10^2	1.9×10^3	3.2×10^3	5.2×10^3	9.3×10^3	5.9×10^3	6.9×10^3	7.6×10^3
S	80.0	70.0	60.0	60.0	55.0	53.0				
N	1.1×10^4	1.8×10^4	2.5×10^4	3.7×10^4	7.7×10^4	1.5×10^5				

Data Correlation Ks

Parameters: m 4.517

E -6,197 } C

Comments:

3. Good data

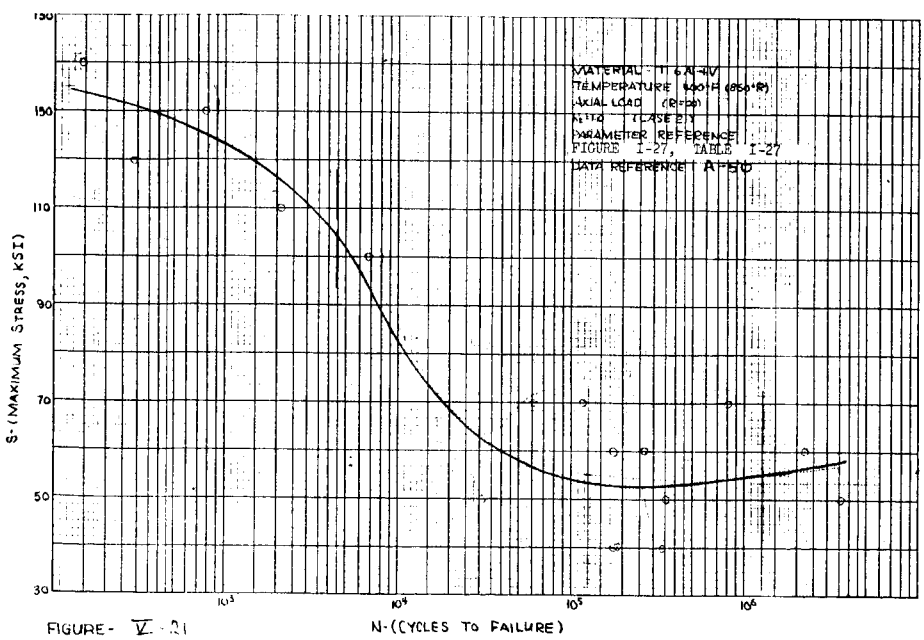


FIGURE- V-21

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-6Al-4V Condition [illegible]

Reference [illegible]

Reference No. 50 Code No. 39

Test Temperature 600°F Environment [illegible]

Type of Test [illegible] Specimen Data [illegible]

Type of Data [illegible] Surface Finish [illegible]

Stress Ratio [illegible] Stress Concentration Factor [illegible]

Mean Stress [illegible] Notch Description [illegible]

Date of Tabulation [illegible]

Tabulated by DS

Checked by [illegible]

Fatigue Data Source:

Author [illegible]

Publication [illegible]

[illegible]

No. References [illegible]

Principal Investigator [illegible]

Affiliation [illegible]

Comments [illegible]

Mechanical Properties Source:

[illegible]

Mechanical Properties:

				Other Properties:
F_{tu}	132 ksi	at	[illegible]	TS' = 132.0 Ksi
F_{ty}	103 ksi	at	[illegible]	E' = 39.68 Ksi
E	12.8 (10^3 ksi)	at	[illegible]	
G	(10^3 ksi)	at	[illegible]	
μ		at	[illegible]	
% E	1.0	at	600°F	
% RA		at	[illegible]	
Hardness		at	[illegible]	

	1	2	3	4	5	6	7	8	9	10
S										
N										
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation Fig.						
S	113.0	110.0	105.0	100.0	95.0	90.0	85.0	75.0	65.0	55.0
N	3.2×10^2	8.2×10^2	2.4×10^3	9.2×10^3	6.8×10^3	9.8×10^3	1.3×10^4	2.2×10^4	3.4×10^4	5.6×10^4
S	50.0	45.0	41.0							
N	7.4×10^4	2.0×10^5	4.0×10^5							
S										
N										
S										
N										
S										
N										

Parameters: m = 3.350

b = -4.870 } c

Comments: [illegible]

3. Good data

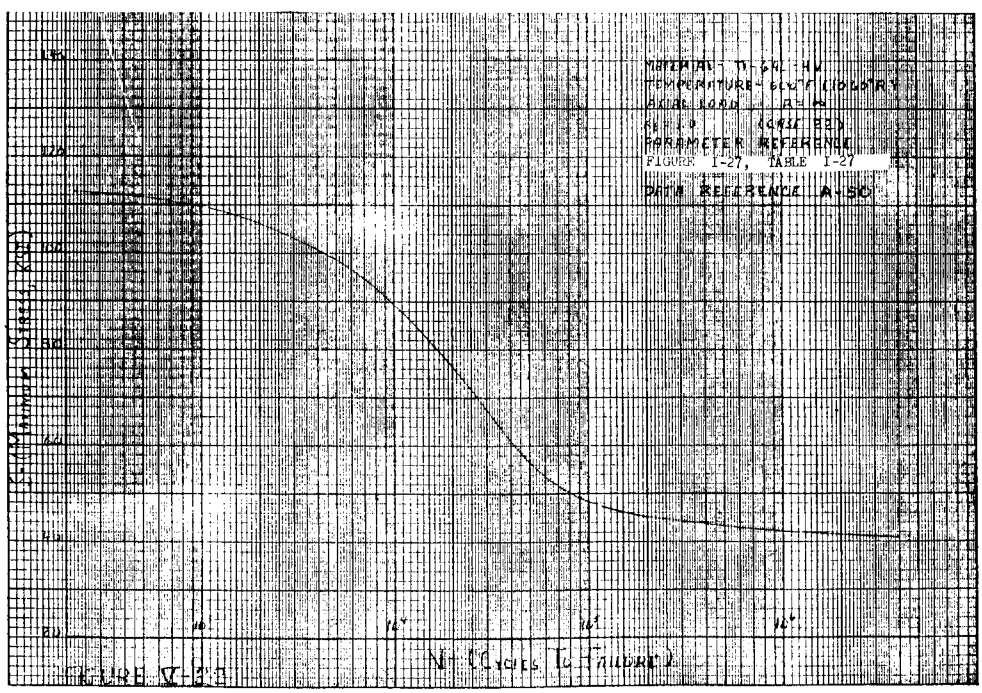


FIGURE V-2-21

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-6Al-4V Condition
Reference Lockheed Rpt #9
Reference No. 50 Code No. 39

Date of Tabulation
Tabulated by DS
Checked by RMA

Test Temperature 800°F Environment
Type of Test
Type of Data
Stress Ratio Stress Concentration Factor
Mean Stress Notch Description

Fatigue Data Source:
Author
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:

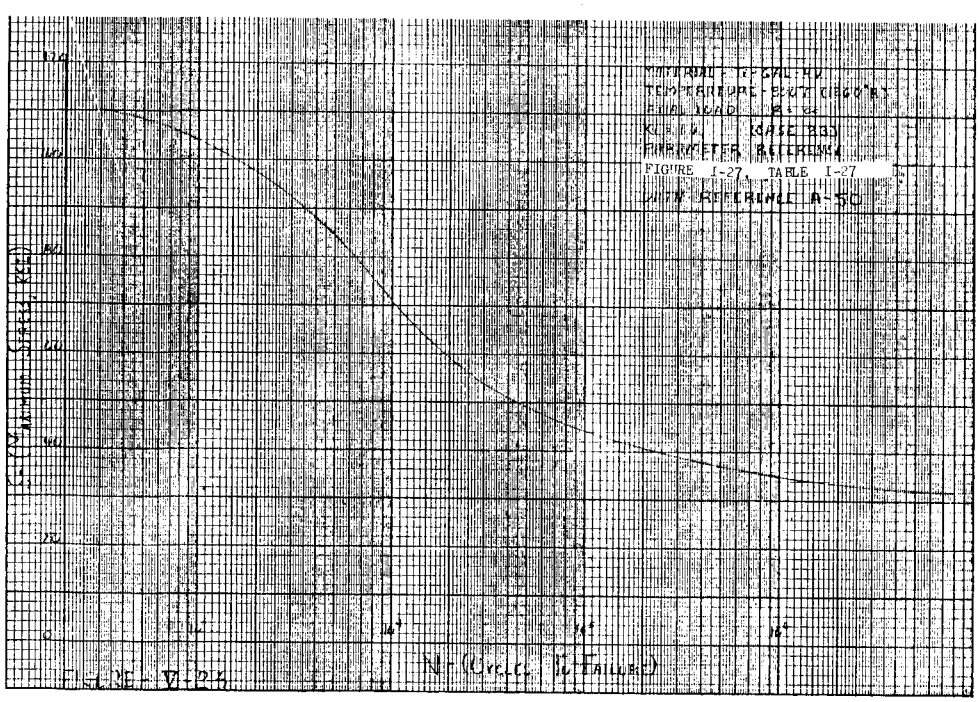
Mechanical Properties:

			Other Properties:
F_{tu}	123 ksi	at	70°-123 ksi
F_{ty}	94.7 ksi	at	E = 30.77 ksi
E	11.7 10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	15	at	
% RA		at	
Hardness		at	

	1	2	3	4	5	6	7	8	9	10
S										
N										
S										
N										
S										
N										
S										
N										
S				Data Correlation Table						
N										
S	110.0	105.0	100.0	75.0	70.0	75.0	70.0	75.0	70.0	65.0
N	3.0×10^2	8.2×10^2	1.5×10^3	2.8×10^3	3.6×10^3	4.7×10^3	6.4×10^3	8.2×10^3	1.05×10^4	1.2×10^4
S	60.0	55.0	50.0	45.0	40.0	37.0	36.0	34.0	32.0	
N	1.7×10^5	2.7×10^5	4.6×10^5	1.3×10^6	2.6×10^6	9.2×10^6	7.8×10^6	1.7×10^7	8.0×10^7	
S										
N										
S										
N										
S										
N										

Parameters: A 3.554 } C
b -5.196

Comments:
3. Goal data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-6Al-4V Condition

Reference Lockheed Prog Rept #9

Reference No. 50 Code No. 37

Test Temperature 900°F Environment

Type of Test Specimen Data

Type of Data Surface Finish

Stress Ratio Stress Concentration Factor

Mean Stress Notch Description

Fatigue Data Source:

Author Hanks, White D.L. Morrow

Publication

No. References

Principal Investigator

Affiliation

Comments

Mechanical Properties Source:

Date of Tabulation

Tabulated by DS

Checked by RHT

	1	2	3	4	5	6	7	8	9	10
S	1									
N										
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation						
S	105									
N	3.0×10^2			1.0×10^3						
S										
N				2.0×10^3						
S										
N										
S										
N										
S										
N										

Mechanical Properties:

F_{tu}	111.0 ksi	at	
F_{ty}	88.9 ksi	at	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:

75°: 111.0 ksi

E = 30.11 ×

Parameters: m 4.054 } C

b -5.868 }

Comments:

3 pt. Good data

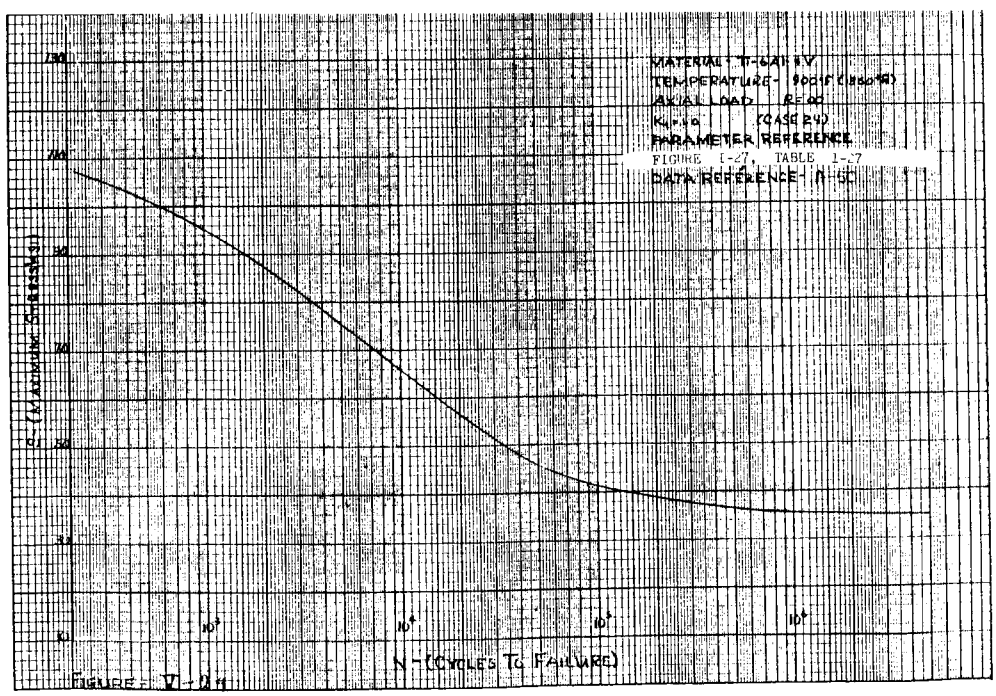


FIGURE V-11

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2014-T Condition

Reference [illegible] Ref 1

Reference No. 111 Code No. 55

Date of Tabulation

Tabulated by [illegible]

Checked by [illegible]

Test Temperature RT Environment

Type of Test [illegible] Specimen Data

Type of Data [illegible] Surface Finish

Stress Ratio 1 Stress Concentration Factor

Mean Stress 0 Notch Description

Fatigue Data Source:

Author Wyman LL

Publication [illegible]

No. References

Principal Investigator

Affiliation

Comments

Mechanical Properties Source:

[illegible]

S	[illegible]									
N	[illegible]									
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Mechanical Properties:

				Other Properties:
F_{tu}	70.0	ksi	at RT	
F_{ty}	66.0	ksi	at RT	
E		10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E	14		at RT	
% RA	31		at RT	
Hardness			at	

Parameters: m: 1.734 } C
c: -2.418

Comments: Design Data

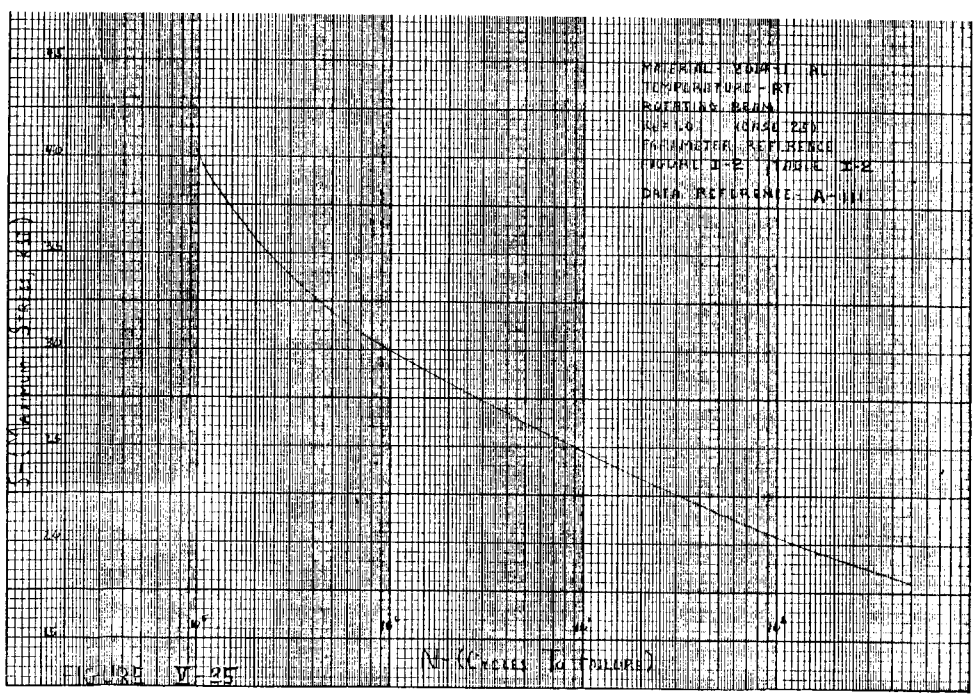


FIG. 102 V-25

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2014-T Al Condition
Reference
Reference No. 111 Code No. 55

Test Temperature 300°F Environment
Type of Test Specimen Data
Type of Data Surface Finish
Stress Ratio Stress Concentration Factor 1
Mean Stress Notch Description

Fatigue Data Source:

Author Wyman L.L.
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:

Mechanical Properties:

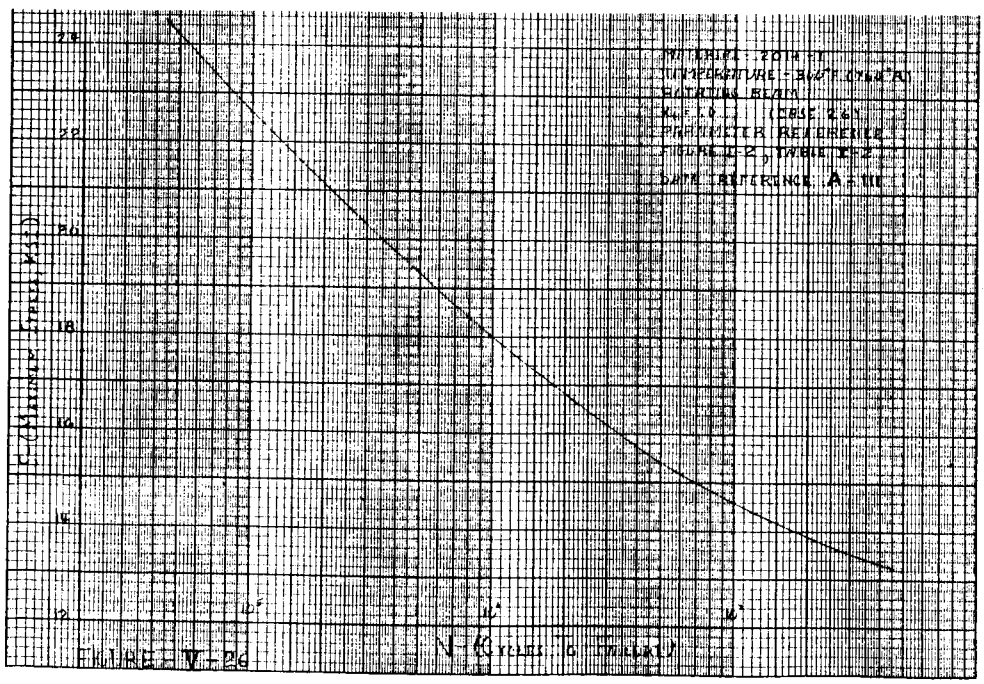
				Other Properties:
F_{tu}		ksi	at	
F_{ty}		ksi	at	
E		10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E	14		at	
% RA	51		at	
Hardness			at	

Date of Tabulation
Tabulated by CB
Checked by

	1	2	3	4	5	6	7	8	9	10
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S	2.4.2	2.2	2.1.1	1.7			1			
N	1		2.4.2						2	
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 2.034, b = -2.652 } C

Comments: Design Data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2014-T Al Condition
Reference
Reference No. 111 Code No. 55

Date of Tabulation
Tabulated by JE
Checked by MA

Test Temperature 400 °F Environment
Type of Test Axial Specimen Data
Type of Data Number of Cycles Surface Finish
Stress Ratio Stress Concentration Factor
Mean Stress Notch Description

Fatigue Data Source:
Author Dixon, L.G.
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:

S N	1	2	3	4	5	6	7	8	9	10
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Mechanical Properties:

F_{tu}	ksi	at	
F_{ty}	ksi	at	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	400 °F
% RA		at	400 °F
Hardness		at	

Other Properties:
E' = 8.21 max

Parameters: m = 2.277
b = -3.525
} C

Comments: Design Data

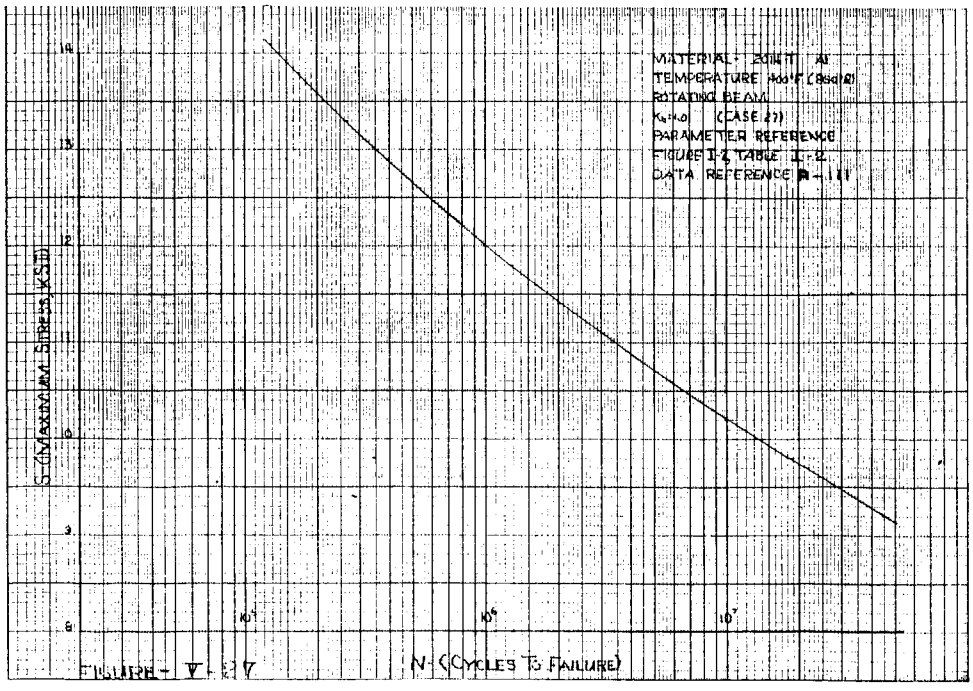


FIGURE - V-2.17

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2014 - T Condition
Reference
Reference No. 111 Code No. 55

Date of Tabulation
Tabulated by
Checked by

Test Temperature 500F Environment
Type of Test Specimen Data
Type of Data Surface Finish
Stress Ratio Stress Concentration Factor
Mean Stress Notch Description

Fatigue Data Source:
Author Wyman L. L.
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Same
x40

Mechanical Properties:

F_{tu}	10.5 ksi	at	
F_{ty}	8.0 ksi	at	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	32.0	at	400 F
% RA	93.0	at	500 F
Hardness		at	

Other Properties:

S	N	1	2	3	4	5	6	7	8	9	10
S	N										
S	N										
S	N										
S	N										
S	N										
S	N										
S	N				Correlation Data						
S	N	10.5	7.5	6.4		5.20	5.1	4.10	6.61	5.15	4.6
S	N										
S	N										
S	N										
S	N										
S	N										
S	N										
S	N										

Parameters: m = 2.469
b = -4.174
C

Comments: Design Data

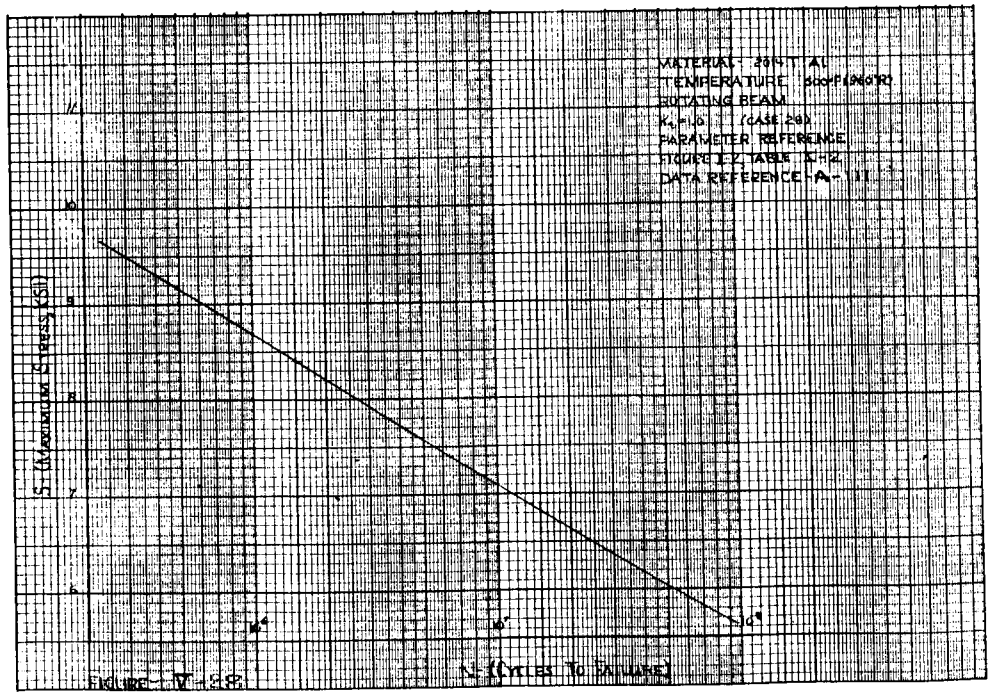


FIGURE IV-1-58

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075-T6 Condition

Reference [illegible] p42

Reference No. 34 Code No. 108

Date of Tabulation

Tabulated by h

Checked by RMA

Test Temperature +25°C or 77°F Environment Air

Type of Test Vibration Beam Specimen Data [illegible]

Type of Data Design Curves Surface Finish

Stress Ratio [illegible] Stress Concentration Factor

Mean Stress 0 Notch Description [illegible]

Fatigue Data Source:

Author Fortner M.G.

Publication [illegible]

No. References

Principal Investigator

Affiliation

Comments

Mechanical Properties Source:

[illegible]

Mechanical Properties:

F_{tu}	74.0 ksi	at	2
F_{ty}	ksi	at	
E	10.4 10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:

TS = 74.0 KSI

E = 15.26 KSI

	1	2	3	4	5	6	7	8	9	10
S	50.0	45.0	40.0	35.0	30.0	25.0	22.5	20.0	17.5	16.0
N	$4.0(10)^3$	$8.4(10)^3$	$1.2(10)^4$	$3.6(10)^4$	$7.7(10)^4$	$1.2(10)^5$	$2.8(10)^5$	$6.2(10)^5$	$2.5(10)^6$	$1.5(10)^7$

Correlation Data:

Parameters: m = 3.173, b = -4.703 } C

Comments:

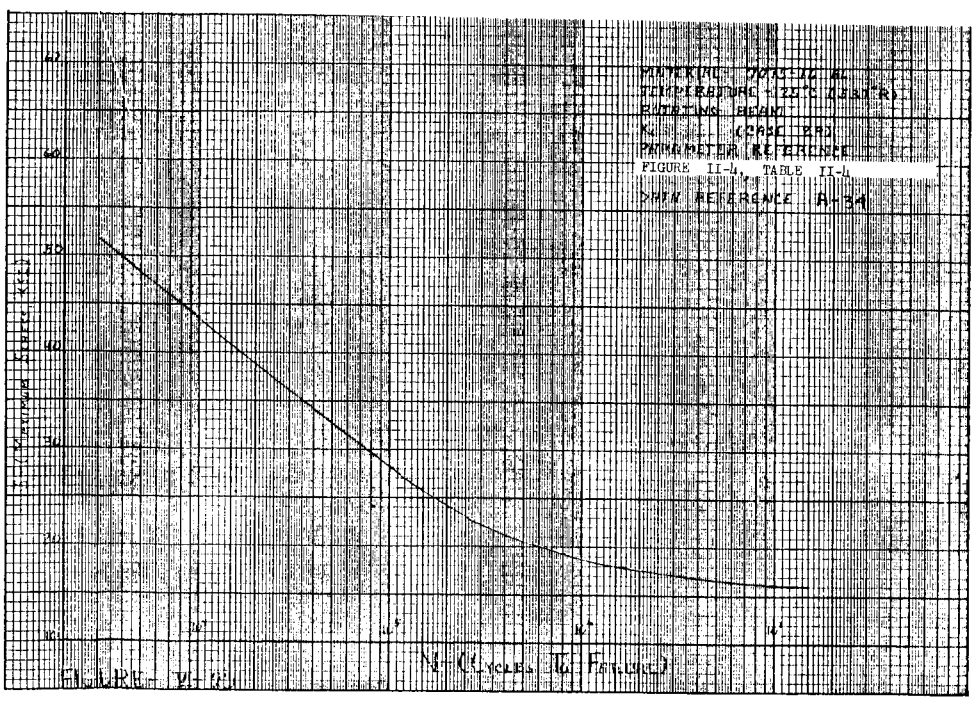


FIGURE VI-[illegible]

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075-T6 Condition

Reference

Reference No. 34 Code No. 108

Test Temperature −78°C or −108°F Environment

Type of Test Vibr. Beam Specimen Data

Type of Data Surface Finish

Stress Ratio Stress Concentration Factor

Mean Stress Notch Description

Fatigue Data Source:

Author Fontana M.G

Publication

No. References

Principal Investigator

Affiliation

Comments

Mechanical Properties Source:

* Interpolated From Metals Handbook P. 948

Mechanical Properties:

			Other Properties:
F_{tu}	85.5 ksi	at	75°: 85.5 KSI
F_{ty}	ksi	at	E: 10.14 KSI
*E	1.05 (RT Value of E) 10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Date of Tabulation

Tabulated by MB

Checked by MB

	1	2	3	4	5	6	7	8	9	10
S			40.5		42.5		9			
N			410⁶		410⁶		410⁶			
S										
N										
S										
N										
S										
N										
S										
N	Correlation Data:									
S	50.0	45.0	40.0	35.0	32.0	27.5	25.0	22.5	20.0	18.0
N	6.0(10)³	1.4(10)⁴	3.2(10)⁴	7.7(10)⁴	1.9(10)⁵	3.0(10)⁵	4.8(10)⁵	9.0(10)⁵	23(10)⁵	41(10)⁵
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 3.112, b = −4.536 } C

Comments:

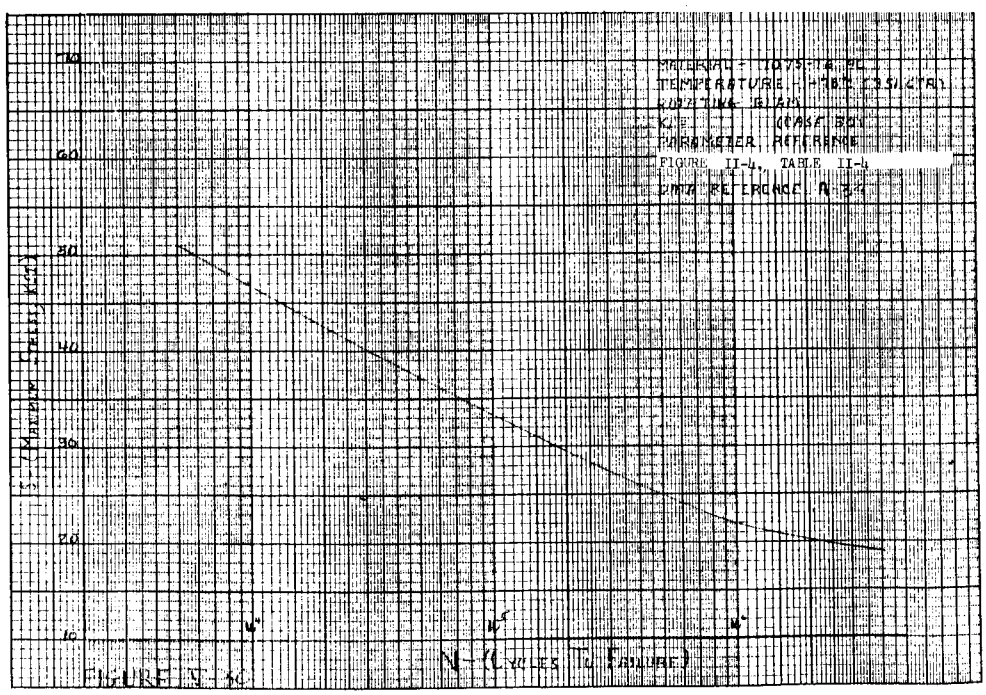


FIGURE 5-20

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075 -T6 Condition

Reference AD 27726

Reference No. 34 Code No. 108

Test Temperature -196 °C (-320.8 °F) Environment

Type of Test V... Beam Specimen Data

Type of Data Surface Finish

Stress Ratio Stress Concentration Factor

Mean Stress Notch Description

Fatigue Data Source:

Author Fontana M6

Publication

No. References

Principal Investigator

Affiliation

Comments

Mechanical Properties Source:

Extrapolated

*Metals Handbook p. 348

Mechanical Properties:

F_{tu}	97.0 ksi	at	
F_{ty}	ksi	at	
E	*1.12 x RT Modulus 10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:

TS = 92.0 KSI

E' = 2003 KSI

Date of Tabulation

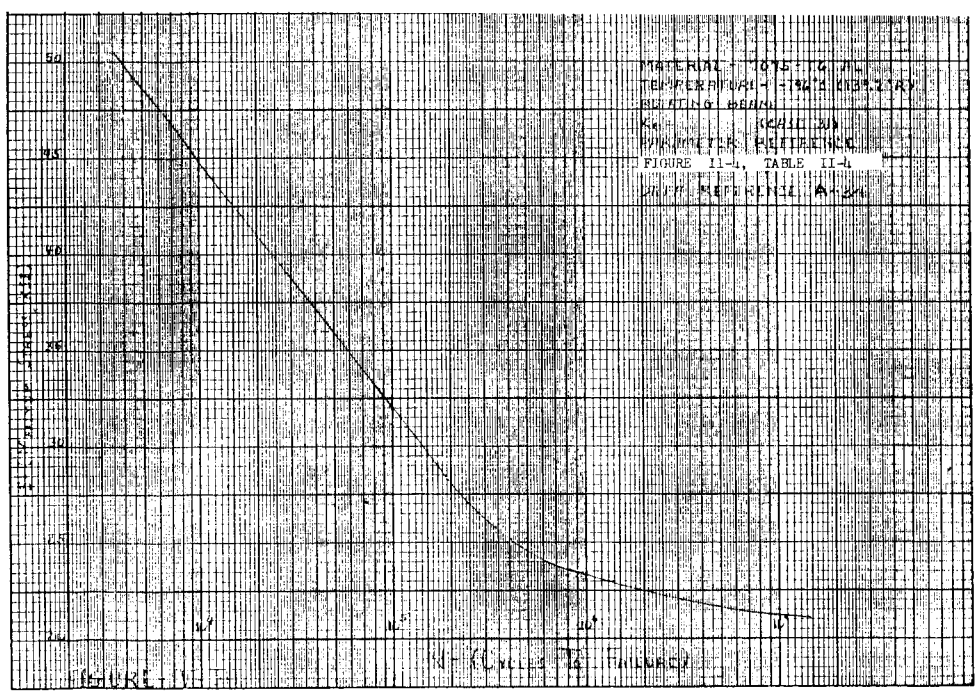
Tabulated by MB

Checked by MJ

	1	2	3	4	5	6	7	8	9	10
S	CORRELATION DATA:									
S	50.0	44.0	38.0	32.0	29.0	26.0	24.0	23.0	22.0	21.0
N	$4.0(10)^3$	$1.2(10)^4$	$3.4(10)^4$	$1.0(10)^5$	$1.7(10)^5$	$3.2(10)^5$	$6.4(10)^5$	$1.4(10)^6$	$3.8(10)^6$	$1.5(10)^7$

Parameters: $m = 2.352$, $b = -3.120$ } C

Comments:



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075-T6 Condition
Reference AD 27726
Reference No. 34 Code No. 108

Test Temperature −253°C or −423°F Environment
Type of Test Vibrating Beam Specimen Data
Type of Data Curve ✓ Surface Finish
Stress Ratio −1 Stress Concentration Factor
Mean Stress Notch Description

Date of Tabulation
Tabulated by SB
Checked by RD

	1	2	3	4	5	6	7	8	9	10
S	47.5	47.5	42.3	34.2	31.5	28.2	25.1	22.6		
N	4×10^4	1×10^5	2×10^5	1×10^6	2×10^6	2×10^7	4×10^7	1×10^8		
S										
N										
S										
N										
S										
N										
S				Correlation Data, Ksi						
N										
S	54.5	51.5	48.3	42.3	38.2	35.3	31.5	28.2	25.1	22.6
N	4×10^3	7×10^3	1×10^4	2×10^4	4×10^4	7×10^4	1×10^5	2×10^5	3×10^5	5×10^5
S										
N										
S										
N										
S										
N										
S										
N										

Fatigue Data Source:
Author Fontana
Publication [illegible] 662
Part 5
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
[illegible]
Vol. VIII
Extrapolated from
* Metals Handbook p. 948

Mechanical Properties:

F_{tu}	113.4 ksi	at −253°C	25 113.4
F_{ty}	113.4 ksi	at −253°C	5
*E	1.135 (E at Room Temp) 10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:

Parameters: m 2.761
k −3.459 } C

Comments:

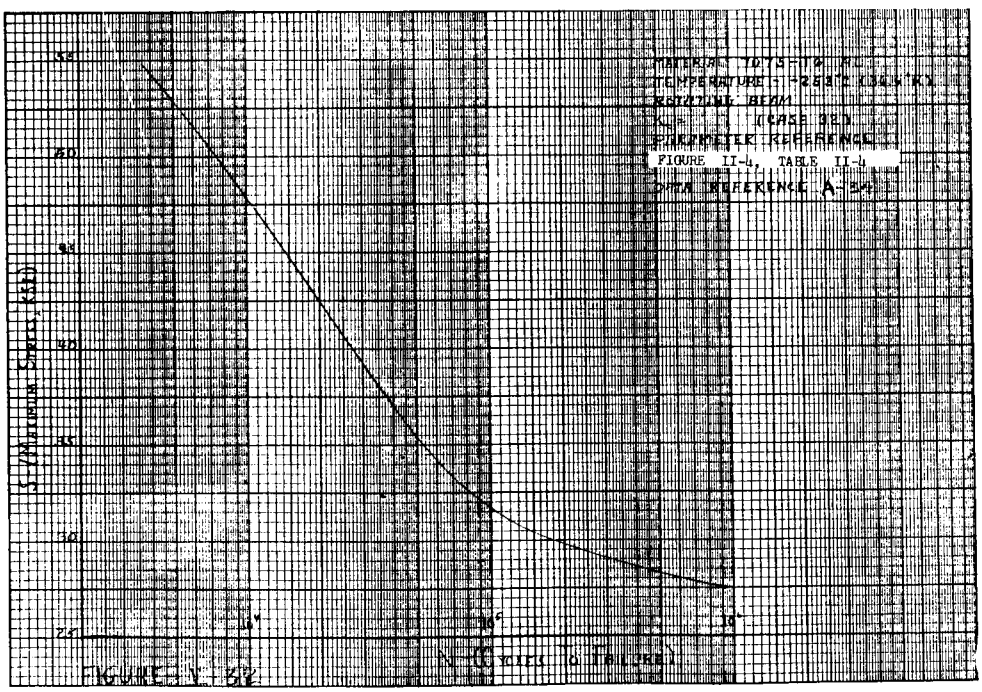


FIGURE V-32

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material QMV Beryllium Condition Hot Pressed + Extruded

Reference Mechanical Properties of Beryllium, p. 20

Reference No. 73 Code No. 78

Date of Tabulation

Tabulated by DS

Checked by RMH

Test Temperature RT Environment Air

Type of Test Axial Load Specimen Data .270" dia.

Type of Data Numerical Surface Finish

Stress Ratio 0.67 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Rieca, A.E., Air Force

Publication WADD TR 60-165

No. References 0

Principal Investigator Rieca

Affiliation

Comments

Mechanical Properties Source:

Same, p. 1

Mechanical Properties:

				Other Properties:
F_{tu}	77.17	ksi	at RT	T.S. 77.17
F_{ty}	43.93	ksi	at RT	E 35.228
E		10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E	7.33		at RT	
% RA			at	
Hardness			at	

S	60.00	58.00	57.00	54.00						
N	5.0E+04	1.0E+05	2.0E+05	1.0E+06						
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation						
S	60.0	57.5	57.0	53.5	52.0	51.5	51.0	56.6	50.9	50.0
N	2.5×10^5	3.8×10^5	7.8×10^5	9.9×10^5	5.1×10^6	6.2×10^5	7.6×10^5	8.9×10^5	1.07×10^6	1.5×10^6
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

a - Best Curve Fit

Parameters: m = 6830

b = -11.187 } C

Comments: 10^6 Cycles

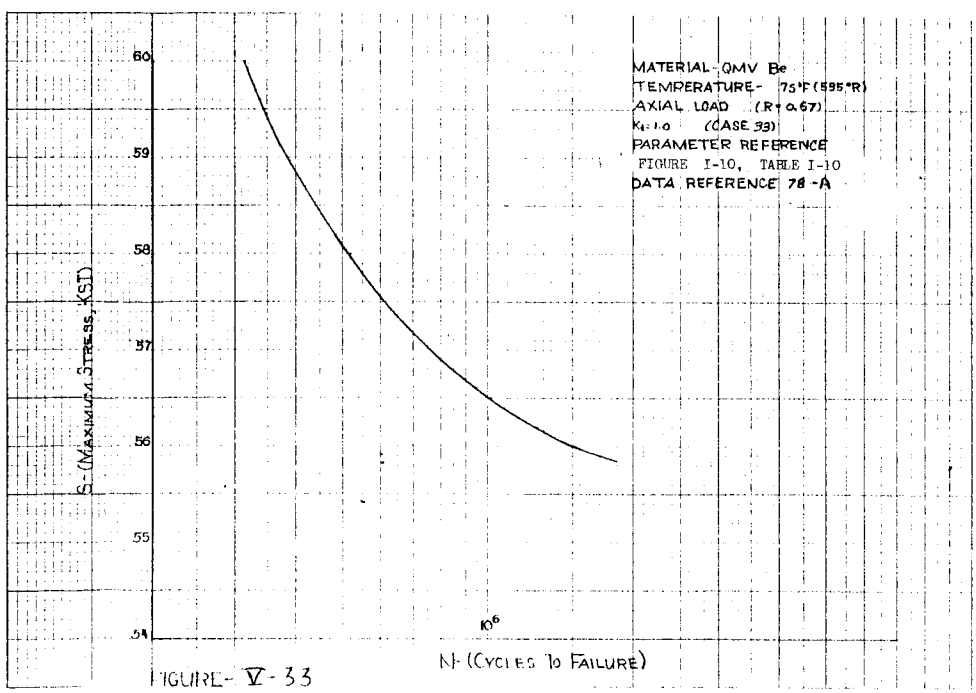


FIGURE - V - 33

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material QMV Beryllium Condition [illegible]

Reference [illegible]

Reference No. 78 Code No. 78

Date of Tabulation

Tabulated by DS

Checked by

Test Temperature 1100°F Environment Air

Type of Test Axial Load Specimen Data [illegible]

Type of Data Numerical Surface Finish

Stress Ratio 0.67 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Rice, A.E., Ault, R.T.

Publication WADD TR-60-765

No. References 0

Principal Investigator Rice

Affiliation

Comments

Mechanical Properties Source:

[illegible]

	1	2	3	4	5	6	7	8	9	10
S	0.0	19.0	15.0	12.0	16.0	12.0	19.0	13.5	13.0	12.5
N	0.5×10⁵	4.8×10⁵	6.0×10⁵	9.1×10⁵	4.1×10⁵	1.5×10⁶	[illegible]	3.00×10⁶	4.1×10⁶	[illegible]
S	12.0									
N	1.2×10⁷									

Parameters: A: 20.531 B: -37.866 } C

Comments: [illegible]

Mechanical Properties:

F_{tu}	20.1 ksi	at 1100°F	
F_{ty}	16.5 ksi	at 1100°F	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:

75°F: [illegible] Ksi

E = 11.199 Ksi

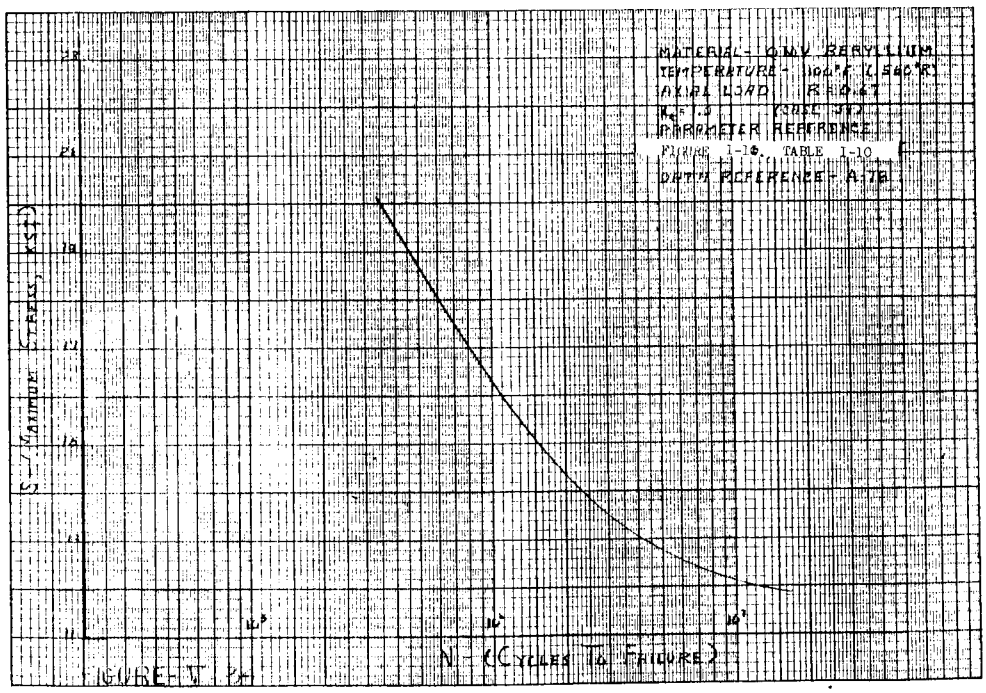


FIGURE 7 P4

TOPIC SAE 4340 Steel

T = RT R = -1.0

TYPE TEST - AXIAL (DESIGN DATA)

TABULATION SHEET

DATE OF TABULATION 8/18/61

TABULATED BY DTS checked by JB

	S	ε'	S-ε'	TS'	TS-ε	TS-ε / S-ε	log TS-ε / S-ε	log TS-ε / S-ε²	N	log N	1/log N	Σx_i^2	Σx_i	$\Sigma x_i y_i$	Σy_i	m	b
1	96	68.415	27.585	158.5	90.085	3.26457	0.5140	-0.2890	10^4	4.0000	0.6021	2.1893	2.4352	0.2469	0.1876	2.2327	-1.5984
2	78		9.585			7.3385	0.8731	-0.3118	10^5	5.0000	0.6990						
3	70		1.585			56.836	1.7546	0.2442	10^6	6.0000	0.7782						
4	70		1.585			56.836	1.7546	0.2442	1.5(10⁷	7.1761	0.9559						
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
18																	
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20																	
21																	
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24																	
25																	
26																	
27																	
28																	
29																	
30																	
31																	
32																	
33																	
34																	
35																	

Ftuc = 158.5 KSI

E = 30.00 $\times 10^6$ PSI

Fatigue Data Ref - AMC-5, March 1955, p. 53.

Mechanical Properties Data - WADC TR 52-325 Pt 1, p. 11.

Parameters by Hand calculator

∴ Intercept b = $\log_{10}[(\log_{10} e) K]$

b = $\log_{10}[0.434 K]$

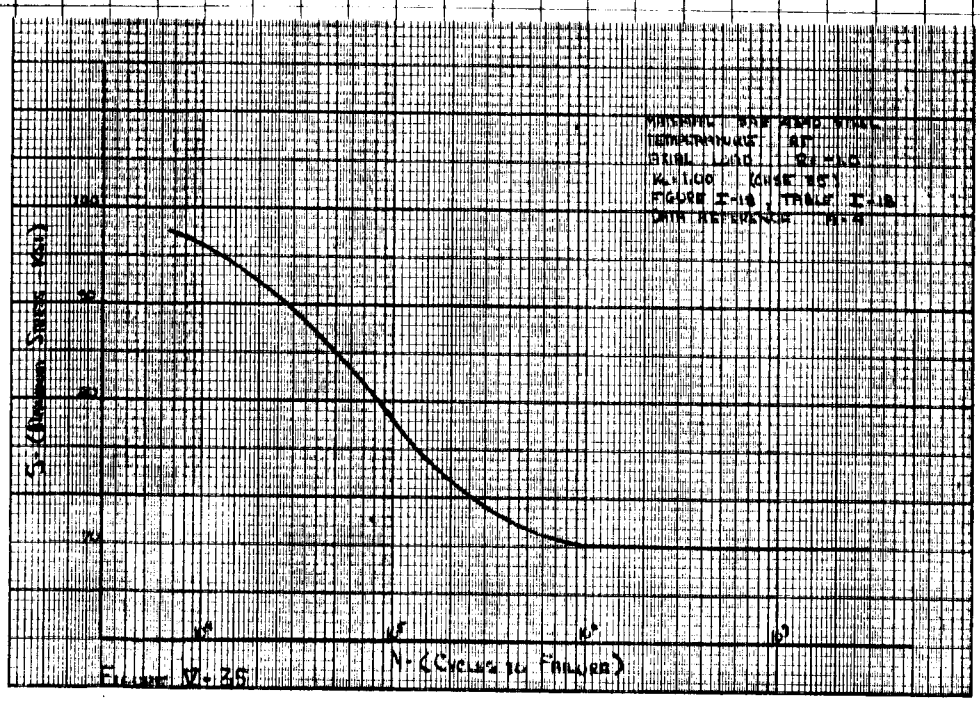


Figure V-25

TOPIC SAE 4340 Steel T = 600 °F R = -1.0 TYPE TEST AXIAL

TABULATION SHEET

DATE OF TABULATION 8-18-61

TABULATED BY RTS check by JB

	S	E'	S-E'	TS'	TS-E'	$\frac{TS-E'}{S-E'}$	$\log\frac{TS-E'}{S-E'}$	$\frac{1}{\log\log\frac{TS-E'}{S-E'}}$	N'	$\log N'$	$\log S'$	Σx_i^2	Σx_i	Σy_i	$\Sigma x_i y_i$	m	b
1	87	63.472	23.528	152.8	89.328	3.7966	0.5794	-0.2360	10×10^4	1.0000	0.6021	2.1713	2.3	1.6020	1.3842	1.3842	1.3842
2	72		8.528			10.475	1.0201	-0.2237	1.0×10^5	5.0000	0.6990						
3	68		4.528			19.728	1.2951	-0.1123	1.0×10^6	6.0000	0.7782						
4	65		1.528			58.461	1.7669	-0.2428	1.5×10^7	7.1761	0.8376						
5																	
6																	
7																	
8																	
9																	
10																	
11																	
12																	
13																	
14																	
15																	
16																	
17																	
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23																	
24																	
25																	
26																	
27																	
28																	
29																	
30																	
31																	
32																	
33																	
34																	
35																	

Fatigue Data Ref - ANC-5, March 1955, p. 54.

Mechanical Properties Ref - WADC TR-52-325 Pt 1, p. 11.

F_{TU} = 152,80

E = 26.49 X 10^6 psi

Parameters by Hand Calculator

∴ Intercept $b = [\log_{10}[(\log_e e)\,K]$

$b = \log_{10}[0.434\,K]$

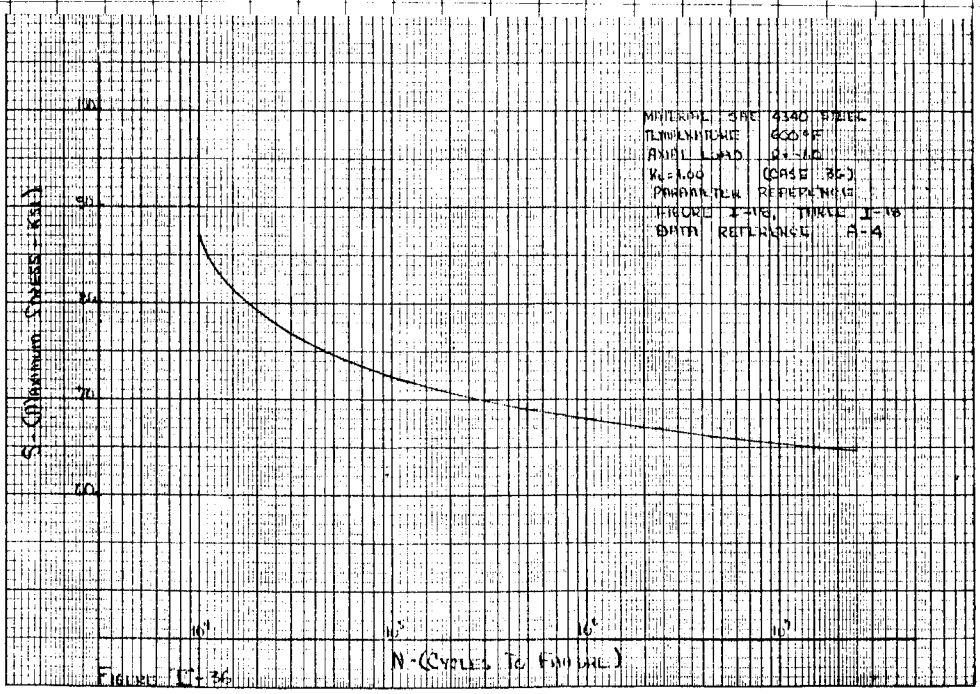


FIGURE I-36

TOPIC SAE 4340 Steel T = 800°F R = -1.0

TABULATION SHEET

DATE OF TABULATION 9/19/61 37

TABULATED BY DTS Checked by JB

TYPE TEST - AXIAL (DESIGN DATA)

	S	E'	S-E'	TS'	TS-E'	$\frac{TS-E'}{S-E'}$	$\frac{\log TS-E'}{S-E'}$	$\frac{\log\log TS-E'}{S-E'}$	N	log N	log log N	Σx_i	Σx_i^2	$\Sigma x_i y_i$	Σy_i	m	b
1	86.0	58.75	27.25	125.0	66.25	2.4311	0.3858	-0.4136	10^0	1.0000	0.0000	2.1873	2.7352	-0.0913	-0.1735	2.4270	1.4197
2	70.0		11.25			5.8889	0.7700	-0.1135	10^3	3.0000	0.4771						
3	62.0		3.25			20.385	1.3093	0.1170	10^5	5.0000	0.7782						
4	60.0		1.25			53.000	1.7243	0.2366	1.5×10^7	7.1761	0.8559						

Fatigue Data Ref. - ANC-5 March 1955, p. 54.

Mechanical Properties Ref. - WADC TR 52-325 Pt I, p. 11.

F_{TU} = 125.0 KSI

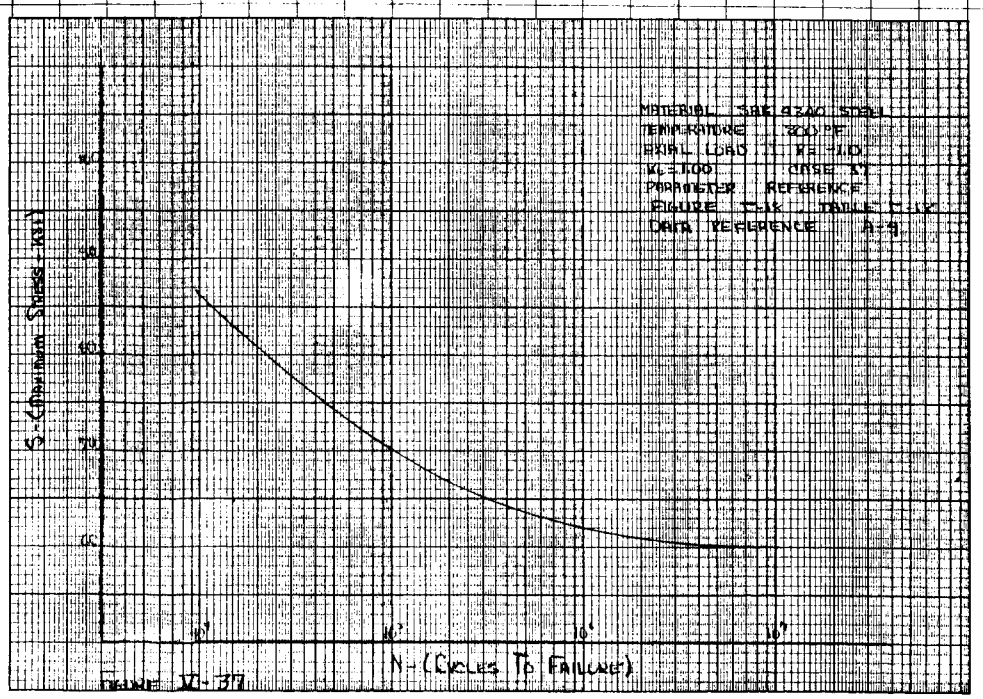
E = 23.98 $\times 10^6$

Parameters by Hand Calculator

Intercept $b = \log_{10}[(\log_e e)K]$

$b = \log_{10}[0.434\,K]$

FIGURE I-18, Table I-18



TOPIC SAE 4340 Steel

T = 1000°F R = -1.0

TYPE TEST - AXIAL (DESIGN DATA)

TABULATION SHEET

DATE OF TABULATION

TABULATED BY GTS checked by JG

	S	ε'	S-ε'	TS'	TS-ε'	TS-ε'/S-ε'	log TS-ε'/S-ε'	log log TS-ε'/S-ε'	N	ln N	log log N	Σx_i	$\Sigma x_i y_i$	$\Sigma x_i y_i$	Σy_i	m	b
1	61	38.193	22.807	80.7	42.507	1.8637	0.2704	-0.5680	10^4	1.0000	0.6021						
2	54		15.807			2.6891	0.4296	-0.3669	10^5	5.0000	0.6990						
3	42		3.807			11.165	1.0479	0.0203	10^6	6.0000	0.7782						
4	39		0.807			52.673	1.7216	0.2359	1.5×10^7	7.1761	0.8559						

Fatigue Data Ref.- ANC-5, March 1955, P 54.

Mechanical Properties Ref.- WADC-TR 52-325 Pt. 1, p. 11.

F_{TU} = 80.7 KSI

E = 19.98×10^6 psi

PARAMETERS By Hand Calculator

∴

Intercept $b = \log_{10}\left[(\log_{10} e)\, K\right]$

$b = \log_{10}\left[0.434\, K\right]$

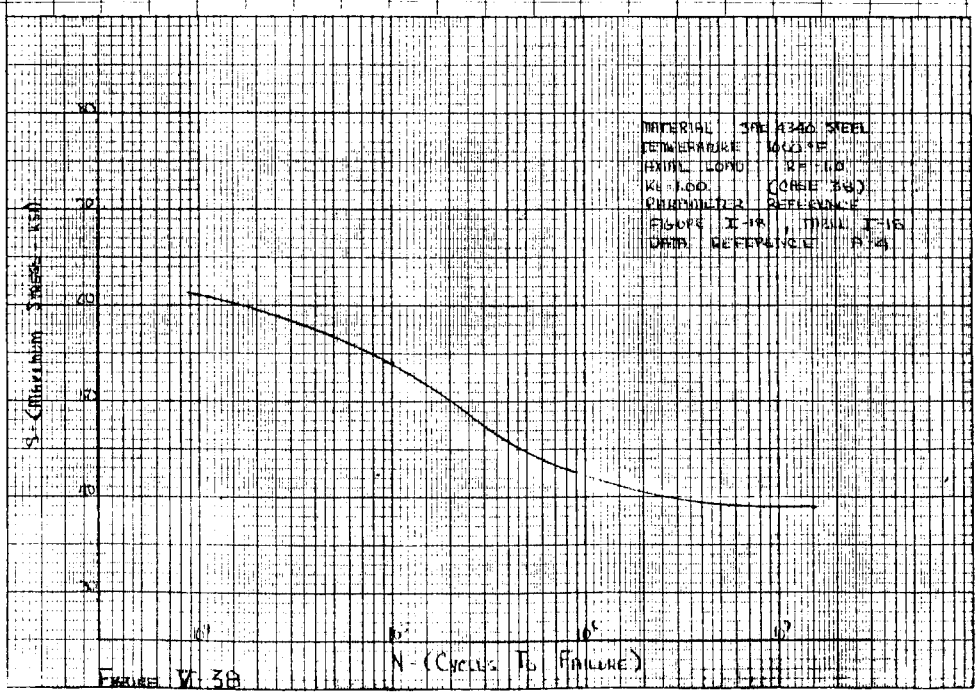


FIGURE VI-38

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Austenitic Cast Iron Condition as cast

Reference NAVAER 00-25-531, p.277

Reference No. 42 Code No. 41

Date of Tabulation

Tabulated by CB

Checked by BF

Test Temperature RT Environment Air

Type of Test Rotating Beam Specimen Data 0.30d

Type of Data Design Surface Finish

Stress Ratio = 1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Grover, H.J., Gordon, S.A., and Jackson, L.R.

Publication Fatigue of Metals and Structures NAVAER 00-25-534 p.277

No. References

Principal Investigator Author

Affiliation

Comments

Mechanical Properties Source:

same

Mechanical Properties:

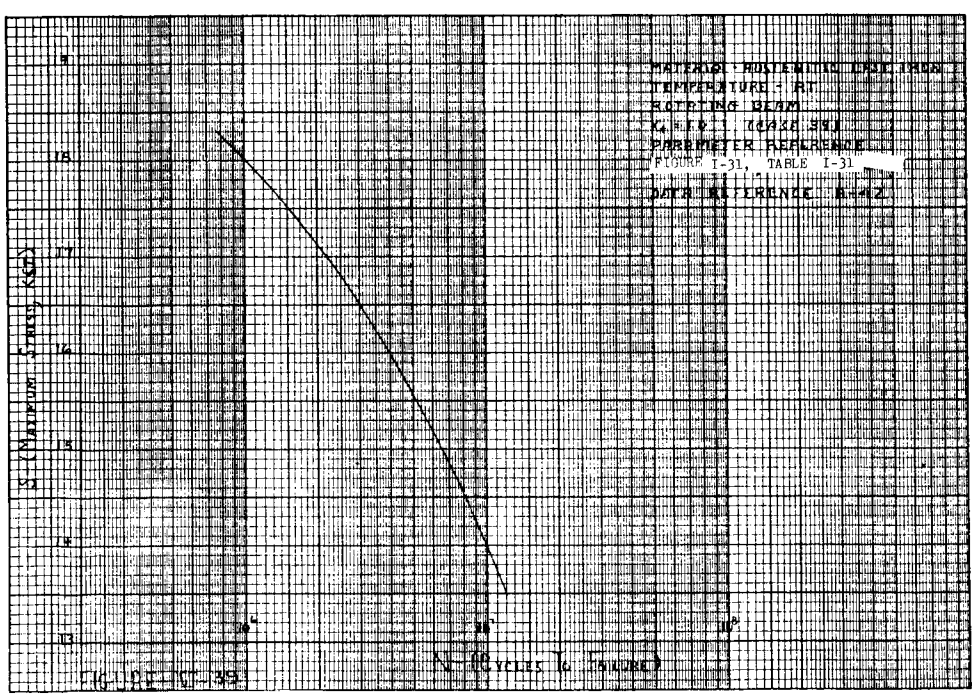
				Other Properties:
F_{tu}	85.0	ksi	at RT	75': 61.2 Ksi
F_{ty}		ksi	at	E' = 12,888 Ksi
*E	20.0	10^3 ksi	at RT	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

	1	2	3	4	5	6	7	8	9	10
S*	18,000	16,000	14,000							
N	1×10^6	9.0×10^5	1.0×10^7							
S										
N										
S										
N										
S										
N										
S										
N										
S	18.0	17.5	17.0	16.5	16.0	15.5	15.0	14.5	14.0	13.5
N	1.0×10^6	1.52×10^6	2.2×10^6	3.0×10^6	4.0×10^6	5.1×10^6	6.5×10^6	8.0×10^6	1.0×10^7	1.2×10^7
S										
N										
S										
N										
S										
N										
S										
N										

Data Correlation Ksi

Parameters: m = 3.727, b = -5.958 } C

Comments:
1. P.O.L. cycles
2. Estimated from Met. Hand'b'k
3. Poor data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Austenitic Cast Iron Condition
Reference NAVAER 00-25-534, p277
Reference No. 42 Code No. 47

Test Temperature 400°F Environment
Type of Test Rotating Beam Specimen Data
Type of Data Design Surface Finish
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Grover, H.J., Gordon, S.A., and Jackson, L.R.
Publication Fatigue of Metals and Structures
NAVAER 00-25-534, p277
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Same

Mechanical Properties:

F_{tu} 31.0	ksi	at [illegible]	
F_{ty}	ksi	at	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:
T_S^1 = 52.76 ksi
E^1 = 16.456 ksi
T_S^1 = 52.76 ksi
E^1 = 16.47 ksi

Date of Tabulation
Tabulated by QB
Checked by PMD

	1	2	3	4	5	6	7	8	9	10
S	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
N	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation						
S	31.0	27.5	20.0	17.5	17.0	18.5	18.0	17.6	17.2	17.1
N	1.0×10^4	$1.[illegible]\times10^4$	$1.[illegible]\times10^4$	1.9×10^4	$[illegible]\times10^4$	3.1×10^4	3.9×10^4	5.6×10^4	8.1×10^4	1.4×10^5
S	17.0									
N	2.5×10^5									
S										
N										
S										
N										
S										
N										

Parameters: m = 2.617, b = -2.878 } C

Comments: 4 (?) Cycles
Too few data points

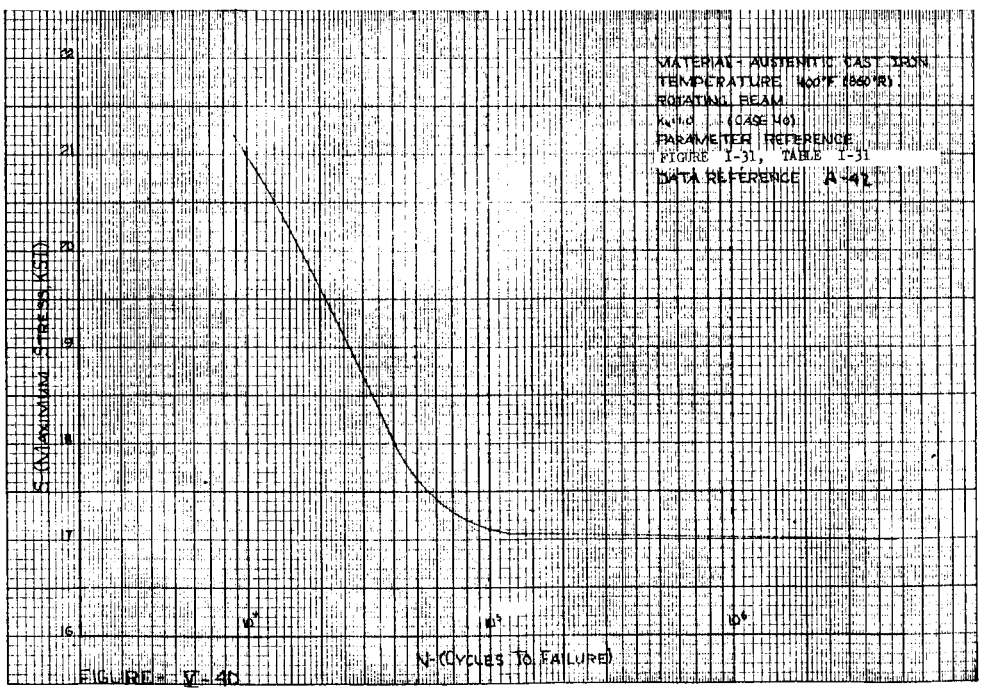


FIGURE - V-40

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Austenitic Cast Iron Condition

Reference NAVAER 00-25-534 p.277

Reference No. 42 Code No. 41

Test Temperature 700°F Environment air

Type of Test Rotating Beam Specimen Data [illegible]

Type of Data Design Surface Finish

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Grover, H. J., Gordon, S. A., and Jackson, L. R.

Publication Fatigue of Metals and Structures NAVAER 00-25-534 p.277

No. References

Principal Investigator Author

Affiliation

Comments

Mechanical Properties Source:

None

Mechanical Properties:

F_{tu}	80 ksi	at 700°	
F_{ty}	ksi	at	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:

Date of Tabulation

Tabulated by CS

Checked by

S/N	1	2	3	4	5	6	7	8	9	10
S	[illegible]	18,500	17,000	15,000	15,000					
N	[illegible]	1.0×10^5	1.5×10^5	9.0×10^5	1×10^7					
S										
N										
S										
N										
S										
N										
S										
N										
S			Data Correlation, Ksi							
N	21.0 1.0×10^5	20.0 1.2×10^5	17.0 3.15×10^5	15.0 6.0×10^5	13.0 9.0×10^5	11.0 1.5×10^6	10.5 2.0×10^6	10.1 3.0×10^6	10.0 4.0×10^6	10.0 5.0×10^6
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: $m = 5.153$, $b = -4.559$ } C

Comments: Poor data — too few points

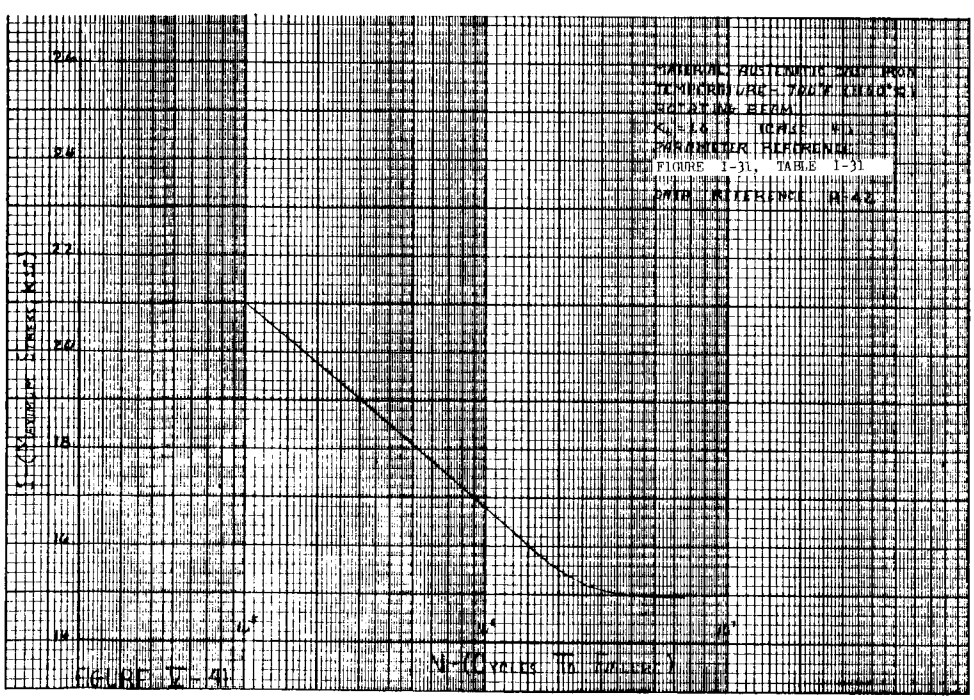


FIGURE I-41

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Austenitic Cast Iron Condition [illegible]
Reference NAVAER [illegible]
Reference No. 42 Code No. 4

Test Temperature 900°F Environment Air
Type of Test Rotating Beam Specimen Data [illegible]
Type of Data Design Surface Finish
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author [illegible]
Publication Fatigue of Metals [illegible]
NAVAER [illegible]
No. References
Principal Investigator [illegible]
Affiliation
Comments

Mechanical Properties Source:

Mechanical Properties:

F_{tu}	26.0 ksi	at	700°
F_{ty}	ksi	at	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

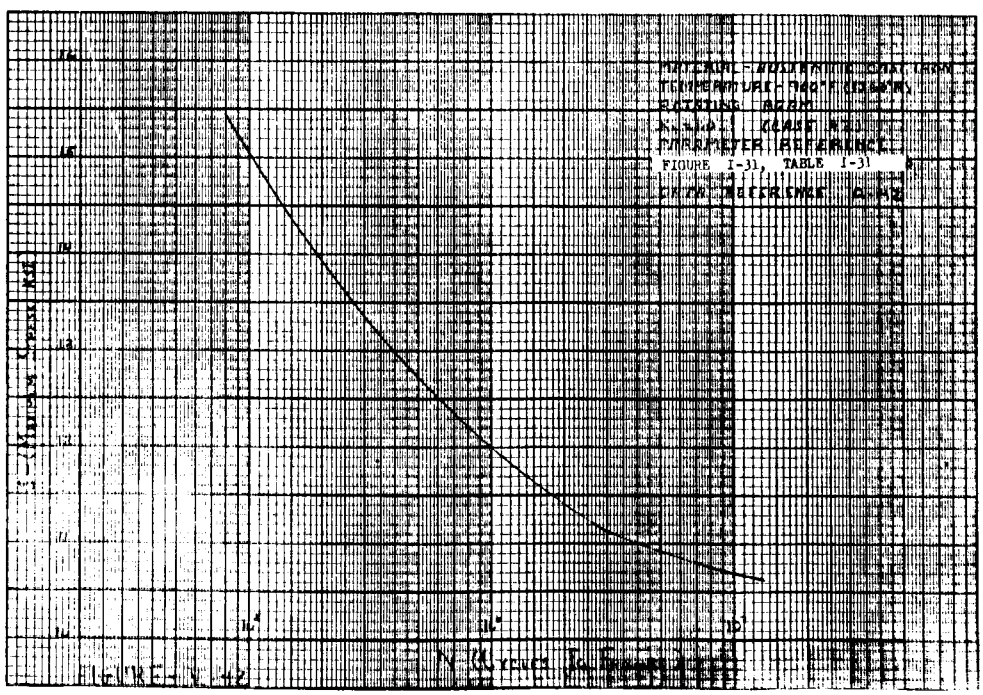
Other Properties:
[illegible] ksi
E' = 10,241 [illegible]

Date of Tabulation
Tabulated by QB
Checked by [illegible]

	1	2	3	4	5	6	7	8	9	10
S	[illegible]	[illegible]	12,000	12,000	10,000					
N	[illegible]	[illegible]	1.0×10^6	[illegible]	1.0×10^7					
S										
N										
S										
N										
S										
N										
S										
N				Data Curve Fitting Key						
S	12.0	14.5	14.0	13.5	13.0	11.5	12.0	11.5	11.0	[illegible]
N	1.0×10^6	1.3×10^6	1.7×10^6	2.15×10^6	[illegible]	6.1×10^5	1.0×10^6	1.9×10^6	[illegible]	1.0×10^7
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: A 2.322
b -3.052 } C

Comments: [illegible]
Poor data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Austenitic Cast Iron Condition [illegible]
Reference [illegible]
Reference No. 42 Code No. 41

Test Temperature 1160° F Environment [illegible]
Type of Test Rotating Beam Specimen Data .330" dia.
Type of Data Design Surface Finish
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Grover, H.J., Gordon, S.A., and Jackson, L.R.
Publication Fatigue of Metals and Structures
NAVAER 00-25-534, p. 217
No. References
Principal Investigator Author
Affiliation
Comments

Mechanical Properties Source:
Same

Mechanical Properties:
F_{tu} 20.0 ksi at 1160°
F_{ty} ksi at
E 10^3 ksi at
G 10^3 ksi at
μ at
% E at
% RA at
Hardness at

Other Properties:
~~S_u = 39.85 ksi~~
~~Elevated~~
B' = 34.00
E' = 11.60 Final

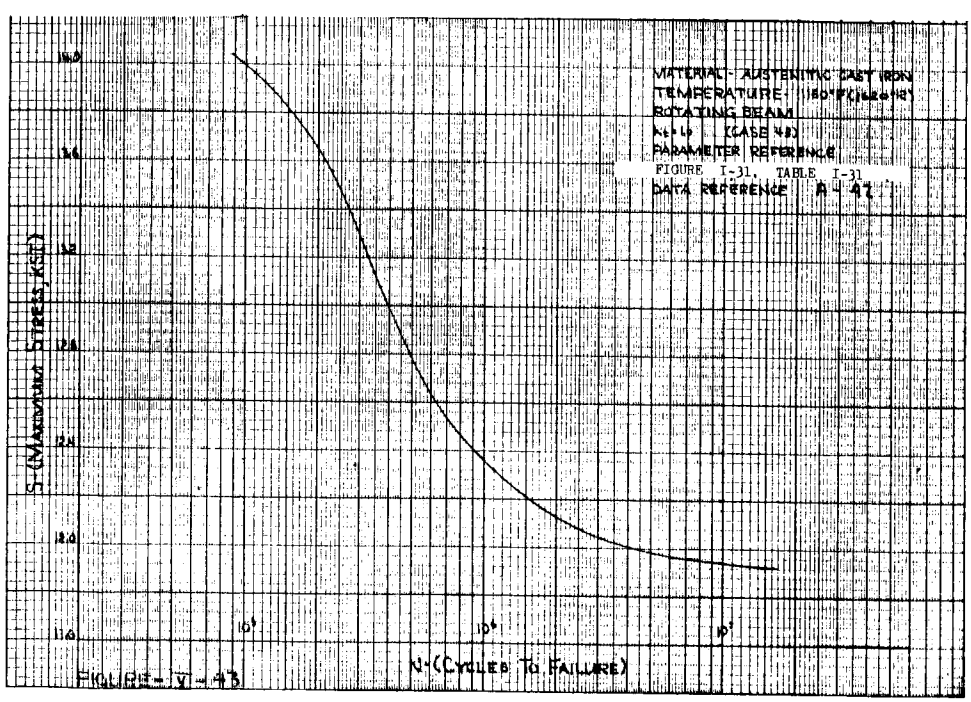
Date of Tabulation
Tabulated by CB
Checked by Bmc

	1	2	3	4	5	6	7	8	9	10
S	[illegible]	[illegible]	12,000	[illegible]	17,000					
N	[illegible]	[illegible]	1.0×10^5	[illegible]	1.5×10^5					
S										
N										
S										
N										
S										
N										
S										
N										
S	17.6	13.8	13.6	13.9	12.0	[illegible]	12.3	12.2	12.1	12.0
N	[illegible]	1.7×10^5	2.2×10^5	[illegible]	3.9×10^5	[illegible]	6.5×10^5	8.7×10^5	[illegible]	9.0×10^6
S										
N										
S										
N										
S										
N										
S										
N										

Data Correlation Key

Parameters: m = 2.638
b = -3.489
} C

Comments: [illegible]
Too few data points —



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material HK31A-H24 Magnesium Condition
Reference Al, Mg Alloys, Notebook 2
Reference No. 6 Code No. 113

Date of Tabulation
Tabulated by DS
Checked by

Test Temperature RT Environment Air
Type of Test Axial Load Specimen Data .071 sheet
Type of Data Points Surface Finish
Stress Ratio 0.25 Stress Concentration Factor
Mean Stress Notch Description

Fatigue Data Source:
Author Dow Chemical - Unpublished
Publication Aluminum, Magnesium Alloys Notebook No. 2
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Aluminum, Magnesium Alloys Notebook 2

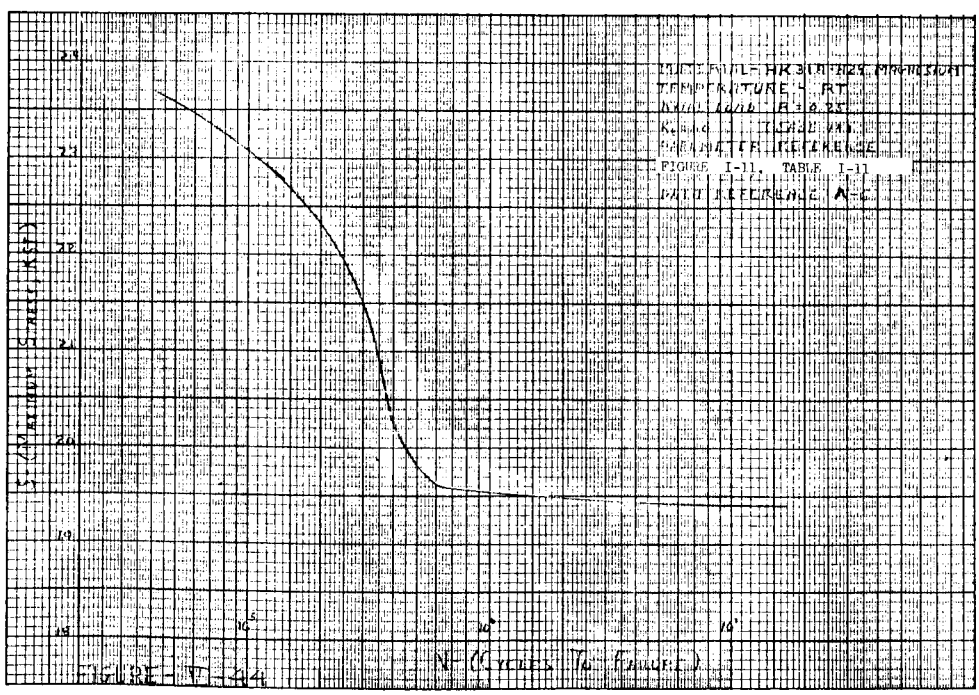
S/N	1	2	3	4	5	6	7	8	9	10
S				Data Correlation (K: Log-Log)						
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 4.565
C = -6.924

Comments:

Mechanical Properties:

			Other Properties:
F_{tu}	37.0 ksi	at 70°F	TS = 37.0 Ksi
F_{ty}	29.0 ksi	at 70°F	YS = 29.0 Ksi
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material HK31A - H24 Magnesium Condition
Reference Al, Mg, Alloys Notebook 2
Reference No. 6 Code No. 113

Test Temperature 400°F Environment Air
Type of Test Axial Load Specimen Data
Type of Data Points Surface Finish
Stress Ratio 0.25 Stress Concentration Factor
Mean Stress Notch Description

Fatigue Data Source:
Author Dow Chemical - unpublished
Publication Aluminum, Magnesium Alloys Note book No. 2
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Al, Mg Alloys Notebook No. 2

Mechanical Properties:

F_{tu}	41.0 ksi	at 400°F	
F_{ty}	31.0 ksi	at 400°F	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:
T_{tu} 43.0 Ksi
E' 9.76 Ksi

Date of Tabulation
Tabulated by DS
Checked by MH

	1	2	3	4	5	6	7	8	9	10
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S				Data Correlation (KSI, Cycles)						
N										
S	42.0	38.5	38.0	37.5	37.0	36.0	35.0	34.0	33.0	32.0
N	2.3×10^4	4.2×10^4	2.1×10^5	3.2×10^5	5.2×10^5	8.1×10^5	1.1×10^6	1.79×10^6	1.68×10^6	2.1×10^6
S	41.0	40.5	39.0							
N	2.7×10^4	5.1×10^4	1.3×10^5							
S										
N										
S										
N										

Parameters: m = 7.401
b = -13.072
} C

Comments:

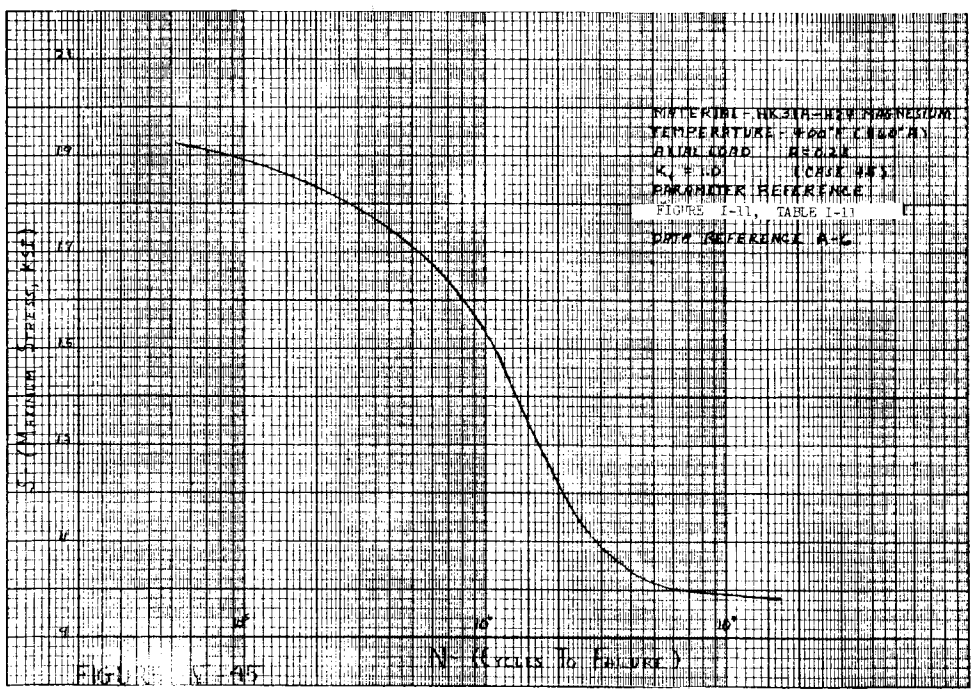


Fig. I-45

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-3Al-5Cr Condition Hot-rolled and cleaned

Reference NACA RM 56B07, p.3

Reference No. 77 Code No. 26

Date of Tabulation

Tabulated by CB

Checked by RMH

Test Temperature RT Environment Air

Type of Test Krouse Rotating-Beam Specimen Data 0.271 in. min. dia. bar

Type of Data Numerical Surface Finish Polish

Stress Ratio -1 Stress Concentration Factor 1.0

Mean Stress Notch Description

	1	2	3	4	5	6	7	8	9	10
S	99,830	78,240	77,000	67,280	95,020	94,460	94,300	94,090	99,090	98,870
N	16,800	19,600	23,200	34,400	29,000	57,100	105,220	1,012,000	12,786,580[2]	57,400
S	72,440	91,720	91,480	71,450	71,060	70,710	87,120	81,220		
N	1,093,200[2]	66,300	65,400	54,600	54,257,300[2]	13,466,900[2]	13,093,320[2]	21,322,900[2]		
S										
N										
S										
N	Correlation Data:			P.2						
S	28,400	98,000	97,500	97,000	94,000	25,200	94,000	23,500	23,000	22,600
N	17,000	20,400	24,500	28,700	34,000	42,000	48,000	53,000	63,000	100,000
S	92,400	92,240	92,000							
N	135,000	220,000	360,000							
S										
N										
S										
N										
S										
N										
S										
N										

2 Did not fail

Fatigue Data Source:

Author Reig, William K.

Publication NACA RM 56B07

p. 9

No. References 1

Principal Investigator Arthur

Affiliation AE Professor University of Alabama

Comments

Mechanical Properties Source:

NACA RM 56B07

p. 3

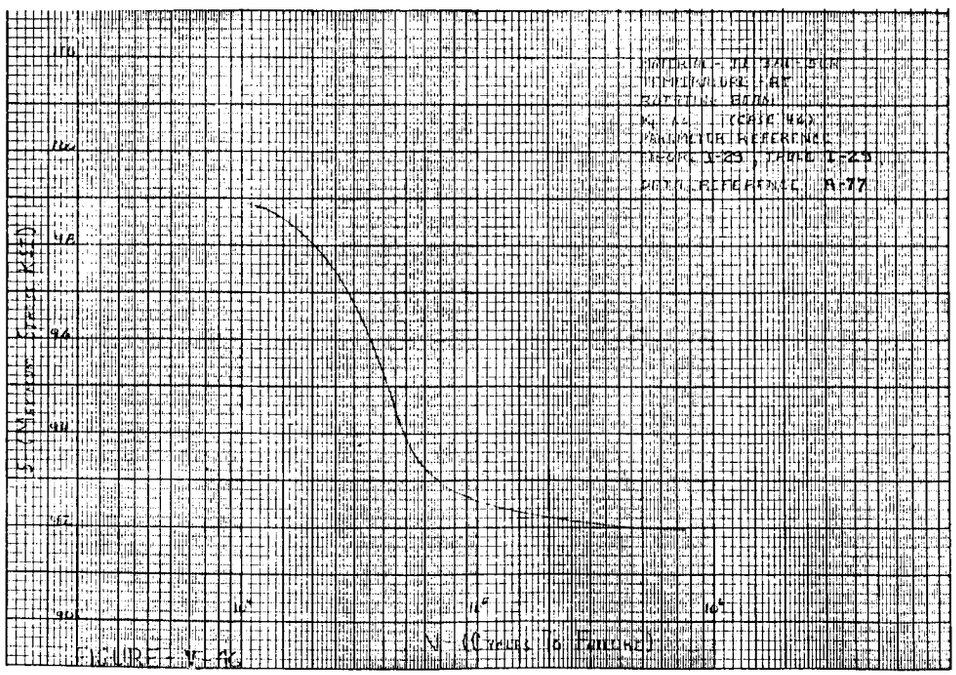
Mechanical Properties:

				Other Properties:
F_{tu}	140.8	ksi	at RT	TS = 139,400 Psi
F_{ty}	125.3	ksi	at RT	E' = 83,610 Psi
E	15.5	10^3 ksi	at RT	
G		10^3 ksi	at	
μ			at	
% E*	21.0		at RT	
% RA	57.8		at RT	
Hardness*2	35.5C		at RT	

Parameters: m = 1.458, b = -1.035 } C

*Comments: 1 Percent elongation is 1 inch.

2 Rockwell C hardness



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-3Al-5Cr Condition Hot-rolled and ground

Reference NACA RM 56B07, p.3

Reference No. 77 Code No. 26

Test Temperature 200°F Environment Air

Type of Test Krause rotating-beam Specimen Data 0.271 in. minimum dia. bar

Type of Data Numerical Surface Finish Polish

Stress Ratio -1 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Reg, William K.

Publication NACA RM 56B07 p. 9

No. References

Principal Investigator Author

Affiliation AE Professor, University of Alabama

Comments

Mechanical Properties Source:

NACA RM 56E07 p.3

Mechanical Properties:

				Other Properties:
F_{tu}	140.8	ksi	at RT	TS: 239,360 psi
F_{ty}	125.3	ksi	at RT	E' = 82,392 ksi
E	15.5	10^3 ksi	at RT	
G		10^3 ksi	at	
μ			at	
% E	21.0		at RT	
% RA	57.8		at RT	
Hardness	35.5 C		at RT	

Date of Tabulation

Tabulated by DS

Checked by RH

	1	2	3	4	5	6	7	8	9	10
S	72,850	70,150	81,280	87,650	87,220	84,000	85,860	85,770	85,770	85,490
N	58,300	72,120	84,300	45,900	112,700	57,000	75,600	65,700	77,100	184,200
S	55,270	85,000[a]	84,860	84,760	84,490	54,010				
N	57,500	14,160,300	71,500	101,549,200[a]	51,800	104,530,400[a]				
S										
N										
S										
N	Correlation Data:		Psi							
S	93,000	92,000	91,000	90,000	83,000	88,000	87,000	86,000	85,000	84,600
N	28,000	33,000	40,000	43,000	60,000	76,000	101,000	146,000	257,000	395,000
S	84,200	84,000								
N	740,000	1,200,000								
S										
N										
S										
N										
S										
N										
S										
N										

a Did not fail

Parameters: m = 1.780, b = -1.635 } C

Comments:

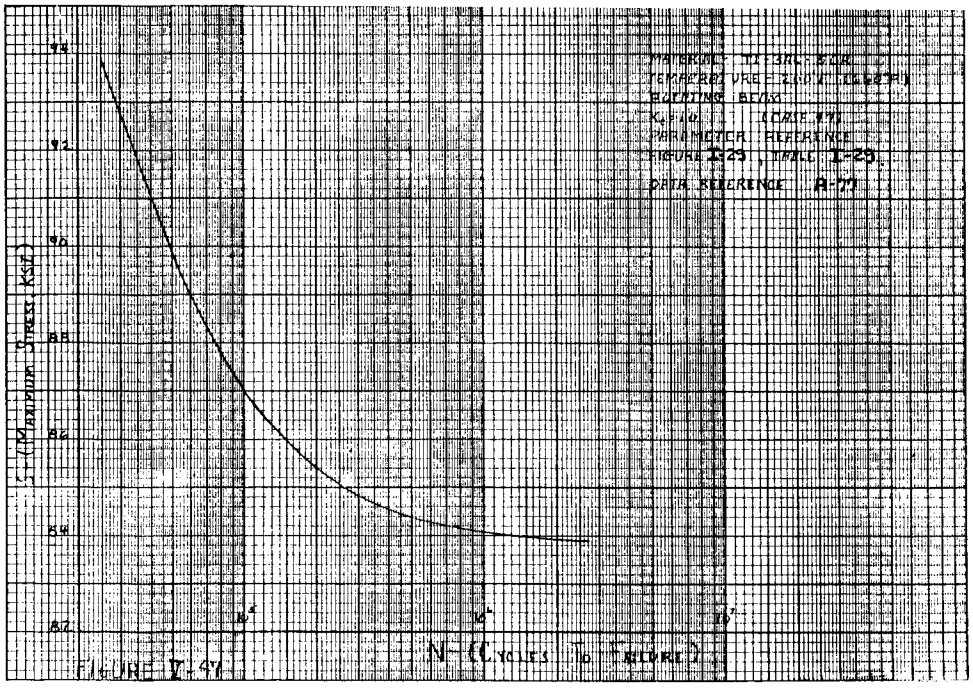


FIGURE V-47

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-3Al-5V Condition Heat-treated and aged

Reference NACA RM 56B07 p. 3

Reference No. 77 Code No. 26

Date of Tabulation

Tabulated by DS

Checked by

Test Temperature 400°F Environment Air

Type of Test Krouse rotating-beam Specimen Data 0.271 in. minimum bar dia.

Type of Data Numerical Surface Finish Polish

Stress Ratio -1 Stress Concentration Factor 1.0

Mean Stress Notch Description

	1	2	3	4	5	6	7	8	9	10
S	97,500	91,500	84,810	84,650	83,870	92,250	91,110	63,970	80,250	77,906
N	23,000	36,830	72,533	45,200	27,200	72,400	65,200	25,200	97,772,400[a]	2,284,400
S	74,230	75,550	75,030	74,320	73,240					
N	2,072,330	22,286,133[a]	12,757,583[a]	14,082,202[a]	13,498,332[a]					
S										
N										
S										
N	Correlation Data:			1'24						
S	88,000	87,000	84,000	85000	84,000	83,000	82,000	81,600	81,400	81,200
N	19,000	25,000	29,200	33,000	37,000	42,500	56,000	68,000	82,000	135,000
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

a Did not fail

Fatigue Data Source:

Author Reg, William K.

Publication NACA RM 56B07 p. 9

No. References

Principal Investigator Author

Affiliation AE Professor, University of Alabama

Comments

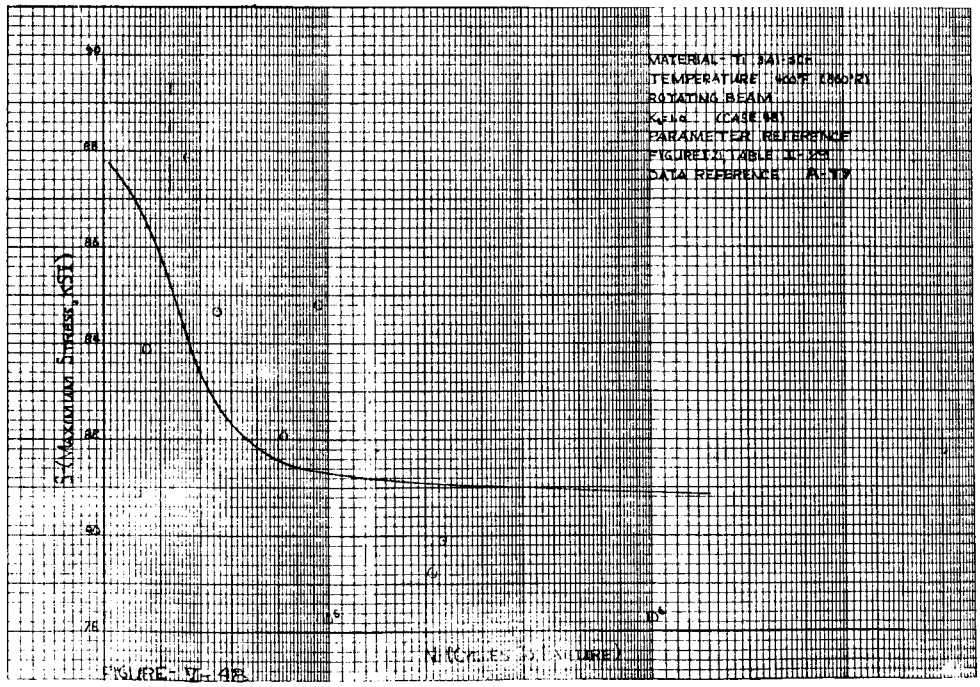
Mechanical Properties Source:

Mechanical Properties:

				Other Properties:
F_{tu}	135.0	ksi	at 400°F	Ts: 221,000 psi
F_{ty}		ksi	at	E: 79,650 psi
E		10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Parameters: m = 2.973 } C
b = -3.261

Comments:



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-6Al-5Zr Condition Hot rolled + Aged

Reference NACA RM E57K07 p10

Reference No. 77 Code No. 26

Date of Tabulation

Tabulated by DS

Checked by RJS

Test Temperature 600°F Environment Air

Type of Test Krause rotating-beam Specimen Data 0.270 in minimum dia. bar

Type of Data Numerical Surface Finish R.M.S.

Stress Ratio -1 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Roy, William K.

Publication NACA RM E57K07 p10

No. References

Principal Investigator Adler

Affiliation Asst Professor, University of Alabama

Comments

Mechanical Properties Source:

Reactive Metals, Inc. by private communication

Mechanical Properties:

				Other Properties:
F_{tu}	117.5 ksi	at	600°F	TS = 119,750 psi
F_{ty}	92.0 ksi	at	600°F	E = 62,725 ksi
E	14.1 10^3 ksi	at	600°F	
G	10^3 ksi	at		
μ		at		
% E in 1"	22.0	at	600°F	
% RA	70.2	at	600°F	
Hardness		at		

	1	2	3	4	5	6	7	8	9	10
S	76,110	74,070	75,700	75,200	74,930	74,600	74,240	74,140	74,020	73,9[illegible]
N	6,587,100	143,300	37,630	7,400	443,500	98,300	4,587,000	4,325,300	34,900	[illegible]
S	73,027	73,520	72,260	71,750						
N	13,043,100	46,405,000	12,146,900	13,225,000						
S										
N										
S										
N	Correlation Data: P.E.									
S	76,000	75,500	75,000	74,500	74,000	73,900	73,800	73,700	73,600	73,500
N	38,000	42,000	68,000	107,000	285,000	410,000	660,000	1,130,000	2,300,000	6,000,000
S										
N										
S										
N										
S										
N										
S										
N										

2. did not fail

Parameters: m = 0.208, b = -0.551 } C

Comments:

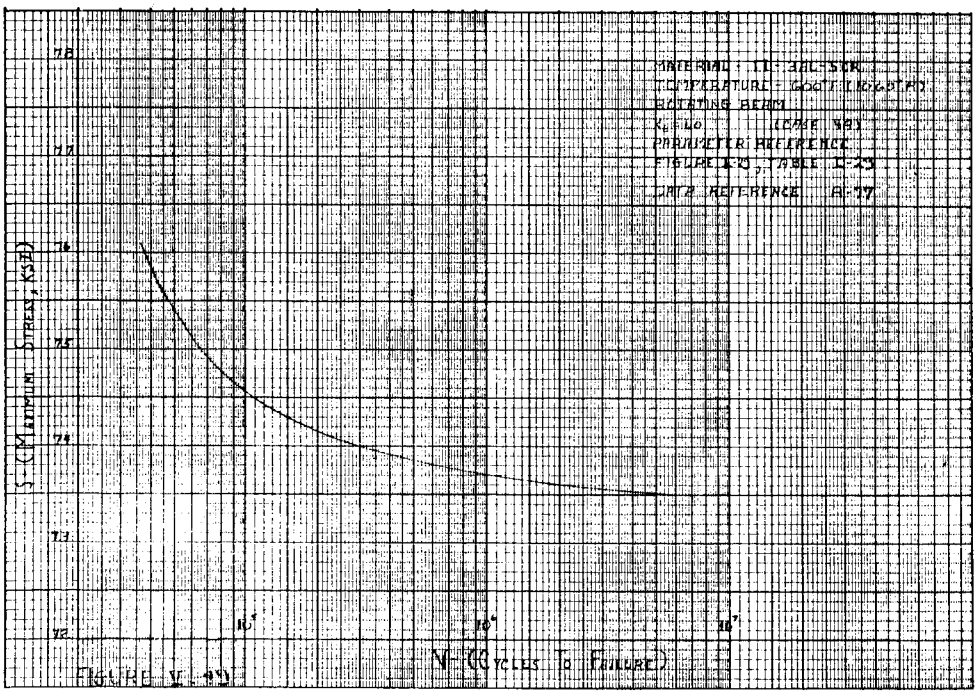


FIGURE V-49

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti - 3Al-5Cr Condition Hot-rolled and annealed

Reference NACA RM 56B07

Reference No. 77 Code No. 26

Test Temperature 800°F Environment Air

Type of Test Krause rotating-beam Specimen Data 0.271 in. minimum diameter

Type of Data Numerical Surface Finish Polish

Stress Ratio -1 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Reg. William K

Publication NACA RM 56B07 p.10

No. References

Principal Investigator Author

Affiliation AE Professor, University of Alabama

Comments

Mechanical Properties Source:

Reactive Metals, Inc. private communication

Mechanical Properties:

F_{tu}	111.0 ksi	at	800°F
F_{ty}	75.0 ksi	at	800°F
E	13.0 10^3 ksi	at	800°F
G	10^3 ksi	at	
μ		at	
% E 1"	24.0	at	800°F
% RA	78.0	at	800°F
Hardness		at	

Other Properties:

TS: 188,700 P_{sc}

E: 60,213 P_{sc}

Date of Tabulation

Tabulated by DS

Checked by PRA

	1	2	3	4	5	6	7	8	9	10
S	74,000	72,970	71,970	71,000	70,040	69,070	68,970	67,960	67,000	66,570
N	40,300	22,000	27,700	25,600	76,600	19,100	22,800	57,100	26,600	166,000
S	65,970	64,000	64,970	64,010	63,500	63,010	62,510	61,990		
N	32,600	149,400	182,000	78,500	90,400	271,200	1,852,200[a]	4,996,500		
S										
N										
S										
N										
S	Correlation Data: P_{sc}									
N										
S	74,000	73,000	72,000	71,000	70,000	69,000	68,000	67,000	66,000	65,000
N	17,500	20,100	23,600	27,900	33,000	40,000	49,000	62,000	79,000	106,000
S	64,000	63,000	62,500	62,200						
N	150,000	230,000	420,000	3,000,000						
S										
N										
S										
N										
S										
N										
S										
N										

a did not fail

Parameters: m = 1.706, b = -1.612 } C

Comments:

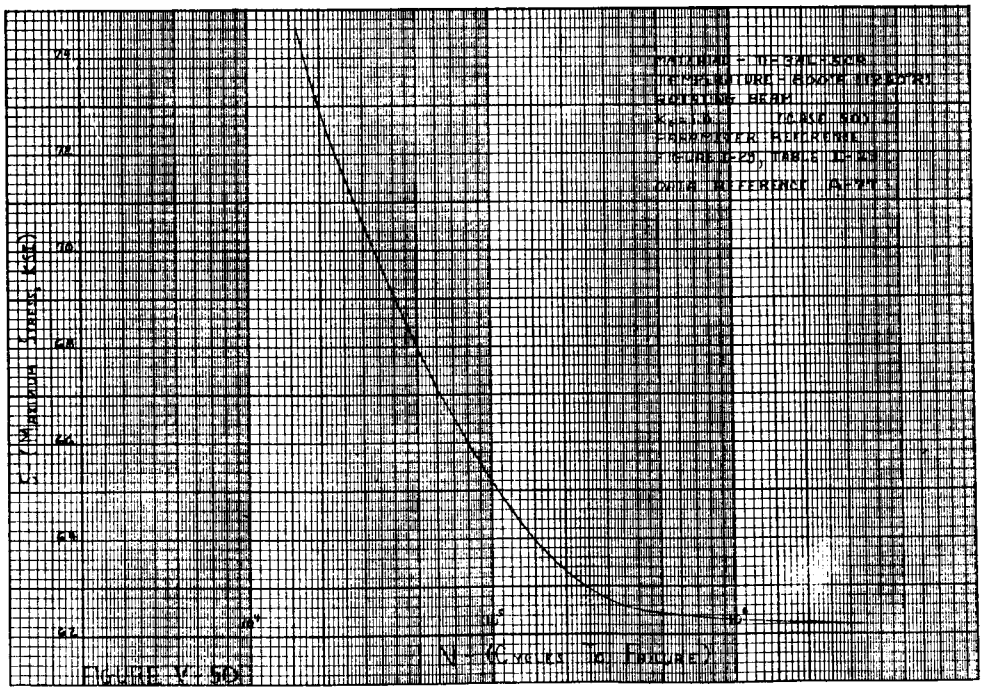


FIGURE V-50

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-3Al-5Cr Condition Notched at K_t = 3.1

Reference NACA RM 56B07

Reference No. 77 Code No. 26

Date of Tabulation

Tabulated by DS / CB

Checked by RAD

Test Temperature 1000°F Environment Air

Type of Test Krause rotating-beam Specimen Data 0.221 inch minimum diameter

Type of Data Numerical Surface Finish Polished

Stress Ratio Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Reg, William K.

Publication NACA RM 56B07

p. 10

No. References

Principal Investigator Author

Affiliation AE Professor, University of Alabama

Comments

Mechanical Properties Source:

Mechanical Properties:

				Other Properties:
F_{tu}	106.0	ksi	at 1000°F	TS' = 180,000 psi (RMM)
F_{ty}		ksi	at	E' = 46,200 ksi (RMM)
E		10^3 ksi	at	
G		10^3 ksi	at	TS' = 180.20
μ			at	E' = 46.20 (RMM)
% E			at	
% RA			at	
Hardness			at	

	1	2	3	4	5	6	7	8	9	10
S	56,000	54,000	53,000	53,500	52,000	49,000	47,490	46,570	45,000	
N	4,000	53,000	117,000	145,000	2,400,000	No Fail	425,000	12,222,000	11,089,000	
S										
N										
S										
N										
S										
N	Correlation Data:		P56							
S	57,000	56,000	55,000	54,000	53,000	52,000	51,000	50,000	49,500	49,000
N	42,000	57,000	78,000	110,000	160,000	240,000	375,000	630,000	900,000	1,470,000
S	48,600	47,200								
N	2,000,000	6,000,000								
S										
N										
S										
N										
S										
N										
S										
N										

a did not fail

Parameters: m = 1.423, b = -1.250 } C

Comments:

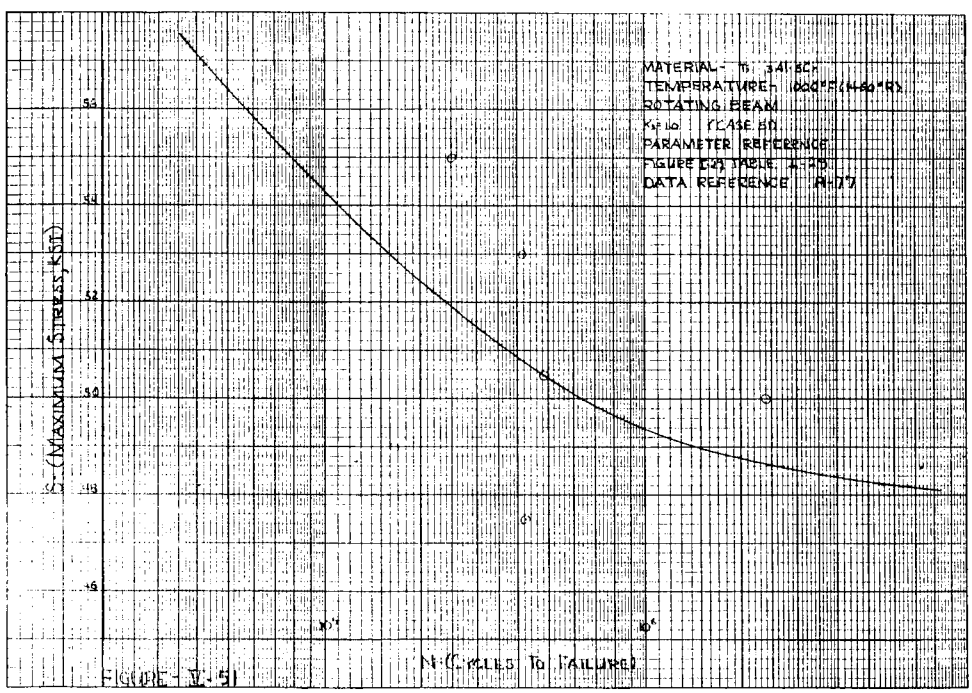


FIGURE - V-51

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel 700 Condition Solution treated 2100°F/4hr.
Aged 1500°F/16hrs.
Reference INCO
Reference No. 3 Code No. 43

Date of Tabulation
Tabulated by JS
Checked by RA

Test Temperature RT Environment Air
Type of Test Rotating beam Specimen Data 21/32" dia bar
Type of Data Numerical Surface Finish —
Stress Ratio — Stress Concentration Factor 1.0
Mean Stress — Notch Description —

Fatigue Data Source:
Author INCO (Private communication)
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
INCO

Mechanical Properties:

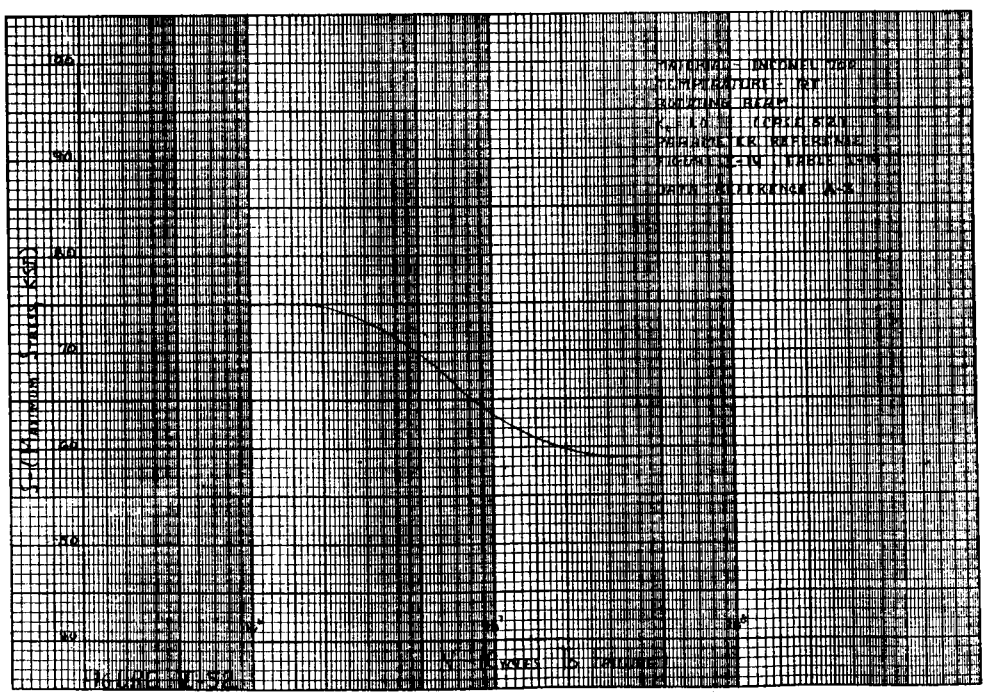
F_{tu}	171 ksi	at RT	
F_{ty}	104 ksi	at RT	
E	32 10^3 ksi	at RT	
G	10^3 ksi	at	
μ		at	
% E	25	at RT	
% RA	27	at RT	
Hardness		at	

Other Properties:
TS = 270.7 ksi
E = 56.013 ksi

S	75,000	70,000	65000	60,000	58,000	52,000				
N	2,868,000	3,658,000	14,704,000	1,258,000	38,617,000	123,000				
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation (KSI)						
S	75.0	74.0	73.0	72.0	71.0	70.0	69.0	68.0	67.0	66.0
N	1.5×10^6	2.95×10^6	3.1×10^6	3.7×10^6	4.9×10^6	4.8×10^6	5.5×10^6	6.1×10^6	6.8×10^6	7.6×10^6
S	65.0	64.0	63.0	62.0	61.0	60.0	59.0			
N	8.9×10^6	9.9×10^6	1.06×10^7	1.2×10^7	1.97×10^7	1.9×10^7	3.5×10^7			
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Parameters: m = 3.302
b = -5.194
C

Comments:



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel 700 Condition [illegible]
Reference Inco Ref. [illegible]
Reference No. 3 Code No. 43

Date of Tabulation
Tabulated by DS & JB
Checked by RA

Test Temperature 1200°F Environment Air
Type of Test Rotating beam Specimen Data 21/32 inch dia. bar
Type of Data Numerical Surface Finish —
Stress Ratio — Stress Concentration Factor 1.0
Mean Stress — Notch Description —

Fatigue Data Source:
Author INCO (Private communication)
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
INCO

Mechanical Properties:

F_{tu}	145.5 ksi	at	1200°F
F_{ty}	91.5 ksi	at	1200°F
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	23.0	at	1200°F
% RA	26.5	at	1200°F
Hardness		at	

Other Properties:
$TS' = 247.35$
$E' = 55.0 \times 6$

S	72.0	65.0	58.0	52.0	51.0	55.0			
N	7.5×10^3	1.72×10^4	5.3×10^4	2.0×10^5	1.2×10^6	1.6×10^6			
S									
N									
S									
N									
S									
N									
S									
N									
S	72.0	67.0	62.0	57.0	64.0	61.0	59.0	63.0	62.0	61.0
N	1.1×10^4	1.27×10^5	1.86×10^5	1.68×10^6	1.9×10^6	2.1×10^6	2.6×10^6	2.9×10^6	2.85×10^6	3.8×10^6
S	60.0	51.0	58.0							
N	3.9×10^5	5.6×10^6	3.1×10^6							
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Data Correlation

Parameters: $m = 4.475$, $b = -7.144$ } C

Comments:

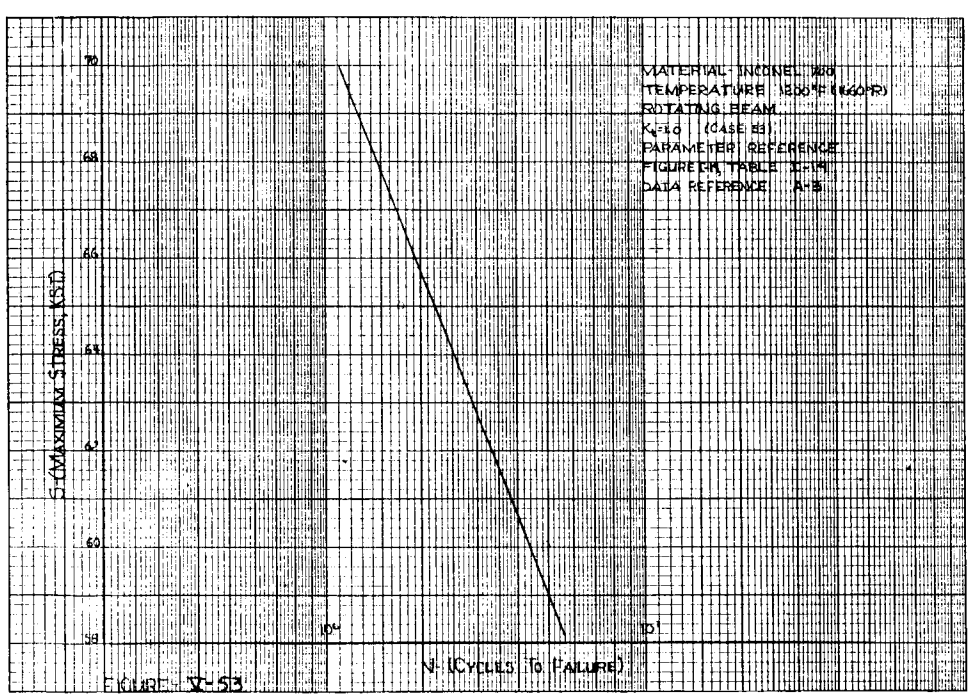


FIGURE V-53

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material: Inconel 700 Condition: Solution treated 2150/2 hr.
Aged 1500/16 hrs.
Reference: INCO
Reference No. 3 Code No. 43

Date of Tabulation
Tabulated by: JB
Checked by: RAD

Test Temperature: 1350°F Environment: air
Type of Test: Rotating beam Specimen Data: 21/32 inch diameter
Type of Data: Numerical Surface Finish: --
Stress Ratio: -1 Stress Concentration Factor: 1.0
Mean Stress: — Notch Description: --

Fatigue Data Source:
Author: INCO (Private communication)
Publication:
No. References:
Principal Investigator:
Affiliation:
Comments:

Mechanical Properties Source:
INCO
Also checks with data in Ref 1

Mechanical Properties:

				Other Properties:
F_{tu}	135	ksi	at 1350°F	~~TS' = 229.5~~
F_{ty}	92	ksi	at 1350°F	~~E' = 50.71~~
E		10^3 ksi	at	
G		10^3 ksi	at	TS' = 229.5 ksi
μ			at	E' = 47.71 10^3 ksi
% E	14.0		at 1350°F	
% RA	14.5		at 1350°F	
Hardness			at	

	1	2	3	4	5	6	7	8	9	10
S	72,000	68,000	66,000	69,000	55,000					
N	1.6×10⁶	2.75×10⁶	4.8×10⁶	8.0×10⁶	1.9×10⁷					
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation KSC						
S	70.0	68.0	66.0	69.0	62.0	60.0	58.0	56.0	54.0	52.0
N	1.6×10⁶	2.75×10⁶	4.8×10⁶	8.0×10⁶	1.9×10⁷	2.9×10⁷	4.0×10⁷	7.0×10⁷	1.19×10⁸	2.0×10⁸
S										
N										
S										
N										
S										
N										
S										
N										

2 extrapolation

Parameters: m = 1.917, b = -2.803 } C

Comments:

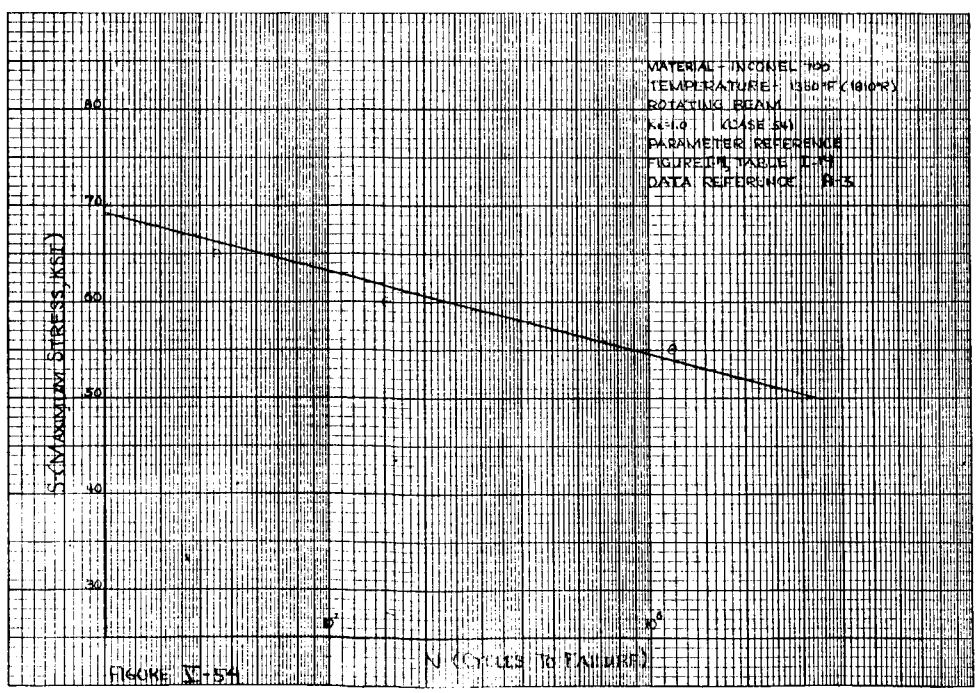


FIGURE 54

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel 700 Condition Solution treated at 1275°C for 8 hrs
Reference INCO duplex aged 1000°C/24 hrs
Reference No. 3 Code No. 93

Test Temperature 1500°F Environment Air
Type of Test Rotating beam Specimen Data 3/8" dia. x 3" gage bar
Type of Data Numerical Surface Finish —
Stress Ratio -1 Stress Concentration Factor 1.0
Mean Stress — Notch Description —

Fatigue Data Source:
Author INCO (Private communication)
Publication
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
INCO

Mechanical Properties:

F_{tu}	106.5	ksi	at 1500°F	
F_{ty}	74.5	ksi	at 1500°F	
E	29	10^3 ksi	at 1500°F	
G		10^3 ksi	at	
μ			at	
% E	6.0		at 1500°F	
% RA	8.0		at 1500°F	
Hardness			at	

Other Properties:
TS' = 181.05 KSI
E' = 98.190 KSI

Date of Tabulation
Tabulated by JB
Checked by RT

	1	2	3	4	5	6	7	8	9	10
S	60,200	57,100	53,000	50,000	47,500					
N	46,000	40,000	32,000	32,000	28,000					
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation						
S	60.0	57.0	53.0	50.0	47.5					
N	1.2×10^5	2.2×10^5	4.1×10^5	7.6×10^5	1.4×10^6	2.67×10^6	5.0×10^6	9.1×10^6	1.8×10^7	3.2×10^7
S	50.0									
N	5.9×10^7									
S										
N										
S										
N										
S										
N										

As Specimen Fractured

Parameters: M = 1.270, δ = -1.232 } C

Comments:

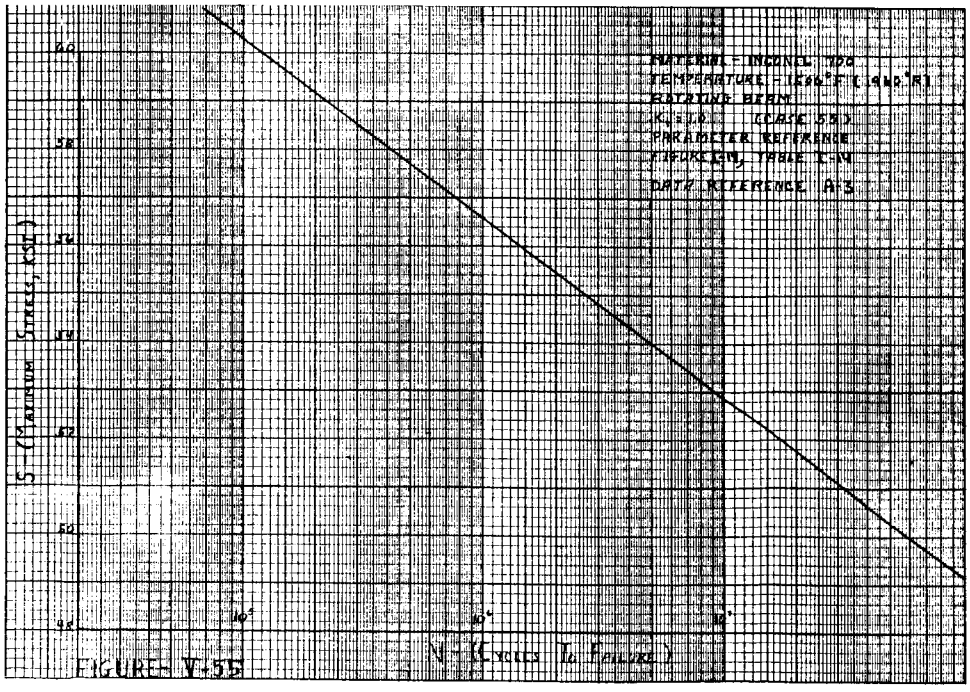


FIGURE V-55

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel 700 Condition Solution treated and aged bars
Reference INCO (Private Communication) Ann Arbor Works
Reference No. 3 Code No. 43

Test Temperature 1600°F Environment Air
Type of Test Rotating beam Specimen Data 21/32 inch plain bar
Type of Data Numerical Surface Finish —
Stress Ratio — Stress Concentration Factor 1.0
Mean Stress — Notch Description —

Fatigue Data Source:
Author INCO (Private communication)
Publication Unpublished design data
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
INCO

Mechanical Properties:

				Other Properties:
F_{tu}	83.5	ksi	at 1600°F	TS = 141.95 ksi
F_{ty}	55.5	ksi	at 1600°F	E = 33.08 ksi
E		10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E	20		at 1600°F	
% RA	80		at 1600°F	
Hardness			at	

Date of Tabulation
Tabulated by JB
Checked by PAD

	1	2	3	4	5	6	7	8	9	10
S	47,000	53,000	56,000	59,000						
N	614,000	822,000	1,143,000	1,966,000						
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation KSI						
S	40.0	37.5	31.0	28.5	38.0	31.5	31.0	26.5	36.0	35.5
N	8.4×10^5	1.26×10^6	1.92×10^6	2.9×10^6	4.9×10^6	6.6×10^6	1.0×10^7	1.5×10^7	2.25×10^7	3.4×10^7
S	35.0	34.5								
N	5.1×10^7	1.6×10^7								
S										
N										
S										
N										
S										
N										

Parameters: m = 1.522
b = −1.732
} C

Comments:

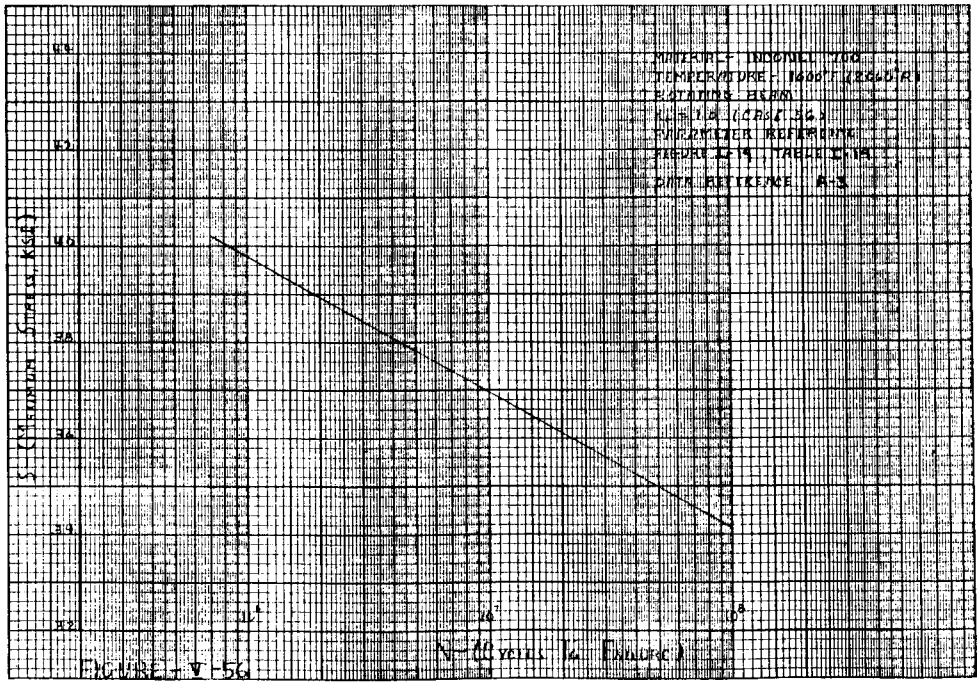


FIGURE V-56

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material* Udimet 500 Condition

Reference WADC TR 58-340, p 12

Reference No. 102 Code No. 74

Test Temperature 75°F Environment

Type of Test Axial Specimen Data

Type of Data Numerical Surface Finish

Stress Ratio ∞ Stress Concentration Factor 1.0

Mean Stress 0 Notch Description

Fatigue Data Source:

Author Vitovec, F.H.

Publication WADC TR 58-340

p.8

No. References 7

Principal Investigator Arthur

Affiliation University of Minnesota

Comments

Mechanical Properties Source:

Metals Handbook, V.1, 8e (

p.518

Mechanical Properties:

				Other Properties:
F_{tu}	175.0	ksi	at 75°F	TS = 175.0 Ksi
F_{ty}	110.0	ksi	at 75°F	E = 23.25 Ksi
E		10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E	15.0		at 75°F	
% RA	15.0		at 75°F	
Hardness			at	

Date of Tabulation

Tabulated by DS

Checked by MN

S*	70.0	75.0	80.0	90.0	72.0	100.0				
N	34,920	13,153	1,103	1,398	514	425				
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation Ksi						
S	100.0	99.0	98.0	96.0	99.0	92.0	90.0	88.0	86.0	84.0
N	3.1×10^2	3.65×10^2	4.2×10^3	5.0×10^3	5.7×10^2	6.8×10^2	7.8×10^2	8.9×10^2	1.09×10^3	1.29×10^3
S	82.0	80.0	78.0	75.0						
N	1.59×10^3	2.05×10^3	3.24×10^3	1.05×10^4						
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

a - Test discontinued

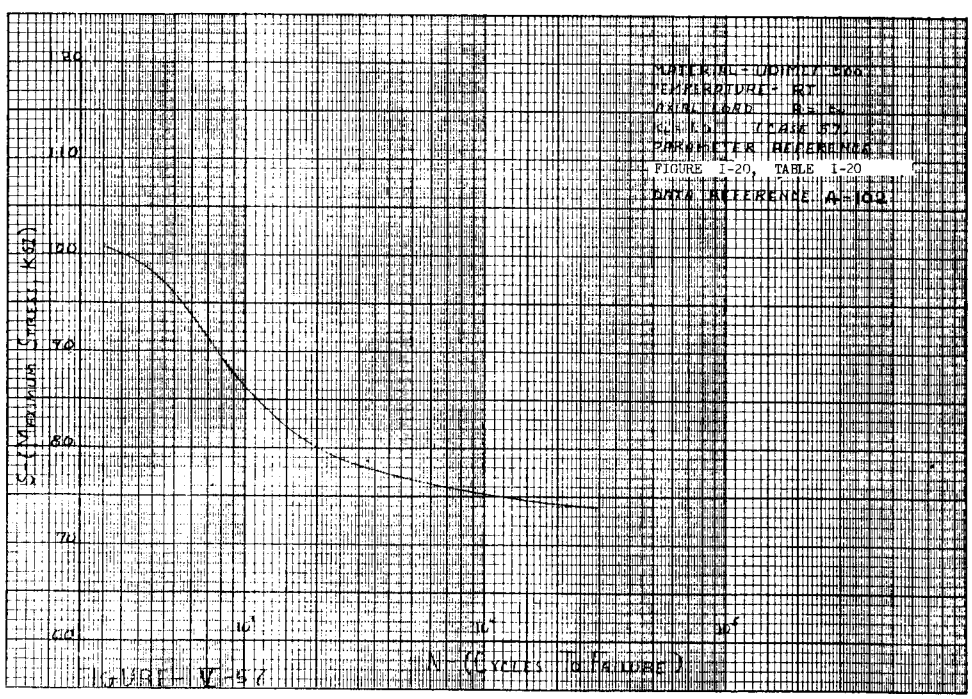
Parameters: $m = 2.510$

$b = -2.061$

*Comments: 1. 0.08C, 0.008S, 2.17Al, 3.02Ti, 4.30Mo, 18.0Cr, 17.3Co, 0.42Fe, 0.11Si, 0.1Mn, 0.10Cu, 0.01Mg, Bal Ni

2. S - ksi, N - Kilocycles

3. (Too few points)



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material* Udimet 500 Condition [illegible]

Reference WADC TR 58-340, p.12 [illegible]

Reference No. 102 Code No. 74

Date of Tabulation

Tabulated by DS

Checked by

Test Temperature 1200°F Environment Air

Type of Test Axial Specimen Data 0.20 in. dia

Type of Data Numerical Surface Finish

Stress Ratio -∞ Stress Concentration Factor 1.0

Mean Stress 0 Notch Description

Fatigue Data Source:

Author Litovec, F.H.

Publication WADC TR 58-340 p.13

No. References 7

Principal Investigator Author

Affiliation University of Minnesota

Comments

Mechanical Properties Source:

Metals Handbook, V.1, 8th Ed p. 518

Mechanical Properties:

				Other Properties:
F_{tu}	175.0 ksi	at	1200°F	TS' = 175.0
F_{ty}	110.0 ksi	at	1200°F	E' = 68.25
E	10^3 ksi	at		
G	10^3 ksi	at		
μ		at		
% E	17.0	at	1200°F	
% RA	17.0	at	1200°F	
Hardness		at		

S', N	1	2	3	4	5	6	7	8	9	10
S'	62.0	72.0	75.0	82.0	85.0					
N	14,570	21,490	2210	270	255					
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation						
S	89.0	83.0	82.0	81.0	80.0	79.0	78.0	77.0	76.0	75.0
N	1.1×10^2	1.6×10^3	2.3×10^3	3.25×10^2	4.5×10^3	6.2×10^2	9.0×10^2	1.29×10^3	1.8×10^3	2.9×10^3
S	74.0	73.0	72.0	71.0	70.0					
N	3.9×10^3	5.0×10^3	7.1×10^3	1.2×10^4	2.5×10^4					
S										
N										
S										
N										
S										
N										

2 test discontinued

Parameters: m = 0.983

b = -0.140

Comments: 1 0.08 C, 0.008 S, 2.15 Al, 3.03 Ti, 4.38 Mo, 13.0 Cr, 19.3 Co, 0.48 Fe, 0.11 Si, 0.12 Mn, 0.10 Cu, 0.01 Mg, Bal Ni

2 S- ksi; N- kilocycles

3 Computer values

4 (Too few data points)

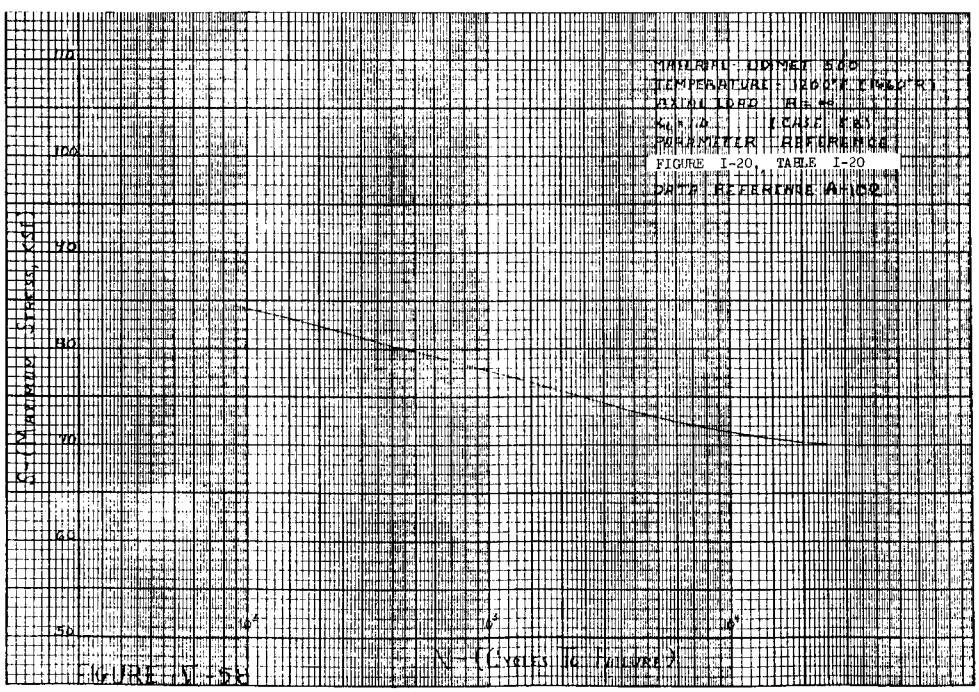


FIGURE I-58

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Udimet 500 Condition 2150°F-4hrs Air; 1975°F-4hrs Air; 1550°F-24 hrs. Air; 1400°F-16 hrs. Air.

Reference WADC TR 58-340 p.12

Reference No. 102 Code No. 74

Test Temperature 1650°F Environment Air

Type of Test Axial Specimen Data .225 in. dia.

Type of Data Numerical Surface Finish —

Stress Ratio ∞ Stress Concentration Factor 1.0

Mean Stress — Notch Description —

Fatigue Data Source:

Author Vitovec, F.H.

Publication WADC TR 58-340 p.14

No. References 7

Principal Investigator Author

Affiliation University of Minnisota

Comments

Mechanical Properties Source:

WADC TR 58-340

p. 12

Metals Handbook, v.1, ed.8

p. 518

Mechanical Properties:

F_{tu}	84.0 ksi	at	1650°F
F_{ty}	65.0 ksi	at	1650°F
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	14.0	at	1650°F
% RA	32.0	at	1650°F
Hardness		at	

Other Properties:

grain size 8

TS = 84.0 Ksi

E' = 25.16 Ksi

Date of Tabulation

Tabulated by DS

Checked by

	1	2	3	4	5	6	7	8	9	10
S	27.0	30.0	35.0	35.0	40.0	42.0	45.0			
N	35,210	22,670	11,640	4,520	3,910	227	218			
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation Ksi						
S	95.0	99.0	92.0	90.0	38.0	36.0	34.0	32.0	30.0	28.0
N	1.5×10^2	9.5×10^2	2.0×10^3	4.0×10^3	5.3×10^3	7.8×10^3	1.12×10^4	1.6×10^4	2.27×10^4	3.15×10^4
S	26.0									
N	4.6×10^4									
S										
N										
S										
N										
S										
N										

a test discontinued

Parameters: m = 2.200

b = -2.316

Comments: 1 0.08C, 0.008 S, 2.91Al, 3.03 Ti, 4.30 Mo, 19.0 Cr, 19.3 Co, 0.40 Fe, 0.11 Si, 0.10 Mn, 0.10 Cu, 0.01 Mg, Bal Ni

2 S: Ksi ; N: kilocycles

3 Computer values

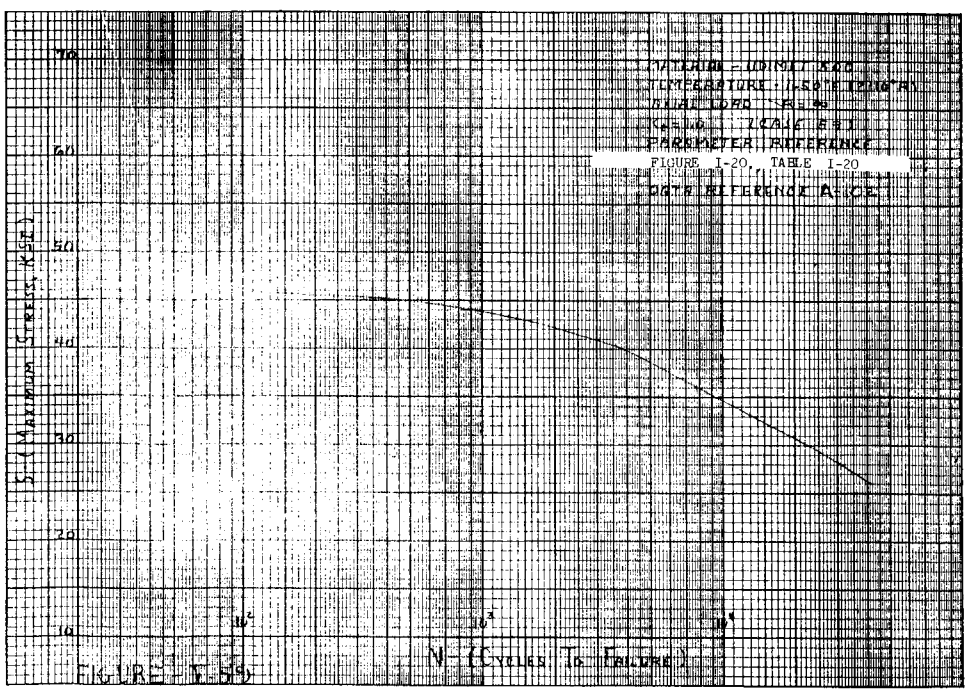


FIGURE I-59

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Cobalt S-816 Condition 1 hr at 2150°F ; Water Quenched
Reference NACA TN 3142 p. 2 16 hr at 1400°F ; AQ
Reference No. 32 Code No. 9

Date of Tabulation
Tabulated by CB
Checked by

Test Temperature RT (80°F) Environment Air
Type of Test CB Specimen Data 0.333" dia. bar
Type of Data Numerical Surface Finish Polish & Rough
Stress Ratio −1 Stress Concentration Factor —
Mean Stress — Notch Description —

Fatigue Data Source:
Author Ferguson, Robert L.
Publication NACA TN 3142
No. References 10
Principal Investigator Author
Affiliation Lewis Flight Propulsion Laboratory
Comments Cleveland, Ohio

Mechanical Properties Source:
Metals Handbook, Vol. 1
p. 521

		1	2	3	4	5	6	7	8	9	10
	Polish										
S		84,800	83,000	76,300	76,200	74,600	72,600	79,000 [c]			
N		458,000	670,000	1,600,000	1,550,000	15,100,000	92,000,000 [b]	2,203,000			
S											
N	Rough										
S		75,400	71,200	68,800	65,000	64,900	78,400				
N		475,000	1,040,000	2,200,000	2,760,000	92,200,000 [b]	24,400,000				
S											
N											
S											
N											
	Data Correlation (Polished Data, Ksi)										
S		91.8	89.0	83.5	83.0	82.0	81.0	80.0	79.0	78.0	77.0
N		9.9×10^5	9.6×10^5	4.8×10^5	5.0×10^5	5.2×10^5	6.0×10^5	6.8×10^5	7.9×10^5	9.5×10^5	1.22×10^6
S		76.0	75.0	74.8	71.9						
N		1.77×10^6	3.5×10^6	4.2×10^6	1.6×10^7						
S											
N											
S											
N											
S											
N											

b = unbroken c = replotted after smoothing

Mechanical Properties:

			Other Properties:
F_{tu}	150 ksi	at RT	TS' = 255.0 Ksi
F_{ty}	80 ksi	at RT	E' = 71.85 Ksi
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	35	at RT	
% RA	30	at RT	
Hardness		at	

*Parameters: m = 2.142
b = -2.662

*Comments: 1 Computer values

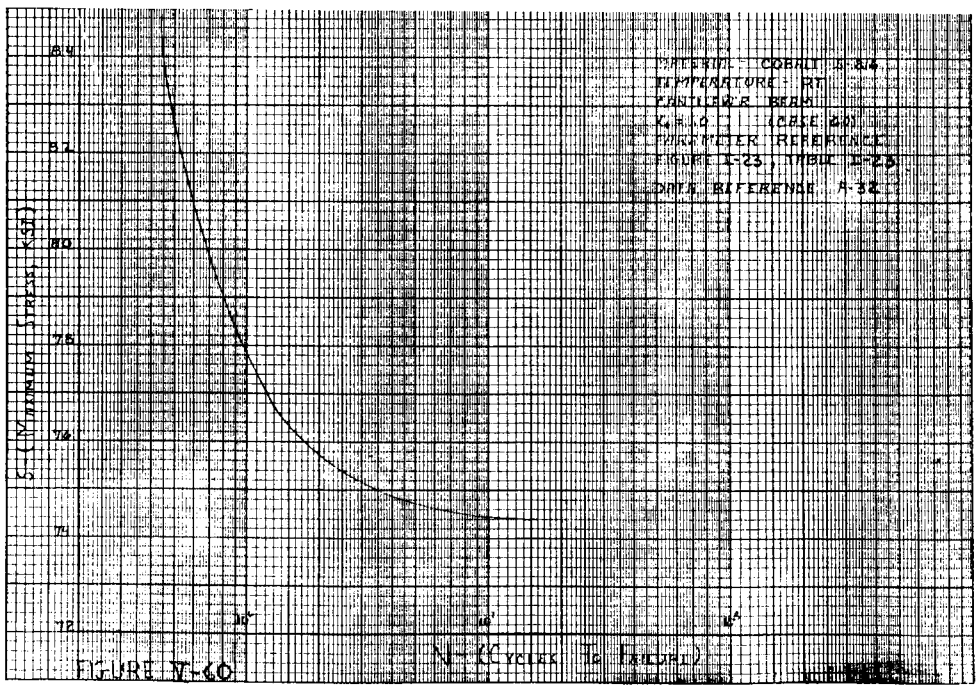


FIGURE V-60

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Cobalt S-816 Condition 1 hr. at 2150°F ; WQ.
Reference NACA TN 3142 p.2 16 hr at 1400°F ; AQ.
Reference No. 32 Code No. 9

Date of Tabulation
Tabulated by CB
Checked by RB

Test Temperature 1200°F Environment Air
Type of Test CB Specimen Data 0.333 in. dia bar
Type of Data Numerical Surface Finish Polish and Rough
Stress Ratio -1.0 Stress Concentration Factor —
Mean Stress — Notch Description —

Fatigue Data Source:
Author Ferguson, Robert L.
Publication NACA TN 3142
No. References 10
Principal Investigator Author
Affiliation Lewis Flight Propulsion Laboratory
Comments Cleveland, Ohio

Mechanical Properties Source:
Metals Handbook Vol. 1
p. 521

		1	2	3	4	5	6	7	8	9	10
Polish	S	71,000	71,000	68,000	63,000	64,000					
	N	172,000	1,212,000	4,170,000	9,159,000	103,000,000[b]					
Rough	S	69,000	68,000	64,500	62,500						
	N	178,000	302,000	1,970,000	57,000,000						
Data Correlation (Polished Data, NAS	S	71.7	71.5	71.0	70.5	70.0	69.5	69.0	68.5	68.0	67.5
	N	2.7×10^5	9.6×10^5	6.9×10^5	9.7×10^5	1.3×10^6	1.8×10^6	2.9×10^6	3.15×10^6	9.2×10^6	5.6×10^7
	S	61.0	66.5	66.0							
	N	7.6×10^6	1.0×10^7	1.6×10^7							

[b] Unbroken

Parameters: α = 1.580
b = -1.230

Comments: 1 Computer values

Mechanical Properties:

			Other Properties:
F_{tu}	110.0 ksi	at 1200°F	$T\sigma'$ = 187.0 ksi
F_{ty}	60.0 ksi	at 1200°F	E' = 69.13 ksi
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	22	at 1200°F	
% RA	20	at 1200°F	
Hardness		at	

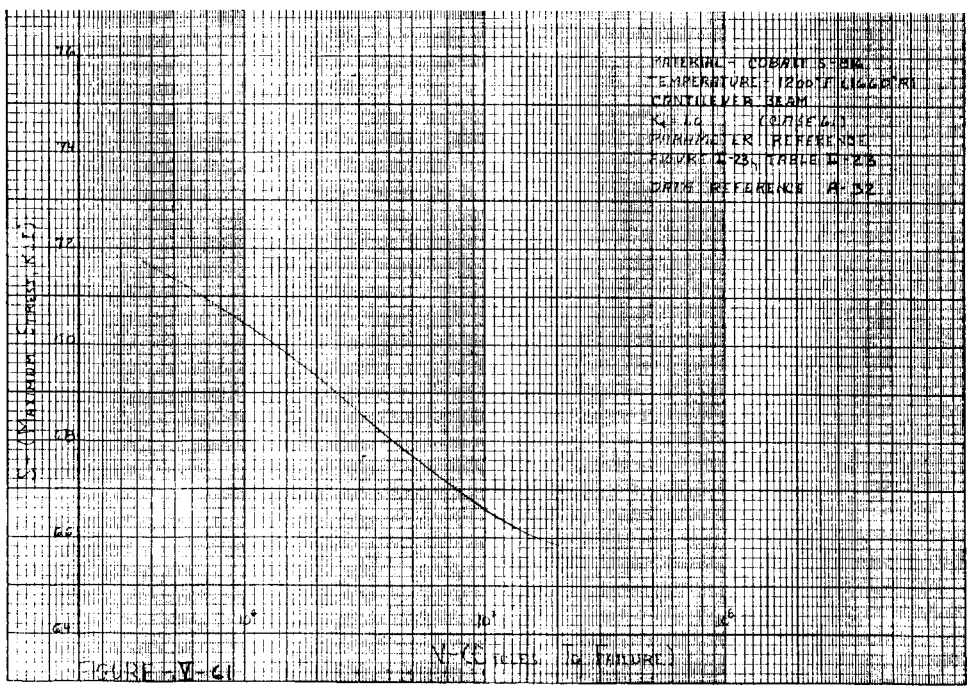


FIGURE -V- 61

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material: Cobalt S-816 — Condition: 1 hr at 2150°F; WQ
Reference: NACA TN 3142 p.2 — 16 hr. at 1400°F; AQ.
Reference No. 32 Code No. 9

Test Temperature: 1500°F — Environment: Air
Type of Test: CB — Specimen Data: 0.333 in. dia. bar
Type of Data: Numerical — Surface Finish: Polish and Rough
Stress Ratio: -1.0 — Stress Concentration Factor: 1.0 (Polish)
Mean Stress: — Notch Description:

Fatigue Data Source:
Author: Ferguson, Robert L.
Publication: NACA TN 3142
No. References: 10
Principal Investigator: Author
Affiliation: Lewis Flight Propulsion Laboratory
Comments: Cleveland, Ohio

Mechanical Properties Source:
Metals Handbook vol. 1
p. 521

Mechanical Properties:

F_{tu}	70.0 ksi	at 1500°F	
F_{ty}	50.0 ksi	at 1500°F	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	35	at 1500°F	
% RA	40	at 1500°F	
Hardness		at	

Other Properties:
TS' = 110.0 Ksi
E' = 36.81 Ksi

Date of Tabulation:
Tabulated by: CB
Checked by: MO

		1	2	3	4	5	6	7	8	9	10
Polish	S	41,000	45,000	44,400	42,800	40,000	37,200				
	N	172,000	2,810,000	2,200,000	3,810,000	5,200,000	55,600,000				
Rough	S										
	N										
	S	42,800	40,400	36,700	34,900						
	N	442,000	1,680,000	3,100,000	113,000,000						
	S										
	N										
	S										
	N										
Data Correlation (Calculated Data, Ksi)											
	S	111.0	98.5	98.0	97.0	96.0	95.0	94.0	93.0	92.0	91.0
	N	1.75×10^5	3.0×10^5	9.6×10^5	9.0×10^5	1.5×10^6	2.4×10^6	3.6×10^6	5.2×10^6	7.8×10^6	1.2×10^7
	S	90.0	87.0	98.0							
	N	1.9×10^7	3.2×10^7	1.4×10^7							
	S										
	N										
	S										
	N										
	S										
	N										
		1	2	3	4	5	6	7	8	9	10

*Parameters: m = 1.944
b = 2.692

*Comments: 1 Computer values

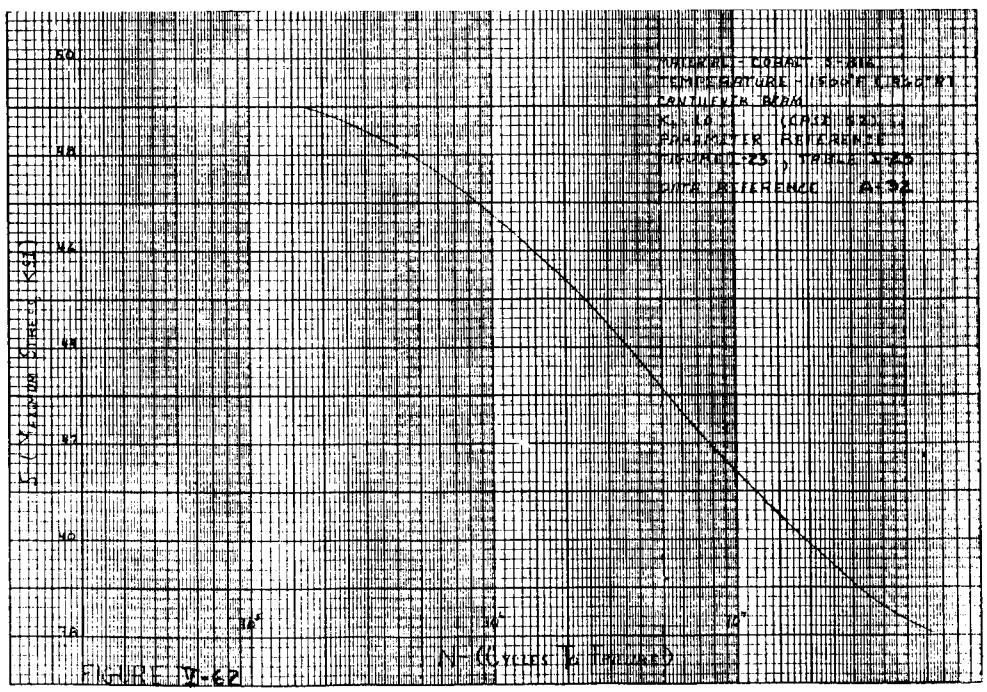


FIGURE V-62

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material* Hastelloy R-235 Condition 2100°F 5 hrs Air
Reference WADC TR 58-340 p.132
Reference No. 102 Code No. 133 - 74

Date of Tabulation
Tabulated by CB
Checked by PMA

Test Temperature 75°F Environment Air
Type of Test Axial Specimen Data 0.20 in. dia
Type of Data Numerical Surface Finish —
Stress Ratio ∞ Stress Concentration Factor 1.0
Mean Stress — Notch Description

Fatigue Data Source:
Author Vitovec, F.H
Publication WADC TR 58-340
p.116
No. References 7
Principal Investigator Author
Affiliation University of Minnesota
Comments

Mechanical Properties Source:
Metals Handbook, v.1, ed.8
p. 513

*S	61.0	63.0	65.0	70.0	72.0	80.0		5 points		
N	21,860	727	945	540	327	367		for		
S								$N < 10^3$		
N										
S										
N										
S										
N										
S										
N										
				Data Corrections						
S	80.0	77.0	77.0	76.0	74.0	72.0	70.0	68.0	66.0	64.0
N	2.85×10^2	3.06×10^2	3.28×10^2	3.78×10^2	9.2×10^2	9.7×10^2	5.2×10^2	6.0×10^2	6.17×10^2	8.2×10^2
S	63.0									
N	9.3×10^4									
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

*a test discontinued

Mechanical Properties:

F_{tu}	~ 120 ksi	at 75°F	
F_{ty}	~ 60 ksi	at 75°F	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	~ 50.0	at 75°F	
% RA		at	
Hardness		at	

Other Properties:
75' = 120 KSI
E' = 61.80 KSI

Parameters: m = 0.870
b = -0.364

Comments: 1 0.07C, 0.07S, 2.0% Al, 2.55 Ti, 5.3% Mo, 15.5% Cr, 0.25% Co, 9.0% Fe, 0.25% Si, 0.03% Mn, 0.005% B, Bal. Ni
2 S-ksi, N-kilocycles
3 Computer values

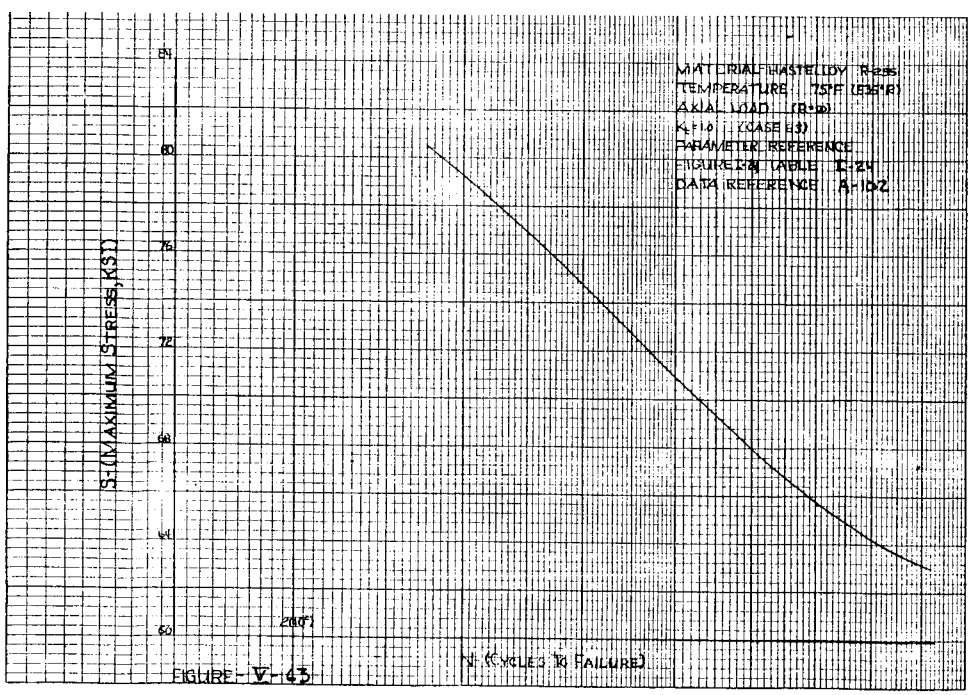


FIGURE - V-163

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Hastelloy R-235 Condition [illegible]
Reference WADC TR 58-340
Reference No. 102 Code No. [illegible]-74

Date of Tabulation
Tabulated by CB
Checked by PHA

Test Temperature 1200°F Environment Air
Type of Test Axial Specimen Data [illegible]
Type of Data Numerical Surface Finish —
Stress Ratio ∞ Stress Concentration Factor 1.0
Mean Stress — Notch Description

Fatigue Data Source:
Author Vitovec F.H.
Publication WADC TR 58-340
16
No. References 7
Principal Investigator Author
Affiliation [illegible]
Comments

Mechanical Properties Source:
Metals Handbook
V.1, ed. 8
p 513

Mechanical Properties:

F_{tu}	105.0	ksi	at	1200°F
F_{ty}	79.6	ksi	at	1200°F
E		10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E	15.0		at	1200°F
% RA			at	
Hardness			at	

Other Properties:
TS' = 105.0 Ksi
E' = 55.95 Ksi

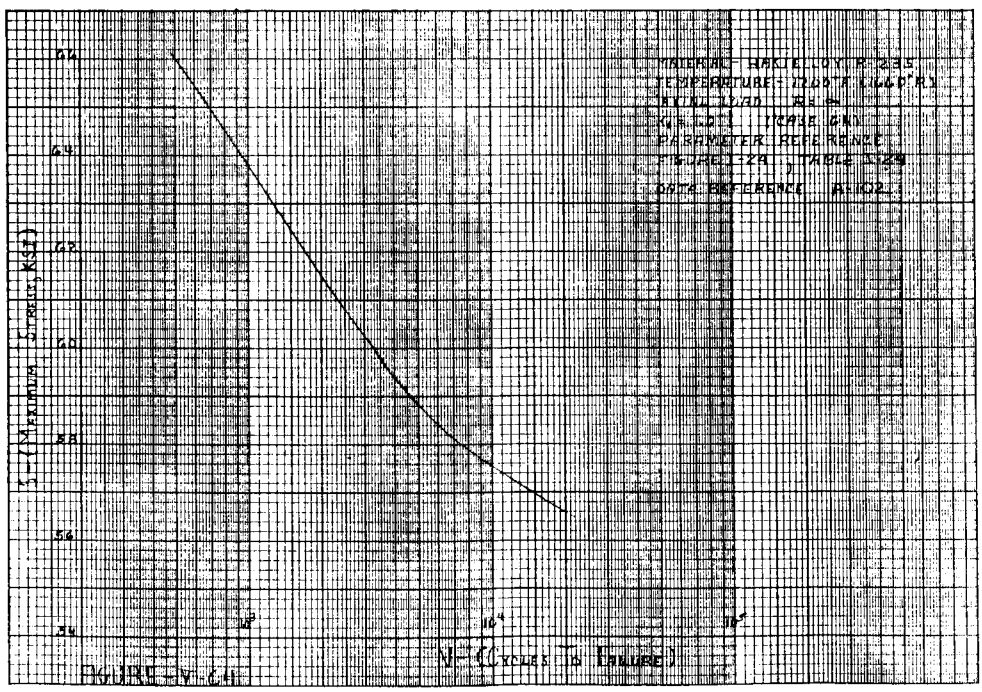
4 Points only

	1	2	3	4	5	6	7	8	9	10
S	[illegible]	[illegible]	[illegible]	[illegible]						
N	[illegible]	[illegible]	[illegible]	[illegible]						
S										
N										
S										
N										
S										
N										
S										
N										
S	65.0	61.0	63.0	62.0	61.0	[illegible]	57.0	58.5	58.0	57.5
N	6.87×10^2	9.3×10^2	1.24×10^3	1.7×10^3	2.32×10^3	3.2×10^3	4.68×10^3	5.8×10^3	7.9×10^3	1.0×10^4
S	57.0									
N	1.5×10^4									
S										
N										
S										
N										
S										
N										

Data Correlation Ksi

Parameters: m = 2.154
b = -1.763

Comments: [illegible]
2 S - ksi, N - kc, ∞
3 Computer values



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Hastelloy R-235 Condition
Reference WADC TR 58-340 p.12
Reference No. 102 Code No. 115-74

Date of Tabulation
Tabulated by CB
Checked by RBS

Test Temperature 1650°F Environment Air
Type of Test Axial Specimen Data 0.25 in dia
Type of Data Numerical Surface Finish
Stress Ratio -1 Stress Concentration Factor 1.0
Mean Stress — Notch Description

Fatigue Data Source:
Author Wawro, F.H.
Publication WADC TR 58-340
p.17
No. References 1
Principal Investigator Butler
Affiliation University of Minn.
Comments

Mechanical Properties Source:
Metals Handbook
V.1, ed. 8
p. 518

	1	2	3	4	5	6	7	8	9	10
S										
N										
S										
N										
S										
N										
S										
N										
S				Data Correlation						
N										
S	95.0	99.0	93.0	92.0	91.0	90.0	39.0	38.0	37.0	36.0
N	6.1×10^{1}	9.5×10^{1}	1.47×10^{2}	2.25×10^{2}	3.5×10^{2}	5.2×10^{2}	8.0×10^{2}	1.22×10^{3}	1.9×10^{3}	3.0×10^{3}
S	25.0	24.0	23.0							
N	9.75×10^{2}	7.6×10^{3}	1.29×10^{4}							
S										
N										
S										
N										
S										
N										

Mechanical Properties:

F_{tu}	70.0 ksi	at 1650°F	
F_{ty}	70.0 ksi	at 1650°F	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	3.0	at 1650°F	
% RA		at	
Hardness		at	

Other Properties:
TS' = 70.0 KSI
ε' = 32.30 KSI

Parameters: m = 1.224
b = -0.969

Comments:
3 Computer values

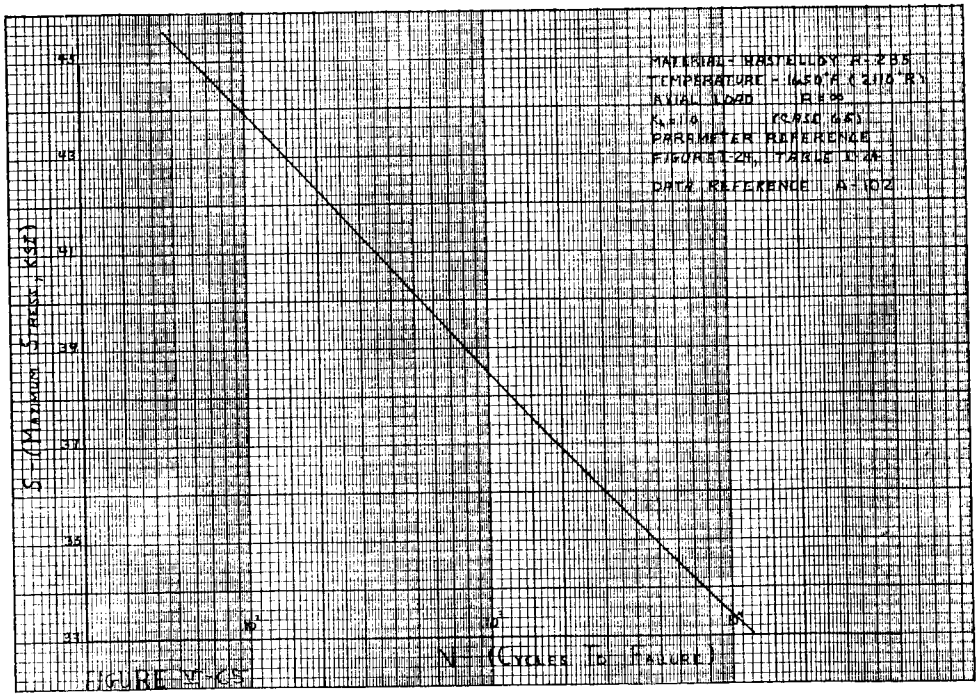


FIGURE 4-65

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-2.5Al-16V Condition SOL'N TREATED AND
Reference PROG. REP. NO. 6, P.A-64 (LOCKHEED) AGED, MALLORY-SHARON
Reference No. 50 Code No. 604 HEAT NO. 23345

Date of Tabulation
Tabulated by DS
Checked by RH

Test Temperature RT Environment AIR
Type of Test AXIAL LOAD Specimen Data 0.125 IN. SHEET
Type of Data NUMERICAL Surface Finish
Stress Ratio[#1] 0.3 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author P.J. HUGHS, W.M. McGEE
Publication PROG. REP. NO. 6, P.A-64 (LOCKHEED) CONTRACT NO. AF 33(616)-6346
No. References
Principal Investigator W.M. McGEE
Affiliation
Comments

Mechanical Properties Source:
PROG. REP. NO. 7, P.A-60 (LOCKHEED) CONT. NO. AF 33(616)-6346

Mechanical Properties:[#]

F_{tu}	174 ksi	at	RT, K_t=1
F_{ty}	161 ksi	at	RT, K_t=1
E	14.9 10^3 ksi	at	RT, K_t=1
G	10^3 ksi	at	
μ		at	
% E	7.5	at	RT, K_t=1
% RA		at	
Hardness		at	

Other Properties:
~~TS' = 174~~
~~E' = 115.26~~
TS' = 195.00
E' = 115.00

	1	2	3	4	5	6	7	8	9	10
S	195,000	193,000	189,000	188,000	155,000	155,000	122,000	122,000	122,000	120,000
N	88	2	339	1424	5,169	15,899	51,000	79,000	121,000	109,000
S	120,000	120,000	117,000	117,000	117,000	115,000	115,000	115,000	115,000	118,000
N	144,000	239,000	169,000	197,000	4,809,000	119,000	2,585,000	5,904,000	>10,000,000	>10,000,000
S	110,000	110,000								
N	>10,000,000	>10,000,000								
S										
N										
S										
N				Data Correction						
S	190.0	185.0	180.0	175.0	170.0	160.0	150.0	140.0	130.0	120.0
N	1.18×10^2	1.39×10^3	2.15×10^3	3.1×10^3	1.25×10^3	6.2×10^3	1.15×10^4	1.8×10^4	3.35×10^4	7.9×10^4
S	118.5	117.0								
N	1.97×10^5	4.5×10^5								
S										
N										
S										
N										
S										
N										

Parameters: m = 4.917
b = -7.123

Comments: 1. STRESS RATIO = MAX. ALT. STRESS / MEAN STRESS
2. LONGITUDINAL PROPERTIES.

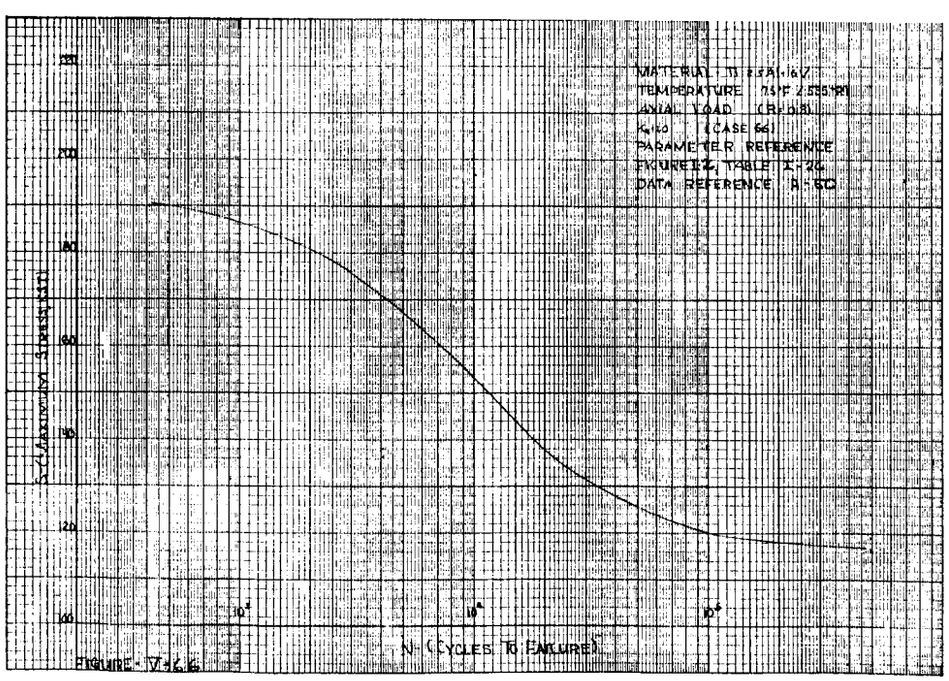


FIGURE - V-16.6

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-2.5Al-16V Condition SOLN TREATED AND
Reference PROG. REP. NO. 6, P.A-84, LOCKHEED AGED, DIALLOY-SHARON
Reference No. 50 Code No. 604 HEAT NO. 23345

Test Temperature 400°F Environment AIR
Type of Test AXIAL LOAD Specimen Data 0.125 IN. SHEET
Type of Data NUMERICAL Surface Finish
Stress Ratio*1 0.3 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:

Author P.J. HUGHS, W.M. McGEE
Publication PROG. REP. NO. 6, P.A-84, LOCKHEED
CONT. NO. AF33(616)-6346
No. References
Principal Investigator W. M. McGEE
Affiliation
Comments

Mechanical Properties Source:

PROG. REP. NO. 7, P.A-60,
LOCKHEED AIRCRAFT CO.,
CONT. NO. AF33(616)-6346

Mechanical Properties:*2

F_{tu}	151	ksi	at	400°F, K_T=1
F_{ty}	133	ksi	at	400°F, K_T=1
E	14.0	10^3 ksi	at	400°F, K_T=1
G		10^3 ksi	at	
μ			at	
% E	7.7		at	400°F, K_T=1
% RA			at	
Hardness			at	

Other Properties:

~~S^1=151.0~~
E^1=89.29

B^1 = 175.00
E^1 = 89.25 (PIII)

Date of Tabulation
Tabulated by CB & DS
Checked by

	1	2	3	4	5	6	7	8	9	10
S	180,000	175,000	170,000	170,000	165,000	160,000	145,000	105,000	105,000	100,000
N	3	10,204	5	13,386	11,017	371	111,000	143,000	345,000	1,396,000
S	100,000	100,000	95,000	95,000	95,000	92,000	92,000	85,000	85,000	85,000
N	243,000	448,000	477,000	744,000	942,000	6,460,000	6,742,000	>10,000,000	>10,000,000	>10,000,000
S	89,000	75,000								
N	>10,000,000	>10,000,000								
S										
N										
S										
N				Data Correlation						
S	172.0	170.0	165	160.0	150.0	130.0	130.0	120.0	110.0	100.0
N	5.3×10^3	1.08×10^4	1.53×10^4	2.35×10^4	9.05×10^4	9.72×10^4	6.2×10^4	7.5×10^4	1.1×10^5	2.6×10^5
S	150	72.5	70.8							
N	1.9×10^5	1.9×10^5	7.9×10^5							
S										
N										
S										
N										
S										
N										

Parameters: $m = 8.695$, $b = -114.422$ } C

*Comments: 1 STRESS RATIO = MAX. ALT. STRESS / MEAN STRESS
2 LONGITUDINAL PROPERTIES

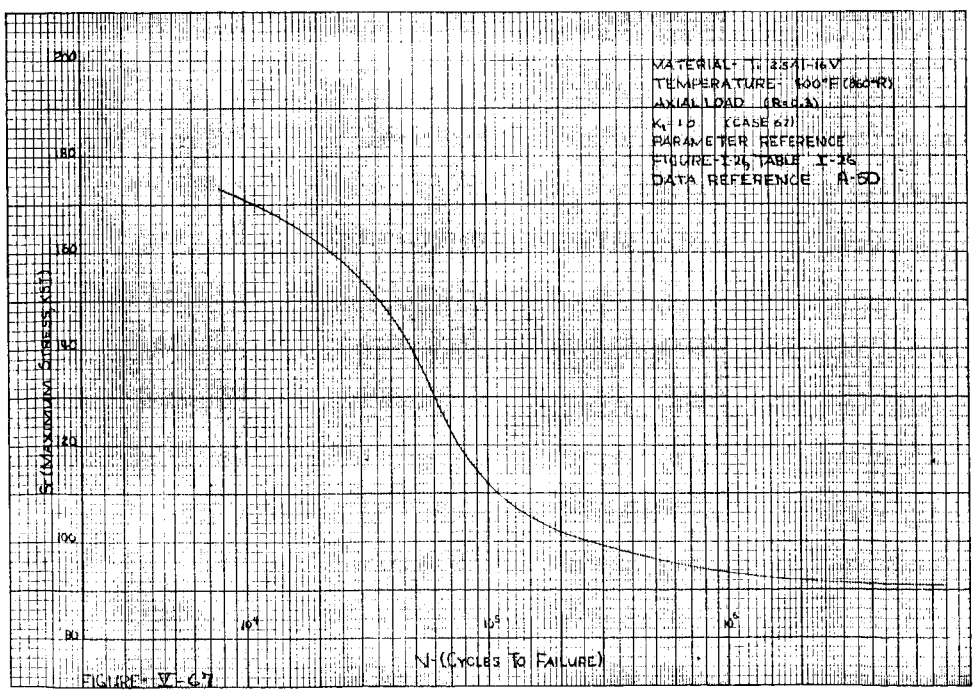


FIGURE V-67

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-2.5Al-16V Condition SOLN TREATED AND AGED (HALLORY-SHANNON)
Reference PROG. REP. NO. 6, PR-84, LOCKHEED HEAT NO. 23345
Reference No. 50 Code No. 1.4

Date of Tabulation
Tabulated by DS
Checked by RJ

Test Temperature 600°F Environment AIR
Type of Test AXIAL LOAD Specimen Data 0.125 IN. SHEET
Type of Data NUMERICAL Surface Finish
Stress Ratio*1 0.3 Stress Concentration Factor 1.0
Mean Stress Notch Description

	1	2	3	4	5	6	7	8	9	10
S	170,000	165,000	165,000	150,000	145,000	140,000	110,000	110,000	110,000	105,000
N	4	24	74.95	14,098	70	145,000	49,000	84,000	112,000	876,000
S	195,000	190,000	190,000	190,000	96,000	96,000	96,000	92,500	92,500	90,000
N	1,233,000	818,000	1,147,000	10,000,000	117,000	1,095,000	10,000,000	$3,573,000	$426,000	10,000,000
S	90,000	90,000								
N	10,000,000	10,000,000								
S										
N										
S										
N				Ultimate Correlation						
S	160.0	158.0	159.0	150.0	145.0	136.0	130.0	120.0	110.0	105.0
N	6.0×10^4	8.6×10^4	1.7×10^5	1.5×10^5	1.8×10^5	1.1×10^5	2.7×10^5	3.7×10^5	5.2×10^5	7.0×10^5
S	100.0	77.0	77.0							
N	9.0×10^5	1.2×10^6	6.0×10^6							
S										
N										
S										
N										
S										
N										

Fatigue Data Source:

Author P.J. HUGHS, W.M. McGEE
Publication PROG. REP. NO. 6, P.R. 84, LOCKHEED, CONT. NO. AF 33(616)-6386
No. References
Principal Investigator W.M. McGEE
Affiliation
Comments

Mechanical Properties Source:

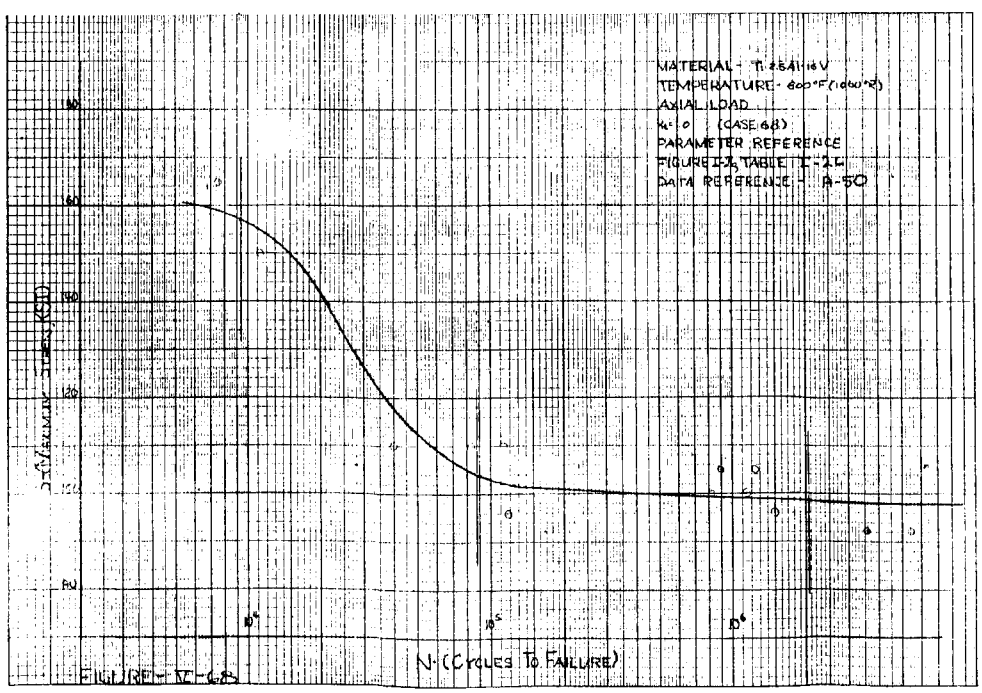
PROG. REP. NO. 7, P.R. A-60.
LOCKHEED
CONTRACT NO. AF33(616)-6386

Mechanical Properties:*2

				Other Properties:
F_{tu}	142	ksi	at 600°F, K_t=1	75° = 142.0
F_{ty}	120	ksi	at 600°F, K_t=1	E' = 26.58
E	12.9	10^3 ksi	at 600°F, K_t=1	
G		10^3 ksi	at	15° = 162.66
μ			at	E' = 96.41 [illegible]
% E	7.7		at 600°F, K_t=1	
% RA			at	
Hardness			at	

Parameters: m = 7.865
b = -12,723
} C

Comments: 1. STRESS RATIO = MAX. HLT. STRESS / MEAN STRESS
2 LONGITUDINAL PROPERTIES



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-2.5Al-16V Condition SOLN TREATED AND AGED, MALLORY-SHARON HEAT NO. 23345

Reference PROG. REP NO. 6, P.A-84, LOCKHEED

Reference No. 50 Code No. 604

Test Temperature 800°F Environment AIR

Type of Test AXIAL LOAD Specimen Data 0.125 IN. SHEET

Type of Data NUMERICAL Surface Finish

Stress Ratio*1 0.3 Stress Concentration Factor 1.0

Mean Stress Notch Description

Date of Tabulation

Tabulated by PS

Checked by

	1	2	3	4	5	6	7	8	9	10
S	168,000	165,000	150,000	105,000	105,000	105,000	100,000	100,000	100,000	95,000
N	2	2	10,257	66,000	78,000	203,000	32,000	164,000	489,000	113,000
S	95,000	95,000	90,000	90,000	90,000	90,000	82,500	82,500	82,500	85,000
N	1,119,000	4,179,000	321,000	748,000	2,804,000	481,000	481,000	2,338,000	8,087,000	3,616,000
S	83,000	83,000	83,000	78000	78000	78000	78000			
N	1485000	5863000	8,371000	5312,000	>10,000,000	>10,000,000	>10,000,000			
S										
N										
S										
N				Data Correlation						
S	196.0	192.0	138.0	129.0	130.0	130.0	117.0	108.0	109.0	100.0
N	1.0×10^3	1.23×10^3	1.93×10^3	1.6×10^4	1.75×10^4	2.0×10^4	2.5×10^4	2.8×10^4	9.2×10^4	1.1×10^5
S	92.0	89.0								
N	7.6×10^5	1.4×10^6								
S										
N										
S										
N										
S										
N										

Fatigue Data Source:

Author P.J. HUGHS, W.M. McGEE

Publication PROG. REP NO. 6, P.A-84, LOCKHEED, CONT. NO. AF 33(616)-6346

No. References

Principal Investigator W.M. McGEE

Affiliation

Comments

Mechanical Properties Source:

PROG. REP NO. 7, P.A-60, LOCKHEED CONT. NO. AF 33(616)-6346

Mechanical Properties:*2

F_{tu}	129	ksi	at 800°F, K_T=1	
F_{ty}	107	ksi	at 800°F, K_T=1	
E	11.8	10^3 ksi	at 800°F, K_T=1	
G		10^3 ksi	at	
μ			at	
% E	13.2		at 800°F, K_T=1	
% RA			at	
Hardness			at	

Other Properties:

~~TS=128.9~~

E = 92.73

TS = 148.00

E = 81.52 RM

Parameters: m = 6.573, b = -10.841 } C

*Comments: 1 STRESS RATIO = MAX. NET. STRESS / MEAN STRESS

2 LONGITUDINAL PROP.

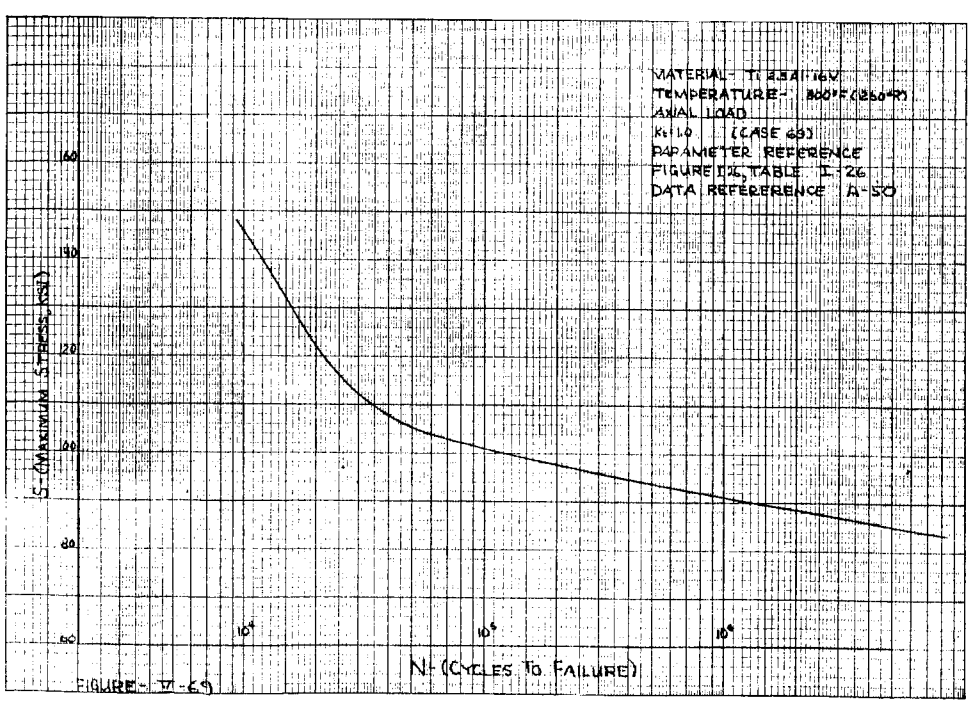


FIGURE - IV-69

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti - 2.5Al - 16V Condition SOL'N TREATED AND
Reference PROG. REP. NO. 6, P.A-84, LOCKHEED AGED, MALLORY-SHARON
Reference No. 50 Code No. 604 HEAT NO. 23345

Test Temperature 900°F Environment AIR
Type of Test AXIAL LOAD Specimen Data 0.125 IN. SHEET
Type of Data NUMERICAL Surface Finish
Stress Ratio*1 0.3 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:

Author P.J. HUGHS, W.M. McGEE
Publication PROGRESS REP. NO. 6, LOCKHEED
CONT. NO. AF 33(616)-6346
No. References
Principal Investigator W.M. McGEE
Affiliation
Comments

Mechanical Properties Source:

PROG. REP. NO. 7, P.A-60,
LOCKHEED
CONT. NO. AF 33(616)-6346

Mechanical Properties:*2

				Other Properties:
F_{tu}	107	ksi	at 900°F, K_T=1	TS' = 107.0
F_{ty}	85	ksi	at 900°F, K_T=1	E' = 57.93
E	10.2	10^3 ksi	at 900°F, K_T=1	
G		10^3 ksi	at	
μ			at	
% E	25		at 900°F, K_T=1	
% RA			at	
Hardness			at	

Date of Tabulation
Tabulated by DS
Checked by RD

	1	2	3	4	5	6	7	8	9	10
S	150,000	140,000	130,000	100,000	90,000	90,000	85,000	85,000	85,000	75,000
N	5	9	77	37,000	84,000	91,000	103,000	387,000	664,000	378,000
S	75,000	75,000	70,000	70,000	70,000	70,000	65,000	65,000	60,000	55,000
N	754,000	887,000	158,000	617,000	1,496,000	1,681,000	729,000	1,994,000	850,000	3,311,000
S	40,000	40,000	40,000							
N	>10,000,000	>10,000,000	>10,000,000							
S										
N										
S										
N				Data Correlation						
S	90.0	87.5	85.0	82.5	80.0	17.5	75.0	72.5	70.0	67.5
N	9.0×10^4	8.2×10^4	1.3×10^5	2.0×10^5	2.85×10^5	9.0×10^5	5.5×10^5	7.6×10^5	1.09×10^6	1.15×10^6
S	65.0	62.5	60.0	57.0						
N	1.72×10^6	2.0×10^6	9.7×10^6	6.8×10^6						
S										
N										
S										
N										
S										
N										

Parameters:*3
m = 5.669
b = -9.751

Comments: 1. STRESS RATIO = MAX. ALT. STRESS / MEAN STRESS
2. LONGITUDINAL PROPERTIES.
3 Computer values

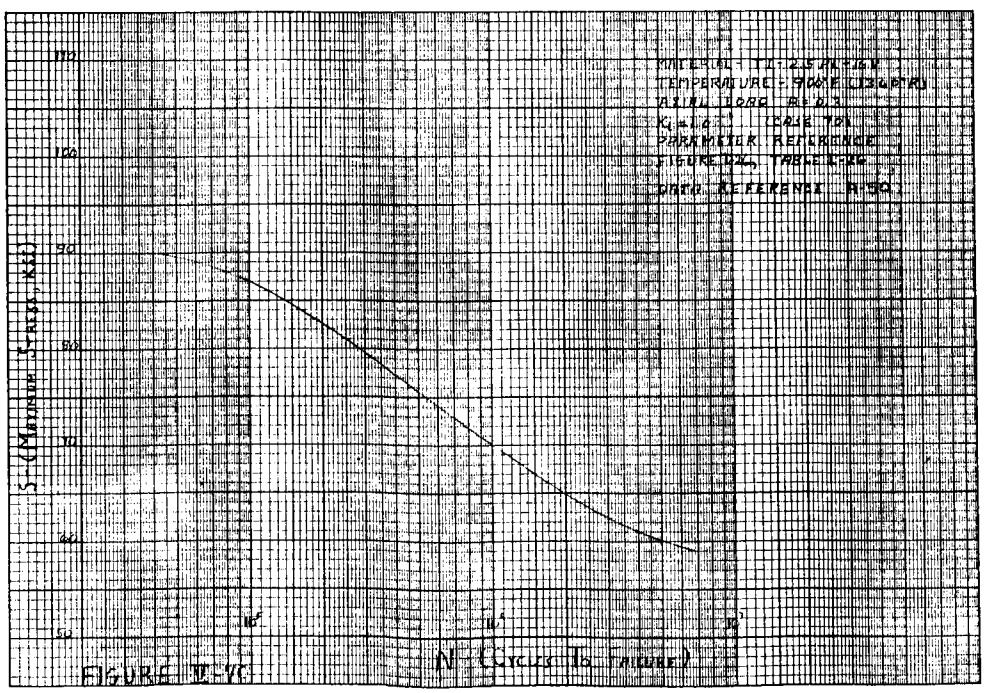


FIGURE T-VI

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-2.5Al-16V Condition S

Reference Lockheed Rpt [illegible]

Reference No. 50 Code No. 1

Test Temperature RT Environment Air

Type of Test Axial Specimen Data 0.163 in Acct

Type of Data Numerical Surface Finish

Stress Ratio 1.0 Stress Concentration Factor

Mean Stress Notch Description

Fatigue Data Source:

Author White DL, McGee

Publication [illegible]

No. References

Principal Investigator

Affiliation

Comments

Mechanical Properties Source:

D 94

Mechanical Properties:

				Other Properties:
F_{tu}	176.0	ksi	at RT	TS = 176.0 KSI
F_{ty}	159.0	ksi	at "	E = 87.54
E	14.8	10^3 ksi	at "	
G		10^3 ksi	at "	
μ			at	
% E	7.3		at "	
% RA			at "	
Hardness			at	

Date of Tabulation

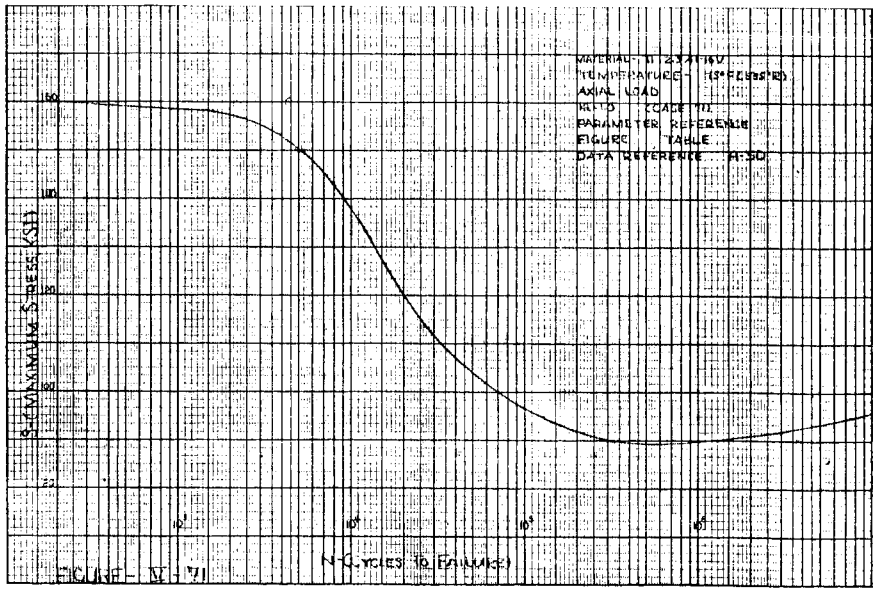
Tabulated by CS

Checked by CW Ellis

	1	2	3	4	5	6	7	8	9	10
S										
N										
S										
N										
S										
N										
S										
N										
S										
N	Correlation Data: S, KSI									
S	160.0	155.0	150.0	145.0	140.0	130.0	120.0	110.0	105.0	100.0
N	$1.5(10^3)$	$3.1(10^3)$	$5.2(10^3)$	$7.1(10^3)$	$9.0(10^3)$	$1.38(10^4)$	$2.0(10^4)$	$3.3(10^4)$	$4.6(10^4)$	$7.0(10^4)$
S	95.0	90.0	89.3							
N	$1.22(10^5)$	$3.2(10^5)$	$6.0(10^5)$							
S										
N										
S										
N										
S										
N										

Parameters: $m = 3.601$, $b = -5.225$ } C

Comments:



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-2.5Al-16V Condition

Reference Lockheed Report Kyt 8?

Reference No. Code No. 685

Date of Tabulation

Tabulated by

Checked by

Test Temperature 400°F Environment Air

Type of Test Axial Load Specimen Data 0.065 sheet

Type of Data Numerical Surface Finish

Stress Ratio 1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author White DL Mc Gee

Publication

No. References

Principal Investigator

Affiliation

Comments

Mechanical Properties Source:

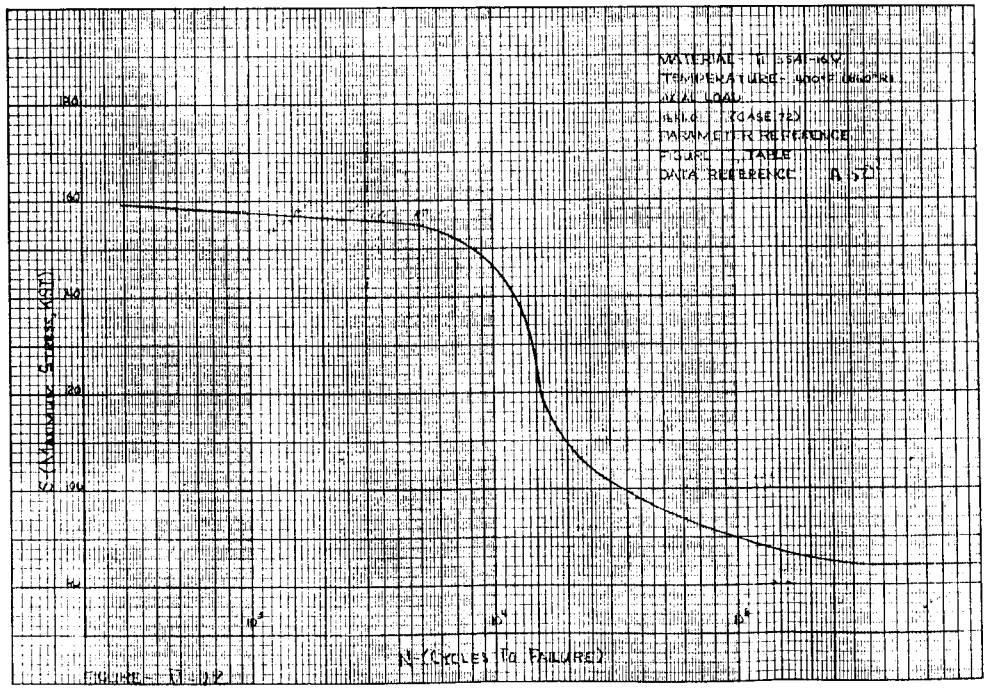
Mechanical Properties:

				Other Properties:
F_{tu}	161.0	ksi	at 400	75° = 161.0 KSI
F_{ty}	144.0	ksi	at "	E' = 82.39
E	13.5	10^3 ksi	at "	
G		10^3 ksi	at	
μ			at	
% E	7.7		at "	
% RA			at	
Hardness			at	

	1	2	3	4	5	6	7	8	9	10
S										
N										
S										
N										
S										
N										
S										
N										
S										
N	Correlation Data: S, ksi									
S	158	150	144	140	130	120	110	104	100	94
N	7.0(10³)	9.2(10³)	1.1(10⁴)	1.23(10⁴)	1.45(10⁴)	1.56(10⁴)	1.99(10⁴)	2.60(10⁴)	3.48(10⁴)	6.0(10⁴)
S	90	84								
N	1.0(10⁵)	3.5(10)⁵								
S										
N										
S										
N										
S										
N										

Parameters: m = 7.713 } C
b = 11.624

Comments:



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-2.5Al-16V Condition

Reference Lockheed Progress Rept #8 A-122

Reference No. Code No. 65

Date of Tabulation

Tabulated by CB

Checked by RFS

Test Temperature 600 °F Environment Air

Type of Test Axial Specimen Data 0.063 in sheet

Type of Data Numerical Surface Finish

Stress Ratio 1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author White DL McGee WM

Publication

No. References

Principal Investigator WM DL

Affiliation Lockheed

Comments

Mechanical Properties Source:

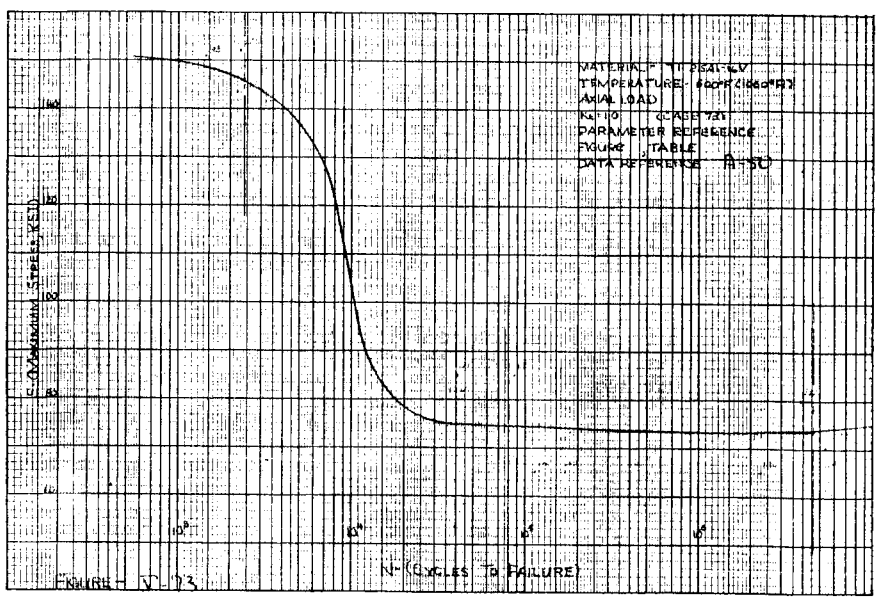
	1	2	3	4	5	6	7	8	9	10
S										
N										
S										
N										
S										
N										
S										
N										
S										
N	Correlation Data: S, ksi									
S	135	130	125	110	95	90	85	80	76.7	73.3
N	56(10)^3	6.7(10)^3	26(10)^3	92(10)^3	1.11(10^4)	1.2(10^4)	1.4(10^4)	1.8(10^4)	2.4(10^4)	1.0(10^5)
S	140	145	150							
N	4.3(10^3)	2.6(10^3)	9.0(10^2)							
S										
N										
S										
N										
S										
N										

Mechanical Properties:

			Other Properties:
F_{tu}	138.00 ksi	at 600	~~75' = 138.0 ksi~~
F_{ty}	118.00 ksi	at "	~~E' = 71.92~~
E	14.7 10^3 ksi	at "	
G	10^3 ksi	at	13' = 154.00
μ		at	E' = 72.40
% E	6.2	at 600	
% RA		at	
Hardness		at	

Parameters: m = 7.484, b = -10.752 } C

Comments:



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-2.5Al-16V Condition Solution treated & Aged
Reference LockHeed Prog. Rept #8, A-122
Reference No. _____ Code No. 685

Test Temperature 800F Environment Air
Type of Test Axial Load Specimen Data .06 sip Sheet
Type of Data Numerical Surface Finish _____
Stress Ratio Lo Stress Concentration Factor 1.0
Mean Stress _____ Notch Description _____

Fatigue Data Source:
Author White D.L. Mc Gee W.M.
Publication Prog. Rep #9 (LockHeed) cont AF 33(616)-6346
No. References _____
Principal Investigator W.M. McGee
Affiliation LockHeed
Comments _____

Mechanical Properties Source:
Same
A-94

Mechanical Properties:

F_{tu}	134 ksi	at 800°F	
F_{ty}	111 ksi	at 800°F	
E	11.2 10^3 ksi	at 800°F	
G	10^3 ksi	at	
μ		at	
% E	9.8	at 800°F	
% RA		at	
Hardness		at	

Other Properties:
TS = 134.0 KSI
E' = 64.86

Date of Tabulation _____
Tabulated by _____
Checked by Bill ck

	1	2	3	4	5	6	7	8	9	10
S	134×10^3	131×10^3	130×10^3	125×10^3	120×10^3	115×10^3	95×10^3	85×10^3	85×10^3	82×10^3
N	234	112	32	3 111	5832	$4,924$	810^3	15×10^3	41×10^3	14×10^3
S	82×10^3	82×10^3	75×10^3	75×10^3	75×10^3	60×10^3	60×10^3	60×10^3	50×10^3	50×10^3
N	218×10^3	455×10^3	26×10^3	730×10^3	1447×10^3	57×10^3	165×10^3	$2,388\times10^3$	7×10^7	7×10^7
S	540^3									
N	7×10^7									
S										
N										
S										
N	Correlation Data:									
S	133.0	130.0	125.0	120.0	110.0	100.0	95.0	90.0	85.0	80.0
N	$1.5(10^2)$	$1.1(10^3)$	$3.6(10^3)$	$4.7(10^3)$	$6.1(10^3)$	$6.8(10^3)$	$7.2(10^3)$	$8.6(10^3)$	$12(10^5)$	$2.5(10^7)$
S	75.0	70.0	66.7							
N	$1.15(10^5)$	$5.5(10^5)$	$4.0(10^6$							
S										
N										
S										
N										
S										
N										

Parameters: m = 5.162
b = -7.954

Comments: _____

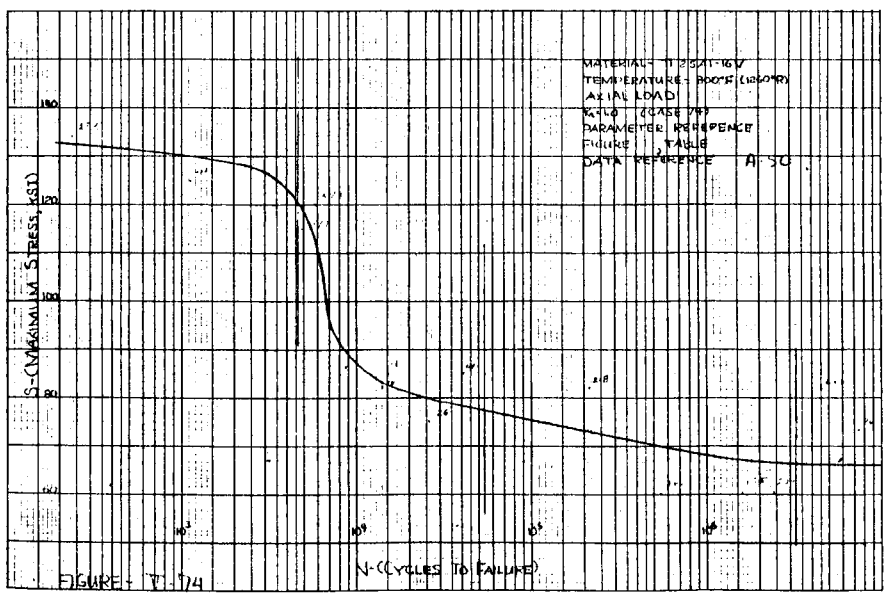


FIGURE - Ti-74

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Ti-2.5Al-16V Condition Solution treated & Aged
Reference LockHeed Prog Rept. #9 A-122
Reference No. ____ Code No. 189

Test Temperature 900F Environment Air
Type of Test Axial Load Specimen Data 0.063 in Sheet
Type of Data Numerical Surface Finish ____
Stress Ratio 1.0 Stress Concentration Factor 1.0
Mean Stress ____ Notch Description ____

Fatigue Data Source:
Author Hughes P.J., Mc Gee W.M.
Publication Prog # Rept #9 (Lockheed) Cont AF 336616)-6346
No. References ____
Principal Investigator W.M Mc Gee
Affiliation Lockheed
Comments ____

Mechanical Properties Source:
Same
A-84

Mechanical Properties:

F_{tu}	105 ksi	at	900°F
F_{ty}	86.5 ksi	at	900°F
E	9.35 10^3 ksi	at	900°F
G	____ 10^3 ksi	at	____
μ	____	at	____
% E	15.7	at	900°F
% RA	____	at	____
Hardness	____	at	____

Other Properties:
~~T.S' = 105.0 ksi~~
~~E' = 87.75~~
T_S' = 122.0
E' = 99.8

Date of Tabulation ____
Tabulated by ____
Checked by RMS

	1	2	3	4	5	6	7	8	9	10
S	$125\ 10^3$	$120\ 10^3$	$115 10^3$	$110 10^3$	$102 10^3$	$95\ 10^3$	$85 10^3$	$85\ 10^3$	$85 10^3$	$85\ 10^3$
N	19	338	529	795	4,900	7,240	$10\ 10^3$	$14 10^3$	$21 10^3$	$37 10^3$
S	$75 10^3$	$75 10^3$	$73 10^3$	$72 10^3$	$70 10^3$	$70 10^3$	$70 10^3$	$55 10^3$	$55 10^3$	$55 10^3$
N	$45 10^3$	$77 10^3$	$100 10^3$	511^3	$122 10^3$	$142 10^3$	$348 10^3$	$673 10^3$	$3644 10^3$	$9424 10^3$
S	$45 10^3$	$45 10^3$	$45 10^3$							
N	$10 10^7$	$10 10^7$	$10 10^7$							
S										
N										
S										
N	Correlation Data:									
S	105.0	100.0	95.0	90.0	85.0	80.0	70.0	65.0	60.0	55.0
N	$2.1(10^3)$	$4.0(10^3)$	$7.0(10^3)$	$1.21(10^4)$	$2.1(10^4)$	$3.6(10^4)$	$1.3(10^5)$	$2.5(10^5)$	$5.2(10^5)$	$2.3(10^6)$
S	52.2	110.0	120							
N	$9.0(10^3)$	$1.1(10^5)$	$2.4(10^5)$							
S										
N										
S										
N										
S										
N										

Parameters: m = 4.109, b = -6.470 } C

Comments: ____

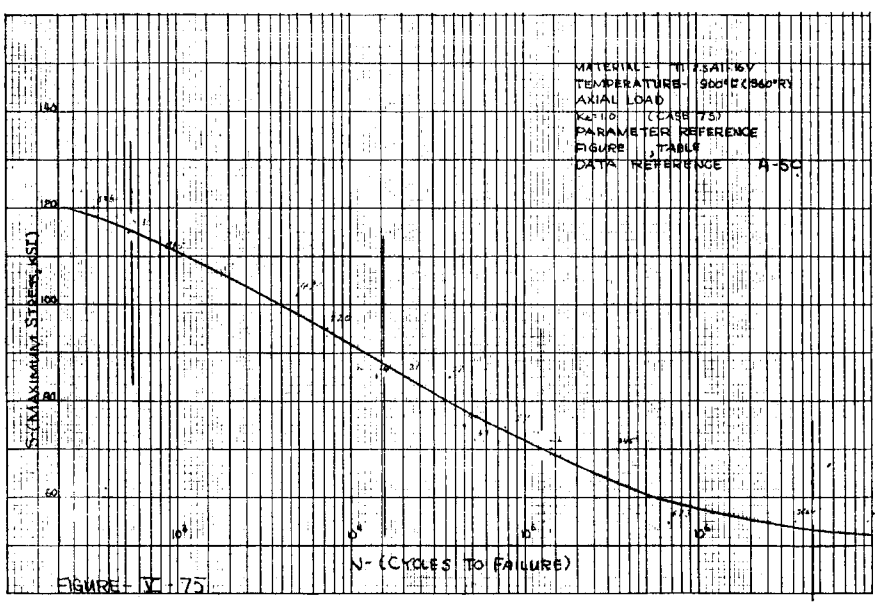


FIGURE - V - 75

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material* GMR-235 p12 Condition
Reference WADC TR 58-340 p12
Reference No. 107 Code No. 403-74

Date of Tabulation
Tabulated by RHH
Checked by CB

Test Temperature 75°F Environment Air
Type of Test Axial Specimen Data 0.20 in. dia.
Type of Data Numerical Surface Finish —
Stress Ratio ∞ Stress Concentration Factor 1.0
Mean Stress — Notch Description —

Fatigue Data Source:
Author Viteve, F.H.
Publication WADC TR 58-340 p19
No. References 7
Principal Investigator Author
Affiliation University of Minnesota
Comments

Mechanical Properties Source:
Metals Handbook Vol. 1, ed. 8, p. 463

Mechanical Properties:

F_{tu}	106.0	ksi	at 75°F	
F_{ty}	90.0	ksi	at 75°F	
E	30.0	10^3 ksi	at 75°F	
G		10^3 ksi	at	
μ			at	
% E	4.0		at 75°F	
% RA			at	
Hardness			at	

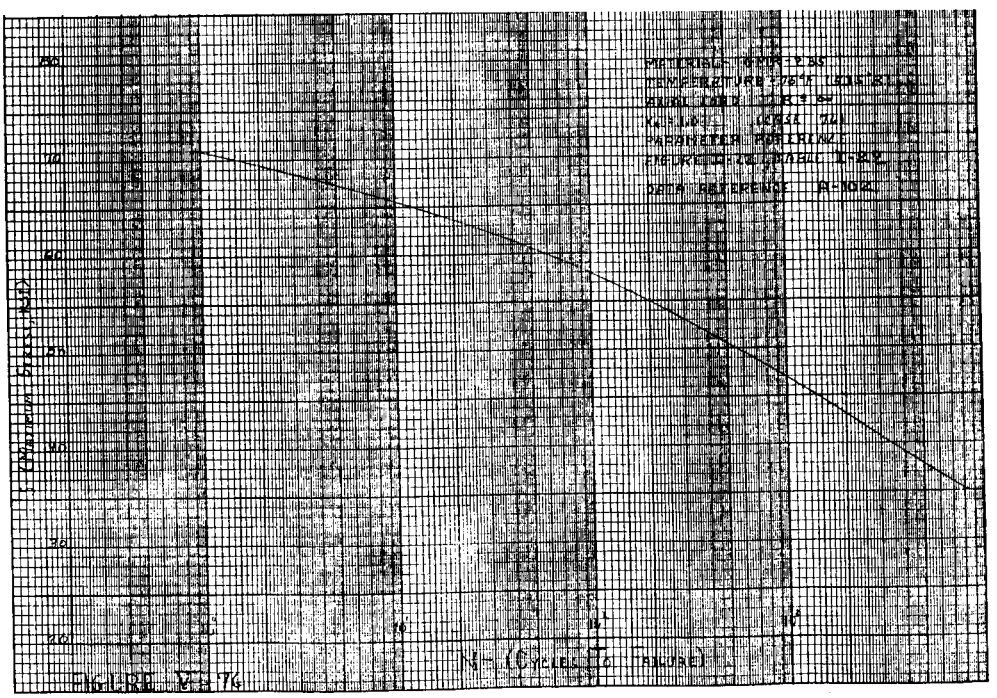
Other Properties:
$TS' = 106.0$ KSI
$E' = 33.99$ KSI

*S	32.0 a	35.0	43.0	50.0	60.0	70.0				
N	29,970	6,574	1,296	672	97	1.8				
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation						
S	70.0	67.5	65.0	60.0	55.0	50.0	45.0	40.0	37.5	35.0
N	1.6×10^6	5.3×10^6	1.3×10^7	5.8×10^7	1.95×10^8	5.9×10^8	1.9×10^9	3.9×10^9	5.3×10^9	8.3×10^9
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

@ Test Discontinued

Parameters:*
m = 0.556
b = −0.105

Comments: 1; 0.19C, 2.95Al, 2.25Ti, 5.50Mo, 15.7Cr, 10.0Fe, 0.20Si, 0.02Mn 0.092Bi, Bal Ni
2 S - ksi - N-kilocycles
3 Computer values



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material GMR-235 Condition —
Reference WADC TR 58-340 p 12
Reference No. 102 Code No. 403-74

Date of Tabulation
Tabulated by
Checked by CB

Test Temperature 1200°F Environment Air
Type of Test Axial Specimen Data 0.20 in. dia.
Type of Data Numerical Surface Finish —
Stress Ratio ∞ Stress Concentration Factor 1.0
Mean Stress — Notch Description

Fatigue Data Source:

Author Vitovec, F.H.
Publication WADC TR 58-340
p.19
No. References 7

Principal Investigator Author
Affiliation University of Minnesota
Comments

Mechanical Properties Source:

Metals Handbook
V.1, ed. 8
p. 463

S	36.0 a	38.0	38.0	40.0	42.0	45.0	45.0	50.0	55.0	
N	27,440	17,390	9,742	5,724	5,255	50	52	50	17	
S										
N										
S										
N										
S										
N										
S										
N										
S	53.0	52.0	51.0	50.0	49.0	48.0	47.0	46.0	45.0	44.0
N	1.1×10⁴	1.5×10⁴	2.1×10⁴	2.9×10⁴	4.3×10⁴	6.3×10⁴	1.0×10⁵	1.6×10⁵	2.8×10⁵	5.4×10⁵
S	93.0	92.0	91.0	90.0	89.0	88.0				
N	1.0×10³	2.0×10³	5.0×10³	1.1×10⁴	2.1×10⁴	4.1×10⁴				
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Data Correlation

@ Test Discontinued

Parameters: M = 0.686
b = 0.135

Mechanical Properties:

F_{tu}	95.0	ksi	at 1200°F	
F_{ty}	83.0	ksi	at 1200°F	
E	25.0	10^3 ksi	at 1200°F	
G		10^3 ksi	at	
μ			at	
% E	3.0		at 1200°F	
% RA			at	
Hardness			at	

Other Properties:

TS = 95.0 ksi
E' = 27.05 ksi

Comments: 1; 0.19C, 2.95Al, 2.25Ti, 5.60Mo, 15.7Cr, 10.0Fe, 0.20Si, 0.02Mn, 0.0928; Bal Ni
2; S-ksi N-kilocycles
3 Computer values

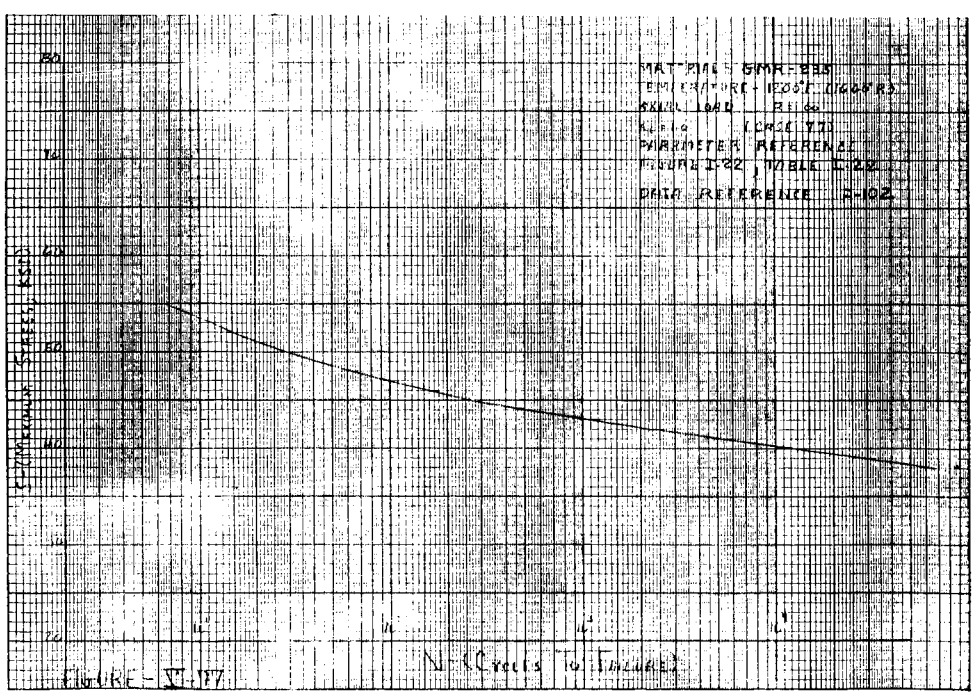


FIGURE - XI-17

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material* GMR-235 Condition —

Reference WADC TR 58-340 p. 12

Reference No. 102 Code No. 403-74

Date of Tabulation

Tabulated by VA

Checked by CB

Test Temperature 1650°F Environment Air

Type of Test Axial Specimen Data 0.25 in. dia.

Type of Data Numerical Surface Finish —

Stress Ratio ∞ Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Vitovec, F.H.

Publication WADC TR 58-340 p. 20

No. References 17

Principal Investigator Author

Affiliation University of Minnesota

Comments

Mechanical Properties Source:

Metals Handbook Vol. 1, ed. 8 p. 463

Mechanical Properties:

F_{tu}	64.0 ksi	at 1650°F	
F_{ty}	60.0 ksi	at 1650°F	
E	21.0 10^3 ksi	at 1650°F	
G	10^3 ksi	at	
μ		at	
% E	10.0	at 1650°F	
% RA		at	
Hardness		at	

Other Properties:

TS' = 64.0 KSI

E' = 22.86 KSI

S	23.0	25.0	27.0	28.5	28.5	30.0				
N	26,170	4,953	3,719	108	29	222				
S										
N										
S										
N										
S										
N										
S										
N										
S				Data Correlation						
N										
S	29.5	29.0	28.5	28.0	27.5	27.0	26.5	26.0	25.0	24.0
N	2.6×10^1	9.5×10^1	2.3×10^2	4.8×10^2	9.6×10^2	1.73×10^3	3.2×10^3	5.4×10^3	1.54×10^4	4.2×10^4
S	23.5									
N	6.9×10^4									
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Parameters:* m = 0.632

b = 0.214

Comments: 1; 0.19C, 2.8Al, 2.25Ti, 5.50Mo, 15.7Cr, 10.0Fe, 0.20Si, 0.02Mn, 0.092Bi Bal. Ni

2; S-Ksi N-kilocycles

3 Computer values

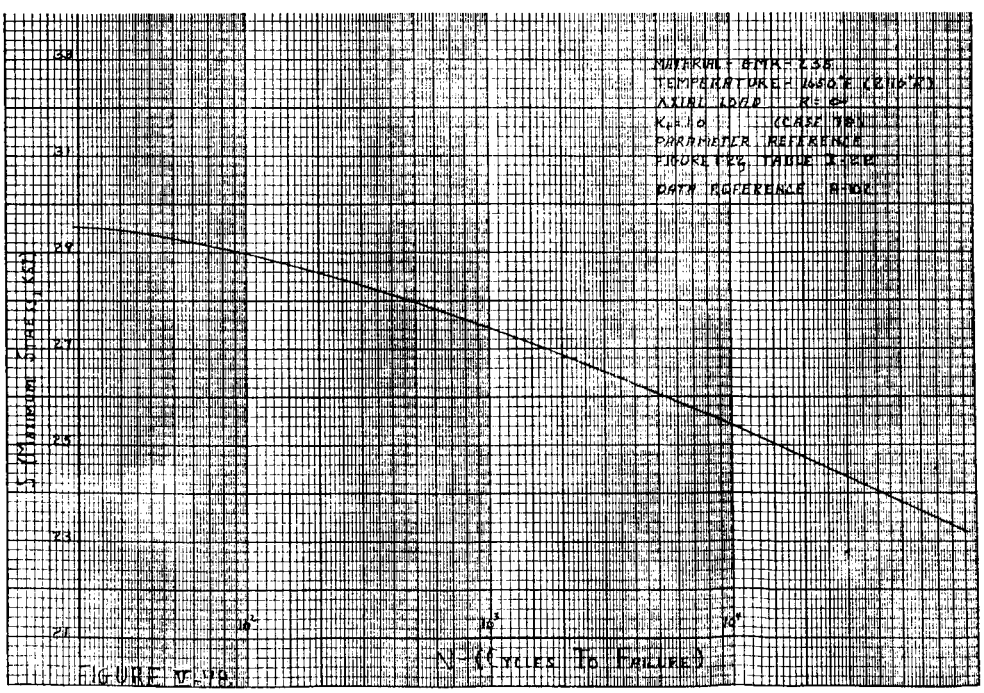


FIGURE V-78

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material* Cr Mo STEEL Condition 1650°F O.Q., 1022°F

Reference*2 SAME AS FATIGUE DATA A.Q.

Reference No. 47 Code No. 116 91

Test Temperature RT Environment AIR

Type of Test Ax Specimen Data 0.55"D

Type of Data NUMERICAL Surface Finish

Stress Ratio -1 Stress Concentration Factor 1

Mean Stress 0 Notch Description

Fatigue Data Source:*2

Author GROVER, H.J., GORDON, S.A., JACKSON, L.R.

Publication THE FATIGUE OF METALS AND STRUCTURES. P. 298

No. References

Principal Investigator*2

Affiliation

Comments

Mechanical Properties Source:*2

SAME AS FATIGUE DATA

Mechanical Properties:

F_{tu}	110 ksi	at	RT
F_{ty}	88 ksi	at	RT
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	15	at	RT
% RA		at	
Hardness		at	

Other Properties:

TS' = 110.0 Ksi

E' = 47.90 Ksi

Date of Tabulation

Tabulated by CB

Checked by RW

Data Correlation, Ksi

	1	2	3	4	5	6	7	8	9	10
S	56.0	55.5	55.0	54.5	54.0	53.0	52.0	51.0	50.0	49.5
N	4.0×10^5	4.9×10^5	6.0×10^5	7.0×10^5	8.0×10^5	1.0×10^6	1.29×10^6	1.5×10^6	1.93×10^6	2.4×10^6
S	49.0									
N	7.0×10^6									
S										
N										
S										
N										
S										
N										
S										
N										
S	56,000	53,000	49000	47,000						
N	400,000	1,000,000	4000,000	10,000,000						
S										
N										
S										
N										
S										
N										

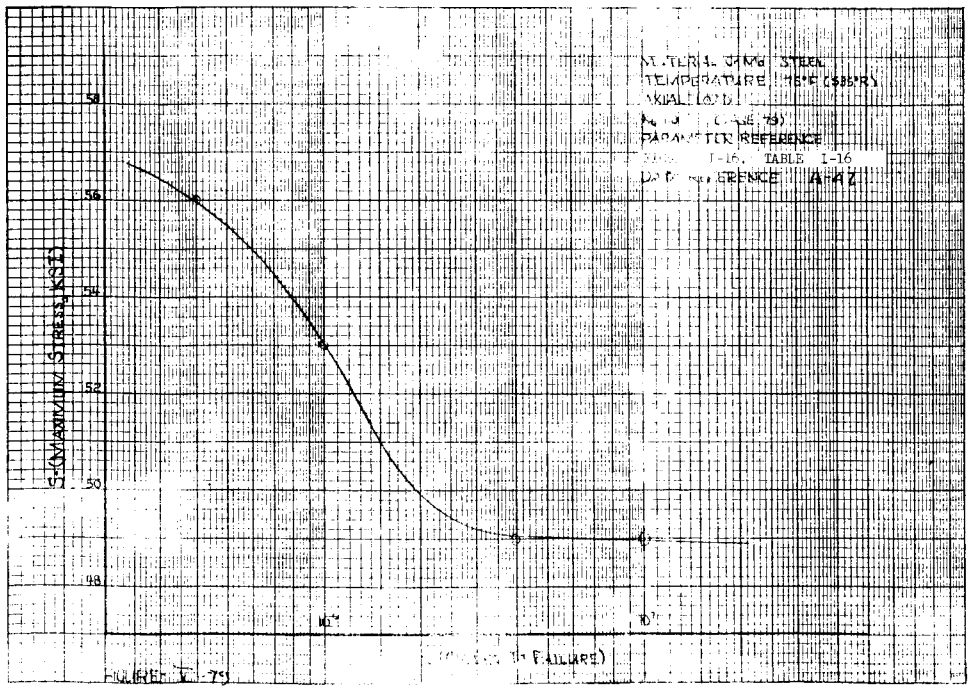
Parameters:*3 m = 1.867

b = -2.478

Comments:* 1. 0.13C, 0.51Si, 0.40Mn, 0.007P, 0.014S, 0.74Cr, 0.67Mo, 0.18Ni.

2. HEMPEL, MAX, AND KRUG, HERMAN, "TENSION-COMPRESSION FATIGUE TESTS ON STEEL AT HIGH TEMPERATURES AND THEIR EVALUATION ACCORDING TO DIFFERENT PROCEDURES", MITT. KAISER-WILHELM-INST. EISENFORSCH. DUSSELDORF, VOL. 24, PP. 71-95(1)

3 Computer values Per data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material[*1] Cr-Mo STEEL Condition 1650°F O.Q., 1022°F A.Q.
Reference SEE FATIGUE REF.
Reference No. 42 Code No. 46 41

Test Temperature 212°F Environment AIR
Type of Test Ax Specimen Data 0.55"D
Type of Data NUMERICAL Surface Finish —
Stress Ratio -1 Stress Concentration Factor 1
Mean Stress 0 Notch Description —

Fatigue Data Source:[*2]
Author GROVER, H.J., GORDON, S.A., JACKSON, L.R.
Publication THE FATIGUE OF METALS AND STRUCTURES, P.298
No. References
Principal Investigator[*2]
Affiliation
Comments

Mechanical Properties Source:
SEE FATIGUE DATA REF.

Mechanical Properties:

F_{tu}	96 ksi	at 212°F	
F_{ty}	76 ksi	at 212°F	75 = 96 Ksi
E	10^3 ksi	at	E' = 96.09 Ksi
G	10^3 ksi	at	
μ		at	
% E	15	at 212°F	
% RA		at	
Hardness		at	

Other Properties:

Date of Tabulation
Tabulated by CB
Checked by RAP

Data Correlation KSI

	1	2	3	4	5	6	7	8	9	10
S	60.0	58.0	56.0	54.0	52.0	51.0	50.0	49.0	48.0	47.5
N	1.0×10^5	1.6×10^5	2.5×10^5	4.0×10^5	7.2×10^5	1.0×10^6	1.34×10^6	1.83×10^6	2.5×10^6	2.95×10^6
S	47.0									
N	4.6×10^6									
S										
N										
S										
N										
S										
N										
S	60,000	58,000	56,000	54,000	52,000					
N	100,000	400,000	400,000	400,000	400,000					
S										
N										
S										
N										
S										
N										
S										
N										

Parameters:[*3] m = 3.940
b = -6.159

Comments:[*4]
1. 0.13 C, 0.51 Si, 0.40 Mn, 0.007 P, 0.045 S, 0.74 Cr, 0.67 Mo, 0.18 Ni
2. HEMPEL, MAX., AND KRUG, HERMAN, "TENSION-COMPRESSION FATIGUE TESTS ON STEEL AT HIGH TEMPERATURES AND THEIR EVALUATION ACCORDING TO DIFFERENT PROCEDURES," MITT. KAISER-WILHELM-INST. EISENFORSCH DUSSELDORF, VOL. 24, pp. 71-95 (1942).
3. Computer values
4. Poor data

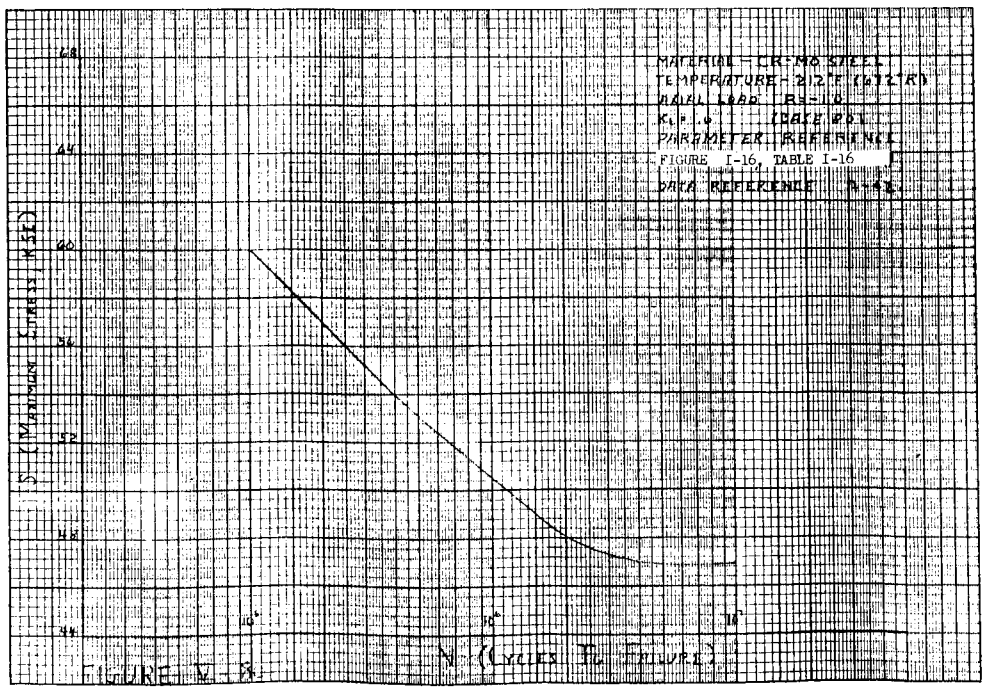


FIGURE V-8

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material *1 Cr-Mo STEEL Condition 1650°F 2 hr., 1325°F

Reference SEE FATIGUE DATA REF. A.D.

Reference No. 42 Code No. ~~Ha-41~~

Test Temperature 392°F Environment AIR

Type of Test Ax Specimen Data 0.55"D

Type of Data NUMERICAL Surface Finish ——

Stress Ratio -1 Stress Concentration Factor 1

Mean Stress 0 Notch Description ——

Fatigue Data Source: *2

Author GROVER, H.J., GORDON, S.A., JACKSON, L.R.

Publication THE FATIGUE OF METALS AND STRUCTURES, P. 298

No. References

Principal Investigator *2

Affiliation

Comments

Mechanical Properties Source:

SEE FATIGUE DATA

Mechanical Properties:

				Other Properties:
F_{tu}	94	ksi	at 392°F	
F_{ty}	77	ksi	at 392°F	TS' = 94.0 Ksi
E		10^3 ksi	at	E' = 46.06
G		10^3 ksi	at	
μ			at	
% E	12		at 392°F	
% RA			at	
Hardness			at	

Date of Tabulation

Tabulated by C B

Checked by BY

Data Correlation K2i

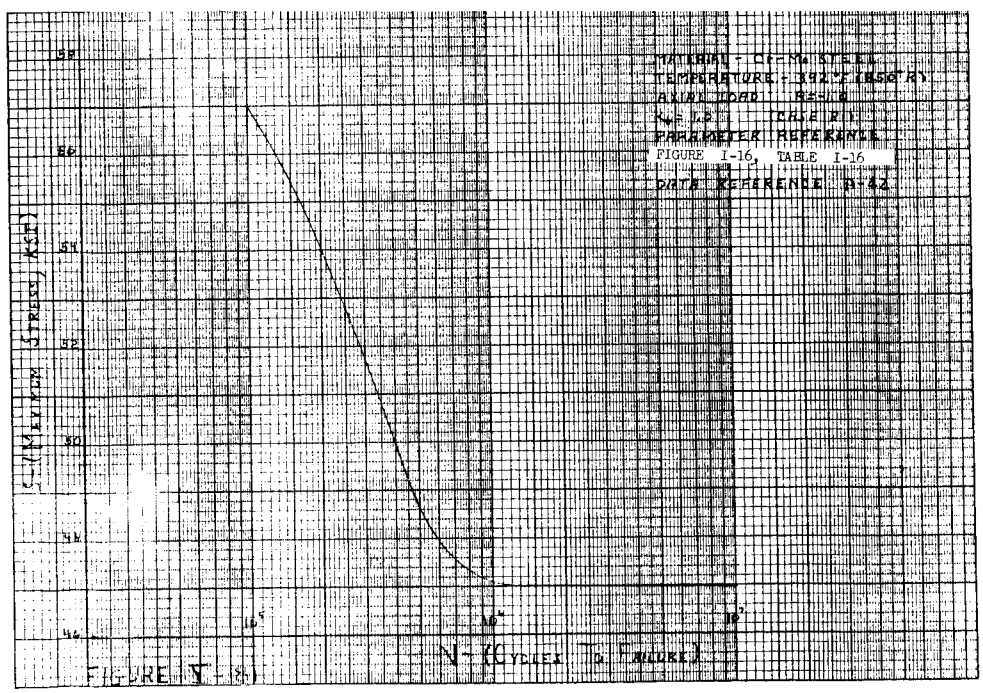
	1	2	3	4	5	6	7	8	9	10
S	57.0	56.0	55.0	54.0	53.0	52.0	51.0	50.0	49.0	48.0
N	1.0×10^5	1.3×10^5	1.6×10^5	2.0×10^5	2.4×10^5	2.75×10^5	3.9×10^5	9.0×10^5	9.6×10^5	5.7×10^5
S	51.5	47.0								
N	1.2×10^5	9.0×10^5								
S										
N										
S										
N										
S										
N										
S	57000	50,000	47000	47,000	47000					
N	10,2000	420000	1000,000	4,000,000	10,000,000					
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: C = 4.158, K = -6.281

*Comments: 1. 0.13C, 0.58Si, 0.40Mn, 0.022P, 0.014S, 0.74Cr, 0.67Mo, 0.18Ni

2. HEMPEL, MAX AND KRUG, HERMAN, "TENSION-COMPRESSION FATIGUE TESTS ON STEEL AT HIGH TEMPERATURES AND THEIR EVALUATION ACCORDING TO DIFFERENT PROCEDURES," MITT. KAISER WILHELM-INST. EISENFORSCH DUSSELDARF, VOL 24, PP. 71-95 (1942)

Poor data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material *1 Cr-Mo STEEL Condition 1658°F O.Q., 1022°F

Reference SAME AS FATIGUE DATA A.Q.

Reference No. 442 Code No. X46 41

Test Temperature 572°F Environment AIR

Type of Test AX Specimen Data 0.55" D

Type of Data NUMERICAL Surface Finish —

Stress Ratio — Stress Concentration Factor 1.0

Mean Stress 0 Notch Description —

Fatigue Data Source: *2

Author GROVER, H.J., GORDON, S.A., JACKSON, L.R.

Publication THE FATIGUE OF METALS AND STRUCTURES, P.298

No. References

Principal Investigator *2

Affiliation

Comments

Mechanical Properties Source:

SAME AS FATIGUE DATA

Mechanical Properties:

				Other Properties:
F_{tu}	96	ksi	at 572°F	K_T=1
F_{ty}	74	ksi	at 572°F	TS' = 96 Ksi
E		10^3 ksi	at	E' = 56.09 Ksi
G		10^3 ksi	at	
μ			at	
% E	13		at 572°F	
% RA			at	
Hardness			at	

Date of Tabulation

Tabulated by CB

Checked by Am

Data Correction, Ksi

	1	2	3	4	5	6	7	8	9	10
S	68.0	67.0	66.0	65.0	64.0	63.0	62.0	61.0	60.0	59.0
N	4.0×10^4	6.8×10^4	1.04×10^5	1.5×10^5	2.1×10^5	2.9×10^5	4.0×10^5	5.4×10^5	7.3×10^5	1.0×10^6
S	58.0	57.5	57.0							
N	1.6×10^6	2.25×10^6	4.0×10^6							
S										
N										
S										
N										
S										
N										
S	68,000	68,000	62,000	59,000	57,000	57,000				
N	40,000	100,000	400,000	1,000,000	4,000,000	10,000,000				
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 3.337, b = -5.037 } C

Comments: 1 0.13 C, 0.54 Si, 0.40 Mn, 0.007 P, 0.014 S, 0.74 Cr, 0.67 Mo, 0.18 Ni

2 HEMPEL, MAX AND KRIG, HERMAN, "TENSION — COMPRESSION FATIGUE TESTS ON STEEL AT HIGH TEMPERATURES AND THEIR EVALUATION ACCORDING TO DIFFERENT PROCEDURES," MITT. KAISER-WILHELM-INST. EISENFORSCH DUSSELDORF, VOL. 24, pp 71-93 1942.

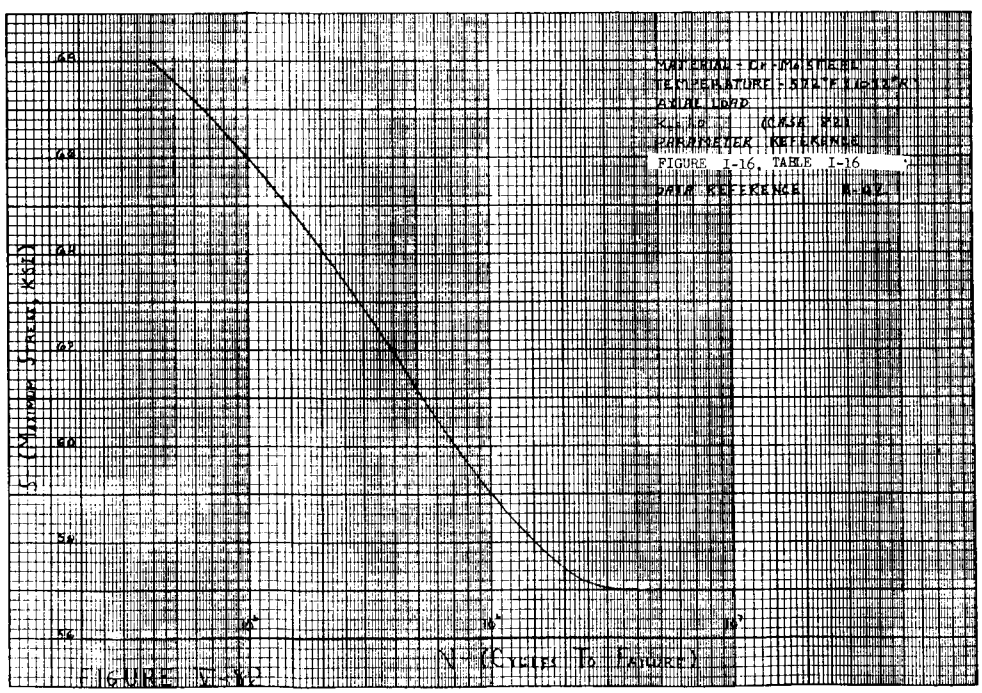


FIGURE V-42

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material #1 Cr-Mo STEEL Condition 1650°F 0.9, 1022°F

Reference SAME AS FATIGUE DATA A.Q.

Reference No. 42 Code No. #641

Test Temperature 752°F Environment AIR

Type of Test AX Specimen Data 0.55"D

Type of Data NUMERICAL Surface Finish —

Stress Ratio -1 Stress Concentration Factor 1.0

Mean Stress 0 Notch Description —

Fatigue Data Source: #2

Author GROVER, H.J., GORDON, S.A., JACKSON, L.R.

Publication THE FATIGUE OF METALS AND STRUCTURES, P.298.

No. References

Principal Investigator #3

Affiliation

Comments

Mechanical Properties Source:

SAME AS FATIGUE DATA

Mechanical Properties:

F_{tu}	101	ksi	at 752°F	
F_{ty}	76	ksi	at 752°F	
E		10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E	16		at 752°F	
% RA			at	
Hardness			at	

Other Properties:

$K_T = 1$

$TS' = 101.0$ KSI

$E' = 52.99$ MSI

Date of Tabulation

Tabulated by CB

Checked by MW

Data Correlation, K_t

	1	2	3	4	5	6	7	8	9	10
S	65.0	62.0	61.0	60.0	59.0	58.0	57.0	56.0	55.0	54.5
N	9.2×10^4	6.3×10^4	1.0×10^5	1.58×10^5	2.5×10^5	4.0×10^5	6.3×10^5	1.0×10^6	1.55×10^6	2.05×10^6
S	59.0									
N	9.2×10^6									
S										
N										
S										
N										
S										
N										
S	63,000	61,000	58,000	56,000	54,000	54,000				
N	40000	400,000	400,000	400,000	400,000	400,000				
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: $m = 2.547$ } C

$b = -3.511$ }

Comments: * 1 0.13C, 0.57Si, 0.40Mn, 0.007P, 0.014S, 0.74Cr, 0.67Mo, 0.18Ni.

2 HEMPEL, MAX, KRUG H., "TENSION-COMPRESSION FATIGUE TESTS ON STEEL AT HIGH TEMPERATURES AND THEIR EVALUATION ACCORDING TO DIFFERENT PROCEDURES," MITT. KAISER-WILHELM-INST. EISENFORSCH DUSSELDORF, VOL. 24, PP. 71-95, 1942.

Poor data

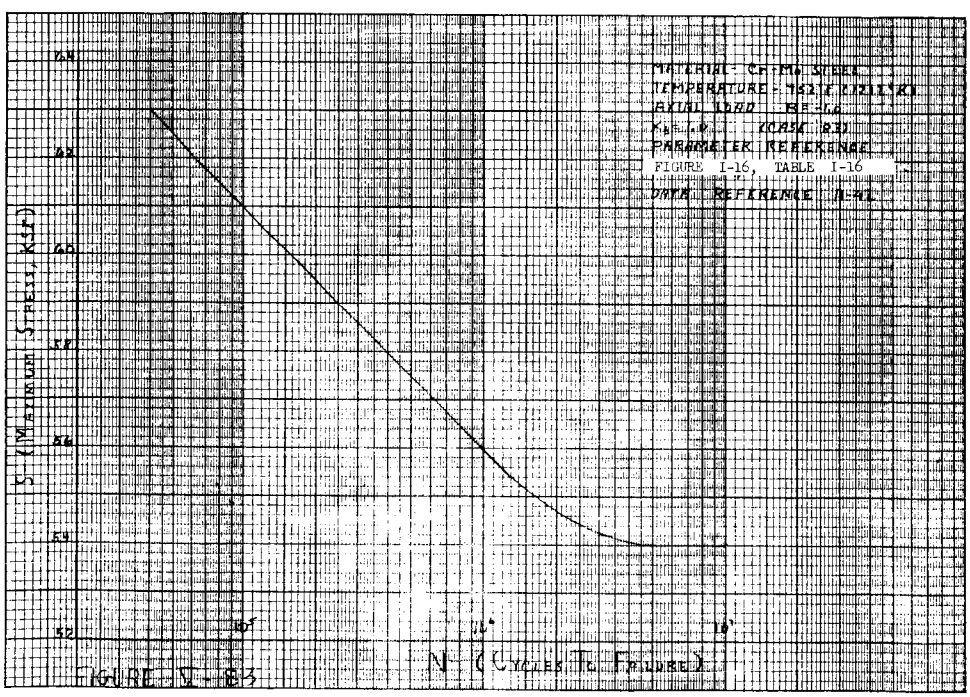


FIGURE I - 83

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Cr Mo Steel 0.13C 0.59Si 0.40Mn 4007P 0.014S 0.34Cr 0.18Ni Condition 1688 OQ, 1022 AQ

Reference

Reference No. 42 Code No. 44 41

Date of Tabulation

Tabulated by

Checked by RMJ

Test Temperature 932°F Environment Air

Type of Test Axial Load Specimen Data 0.53"

Type of Data Design Data (Numerical) Surface Finish

Stress Ratio -1 Stress Concentration Factor 1.0

Mean Stress Notch Description —

Fatigue Data Source:

Author 2

Publication

No. References

Principal Investigator 2

Affiliation

Comments

Mechanical Properties Source:

Mechanical Properties:

F_{tu}	89 ksi	at	932°F
F_{ty}	66.0 ksi	at	932°F
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	11.0	at	932°F
% RA		at	
Hardness		at	

Other Properties:

~~TS' = 89.0 K_t~~

~~E' = 85.11 K_t~~

~~TS' = 92.7~~

TS' = 92.30

E' = 85.10

Data Correlation, K_t

	1	2	3	4	5	6	7	8	9	10
S	91.0	90.0	89.0	88.0	87.6	87.2	86.8	86.4	86.2	86.0
N	9.0×10^5	5.9×10^5	7.2×10^5	1.0×10^6	1.18×10^6	1.4×10^6	1.7×10^6	2.27×10^6	2.85×10^6	6.0×10^6
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S	91×10^3	88×10^3	86×10^3	86×10^3						
N	4×10^5	10^6	4×10^6	10^7						
S										
N										

USE THIS INTERMITTION FOR COMPUTER REDUCTION OF PARAMETERS

Parameters: $m = 12.608$ } C

$b = -22.309$

Comments: 1. Grover HJ. Gordon SA. Jackson LR. The Fatigue of Metals and Structures

2. Hempel M Krug H. Tension-Compression Fatigue Tests on steel at High Temperature and Their evaluation according to different procedures. Mit Kaiser Wilhelm Inst. Eisenfrsch, Dusseldurf vol 24 071 1942

POOR DATA

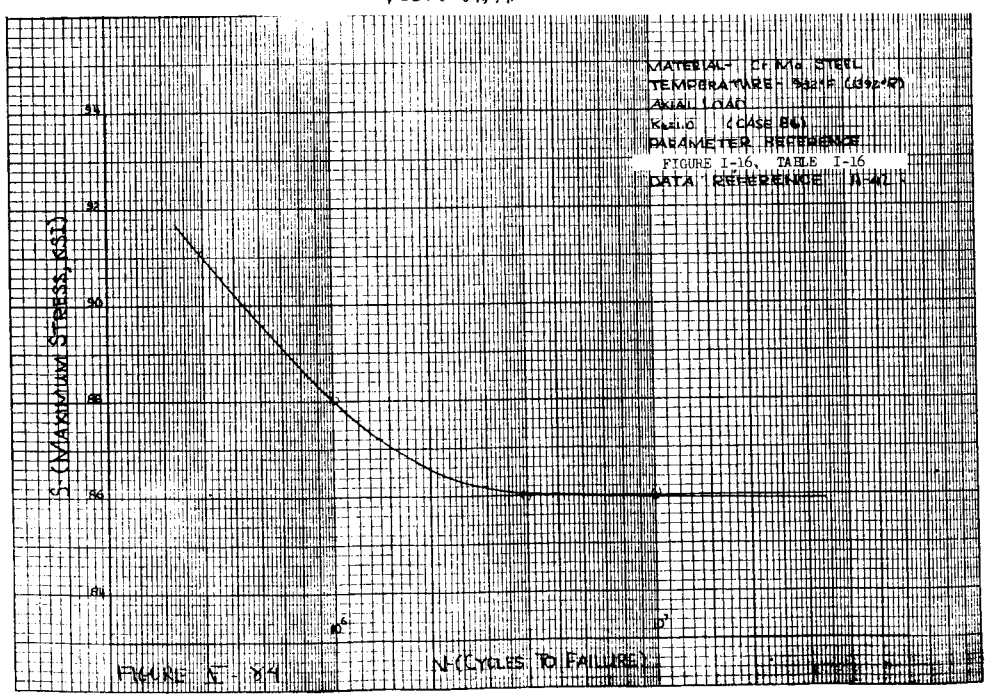


FIGURE N- 84

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2014 T Al Condition Forged (Test Specimens were cut from the bar of a propeller)

Reference AD 63977 (ASTIA), p.7

Reference No. 85 Code No. 103

Test Temperature RT Environment Air

Type of Test Rotating Beam Specimen Data 0.30 in min. dia.

Type of Data Numerical Surface Finish 54

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress — Notch Description —

Fatigue Data Source:

Author Stelk, George

Publication ASTIA AD 63977 p. 21

No. References 6

Principal Investigator Author

Affiliation Capt. U.S.A.F.

Comments Thesis (California Inst. of Tech) 1955.

Mechanical Properties Source:

Metals Handbook Vol, 8 ed. p. 937, 938.

Mechanical Properties:

				Other Properties:
F_{tu}	62.0 ksi	at	RT	TS = 105.4 Ksi
F_{ty}	42.0 ksi	at	RT	E' = 22.15 Ksi
E	10.6 10^3 ksi	at	RT	
G	10^3 ksi	at		
μ		at		
% E	20	at	RT	
% RA		at		
Hardness		at		

Date of Tabulation

Tabulated by DS

Checked by RM

Correlation Data K_{ei}

S	37,000	36,000	34,000	32,000	30,000	28,000	26000	25,000	24000	23200
N	68,000	94,000	172,000	310,000	550,000	1,550,000	5,200,000	11,300,000	25,000,000	80,000,000
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Parameters*: $(m) = 1.881$

$b = -2.439$

Comments*: 1 Computer values

Statistical mean curve used

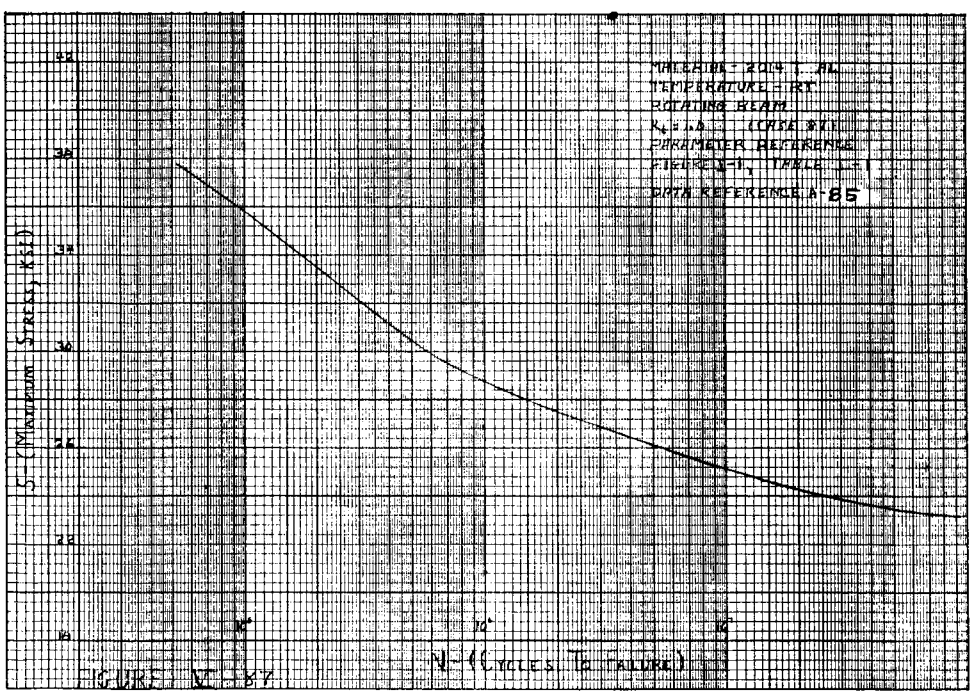


FIGURE 8-11

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2014 T Al Condition Forged
Reference AD 63977 (ASTIA), p.7
Reference No. 85 Code No. 103

Date of Tabulation
Tabulated by RMA
Checked by DS

Test Temperature 200°F Environment Air
Type of Test Rotating Beam Specimen Data 0.30 inch min. dia.
Type of Data Numerical Surface Finish 54
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Stalk, George
Publication ASTIA AD 63977, p. 25
No. References 6
Principal Investigator Author
Affiliation Capt. USAF
Comments Thesis (Cal. Inst. of Tech.) 1955

Mechanical Properties Source:
Metals Handbook
V.1, 8ed.
p.931, 938

Mechanical Properties:

F_{tu}	54.0 ksi	at 200°F	
F_{ty}	ksi	at	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

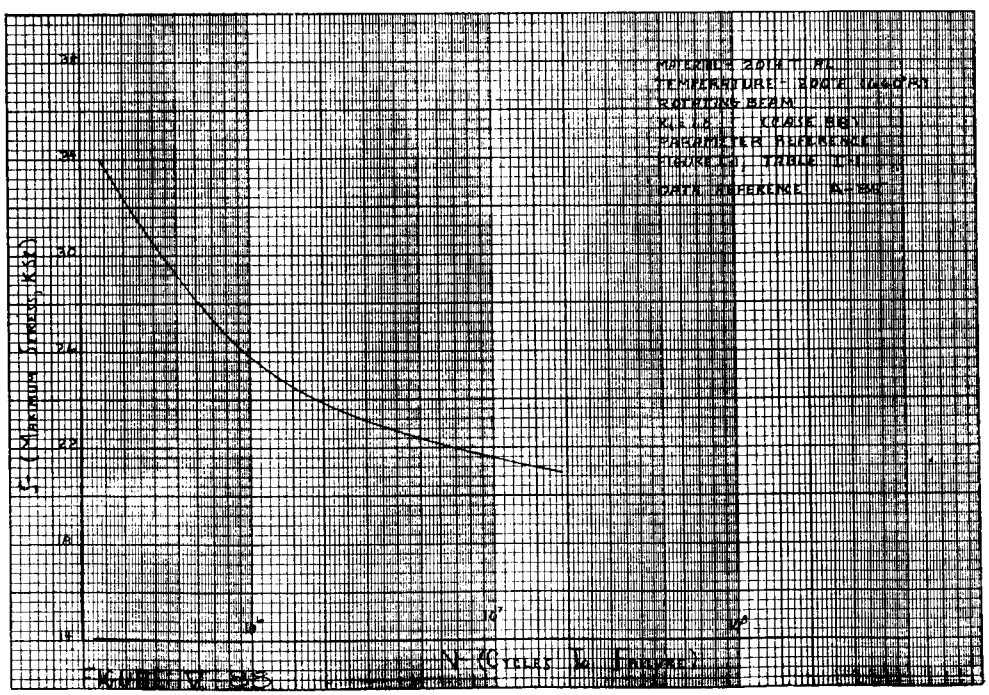
Other Properties:
TS = 91.8 KSI
E' = 20.08 KSI

Correlation Data: KSI

	1	2	3	4	5	6	7	8	9	10
S	34,000	32,000	30,000	28,000	26,000	25,000	24,000	23,000	22,000	21,000
N	242000	320,000	430,000	610,000	940,000	1,270,000	1,820,000	3,200,000	6,200,000	12,000,000
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 3.238
b = -4.910

Comments: Computer values
Mean Statistical Curve used for data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2014 T 61 Condition Forged
Reference ASTIA AD 63977, p.7
Reference No. 85 Code No. 103

Test Temperature 400°F Environment Air
Type of Test Rotating Beam Specimen Data 0.30 in min. dia.
Type of Data Numerical Surface Finish 54
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Stalk, George
Publication ASTIA AD 63977
p.29
No. References 6

Principal Investigator Author
Affiliation Capt. USAF
Comments Thesis (Cal. Inst. of Tech.)
1955

Mechanical Properties Source:
Metals Handbook
p. 937, 938
V.1 8 ed.

Mechanical Properties:

F_{tu}	180 ksi	at	400°F
F_{ty}	ksi	at	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:
TS = 30.60 KSI
E' = 15.69 KSI

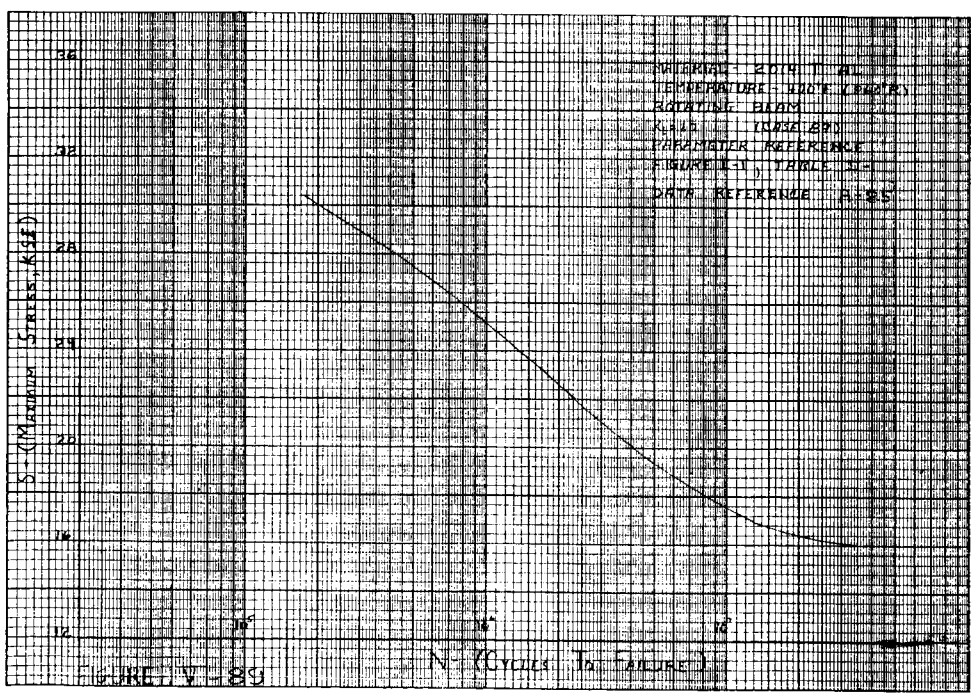
Date of Tabulation
Tabulated by RAA
Checked by DS

Correlation Data: KSI

	1	2	3	4	5	6	7	8	9	10
S	32,400	29,200	26000	24,000	22,000	20,000	19,000	18,000	17,000	16,000
N	175,000	420,000	780,000	1,394,000	2,400,000	4200,000	5,800,000	9,200,000	13,000,000	35,000,000
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 13.786
b = 25.980

Comments: 1. Computer values
Mean Statistical S-N curve used



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075-T Al Condition Forged
Reference ASTIA AD63977 p.7
Reference No. 85 Code No. 103

Test Temperature RT Environment Air
Type of Test Rotating Beam Specimen Data 0.30 in. min. dia.
Type of Data Numerical Surface Finish 54
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Stalk, George
Publication ASTIA AD 63977
p.33
No. References 6
Principal Investigator Author
Affiliation Capt. USAF
Comments Thesis (Col. Inst. of Tech.)
1955

Mechanical Properties Source:
Alcoa PT No. 9-47-9
Copy 251, p. 26.

Mechanical Properties:

F_{tu}	82.0 ksi	at	RT
F_{ty}	72.0 ksi	at	RT
E	10.4 10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	11.0	at	RT
% RA		at	
Hardness		at	

Other Properties:
TS = 139.4 Ksi
E = 27.41 Ksi

Date of Tabulation
Tabulated by CB
Checked by MA

Correlation Data Ksi

	1	2	3	4	5	6	7	8	9	10
S	45000	42000	40,000	38000	36,000	34000	32,000	31,000	30,000	29,800
N	140000	215000	250,000	360,000	460,000	590000	830,000	1,040,000	1,370,000	15,000,000
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters:* A = 2.867
k = -4.020

Comments:* 1 Computer values

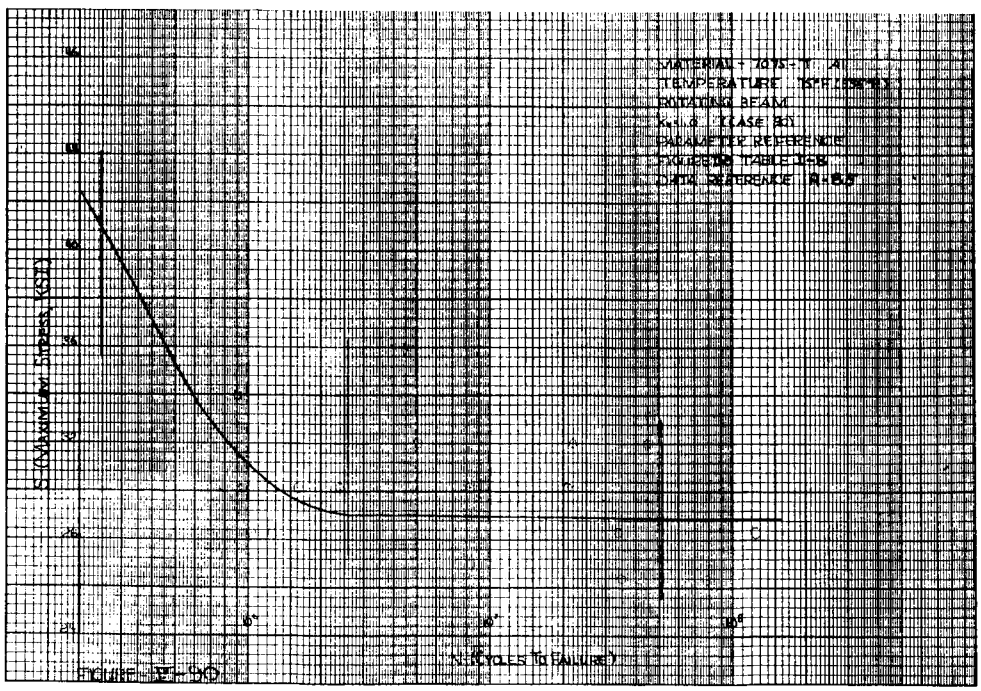


FIGURE E-1-20

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075 T Al Condition Forged
Reference ASTIA AD 63977
Reference No. 85 Code No. 103

Test Temperature 200 °F Environment Air
Type of Test Rotating Beam Specimen Data 0.30 inch min. dia
Type of Data Numerical Surface Finish 5 µ
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Stalk, George
Publication ASTIA AD 63977
P. 37
No. References 6
Principal Investigator Author
Affiliation Capt. USAF
Comments Thesis (Cal. Inst. of Tech.)
1955

Mechanical Properties Source:
ALCOA PT 9.47.3
Copy 251, p.26

Mechanical Properties:

				Other Properties:
F_{tu}	72.0	ksi	at 210°F	TS' = 122.4
F_{ty}	64.0	ksi	at 212°F	E' = 25.38
E	10.0	10^3 ksi	at 200°F	
G		10^3 ksi	at	
µ			at	
% E	15		at 212°F	
% RA			at	
Hardness			at	

Date of Tabulation
Tabulated by CB
Checked by RA

Correlation Data: Ksi

	1	2	3	4	5	6	7	8	9	10
S	42,000	40,000	38,000	36,000	34,000	32,000	30,000	29,000	28,000	26,500
N	160,000	260,000	420,000	640,000	970,000	1,500,000	2,500,000	3,700,000	4,800,000	25,000,000
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: * m = 2.831
b = -4.147

Comments: * Computer values

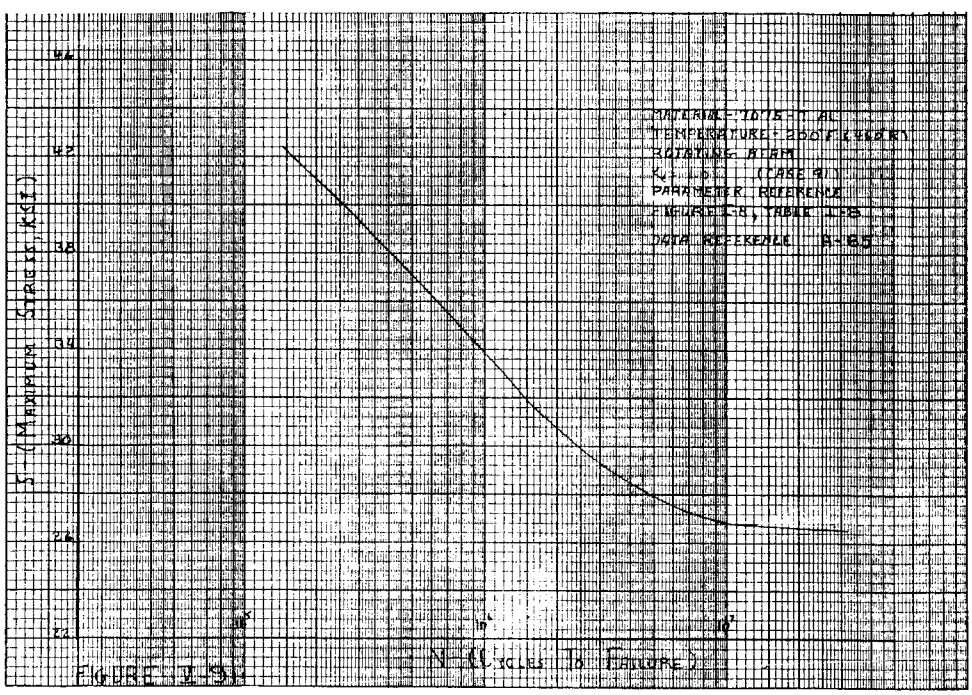


FIGURE 1-5

92/92

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075 T Al Condition Forged
Reference ASTIA AD 63977 p.7
Reference No. 85 Code No. 103

Test Temperature 400°F Environment Air
Type of Test Rotating Beam Specimen Data 0.30 inch min. dia
Type of Data Numerical Surface Finish 54
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Stalk, George
Publication ASTIA AD 63977, p. 41
No. References 6
Principal Investigator Author
Affiliation Capt. USAF
Comments Thesis (Cal. Inst. of Tech.) 1955

Mechanical Properties Source:
AICOA RT 9-47-9
Copy 25', p. 26.

Mechanical Properties:

F_{tu}	38.0	ksi	at	400°F
F_{ty}	34.0	ksi	at	400°F
E	9.4	10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E	20.0		at	400°F
% RA			at	
Hardness			at	

Other Properties:
TS' = 64.60 Ksi
E' = 19.35 Ksi

Date of Tabulation
Tabulated by CB
Checked by BD

Correlation Data K_{se}

	1	2	3	4	5	6	7	8	9	10
S	33,000	32,000	31,000	30,000	28,000	26,000	24,000	22,000	21,000	20,000
N	230,000	385,000	600,000	900,000	1,900,000	3,650,000	6,900,000	14,000,000	22,000,000	52,000,000
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters:* m = 3.470
b = -5.7722

Comments:* 1 Computer values

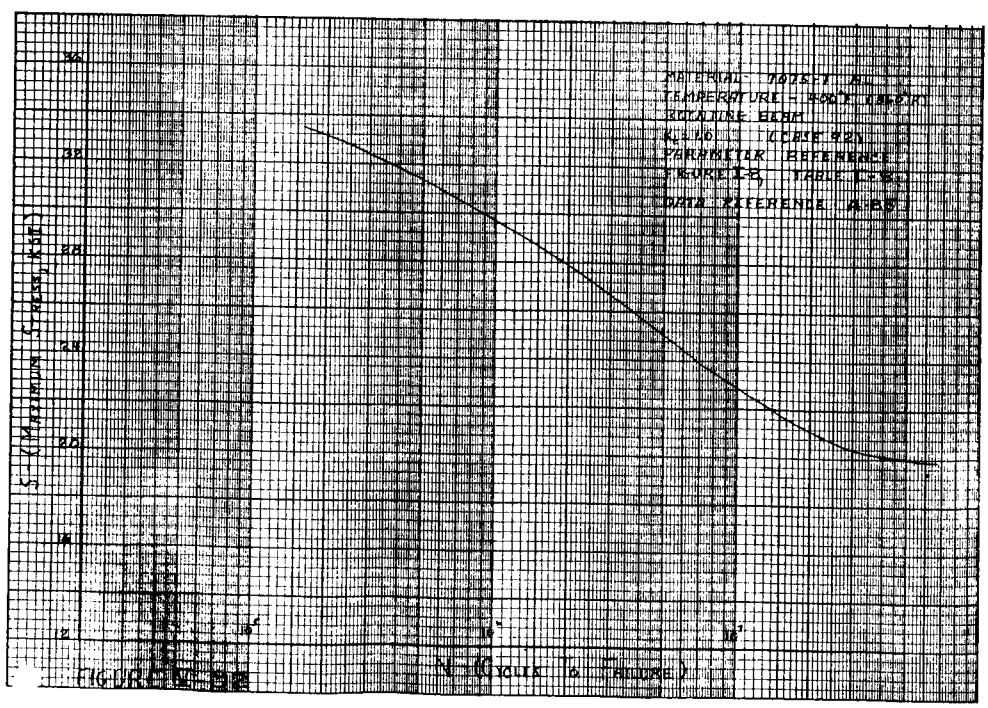


FIGURE I-92

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material SAE 4130 STEEL — Condition HEAT-TREATED TO MILITARY SPECIFICATION S 6758, CONDITION F.S.

Reference NACA TN 4284, P.7

Reference No. 76 — Code No. 125

Test Temperature RT — Environment AIR

Type of Test KROUSE ROTATING-BEAM — Specimen Data ½ INCH DIAMETER ROD

Type of Data NUMERICAL — Surface Finish POLISHED

Stress Ratio −1 — Stress Concentration Factor 1

Mean Stress — Notch Description

Date of Tabulation

Tabulated by CB

Checked by RM

Fatigue Data Source:

Author REY, WILLIAM K.

Publication NACA TN 4284, P.21

No. References

Principal Investigator REY, WILLIAM K.

Affiliation UNIVERSITY OF ALABAMA

Comments AE DEPT.

Mechanical Properties Source:

NACA TN 4284, P.7

Mechanical Properties:

F_{tu}	133.8 ksi	at	RT
F_{ty}	111.3 ksi	at	RT
E	30.04 10^3 ksi	at	RT
G	10^3 ksi	at	
μ		at	
% E	26 (IN 1 INCH)	at	RT
% RA	65.7	at	RT
Hardness	RC 26.3	at	RT

Other Properties:

$TS' = 227,460$ Ksi

$E' = 75,22$ Ksi

	1	2	3	4	5	6	7	8	9	10
S	98000	75000	75000	73000	94,000	94,000	94,000	94,000	90,000	90,000
N	29,700	39,700	34,200	34,600	56,000	53,300	60,300	64,300	62,100	73,400
S	92000	90,000	88,000	89,000	89,000	89,000	85,000	85,000	85,000	85,000
N	75,200	86,200	105,300	118,200	132,200	142,200	138,000	164,500	123,000	193,600
S	84000	84,000	84,000	84,000	82,000	82,000	82,000	82,000	82000	82,000
N	120,100	123,500	125,800	186,200	225,000	244,000	244,800	245,500	228,000	270,500
S	80,000	84,000	78,000	78,000	78,000	78,000	77,000	77,000	77,000	77,000
N	276,400	334,200	386,300	444,300	547,600	550,600	495,400	537,100	1,201,000	1,793,700
S	77,000									
N	2,404,900									
S										
N	Coil Slot		Ks	Ks						
S	98.1	94.5	88.9	83.1	80.0	78.5	77.7	77.5	77.5	77.5
N	3104	5.10^4	1.10^5	2405	3.10^5	4.10^5	5.10^5	6.10^5	10^6	10^7
S										
N										
S										
N										
S										
N										

Parameters: [1] $A = 2.189$

$b = -2.557$

Comments: 1 Computer values

Good available data

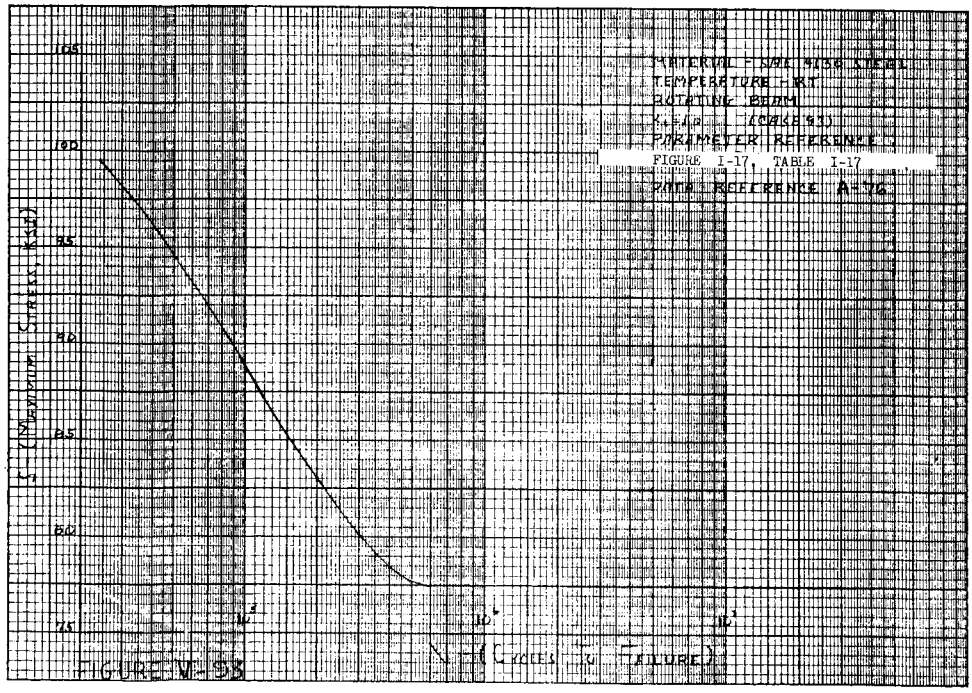


FIGURE V-95

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CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material SAE 4130 Condition Heat treated to Military Spec. S6758 Condition F5

Reference NACA TN 4284 pg 28

Reference No. 76 Code No. 25

Date of Tabulation

Tabulated by CB

Checked by BA

Test Temperature 400 Environment Air

Type of Test Krouse rotating beam Specimen Data ¼ Dia specimen

Type of Data Numerical Surface Finish polished

Stress Ratio −1 Stress Concentration Factor 1

Mean Stress Notch Description

Fatigue Data Source:

Author W.K. Rey

Publication Cumulative Fatigue Damage at Elevated Temperatures NACA TN 4284 p 28

No. References 37

Principal Investigator W.K Rey

Affiliation University of Alabama

Comments AE Dept

Mechanical Properties Source:

NADC TR 55-199, Pt. 2

AD 110540, p. 164.

Mechanical Properties:

F_{tu}	127.80	ksi	at 400°F	
F_{ty}	100.70	ksi	at 400°F	
E	24.60	10^3 ksi	at 400°F	
G		10^3 ksi	at	
μ			at	
% E avg.	7.5		at 400°F	
% RA			at	
Hardness			at	

Other Properties:

TS = 217.26 KSI

E' = 58.83 KSI

	1	2	3	4	5	6	7	8	9	10
S	$84\,10^3$	$84\,10^3$	$344\,0^3$	$84\,10^3$	$80\,10^3$	$80\,10^3$	$80\,10^3$	$80\,10^3$	$78\,10^3$	$78\,10^3$
N	56,500	52,400	50,000	48,700	82,500	77,200	73,200	66,400	116,000	110,500
S	$78\,10^3$	$78\,10^3$	$76\,10^3$	$76\,10^3$	$76\,10^3$	$76\,10^3$	$76\,10^3$	$72\,10^3$	$72\,10^3$	$72\,10^3$
N	94,000	85,080	159,600	146,500	139,100	110,400	108,400	324,400	321,200	234,600
S	$72\,10^3$	$70\,10^3$	$70\,10^3$	$70\,10^3$	$70\,10^3$	$70\,10^3$	$68\,10^3$	$68\,10^3$	$68\,10^3$	$68\,10^3$
N	130,400	318400	334,400	273,100	253,500	221,800	502,900	403,200	343,800	324,400
S	$66\,10^3$	$66\,10^3$	$66\,10^3$	$66\,10^3$	$64\,10^3$	$64\,10^3$	$64\,10^3$	$64\,10^3$	$64\,10^3$	$62\,10^3$
N	691,800	558,500	429,400	271,580	940,900	544,600	526,200	293,800	274,580	1,106,800
S	$62\,10^3$	$62\,10^3$	$62\,10^3$	$60\,10^3$	$60\,10^3$					
N	2,117,200	3,949,000	376,300	1,572,400	1,837,700					
S										
N										
S										
N	Correlation Data									
S	84.0	79.8	77.7	77.6	68.5	65.5	64.9	63.1	62	61.8
N	$.510^7$	$.810^7$	1.10^6	2.10^6	3.10^6	5.10^6	7.10^6	1.10^6	2.10^6	5.10^6
S	61.0	61.0								
N	1.10^7	2.10^7								
S										
N										

Parameters: M = 20.80, b = −2.544 } C

Comments: 1 Properties are for AISI 4130

Strain rate = 5.7×10^{-5} in/in/sec

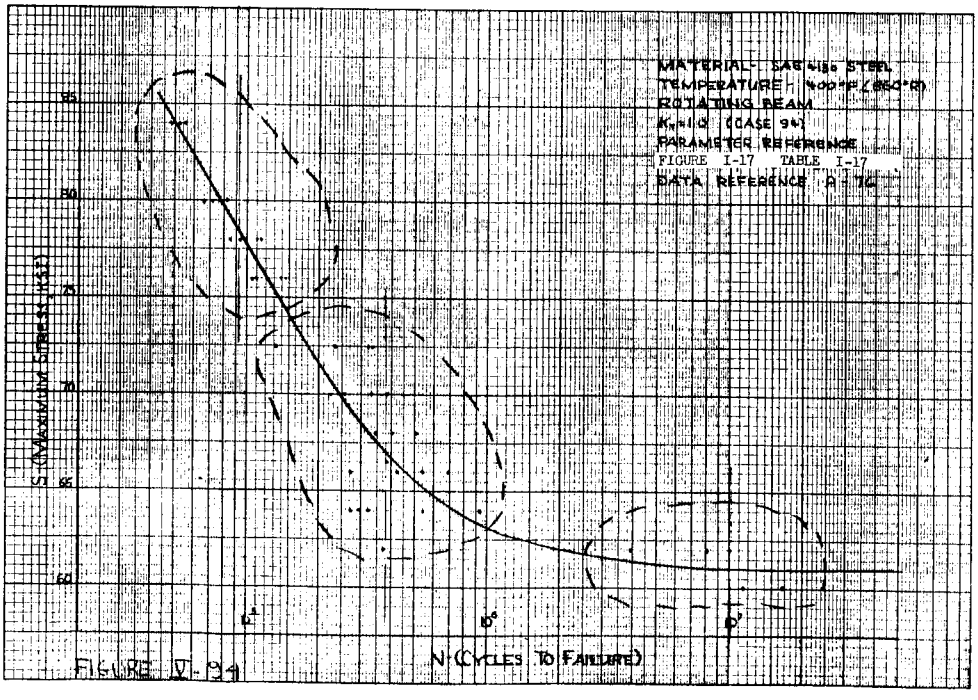


FIGURE V-94

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material SAE 4130 STEEL Condition HEAT TREATED TO
Reference NACA TN 4284, P.7 MILITARY SPECIFICATION
Reference No. 76 Code No. 25 S 6758, CONDITION F5

Test Temperature 800°F Environment AIR
Type of Test KROUSE ROTATING-BEAM Specimen Data ½ INCH DIA. ROD
Type of Data NUMERICAL Surface Finish POLISHED
Stress Ratio -1 Stress Concentration Factor 1
Mean Stress Notch Description

Date of Tabulation
Tabulated by CB
Checked by RM

		1	2	3	4	5	6	7	8	9	10
S		82,000	82,000	82,000	82,000	80,000	80,000	80,000	80,000	89,000	89,000
N		41,100	47,400	53,100	58,200	40,900	43,200	45,200	47,200	62,800	77,800
S		82,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	78,000	76,000
N		110,200	65,800	75,000	102,100	103,600	111,200	127,700	131,800	192,200	93,800
S		76,000	76,000	76,000	76,000	74,000	74,000	74,000	74,000	72,000	72,000
N		132,600	222,800	229,900	274,600	360,800	377,800	417,300	418,100	181,100	235,000
S		72,000	72,000	72,000	72,000	72,000	70,000	70,000	70,000	70,000	70,000
N		493,000	574,400	738,800	867,100	1,118,500	753,300	803,500	1,043,000	1,141,700	1,109,800
S		70,000	70,000	70,000	68,000	68,000	65,000	65,000	69,000	68,000	66,000
N		1,223,000	829,300	1,617,500	518,100	657,800	748,100	802,300	1,113,300	1,672,000	2,293,300
S		69,000	66,000	66,000	66,000	66,000	65,000	65,000	65,000	65,000	65,000
N		2,545,800	3,374,800	3,994,000	4,303,700	5,178,500	2,802,[illegible]	4,287,700	4,748,700	8,677,700	8,223,500
S											
N		Calculation									
S		81.[illegible]	79.[illegible]	78.3	75.2	71.8	[illegible]	67,100	65,300	[illegible]	[illegible]
N		5×10^4	2×10^4	1×10^5	2×10^5	5×10^5	1×10^6	$> 10^6$	$> 10^6$	1×10^7	2×10^7
S											
N											
S											
N											

Fatigue Data Source:

Author REY, WILLIAM K.
Publication NACA TN , P. 39
No. References
Principal Investigator REY, WILLIAM K.
Affiliation UNIVERSITY OF ALABAMA
Comments AE DEPT.

Mechanical Properties Source:

WADC TR 55-199, PT. 2
AD 110540, P. 164

Mechanical Properties: *1

F_{tu}	92.63	ksi	at 800°F	
F_{ty}	82.73	ksi	at 800°F	
E	19.5	10^3 ksi	at 800°F	
G		10^3 ksi	at	
μ			at	
% E avg.	6.8		at 800°F	
% RA			at	
Hardness			at	

Other Properties:

TS = 152.47 KSI
E' = 63.43 KSI

Parameters: m = 2.267, b = -3.026 } C

*Comments: 1 Properties for AISI 4130 (Heat treated)
Strain rate = $5.13(10)^{-5}$ in/in/sec.

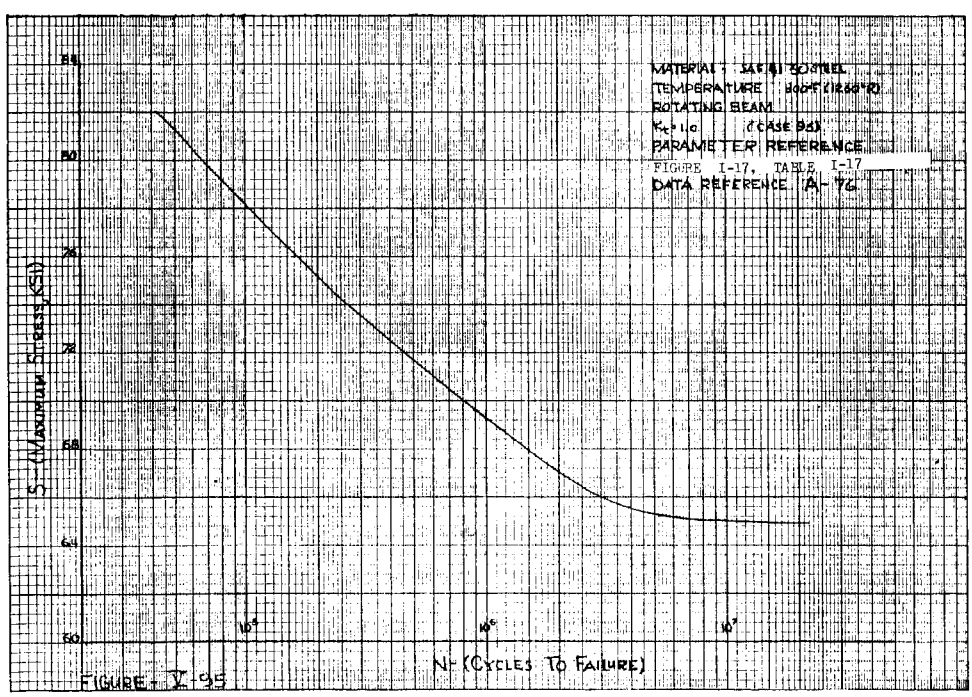


FIGURE I-95

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075-T6 Condition Soln treated and
Reference Aircraft Fatigue Handbook, VIII p 3.21.76-15, aged.
Reference No. 74 Code No. 111

Test Temperature 25°C Environment Air
Type of Test RB (Krouse) Specimen Data 0.500 in. dia
Type of Data Mean S-N Curve Surface Finish
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Oberg, T.T., Rooney R.S.
Publication Proc. ASTM V 49, 1949
No. References

Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
DMIC Report 148
PB151102, p. 12
(Estimate from a Temp vs. F_{tu} Curve)

Mechanical Properties:

				Other Properties:
F_{tu}	820	ksi	at 97°F	TS = 147.9 KSI
F_{ty}		ksi	at	E' = 29.52 KSI
E	10.4	10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Date of Tabulation 3/22/61
Tabulated by DTS
Checked by BD

Correlation Data, K_{sc}

	1	2	3	4	5	6	7	8	9	10
S	82.0	85.0	80.0	75.0	70.0	600	50.0	40.0	35.0	31.0
N	1.2×10^3	2.1×10^3	2.9×10^3	6.8×10^3	1.4×10^4	2.6×10^4	5.8×10^4	1.6×10^5	4.8×10^5	3.9×10^6
S			3.9×10^3							
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 2.494
b = -3.316
} C

Comments:

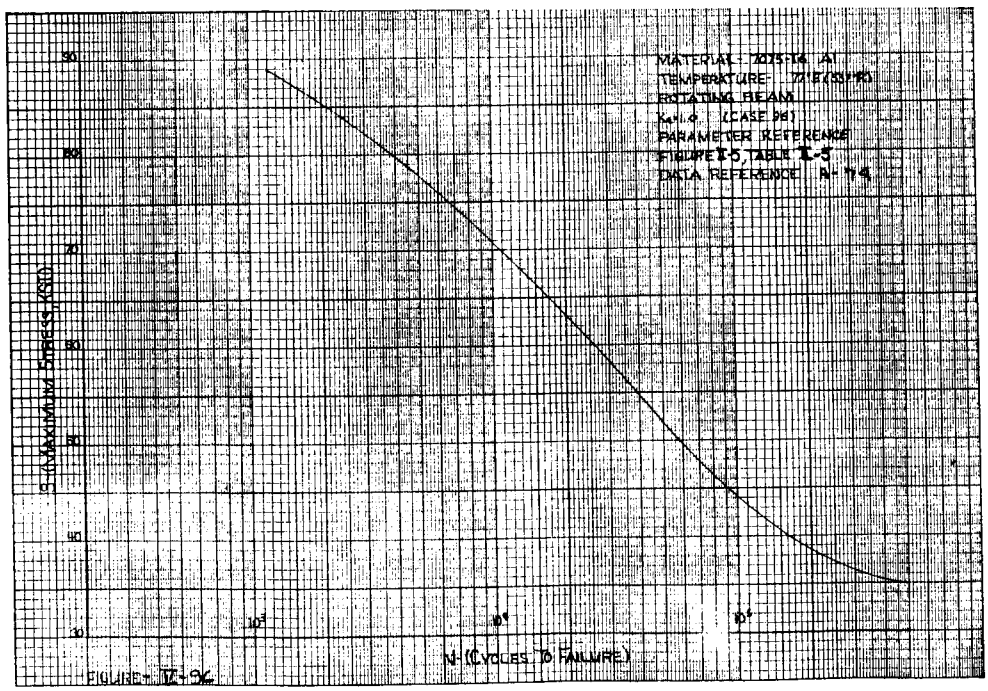


FIGURE 74-96

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075-T6 Condition Soln treated and aged.
Reference Aircraft Fatigue Handbook Vol II p. 3.21.76-15
Reference No. 74 Code No. 111

Test Temperature -78°C Environment Air
Type of Test RB (Krouse) Specimen Data 0.500 in dia.
Type of Data Mean S-N Curve Surface Finish
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Ober, T.T., Rooney
Publication Proc. ASTM V.49, 1949
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
DMIC Report 148
PB 151107, p. 12.
(Estimated from a Temp. vs F_{tu} curve)

Mechanical Properties:

F_{tu}	98.2 ksi	at -78°C	
F_{ty}	ksi	at	
E	10.9 10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:
TS' = 160.9 KSI
E' = 34.33 KSI

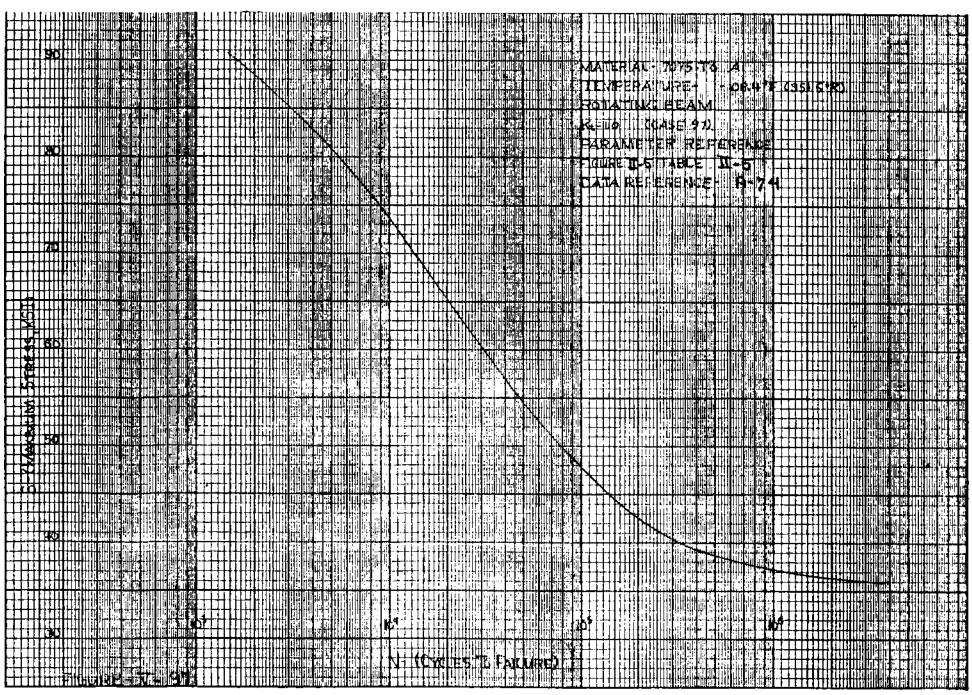
Date of Tabulation
Tabulated by DTT
Checked by RR

Correlation Data, KSi

S	90	85	80	75	70	65	60	55	50	45
N	1.6×10^3	3.4×10^3	5.5×10^3	8.8×10^3	1.35×10^4	2.1×10^4	3.1×10^4	4.8×10^4	7.9×10^4	1.45×10^5
S	40	36								
N	3.4×10^5	3.5×10^6								
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Parameters: m = 2.435
b = -3.113
} C

Comments:



98/98

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075-T6 Condition Soln treated and aged.
Reference Aircraft Fatigue Handbook, Vol III, p 3.21.76-15
Reference No. 74 Code No. 111

Test Temperature -198°C Environment Air
Type of Test RB (Krouse) Specimen Data 0.500 in. dia.
Type of Data Mean S-N Curve Surface Finish
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Oberg, T.T. Roosy R.J.
Publication Proc. ASTM Vol 49 1949
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Estimated from curve drawn from: DMIC Report 148, PB 151102, p. 12. Aircraft Fatigue Handbook Vol III, p. 3.21.76-12

Mechanical Properties:

				Other Properties:
F_{tu}	118.0	ksi	at	TS = 200.6 KSI
F_{ty}		ksi	at	E = 58.0 KSI
E	11.6	10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

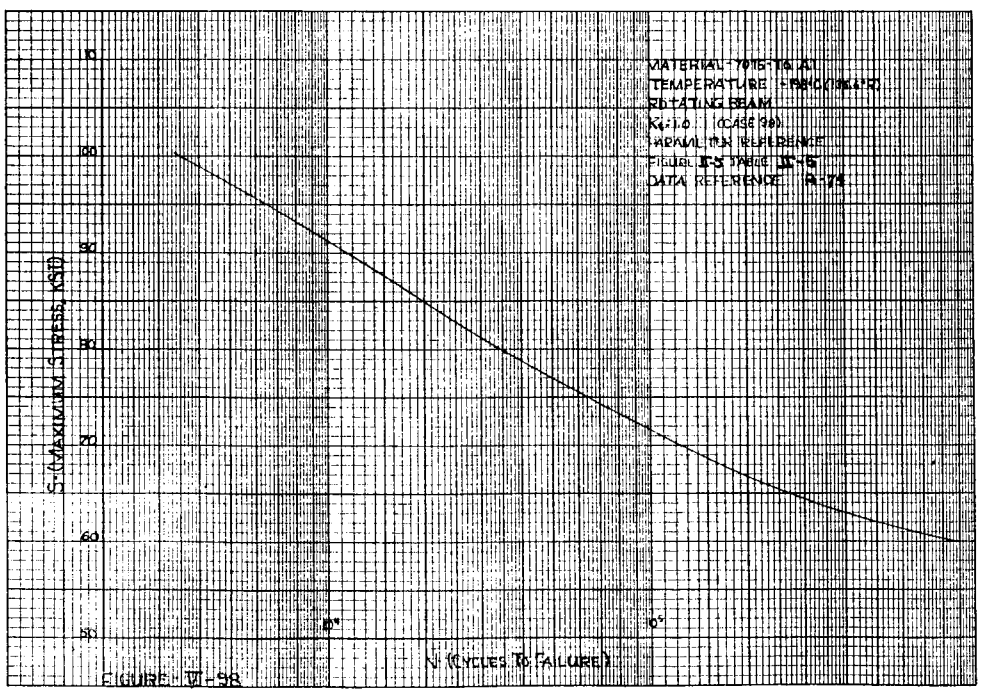
Date of Tabulation
Tabulated by DS
Checked by RT

Corrected for P_{tu}, KSI

S	100	95	90	85	80	75	70	65	62.5	60
N	3.5×10^3	6.4×10^3	1.15×10^4	2.0×10^4	3.4×10^4	6.3×10^4	1.24×10^5	2.8×10^5	4.7×10^5	8.8×10^5
S										
N										
S										
N										
S										
N										
S										
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N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Parameters: m 2.381 } C
b -2.914 }

Comments:



99/99

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2024-T Condition
Reference Aircraft Fatigue Handbook, V. III, p 3.21.24-2
Reference No. 7 Code No. 112

Test Temperature 25°C (77°F) (537°K) Environment Air
Type of Test RB (Krouse) Specimen Data 0.50 in. dia.
Type of Data Mean S-N Curve Surface Finish polish (longitudinal)
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress — Notch Description —

Fatigue Data Source:
Author
Publication Aircraft Fatigue Handbook V. III, p 3.21.24-2
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
DMIC Rpt 148 p. 8
DB 151107

Properties are for 2024-T3 temper

Mechanical Properties:[*1]

				Other Properties:
F_{tu}	68.0	ksi	at 78°F	TS = 115.6 KSI
F_{ty}	47.7	ksi	at 78°F	E' = 21.34 KSI
E	10.6	10^3 ksi	at 78°F	
G		10^3 ksi	at	
μ			at	
% E	18.0		at 78°F	
% RA			at	
Hardness			at	

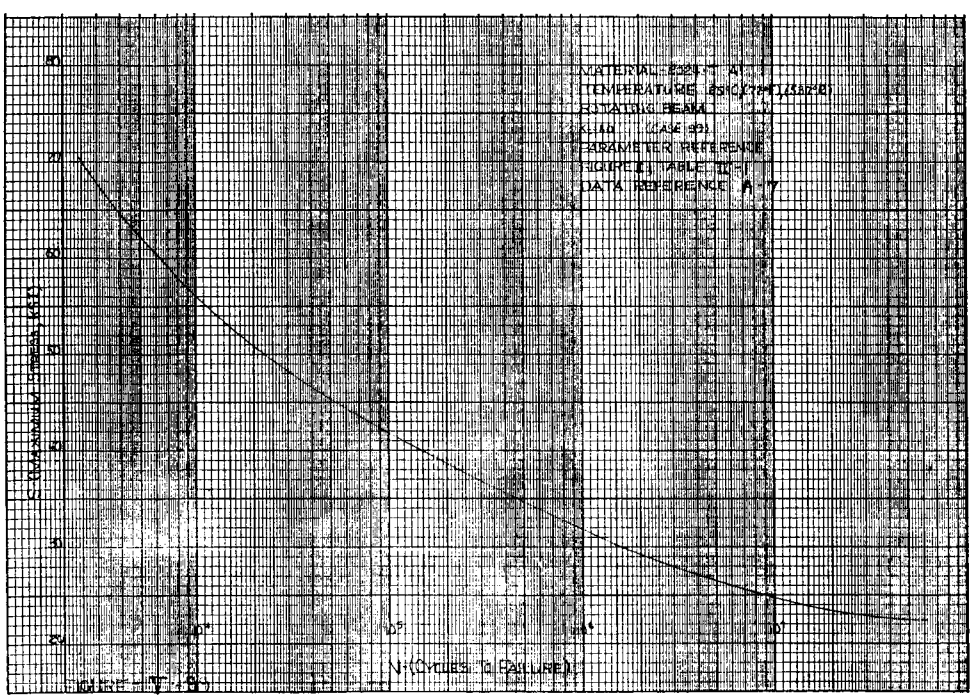
Date of Tabulation
Tabulated by JB
Checked by AM

Data Correlation: KSI

	1	2	3	4	5	6	7	8	9	10
S	80.0	75.0	70.0	65.0	60.0	55.0	50.0	45.0	40.0	35.0
N	1.0×10^3	1.6×10^3	2.5×10^3	4.0×10^3	6.6×10^3	1.1×10^4	2.25×10^4	5.2×10^4	1.5×10^5	4.8×10^5
S	30.0	25.0	22.5							
N	1.6×10^6	8.5×10^6	6.0×10^7							
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 2.231 } SC
b = -3.148

Comments:[*] 1 Properties on 2024-T3 temper.



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2024-T Condition
Reference Aircraft Fatigue Handbook V.III, p. 3.21.24-2
Reference No. 7 Code No. 111c

Date of Tabulation
Tabulated by JB
Checked by

Test Temperature -78°C Environment Air
Type of Test RB (Krouse) Specimen Data 0.50 in dia
Type of Data Mean S-N Curve Surface Finish polished longitudinally
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author
Publication Aircraft Fatigue Handbook V.III, p. 3.21.24-2
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Estimated from a Temperature vs. Tensile Strength Curve using data from:
DMIC RT 148, p. 8
PB 151107.

Mechanical Properties:*

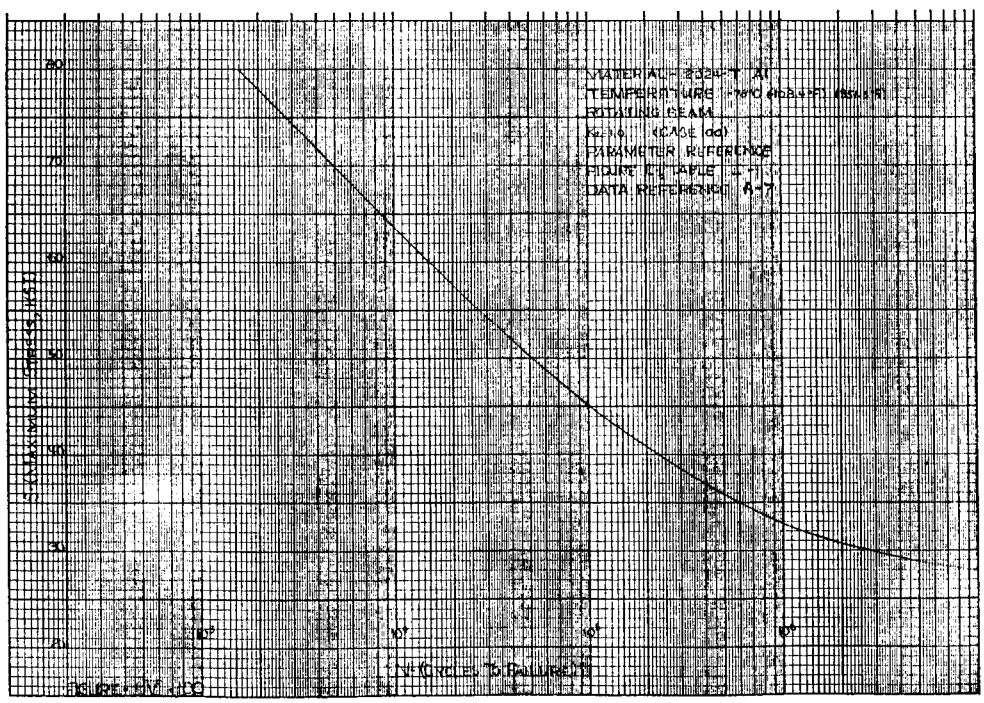
F_{tu}	75.5 ksi	at	-108.4°F
F_{ty}	ksi	at	
E	11.0 10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:
TS' = 128.4 KSI
E' = 25.72 KSI

S/N	1	2	3	4	5	6	7	8	9	10
S	80.0	75.0	70.0	65.0	60.0	55.0	50.0	45.0	40.0	35.0
N	1.6×10^3	2.8×10^3	4.9×10^3	8.5×10^3	1.5×10^4	2.8×10^4	5.2×10^4	1.05×10^5	2.3×10^5	6.4×10^5
S	30.0	29.0	28.0	27.0						
N	3.0×10^4	5.0×10^4	9.6×10^4	3.0×10^5						
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 2.330, b = -3.217 } C

Comments:* 1 Properties on 2024-T3 temper.
2 Stress in KSI.



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

101

Material 2024-T Condition

Reference Aircraft Fatigue Handbook, V.III, p. 321.24-2

Reference No. 7 Code No. 112

Date of Tabulation

Tabulated by LB

Checked by RAT

Test Temperature -196 °C Environment Air

Type of Test RB (Krause) Specimen Data 0.50 in dia

Type of Data Mean S-N Curve Surface Finish polished longitudinally

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Correlation Data

S* / N	90.0	85.0	80.0	75.0	70.0	65.0	60.0	55.0	50.0	49.0
N	2.2×10^3	6.6×10^3	1.5×10^4	3.2×10^4	6.2×10^4	1.2×10^5	2.3×10^5	5.0×10^5	1.4×10^6	2.0×10^6
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Fatigue Data Source:

Author

Publication Aircraft Fatigue Handbook V.III, p. 3.21.24-2.

No. References

Principal Investigator

Affiliation

Comments

Mechanical Properties Source:

Estimated from a Temperature vs. Tensile Strength Curve using data from:

DMIC Rpt 148 p.8

PB 151107

Mechanical Properties:

F_{tu}	97.0 ksi	at -320.8 °F	
F_{ty}	ksi	at	
E	11.6 10^3 ksi	at -320 °F	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

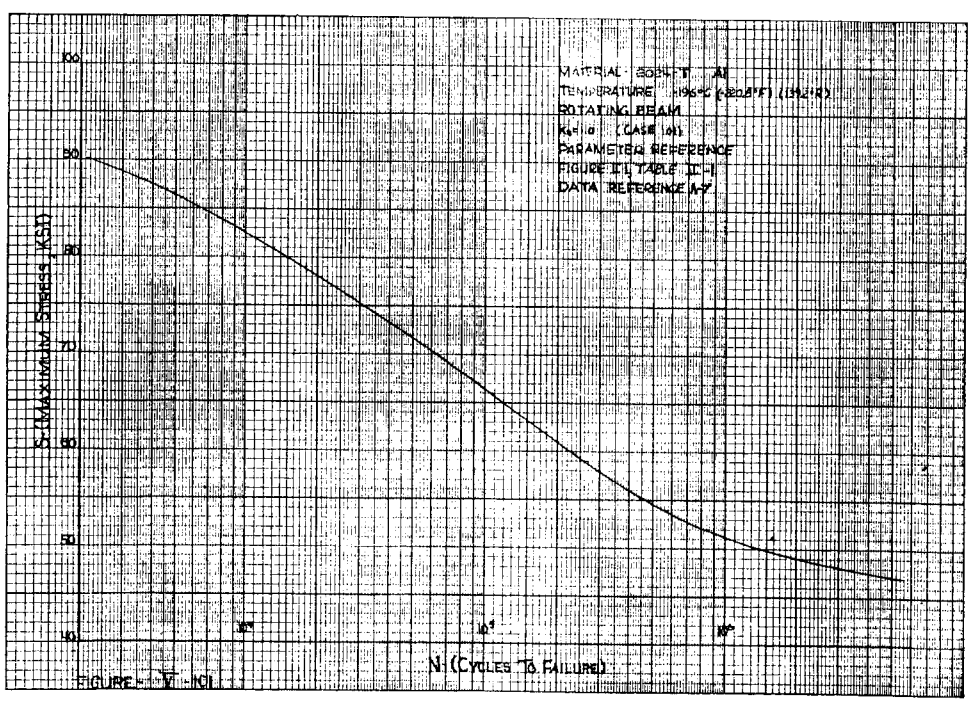
Other Properties:

TS: 164.9 KSI

E: 47.35 KSI

Parameters: m = 2.297, b = -2.968 } C

Comments: 1 Properties for 2024-T3 temper.
2 Stress in KSI



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 403 Stainless Condition Solution annealed
Reference AD 9/240 p 59
Reference No. 105 Code No. 59

Date of Tabulation
Tabulated by CB
Checked by RMS

Test Temperature 75 °F Environment air
Type of Test Axial load Specimen Data 0.250" Dia
Type of Data Numerical Surface Finish
Stress Ratio $S_a/S_m = \infty$ Stress Concentration Factor 1
Mean Stress 0 Notch Description

Fatigue Data Source:
Author Vitovec F.H, Lazan B.J.
Publication Fatigue, Creep, & Rupture Properties of Heat Resistant Materials WADC TR 56-181 p. 59
No. References —
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Same

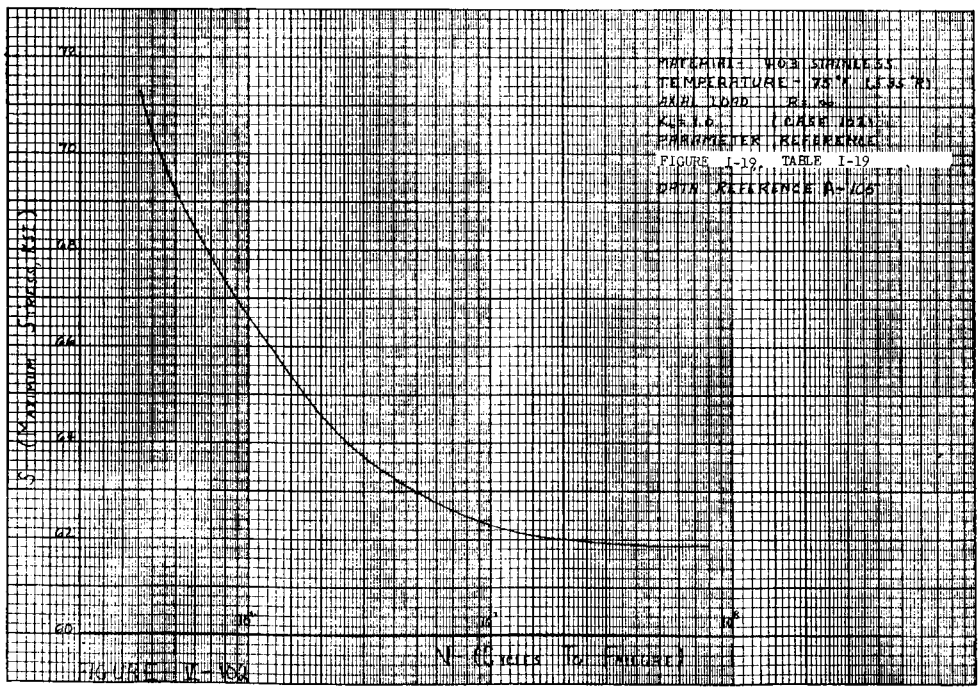
Mechanical Properties:

				Other Properties:
F_{tu}	141.0	ksi	at RT	TS = 141.0 KSI
F_{ty}	127.0	ksi	at RT	E = 60.49 KSI
E	29.5	10^3 ksi	at RT	
G		10^3 ksi	at	
μ			at	
% E	110		at RT	
% RA			at	
Hardness	Rc 24-26		at RT	

	1	2	3	4	5	6	7	8	9	10
S	70,000	65,000	65,000	62,000	60,000					
N	4.6×10^5	1.2×10^6	1.87×10^6	21.9 M	30.5 M					
S										
N										
S										
N										
S										
N										
S										
N	Correlation Data (Approximated Curve)									
S	71,000	70,000	69,000	68,000	67,000	65,000	65,000	64,000	63,000	62,000
N	370,000	420,000	545,000	650,000	830,000	1,200,000	1,700,000	2,640,000	5,000,000	26,000,000
S	69,000									
N	80,000,000									
S										
N										
S										
N										
S										
N										

Parameters: m = ~~2.053~~ 2.057
b = ~~-2.753~~ −2.753

Comments: 1 Test Stopped
Too few points for statistical data analysis



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 403 Stainless Condition Solution Treated
Reference AD 97240 p54 and Aged
Reference No. 105 Code No. 57

Date of Tabulation
Tabulated by CB
Checked by

Test Temperature 500°F Environment Air
Type of Test Axial load Specimen Data 0.250" Dia
Type of Data Numerical Surface Finish
Stress Ratio $S_{min}/S_{max} = \infty$ Stress Concentration Factor 1
Mean Stress 0 Notch Description

Fatigue Data Source:
Author Vidoce F.N., Lazan B.J.
Publication WADC TR 56-181
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Metals Handbook
p500

	1	2	3	4	5	6	7	8	9	10
S	62,000	58,000	56,000	54,000	54,000					
N	3.1×10^5	2.38×10^5	6.44×10^5	1.09×10^7 TS	1.35×10^7					
S										
N										
S										
N										
S										
N										
S										
N	Correlation Line (Approximated Curve)									
S	64,000	62,000	62,000	61,000	60,000	59,000	58,000	57,000	56,000	55,000
N	115,000	126,000	142,000	162,000	203,000	265,000	375,000	590,000	1,100,000	2,900,000
S	54,500	54,000								
N	620,000	25,000,000								
S										
N										
S										
N										
S										
N										

Parameters: $m = 2.602$, $b = -3.253$ } C

Comments: TS. - Test stopped
Too few points for statistical data analysis

Mechanical Properties:

			Other Properties:
F_{tu}	98,000 ksi	at 500	75' = 98.0 KSI
F_{ty}	80,000 ksi	at 500	E = 53.02 KSI
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	22	at 500	
% RA	18	at	
Hardness		at	

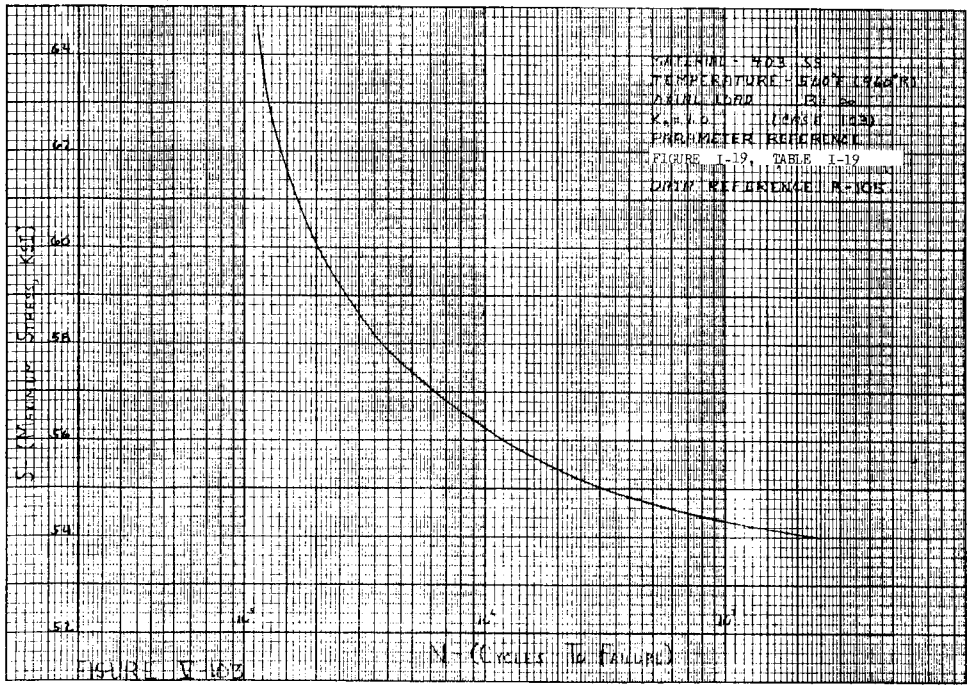


FIGURE I-19

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 403 Stainless Condition Solution treated and
Reference AD 97240 p 60
Reference No. 105 Code No. 57

Test Temperature 700°F Environment Air
Type of Test Axial load Specimen Data 0.250"
Type of Data Numerical Surface Finish
Stress Ratio $\frac{S_a}{S_m}$ = 00 Stress Concentration Factor
Mean Stress 0 Notch Description

Fatigue Data Source:
Author Vilvec F.H, Latan B.J.
Publication WADC TR 56-181
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:

Mechanical Properties:

				Other Properties:
F_{tu}	82,000	ksi	at	75°= 82.0 KSI
F_{ty}	75,000	ksi	at	E'= 47.73 KSI
E		10^3 ksi	at	
G		10^3 ksi	at	
μ			at	
% E	7		at	
% RA	19		at	
Hardness			at	

Date of Tabulation
Tabulated by CB
Checked by RHO

	1	2	3	4	5	6	7	8	9	10
S	56,500	55 000	52,000	52,000	50 000	50,000	48,000	46 000		
N	16.5×10^3	12.3×10^3	1.27×10^6	1.40×10^6	3.25×10^6	5.20×10^6	11.8×10^6	73.9×10^6		
S										
N										
S										
N										
S										
N										
S										
N	Correlation Data: (Approximated Curve)									
S	57000	55,000	53,000	52,000	51,000	50,000	50,000	49,000	49,000	49,000
N	40,000	136,000	210,000	300,000	500,000	750,000	1,100,000	2,600,000	4,200,000	7,600,000
S	48,800	48,600								
N	60,000	70,000,000								
S										
N										
S										
N										
S										
N										

Parameters: m = 2.088
b = -2.806
} C

Comments: T.S. - Test Stopped
Too few points for statistical data analysis

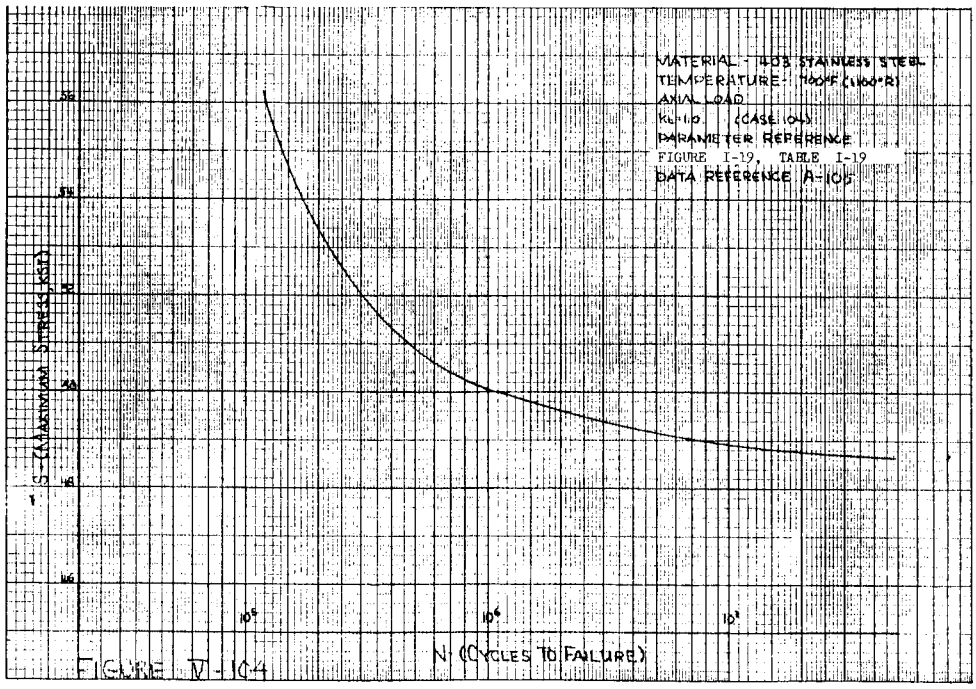


FIGURE V-104

105

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 403 Stainless Condition Solution treated and
Reference AD 97240 p 61 aged
Reference No. 105 Code No. 59

Test Temperature 900°F Environment Air
Type of Test Axial load Specimen Data 0.250" Dia
Type of Data Numerical Surface Finish
Stress Ratio $\frac{S_a}{S_m}$ = 00 Stress Concentration Factor
Mean Stress 0 Notch Description

Fatigue Data Source:
Author Vitovec F.H., Lozan B.J.
Publication WADC TR 56-181
p. 61
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Metals Handbook
p 500

Mechanical Properties:

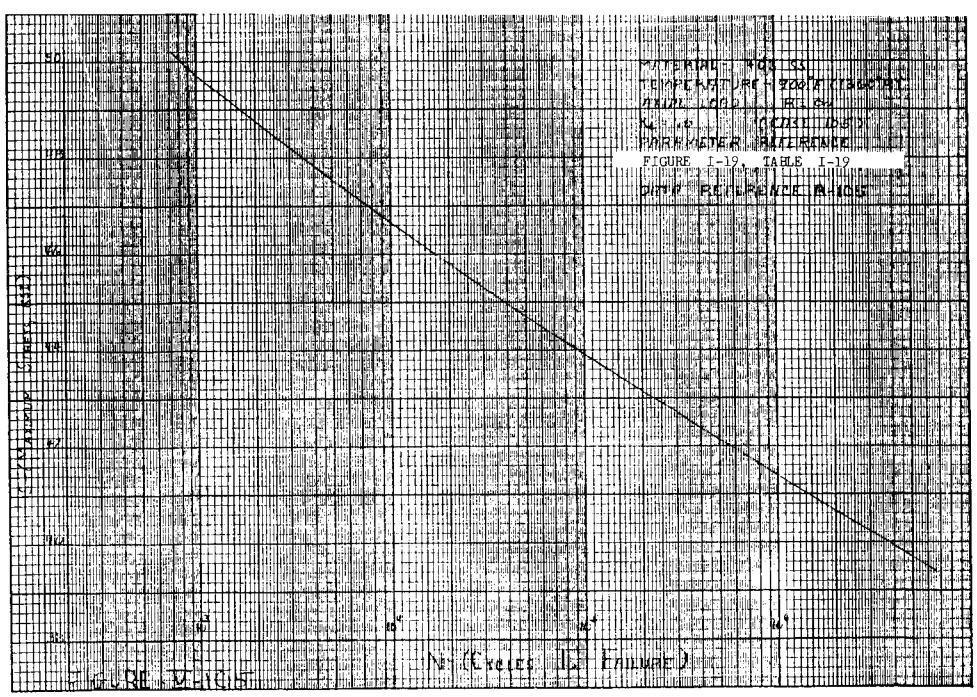
				Other Properties:
F_{tu}	70,000 ksi	at	900	75°= 70.0 KSI
F_{ty}	60,000 ksi	at	900	E'= 33.10 KSI
E	10^3 ksi	at		
G	10^3 ksi	at		
μ		at		
% E	25	at	900	
% RA	20	at	900	
Hardness		at		

Date of Tabulation
Tabulated by CB
Checked by RA

	1	2	3	4	5	6	7	8	9	10
S	50,000	45,000	43,000	40,000	37,000	} Data Points				
N	864	15.9×10^3	55.7×10^3	1.81×10^6	36.2×10^6					
S										
N										
S										
N										
S										
N										
S										
N	Correlation Data (Approximated Curve)									
S	52,220	42,000	42,800	46,600	45,400	44,200	43,000	41,800	40,600	39,400
N	740	1,700	4,100	10,400	28,000	79,000	232,000	682,000	2,100,000	6,600,000
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 1.417, b = -1.602 } C

Comments: Too few points for statistical data analysis



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 4340, 159000 PSI Condition Heat treated 1c
Reference Trans ASM Vol 43 p 561 U_{T_u} = 159,000 PSI
Reference No. 84 Code No. 28

Date of Tabulation
Tabulated by CB
Checked by AG

Test Temperature 25°C Environment air
Type of Test Vibrating Beam Specimen Data 0.300" Dia
Type of Data points on a graph Surface Finish
Stress Ratio ∞ Stress Concentration Factor 1
Mean Stress 0 Notch Description

Fatigue Data Source:
Author Spretnak J.W. Fontana M.G.
Publication Trans ASM vol 43 p 547
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Same

Mechanical Properties:

F_{tu}	146,000 ksi	at 25°C	
F_{ty}	136,000 ksi	at 25°C	
E	30.9 10^3 ksi	at 25°C	
G	10^3 ksi	at	
μ		at	
% E	20.4	at 25°C	
% RA	45.8	at 25°C	
Hardness		at	

Other Properties:
~~T5' = 14670 KSI~~
omit → ~~E' = 130.64 KSI~~
new E' = 128.24
B' = 248.06
E' = 127.62

	1	2	3	4	5	6	7	8	9	10
S	225,000	209,000	180,000	175,000	160,000	150,000	140,000	135,000	132,000	123,000
N	$3.5\,10^3$	910	1.240^4	1.610^4	4.510^4	1.710^5	1.510^5	4.310^5	3.010^6	$>10^7$
S	130,000	125,000								
N	$4.5\,10^6$	$\cdot 10^7$								
S										
N										
S										
N	Correlation Data:									
S	220,000	200,000	190,000	180,000	170,000	160,000	150,000	144,000	140,000	138,000
N	$4.8(10)^3$	$6.8(10)^3$	$8.7(10)^3$	$1.2(10^4)$	$1.9(10)^4$	$3.45(10^4)$	$8.2(10)^4$	$2.5(10)^5$	$3.2(10)^5$	$4.6(10^5)$
S	136,000	134,000	132,000	130.2	146					
N	$7.0(10)^5$	$1.2(10)^6$	$2.6(10)^6$	$8.4(10^6)$	$1.32(10^7)$					
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 3.676, b = -5.511 } C

Comments: Fair data no stat. refinement

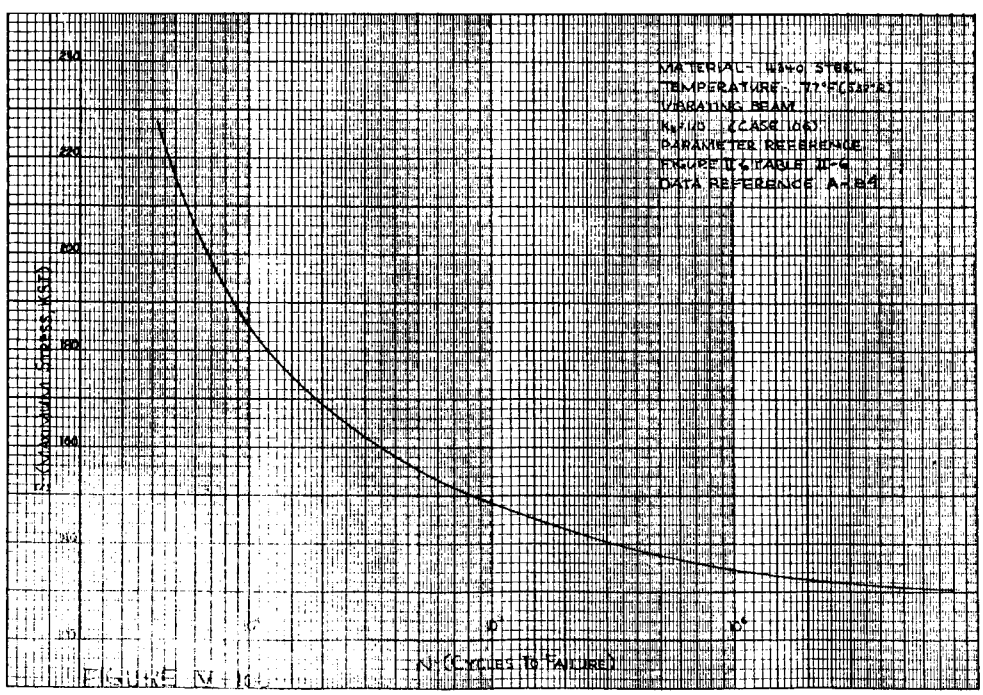


FIGURE N 106

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 4340, 150,000 psi Condition Heat treated to
Reference Trans ASM Vol 43, 561 150,000 Psi UTS
Reference No. 84 Code No. 28

Test Temperature −196 °C Environment N_2
Type of Test Vibrating beam (Ax) Specimen Data 0.300" Dia.
Type of Data points on a graph Surface Finish
Stress Ratio ∞ Stress Concentration Factor
Mean Stress 0 Notch Description

Fatigue Data Source:
Author Spretnak J.W. Fontana M.G.
Publication Trans ASM Vol 43 p561
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:

Mechanical Properties:

F_{tu}	208 ksi	at −196 °C	
F_{ty}	199.5 ksi	at −196 °C	
E	31.8 10^3 ksi	at −196 °C	
G	10^3 ksi	at	
μ		at	
% E	20.0	at −196 °C	
% RA	44.5	at −196 °C	
Hardness		at	

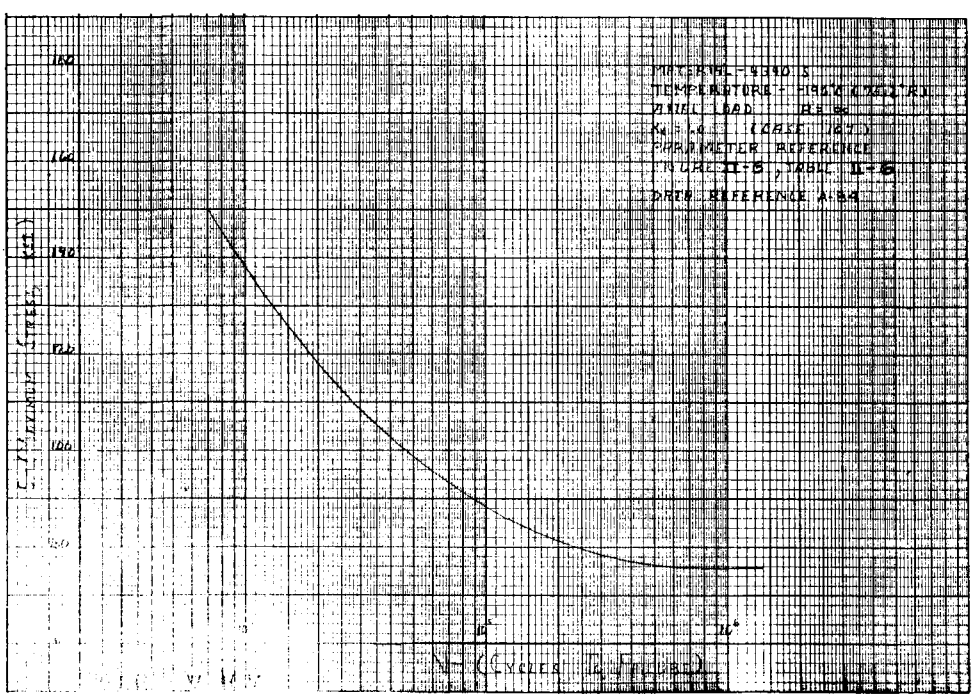
Other Properties:
TS = 208.0 KSI
E = 73.92 KSI
TS − F / S − F

Date of Tabulation
Tabulated by
Checked by

	1	2	3	4	5	6	7	8	9	10
S	150,000	125,000	100,000	75,000	75,000	74,000	73,000	71,000		
N	6.5×10^3	1.5×10^4	5.5×10^4	2.5×10^5	$\times10^7$	$\times10^7$	$\times10^7$	$\times10^7$		
S										
N										
S										
N										
S										
N										
S										
N	Correlation Data:									
S	150,000	140,000	130,000	120,000	110,000	100,000	90,000	86,000	82,000	80,000
N	$7.0(10)^3$	$2.4(10)^3$	$1.3(10)^4$	$1.9(10)^4$	$2.8(10)^4$	$4.5(10)^4$	$8.4(10)^4$	$1.2(10)^5$	$1.8(10)^5$	$2.5(10)^5$
S	78,000	76,000								
N	$3.4(10)^5$	$6.2(10)^5$								
S										
N										
S										
N										
S										
N										

Parameters: a = 9.783
b = −6.916

Comments: Fan Data no stat refinement



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Re 130-13 (Titanium) Condition annealed
Reference Trans ASM, Vol 45, P 998
Reference No. 11 Code No. 46

Test Temperature 25°C Environment Air
Type of Test Vibrating Beam X Specimen Data 0.250" Dia
Type of Data Points on a Graph Surface Finish
Stress Ratio $\frac{S_a}{S_m}$ = 00 Stress Concentration Factor
Mean Stress 0 Notch Description

Date of Tabulation
Tabulated by DS
Checked by

		1	2	3	4	5	6	7	8	9	10
	PSI										
S		192,000	178,000	161,000	153,000	145,000	145,000	138,000	134,000	134,000	128,104
N		4×10^3	4.3×10^3	8.2×10^3	2.2×10^4	1.3×10^4	2.8×10^4	1×10^5	1×10^5	6.2×10^5	7×10^5
S		123,000									
N		5.5×10^5									
S											
N											
S											
N		Correlation		Data							
S		190,000	180,000	170,000	160,000	150,000	140,000	135,000	130,000	128,000	126,000
N		$3.3(10)^3$	$4.7(10)^3$	$6.8(10)^3$	$1.03(10)^4$	$1.8(10)^4$	$3.9(10)^4$	$6.8(10)^4$	$2.7(10)^5$	$5.6(10)^5$	$1.5(10)^6$
S		124,000		149	137	133					
N		$9.0(10)^5$		$1.9(10^4)$	$5.2(10^4)$	$1.02(10^5)$					
S											
N											
S											
N											
S											
N											
S											
N											

Fatigue Data Source:
Author Bishop S.M.
Publication Trans ASM Vol 45 993–1007
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:

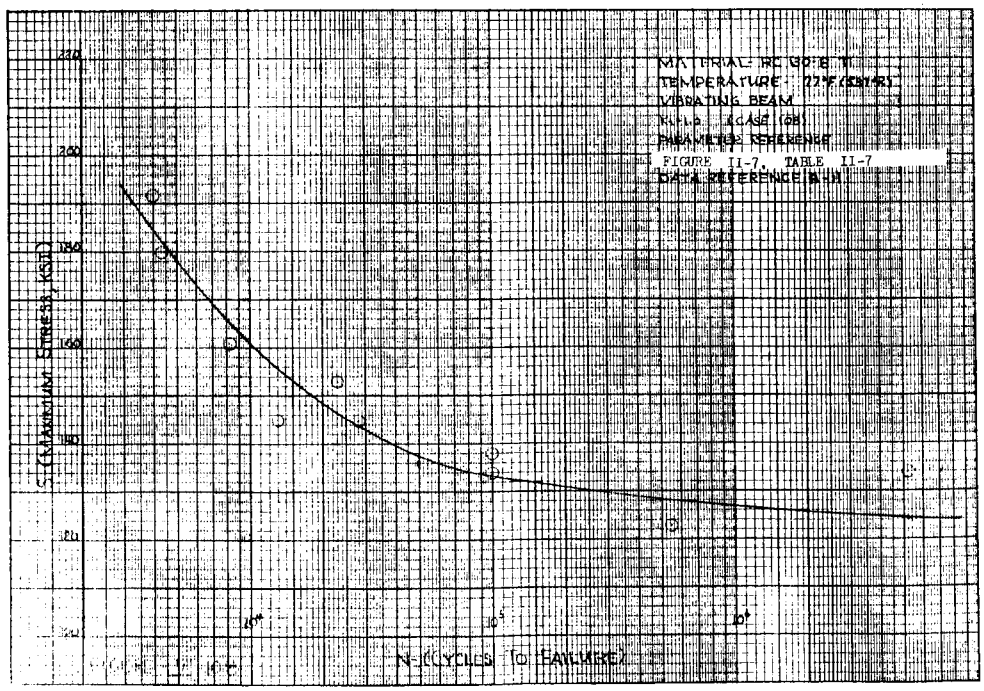
Mechanical Properties:

F_{tu}	149 ksi	at	25°C
F_{ty}	143 ksi	at	25°C
E	16.8 10^3 ksi	at	25°C
G	10^3 ksi	at	
μ		at	
% E	19.6	at	25°C
% RA	41.3	at	25°C
Hardness		at	

Other Properties:
~~TS = 149.0 KSI~~
~~E = 122.5 KSI~~
TS = 252.0
L = 121.46

Parameters: m = 2.621 } C
b = -3.468

Comments: Grid data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Rc 130-B Titanium Condition annealed
Reference Trans ASM, Vol 45 p. 998
Reference No. 11 Code No. 46

Test Temperature -78 °C Environment N_2
Type of Test Vibrating Beam Specimen Data 0.250" Dia
Type of Data points on a graph Surface Finish
Stress Ratio $S_a/S_m = \infty$ Stress Concentration Factor 1
Mean Stress 0 Notch Description

Date of Tabulation
Tabulated by DS
Checked by Hm

	1	2	3	4	5	6	7	8	9	10
S	179,000	161,000	145000	129,000	123,000	115,000	119000	106,000	103,000	99,000
N	$3.3\,10^3$	$6.7\,10^3$	$1.6\,10^4$	$3.2\,10^4$	$3.2\,10^4$	$1.\,10^5$	$1.7\,10^5$	$7.5\,10^4$	$4.3\,10^6$	$1.2\,10^5$
S	95,000									
N	$> 10^7$									
S										
N										
S										
N	Correlation Data:									
S	180,000	170,000	162,000	150,000	140,000	130,000	120,000	110,000	105,000	100,000
N	$3.1(10)^3$	$4.2(10)^3$	$5.8(10)^3$	$8.4(10)^3$	$1.26(10)^4$	$2.0(10)^4$	$3.6(10)^4$	$7.8(10)^4$	$1.33(10)^5$	$3.1(10)^5$
S	96,000	96,000	94,000							
N	$5.2(10)^5$	$1.05(10)^6$	$4.1(10)^6$							
S										
N										
S										
N										
S										
N										
S										
N										

Fatigue Data Source:
Author Bishop S.M.
Publication Trans ASM Vol 45 p 993-1007
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Same

Mechanical Properties:

				Other Properties:
F_{tu}	172 ksi	at	-78	~~TS' = 172.0 KSI~~
F_{ty}	169 ksi	at	-78	~~E' = 92.28 KSI~~
E	17.3 10^3 ksi	at	-78	
G	10^3 ksi	at		TS' = 291.00
μ		at		E' = 91.10
% E	15	at	-78	
% RA	25	at	-78	
Hardness		at		

Parameters: m = 2.665
b = -3.446

Comments: Good data

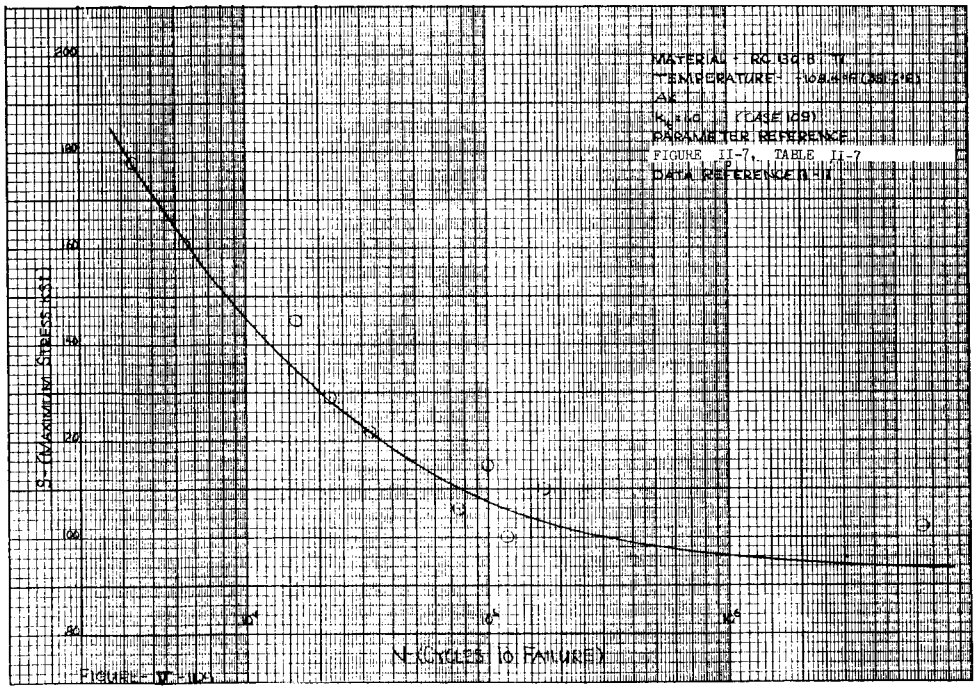


Figure - W-16

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material RC-130-13 Condition annealed
Reference Trans ASM Vol 45 p 998
Reference No. 11 Code No. 46

Test Temperature −196 °C Environment N_2
Type of Test Vibrating beam Specimen Data 0.250" Dia
Type of Data points on a graph Surface Finish
Stress Ratio ∞ Stress Concentration Factor 1
Mean Stress 0 Notch Description –

Fatigue Data Source:
Author Bishop SM
Publication Trans ASM Vol 45 p 998
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Same

Mechanical Properties:

F_{tu}	256	ksi	at −196 °C	
F_{ty}	254	ksi	at 196 °C	
E	18.9	10^3 ksi	at 196 °C	
G		10^3 ksi	at	
μ			at	
% E	2.1		at 196 °C	
% RA	49		at 196 °C	
Hardness			at	

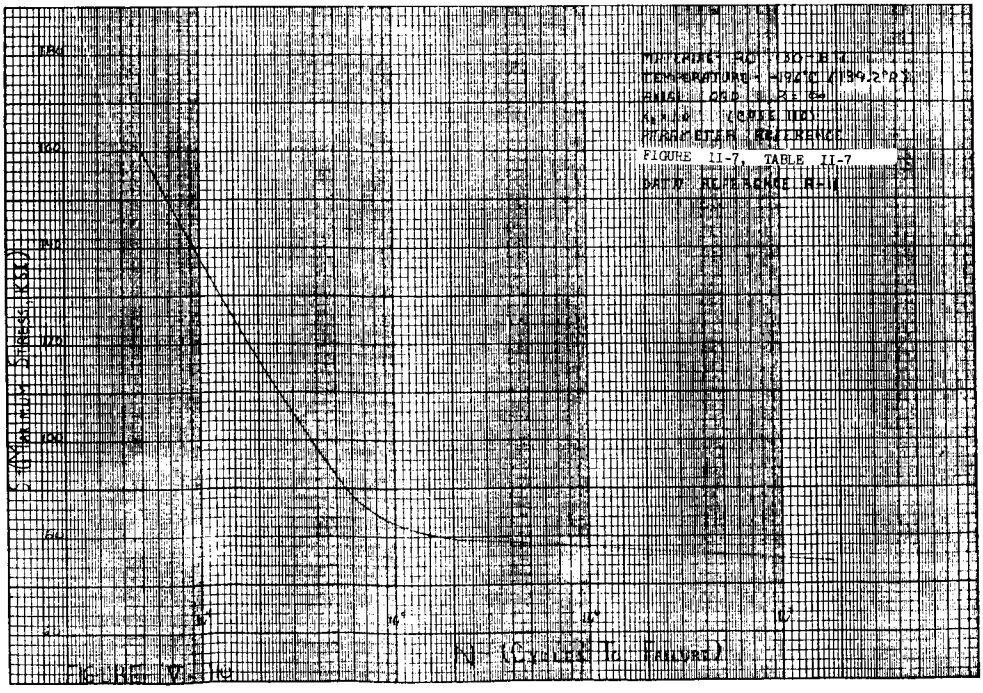
Other Properties:
TS = 256.0 KSI
E = 74.94 KSI

Date of Tabulation
Tabulated by TS
Checked by BDD

	1	2	3	4	5	6	7	8	9	10
S	161,000	146,000	139,000	117,000	115,000	107,000	98,000	90,000	85,000	86,000
N	7.6×10^3	7×10^3	1×10^4	2.7×10^4	3.4×10^4	8×10^4	4.5×10^4	6.2×10^4	4.8×10^4	6×10^4
S	85,000	88,000	83,000	83,000						
N	9×10^4	7×10^5	$(1)\times10^7$	7×10^7						
S										
N										
S										
N										
S										
N	Correlation Data:									
S	160,000	150,000	140,000	130,000	120,000	110,000	100,000	92,000	85,000	82,000
N	5.2×10^3	6.9×10^3	9.3×10^3	1.28×10^4	1.78×10^4	2.5×10^4	3.7×10^4	5.5×10^4	7.6×10^4	1.7×10^5
S	21,500									
N	1.7×10^7									
S										
N										
S										
N										
S										
N										

Parameters: m = 2835, b = −7.751 } C

Comments: Good data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Stellite 31, or 115-31 or X-40 Condition 1350°F 16 hrs, F.C. to 1000°F in 1hr, A.C.

Reference WADC TR 56-37

Reference No. 75 Code No. 329-58

Test Temperature 1200°F Environment Air

Type of Test Rotating Cantilever Beam Specimen Data 0.250 in. dia.

Type of Data Numerical Surface Finish polished

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Podnieks, E.R.

Publication WADC TR 56-37 p 28

No. References 45

Principal Investigator Author

Affiliation University of Minnesota

Comments

Mechanical Properties Source:

ASM Handbook p. 522

Mechanical Properties:

				Other Properties:
F_{tu}	92	ksi	at 1200°F	TS = 156.4 KSI
F_{ty}	52	ksi	at 1200°F	E' = 43.84 KSI
E	27	10^3 ksi	at 1200°F	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Date of Tabulation

Tabulated by B

Checked by BJ

	1	2	3	4	5	6	7	8	9	10
S	65,950	59,500	43,250	31,100 [a]	22,100 [a]	29,700 [a]	40,100 [a]	50,000 [a]	58,700	51,400
N	8,080	22,900	104,000	50,370	123,600	1,189,000	930,000	182,000	13,300	64,000
S	46,700	40,800 [b]								
N	123,000	20,600,000								
S										
N										
S										
N										
S										
N	Correlation Data:									
S	66,000	64,000	62,000	60,000	58,000	56,000	54,000	52,000	50,000	48,000
N	7200	8,000	19300	12,700	16,000	20,700	27,000	38,000	58,000	110,000
S	42,000	46,000	45,400							
N	185,000	330,000	840,000							
S										
N										
S										
N										
S										
N										

[a] Exploratory Test
[b] Test Discontinued

Parameters:

m = 2.330
b = 2618
} C

Comments: 1. 0.45C - 24.8Cr - 0.42Mn - 10.4Ni - 0.93Si - 1.39Fe - .01P - 0.016S - 7.26W Co. Bal

2 S-pal, N-Cycles

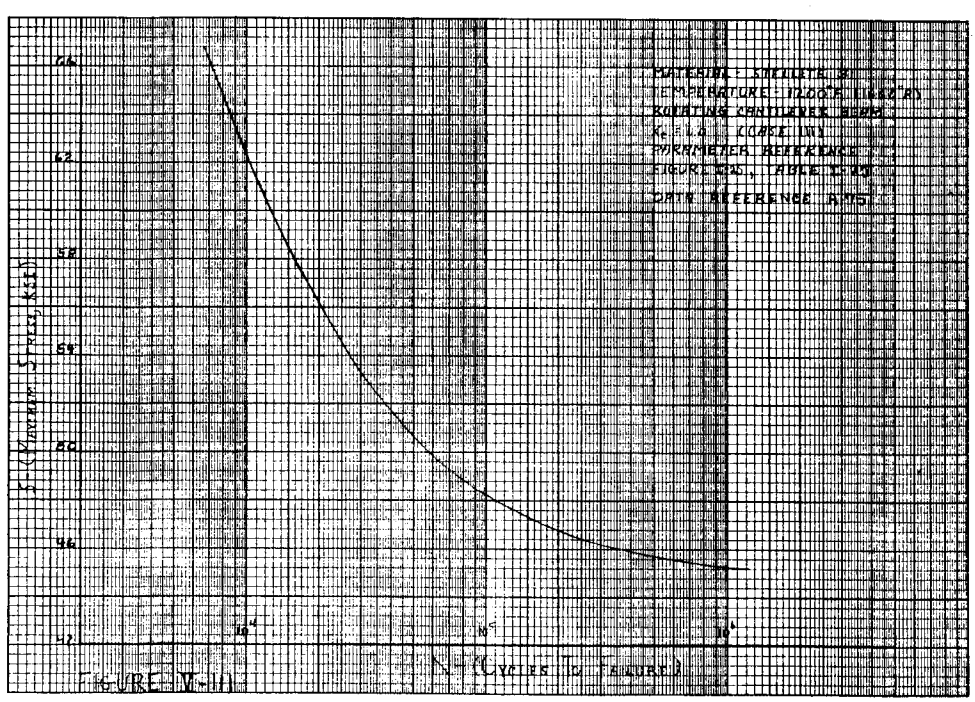


FIGURE V-111

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material* Stellite 31 Condition 1350° F 16 hrs., F.C. to 1000° in 1hr. A.C.

Reference WADC TR 56-37

Reference No. 75 Code No. 889-5Y

Date of Tabulation

Tabulated by JB

Checked by RHL

Test Temperature 1350°F Environment Air

Type of Test Rotating Cantilever beam Specimen Data 0.250 in. dia.

Type of Data Numerical Surface Finish polished

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Podnieks, E.R.

Publication WADC TR 56-37 p.28

No. References 45

Principal Investigator Author

Affiliation University of Minnesota

Comments

Mechanical Properties Source:

Page [illegible]

[illegible]

p. 522

		1	2	3	4	5	6	7	8	9	10
S		99,100	96,900	55,100	11,600[a]	19,500[a]	30,000[a]	40,000[a]	49,600[a]	43,800	52,900[b]
N		16,200	26,000[a]	8,200	11,000	243,000	216,000	956,000	7,500	67,200	19,000
S		37,500	39,000[a]								
N		860,000	1,300,000								
S											
N											
S											
N											
S											
N		Correlation Data:									
S		56,000	54,000	52,000	50,000	48,000	46,000	44,000	42,000	41,000	40,000
N		4,300	6,000	8,700	13,000	29,500	34,000	60,000	120,000	190,000	340,000
S		39,000	38,600								
N		1,070,000	4,000,000								
S											
N											
S											
N											
S											
N											

[a] Exploratory test [b] Test Discontinued [c] Previous Stress History

Parameters:

m = 1.200
b = -1.679 } C

Comments: 1; 0.45C - 24.8Cr - 0.42Mn - 10.4Ni - 0.935i - 1.39Fe - .01P - 0.0165
7.26W Co. Bal
2; S = psi N = cycles

Mechanical Properties:

				Other Properties:
F_{tu}	80 ksi	at	1350	TS = 136.0 KSI
F_{ty}	48 ksi	at	1350	E' = 3724 KSI
E	25.7 10^3 ksi	at	1350°F	
G	10^3 ksi	at		
μ		at		
% E		at		
% RA		at		
Hardness		at		

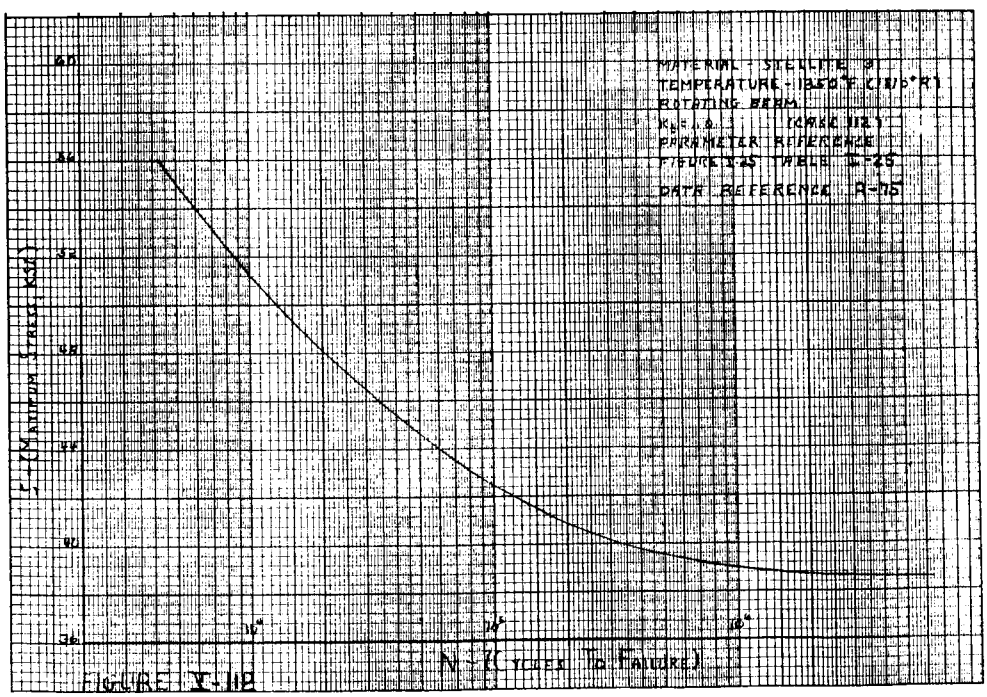


FIGURE X-112

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Stellite 31 Condition 1350°F 16 hrs., F.C. to 1000°F in 1 hr
Reference WADC TR 56-37 A.C.
Reference No. 75 Code No. 8-9-58

Test Temperature 1500°F Environment Air
Type of Test Rotating Cantilever beam Specimen Data Polished
Type of Data _____ Surface Finish _____
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress _____ Notch Description _____

Fatigue Data Source:
Author Grant, H.P.
Publication WADC TR 56-37
No. References 45
Principal Investigator _____
Affiliation University of Minnesota
Comments _____

Mechanical Properties Source:
ASM Metals Handbook
p. 512

Mechanical Properties:

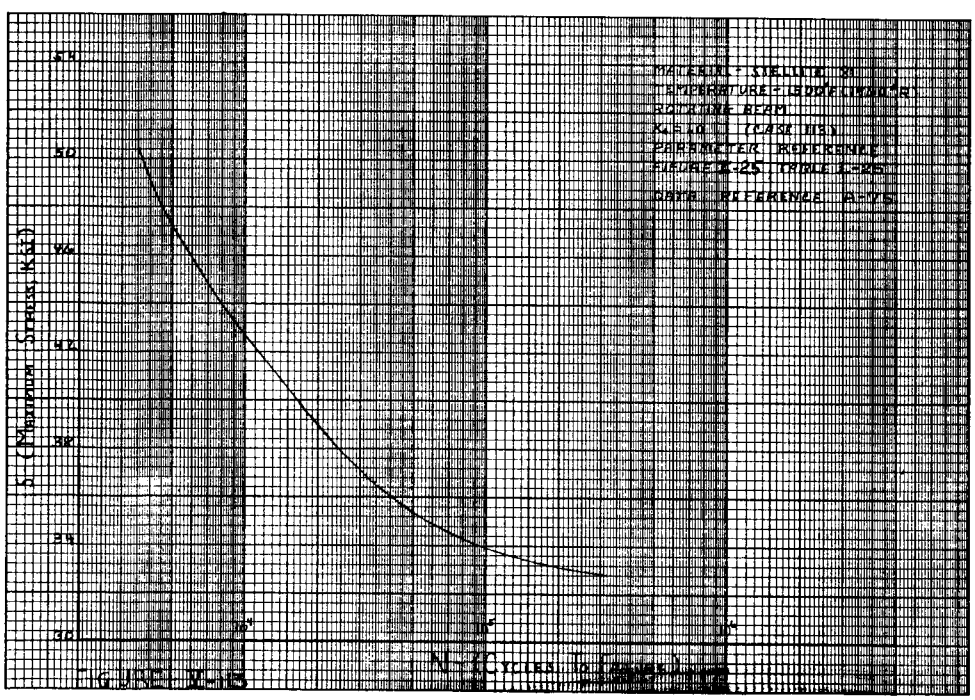
				Other Properties:
F_{tu}	68	ksi	at 1500	TS = 115.6 KSI
F_{ty}	41	ksi	at 1500	E' = 31.64 KSI
E	24.6	10^3 ksi	at 1500°F	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Date of Tabulation _____
Tabulated by JB
Checked by BH

	1	2	3	4	5	6	7	8	9	10
S	60,000[a]	50,000[a]	50,000[a]	40,000[a]	41,900	48,400	40,200	34,600	32,400	27,450
N	120,000	330,000	52,500	71,400	7,880	12,200	14,870	20,000	53,800	5,000,000[b]
S	30,100[b]									
N	20,000,000									
S										
N										
S										
N										
S										
N	Correlation Data:									
S	49,000	48,000	46,000	44,000	42,000	40,000	38,000	36,000	35,000	34,000
N	4,090	4,600	6,000	8,000	11,200	16,300	24,700	41,000	58,000	90,000
S	32,800									
N	310,000									
S										
N										
S										
N										
S										
N										

Parameters:
m = 2.476
b = -2.718
} C

Comments: [illegible] 0.45C - 24.4Cr - 0.42Mn - 10.4Ni - 0.935i - 1.39Fe - .01F - .0165 - 7.26W
Co. Bal
2; 6-psi N-cycles



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Stellite 31 Condition [illegible]
Reference WADC TR 56-37
Reference No. 75 Code No. 884-58

Date of Tabulation
Tabulated by JB
Checked by BD

Test Temperature 1600°F Environment
Type of Test Rotating Cantilever Beam Specimen Data
Type of Data Numerical Surface Finish
Stress Ratio -1.0 Stress Concentration Factor
Mean Stress — Notch Description

Fatigue Data Source:
Author Pedricks, E.R.
Publication WADC [illegible]
No. References 5
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
ASM Metals Handbook
p. 223

½		1	2	3	4	5	6	7	8	9	10
S		10,000[a]	19,700[a]	30,000[a]	40,100	30,000	25,000[b]	27,600[b,c]			
N		31,700	44,500	23,900	9,160	29,100	5,000,000	20,000,000			
S											
N											
S											
N											
S											
N											
S											
N		Correlation Data:									
S		40,000	38,000	34,000	34,000	32,000	31,000	30,000	29,500	29,000	28,400
N		9200	11,000	13,200	15,700	17,800	20,600	23,800	27,400	36,000	160,000
S											
N											
S											
N											
S											
N											
S											
N											

[a] Exploratory Test [b] Test Discontinued [c] Previous Stress History

Parameters:
m = 3.268
b = -3.730
} C

Comments: [illegible]

Mechanical Properties:

				Other Properties:
F_{tu}	65 ksi	at		TS = 110.5 KSI
F_{ty}	40 ksi	at		E = 27.30 KSI
E	23.7 10^3 ksi	at		
G	10^3 ksi	at		
μ		at		
% E		at		
% RA		at		
Hardness		at		

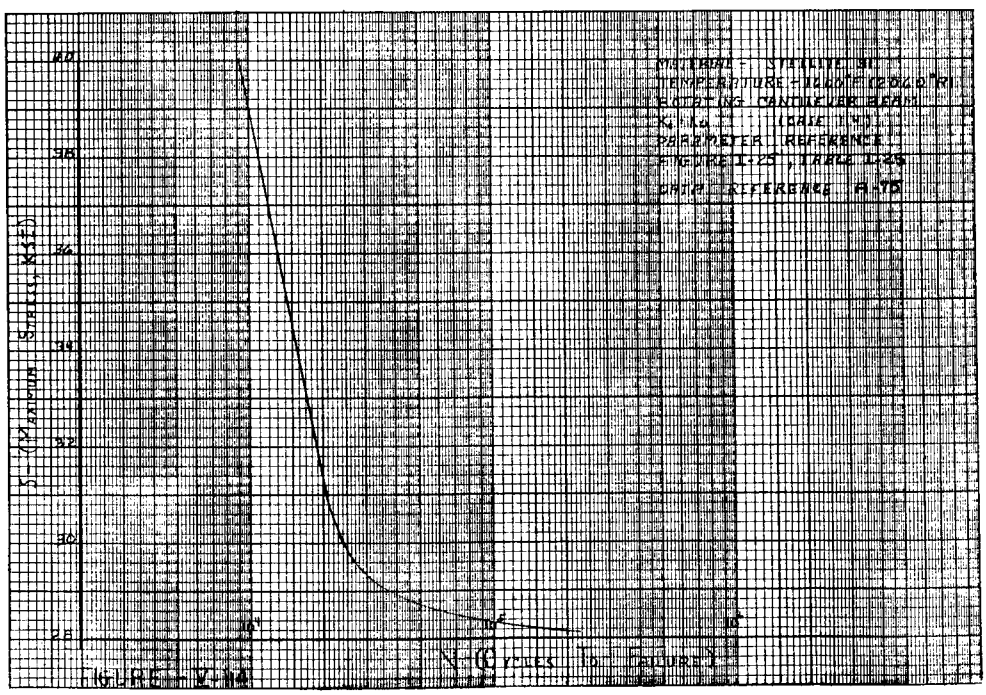


FIGURE V-14

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 3 Mn Complex Titanium Alloy Condition Hot-rolled and Stress Relieved
Reference NACA RM 56B07 p. 2
Reference No. 77 Code No. 26

Test Temperature RT Environment Air
Type of Test Krouse Rotating Beam Specimen Data 0.221 in. minimum dia. bar
Type of Data Numerical Surface Finish Polish
Stress Ratio Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Reg, William K.
Publication NACA RM 56B07
p. 7
No. References
Principal Investigator Author
Affiliation AE Professor, University of Alabama
Comments

Mechanical Properties Source:
NACA RM 56B07
p. 2.

Mechanical Properties:

				Other Properties:
F_{tu}	147.90	ksi	at RT	TS = 251.43 KSI
F_{ty}	134.75	ksi	at RT	E' = 78.49 KSI
E	16.20	10^3 ksi	at RT	
G		10^3 ksi	at	
μ			at	
% E	24.0 (1 inch)		at RT	
% RA	57.8		at RT	
Hardness	33.8 RC		at RT	

Date of Tabulation
Tabulated by RMH
Checked by DS & CB

	1	2	3	4	5	6	7	8	9	10
S	100,720	100,230	98,230	79,230	94,270	77,270	97,710	86,320	84,760	82,030
N	7,300	10,700	16,820	18,520	20,630	29,700	64,800	97,700	64,100	148,900
S	77,721	74,640	79,230	78,460						
N	452,620	2,713,893[a]	340,400	434,580[a]						
S										
N										
S										
N										
S										
N	Correlation Data									
S	100,000	98,000	94,000	90,000	88,000	86,000	85,000	84,000	83,000	82,000
N	12,000	16,000	22,000	30,000	40,000	53,000	76,000	104,000	148,000	258,000
S	81,000									
N	489,000									
S										
N										
S										
N										
S										
N										

[a] Did not fail

Parameters:
m = 2.211
b = -2.347
} C

Comments:

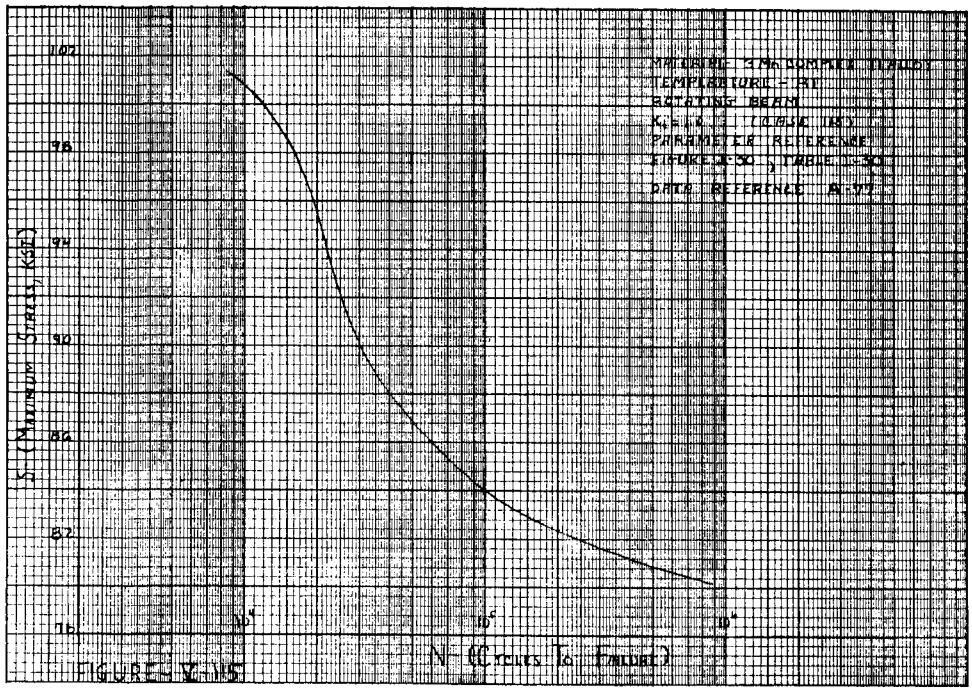


FIGURE X-115

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 3 Mn Complex Titanium Alloy Condition Hot-rolled and annealed

Reference NACA RM 56B07 p.8

Reference No. 77 Code No. 26

Date of Tabulation

Tabulated by RMA

Checked by DS SCB

Test Temperature 200°F Environment Air

Type of Test Krouse rotating-beam Specimen Data 0.371 in. minimum dia. bar

Type of Data Numerical Surface Finish Polish

Stress Ratio Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author Reg. William K.

Publication NACA RM 56B07 p. 7

No. References

Principal Investigator Author

Affiliation AE Professor, University of Alabama

Comments

Mechanical Properties Source:

	1	2	3	4	5	6	7	8	9	10
S	83820	81070	80580	76,570	72,300	72,000	69210	67730	66520	65930
N	46,100	24,800	47,000	44,400	88,000	318,500	704,800	2,272,100	3619100	1710,000
S	65700	65080	64,500	64,300	64,230					
N	(3205100 [a]	4711900	1456,500	10,129,803 [a]	12,065,000 [a]					
S										
N										
S										
N										
S										
N	Correlation Data:									
S	94,000	80,000	78,000	76,000	74,000	72,000	70,000	68,000	66,000	65,000
N	23000	35,000	42,000	66,000	100,000	167,000	320,000	720,000	2,200,000	6,500,000
S										
N										
S										
N										
S										
N										
S										
N										

[a] did not fail

Parameters: $m = 1.546$, $b = -1.491$ } C

Mechanical Properties:

				Other Properties:
F_{tu}	142.0	ksi	at 200	TS = 241.4 KSI
F_{ty}		ksi	at	E = 62.59 KSI
E	16.0	10^3 ksi	at 200	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Comments: U_f^E estimated from Ti-6Al-4V Data and Ti-8 Mn Data

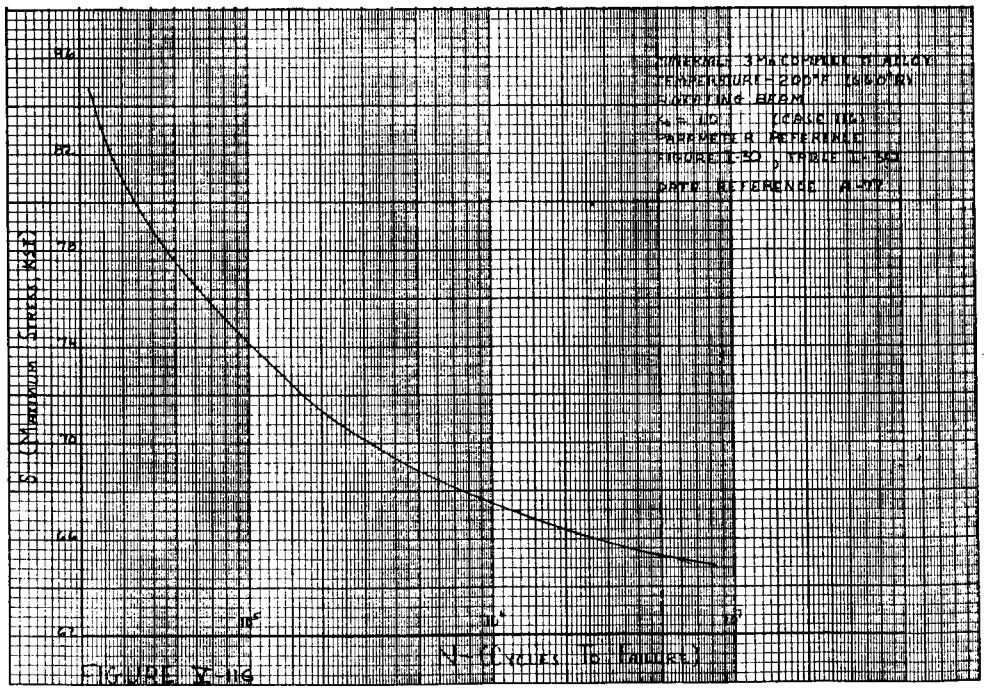


FIGURE X-116

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 3 Mn Complex Titanium Alloy Condition Hot-rolled and cleaned
Reference NACA RM 56B07, p. 2
Reference No. 77 Code No. 26

Test Temperature 400°F Environment Air
Type of Test Krouse rotating-beam Specimen Data 0.271 in minimum dia. bar
Type of Data Numerical Surface Finish Polish
Stress Ratio Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Roy, William K.
Publication NACA RM 56B07
p. 7
No. References
Principal Investigator Author
Affiliation AE Professor, University of Alabama
Comments

Mechanical Properties Source:

Mechanical Properties:

F_{tu}	131.0 ksi	at 400°F	
F_{ty}	ksi	at	
E	10^3 ksi	at	
G	15.0 10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:
TS': 222.2 KSI
E': 62.37 KSI

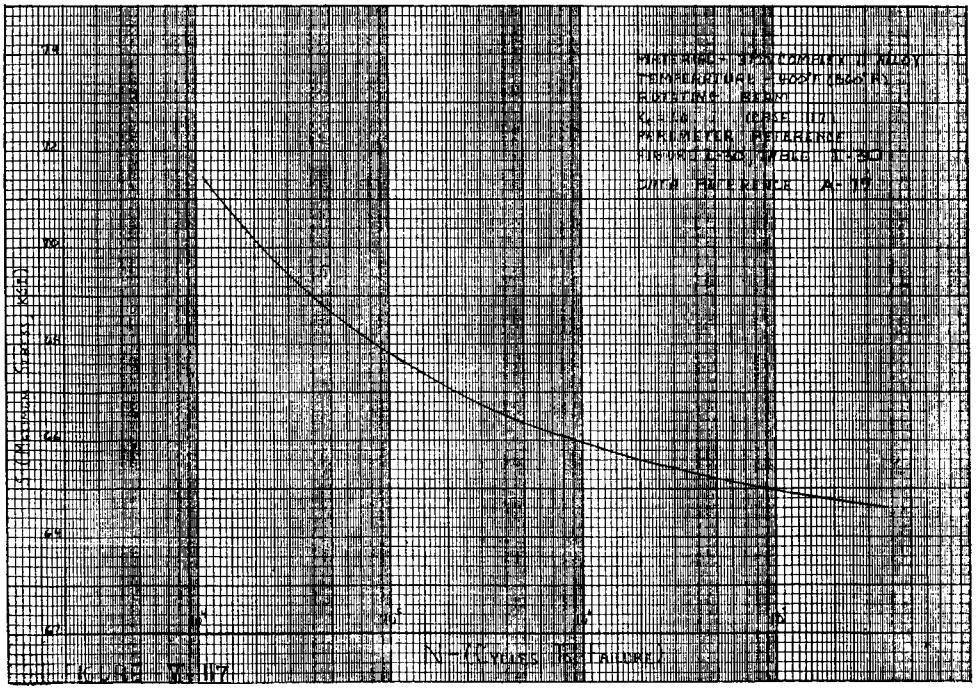
Date of Tabulation
Tabulated by RMH
Checked by BSDS

	1	2	3	4	5	6	7	8	9	10
S (PSI)	74,230	70,060	67,260	69,160	68,700	68,010	67,570	66,760	66,400	65,380
N	32,200	165,100	46,500	1,262,100	402,400	38,400	34,300	173,300	80,400	47,800
S	65,020	64,670	64,140	64,070	63,029	61,970				
N	2,003,500	2,830,400[a]	1,905,900	1,028,200	1,256,600[a]	1,041,200[a]				
S										
N										
S										
N										
S										
N	Correlation Data:									
S	71,000	70,000	69,000	68,000	67,000	66,400	66,000	65,400	65,000	64,600
N	13,500	22,400	41,000	88,000	230,000	490,000	940,000	1,500,000	2,400,000	3,800,000
S										
N										
S										
N										
S										
N										
S										
N										

a did not fail

Parameters:

Comments: Ur estimated from Ti-6Al-4V and Ti-8Mn Data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 3 Mn Cowpler Titanium Alloy Condition Hot-rolled and cleaned
Reference NACA RM 56B07, p.2
Reference No. 77 Code No. 26

Test Temperature 600°F Environment Air
Type of Test Krause rotating-beam Specimen Data 0.27 in minimum dia. bar
Type of Data Numerical Surface Finish polish
Stress Ratio Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Roy William K.
Publication NACA RM 56B07
p.8
No. References
Principal Investigator Author
Affiliation AE Professor, University of Alabama
Comments

Mechanical Properties Source:

Mechanical Properties:

F_{tu}	117.0 ksi	at 600	
F_{ty}	ksi	at	
E	13.5 10^3 ksi	at 600	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:
TS: 202.3 KSI
E = 56.58 KSI

Date of Tabulation
Tabulated by RHD
Checked by CB DS

	1	2	3	4	5	6	7	8	9	10
S	94,060	66,000	63,250	62,700	62,970	60,500	60,200	61,530	61,000	60,930
N	4,100	23,000	20,300	135,400	116,200	89,200	32,600	583,900	127,300	154,100
S	63,920	60,250	59,250	59,490	59,060	57,060	57,900	57,250	56,380	54,950 a
N	768,200	220,700	1,106,300	305,400	130,700	353,900	1,547,300	2,598,400	344,100	12,000,000
S	43,060									
N	12,406,440 a									
S										
N										
S										
N	Correlation Data:									
S	84,000	80,000	76,000	72,000	68,000	66,000	64,000	62,000	60,800	60,000
N	3,000	3,800	5,100	7,400	13,000	19,300	32,000	72,000	150,000	300,000
S	59,000	58,600								
N	1,100,000	4,200,000								
S										
N										
S										
N										
S										
N										

a did not fail

Parameters: m = 1.461, b = -1.188 } C

Comments: N_f vs $\frac{S}{S_u}$ relation from Ti-6Al-4V and Ti-6Mn data

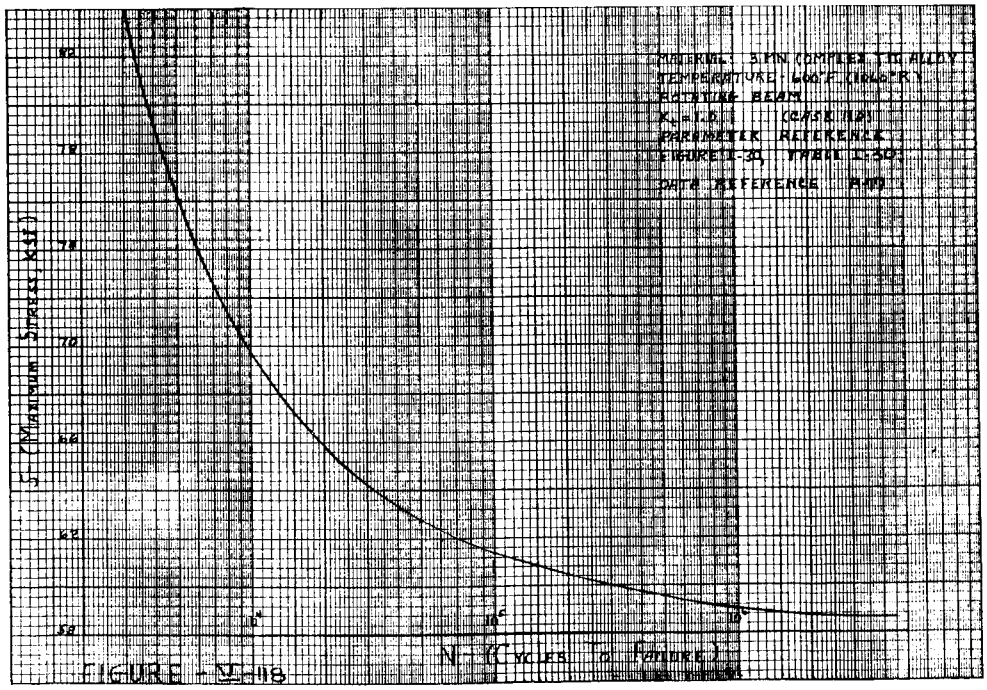


FIGURE - N-118

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 3Al-Mn Complex Titanium Alloy Condition Hot-rolled and cleaned
Reference NACA RM 56B07, p.2
Reference No. 77 Code No. 26

Test Temperature 800°F Environment Air
Type of Test Krouse rotating-beam Specimen Data 0.277 in. minimum diameter
Type of Data Numerical Surface Finish polish
Stress Ratio -1 Stress Concentration Factor 1.0
Mean Stress 0 Notch Description

Fatigue Data Source:
Author Rey, William K.
Publication NACA RM 56B07
p.8
No. References
Principal Investigator Author
Affiliation AE Professor, University of Alabama
Comments

Mechanical Properties Source:

Mechanical Properties:

F_{tu}	101.0 ksi	at	800
F_{ty}	ksi	at	
E	12.0 10^3 ksi	at	800
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:
T_S = 171.2 KSI
E' = 4468 KSI

Date of Tabulation
Tabulated by RMT
Checked by CB DS

	1	2	3	4	5	6	7	8	9	10
S	59,030	57,870	57,000	55,960	55,020	53,830	53,170	52,040	51,020	50,000
N	12,200	16,200	14,800	28,100	23,200	31,400	52,500	61,900	102,500	183,200
S	49,490	47,080	48,160	47,970	47,540	47,060	46,010	45,460	45,040	
N	139,300	201,700	172,200	624,300	652,300	335,700	933,700	1,765,300	19,159,700	
S										
N										
S										
N										
S										
N	Correlation Data:									
S	58,000	54,000	54,000	52,000	50,000	48,000	47,600	47,200	46,800	46,400
N	14,000	24,000	43,000	79,000	150,000	300,000	370,000	520,000	1,000,000	6,000,000
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 1.472, b = -1.267 } C

Comments: Used estimated from T. CR1-6V and T. 2Pin data

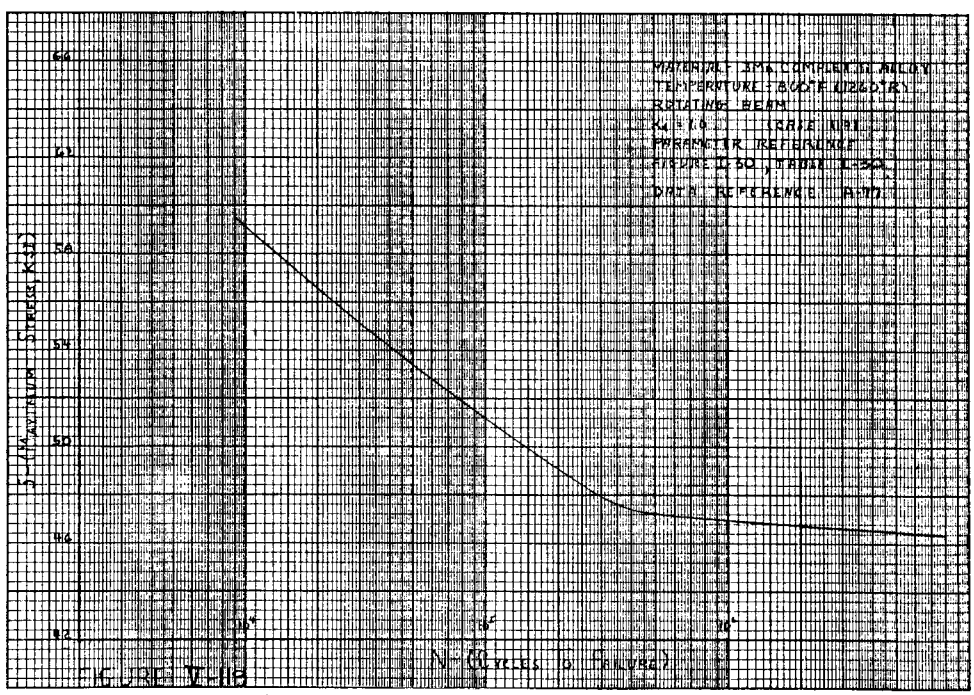


FIG. NO. V-118

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 3 Mn Complex Titanium Alloy Condition Hot-rolled and sheared
Reference NACA RM 56E07, p 2
Reference No. 71 Code No. 21

Date of Tabulation
Tabulated by RM
Checked by CB DS

Test Temperature 1000°F Environment Air
Type of Test Krause rotating-beam Specimen Data 0.271 in. minimum dia. bar
Type of Data Numerical Surface Finish polish
Stress Ratio Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author Reg, William K.
Publication NACA RM 56E07
p.8
No. References
Principal Investigator Author
Affiliation AE Professor, University of Alabama
Comments

Mechanical Properties Source:

Mechanical Properties:

F_{tu}	72.0 ksi	at	1000°F
F_{ty}	ksi	at	
E	10 10^3 ksi	at	1000°F
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:
T5' = 122.4 KSI
E' = 25.28 KSI

	1	2	3	4	5	6	7	8	9	10
S	54.9	52.4	49.0	43.5	42.0	38.3	34.3	30.6	26.8	23.0
N	5×10³	1×10⁴	2×10⁴	5×10⁴	7×10⁴	1×10⁵	2×10⁵	5×10⁵	7×10⁵	10⁶
S	27.0	25.5								
N	5×10⁵	1×10⁷								

Correlation

Parameters: m = 2.227, b = -2.850

Comments: (1) E extrapolated from Ti 6Al 4V curve

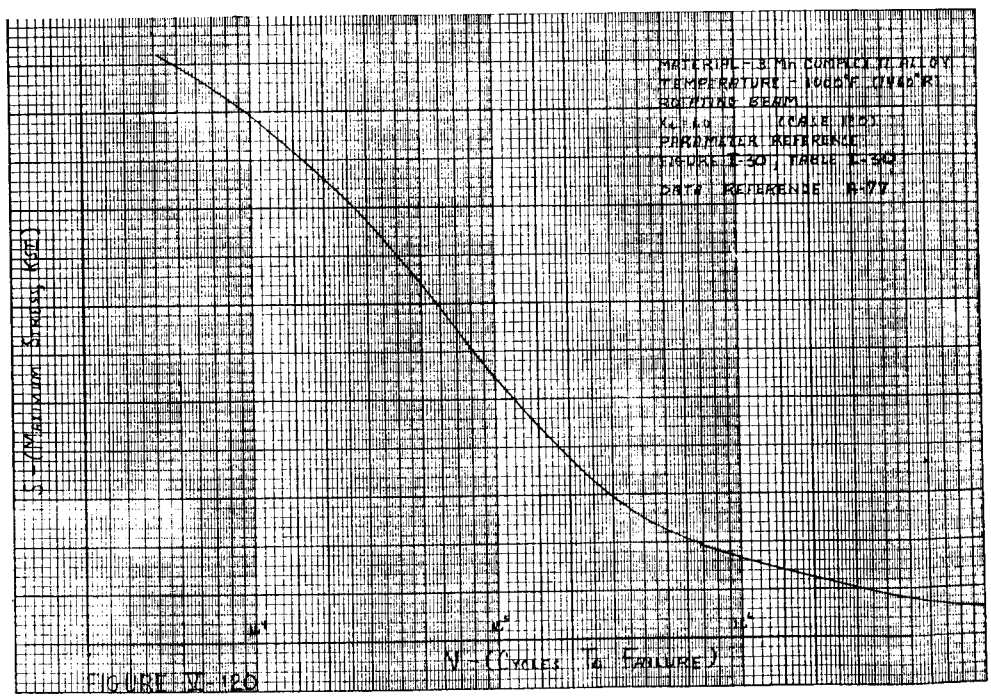


FIGURE V-120

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075 T Condition
Reference Trans. ASM Vol. 43 p557
Reference No. 84 Code No. 26

Test Temperature RT Environment air
Type of Test Krouse RB Specimen Data 0.500 in Dia.
Type of Data points on a curve Surface Finish
Stress Ratio -1 Stress Concentration Factor
Mean Stress 0 Notch Description

Fatigue Data Source:
Author Spretnak JW.
Publication Trans. ASM vol 43, 1951
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Same
p 554

Mechanical Properties:

F_{tu}	83.9 ksi	at	R_t
F_{ty}	72.2 ksi	at	R_t
E	10.3 10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E	13.5	at	R_t
% RA	28.0	at	R_t
Hardness		at	

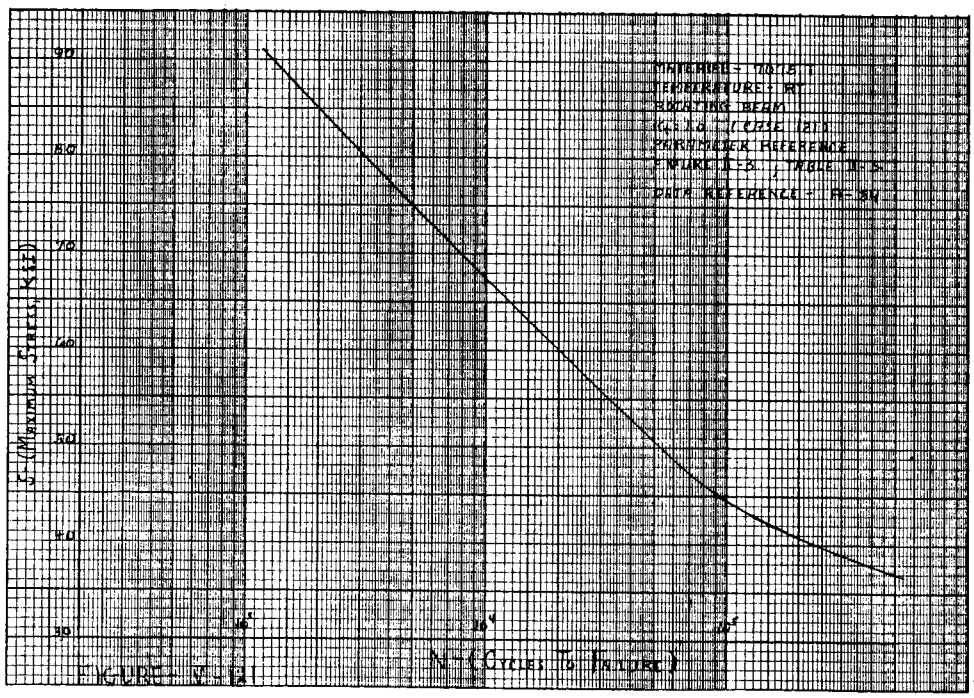
Other Properties:
TS = 142.63 KSI
E' = 34.57 MSI

Date of Tabulation
Tabulated by RAA
Checked by CB

	1	2	3	4	5	6	7	8	9	10
S	95.0	90.0	70.0	60.0	50.0	50.0	40.0	39.0	35.0	
N	1.2×10^3	3.0×10^3	9.0×10^3	2.2×10^4	4.2×10^4	6.5×10^4	1.3×10^5	6.5×10^5	7×10^5	
S										
N										
S										
N										
S										
N	Correlation Data:									
S	90.0	80.0	70.0	60.0	50.0	45.0	41.0	39.0	37.0	36.0
N	$1.3(10)^3$	$3.2(10)^3$	$8.0(10)^3$	$2.0(10)^4$	$5.3(10)^4$	$9.2(10)^4$	$1.8(10)^5$	$2.8(10)^5$	$4.8(10)^5$	$6.8(10)^5$
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 2.981, b = -3.893 } C

Comments:



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075 T Condition
Reference From P.S.M. V.143 p.55
Reference No. 41 Code No.

Date of Tabulation
Tabulated by KHS
Checked by CB

Test Temperature -196 °C Environment
Type of Test Krouse Specimen Data
Type of Data points on a curve Surface Finish
Stress Ratio -1 Stress Concentration Factor 1.0
Mean Stress 0 Notch Description

Fatigue Data Source:
Author Sprotbok J.W.
Publication Trans. ASM. vol 43, 1951
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
Same p 554

Mechanical Properties:

F_{tu}	99.5	ksi	at -196 °C	
F_{ty}	89.5	ksi	at -196 °C	
E	11.6	10^3 ksi	at -196 °C	
G		10^3 ksi	at	
μ			at	
% E	12.0		at -196 °C	
% RA	15.0		at -196 °C	
Hardness			at	

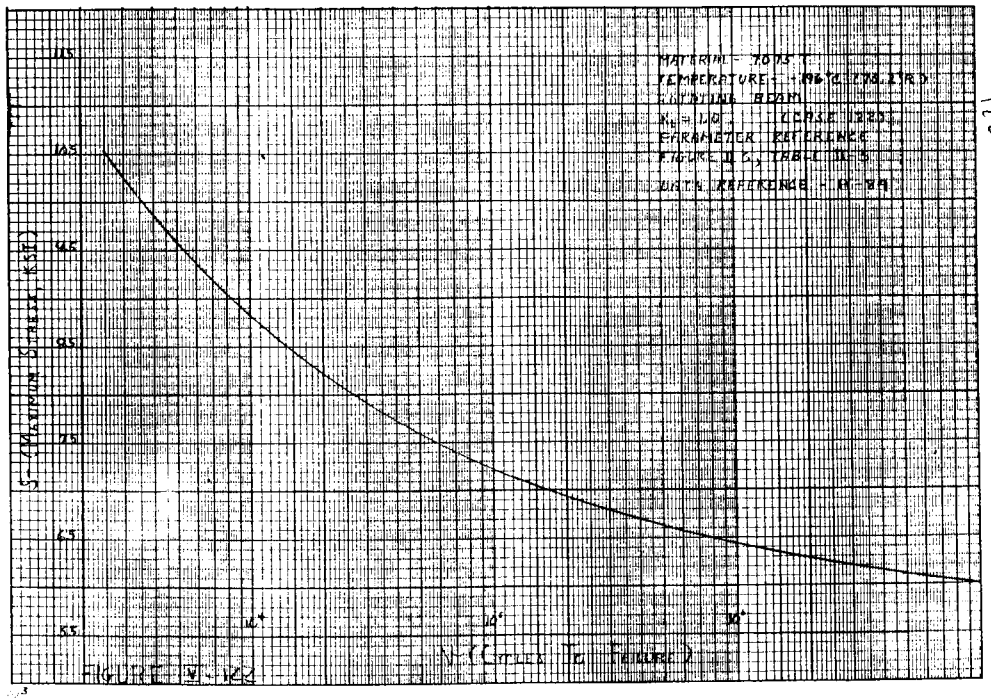
Other Properties:
TS = 169.15 KSI
E' = 5831 KSI

KSi

	1	2	3	4	5	6	7	8	9	10
S	100.0	90.0	80.0	70.0	60.0					
N	$3.5\,10^{-3}$	$9.0\,10^{-3}$	$3.0\,10^{-4}$	$1.8\,10^{-5}$	9×10^{-6}					
S										
N										
S										
N										
S										
N	Correlation Data:									
S	105,000	100,000	95,000	90,000	85,000	80,000	75,000	70,000	65,000	60,000
N	$2.5(10)^{-3}$	$3.5(10)^{-3}$	$5.4(10)^{-3}$	$8.4(10)^{-3}$	$1.4(10)^{-4}$	$2.7(10)^{-4}$	$5.3(10)^{-4}$	$1.7\ (10)^{-5}$	$3.0(10)^{-5}$	$9.6(10)^{-6}$
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 2.123, b = -2.698 } C

Comments:



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075-T6 Al Condition Wrought
Reference ALCOA RT 9-47-9 Copy 251
Reference No. 49 Code No. 13

Date of Tabulation
Tabulated by DS
Checked by RMA

Test Temperature 75°F Environment Air
Type of Test Rotating-beam Specimen Data 0.4 in. dia.
Type of Data Numerical Surface Finish —
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress — Notch Description —

Fatigue Data Source:
Author Howell, F.M., Stickley, G.W.
Publication ALCOA RT 9-47-9 Copy 251 p. 120
No. References
Principal Investigator Howell, F.M.
Affiliation Chief Mechanical Testing Div, ALCOA
Comments

Mechanical Properties Source:
ALCOA RT 9-47-9, Copy 251 p. 26, 27

Mechanical Properties:

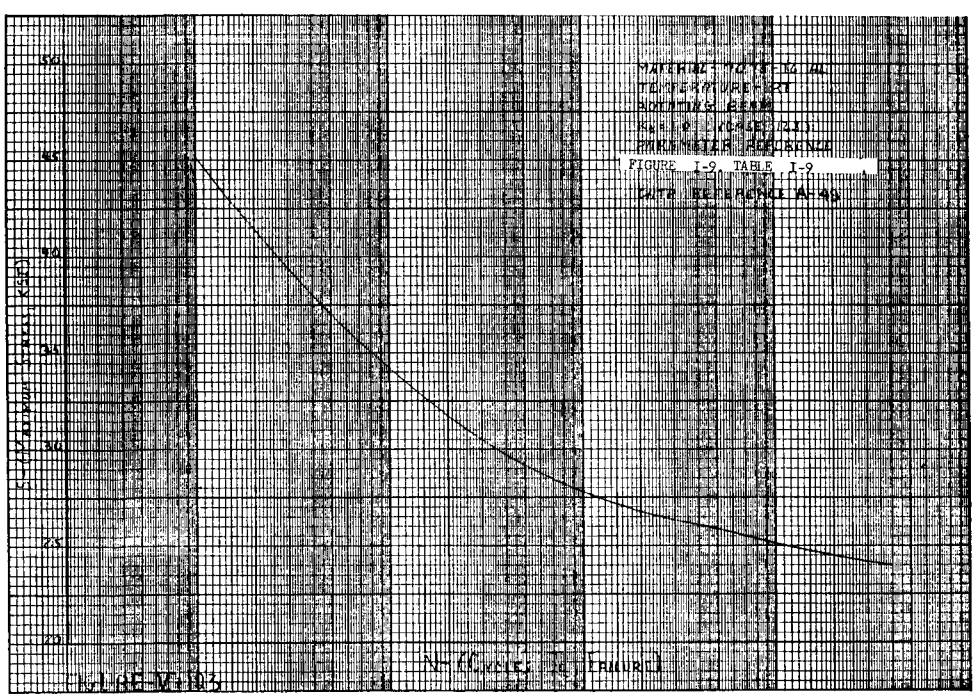
				Other Properties:
F_{tu}	82.0 ksi	at	75°F	T_c' 139.9 KSI
F_{ty}	72.0 ksi	at	75°F	E' = 22.606 KSI
E	10.4 10^3 ksi	at	75°F	
G	~ 3.9 10^3 ksi	at	75°F	
μ	~ 1/3	at	75°F	
% E_{in}	11.0	at	75°F	
% RA		at		
Hardness		at		

Data Correlation, KSI

	1	2	3	4	5	6	7	8	9	10
S	45,000	37,500	29,000	25,000	24,000					
N	100,000	1,000,000	10,000,000	100,000,000	500,000,000					
S										
N										
S										
N										
S										
N										
S										
N										
S	45.0	42.5	40.0	37.5	35.0	32.5	30.0	27.5	21.0	26.0
N	1.0×10^5	1.7×10^5	2.75×10^5	4.6×10^5	8.0×10^5	1.6×10^6	3.7×10^6	1.3×10^7	1.8×10^7	4.0×10^7
S	25.0	29.0								
N	1.1×10^8	3.7×10^8								
S										
N										
S										
N										
S										
N										

Parameters: $m = 1.835$, $b = -2.455$ } C

Comments: Design Data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075-T6 Al Condition Wrought
Reference ARCOA RT 9-47-9, Copy 251
Reference No. 49 Code No. 13

Test Temperature 300°F Environment Air
Type of Test Cantilever-beam Specimen Data 0.40 in. dia
Type of Data Numerical Surface Finish —
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress — Notch Description —

Fatigue Data Source:
Author Howell, F.M., Stickley, G.W.
Publication ARCOA RT 9-47-9, Copy 251
p. 120
No. References
Principal Investigator Howell, F.M.
Affiliation Chief, Mechanical Testing Div., ARCOA
Comments

Mechanical Properties Source:
ARCOA RT 9-47-9, Copy 251
p. 26, 27

Mechanical Properties:

				Other Properties:
F_{tu}	25.0 ksi	at	300°F	75' = 92.5 KSI
F_{ty}	21.0 ksi	at	300°F	E' = 11.515 KSI
E	9.88 10^3 ksi	at	300°F	
G	10^3 ksi	at		
μ		at		
% E in 4D	30.0	at	300°F	
% RA		at		
Hardness		at		

Date of Tabulation
Tabulated by RMA
Checked by DS

	1	2	3	4	5	6	7	8	9	10
S*	18,000	15,000	13,000	12,000	11,000					
N	100,000	1,000,000	10,000,000	100,000,000	500,000,000					
S										
N										
S										
N										
S										
N										
S										
N				Data Corrections KSI						
S	18.0	17.5	17.0	16.5	16.0	15.5	15.0	14.5	14.0	13.5
N	1.0×10^5	1.5×10^5	2.0×10^5				1.2×10^6	1.56×10^6		
S	13.0	12.5	12.0	11.5						
N	1.5×10^7			5.0×10^7						
S										
N										
S										
N										
S										
N										

Parameters: m = 2.018
b = -2.882 } SC

Comments: *1 Stress in KSI
Dummy Data

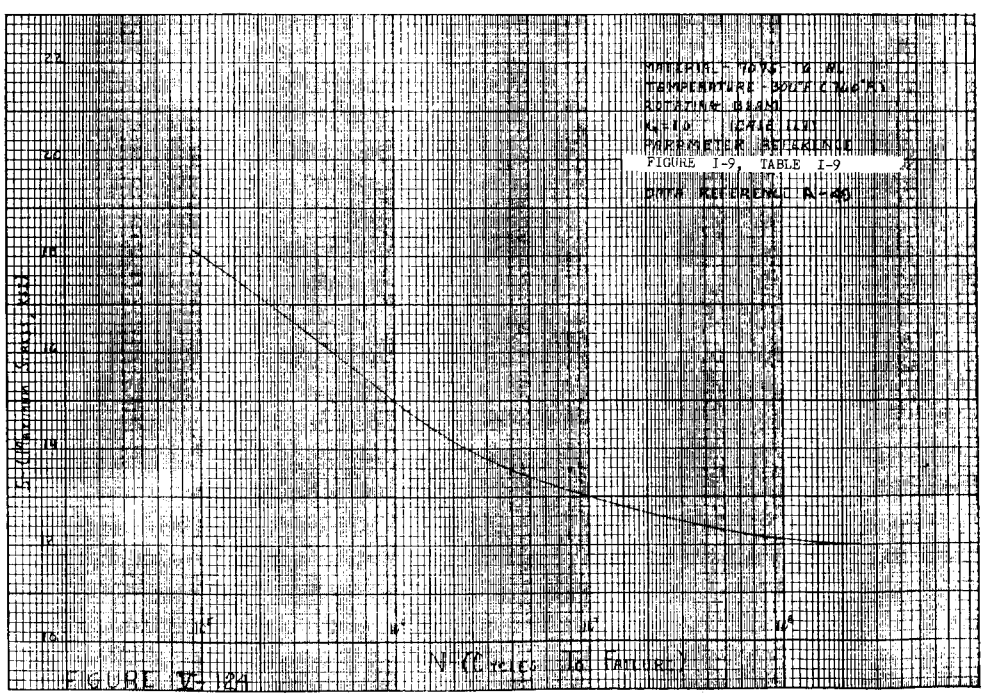


FIGURE V-24

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075-T6 Al — Condition Wrought
Reference AKDA RT 9-47-9, Copy 251
Reference No. 49 — Code No. 13

Date of Tabulation
Tabulated by DS
Checked by PBA

Test Temperature 400°F — Environment Air
Type of Test Cantilever-beam — Specimen Data 0.40 in. dia.
Type of Data Numerical — Surface Finish —
Stress Ratio −1.0 — Stress Concentration Factor 1.0
Mean Stress — — Notch Description —

Fatigue Data Source:
Author Howell, F.M., Stickley, G.W.
Publication AKDA RT 9-47-9, Copy 251 p. 120
No. References
Principal Investigator Author
Affiliation AKDA
Comments

Mechanical Properties Source:
AKDA RT 9-47-9, Copy 251 pp. 26, 27

Mechanical Properties:

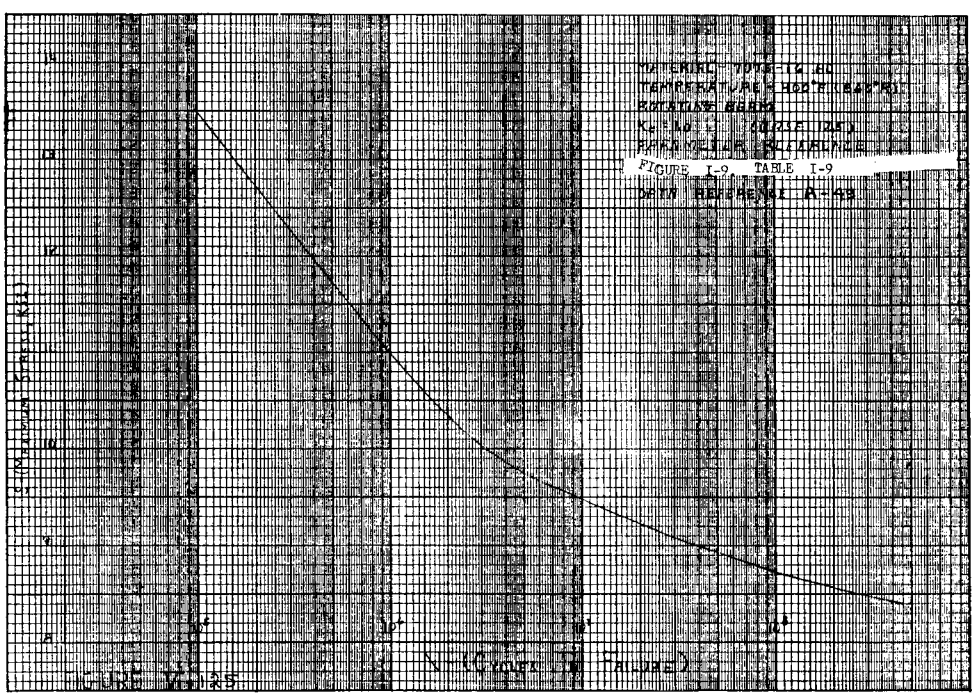
F_{tu}	14.0	ksi	at 400°F	
F_{ty}	12.0	ksi	at 400°F	
E	9.36	10^3 ksi	at 400°F	
G		10^3 ksi	at	
μ			at	
% E in 4D	6.00		at 400°F	
% RA			at	
Hardness			at	

Other Properties:
TS' = 23.8 Ksi
E' = 8.162 Ksi

		1	2	3	4	5	6	7	8	9	10
S		13,500	11,000	9,500	8,500	8,500					
N		109,000	1,000,000	10,000,000	100,000,000	100,000,000					
S											
N											
S											
N											
S											
N											
S											
N					Data Correlation Ksi						
S		13.5	13.0	12.5	12.0	11.5	11.0	10.5	10.0	9.5	9.0
N		1.0×10^5	1.6×10^5	2.5×10^5	3.9×10^5	6.1×10^5	9.9×10^5	1.65×10^6	3.2×10^6	9.2×10^6	4.1×10^7
S		8.8	8.6	8.4							
N		8.2×10^7	1.8×10^8	9.9×10^8							
S											
N											
S											
N											
S											
N											

Parameters: m = 2.427, b = −3.826 } c

Comments: Design Data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 7075-T6 Al Condition Wrought
Reference ALCOA RT 9-47-9, Copy 251
Reference No. 49 Code No. 13

Test Temperature 500°F Environment Air
Type of Test Cantilever-beam Specimen Data 0.42 in. dia.
Type of Data Numerical Surface Finish —
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress — Notch Description —

Fatigue Data Source:

Author Howell, F.M., Stickley, G.W.
Publication ALCOA RT 9-47-9, Copy 251 p. 120
No. References
Principal Investigator Author
Affiliation ALCOA
Comments

Mechanical Properties Source:

ALCOA RT 9-47-9, Copy 251 pp. 26, 27

Mechanical Properties:

F_{tu}	11.0	ksi	at 500°F	
F_{ty}	8.5	ksi	at 500°F	
E	8.32	10^3 ksi	at 500°F	
G		10^3 ksi	at	
μ			at	
% E in 4D	65.0		at 500°F	
% RA			at	
Hardness			at	

Other Properties:

TS = 18.7 Ksi
E = 6.813 Ksi

Date of Tabulation
Tabulated by DS
Checked by BA

	1	2	3	4	5	6	7	8	9	10
S	11,000	9,000	7,000	7,000	7,000					
N	100,000	1,000,000	10,000,000	100,000,000	500,000,000					
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation						
S	11.0	10.5	10.0	7.5	7.0	8.5	8.0	7.5	7.1	7.2
N	1.0×10^5	1.8×10^5	3.2×10^5	5.6×10^5	1.0×10^6	1.8×10^6	3.2×10^6	1.0×10^7	1.4×10^7	4.1×10^7
S	2.1	7.0								
N	1.0×10^7	2.9×10^5								
S										
N										
S										
N										
S										
N										

Parameters: m = 2.799, b = -4.470 } C

Comments: Design Data

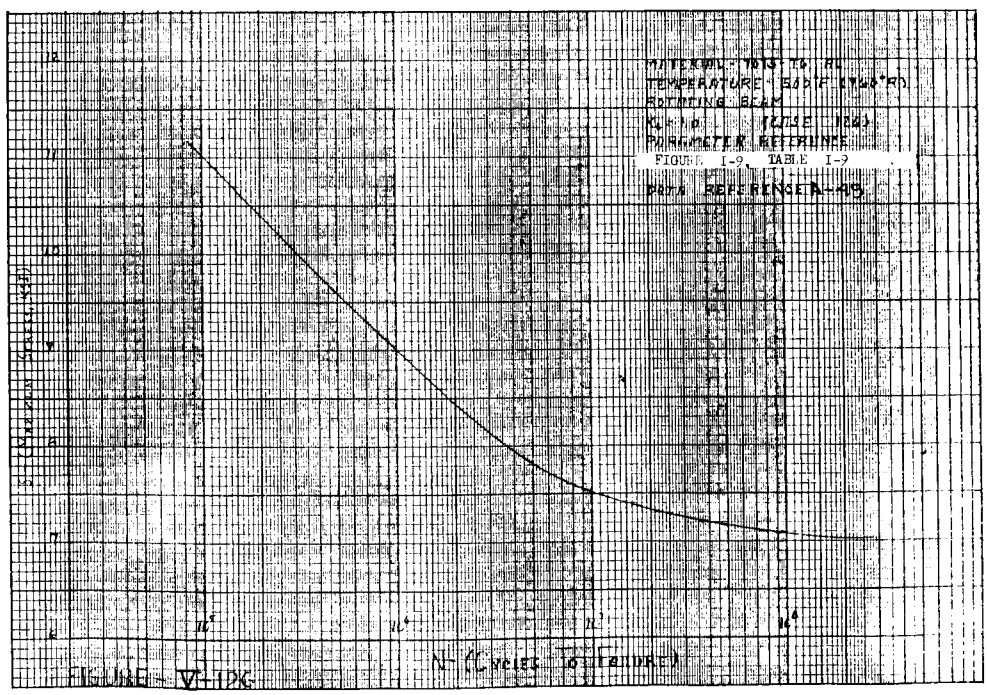


FIGURE V-1DK

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

(127)

Material 2014-T6 Al Condition Wrought
Reference ALCOA RT 9-47-9 Copy 251
Reference No. 49 Code No. 13

Date of Tabulation
Tabulated by DS
Checked by

Test Temperature 75°F Environment Air
Type of Test Rotating-Beam Specimen Data 0.4-in. dia.
Type of Data Numerical Surface Finish —
Stress Ratio -1 Stress Concentration Factor 1.0
Mean Stress Notch Description —

Fatigue Data Source:
Author Howell, F.M., Stickley, G.W.
Publication ALCOA RT 9-47-9 Copy 251
p. 120
No. References
Principal Investigator Author
Affiliation ALCOA
Comments

Mechanical Properties Source:
ALCOA RT 9-47-9 Copy 251
p. 11, 27

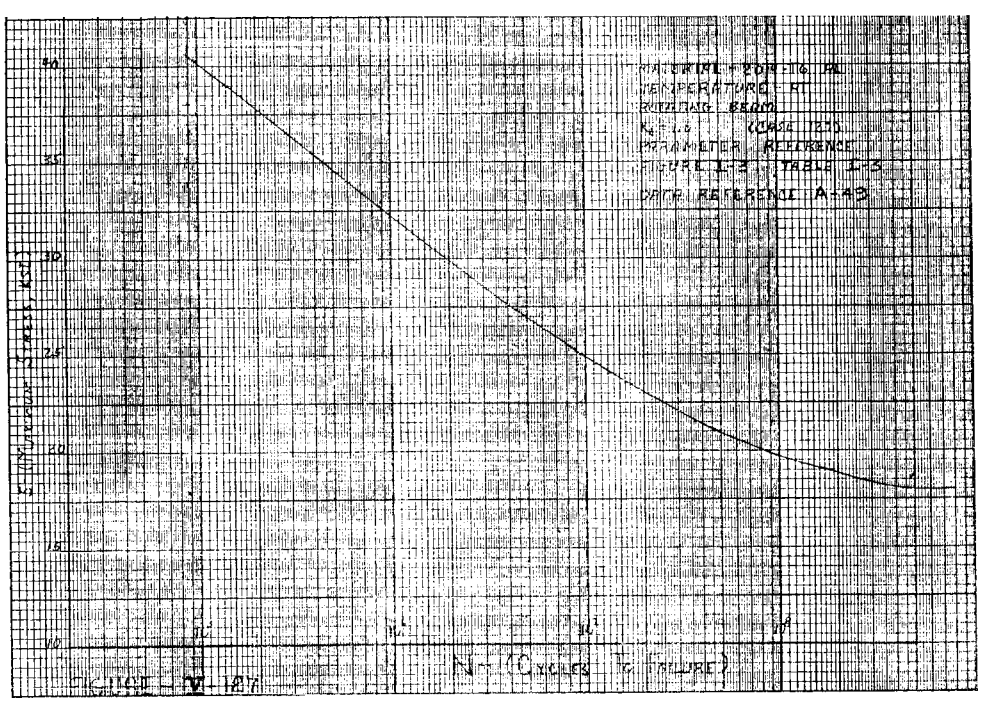
S	42,200	32,200	25,200	20,000	18,200					
N	100,000	1,000,000	10,000,000	100,000,000	500,000,000					
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation (KSI, Cycles)						
S	40.0	37.5	35.0	32.5	30.0	27.5	25.0	22.5	20.0	17.0	18.0
N	1.0×10^5	2.1×10^5	4.5×10^5	1.9×10^6	3.2×10^6	1.1×10^7	2.55×10^7	9.6×10^7	1.8×10^8	8.0×10^8
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Parameters: $m = -4.951$
$b = -2.814$ } SC

Comments: Design Data

Mechanical Properties:

				Other Properties:
F_{tu}	70.0 ksi	at	75°F	75°=119.0 ksi
F_{ty}	60.0 ksi	at	75°F	E' = 16.81 ksi
E	10.6 10^3 ksi	at	75°F	
G	3.9 10^3 ksi	at	75°F	
μ	~ 1/3	at	75°F	
% E_{in4D}	13.0	at	75°F	
% RA		at		
Hardness		at		



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2014-T6 Al Condition Wrought
Reference ALCOA RT 9-47-9 Copy 251
Reference No. 49 Code No. 13

Date of Tabulation
Tabulated by DS
Checked by

Test Temperature 300°F Environment Air
Type of Test Cantilever-Beam Specimen Data 0.4 in. Dia.
Type of Data Numerical Surface Finish —
Stress Ratio -1 Stress Concentration Factor 1.0
Mean Stress — Notch Description —

Fatigue Data Source:
Author Howell, F.M., Stickley, G.W.
Publication ALCOA RT 9-47-9 Copy 251 p. 120
No. References
Principal Investigator Howell, F.M.
Affiliation Chief Mechanical Testing Div, ALCOA
Comments

Mechanical Properties Source:
ALCOA RT 9-47-9 Copy 251 pp. 11, 27

Mechanical Properties:

F_{tu}	47.00	ksi	at 300°F	
F_{ty}	40.00	ksi	at 300°F	
E	10.07	10^3 ksi	at 300°F	
G		10^3 ksi	at	
μ			at	
% E in 4D	15.00		at 300°F	
% RA			at	
Hardness			at	

Other Properties:
$T\sigma' = 17.9$ ksi
$E' = 11.201$ ksi

	1	2	3	4	5	6	7	8	9	10
S	22,500	18,000	15,000	13,000	12,000					
N	100,000	1,000,000	12,000,000	100,000,000	500,000,000					
S										
N										
S										
N										
S										
N										
S										
N					Data Correlation (ksi, cycles)					
S	22.5	21.0	20.0	19.0	18.0	17.0	16.0	15.0	14.0	13.5
N	1.0×10^5	2.7×10^5	2.6×10^6	5.7×10^5	1.0×10^6	1.9×10^6	3.7×10^6	9.9×10^6	2.6×10^7	9.6×10^7
S	1	1.5	13.0							
N	1	1.0×10^7	1.0×10^7							
S										
N										
S										
N										
S										
N										

Parameters: $m = 1.605$ } C
$b = -2.029$

Comments: Design Data

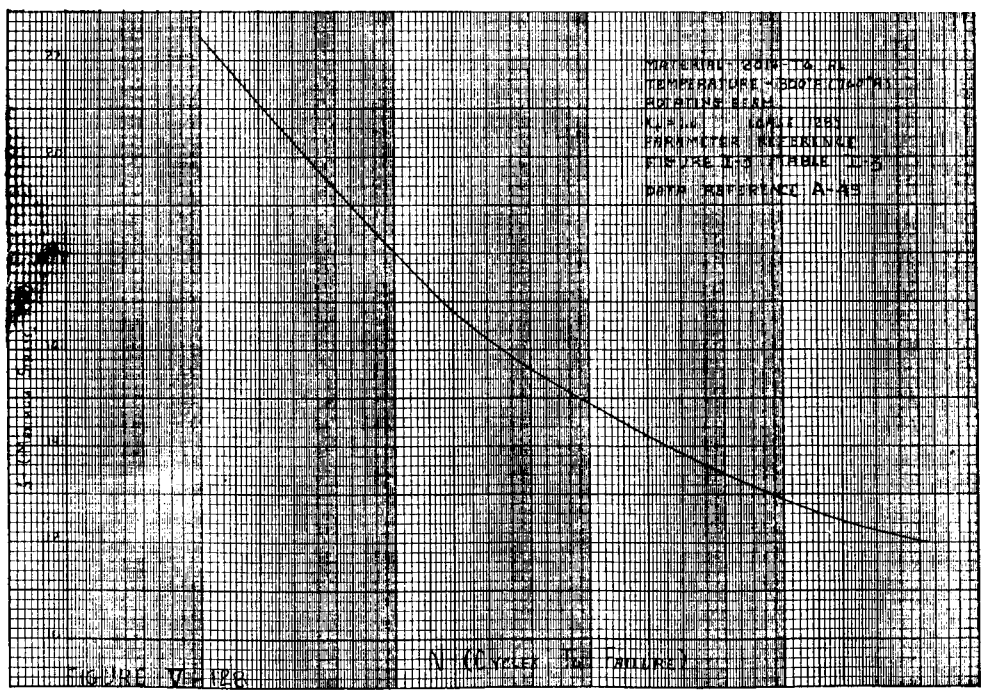


FIGURE V-1-128

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2014-T6 Al Condition Bar

Reference ALCOA RT 1-47-9 Supp. #1

Reference No. 49 Code No. 13

Test Temperature 400°F Environment Air

Type of Test Cantilever-beam Specimen Data

Type of Data Numerical Surface Finish —

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress — Notch Description —

Fatigue Data Source:

Author Howell, F. M., Stickley, G. W.

Publication ALCOA RT 9-47-9, Copy #51 p. 120

No. References

Principal Investigator Howell, F.M.

Affiliation Chief, Mechanical Testing Div., ALCOA

Comments

Mechanical Properties Source:

ALCOA RT 1-47-1 Supp. #1 p. 11,22

Mechanical Properties:

				Other Properties:
F_{tu}	18.00	ksi	at 400°F	
F_{ty}	12.00	ksi	at 400°F	
E	7.54	10^3 ksi	at 400°F	
G		10^3 ksi	at	
μ			at	
% E in 4D	35.00		at 400°F	
% RA			at	
Hardness			at	

Date of Tabulation

Tabulated by DS

Checked by RHH

	1	2	3	4	5	6	7	8	9	10
S	15,000	12,000	10,000	8,500	8,000					
N										
S										
N										
S										
N										
S										
N										
S										
N										
S				Data Correlation Fig.						
N		19.0					9.5	9.0	8.5	8.0
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m 2.321

b -3.632

Comments: Design Data

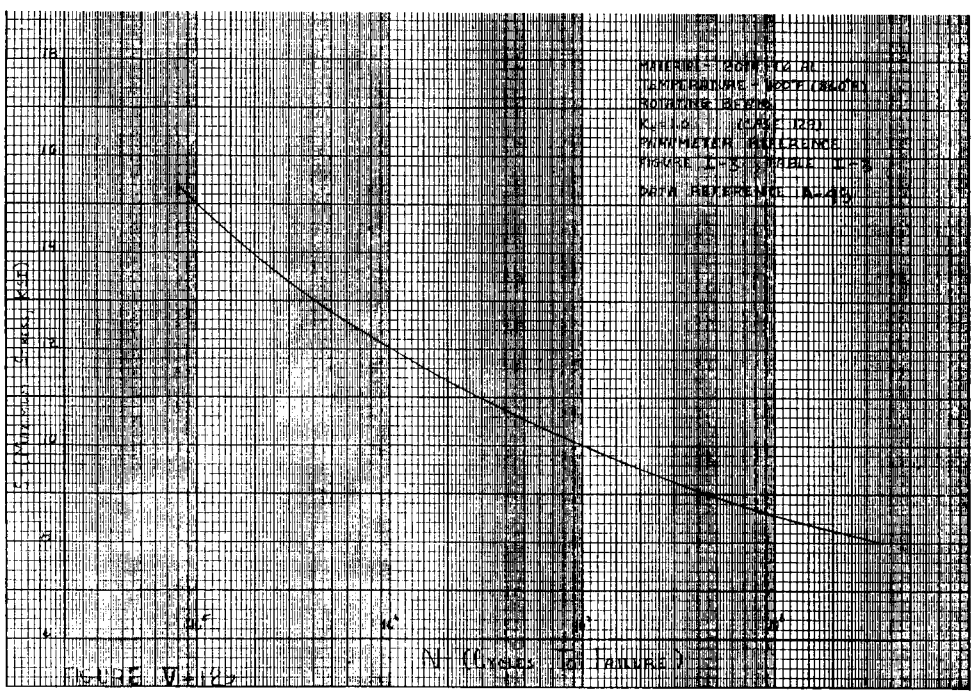


FIGURE V-12

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2014-T6 Al Condition Wrought
Reference ALCOA RT 7-46-9, Copy #1
Reference No. 49 Code No. 103

Date of Tabulation
Tabulated by DS
Checked by RMA

Test Temperature 500°F Environment Air
Type of Test Cantilever-beam Specimen Data 0.4 in dia.
Type of Data Numerical Surface Finish —
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress — Notch Description —

Fatigue Data Source:
Author Howell, F.M., Stickley, G.W.
Publication ALCOA RT 7-47-9
p. 120
No. References
Principal Investigator Howell, F.M.
Affiliation Chief, Mechanical Testing Div., ALCOA
Comments

Mechanical Properties Source:
ALCOA RT 7-47-9, Copy #1
pp. 11, 20

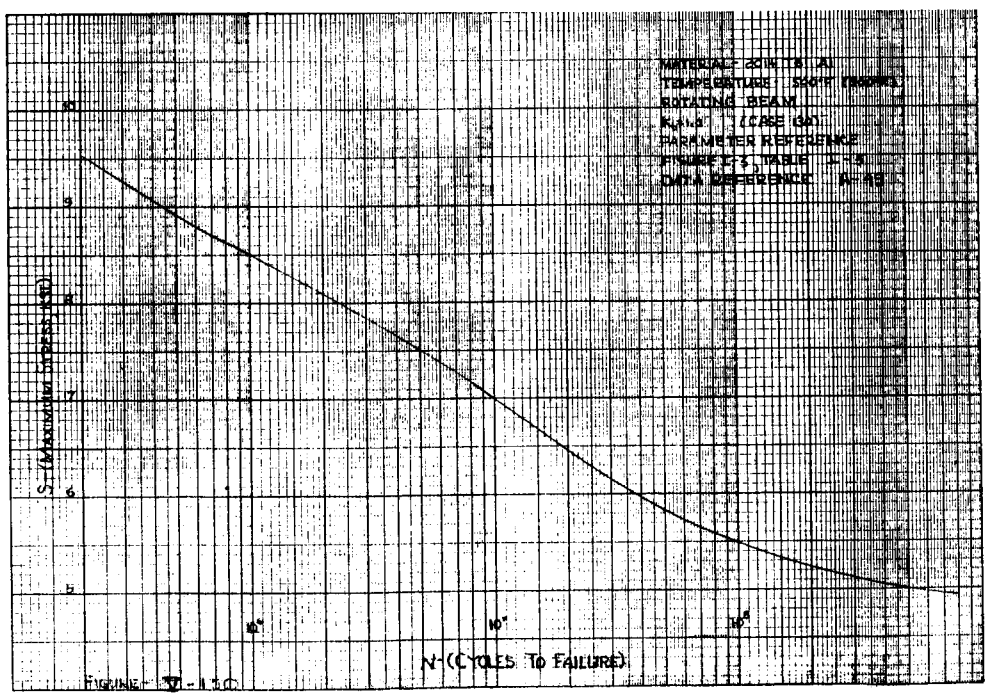
	1	2	3	4	5	6	7	8	9	10
S	18,000	8,500	7000	5,500	4000					
N	10⁴,⁶⁰⁰	1,0⁴,⁰⁰⁵	10,000,000	100,000,000	500,000,000					
S										
N										
S										
N										
S										
N										
S										
N				Data Correlation						
S	10.0	7.5	1.0	2.5	4.0	1.5	1.2	6.5	6.0	5.5
N	1.6×10⁵	2.9×10⁵	5.3×10⁵	1.1×10⁶	2.3×10⁶	9.7×10⁶	9.0×10⁶	1.9×10⁷	[illegible]	1.1×10⁹
S	50									
N	4.9×10⁸									
S										
N										
S										
N										
S										
N										

Mechanical Properties:

				Other Properties:
F_{tu}	11.00	ksi	at 500°F	Ts = 18.7 Ksi
F_{ty}	850	ksi	at 500°F	E = 9.813 Ksi
E	8.48	10^3 ksi	at 500°F	
G		10^3 ksi	at	
μ			at	
% E in 4D	45		at 500°F	
% RA			at	
Hardness			at	

Parameters: m = 2.608
b = -5.192

Comments: Parameter obtained with hand calculator (Data input to computer was in error)
Design Data



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2024-T4 Condition W1600...

Reference ALCOA REPORT NO 9-47-9, COPY 251.

Reference No. 99 Code No.

Date of Tabulation

Tabulated by DS

Checked by RMA

Test Temperature 75°F Environment AIR

Type of Test ROTATING BEAM Specimen Data 0.4 IN. DIA.

Type of Data NUMERICAL Surface Finish

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author HOWELL, F.M., STICKLEY, G.W.

Publication ALCOA RT 9-47-9, COPY 251 p. 120

No. References

Principal Investigator HOWELL

Affiliation CHIEF MECHANICAL TESTING DIV., ALCOA

Comments

Mechanical Properties Source:

ALCOA RT 9-47-9, COPY 251 p. 14, 27.

Mechanical Properties:

				Other Properties:
F_{tu}	68.00	ksi	at 75°F	TS = 115.6 KSI
F_{ty}	46.00	ksi	at 75°F	E = 16.84 KSI
E	10.60	10^3 ksi	at 75°F	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

	1	2	3	4	5	6	7	8	9	10
S	40.0	35.0	35.0	30.0	18.0					
N	10^5	10^6	10^7	10^8	$5(10^8)$					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 1.975

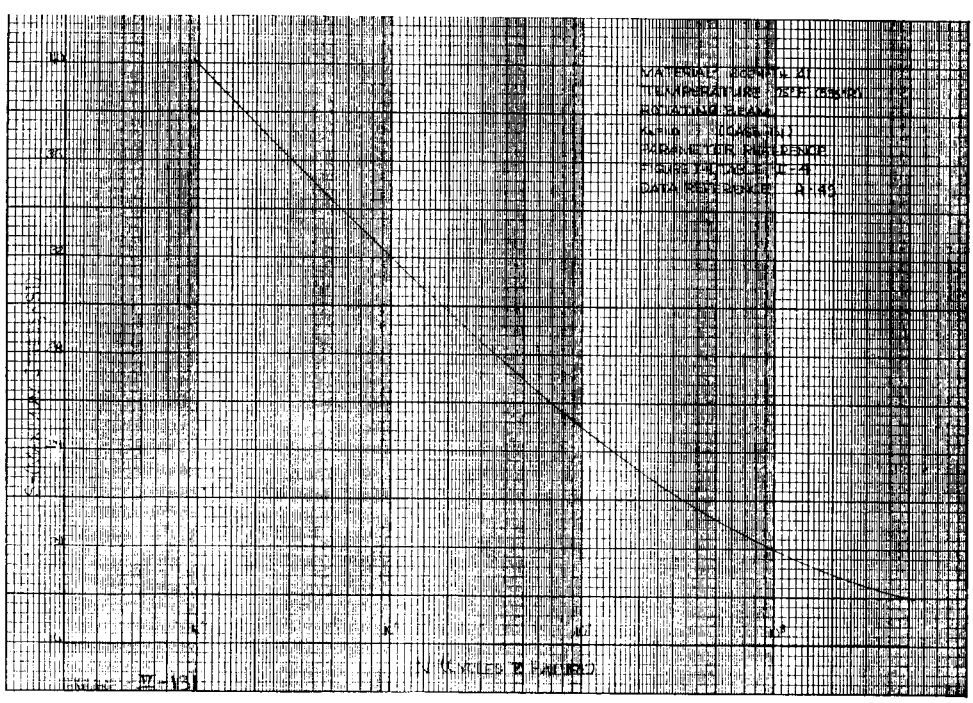
b = −1.616

Comments: Parameters obtained by hard calculator ∴ Intercept b

$b = \log_{10}[(\log_{10} c)K]$

Design Data

$b = \log_{10}[0.434\,K]$



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2024-T4 Al Condition WROUGHT
Reference ALCOA RT. No. 9-47-9, COPY 251
Reference No. 49 Code No.

Date of Tabulation
Tabulated by DS
Checked by RMH

Test Temperature 300°F Environment AIR
Type of Test CB Specimen Data 0.40 in. DIA.
Type of Data NUMERICAL Surface Finish
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

	σ, ksi									
S	24.0	21.0	17.5	15.0	14.0					
N	10^5	10^5	10^7	10^8	$5(10^8)$					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Fatigue Data Source:

Author HOWELL, F.M., STICKLEY, G.W.
Publication ALCOA RT. 9-47-9, COPY 251
P 120.
No. References
Principal Investigator HOWELL
Affiliation CHIEF MECHANICAL TESTING DIV., ALCOA.
Comments

Mechanical Properties Source:

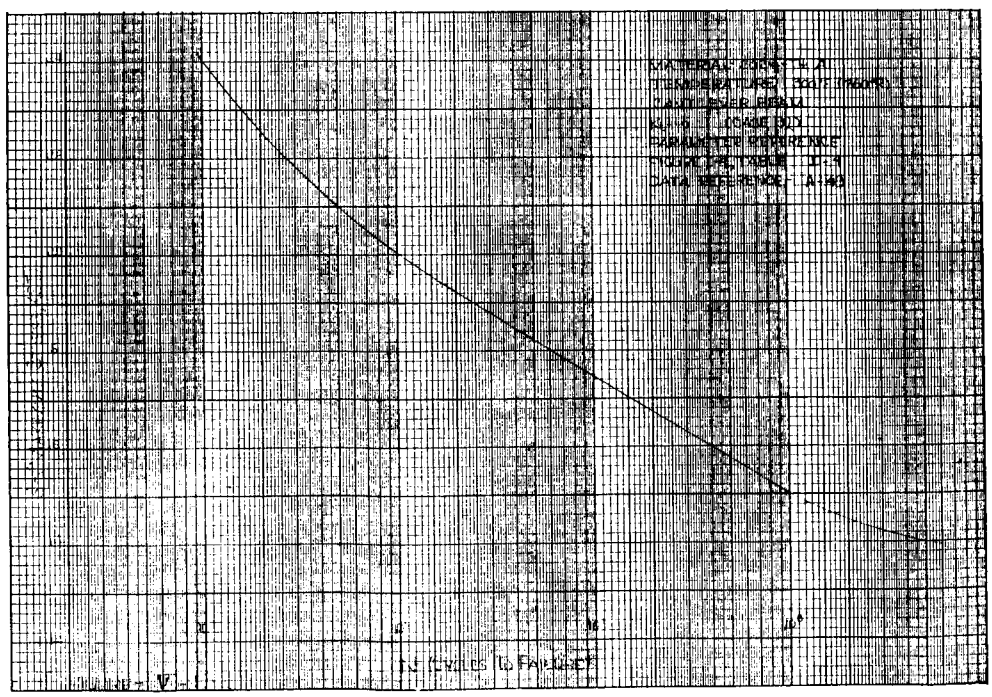
ALCOA RT. 9-47-9, COPY 251
P. 14, 27.

Mechanical Properties:

				Other Properties:
F_{tu}	43.00	ksi	at 300°F	TS = 73.10 KSI
F_{ty}	36.00	ksi	at 300°F	E = 1327 KSI
E	10.07	10^3 ksi	at 300°F	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Parameters: m = 1.512
b = -1.192

Comments: Values obtained by hand calculator ∴ Interpret b
Design Data $b = \log_{10}[(\log_{10} e)K]$
$b = \log_{10}(0.434\,K)$



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2024-T4 Al Condition WROUGHT

Reference ALCOA RT. NO. 9-47-9, COPY 251.

Reference No. 49 Code No.

Date of Tabulation 1/31/62

Tabulated by D.S.

Checked by First

Test Temperature 400°F Environment AIR

Type of Test C.B Specimen Data 0.40 in. DIA.

Type of Data NUMERICAL Surface Finish

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author HOWELL, F.M., STICKLEY, G.W.

Publication ALCOA RT. 9-47-9, COPY 251 P. 120

No. References

Principal Investigator HOWELL

Affiliation CHIEF MECHANICAL TESTING DIV., ALCOA

Comments

Mechanical Properties Source:

ALCOA RT. 9-47-9, COPY 251 P. 14, 27.

Mechanical Properties:

				Other Properties:
F_{tu}	26.00 ksi	at	400°F	TS = 44.2 KSI
F_{ty}	21.00 ksi	at	400°F	E' = 8.56 KSI
E	9.54 10^3 ksi	at	400°F	
G	10^3 ksi	at		
μ		at		
% E		at		
% RA		at		
Hardness		at		

S, KSI

	1	2	3	4	5	6	7	8	9	10
S	20.0	16.0	12.5	10.0	9.000					
N	10^5	10^6	10^7	10^8	$5(10^8)$					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 2.378

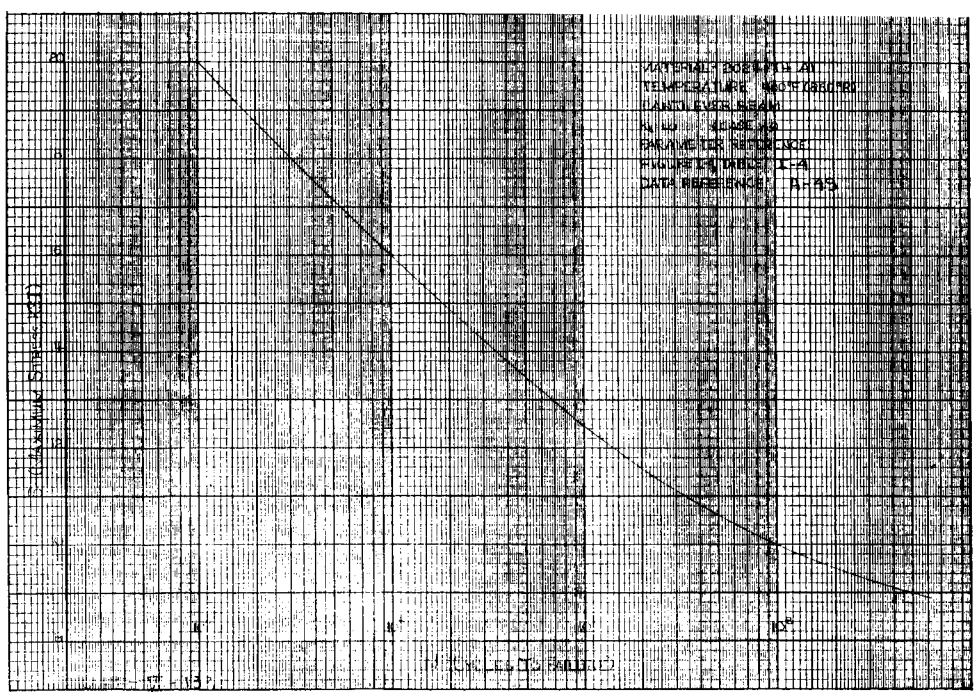
b = -2.005

Comments: Parameters obtained by hand calculator: Intercept b

Design Data

$b = \log_{10}[(\log_e e)K]$

$b = \log_{10}[0.434\,K]$



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 2024-T4 Al Condition WROUGHT
Reference ALCOA RT. No. 9-47-9, COPY 251.
Reference No. _____ Code No. _____

Test Temperature 500°F Environment AIR
Type of Test CB Specimen Data 0.40 IN DIA.
Type of Data NUMERICAL Surface Finish _____
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress _____ Notch Description _____

Fatigue Data Source:
Author HOWELL, F.M., STICKLEY, G.W.
Publication ALCOA RT. 9-47-9, COPY 251. P. 120
No. References _____
Principal Investigator HOWELL
Affiliation CHIEF MECHANICAL TESTING DIV., ALCOA
Comments _____

Mechanical Properties Source:
ALCOA RT. 9-47-9, COPY 251. P. 14, 27

Mechanical Properties:

F_{tu}	14.00 ksi	at	500°F
F_{ty}	9.50 ksi	at	500°F
E	8.48 10^3 ksi	at	500°F
G	_____ 10^3 ksi	at	_____
μ	_____	at	_____
% E	_____	at	_____
% RA	_____	at	_____
Hardness	_____	at	_____

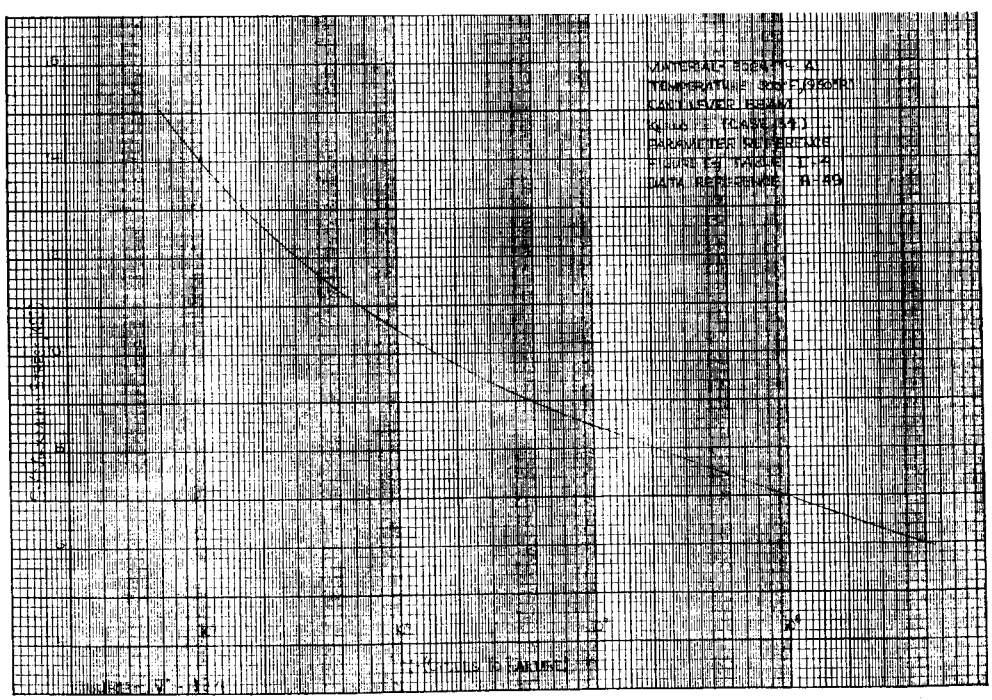
Other Properties:
TS' = 23.8 KSI
E' = 5.76 KSI

Date of Tabulation _____
Tabulated by DS
Checked by [illegible]

S, KSI										
S	14.0	10.5	8.5	7.0	6.0					
N	10^5	10^6	10^7	10^8	5(10^8)					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Parameters: m = 2.856
b = 2.469

Comments: Parameter obtained by hand calculator ∴ Intercept b
Design Data
$b = \log_{10}[(\log_{10}c)K]$
$b = \log_{10}[.434K]$



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 6061-T6 Al Condition Wrought

Reference ALCOA RT 9-47-9, COPY 251

Reference No. 19 Code No.

Date of Tabulation 1/31/62

Tabulated by D.S.

Checked by

Test Temperature 75°F Environment AIR

Type of Test RB Specimen Data 0.40 IN. DIA.

Type of Data NUMERICAL Surface Finish

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author HOWELL, F.M., STICKLEY, G.W.

Publication ALCOA RT 9-47-9 COPY 251

p. 120

No. References

Principal Investigator HOWELL

Affiliation CHIEF MECHANICAL TESTING LAB, ALCOA

Comments

Mechanical Properties Source:

ALCOA RT 9-47-9, COPY 251

PP. 22, 27

Mechanical Properties:

F_{tu}	45.0	ksi	at 75°F	
F_{ty}	40.0	ksi	at 75°F	
E	10.0	10^3 ksi	at 75°F	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Other Properties:

TS = 45 KSI

E = 13.24 KSI

S (KSI)	31.0	25	17.5	15.0	13.5					
N	10^5	10^5	10^7	10^8	5(10⁸)					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Parameters: a = 2.231

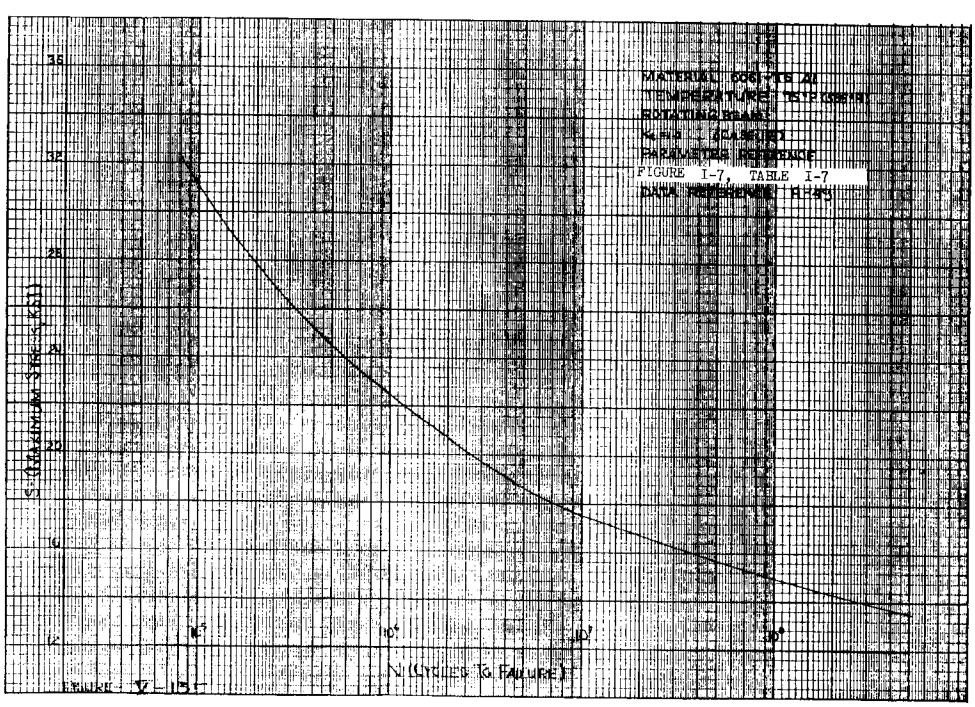
b = -1.860

Comments: Parameters by hand calculator ∴ Intercept b

Design Data

$b = \log_{10}[(\log_{10} C)K]$

$b = \log_{10}[0.434K]$



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 6061-T6 Al Condition WROUGHT

Reference ALCOA RT. 9-47-9. COPY 251

Reference No. 49 Code No.

Date of Tabulation 1/31/62

Tabulated by D. S.

Checked by [illegible]

Test Temperature 300°F Environment AIR

Type of Test CB Specimen Data 0.40 IN. DIA.

Type of Data NUMERICAL Surface Finish

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Fatigue Data Source:

Author HOWELL, F.M., STICKLEY, G.W.

Publication ALCOA RT. 9-47-9 COPY 251

P. 120

No. References

Principal Investigator HOWELL

Affiliation CHIEF MECHANICAL TESTING DIV., ALCOA.

Comments

Mechanical Properties Source:

ALCOA RT. 9-47-9. COPY 1

PL. 22, 27.

Mechanical Properties:

F_{tu}	34.0	ksi	at 300°F	
F_{ty}	31.0	ksi	at 300°F	
E	9.5	10^3 ksi	at 300°F	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Other Properties:

TS = 57.8 KSI

E' = 10.42 KSI

S, KSI										
S	24.0	19.5	13.5	11.5	11.0					
N	10^5	10^6	10^7	10^8	$5(10^8)$					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

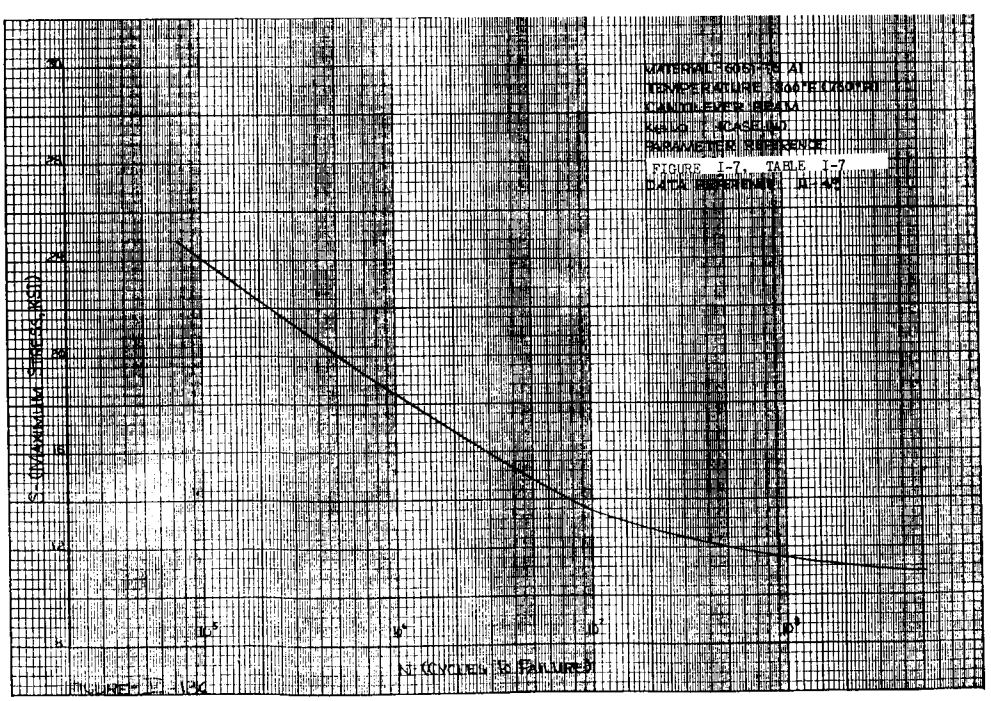
Parameters: m = 2.370

b = -1.94

Comments: Parameters by Hand calculator ∴ Intercept b

Design Data $b = \log_{10}[(\log_e e)\cdot K]$

$b = \log_{10}[.434\,K]$



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 6061-T6 Al Condition WROUGHT
Reference ALCOA RT 9-47-9, COPY 251
Reference No. 49 Code No.

Date of Tabulation
Tabulated by
Checked by

Test Temperature 400°F Environment AIR
Type of Test CB Specimen Data 0.252 D. SM.
Type of Data NUMERICAL Surface Finish
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress Notch Description

Fatigue Data Source:
Author HOWELL, F.M., STICKLEY, G.W.
Publication ALCOA RT 9-47-9, COPY 251, P.120.
No. References
Principal Investigator HOWELL
Affiliation CHIEF MECHANICAL TESTING DIV., ALCOA
Comments

Mechanical Properties Source:
ALCOA RT 9-47-9, COPY 251
pp 22, 27

Mechanical Properties:

F_{tu}	19.0	ksi	at 400°F	
F_{ty}	15.0	ksi	at 400°F	
E	9.0	10^3 ksi	at 400°F	
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Other Properties:
TS' = 32.3 KSI
E' = 718 KSI

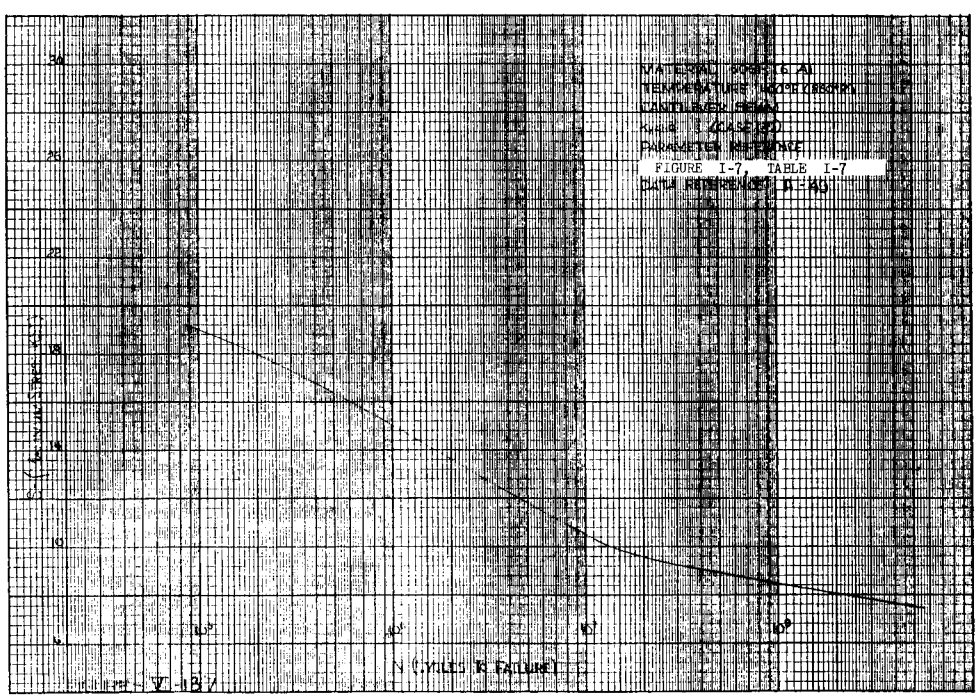
S, KSI

	1	2	3	4	5	6	7	8	9	10
S	19.0	15.0	10.5	8.5	7.5					
N	10^5	10^6	10^7	10^8	$5(10^8)$					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 3.209
b = -2.769

Comments: Parameters by hand calculator ∴ Design Data

Intercept b
$b = \log_{10}[(\log_{10} e)\,K]$
$= \log_{10}[0.434\,K]$



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 5052-T6 Al Condition WROUGHT

Reference ALCOA RT 9-47-9, COPY 251

Reference No. 49 Code No.

Test Temperature 500°F Environment AIR

Type of Test CB Specimen Data 0.40 in. DIA

Type of Data NUMERICAL Surface Finish

Stress Ratio -1.0 Stress Concentration Factor 1.0

Mean Stress Notch Description

Date of Tabulation 1/31/62

Tabulated by D. S.

Checked by PHT

	S, ksi									
S	7.0	6.0	5.0	4.5	4.5					
N	10^5	10^6	10^7	10^8	$5(10^8)$					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Fatigue Data Source:

Author HOWELL, F.M., STICKLEY, G.W.

Publication ALCOA RT 9-47-9, COPY 251, P. 120.

No. References

Principal Investigator HOWELL

Affiliation CHIEF MECHANICAL TESTING DIV, ALCOA

Comments

Mechanical Properties Source:

ALCOA RT 9-47-9, COPY 251, PAGES 27

Mechanical Properties:

				Other Properties:
F_{tu}	7.5 ksi	at	500°F	TS = 12.25 KSI
F_{ty}	5.0 ksi	at	500°F	E' = KSI
E	8.0 10^3 ksi	at	500°F	
G	10^3 ksi	at		
μ		at		
% E		at		
% RA		at		
Hardness		at		

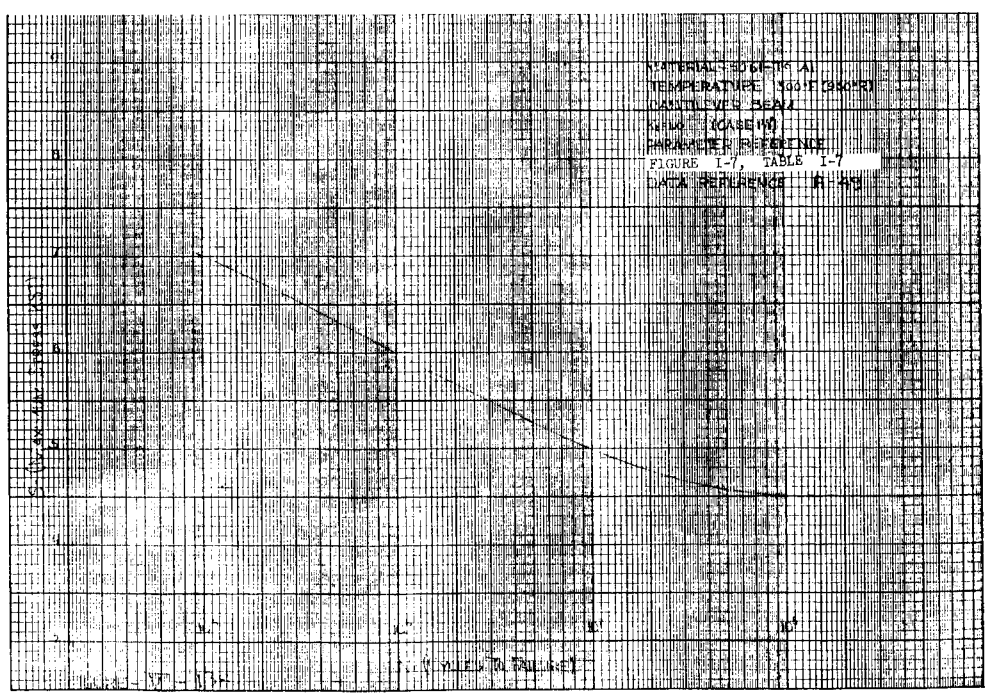
Parameters: m = 2.805

b = -2.301

Comments: Parameters by hand calculator

$\therefore b = \log_{10}[(\log_{10} e)K]$

$= \log_{10}[0.434K]$



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CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 5052 - H36 Aluminum Condition Wrought
Reference ALCOA RT 9-47-9 Copy 251
Reference No. 49 Code No. 13

Date of Tabulation
Tabulated by RMA
Checked by

Test Temperature 300°F Environment Air
Type of Test Rotating Beam - Cantilever Specimen Data 0.4 in Dia.
Type of Data Numerical DD Surface Finish —
Stress Ratio −1.0 Stress Concentration Factor 1.0
Mean Stress 0 Notch Description —

Fatigue Data Source:
Author Howell, F.M. Stickley, G.W
Publication Same
P.120
No. References
Principal Investigator Howell, F.M
Affiliation See CASE 123
Comments

Mechanical Properties Source:
Same
pp. 18, 19, 27

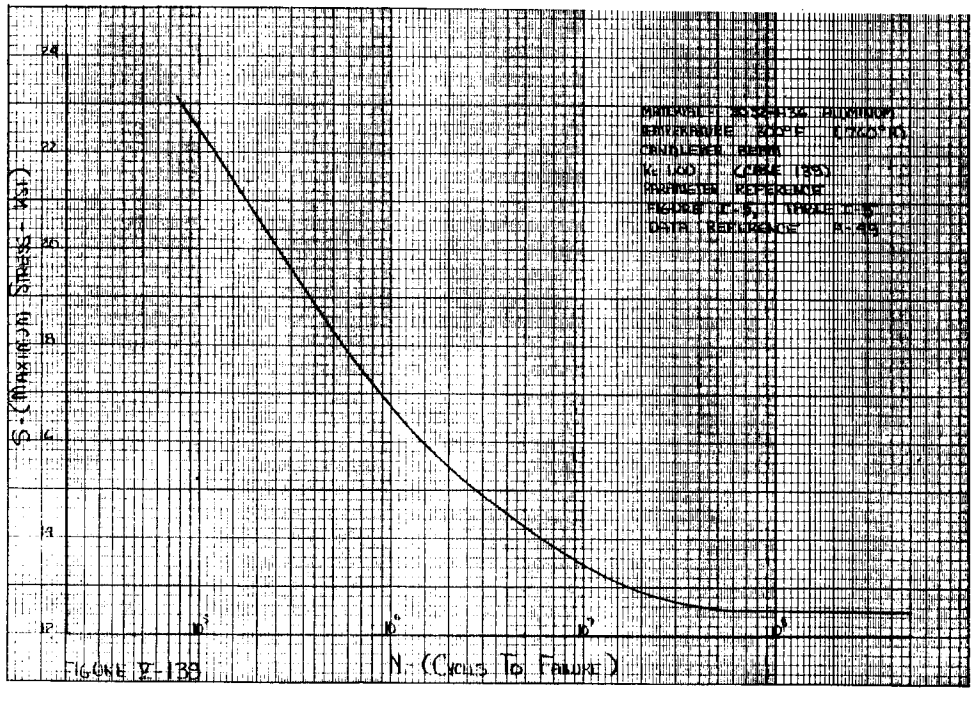
	1	2	3	4	5	6	7	8	9	10
S	22,500	16,500	13,500	12,500	12,500					
N	10^5	10^6	10^7	10^8	5×10^8					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Mechanical Properties:

			Other Properties:
F_{tu}	36,000 ksi	at 300°F	TS - 61,020
F_{ty}	31,000 ksi	at "	E! 11,990
E	9.5 10^3 ksi	at "	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Parameters: m = 1.977
b = -1.554

Comments: DD
Parameters by hand calculator ∴ Intercept b =
$b = \log_{10}[(\log_{10} e)K]$
$= \log_{10}[0.434K]$



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 5052-H36 Condition Wrought
Reference ALCOA RT 9-97-9 C.251
Reference No. 49 Code No. 13

Date of Tabulation
Tabulated by RW
Checked by

Test Temperature 400° F Environment Air
Type of Test R.B - Cantilever Specimen Data 0.4 Da
Type of Data Numerical - DD Surface Finish —
Stress Ratio Stress Concentration Factor 1.0
Mean Stress Notch Description —

S	19,500	14,500	10,500	9,500	9,500					
N	10^5	10^6	10^7	10^8	5×10^8					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Fatigue Data Source:
Author Howell, F.M., Stickley G.W
Publication Same
p. 120
No. References
Principal Investigator
Affiliation See Case 123
Comments

Mechanical Properties Source:
Same
pp. 18, 19, 27

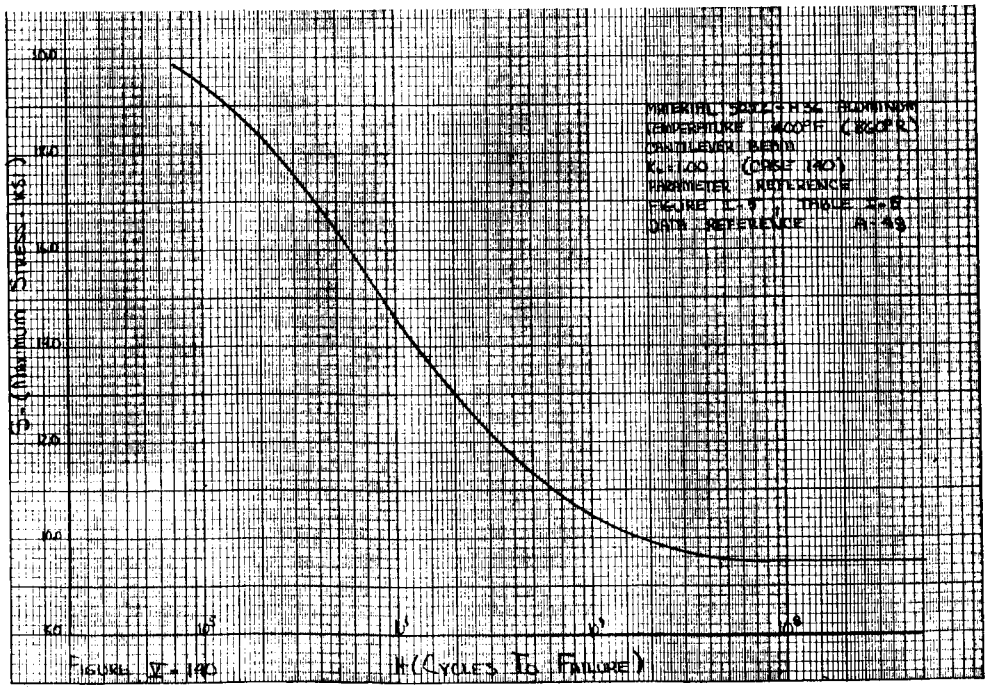
Mechanical Properties:

F_{tu}	28,000	ksi	at	400° F
F_{ty}	15,000	ksi	at	"
E	9.0	10^3 ksi	at	"
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Other Properties:
TS = 40,460
E' = 9025

Parameters: m = 2.431
b = -1.988

Comments: DD
Parameters by hand calculator
i.e. Intercept $b = \log_{10}[(\log_{10} c) \cdot K]$
$= \log_{10}[0.434\,K]$



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 5052-H36 Aluminum Condition Wrought
Reference ALCOA RT 9-47-9 C.25
Reference No. 49 Code No. 13

Date of Tabulation
Tabulated by
Checked by

Test Temperature 500 Environment Air
Type of Test Rotating Cantilever Bea Specimen Data 0.4 In. Dia
Type of Data Numerical - DD Surface Finish —
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress 0 Notch Description —

Fatigue Data Source:
Author Howell, F.M. Stickley, G.W.
Publication Same
p. 120
No. References
Principal Investigator
Affiliation See CASE 123
Comments

Mechanical Properties Source:
Same
pp 18, 19, 27

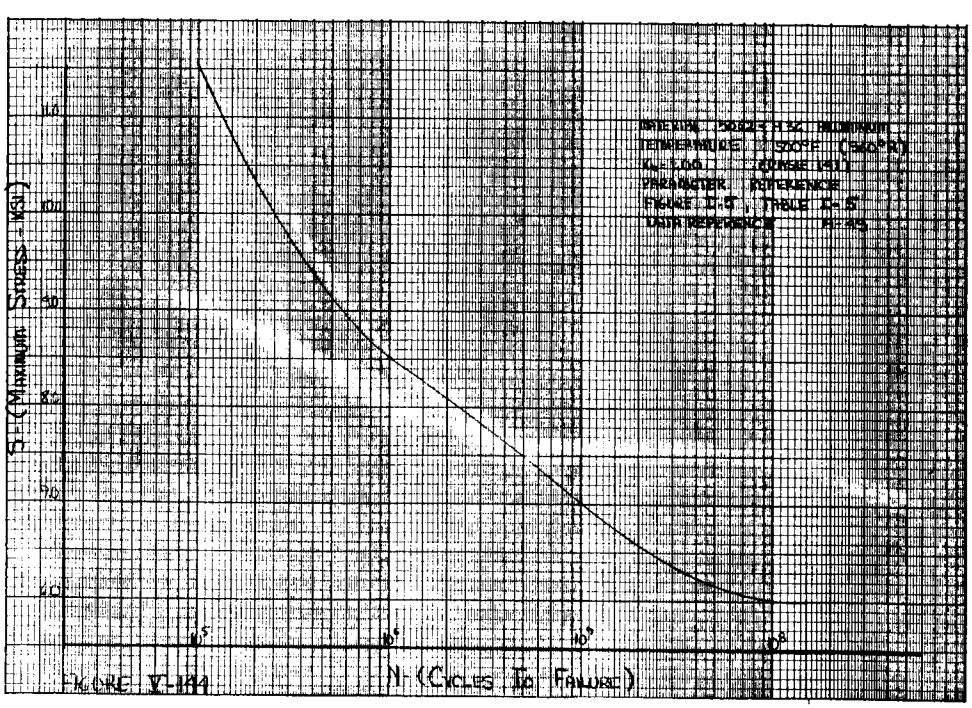
S	5,500	4,500	4000	4000	3500					
N	10^5	10^6	10^7	10^8	5×10^8					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Mechanical Properties:

				Other Properties:
F_{tu}	15,000 ksi	at	500°F	TS' = 25,455
F_{ty}	7,000 ksi	at	"	E' = 3280
E	8.0 10^3 ksi	at	"	
G	10^3 ksi	at		
μ		at		
% E		at		
% RA		at		
Hardness		at		

Parameters: m = 2.390
b = -1.956

Comments: DD
Parameters by hand calculator
∴ Intercept $b = \log_{10}[(\log_{10}e)K]$
$b = \log_{10}[.434K]$



CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 6053-T6 Condition Wrought
Reference ALCOA RT 9-47-9 C.251
Reference No. 49 Code No. 13

Date of Tabulation
Tabulated by RMH
Checked by AB

Test Temperature 300 °F Environment Air
Type of Test Rotating Cantilever Beam Specimen Data 0.9 in. dia
Type of Data Numerical - DD Surface Finish —
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress 0 Notch Description —

Fatigue Data Source:
Author Howell, F.M Stickley G.W
Publication Same
P. 120
No. References
Principal Investigator Howell, F.M.
Affiliation
Comments See Case 123

Mechanical Properties Source:
Same
pp. 18, 19, 28

S	18,500	14,000	11,000	9000	8500					
N	10^5	10^6	10^7	10^8	5×10^8					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
	1	2	3	4	5	6	7	8	9	10

Mechanical Properties:

F_{tu}	28,000	ksi	at	300 °F
F_{ty}	25,000	ksi	at	"
E	9.5	10^3 ksi	at	"
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Other Properties:

Parameters: m = 2.178
b = -1.792

Comments:
Parameters by hand calculator
∴ Intercept $b = \log_{10}[(\log_{10} e)\,K]$
$= \log_{10}[.434\,K]$

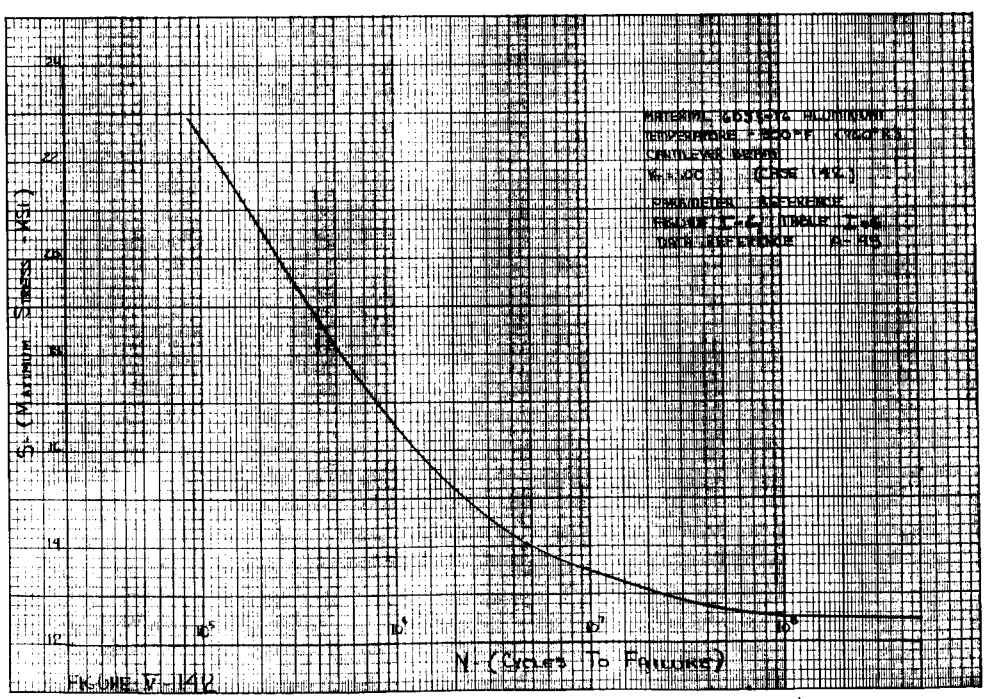


FIGURE V-142

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 6053-T6 Condition Wrought
Reference ALCOA RT 9-47-9
Reference No. 49 Code No. 13

Date of Tabulation
Tabulated by BH
Checked by

Test Temperature 400° F Environment Air
Type of Test Rotating Cantilever Beam Specimen Data 0.4 in Dia
Type of Data Numerical DD Surface Finish —
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress 0 Notch Description —

Fatigue Data Source:
Author Howell, F.M., Stickley G.W
Publication ALCOA RT 9-47-9 C.251
No. References
Principal Investigator Howell, F.M
Affiliation
Comments See Case 123

Mechanical Properties Source:
Same
pp. 18, 19, 28

	1	2	3	4	5	6	7	8	9	10
S	13,000	10,000	7500	6500	5500					
N	10^5	10^6	10^7	10^8	5×10^8					
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 1.909
b = -1.587

Mechanical Properties:

				Other Properties:
F_{tu}	23,000 ksi	at	400°F	
F_{ty}	22,000 ksi	at	"	
E	9.0 10^3 ksi	at	"	
G	10^3 ksi	at		
μ		at		
% E		at		
% RA		at		
Hardness		at		

Comments: Parameters by hand calculator
∴ Intercept b = $\log_{10}[(\log_{10}e)K]$
$b = \log_{10}[.434K]$

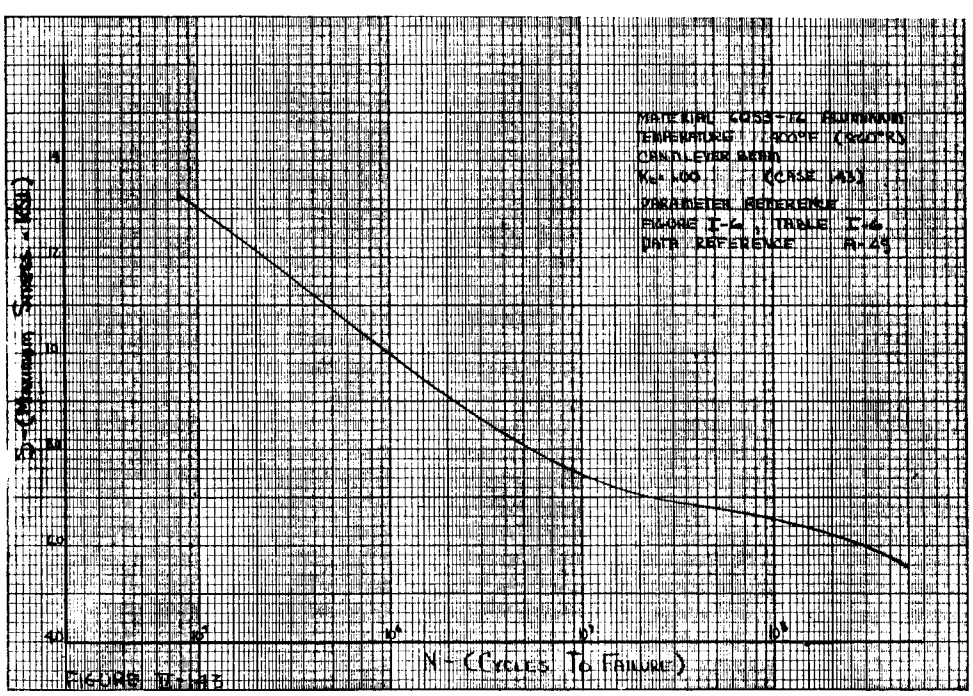


FIGURE TC-143

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material 6053-T6 Condition Wrought
Reference ALCOA RT-9-47-9 C.251
Reference No. 49 Code No. 13

Date of Tabulation
Tabulated by BH
Checked by BL

Test Temperature 500° F Environment Air
Type of Test R. Cantilever Beam Specimen Data 0.4 in Dia
Type of Data Numerical DD Surface Finish —
Stress Ratio -1.0 Stress Concentration Factor 1.0
Mean Stress 0 Notch Description —

Fatigue Data Source:
Author Howell, F.M., Stickley, G.W
Publication ALCOA RT-9-47-9 C.251
No. References
Principal Investigator Howell, F.M
Affiliation
Comments See Case 123

Mechanical Properties Source:
Same
pp. 18, 19, 28

S N	5,500 10^5	4,500 10^6	4000 10^7	4000 10^8	3500 5×10^8					
S N										
S N										
S N										
S N										
S N										
S N										
S N										
S N										
S N										
S N										
	1	2	3	4	5	6	7	8	9	10

Mechanical Properties:

				Other Properties:
F_{tu}	15,000	ksi	at 500°F	
F_{ty}	13,000	ksi	at "	25,425 = TS'
E	8.0	10^3 ksi	at "	E' = 3250
G		10^3 ksi	at	
μ			at	
% E			at	
% RA			at	
Hardness			at	

Parameters: m = 1.053
b = -.7442

Comments: Parameters by hand calculator
∴ Intercept $b = \log_{10}[(\log_{10} e)K]$
$b = \log_{10}[.434K]$

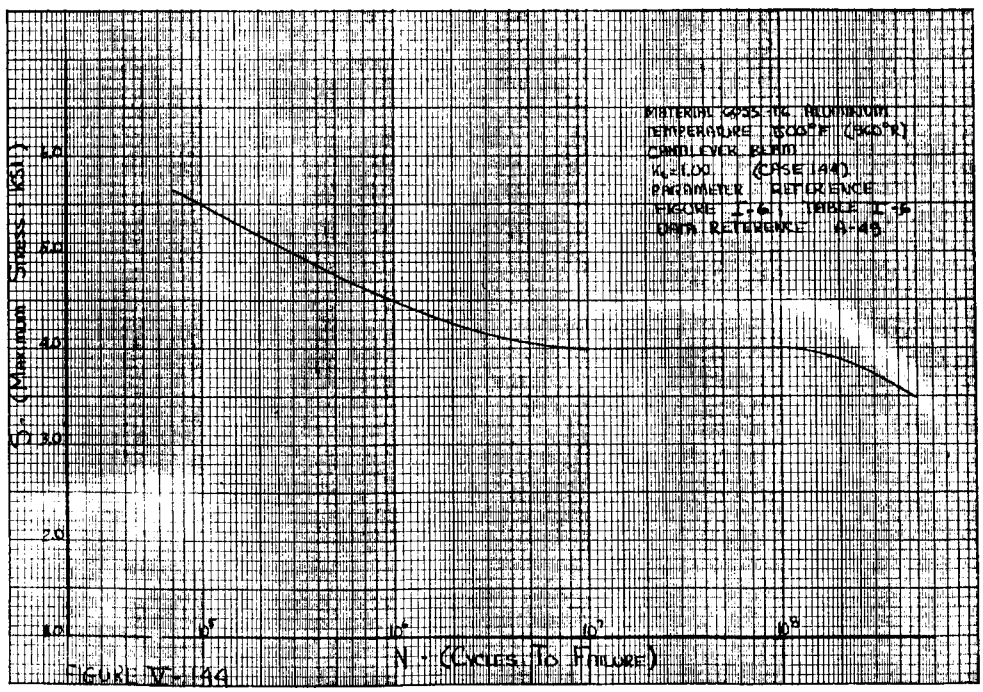


FIGURE V-144

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel X sheet Condition Aged
Reference AD 92492, Table 16
Reference No. 113 Code No. 50

Test Temperature 1350 °F Environment Air
Type of Test Axial load
Type of Data Numerical
Stress Ratio $\frac{\sigma_{max}}{\sigma_{min}}$ = 1.25
Mean Stress
Specimen Data
Surface Finish
Stress Concentration Factor 1
Notch Description

Fatigue Data Source:
Author Yerkovich L.A.
Publication WADC Tr 55-226
AD 72492
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
NASA 4065
p. 13, 14

Mechanical Properties:

F_{tu}	83.0 ksi	at	
F_{ty}	ksi	at	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:
Ts 83.0
Tf 39.3

Date of Tabulation
Tabulated by DS
Checked by BB

		1	2	3	4	5	6	7	8	9	10
		Ksi									
S		140.0	43.75	500	56.25	62.5					
N		28·10^6	16.79·10^6	6.16·10^6	3.96·10^6	1.04·10^6					
S					Cont'd						
N											
S		64.7	63.0	57.6	52.8	49.2	47.0	43.3	41.5	40.4	
N		8·10^5	1×10^6	2×10^6	4×10^6	1×10^7	1×10^7	2×10^7	3×10^7	4×10^7	

Parameters: m = 7.272
b = 73.543 } C

47.4
43.3
39.3

Comments:

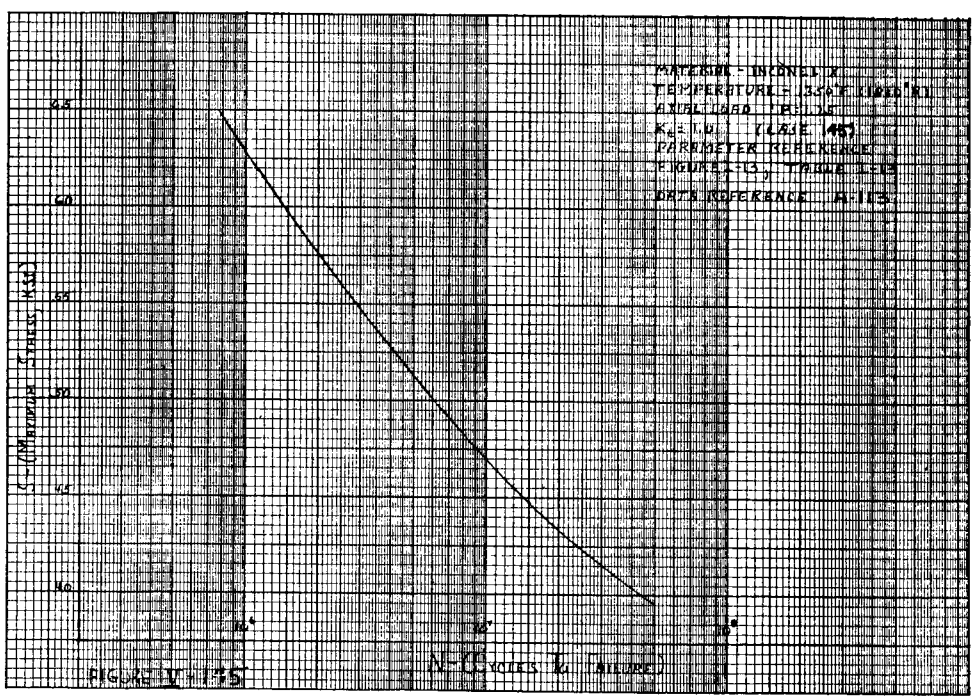


FIG. 2C - V - 175

CORRELATION OF ELEVATED TEMPERATURE FATIGUE DATA — NASA CONTRACT NAS8-1517

Material Inconel X sheet Condition Aged
Reference AD 92492 Table 13
Reference No. 113 Code No. 57

Test Temperature 1500 °F Environment Air
Type of Test Axial Load Specimen Data
Type of Data Numerical Surface Finish
Stress Ratio $\frac{\text{max}}{\text{mean}}$ = 1.25 Stress Concentration Factor 1
Mean Stress Notch Description

Fatigue Data Source:
Author Yerkovich L.A.
Publication WADC Tr 55-226
AD 92492
No. References
Principal Investigator
Affiliation
Comments

Mechanical Properties Source:
NASA TN D-[illegible]
p 13,14

Mechanical Properties:

F_{tu}	60.0 ksi	at 1500	
F_{ty}	ksi	at	
E	10^3 ksi	at	
G	10^3 ksi	at	
μ		at	
% E		at	
% RA		at	
Hardness		at	

Other Properties:
TS 60.2
F 17.8

Date of Tabulation
Tabulated by DS
Checked by RS

	1	2	3	4	5	6	7	8	9	10
S	20.0	22.5	25.0	31.25	37.5					
N	95,331$0^4$	18.091$0^4$	7.45$10^6$	3.51$10^6$	0.861$0^6$					
S										
N										
S										
N										
S					Correlation Data					
N										
S	39.2	37.0	33.3	29.5	26.5	22.3	21.5	18.4		
N	7x10^5	1x10^6	2x10^6	4x10^6	7x10^6	1x10^7	2x10^7	4x10^7		
S										
N										
S										
N										
S										
N										
S										
N										

Parameters: m = 6.608 } C
b = 12.128

Comments:

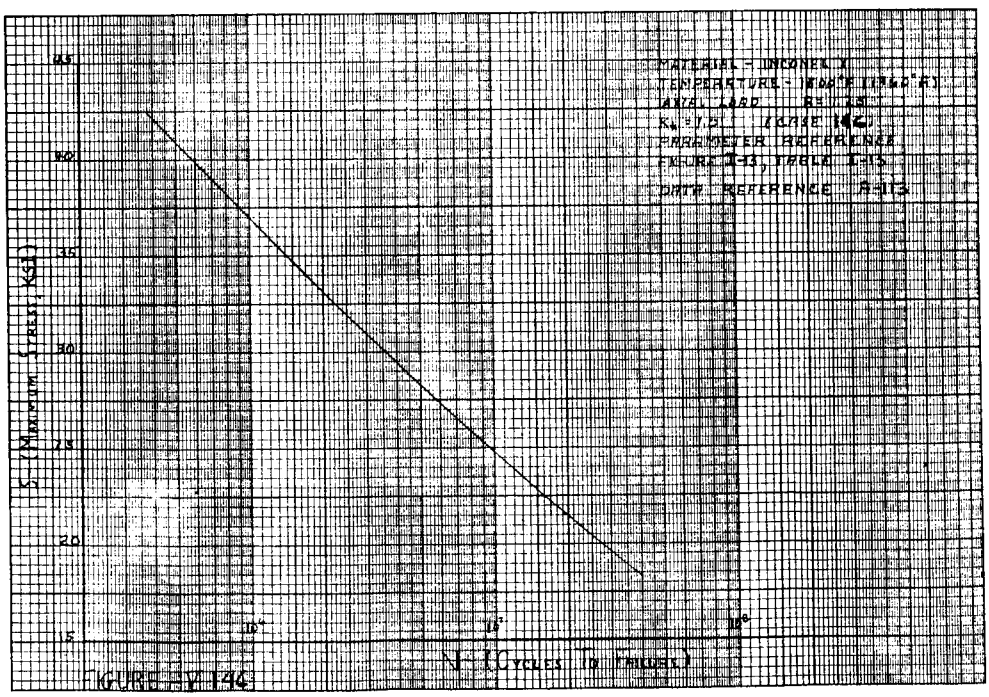


FIGURE V 146