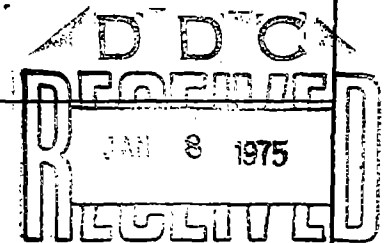


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20. ABSTRACT (Continue on reverse side if necessary and identify by block number) The major objective of this Handbook is to present data that could be used in the development of new concepts in superconducting machinery. Information was collected on the mechanical, thermal electrical, and magnetic properties of selected structural materials for designers and users of equipment that will be exposed to cryogenic temperatures. The data are presented as "best - value" numbers from compilations of data in the temperature range 0 - 300 K.		



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FIRST SUPPLEMENT

to

HANDBOOK ON MATERIALS FOR SUPERCONDUCTING MACHINERY – FIRST EDITION MCIC-HB-04

The original Handbook was prepared by Battelle's Columbus Laboratories under Advanced Research Projects Agency (ARPA) sponsorship, monitored by the Cryogenics Division of the National Bureau of Standards, and published by the Metals and Ceramics Information Center (MCIC). This first supplement was prepared under the same sponsorship to update the information in the initial publication.

This supplement, as does the original handbook, contains information on the mechanical, thermal, electrical, and magnetic properties of selected structural materials that might be considered for components of superconducting machinery. Since this information is primarily intended for designers of equipment that will be exposed to cryogenic temperatures, the data are presented as "best-value" numbers from compilations of data in the temperature range 0 to 300 K.

This first supplement contains a new title page, a Foreword to the First Supplement, an updated Table of Contents, new sheets for Sections 1 through 12, a new Bibliography and a list of references, and a new Appendix.

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ADDITIONAL INFORMATION

Any questions on the Handbook data or any additional data for the Handbook should be addressed to the attention of Mr. K. R. Hanby, Program Manager at:

Metals and Ceramics Information Center
Bettelle—Columbus Laboratories
505 King Avenue
Columbus, Ohio 43201

SECOND SUPPLEMENT
to
HANDBOOK ON MATERIALS FOR SUPERCONDUCTING
MACHINERY – FIRST EDITION
MCIC-HB-04

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This supplement, as does the original handbook, contains information on the mechanical, thermal, electrical, and magnetic properties of selected structural materials that might be considered for components of superconducting machinery. Since this information is primarily intended for designers of equipment that will be exposed to cryogenic temperatures, the data are presented as "best-value" numbers from compilations of data in the temperature range 0 to 300 K.

This second supplement contains a new title page, a Foreword to the Second Supplement, an updated Table of Contents, new sheets for Sections 1 through 12, a new list of references, and new Bibliography pages.

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HANDBOOK ON MATERIALS FOR SUPERCONDUCTING MACHINERY

**Mechanical, Thermal, Electrical, and Magnetic
Properties of Structural Materials
Including Data Sheets for the
First and Second Supplements**

Sponsored by

Advanced Research Projects Agency
ARPA Order No. 2569
Program Code 4D10
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Cryogenics Division
National Bureau of Standards
Boulder, Colorado 80302

January 1977

**METALS AND CERAMICS INFORMATION CENTER
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FOREWORD

The research program that has led to the preparation of this Handbook was supported by the Advanced Research Projects Agency (ARPA) of the Department of Defense, with Dr. Edward C. Van Reuth as Project Monitor. The Handbook preparation task was subcontracted to Battelle Columbus by the Cryogenics Division of the National Bureau of Standards under Contract No. CST-8303 with Dr. Richard P. Reed as Program Manager and Contract Monitor.

The research program was conducted under ARPA Order No. 2569 and Program Code 4D10 by the Metals and Ceramics Information Center (MCIC) with K. R. Hanby and H. J. Hucek as Program Managers, and E. A. Eldridge and J. K. Thompson as Principal Investigators.

Contract No. CST-8303 includes two tasks. Task I provided for the compilation of low temperature property data on selected materials for structural applications in superconducting machinery and has resulted in the production of this Handbook. Task II provided for research on the thermal expansion and specific heats at low temperatures for selected structural alloys. Available data obtained on Task II are incorporated in this edition of the Handbook. Additional data from other concurrent ARPA/NBS programs are included in the First and Second Revisions. The effective date for initiation of the program was September 10, 1973, and the contract expiration date was January 15, 1977.

DISCLAIMER

The views and conclusions contained in this document are those of the authors and should not be interpreted as necessarily representing the official policies, either expressed or implied, of the Advanced Research Projects Agency or of the U. S. Government.

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HANDBOOK ON MATERIALS FOR SUPERCONDUCTING MACHINERY

1.0 INTRODUCTION

Recent advancements in the development of superconducting machinery have demonstrated that superconducting generators, motors, transmission lines, and other electrical equipment are more efficient, occupy less space for equivalent capacity, and have other advantages over more conventional equipment. Because of these advantages, there is considerable incentive to develop superconducting systems for certain military applications. New ship propulsion systems which are being developed by the Navy represent major developments in superconducting generators, motors, and controls. These developments involve considerable new design technology and environments that may expose the components to cryogenic temperatures as low as 4 K. Exposure of structural materials to such low temperatures affects the mechanical and physical properties of the materials. The purpose of the Handbook is to provide a ready reference for designers on the effects of low temperatures on the properties of structural materials that will be considered in developing new designs for superconducting machinery. Formats for presentation of the mechanical, thermal, electrical, and magnetic property data are intended to provide best-value data for the designer based on currently available information. The data also may be used by engineers in selecting materials for certain cryogenic applications. The current list of materials was selected based on available information and suitability for such applications. All data are based on current state-of-the-art information.

2.0 EXPLANATION OF DATA COLLECTION AND PRESENTATION

The structural materials property data presented in this Handbook are based on compilations of data collected from documents in the files of the Metals and Ceramics Information Center (MCIC). These documents either were originally part of the data base of MCIC or were acquired as a result of a search of the accessions of the Cryogenic Data Center, Cryogenics Division, National Bureau of Standards, Boulder, Colorado. Documents from which the data were obtained are listed in the Reference section according to MCIC accession number. The Bibliography, which includes cited data references, lists over 900 citations on properties and applications of the selected materials. The 18 references for the composite materials are listed at the end of Section 11, Composites. When more detailed information is needed than the best-value data presented in later sections of this Handbook, the original sources of the data should be consulted.

Data from the original sources were collected on the selected materials (discussed in Section 3) within the following categories over the temperature range 0 to 300 K:

- (a) Mechanical properties (Includes weld properties)
- (b) Thermal properties
 - Thermal conductivity*
 - Thermal expansion
 - Specific Heat
- (c) Electrical resistivity
- (d) Magnetoresistance
- (e) Magnetic properties.

2.1 Mechanical Properties

After compiling the available mechanical property data from the original sources, the major objective was to reduce the data on metals, welds, composites, and polymers to best values and to present the best-value data in formats that could be used effectively by designers in developing new concepts in superconducting machinery. In general, the available data for any of the parameters was not sufficient for any material in the cryogenic range to permit a statistical analysis to yield A or B basis (minimum design) values as in MIL-HDBK-5. However, judgment was used in analyzing the available data in order to arrive at best-value numbers for the various parameters based on the available data. The best-value numbers are averages obtained usually from a series of tests from one or more sources on individual specimens. From some sources, only average data and not individual specimen data were available for the mechanical property parameters. If information was available on the number of specimens tested in obtaining the original average value, the number of specimens was taken into consideration in arriving at the overall average or best value. If information was not available on the number of specimens tested in arriving at an original average value, the average value reported was considered the same as that for a single specimen in calculating the overall average. If tensile ultimate strength or tensile yield strength data were available for eight or more replicate specimens, standard deviations were determined and are included in the tabulations. If the original input data include average values, the results will not be true standard deviations, but will be the best that can be determined from the available sources.

* Data include the effects of magnetic fields on thermal conductivity.

Data that were not representative of normally produced material (i.e., material with unusual impurity levels, unusual grain sizes, etc.) were not included in the compilations. Furthermore, if the heat treatment, form, or dimensions (thickness, diameter, etc.) of the material were not given or if specimen orientation or other significant information on the specimens or test methods was not given in the original source, the data were omitted from the compilations. When data points occurred outside the range of the usual scatter of data points (outliers), the original source was reviewed to determine any unusual factors that would contribute to the variation. Such an examination usually provided a basis for omitting the outlying points.

Typical formats for compiling best values for mechanical property parameters for metals, alloys, and polymers are shown in Tables 2.1, 2.2, and 2.3. The same formats were used to report weld data when it was available. The parameters in Table 2.1 are for tensile properties. Most of the available mechanical property data at cryogenic temperatures is limited to tensile data. When compressive, shear, impact, fracture toughness, and/or fatigue data were available for any of the materials, the corresponding formats in Tables 2.2 and/or 2.3 were used in recording the best-value data.

Typical formats for compiling best values for mechanical properties of composite materials are shown in Tables 2.4, 2.5, and 2.6. Data are reported for uniaxial laminates and for woven-cloth reinforced composites. Uniaxial laminate data include key mechanical properties required for prediction of crossply properties using macromechanical composite theory, whenever such data were available.

The highly-anisotropic mechanical properties of composite materials require referencing of the properties to the direction of fiber reinforcement. Tensile, compressive and impact data, Tables 2.4 and 2.5, are reported for longitudinal and transverse directions of uniaxial composites. The sheet-normal direction is included in the compressive data format. This refers to loading directions parallel to and at right angles to the fiber direction, plus a direction normal to the plane of pressing in sheet material (pressure direction). For composites reinforced with woven cloth, the longitudinal direction is taken as the warp direction and the transverse direction is taken as the fill direction. Crossply composites frequently display an initial and secondary modulus during the initial load cycle; consequently, both moduli and the strength corresponding to the change in modulus are reported when data were available. Most composite data are reported as average and minimum reported values. However, compressive strength data are reported as maximum, average, and minimum values. Here, the maximum value is the most significant, as the average of compressive strength data tends to become strongly biased toward low values due to experimental difficulties.

Composite interlaminar shear refers to shear between adjacent layers in a layered laminate. Composite in-plane shear refers to shear between parallel fibers in the plane of the fibers.

Available composite fatigue data are presented graphically in the format shown in Table 2.6. In many applications, the useful fatigue life of composite structures will be limited by a decrease in modulus rather than ultimate fracture. The format of Table 2.6 permits data on modulus decrement to be included when available.

Data on Tables 2.4, 2.5, and 2.6 reflect best values from flat coupons, rods or bulk specimens produced from prepregged tape except where noted. References are provided for each value to facilitate consultation of the original source for additional information on test procedures.

It is possible to fabricate composites with widely varying fiber volume fractions and widely varying properties. Most available data have been generated for the nominal fiber volume fractions reported in the tables, corresponding to the fiber content in off-the-shelf prepregged materials.

In most instances, the property data were added to the original compilation tables only when such data were reported for tests at 77 K (-320 F) or lower. When test data were reported for tests at 77 K or lower, all of the test data in the range 0 to 300 K were added to the original compilation tables. This method of selecting the data eliminated much of the data that would not be significant when considering cryogenic properties.

The headings in the tables indicate the alloy, welding method, polymer, or composite designation from the list presented in Section 3. If a specification was identified for the material, the specification is identified in the heading. For metals and alloys and welds, thicknesses or diameters of the material in the form identified are given in the heading for limited ranges, since the size may have a significant effect on the properties. The size ranges are as follows:

Sheet, Plate, and Flat Forgings and Extrusions (Thickness):

Up to 0.099 cm (0.039 in.)
0.100 to 0.319 cm (0.040 to 0.125 in.)
0.320 to 0.634 cm (0.126 to 0.249 in.)
0.635 to 1.269 cm (0.250 to 0.499 in.)
1.270 to 2.540 cm (0.500 to 1.000 in.)
2.541 to 5.080 cm (1.001 to 2.000 in.)
Over 5.080 cm (2.000 in.)

Bar Stock, Forged Stock, and Non-Flat Extrusions
(Diameter or Thickness):

Up to 2.540 cm (1.000 in.)
2.541 to 5.080 cm (1.001 to 2.000 in.)
Over 5.080 cm (2.000 in.)

Data for the same alloy type and thickness range may be available for several different heat treatments and/or mill processing conditions. Data for the alloy are presented for these various conditions if they might be considered for components which will be exposed to low temperatures in service.

The first column in the mechanical property tables indicates the parameters and units. Bold face type is used for the parameters and best-value numbers (indicated as "Avg") so they will stand out from the other numbers. The next column in the tables is for room temperature data which usually are obtained in the range 291 to 300 K (65 to 80 F). The heading for this column is 297 K (75 F). Another key temperature range for low temperature mechanical property tests is obtained by cooling an organic liquid with dry ice. Indicated temperatures for this type of low-temperature bath are 200 to 193 K (-100 to -112 F). To simplify the tabulations, tests made in dry-ice baths are indicated at 195 K (-108 F). Tests made with the specimens in liquid nitrogen, liquid hydrogen, and liquid helium are indicated at 77 K (-320 F), 20 K (-423 F), and 4 K (-452 F), respectively. For test data obtained at intermediate temperatures such as 144 K (-200 F), the data are presented in separate columns with the testing temperature indicated in the column heading.

The primary units in the tables are SI units with corresponding English units in parentheses. Values for stress and energy in SI units were generally converted from English units. In most instances, the average values in English units were not rounded off until after converting to the SI units. The English units were then rounded off usually to three digits for presentation in the tables. Because the English units were rounded off after conversion, conversion of the three-digit numbers will not always result in the corresponding converted SI units in the tables.

Abbreviations used in the mechanical property tables have the following meanings:

TUS	- Tensile ultimate strength
TPL	- Tensile proportional limit
TYS	- Tensile yield strength
Elong.	- Elongation
RA	- Reduction in area
E	- Young's modulus
E ₁	- Initial Young's modulus (composites)
E ₂	- Secondary Young's modulus (composites)
SE ₁	- Strength at transition between E ₁ and E ₂
NTS	- Notched tensile strength
CUS	- Compressive ultimate strength
CPL	- Compressive proportional limit
E _c	- Elastic modulus in compression
SUS	- Shear ultimate strength
SPL	- Shear proportional limit
G	- Shear modulus
Long.	- Longitudinal orientation
Trans.	- Transverse orientation
K _{Ic}	- Plane strain intensity factor obtained on precracked bend or compact specimens according to ASTM E399
K _{IE}	- Plane strain stress intensity factor obtained on part-through surface-crack specimens (requirements for validity of these tests have not been established, but selected data are included in the compilations to indicate the trends in the results that have been obtained according to the current state of the art)
S _N	- The greatest stress which can be sustained for a given number of cycles without fracture
Hz	- Hertz, number of cycles per second
R	- Fatigue ratio, algebraic ratio of the minimum stress to the maximum stress in one cycle
K _t	- Stress concentration factor
S-N	Curves - Plots of stress against number of cycles to failure on testing.

Overall average data (best-value) for tensile and yield strengths of selected materials are plotted in graphical formats to show trends in these properties over the temperature range from 0 to 300 K. If a need occurs for comparing the tensile properties of several materials over this temperature range, the appropriate graphs may be copied and additional data from tables for other materials may be added to achieve the comparisons that are desired.

2.2 Thermal Properties

Low temperature data (in the 0 to 300 K range) on the thermal conductivity, thermal expansion, and specific heat of materials identified in Section 3 have been collected and organized. The data are representative for metals in the annealed condition and for composites in the as-fabricated condition, unless otherwise noted. All the available thermal property data for the various metals and alloys were plotted and curves were visually fitted. Data read from these curves are presented in tables at selected temperatures in both SI and English units according to the format shown in Table 2.7. Data for composite materials obtained directly from the referenced literature is presented in the format of Table 2.8. The English units are shown in parentheses. Data recorded in the superconducting state are marked (s) while data recorded in the normal state are marked (n).

Thermal conductivity and specific heat data were expanded in the low temperature range by the use of log-log plots. In some areas, extra curves were included to further expand the lower temperature data for better readability.

The thermal expansion data have been referenced to 273 K (32 F). The trends of the thermal expansion data did not change rapidly at the lower temperatures and therefore there was no need to expand the data in the low temperature range.

Impurities, heat treatment, and other conditions affect the low temperature properties of the materials. In some cases, curves showing the effects of these variations are included on the same graph.

Table 2.9 is a list of conversion factors that can be used to convert data to SI units or other familiar units.

2.3 Electrical Resistivity

The electrical resistivity of materials listed in Section 3 have been collected and organized in the temperature range from 0 to 300 K. The data are representative for metals and alloys in the annealed condition and for composites in the as-fabricated condition, unless otherwise noted. The data for the various metals and alloys were plotted and curves were visually fitted. Data read from these curves are presented in tables at selected temperatures in both SI and English units along with the thermal properties in the format shown in Table 2.7. Data for composite materials obtained directly from the referenced literature are presented in the format in Table 2.8.

Electrical resistivity data were expanded in the low temperature range by using log-log plots.

Impurities, variation in heat treatment, and other conditions affect the low temperature electrical resistivity of the materials. Several graphs show how these variables affect the electrical resistivity at low temperatures.

A list of conversion factors for electrical resistivity are also included in Table 2.9.

2.4 Magnetic Properties

Structural Materials

For the structural materials of specific interest in the development of superconducting machinery, some efforts to determine their magnetic properties have been noted for at least the last 25 years. However, recent interest in cryogenic structural applications has brought forth a resurgence of magnetic property determinations. Most of the data available from the scientific and technical literature is either in the form of magnetization (M) determinations or magnetic susceptibility (k or χ) determinations at various cryogenic temperatures of research interest. This is the case because the magnetic permeability (μ) of these materials generally differs from unity by only a very small amount (in cgs units).

If available from the literature, values of k are reported in the magnetic property tables in this Handbook, since in some cases they provide a more useful alternative to μ . The volume susceptibility, k, is obtained from reported values of χ , the mass susceptibility, by multiplying the latter by the density of the material, ρ . Values of k are given in mksa units (as used in the SI system) which are 4π times the cgs units generally used in the scientific literature. In some cases, particularly where no variation in μ may be discerned within computational limits, χ is also reported in the tables.

In the magnetic property tables, μ is also reported in mksa units. To obtain μ in mksa units, μ in cgs units is multiplied by $4\pi \times 10^{-7}$. In the cgs system, $\mu = 4\pi k + 1$. Therefore,

$$\mu_{\text{mksa}} = (4\pi k_{\text{cgs}} + 1) 4\pi \times 10^{-7}.$$

For the structural materials of interest, this relation produces extremely small numerical values of μ , but these satisfy the criterion of the consistent use of SI units for the principal values reported in the tables. It may be noted from the magnetic property tables that μ is somewhat dependent on the magnetizing force (H) applied to the material, even for the materials that have a low value of intrinsic magnetism. It may also be noted that copper is diamagnetic, producing magnetic moments that oppose the applied magnetic field; hence, the susceptibilities are shown with a negative sign.

Superconductive Materials

In correlating property data for a given superconductive material, or group of materials, to achieve optimum design in superconducting machinery, it is desirable to have data on critical current density (J_c) versus temperature (for a given applied magnetic field) or on critical field (H_c) versus temperature (for a given current density). Although a large research effort has been carried out during the past decade to determine the superconducting properties of various materials of technical interest, nearly all of the data produced has been in the form of J_c versus H (for a given temperature). The majority of this experimental data was obtained at 4.2 K. Although working with these data may require considerable extrapolation on the part of the design engineer, it is all that the scientific literature provides at the present time. Therefore, most of the superconducting property data presented in this Handbook is in the form of plots of J_c versus H. Data on the critical (or transition) temperature has been given if available. It may be noted from the data presented that superconductivity is a very structure-sensitive property for any given composition.

TABLE 2.1

Alloy Designation:

Specification:

Form:

Thickness, cm (in.):

Condition:

Testing Temperature, K (F)	297 (75)					
Tension, Longitudinal						
TUS, MN/m ² (ksi) ^(a)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References:

(a) Ksi x 6.895 = MN/m²

TABLE 2.2

Alloy Designation:

Specification:

Form:

Thickness, cm (in.):

Condition:

Testing Temperature, K (F)	297 (75)					
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb) (a)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., J(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness						
K _{IC} MN/m ^{3/2} (ksi√in.) (b)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References:

(a) Ft-lb x 1.356 = Joules.

(b) Ksi √in. x 1.093 = MN^{3/2}.

TABLE 2.3

Alloy Designation:

Specification:

Form:

Thickness, cm (in.):

Condition:

Testing Temperature, K (F)	297 (75)					
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m²(ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m²(ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m²(ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m²(ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m²(ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m²(ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References:

TABLE 2.4

Composite Class:

Type:

Specification:

Layup:

Nominal fiber volume fraction:

Nominal ply thickness:

Fiber:

Matrix:

Nominal density:

Comments:

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
<u>Tension, Longitudinal (0°)(a)</u>						
TUS, MN/m ² (ksi)	Avg					
	Min					
References:						
E ₁ , GN/m ² (10 ⁶ psi)	Avg					
	Min					
References:						
SE ₁ , MN/m ² (ksi)	Avg					
	Min					
References:						
E ₂ GN/m ² (10 ⁶ psi)	Avg					
	Min					
References:						
TPL, MN/m ² (ksi)	Avg					
	Min					
References:						
Failure Strain, 10 ⁻³	Avg					
	Min					
References:						
Poisson's Ratio						
References:						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
References:						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
References:						
Tensi						
<u>Tension, Transverse (90°)(b)</u>						
TUS, MN/m ² (ksi)	Avg					
	Min					
References:						
E ₁ , GN/m ² (10 ⁶ psi)	Avg					
	Min					
References:						
SE ₁ , MN/m ² (ksi)	Avg					
	Min					
References:						
E ₂ , GN/m ² (10 ⁶ psi)	Avg					
	Min					
References:						
TPL, MN/m ² (ksi)	Avg					
	Min					
References:						
Failure Strain, 10 ⁻³	Avg					
	Min					
References:						
Poisson's Ratio						
References:						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
References:						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
References:						
(a) Warp direction in woven cloth.						
(b) Fill direction in woven cloth.						

TABLE 2.5

Composite Class:

Type:

Specification:

Fiber:

Layup:

Matrix:

Nominal fiber volume fraction:

Nominal density:

Nominal ply thickness:

Comments:

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)
<u>Compression, Longitudinal (0°) (a)</u>					
CUS, MN/m ² (ksi)	Max				
	Avg				
	Min				
References:					
CPL, MN/m ² (ksi)	Max				
	Avg				
	Min				
References:					
E, GN/m ² (10 ⁶ psi)	Avg				
	Min				
References:					
<u>Compression, Transverse (90°) (b)</u>					
CUS, MN/m ² (ksi)	Max				
	Avg				
	Min				
References:					
CPL, MN/m ² (ksi)	Max				
	Avg				
	Min				
References:					
E, GN/m ² (10 ⁶ psi)	Avg				
	Min				
References:					
<u>In-Plane Shear</u>					
SUS, MN/m ² (ksi)	Avg				
	Min				
References:					
SPL, MN/m ² (ksi)	Avg				
	Min				
References:					
G, GN/m ² (10 ⁶ psi)	Avg				
	Min				
References:					
<u>Interlaminar Shear</u>					
SUS, MN/m ² (ksi)	Avg				
	Min				
References:					
SPL, MN/m ² (ksi)	Avg				
	Min				
References:					
G, GN/m ² (10 ⁶ psi)	Avg				
	Min				
References:					
<u>Impact, Charpy V(Cv), Izod(I)</u>					
Long., (0°) J (ft-lb) (a)	Avg				
	Min				
References:					
Trans., (90°) J (ft-lb) (b)	Avg				
	Min				
References:					
Sheet, Normal, J (ft-lb) (c)	Avg				
	Min				
References:					
2.0-11					
(a) Warp direction in woven cloth.					
(b) Fill direction in woven cloth.					
(c) Press cure direction.					

TABLE 2.6

Composite Class:	Type:
Specification:	Fiber:
Layup:	Matrix:
Nominal fiber volume fraction:	Nominal density:
Nominal ply thickness:	Comments:

Fatigue

Load orientation:

Load direction:

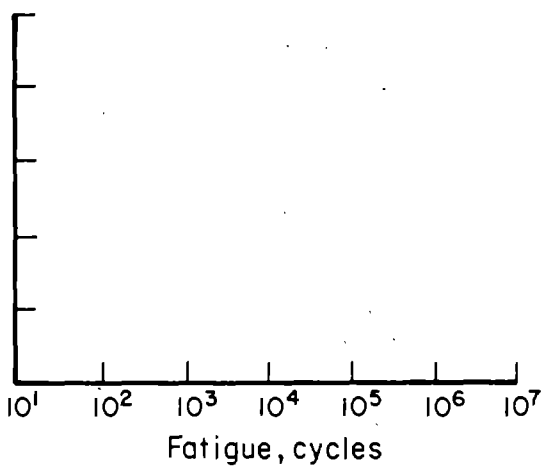
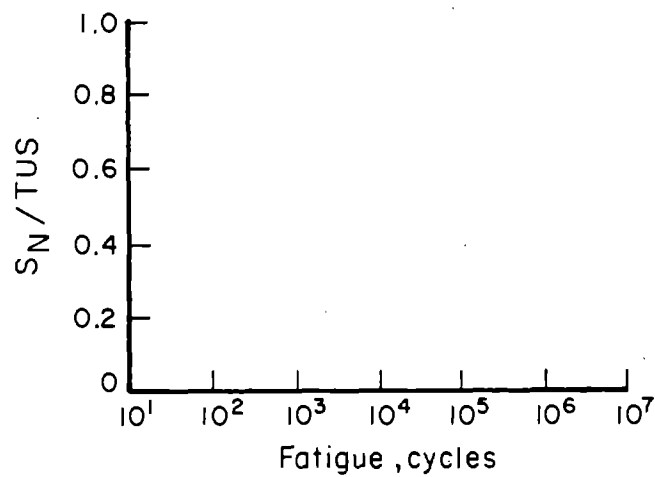
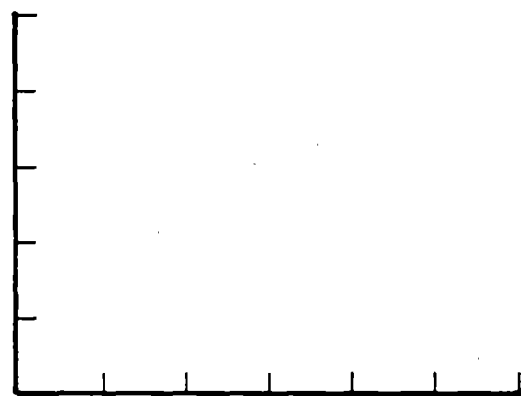
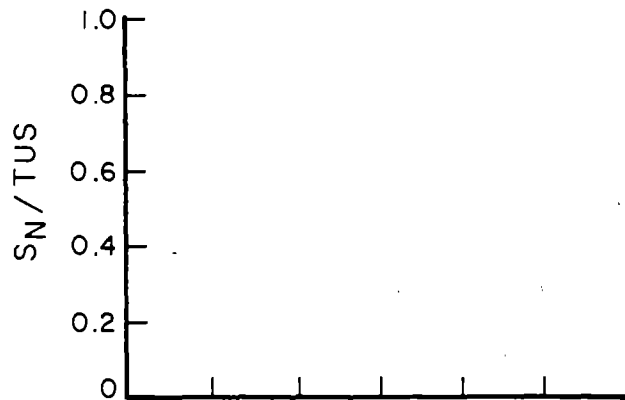


TABLE 2.7

Alloy Designation:

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
<u>Thermal Conductivity</u> Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec. References:						
<u>Thermal Expansion (T₂₇₃ to T)</u> <u>Longitudinal</u> Percent No. of Spec. References:						
<u>Specific Heat</u> Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec. References:						
<u>Electrical Resistivity</u> Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

TABLE 2.8

Composite Class:

Type:

Specification:

Fiber:

Layup:

Matrix:

Nominal fiber volume fraction:

Nominal density:

Nominal ply thickness:

Comments:

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity						
Longitudinal (0°)(a)						
Watts m ⁻¹ K ⁻¹	Avg					
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg					
References:						
Transverse (90°)(b)						
Watts m ⁻¹ K ⁻¹	Avg					
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg					
References:						
Sheet Normal(c)						
Watts m ⁻¹ K ⁻¹	Avg					
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg					
References:						
Thermal Expansion						
Longitudinal (0°)(a)						
10 ⁻⁶ ΔL/L	Avg					
References:						
Transverse (90°)(b)						
10 ⁻⁶ Δ L/L	Avg					
References:						
Sheet Normal(c)						
10 ⁻⁶ Δ L/L	Avg					
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	Avg					
Btu lb ⁻¹ F ⁻¹	Avg					
References:						
Electrical Resistivity						
Longitudinal (0°)(a)						
Ohm m	Avg					
References:						
Transverse (90°)(b)						
Ohm m	Avg					
References:						
Sheet Normal(c)						
Ohm m	Avg					
References:						

(a) Warp direction in woven cloth.

(b) Fill direction in woven cloth.

(c) Press cure direction.

TABLE 2.7
Conversion Factors

<u>Temperature (IPTS)</u>		
$^{\circ}\text{F} = 9/5 ^{\circ}\text{C} + 32$ $= 9/5 (^{\circ}\text{K} - 273.15) + 32$ $= ^{\circ}\text{R} - 459.67$		$^{\circ}\text{K} = 5/9 (^{\circ}\text{F} + 459.67)$ $= ^{\circ}\text{C} + 273.15$ $= 5/9 ^{\circ}\text{R}$
To Convert To	From	Multiply By
Thermal Conductivity and Magnetothermal Conductivity (Thermochemical Units)		
*Watts $\text{m}^{-1} \text{K}^{-1}$	Btu $\text{hr}^{-1} \text{ft}^{-1} \text{F}^{-1}$	1.730
	Btu in. $\text{hr}^{-1} \text{ft}^2 \text{F}^{-1}$	1.441×10^{-1}
	Cal $\text{sec}^{-1} \text{cm}^{-1} \text{C}^{-1}$	4.184×10^2
	Watts $\text{cm}^{-1} \text{C}^{-1}$	1×10^2
Btu $\text{hr}^{-1} \text{ft}^{-1} \text{F}^{-1}$	*Watts $\text{m}^{-1} \text{K}^{-1}$	5.782×10^{-1}
	Watts $\text{cm}^{-1} \text{C}^{-1}$	57.82
	Cal $\text{sec}^{-1} \text{cm}^{-1} \text{C}^{-1}$	2.419×10^2
	Btu in. $\text{hr}^{-1} \text{ft}^2 \text{F}^{-1}$	8.333×10^{-2}
Specific Heat (Thermochemical Units)		
*Joules $\text{kg}^{-1} \text{K}^{-1}$	Btu $\text{lb}^{-1} \text{F}^{-1}$	4.184×10^3
	Cal $\text{g}^{-1} \text{C}^{-1}$	4.184×10^3
Btu $\text{lb}^{-1} \text{F}^{-1}$	*Joules $\text{kg}^{-1} \text{K}^{-1}$	2.390×10^{-4}
	Cal $\text{g}^{-1} \text{C}^{-1}$	1
Thermal Expansion		
Percent	* m m^{-1}	1×10^2
	in. in^{-1}	1×10^2
	cm cm^{-1}	1×10^2
Electrical Resistivity		
*Ohm m	Ohm circular mil ft^{-1}	1.662×10^{-9}
	Ohm cm	1×10^{-2}
Ohm circular mil ft^{-1}	*Ohm m	6.015×10^8
	Ohm cm	6.015×10^6

* SI Units

3.0 SELECTED MATERIALS FOR DATA COLLECTION

Materials selected for data collection for the second revision of this Handbook are presented in Table 3.1. These materials have been selected from the following classes of materials:

- Aluminum and aluminum alloys
- Copper and copper alloys
- Nickel alloys
- Alloy steels
- Stainless steels
- Titanium and titanium alloys
- Special metals and alloys
- Composites
- Polymers

The two major factors that were considered in selecting these materials were (1) is the material suitable for certain cryogenic components or does it have certain intrinsic properties at cryogenic temperatures for superconducting machinery? and (2) are property data available on the material at cryogenic temperatures?

This second revision also includes properties of welded materials where information was available. When data is reported, the welding method, the type of filler metal, test direction, and test material (i.e., weld metal, or base material plus weld metal) is given.

Because of certain aerospace applications, a considerable amount of data at cryogenic temperatures are available in the literature on alloys such as 2219 aluminum alloy, Type 301 stainless steel, and Ti-5Al-2.5Sn alloy. For other materials, applicable data from the literature may be limited to a few references or may not be available.

The heat treatments and/or processing conditions for the selected alloys are intended to represent conditions that would be most appropriate for cryogenic applications, e.g., conditions that would yield a suitable degree of toughness at cryogenic temperatures. At the same time, the condition of the alloy should be such that it represents a reasonable strength level for the alloy. As an example, mechanical property data are presented for welded Ti-6Al-4V (ELI) alloy in the solution-treated, annealed condition. The annealed alloy has better toughness and develops high strength at very low temperatures. Both the extra low interstitial (ELI) and the normal interstitial content versions of the alloy are considered although the alloy with normal interstitial levels has lower ductility and toughness.

The materials listed in Table 3.1 are divided into numbered sections and subsections to permit adding other materials within each section and subsection while retaining the same numbering system for presenting the data.

The numbering system used for the metals and alloys is carried through to the tables and graphs with additional code letters to identify the properties presented. The code letters are as follows:

ME	Mechanical properties
C	Thermal conductivity
E	Thermal expansion
S	Specific heat
R	Electrical resistivity
TR	Combined thermal and resistance properties
MR	Magnetoresistance
MA	Magnetic properties

Thus, the first graph on thermal conductivity of 1100 aluminum will be Figure 4.1.4-C1. The alloy code number 4.1.4 is for 1100 aluminum, the C indicates thermal conductivity, and the 1 is for the first figure of the series. Figures for thermal conductivity of 1100 aluminum for any temper will be found in this series. The data on welded alloys are indicated in the mechanical properties (ME) sections of the appropriate alloy section.

TABLE 3.1. NOMINAL COMPOSITIONS OF ALLOYS AND CORRESPONDING SECTION NUMBERS

Section	Aluminum and Aluminum Alloys									
4.0.0	Unified		Composition in Weight Percent ^(a)							
4.1.0	Unalloyed Aluminum	No. System	Si	Cu	Mn	Mg	Cr	Zn	Others	
4.1.1	99.99Al	A91199								
4.1.2	EC	A91145							(99.45 min Al)	
4.1.3	1050	A91050	0.25	0.05	0.05	0.05		0.05	(99.50 min Al), 0.40Fe	
4.1.4	1100	A91100	1.0(Si+Fe)	0.05-0.20	0.05			0.10	(99.00 min Al)	
4.2.0	2000 Series									
4.2.1	2014	A92014	0.5-1.2	3.9-5.0	0.4-1.2	0.2-0.8	0.10	0.25	0.7Fe, 0.15Ti	
4.2.2	2219	A92219	0.20	5.8-6.8	0.2-0.4	0.02		0.10	0.3Fe, 0.02-0.10Ti	
4.2.3	2024	A92024		4.5	0.6	1.5				
4.3.0	5000 Series									
4.3.1	5083	A95083	0.40	0.10	0.4-1.0	4.0-4.9	0.05-0.25	0.25	0.4Fe, 0.15Ti	
4.3.2	5456	A95456		0.15	0.7	0.5	0.15			
4.4.0	6000 Series									
4.4.1	6061	A96061	0.4-0.8	0.15-0.40	0.15	0.8-1.2	0.04-0.35	0.25	0.7Fe, 0.15Ti	
4.5.0	7000 Series									
4.5.1	7039	A97039	0.30 max	0.10 max	0.25	2.8	0.20	4.0	0.4 max Fe, 0.10 max Ti	
4.5.2	7005	A97005	0.35 max	0.10 max	0.2-0.7	1.0-1.8	0.06-0.20	4.2-5.0	0.01-0.06Ti, 0.06-0.20Zr, 0.35 max Fe	
4.5.3	7006	—	0.10	0.04	0.22	2.24	0.12	4.10	0.17Fe, 0.01Ti	
5.0.0	Copper and Copper Alloys		CDA No.	Composition in Weight Percent ^(a)						
5.1.0	99.9+Cu			Cu	Pb	Fe	Zn	Others		
5.1.1	99.96Cu	C10100	101	99.96+				0.0003 max P, 0.001 max Pb		
5.1.2	Electrolytic Tough Pitch	C11000	110	99.9+						
5.1.3	OFHC	C10200	102	99.95						
5.1.4	Phosphorized	C12200	122	99.9+				0.02P		
5.2.0	Cu-Zn Alloys									
5.2.1	80Cu-20Zn	C24000	240	80	0.05 max	0.05 max	20			
5.2.2	70Cu-30Zn	C26000	260	70	0.07 max	0.05 max	30			
5.2.4	90Cu-10Zn	C22000	220	90	0.05 max	0.05 max	10			
5.3.0	Cu-Ni Alloys									
5.3.1	90Cu-10Ni	C70600	706	Bal.	0.05 max	1.0		1.0Mn, 9.0-11.0Ni		
5.3.2	80Cu-20Ni	C71000	710	Bal.	0.05 max	1.0 max	1.0 max	1.0 max Mn, 19.0-23.0Ni		
5.3.3	70Cu-30Ni	C71500	715	Bal.	0.05 max	0.4-0.7	1.0 max	1.0 max Mn, 29.0-33.0Ni		
5.4.0	Cu-Be Alloys									
5.4.1	Cu-Be(1.6-1.8)	C17000	170	Bal.				1.6-1.8Be, 0.20-0.40Co		
5.4.2	Cu-Be(1.8-2.0)	C17200	172	Bal.				1.8-2.0Be, 0.20 min (Ni+Co) 0.60 max (Ni+Co+Fe)		
5.5.0	Cu-Sn Alloys									
5.5.1	95Cu-5Sn	C51800	518	Bal.	0.02 max			4.0-6.0Sn, 0.10-0.35P		
5.5.2	92Cu-8Sn	C52100	521	Bal.	0.05 max	0.10 max	0.20 max	7.0-9.0Sn, 0.03-0.35P		
5.5.3	90Cu-10Sn	C52400	524	Bal.	0.05 max	0.10 max	0.20 max	9.0-11.0Sn, 0.03-0.35P		
5.6.0	Cu-Zr Alloy									
5.6.1	Cu-0.2Zr (Amzirc)	C15000	150	99.8				0.10-0.20Zr		
5.7.0	Cu-Cr-Cd Alloy									
5.7.1	Cu-0.4Cr-0.4Cd (PD-135)	—	—	Bal.				0.4Cr, 0.4Cd (Te deox.)		

(a) max = maximum, min = minimum.

TABLE 3.1. (Continued)

Section												
5.8.0	Cu-Al ₂ O ₃ Alloys											
5.8.1	Cu+0.2Al ₂ O ₃	(AL-10)	—	Bal.	0.2Al ₂ O ₃ dispersion							
5.8.2	Cu+0.7Al ₂ O ₃	(AL-35)	—	Bal.	0.7Al ₂ O ₃ dispersion							
5.8.3	Cu+1.1Al ₂ O ₃	(AL-60)	—	Bal.	1.1Al ₂ O ₃ dispersion							
	(GlidCop Alloys)											
5.9.1	Cu-Al	C61400									6.0-8.0Al, 1.0 max Mn	
6.0.0	Nickel and Cobalt Alloys											
	Unified											
	No.											
	Composition in Weight Percent ^(a)											
6.1.0	Ni-Cu Alloy	System	Ni	Cr	Fe	Mn	Si	C	Others			
6.1.1	K Monel (K-500)	N05500	Bal.		1.0	0.6	0.15	0.15	29.5Cu, 2.8Al, 0.5Ti			
6.2.0	Ni-Cr-Fe Alloys											
6.2.1	Inconel 600	N06600	Bal.	15.8	7.2	0.2	0.2	0.04	0.10Cu			
6.2.2	Inconel X-750	N07750	Bal.	15.0	6.75	0.7		0.04	0.8Al, 2.5Ti, 0.85Nb			
6.2.3	Inconel 718	N07718	Bal.	18.6	18.5			0.04	0.4Al, 0.9Ti, 5.0Nb, 3.1Mo			
6.2.4	Inconel 706	N09706	39-44	16	Bal.	0.35 max	0.35 max	0.06 max	0.35 max Al, 0.01-0.02B, 3Nb, 1.5-2.0Ti			
6.3.0	Controlled Expansion Alloys											
6.3.1	Invar 36	—	36		Bal.							
6.3.2	Ni-Span C	—	42.1(Ni+Co)	5.4	48.4	0.40			2.4Ti, 0.65Al			
6.3.3	Unnamed Inco LEA Alloy	—	39.6		55.4	0.22	0.12	0.01	0.22Al, 1.46Ti, 2.90Nb+Ta			
6.4.0	Pure Nickels											
6.4.1	High-Purity Ni	—										
6.4.2	Nickel "A"	—										
7.0.0	Alloy Steels											
	Composition in Weight Percent ^(a)											
7.1.0	Nickel Steels		C max	Mn max	P max	S max	Si	Ni	Others			
7.1.1	9-Ni Steel	—	0.13	0.80	0.035	0.04	0.15-0.30	8.5-9.5				
7.1.2	18Ni(200) Maraging Fe-Si Steel	—	0.03	0.10	0.01	0.01	0.10	17-19	8.5Co, 3.25Mo, 0.20Ti, 0.10Al			
7.2.0	Transformer Steel											
7.3.0	Carbon Steels											
7.3.1	AISI 1010	G10100	0.08-0.13	0.30-0.60	0.040	0.050						
7.4.0	Other Ferrous Materials											
7.4.1	Armco Iron											
7.4.3	5-Ni Steel		0.15	0.30-0.60	0.035	0.035	0.2-0.35	5.0	0.20-0.35Mo, 0.05-0.12Al, 0.02 max Ni			
7.4.4	Iron (47-50)Ni Alloy											
8.0.0	Stainless Steels											
	Composition in Weight Percent ^(a)											
8.1.0	300 Series		C	Mn	P max	S	Si	Cr	Ni	Mo	Others	
8.1.1	AISI 301	S30100	0.15 max	2.0 max	0.045	0.03 max		16-18	6-8			
8.1.2	AISI 304	S30400	0.08 max	2.0 max	0.045	0.03 max	1.0 max	18-20	8-10.5			
8.1.3	AISI 304L	S30403	0.03 max	2.0 max	0.045	0.03 max	1.0 max	18-20	8-12			
8.1.4	AISI 310	S31000	0.25 max	2.0 max	0.045	0.03 max	1.5 max	24-26	19-22			
8.1.5	AISI 316	S31600	0.08 max	2.0 max	0.045	0.03 max	1.0 max	16-18	10-14	2.0-3.0		
8.1.6	AISI 321	S32100	0.08 max	2.0 max	0.045	0.03 max	1.0 max	17-19	9-12		(5xC)Ti min	
8.1.7	AISI 303	S30300	0.15 max	2.0 max	0.20	0.15 min	1.0 max	17-19	8-10	0.6 max (or Zr)		
8.1.8	AISI 310S	S31008	0.08 max	2.0 max	0.045	0.03 max	1.5 max	24-26	19-22			
8.1.9	AISI 347	S34700	0.08 max	2.0 max	0.045	0.03 max	1.0 max	17-19	9-13		(10xC)Nb+Ta	
8.1.10	AISI 410	S41000	0.15	1.0 max	0.040	0.03 max	1.0 max	11.5-13.5				
8.1.11	AISI 416	S41600	0.15	1.25 max	0.06		1.0 max	12-14		0.6 max	0.153 min	
8.2.0	Other Stainless Steels											
8.2.1	A-286	K66286	0.05	1.4			0.4	15	26	1.25	0.2Al, 2.15Ti, 0.003B, 0.3V	
8.2.2	Kromarc-58 ^(b)	—	0.03	9.3	0.005	0.005 max	0.05	15.5	23	2.2	0.02Al, 0.008Zr, 0.016B, 0.16V, 0.17Ni	
8.2.3	Armco 21-6-9	—	0.08 max	8.0-10.0				19.0-21.5	5.5-7.5			
8.2.4	Armco 22-13-5	—	0.06 max	4.0-6.0				20.5-23.5	11.5-13.5	1.5-3.0	0.1-0.3Nb, 0.1-0.3V, 0.2-0.4N	

(a) max = maximum, min = minimum.

(b) Analysis of Westinghouse plate used in evaluation program.

TABLE 3.1. (Continued)

Section											
9.0.0	Titanium and Titanium Alloys										
		Composition in Weight Percent ^(a)									
9.1.0	Unalloyed Ti	Al	Sn	V	Fe max	O max	C max	N max	H max	Mn max	
9.1.1	Ti-65A						0.20	0.07	0.015		
9.1.2	Ti-75A					0.40	0.20	0.07	0.0125		
9.2.0	Alpha Ti Alloys										
9.2.1	Ti-5Al-2.5Sn ^(c)	4.0-6.0	2.0-3.0		0.50	0.20	0.15	0.07	0.020	0.30	
9.2.2	Ti-5Al-2.5Sn (ELI) ^(d)	4.7-5.6	2.0-3.0		0.20	0.12	0.08	0.05	0.0175		
9.3.0	Alpha-Beta Ti Alloy										
9.3.1	Ti-6Al-4V (ELI) ^(d)	5.5-6.5		3.5-4.5	0.15	0.13	0.08	0.05	0.015		
9.3.2	Ti-6Al-4V ^(c)	5.5-6.75		3.5-4.5							
10.0.0	Special Metals and Alloys										
10.1.0	Nb and Nb Alloys										
10.1.1	Nb										
10.1.2	Nb ₃ Sn										
10.1.3	Nb-Zr										
10.1.4	Nb-Ti										
10.1.5	Nb-Ti+Cu composites										
10.2.0	V-Ga Alloys										
10.2.1	V ₃ Ga										
10.3.1	Magnesium Alloy AZ31B (3Al, 1Zn, 0.2Mn) Mg-Al-Mn Alloy										
11.0.0	Composites										
11.1.0	Glass-Epoxy										
11.1.1	181/Epox 828										
11.1.2	1581/E-787 (58-68R)										
11.1.3	S-901/NASA Resin 2										
11.2.0	Boron-Epoxy										
11.2.1	4.0 mil Boron/2387										
11.2.2	5.0 mil Boron/2387										
11.3.0	Graphite-Epoxy										
11.3.1	AS/NASA Resin 2										
11.3.2	HT-S/X-904										
11.4.0	Boron-Aluminum										
11.4.1	5.6 mil Boron/6061										
12.0.0	Polymers										
12.1.1	PE	Polyethylene									
12.1.2	PCTFE	Polychlorotrifluoroethylene									
12.1.3	PTFE	Polytetrafluoroethylene									
12.2.1	PMM	Polymethylmethacrylate									
12.3.1	PS	Polystyrene									
12.4.1	PVA	Polyvinylacetate									

(a) max = maximum, min = minimum.

(c) Normal interstitial content.

(d) ELI = extra low interstitial type.

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness (l) Code	Condition (c,d,e)	Mechanical Properties										Thermal-Electrical Properties							Magnetic Properties												
					Weld Properties			Tensile			Shear	Impact	Fracture	Fatigue	Dynamic Modulus (b) E, G, B, ρ	C Prop Code	C Thermal Cond.	C Magneto-Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto-Resistance	Magnetic Properties											
					Process (l)	Filler Alloy	Post-Weld (k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS	SUS G	Charpy V										Toughness K _{IC} , K _{IE} , J _{IC}	da/dN	S-N	Prop Code	Thermal Cond.	C Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto-Resistance	Prop Code	Perm. Suscept
Aluminum Alloys																																		
Aluminum	4.1.1	Rod	F					ME																										
Aluminum	4.1.1			Annealed				ME																										
1099-H14	4.1.4	Plate	E	H14				ME	1,F1																									
1100-H112	4.1.4	Plate	E	H112	MIG	1100	AW	ME	1.1		1.1																							
1100-O	4.1.4	Bar	F	O				ME	2,F1																									
1100-O	4.1.4	Rod	F	O				ME																										
1100-O	4.1.4			O				ME																										
2014-T6	4.2.1	Sheet	A	T6				ME	1																									
2014-T6	4.2.1	Sheet	B	T6				ME	2.4	2	2.4																							
2014-T6	4.2.1	Sheet	B	T6	MIG	4043	AW	ME	4.1																									
2014-T6	4.2.1	Sheet	B	T6	TIG	2014	AW	ME	4.2	4.2																								
2014-T6	4.2.1	Sheet	B	T6	TIG	2319	AW	ME	4.3																									
2014-T6	4.2.1	Sheet	B	T6	TIG	4043	AW	ME	4.4,4.5																									
2014-T6	4.2.1	Sheet	C	T6				ME	5																									
2014-T6	4.2.1	Sheet	C	T6	TIG	4043	AW	ME	5.1																									
2014-T6	4.2.1	Plate	D	T6	MIG	716	AW	ME	5.2																									
2014-T6	4.2.1	Plate	D	T6	MIG	2319	AW	ME	5.3																									
2014-T6	4.2.1	Plate	D	T6	MIG	4043	AW	ME	5.4																									
2014-T6	4.2.1	Plate	D	T6	MIG	5356	AW	ME	5.5																									
2014-T6	4.2.1	Plate	D	T6	MIG	5556	AW	ME	5.6																									
2014-T6	4.2.1	Plate	E	T62				ME	6																									
2014-T6S1	4.2.1	Plate	E	T6S1				ME	8					7																				
2014-T62	4.2.1	Plate	E	T62	TIG	2319	AW	ME	9					9																				
2014-T62	4.2.1	Plate	E	T62	TIG	4043	AW	ME	9.1																									
2014-T62	4.2.1	Plate	E	T62				ME	9.2																									
2014-T6S1	4.2.1	Plate	G	T6S1				ME	9.3		9.3																							
2014-T6	4.2.1	Bar	F	T6				ME	10	10																								
2014-T6	4.2.1	Forging		T6				ME	11																									
2024-T3	4.2.3	Sheet	A	T3				ME	1	1	1																							
2024-T4	4.2.3	Sheet	A	T4				ME	2	2	2																							
2024-T3	4.2.3	Sheet	B	T3				ME	3		3																							
2024-T86	4.2.3	Sheet	B	T86				ME	4		4																							
2024-T3S1	4.2.3	Plate	E	T3S1				ME	5		5																							
2024-T4	4.2.3	Plate	G	T4				ME	6	6	6																							
2024-T8S1	4.2.3	Plate	G	T8S1				ME	7		7																							
2024-T4	4.2.3	Bar	F	T4				ME	8																									
2024-T4	4.2.3	Bar	F	T4				ME																										
2024-T86	4.2.3	Bar	F	T86				ME	10					9																				
2024-T86	4.2.3	Bar	F	T86				ME																										
2024-T3S1	4.2.3	Bar	G	T3S1				ME	12		12			11																				
2024-O	4.2.3			O																														
2024-T4	4.2.3			T4																														
2024-T6	4.2.3			T6																														
2024-T86	4.2.3			T86																														
2219-T87	4.2.2	Sheet	A	T87				ME	1																									
2219-T6	4.2.2	Sheet	B	T6				ME	2																									
2219-T62	4.2.2	Sheet	B	T62				ME	3	3	3																							
2219-T81	4.2.2	Sheet	B	T81				ME	5	5	5																							
2219-T87	4.2.2	Sheet	B	T87				ME	6	6	6																							
2219-T6E46	4.2.2	Sheet	B	T6E46				ME	7.1																									
2219-T31	4.2.2	Sheet	B	T31	TIG	2319	AW	ME	7.2																									
2219-T6	4.2.2	Sheet	B	T6	TIG	2319	AW	ME	7.3																									
2219-T62	4.2.2	Sheet	B	T62	MIG	2319	T62	ME	7.4	7.4	7.4																							
2219-T62	4.2.2	Sheet	B	T62	MIG	2319	HT,A	ME	7.5	7.5																								
2219-T62	4.2.2	Sheet	B	T62	TIG	2319	AW	ME	7.6																									
2219-T62	4.2.2	Sheet	B	T62	TIG	2319	T62	ME	7.7		7.7																							
2219-T62	4.2.2	Sheet	B	T62	TIG	2319	T62	ME	7.8																									
2219-T81	4.2.2	Sheet	B	T81	MIG	2319	AW	ME	7.9		7.9																							
2219-T81	4.2.2	Sheet	B	T81	MIG	2319	Aged	ME	7.10		7.10																							
2219-T81	4.2.2	Sheet	B	T81	TIG	2319	AW	ME	7.11																									
2219-T81	4.2.2	Sheet	B	T81	TIG	2319	AW	ME	7.12																									
2219-T81	4.2.2	Sheet	B	T81	TIG	2319	T81	ME	7.13																									
2219-T87	4.2.2	Sheet	B	T87	MIG	2319	AW	ME	7.14		7.14																							

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness ^(l) Code	Condition ^(c,d,e)	Mechanical Properties										Thermal-Electrical Properties										Magnetic Properties	
					Weld Properties			Tensile			Shear SUS G	Impact Charpy V	Fracture Toughness K _{IC} , K _{IE} , J _{IC}	Fatigue da/dN S-N	Dynamic Modulus ^(h) E, G, B, ρ	C Thermal Cond.	C Magneto- Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto- Resistance	Prop Code	Param., Suscept			
					Process ^(j)	Filler Alloy	Post-Weld ^(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop																
2219-T87	4.2.2	Sheet	B	T87	MIG	2319	Aged	ME	7.15		7.15															
2219-T87	4.2.2	Sheet	B	T87	TIG	2319	AW	ME	7.16	7.16																
2219-T87	4.2.2	Sheet	C	T87	TIG	2319	AW	ME	7.17																	
2219-T81	4.2.2	Plate	D	T81				ME	8		8	9														
2219-T87	4.2.2	Plate	D	T87				ME	10		10															
2219-T6E46	4.2.2	Plate	D	T6E46				ME	10.1	10.1																
2219-O	4.2.2	Plate	D	O	TIG	2319	HT	ME	10.2																	
2219-T87	4.2.2	Plate	E	T87				ME	11	11	11	12	12													
2219-T6E46	4.2.2	Plate	E	T6E46				ME	12.1	12.1																
2219-T851	4.2.2	Plate	E	T851				ME	12.2		12.2															
2219-T6E46	4.2.2	Plate	E	T6E46	TIG	2319	AW	ME	12.3																	
2219-T62	4.2.2	Plate	E	T62	MIG	2319	AW	ME	12.4																	
2219-T81	4.2.2	Plate	E	T81	MIG	2319	AW	ME	12.5																	
2219-T81	4.2.2	Plate	E	T81	MIG	2319	Aged	ME	12.6																	
2219-T87	4.2.2	Plate	E	T87	MIG	2319	AW	ME	12.7		12.7															
2219-T87	4.2.2	Plate	E	T87	MIG	2319	HT	ME	12.8																	
2219-T87	4.2.2	Plate	E	T87	TIG	2319	AW	ME	12.9		12.9															
2219-T87	4.2.2	Plate	E	T87	TIG	None	AW	ME	12.10	12.10																
2219-T87	4.2.2	Plate	G	T87				ME	13.14	13	13		15													
2219-T6E46	4.2.2	Plate	G	T6E46				ME	15.1																	
2219-T62	4.2.2	Plate	G	T62				ME	15.2		15.2															
2219-T851	4.2.2	Plate	G	T851	MIG	2319	AW	ME	15.3																	
2219-T81	4.2.2	Plate	H	T81				ME	16.17																	
2219-T87	4.2.2	Plate	H	T87				ME	18.19	18.19	18.19															
2219-T87	4.2.2	Sheet & Plate	A-H	T87				ME	20																	
2219-T87	4.2.2	Plate	H	T87				ME				21														
2219-T81	4.2.2	Plate	H	T81	MIG	2319	AW	ME	21.1																	
2219-T87	4.2.2	Plate	H	T87	EB	2319	AW	ME	21.2	21.2																
2219-T87	4.2.2	Plate	H	T87	EB	2319	Aged	ME	21.3	21.3																
2219-T87	4.2.2	Plate	H	T87	MIG	2319	AW	ME	21.4	21.4																
2219-T87	4.2.2	Plate	H	T87	MIG	2319	Aged	ME	21.5	21.5																
2219-T87	4.2.2	Plate	H	T87	MIG	2319	Aged	ME				21.6														
2219-T87	4.2.2	Plate	H	T87	Pulse TIG	2319	AW	ME	21.7	21.7																
2219-T87	4.2.2	Plate	H	T87	Pulse TIG	2319	Aged	ME	21.8	21.8																
2219-T87	4.2.2	Plate	H	T87	Pulse TIG	2319	Aged	ME				21.9														
5083-H38	4.3.1	Sheet	B	H38				ME	1		1															
5083-H113	4.3.1	Plate	D	H113				ME																		
5083-H113	4.3.1	Plate	D	H113	MIG	5183	AW	ME	2.1				2													
5083-H113	4.3.1	Plate	D	H113	MIG	5183	AW	ME					2.2													
5083-O	4.3.1	Plate	E	O				ME	3		3															
5083-O	4.3.1	Plate	E	O	MIG	5183		ME	3.1		3.1															
5083-H113	4.3.1	Plate	E	H113	MIG	5556	AW	ME	3.2																	
5083-H113	4.3.1	Plate	E	H113	MIG	5556	AW	ME					3.3													
5083-H321	4.3.1	Plate	E	H321	MIG	5183	AW	ME	3.4		3.4															
5083-H321	4.3.1	Plate	E	H321	MIG	5356	AW	ME	3.5		3.5															
5083-H321	4.3.1	Plate	E	H321	MIG	5556	AW	ME	3.6		3.6															
5083-O	4.3.1	Plate	G	O	MIG	5183	AW	ME	3.7																	
5083-O	4.3.1	Plate	G	O	MIG	5356	AW	ME	3.8																	
5083-O	4.3.1	Sheet/ Plate	B/H	O				ME	4																	
5083-H113	4.3.1	Plate	E	H113				ME	5		5															
5083-O	4.3.1	Plate	E	O				ME																		
5083-H113	4.3.1	Plate	E	H113				ME					6													
5083-H321	4.3.1	Plate	E	H321				ME	7		7															
5083-O	4.3.1	Plate	H	O				ME	8																	
5083-O	4.3.1	Plate	H	O				ME	9																	
5083-O	4.3.1	Plate	H	O	MIG	5183	AW	ME	9.1																	
5456-O	4.3.2	Sheet	B	O				ME	1		1															
5456-H24	4.3.2	Sheet	B	H24				ME	2	2	2															
5456-H24	4.3.2	Sheet	B	H24	TIG	4043	AW	ME	3																	
5456-H321	4.3.2	Sheet	B	H321				ME	4		4															

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness(t) Code	Condition(c,d,e)	Mechanical Properties										Thermal-Electrical Properties										Magnetic Properties		
					Weld Properties			Tensile				Shear SUS G	Impact Charpy V	Fracture Toughness K _{IC} , K _{IE} , J _{IC}	Fatigue da/dN S-N	Dynamic Moduli(b) E, G, B, ρ	C					E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magnetoresistance	Prop Code	Magnetic Moment Perm., Suscept
					Process(j)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS						Prop Code	Thermal Cond.	Magneto- Thermal Cond.	Thermal Cond.							
5456-H321	4.3.2	Sheet	B	H321	TIG	5556	AW	ME	5		5																
5456-H343	4.3.2	Sheet	B	H343				ME	6	6																	
5456-H343	4.3.2	Sheet	B	H343	TIG	5356	AW	ME	7																		
5456-H343	4.3.2	Sheet	B	H343	TIG	5556	AW	ME	8																		
5456-O	4.3.2	Plate	D	O				ME	9		9																
5456-O	4.3.2	Plate	D	O				ME																			
5456-H321	4.3.2	Plate	D	H321				ME																			
5456-O	4.3.2	Plate	E	O				ME	12		12																
5456-H321	4.3.2	Plate	E	H321				ME	13		13																
5456-H321	4.3.2	Plate	E	H321				ME																			
5456-H321	4.3.2	Plate	E	H321	MIG	5556	AW	ME	15																		
5456-H321	4.3.2	Plate	E	H321	MIG	5556	AW	ME																			
5456-H343	4.3.2	Plate	E	H343				ME	17		17																
5456-H343	4.3.2	Plate	E	H343	MIG	5356	AW	ME	18																		
5456-H343	4.3.2	Plate	E	H343	TIG	5356	AW	ME	19																		
5456-H321	4.3.2	Plate	G	H321				ME	20		20																
5456-H343	4.3.2			H343																							
																	TR	1,F1		1,F1		1,F1					
6061-T4	4.4.1	Sheet	A	T4				ME	0.1		0.1																
6061-T4	4.4.1	Sheet	A	T4				ME	0.2		0.2																
6061-T6	4.4.1	Sheet	A	T6				ME	1		1																
6061-T6	4.4.1	Sheet	B	T6				ME	2	2	2																
6061-T6	4.4.1	Sheet	B	T6				ME	F1																		
6061-T4	4.4.1	Sheet	B	T4	MIG	4043	AW	ME	3.1		3.1																
6061-T4	4.4.1	Sheet	B	T4	MIG	4043	T6	ME	3.2		3.2																
6061-T6	4.4.1	Sheet	B	T6	MIG	4043	AW	ME	3.3		3.3																
6061-T6	4.4.1	Sheet	B	T6	TIG	4043	AW	ME	3.4																		
6061-T6	4.4.1	Plate	D	T6				ME	4		4																
6061-T6	4.4.1	Plate	D	T6				ME																			
6061-T6	4.4.1	Plate	E	T6				ME	6,F1																		
6061-T6	4.4.1	Plate	E	T6	MIG	4043	AW	ME	6.1		6.1																
6061-T6	4.4.1	Plate	E	T6	MIG	4043	HT	ME	6.2		6.2																
6061-T6	4.4.1	Plate	E	T6	MIG	5356	AW	ME	6.3		6.3																
6061-T6	4.4.1	Plate	E	T6	MIG	5356	HT	ME	6.4		6.4																
6061-T651	4.4.1	Plate	G	T651				ME	7		7																
6061-T651	4.4.1	Plate	G	T651				ME																			
6061-T6	4.4.1	Bar	F	T6				ME	9																		
6061-T6	4.4.1	Bar	F	T6				ME	F1																		
6061-T6	4.4.1	Bar	F	T6				ME																			
6061-O	4.4.1	Rod	F	O				ME	11.1																		
6061-T4	4.4.1	Rod	F	T4				ME	11.2																		
6061-T91	4.4.1	Rod	F	T91				ME	11.3																		
6061-T6	4.4.1	Forging		T6				ME	12		12																
6061-T6	4.4.1			T6																							
																	TR		1		1						
7005-T6	4.5.2	Sheet	B	T6				ME	1		1																
7005-O	4.5.2	Plate	E	O				ME																			
7005-T6351	4.5.2	Plate	E	T6351				ME	2.1		2.1																
7005-T6351	4.5.2	Plate	H	T6351				ME	2.2		2.2																
7005-T5351	4.5.2	Extrusion	G	T5351				ME	3		3																
7006-T6	4.5.3	Sheet	B	T6				ME	1		1																
7006-T63	4.5.3	Sheet	B	T63				ME	2		2																
7006-W	4.5.3	Sheet	B	W				ME	3		3																
7039-T6	4.5.1	Sheet	A	T6				ME	1		1																
7039-T6	4.5.1	Sheet	B	T6				ME	2	2	2																
7039-T6	4.5.1	Sheet	B	T6				ME	F1																		
7039-T6	4.5.1	Sheet	B	T6	MIG	5183	Aged	ME	3.1		3.1																
7039-T6	4.5.1	Sheet	B	T6	Fusion	Not given	AW	ME	3.2																		
7039-T61	4.5.1	Sheet	C	T61				ME	4																		
7039-T61	4.5.1	Sheet	C	T61	TIG	None	AW	ME	4.1																		
7039-T61	4.5.1	Sheet	C	T61	TIG	None	Aged	ME	4.2																		
7039-T6,T61	4.5.1	Plate	D	T6,T61				ME	5		5																
7039-T6	4.5.1	Plate	D	T6	MIG	5083	Aged	ME	5.1		5.1																
7039-T6	4.5.1	Plate	D	T6	TIG	5039	Aged	ME	5.2		5.2																
7039-T6	4.5.1	Plate	D	T6	TIG	None	Aged	ME	5.3		5.3																

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRO REVISED EDITION

Material	Mat'l Code	Form	Thickness ⁽¹⁾ Code	Condition ^(c,d,e)	Mechanical Properties											Thermal-Electrical Properties										Magnetic Properties																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
					Weld Properties			Tensile				Shear SUS G	Impact Charpy V	Fracture Toughness K _{IC} , K _{IE} , J _{IC}	Fatigue da/dN S-N	Dynamic Moduli ^(b) E, G, B, ρ	C						Prop Code	Thermal Cond.	C Magneto- Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto- Resistance	Prop Code	Perm., Suscept																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																														
					Process ⁽ⁱ⁾	Filler Alloy	Post-Weld ^(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS						Prop Code	Thermal Cond.	Thermal Cond.	Thermal Expansion	Specific Heat	Electrical Resistivity										Magneto-Resistance																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																													
7039-T64	4.5.1	Plate	D	T64	MIG	5039	AW	ME	5.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																				

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Mechanical Properties										Thermal-Electrical Properties										Magnetic Properties	
					Process(j)	Weld Properties			Tensile			Shear SUS G	Impact Charpy V	Fracture Toughness K _{IC} , K _{IE} , J _{IC}	Fatigue da/dN S-N	Dynamic Moduli(b) E, G, B, ρ	C Prop Code	Thermal Cond.	C Magneto- Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto- Resistance	Prop Code	Perm., Suscept	
						Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS															
Cu, phosphorized	5.1.4			Annealed											TR	1,F1										
80Cu-20Zn	5.2.1			Annealed											TR	1,F1		1,F1								
70Cu-30Zn	5.2.2	Sheet	B	Stress relieved				ME	1	1																
70Cu-30Zn	5.2.2	Sheet	B	Stress relieved				ME						2												
70Cu-30Zn	5.2.2	Bar	F	3/4 hard				ME	3																	
70Cu-30Zn	5.2.2	Bar	F	3/4 hard				ME	F1			4														
70Cu-30Zn	5.2.2			Annealed											TR1	1,F1,2,F2										
65Cu-35Zn	5.2.3			Annealed											TR	1,F1		1,F1	1,F1							
90Cu-10Zn	5.2.4	Bar	F	Annealed				ME	1	1	1															
90Cu-10Zn	5.2.4	Bar	F	Annealed				ME				2	2													
90Cu-10Zn	5.2.4			Annealed											TR	1,F1			1,F1,F2	1,F1						
Cu-Ni Alloys	5.3.0	Strip		Annealed																	MA	F1				
90Cu-10Ni	5.3.1	Plate	E	Annealed				ME	0.1																	
90Cu-10Ni	5.3.1	Bar	F	Annealed				ME	1,F1	1	1															
90Cu-10Ni	5.3.1			Annealed																						
90Cu-10Ni	5.3.1	Rod		Homogenized											TR	1,F1			1,F1	1,F1		MA	1			
80Cu-20Ni	5.3.2	Plate	E	Annealed				ME	1																	
80Cu-20Ni	5.3.2	Plate	E		MIG	80Cu-20Ni	AW	ME				2														
80Cu-20Ni	5.3.2			Annealed											TR	1,F1										
70Cu-30Ni	5.3.3	Plate	E	Annealed				ME	0.1																	
70Cu-30Ni	5.3.3	Plate	E		MIG	70Cu-30Ni	AW	ME				0.2														
70Cu-30Ni	5.3.3	Bar	F	Annealed				ME	1	1	1															
70Cu-30Ni	5.3.3	Bar	F	Annealed				ME				2														
70Cu-30Ni	5.3.3			Annealed											TR	1,F1		1,F1		1,F1						
Cu-Be	5.4.2	Sheet	A	AT				ME						0.1												
Cu-Be	5.4.2	Sheet	B	STA				ME	1																	
Cu-Be	5.4.2	Sheet	B	1/2 H				ME	2,F1	2																
Cu-Be	5.4.2	Sheet	B	1/2 HT				ME	3	3																
Cu-Be	5.4.2	Sheet	B	1/2 HT				ME						4												
Cu-Be	5.4.2	Bar	F	STA				ME	5,F1	5																
Cu-Be	5.4.2	Bar	F	STA				ME	6	6																
Cu-Be	5.4.2	Bar	F	Cold drawn				ME	7	7																
Cu-Be	5.4.2	Bar	F	Hard drawn				ME	8																	
Cu-Be	5.4.2	Bar	F	Cold drawn, aged				ME	9,F1	9																
Cu-Be	5.4.2			Age hardened											TR	1,F1		1,F1		1,F1						
95Cu-5Sn	5.5.1	Bar	F	Cold drawn				ME	1	1	1															
95Cu-5Sn	5.5.1	Bar	F	Cold drawn				ME				2														
95Cu-5Sn	5.5.1			Annealed											TR			1,F1		1,F1						
92Cu-8Sn	5.5.2	Bar	F	Full hard				ME	1	1																
92Cu-8Sn	5.5.2			Annealed											TR					1,F1						
90Cu-10Sn	5.5.3														TR			1,F1		1,F1						
Cu-0.2Zr	5.6.1	Bar	F	Annealed, cold drawn, aged				ME	1		1															
Cu-0.2Zr	5.6.1	Bar	F	Annealed, cold drawn, aged				ME				2														
Cu-0.4Cr-0.4Cd	5.7.1	Extrusion	F	Aged				ME	1		1															
Cu-0.4Cr-0.4Cd	5.7.1														TR			1,F1								
Cu-Al	5.9.1	Bar	F	Annealed				ME	1	1	1															
Cu-Al	5.9.1	Bar	F	Annealed				ME				2														
Cu-Al	5.9.1			Annealed											TR	1,F1		1,F1		1,F1						
Nickel Alloys																										
K Monel (K-500)	6.1.1	Sheet	A	Aged				ME	1,F1		1															
K Monel (K-500)	6.1.1	Sheet	B	Aged				ME	2,F1		2															
K Monel (K-500)	6.1.1	Sheet	B	Aged				ME						3												

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Mechanical Properties										Thermal-Electrical Properties										Magnetic Properties	
					Weld Properties			Tensile				Shear SUS G	Impact Charpy V	Fracture Toughness K _{IC} , K _{IE} , J _{IC}	Fatigue da/dN S-N	Dynamic Moduli(b) E, G, B, ρ	C Thermal Cond.	C Magneto- Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto- Resistance	Prop Code	Magnetic Moment Perm., Suscept		
					Process(j)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS															
K Monel (K-500)	6.1.1	Sheet	B	Annealed				ME	3.1		3.1															
K Monel (K-500)	6.1.1	Sheet	B	Annealed	TIG	K Monel	AW	ME	3.2																	
K Monel (K-500)	6.1.1	Sheet	B	Annealed	TIG	K Monel	Aged	ME	3.3																	
K Monel (K-500)	6.1.1	Sheet	B	CR (1/2 H), aged				ME	3.4	3.4																
K Monel (K-500)	6.1.1	Sheet	B	CR (1/2 H), aged				ME							3.5											
K Monel (K-500)	6.1.1	Sheet	B	Aged	TIG	K Monel	AW	ME	3.6																	
K Monel (K-500)	6.1.1	Bar	F	Aged				ME	4,F1																	
K Monel (K-500)	6.1.1	Bar	F	Aged				ME					5													
K Monel (K-500)	6.1.1	Bar	F	Aged				ME							6											
K Monel (K-500)	6.1.1	Rod		Aged																						
K Monel (K-500)	6.1.1			Aged																				MA	1	
Inconel 600	6.2.1	Sheet	A	CR				ME	1																	
Inconel 600	6.2.1	Sheet	A	CR				ME																		
Inconel 600	6.2.1	Bar	F	Cold drawn				ME	3,F1	3	3				2											
Inconel 600	6.2.1	Bar	F	Cold drawn				ME					4													
Inconel 600	6.2.1	Rod	F	ST																				MA	F1	
Inconel X-750	6.2.2	Sheet	A	Annealed, aged				ME	1		1															
Inconel X-750	6.2.2	Sheet	A	Annealed, aged				ME							2											
Inconel X-750	6.2.2	Sheet	B	Annealed, aged				ME	3,F1	3	3															
Inconel X-750	6.2.2	Sheet	B	Annealed, aged				ME							4											
Inconel X-750	6.2.2	Sheet	B	Annealed	TIG	Inconel X-750	AW	ME	4.1																	
Inconel X-750	6.2.2	Sheet	B	Annealed	TIG	Inconel X-750	Aged	ME	4.2																	
Inconel X-750	6.2.2	Sheet	B	Annealed	TIG	Inconel X-750	Aged	ME	4.3																	
Inconel X-750	6.2.2	Sheet	B	Vac. ann., aged	TIG	In 69	Vac. ann., aged	ME	4.4	4.4																
Inconel X-750	6.2.2	Plate	O	Annealed, aged				ME	5		5															
Inconel X-750	6.2.2	Plate	D	Annealed, aged				ME				6														
Inconel X-750	6.2.2	Plate	D	HIP				ME	6.1		6.1				F2											
Inconel X-750	6.2.2	Plate	D	HIP/STDA				ME	6.2		6.2															
Inconel X-750	6.2.2	Bar	F	Annealed, aged				ME	7,F1																	
Inconel X-750	6.2.2	Bar	F	Annealed, aged				ME				8														
Inconel X-750	6.2.2	Bar	F	Complex				ME							9											
Inconel X-750	6.2.2	Bar	F	Complex				ME	10																	
Inconel X-750	6.2.2	Bar	G	Complex				ME	10.1		10.1															
Inconel X-750	6.2.2	Bar	H	ST				ME	10.3		10.3				F3,F4											
Inconel X-750	6.2.2	Bar	H	STDA				ME	10.4		10.4				F5											
Inconel X-750	6.2.2	Bar	H	ST	TIG	In 69	AW	ME	10.5		10.5															
Inconel X-750	6.2.2	Bar	H	Complex	TIG	In 69	AW	ME	10.6		10.6															
Inconel X-750	6.2.2	Bar	H	ST	TIG	In 69	ST, aged	ME	10.7		10.7															
Inconel X-750	6.2.2	Bar	H	ST	Vac., EB	None	AW	ME	10.8		10.8															
Inconel X-750	6.2.2	Bar	H	ST	Vac., EB	None	ST, aged	ME	10.9		10.9															
Inconel X-750	6.2.2	Bar	H	ST, aged	Vac., EB	None	AW	ME	10.10		10.10															
Inconel X-750	6.2.2	Forging		Aged				ME	11																	
Inconel X-750	6.2.2	Forging		Aged				ME																		
Inconel X-750	6.2.2	Forging	G	STDA				ME	12.1																	
Inconel X-750	6.2.2	Forging	G	STDA				ME																		
Inconel X-750	6.2.2	Rod		ST													TR	1,F1		1,F1		1,F1				
Inconel X-750	6.2.2	Rod		STDA																				MA	1	
Inconel 718	6.2.3	Sheet	A	Annealed, aged				ME	1		1													MA	2,3,F1	
Inconel 718	6.2.3	Sheet	A	Annealed				ME	1.1		1.1															

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness(t)	Condition(c,d,e)	Mechanical Properties										Thermal-Electrical Properties										Magnetic Properties	
					Weld Properties			Tensile				Shear SUS G	Impact Charpy V	Fracture Toughness K _{IC} , K _{IE} , J _{IC}	Fatigue		Dynamic Moduli(b) E, G, B, p	C					MR Magneto-Resistance	Magnetic Moment Perm., Suscept		
					Process(j)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS				da/dN	S-N		Thermal Cond.	Magneto-Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity				
																									Prop Code	Thermal Cond.
Inconel 718	6.2.3	Sheet	A	Annealed	TIG	None	Aged	ME	1.2																	
Inconel 718	6.2.3	Sheet	A	Annealed	TIG	None	Aged	ME	1.3																	
Inconel 718	6.2.3	Sheet	A	Annealed	TIG	None	Aged	ME	1.4																	
Inconel 718	6.2.3	Sheet	A	Annealed, aged	TIG	None	AW	ME	1.5																	
Inconel 718	6.2.3	Sheet	A	Annealed, aged	TIG	None	Aged	ME	1.6																	
Inconel 718	6.2.3	Sheet	A	20% CW				ME	1.7																	
Inconel 718	6.2.3	Sheet	A	20% CW, aged				ME	1.8	1.8																
Inconel 718	6.2.3	Sheet	A	20% CW, aged	TIG	None	AW	ME	1.9																	
Inconel 718	6.2.3	Sheet	A	20% CW, aged	TIG	None	Aged	ME	1.10																	
Inconel 718	6.2.3	Sheet	A	30% CR, aged				ME	1.11	1.11																
Inconel 718	6.2.3	Sheet	A	30% CR, aged	TIG	None	AW	ME	1.12																	
Inconel 718	6.2.3	Sheet	A	30% CR, aged	TIG	None	Aged	ME	1.13																	
Inconel 718	6.2.3	Sheet	B	Annealed, aged				ME	2,F1																	
Inconel 718	6.2.3	Sheet	B	Annealed, aged				ME	3	3	3															
Inconel 718	6.2.3	Sheet	B	Annealed, aged				ME	4		4															
Inconel 718	6.2.3	Sheet	B	Annealed, aged				ME																		
Inconel 718	6.2.3	Sheet	B	ST				ME	5.1	5.1	5.1															
Inconel 718	6.2.3	Sheet	B	ST	TIG	Inconel 718	AW	ME	5.2																	
Inconel 718	6.2.3	Sheet	B	Annealed, aged				ME	5.3																	
Inconel 718	6.2.3	Sheet	B	Annealed, aged	TIG	Inconel 718	AW	ME	5.4																	
Inconel 718	6.2.3	Sheet	B	Annealed, aged	TIG	Inconel 718	AW	ME	5.5	5.5																
Inconel 718	6.2.3	Plate	D	Annealed, aged				ME	6																	
Inconel 718	6.2.3	Plate	O	Annealed, aged	TIG	Inconel 718	Annealed, aged	ME	6.1																	
Inconel 718	6.2.3	Plate	E	ST	TIG	Inconel 718	Aged	ME	6.2	6.2																
Inconel 718	6.2.3	Plate	E	ST	EB	None	Aged	ME	6.3	6.3																
Inconel 718	6.2.3	Plate	E	ST	Plasma ARC	Inconel 718	Aged	ME	6.4	6.4																
Inconel 718	6.2.3	Plate	E	Annealed, aged	TIG	Inconel 718	AW	ME			6.5															
Inconel 718	6.2.3	Bar	F	Annealed, aged				ME	7,F1		7															
Inconel 718	6.2.3	Bar	F	Annealed, aged				ME	8	8																
Inconel 718	6.2.3	Bar	F	Annealed, aged				ME																		
Inconel 718	6.2.3	Forging	D	Annealed, aged				ME	10,F1																	
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME	11		11															
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME	12		12															
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME				13	13													
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME	14		14															
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME	15		15															
Inconel 718	6.2.3	Forging	G/H	Annealed, aged				ME				16														
Inconel 718	6.2.3	Forging	H	STA				ME	16.1		16.1															

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness ⁽¹⁾ Code	Condition ^(c,d,e)	Mechanical Properties										Thermal-Electrical Properties										Magnetic Properties	
					Weld Properties			Tensile			Shear SUS G	Impact Charpy V	Fracture Toughness K _{IC} , K _{IE} , J _{IC}	Fatigue		Dynamic Modulus ^(b) E, G, B, ρ	C Prop Code	C Thermal Cond.	Magneto- Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto- Resistance	Prop Code	Perm., Suscept	
					Process ⁽ⁱ⁾	Filler Alloy	Post-Weld ^(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop				NTS	da/dN											S-N
INCO LEA	6.3.3	Sheet	C	Mill annealed				ME 3																		
INCO LEA	6.3.3	Sheet	C	Annealed, aged				ME 4		4																
INCO LEA	6.3.3	Plate	D	Annealed				ME 5		5																
INCO LEA	6.3.3		D	Annealed				ME				6														
INCO LEA	6.3.3		D	Annealed, aged				ME 7		7																
INCO LEA	6.3.3		D	Annealed, aged				ME				8														
INCO LEA	6.3.3		D	Annealed, aged				ME 9		9																
INCO LEA	6.3.3		D	Annealed, aged				ME				10														
INCO LEA	6.3.3	Plate	H	STA				ME 11		11																
INCO LEA	6.3.3	Plate	H	STA				ME						11.1												
INCO LEA	6.3.3	Bar	F	Annealed, aged				ME 12		12																
INCO LEA	6.3.3																TR	1,F1		1,F1	1,F1	1,F1				
Nickel	6.4.1	Bar	F	Hot finished				ME 1	1																	
Nickel	6.4.1			Annealed														TR	1,F1		1,F1	1,F1,F2	1,F1			
"A" Nickel	6.4.2	Sheet	A	Annealed				ME 1	1																	
"A" Nickel	6.4.2	Bar	F	Annealed				ME 2																		
"A" Nickel	6.4.2			Annealed														TR	1,F1		1,F1					
Alloy Steels																										
9Ni Steel	7.1.1	Sheet	A	STWQ				ME								1										
9Ni Steel	7.1.1	Sheet	B	STWQ				ME								2										
9Ni Steel	7.1.1	Sheet	B	2N+T				ME 3																		
9Ni Steel	7.1.1	Sheet	B	2N+T				ME					4													
9Ni Steel	7.1.1	Sheet	B	N+T				ME								5										
9Ni Steel	7.1.1	Plate	D	Q+T				ME 6																		
9Ni Steel	7.1.1	Plate	D	2N+T				ME 7																		
9Ni Steel	7.1.1	Plate	D	Q+T				ME					8													
9Ni Steel	7.1.1	Plate	O	O+T	MIG	Incoweld	AW	ME				9														
9Ni Steel	7.1.1	Plate	D	Q+T	MIG	A-covered	AW	ME 10																		
9Ni Steel	7.1.1	Plate	D	Q+T	Shielded MIG	In 92	AW	ME 11																		
9Ni Steel	7.1.1	Plate	D	2N+T				ME					12													
9Ni Steel	7.1.1	Plate	D	2N+T	MIG	Incoweld	AW	ME				13														
9Ni Steel	7.1.1	Plate	E	Q+T				ME 14																		
9Ni Steel	7.1.1	Plate	E	Q+T				ME					15													
9Ni Steel	7.1.1	Plate	E	2N+T				ME 16																		
9Ni Steel	7.1.1	Plate	E	2N+T				ME					17													
9Ni Steel	7.1.1	Plate	E	Q+T				ME								18										
9Ni Steel	7.1.1	Plate	E	2N+T				ME								19										
9Ni Steel	7.1.1	Plate	E	2N+T	MIG	Incoweld	AW	ME					20													
9Ni Steel	7.1.1	Plate	E	2N+T	MIG	A-covered	AW	ME																		
9Ni Steel	7.1.1	Plate	E	2N+T				ME					21													
9Ni Steel	7.1.1	Plate	G	Q+T				ME 22																		
9Ni Steel	7.1.1	Plate	G	Q+T				ME					23													
9Ni Steel	7.1.1	Plate	G	2N+T				ME 24																		
9Ni Steel	7.1.1	Plate	G	2N+T				ME					25			F2										
9Ni Steel	7.1.1	Plate	H	O+T				ME 26																		
9Ni Steel	7.1.1	Plate	H	Q+T				ME					27	27												
9Ni Steel	7.1.1	Bar	F	2N+T				ME 28,F1																		
9Ni Steel	7.1.1	Forging	H	Q+T				ME 29																		
9Ni Steel	7.1.1	Forging	H	O+T				ME					30													
9Ni Steel	7.1.1	Forging	H	2N+T				ME					31													
9Ni Steel	7.1.1			2N+T																						
9Ni Steel	7.1.1	Plate	H	2N+T													TR	1,F1		1,F1						
18Ni(200) Marag.	7.1.2	Plate	D	Annealed, aged				ME 1,F1	1	1																
18Ni(200) Marag.	7.1.2	Plate	D	Aged	TIG	18Ni marag.	AW	ME 1.1	1.1																	
18Ni(200) Marag.	7.1.2	Plate	E	STA				ME 2,F1	2																	
18Ni(200) Marag.	7.1.2	Plate	E	Aged				ME 2.1																		
18Ni(200) Marag.	7.1.2	Plate	E	Annealed, aged				ME						3												
18Ni(200) Marag.	7.1.2	Plate	E	Aged	TIG	18Ni marag.	AW	ME 3.1	3.1																	
18Ni(200) Marag.	7.1.2	Plate	H	Annealed, aged				ME 4																		

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Mechanical Properties										Thermal-Electrical Properties										Magnetic Properties		
					Weld Properties			Tensile			Shear SUS G	Impact Charpy V	Fracture Toughness K _{IC} , K _{IE} , J _{IC}	Fatigue da/dN S-N	Dynamic Moduli(b) E, G B, ρ	C Prop Code	C Magneto- Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto- Resistance	Prop Code	Perm., Suscept				
					Process(i)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop														NTS			
18Ni(200) Marag.	7.1.2	Plate	H	Annealed, aged				ME					5														
18Ni(200) Marag.	7.1.2																	TR	1,F1								
1010 Steel	7.3.1																	TR	1,F1								
Armco Iron	7.4.1	Bar	F	Annealed				ME	1									TR	1,F1								
5Ni Steel	7.4.3	Plate	D	QTR				ME							1												
5Ni Steel	7.4.3	Plate	D	QTR				ME					2	2													
5Ni Steel	7.4.3	Plate	D	QTR	Pulse TIG	In 92	AW	ME							3												
5Ni Steel	7.4.3	Plate	D	QTR	Shielded MIG	Incoweld B-covered	AW	ME							4												
5Ni Steel	7.4.3	Plate	E	QTR				ME	5																		
5Ni Steel	7.4.3	Plate	E	QTR				ME	F1				6														
5Ni Steel	7.4.3	Plate	E	QTR	Pulse MIG	In 92	AW	ME	7																		
5Ni Steel	7.4.3	Plate	G	QTR				ME	8	8																	
5Ni Steel	7.4.3	Plate	G	QTR				ME	F2				9	9													
5Ni Steel	7.4.3	Plate	G	QTR	Pulse MIG	In 92	AW	ME	10																		
5Ni Steel	7.4.3	Plate	G	QTR	Submerged ARC	In 82	AW	ME					11														
5Ni Steel	7.4.3			Annealed														TR	1,F1								
Fe(47.50)Ni	7.4.4			Annealed														TR	1,F1	1,F2	1,F1			1,F1			
Stainless Steel																											
Type 301	8.1.1	Sheet	A	CR (1/2H)				ME	1																		
Type 301	8.1.1	Sheet	A	CR (H)				ME	2,F1		2																
Type 301	8.1.1	Sheet	A	CR (XH)				ME	3	3					4,F2												
Type 301	8.1.1	Sheet	A	CR	TIG	None	AW	ME	4.1																		
Type 301	8.1.1	Sheet	A	CR	TIG	None	AW	ME	4.2																		
Type 301	8.1.1	Sheet	A	CR	TIG	None	AW	ME	4.3																		
Type 301	8.1.1	Sheet	A	Cryostretched, aged				ME	4.4	4.4					F3												
Type 301	8.1.1	Sheet	B	CR (1/4 H)				ME	5		5																
Type 301	8.1.1	Sheet	B	CR (H)				ME	6		6																
Type 301	8.1.1	Sheet	B	CR (XH)				ME	7,F1	7	7																
Type 301	8.1.1	Sheet	B	CR	TIG	None	AW	ME	7.1																		
Type 301	8.1.1	Sheet	C	Cryostretched				ME	7.2	7.2																	
Type 301	8.1.1	Plate	D	Annealed				ME	8		8		9														
Type 301	8.1.1	Plate	E	Unk.	MIG	Type 308	Tempered	ME	9.1		9.1																
Type 301	8.1.1	Sheet	B	Cryostretched, aged				ME							F3												
Type 301	8.1.1			Annealed														TR			1,F1						
Type 303	8.1.7	Bar	F	Annealed				ME	1				2														
Type 303	8.1.7																	TR			1,F1			1,F1			
Type 304	8.1.2	Sheet	A	CR (H)				ME	1,F1	1	1																
Type 304	8.1.2	Sheet	A	CR	TIG	None	AW	ME	1.1																		
Type 304	8.1.2	Sheet	B	Annealed				ME	2,F1		2																
Type 304	8.1.2	Plate	D	Annealed				ME	3,F1			3.1															
Type 304	8.1.2	Plate	G	Annealed				ME																			
Type 304	8.1.2	Plate	H	Annealed				ME																			
Type 304	8.1.2	Bar	E	Annealed				ME	4,F1		4																
Type 304	8.1.2			Annealed														TR	1,F1		1,F2	1,F1		1,F1			
Type 304	8.1.2	Rod	F	Annealed, WO																					MA	1	
Type 304L	8.1.3	Sheet	A	CR				ME	0.1		0.1																
Type 304L	8.1.3	Sheet	A	CR	TIG	None	AW	ME	0.2																		
Type 304L	8.1.3	Sheet	A	CR				ME	0.3																		
Type 304L	8.1.3	Sheet	B	Annealed				ME	1,F1		1																
Type 304L	8.1.3	Sheet	B	CR				ME	1.1																		
Type 304L	8.1.3	Sheet	B	CR				ME	1.2																		
Type 304L	8.1.3	Sheet	B	CR				ME	1.3																		

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Mechanical Properties										Thermal-Electrical Properties										Magnetic Properties	
					Weld Properties			Tensile			Shear SUS G	Impact Charpy V	Fracture Toughness K _{IC} , K _{IE} , J _{IC}	Fatigue da/dN S-N	Dynamic Moduli(b) E, G, B, ρ	C Prop Code	C Thermal Cond.	Magneto- Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto- Resistance	Prop Code	Perm., Suscept		
					Process(i)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop															NTS	
Type 304L	8.1.3	Plate	G	STA				ME																		
Type 304L	8.1.3	Plate	H	Annealed				ME					1.4													
Type 304L	8.1.3	Bar	F	Annealed				ME	2,F1	2						F2,F21										
Type 304L	8.1.3	Rod	F	Annealed																						
Type 304L	8.1.3	Rod	F	Annealed, WQ													TR					1,F1		1,F1		
Type 304L	8.1.3	Rod	F	Annealed, WQ																				MA	1	
Type 310	8.1.4	Sheet	A	CR				ME	0.1		0.1															
Type 310	8.1.4	Sheet	A	CR				ME	0.2		0.2															
Type 310	8.1.4	Sheet	A	CR				ME	0.3	0.3	0.3															
Type 310	8.1.4	Sheet	A	CR	TIG	None	AW	ME	0.4																	
Type 310	8.1.4	Sheet	A	CR				ME	0.5		0.5															
Type 310	8.1.4	Sheet	A	CR				ME	0.6		0.6															
Type 310	8.1.4	Sheet	B	Annealed				ME	1,F1		1					2										
Type 310	8.1.4	Sheet	B	CR (3/4 H)				ME	2.1	2.1																
Type 310	8.1.4	Sheet	B	CR (3/4 H)	TIG	Type 310	AW	ME	2.2	2.2																
Type 310	8.1.4	Plate	E	Annealed				ME	3		3															
Type 310	8.1.4	Plate	E	Unk.	MIG	Type 310	Tempered	ME	3.1		3.1					F3,F4										
Type 310	8.1.4	Plate	G	Annealed				ME	3.2																	
Type 310	8.1.4	Plate	H	Annealed				ME					3.3													
Type 310	8.1.4	Bar	F	Annealed				ME	4,F1	4	4					F2,F2.1										
Type 310	8.1.4	Rod	F	Annealed													TR	1,F1,F2	1,F1		1,F1					
Type 310	8.1.4	Rod	F	Annealed, WQ																				MA	1	
Type 310S	8.1.8	Sheet	B	Annealed				ME	0.1																	
Type 310S	8.1.8	Forging	F	ST, WQ				ME	1		1					F1										
Type 310S	8.1.8	Forging	F	ST, FC				ME	2		2					F1										
Type 310S	8.1.8	Rod	F	Annealed																						
Type 310S	8.1.8	Rod	F	ST, WQ														TR	1,F1				1,F1		1,F1	
Type 310S	8.1.8	Rod	F	ST, FC																				MA	2,F1	
Type 316	8.1.5	Sheet	B	Annealed				ME	1,F1																	
Type 316	8.1.5	Sheet	B	Annealed	TIG	Type 347	AW	ME	1.1																	
Type 316	8.1.5	Plate	E	Annealed				ME	2,F1		2		3													
Type 316	8.1.5	Plate	E	Unk.	MIG	Type 316	Tempered	ME	3.1		3.1					(I)										
Type 316	8.1.5	Plate	G	Annealed																						
Type 316	8.1.5	Bar	F	Annealed				ME	4,F1																	
Type 316	8.1.5	Rod	F	Annealed																						
Type 316	8.1.5	Rod	F	Annealed, WQ													TR					1,F1		1,F1		
Type 316	8.1.5	Rod	F	Annealed, WQ																				MA	1	
Type 321	8.1.6	Sheet	B	Annealed				ME	1,F1	1	1					2										
Type 321	8.1.6	Sheet	B	Annealed	TIG	Unk.	AW	ME	2.1							F2										
Type 321	8.1.6	Plate	D	Annealed				ME	3,F1		3															
Type 321	8.1.6	Bar	F	Annealed				ME	4,F1																	
Type 321	8.1.6	Rod	F	Annealed, WQ																						
Type 321	8.1.6	Bar	F	Annealed																				MA	1	
Type 321	8.1.6	Bar	F	Annealed, WQ																				MA	2	
Type 321	8.1.6	Balls	F	Annealed, WQ																				MA	3	
Type 347	8.1.9	Sheet	A	Annealed				ME	1	1						2,F1										
Type 347	8.1.9	Sheet	B	Annealed				ME	3							4										
Type 347	8.1.9	Plate	D	HR, annealed, pickled				ME	5			6														
Type 347	8.1.9	Plate	E	Annealed, WQ				ME	7		7		7.1													
Type 347	8.1.9	Plate	E	Unk.	MIG	Type 347	Tempered	ME	7.2		7.2															
Type 347	8.1.9	Plate	H	Annealed				ME					8													
Type 347	8.1.9	Bar	F	Annealed				ME	9		9		10													
Type 347	8.1.9	Rod	F	Annealed													TR	1,F1				1,F1		1,F1		
Type 410	8.1.10	Bar	F	Tempered				ME	1				2													
Type 410	8.1.10	Rod	F	Tempered													TR	1,F1				1,F1		1,F1		
Type 416	8.1.11	Bar	F	Tempered				ME	1				2													
Type 416	8.1.11	Rod	F	Tempered																						
A-286	8.2.1	Sheet	A	STA				ME	1,2,F1		1,2															
A-286	8.2.1	Sheet	B	STA				ME	3,4,F1		3,4					5										
A-286	8.2.1	Sheet	B	Annealed	TIG	A-286	AW	ME	5.1																	
A-286	8.2.1	Sheet	B	Annealed	TIG	A-286	Age Hardened	ME	5.2																	

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Material	Mat'l Code	Form	Thickness(t)	Condition(c,d,e)	Mechanical Properties												Thermal-Electrical Properties										Magnetic Properties	
					Weld Properties			Tensile				Shear	Impact	Fracture	Fatigue	Dynamic Moduli(lb)	C	Magneto-Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto-Resistance	Magnetic Moment Perm., Suscept					
					Process(j)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS	SUS G	Charpy V	K _{IC} , K _{IE} , J _{IC}														
																		da/dN	S-N	E, G, B, ρ	Prop Code	Thermal Cond.					Prop Code	
A-286	8.2.1	Sheet	B	Age Hardened	TIG	A-286	AW	ME	5.3							F1.1												
A-286	8.2.1	Sheet	B	STA	TIG	Hastelloy W	AW	ME	5.4																			
A-286	8.2.1	Plate	D	STA				ME				6																
A-286	8.2.1	Bar	F	STA				ME	7.8,F1	8	7.8		9			F3.1												
A-286	8.2.1	Bar	F	CW, aged				ME	9.1	9.1	9.1	9.2	9.2															
A-286	8.2.1	Bar	H	STA				ME	10					11		F4												
A-286	8.2.1	Plate	G					ME								F2												
A-286	8.2.1	Bar	G	STA				ME								F3												
A-286	8.2.1			Annealed																								
A-286	8.2.1			Age Hardened																								
A-286	8.2.1	Rod	F	ST													TR	1,F1				1,F1						
Kromarc-58	8.2.2	Sheet	B	Annealed				ME	1.4,F1		4													MA	F1			
Kromarc-58	8.2.2	Sheet	B	Annealed, CR				ME	2,3,5,F1		5																	
Kromarc-58	8.2.2	Sheet	B	Annealed, CR				ME	6.7		6.7																	
Kromarc-58	8.2.2	Plate	E	ST, WQ				ME	8		8				F2													
Kromarc-58	8.2.2	Plate	E	Cold worked				ME	9		9				F2													
Kromarc-58	8.2.2	Plate	E	Tempered	TIG	Kromarc-58	AW	ME	10		10																	
Kromarc-58	8.2.2	Plate	E	Cold worked	TIG	Kromarc-58	AW	ME	11		11																	
Kromarc-58	8.2.2	Plate	E	Unk.	TIG	Kromarc-58	AW	ME	12		12																	
Kromarc-58	8.2.2			ST, Q																								
Kromarc-58	8.2.2	Rod		ST, Q													TR	1,F1			1,F1	1,F1	1,F1					
Kromarc-58	8.2.2			Cold worked																				MA	1			
Kromarc-58	8.2.2	Rod		Cold worked	TIG		AW																	MA	2			
Kromarc-58	8.2.2	Rod		Cold worked																				MA	3,4,5			
Armco 21-6-9	8.2.3	Plate	G	Double annealed				ME	0.1																			
Armco 21-6-9	8.2.3	Plate	H	Annealed, WQ				ME	1				2															
Armco 21-6-9	8.2.3	Bar	F	Annealed				ME																				
Armco 21-6-9	8.2.3	Sheet and rod		Various												F1												
Armco 22-13-5	8.2.4	Plate	G	Simulated braze				ME	1					2										MA	1			
Armco 22-13-5	8.2.4			Furnace brazed																								
																	TR	1,F1				1,F1						
Titanium and Titanium Alloys																												
Ti-65A	9.1.1	Bar	F	Annealed				ME	1		1																	
Ti-65A	9.1.1	Bar	G	Annealed				ME	2(g)																			
Ti-75A	9.1.2	Sheet	A	Annealed				ME	1,F1		1																	
Titanium	(h)			Annealed																								
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	A	Annealed				ME	1,F1		1						TR	1,F1			1,F1	1,F1,F2	1,F1					
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	A	20% CR				ME	1.1		1.1					F2												
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	A	40% CR				ME	1.2		1.2																	
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	A	50% CR				ME	1.3		1.3																	
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	A	Annealed	TIG	None	AW	ME	1.4																			
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	B	Annealed				ME	2		2																	
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	B	20% CR				ME	2.1		2.1																	
Ti-5Al-2.5Sn(N)	9.2.1	Sheet	B	Annealed	TIG	None	AW	ME	2.2																			
Ti-5Al-2.5Sn(N)	9.2.1	Plate	E	Annealed				ME	2.3		2.3																	
Ti-5Al-2.5Sn(N)	9.2.1	Bar	F	Annealed				ME	3,F1		3,F3		F5			F6												
Ti-5Al-2.5Sn(N)	9.2.1	Bar	F	Annealed				ME			F4			4														
Ti-5Al-2.5Sn(N)	9.2.1	Bar	F	Annealed				ME	5																			
Ti-5Al-2.5Sn(N)	9.2.1	Bar	H	Annealed				ME																				
Ti-5Al-2.5Sn(N)	9.2.1	Forging	H	Vac. annealed				ME	5.2					5.1		F7												
Ti-5Al-2.5Sn(N)	9.2.1	Forging	H	As forged				ME	6,F1		6																	
Ti-5Al-2.5Sn(N)	9.2.1	Forging	H	As forged				ME	7		7																	

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness ⁽¹⁾ Code	Condition ^(c,d,e)	Mechanical Properties										Thermal-Electrical Properties										Magnetic Properties	
					Weld Properties			Tensile			Shear SUS G	Impact Charpy V	Fracture Toughness K _{IC} , K _{IE} , J _{IC}	Fatigue		Dynamic Moduli ^(b) E, G, B, ρ	C Prop Code	C Thermal Cond.	Magneto- Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto- Resistance	Prop Code	Perm., Suscept	
					Process ^(j)	Filler Alloy	Post-Weld ^(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop				NTS	da/dN											S-N
Ti-5Al-2.5Sn(N)	9.2.1	Forging	H	Annealed				ME	8	8	8															
Ti-5Al-2.5Sn(N)	9.2.1			Annealed													TR	1,F1				1,F1	1,F1			
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	A	Annealed				ME	1	1	1															
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	A	Annealed	TIG	None	AW	ME	1.2																	
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	B	Annealed				ME	2	2	2															
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	B	Annealed				ME	F1																	
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	B	Annealed	TIG	Ti-5Al-2.5Sn	AW	ME	3.1	3.1					3											
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	B	Annealed	TIG	None	AW	ME	3.2		3.2															
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	C	Annealed				ME	4	4																
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	C	Annealed				ME						5												
Ti-5Al-2.5Sn(ELI)	9.2.2	Sheet	C	Annealed	TIG	Ti-5Al-2.5Sn	AW	ME	5.1	5.1																
Ti-5Al-2.5Sn(ELI)	9.2.2	Plate	D	Annealed				ME	6	6																
Ti-5Al-2.5Sn(ELI)	9.2.2	Plate	D	Annealed				ME	F1			7														
Ti-5Al-2.5Sn(ELI)	9.2.2	Plate	D	Annealed	TIG	None	AW	ME	7.1																	
Ti-5Al-2.5Sn(ELI)	9.2.2	Plate	E	Annealed				ME	8	8																
Ti-5Al-2.5Sn(ELI)	9.2.2	Plate	E	Annealed	TIG	None	AW	ME	8.1																	
Ti-5Al-2.5Sn(ELI)	9.2.2	Bar	F	Annealed				ME	9	9	9															
Ti-5Al-2.5Sn(ELI)	9.2.2	Bar	F	Annealed				ME	F1																	
Ti-5Al-2.5Sn(ELI)	9.2.2	Forging	F	As forged				ME	11		11				10											
Ti-5Al-2.5Sn(ELI)	9.2.2	Forging	F	As forged				ME	12		12															
Ti-5Al-2.5Sn(ELI)	9.2.2	Forging	F	As forged				ME	13		13															
Ti-5Al-2.5Sn(ELI)	9.2.2	Forging	F	As forged				ME							14											
Ti-5Al-2.5Sn(ELI)	9.2.2	Extrusion		As extruded				ME	15		15															
Ti-6Al-4V(ELI)	9.3.1	Sheet	A	Annealed				ME	1	1	1															
Ti-6Al-4V(ELI)	9.3.1	Sheet	B	Annealed				ME	2,F1		2															
Ti-6Al-4V(ELI)	9.3.1	Sheet	B	STA	TIG	Ti-6Al-4V	AW	ME	2.1																	
Ti-6Al-4V(ELI)	9.3.1	Plate	D	Annealed				ME	3																	
Ti-6Al-4V(ELI)	9.3.1	Plate	D	Annealed				ME						4												
Ti-6Al-4V(ELI)	9.3.1	Plate	D	Annealed	TIG	Ti-6Al-4V(ELI)	AW	ME	4.1																	
Ti-6Al-4V(ELI)	9.3.1	Bar	F	Annealed				ME	5	5																
Ti-6Al-4V(ELI)	9.3.1	Bar	F	Annealed				ME	F1			6														
Ti-6Al-4V(ELI)	9.3.1	Forging	F	Annealed				ME						6.1		F2										
Ti-6Al-4V(ELI)	9.3.1	Forging	E	As forged				ME	7,F1		7												1,F1			
Ti-6Al-4V(ELI)	9.3.1			Annealed													TR	1,F1	1,F1							
Ti-6Al-4V(N)	9.3.2	Sheet	A	STA				ME	1	1																
Ti-6Al-4V(N)	9.3.2	Sheet	A		TIG	Ti-6Al-4V	Stress relieved	ME	2																	
Ti-6Al-4V(N)	9.3.2	Sheet	B	STA				ME	3	3	3															
Ti-6Al-4V(N)	9.3.2	Sheet	B	Annealed	TIG	Ti-6Al-4V	AW	ME	4																	
Ti-6Al-4V(N)	9.3.2	Sheet	B	STA	TIG	Ti-6Al-4V	Stress relieved	ME	5																	
Ti-6Al-4V(N)	9.3.2	Plate	D	Annealed				ME	6																	
Ti-6Al-4V(N)	9.3.2	Plate	D	STA				ME	7	7																
Ti-6Al-4V(N)	9.3.2	Plate	D	Stress relieved	TIG	Ti-6Al-4V	Air relieved	ME	8																	
Ti-6Al-4V(N)	9.3.2	Plate	E	STA				ME	9																	
Ti-6Al-4V(N)	9.3.2	Bar	F	Annealed				ME	10		10															
Ti-6Al-4V(N)	9.3.2	Forging	F	Annealed				ME	11	11	11															
Ti-6Al-4V(N)	9.3.2			Annealed													TR	1,F1					1,F1			
Special Metals Niobium*	10.1.1																TR	1,F1				F3,F4 1,F1,F2	1,F1			
Nb ₃ Sn	10.1.2																TR	1,F1,F2								
Nb-0.2Zr	10.1.3																TR	1,F1,F2								
Nb-2Zr	10.1.3																TR	2,F3,F4								
Ti-7Nb	10.1.4	Bar	F	Annealed				ME	1		1															
Ti-11Nb	10.1.4	Bar	F	Annealed				ME	2		2															
Nb-Ti-Zr	10.1.4							ME	3,4																	
Nb-35Ti(+Zr)	10.1.4	Wire						ME	5																	
Ti-Nb(to 4% Nb)	10.1.4							ME	F1																	
Ti-9Nb	10.1.4																TR		1,F1							
Ti-18Nb	10.1.4																TR		2,F2							

TABLE 3.2 INDEX TO METALS AND ALLOYS, FORMS, THICKNESSES, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form	Thickness(l) Code	Condition(c,d,e)	Mechanical Properties												Thermal-Electrical Properties							Magnetic Properties																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
					Weld Properties			Tensile			Shear	Impact	Fracture	Fatigue		Dynamic	C Thermal Cond.	C Magneto- Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	MR Magneto- Resistance	Magnetic Moment Prop Code	Perm., Suscept																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																			
					Process(j)	Filler Alloy	Post-Weld(k) Treatment	Prop Code	Ultimate Prop	Elastic Prop	NTS	SUS G	Charpy V	Toughness K _{IC} , K _{IE} , J _{IC}	da/dN	S-N									Moduli(lb) E, G, B, ρ																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																		
Ti-26Nb	10.1.4																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																																										</

- (a) Numbers containing an "F" prefix refer to figure numbers; others refer to table numbers. Each table or figure number contains the material code followed by property code and table or figure number.
 The figure numbers for thermal-electrical properties contain a C (thermal or magneto-thermal conductivity), E (thermal expansion), S (specific heat), or R (electrical resistivity) following the material code.
- (b) Young's, shear, bulk moduli and Poisson's ratio, respectively.
- (c) HR = hot rolled; CR = cold rolled; CD = cold drawn.
- (d) STA = solution treated and aged; STDA = solution treated + double aged; HIP = hot isostatic pressed; FC = furnace cooled.
- (e) Q+T = quenched and tempered; 2N+T = double normalized and tempered; WQ = water quenched; QTR = quenched, tempered, + reversion annealed; Unk. = unknown.
- (f) See Figure 8.1.4 - ME 3.
- (g) See Figure 9.1.2 - ME 1.
- (h) Exact compositions include both Ti-65A (9.1.1) and Ti-75A (9.1.2); data in handbook are on sequence of pages designated 9.1.2.
- (i) See Figure 9.2.1 - ME 6.
- (j) Weld Process: MIG = gas metal ARC welding; TIG = gas tungsten ARC welding; EB = electron beam welding.
- (k) Post-Weld Treatment: AW = tested as welded; HT = heat treated; A = aged.
- (l) Thickness codes: (pick up attached sheet)

TABLE 3.3 INDEX TO POLYMERS, FORMS, CONDITIONS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISED EDITION

Material	Mat'l Code	Form ^(b)	Condition	Mechanical Properties										Thermal-Electrical Properties						Magnetic Properties		
				Prop. Code	Tensile			Compress. CUS, E _c	Shear SUS, G	Impact Charpy V	Fracture Toughness K _{IC} , K _{IC} , J _{IC}	Dynamic		Prop. Code	C Thermal Cond.	C Magneto-Thermal Cond.	E Thermal Expansion	S Specific Heat	R Electrical Resistivity	Prop. Code	Magnetic Moment	Perm. or Suscept.
					Ultimate Prop.	Elastic Props.	NTS					Fatigue da/dN	S-N									
Polymers ^(a)			Crystallinity, %							Izod												
PE-	12.1.1	Am	—											TR			1,F1	1,F1				
PCTFE	12.1.2	xt	37.6-40.0	ME	1	1			1													
PCTFE	12.1.2	xt	52.6-55.0	ME	2	2			2													
PCTFE	12.1.2	xt	57.6-60.0	ME						3												
PCTFE	12.1.2	xt	67.6-70.0	ME	4	4			4	5												
PCTFE	12.1.2	Am												TR	1,F1		1,F1	1,F1				
PTFE	12.1.3	xt	47.6-50.0	ME	1	1		1	2													
PTFE	12.1.3	xt	50.1-52.5	ME	3	3			4	4												
PTFE	12.1.3	xt	55.1-57.5	ME				5														
PTFE	12.1.3	xt	57.6-60.0	ME	6	6																
PTFE	12.1.3	xt	65.1-67.5	ME	7	7			8													
PTFE	12.1.3	xt	67.6-70.0	ME	9			9														
PTFE	12.1.3	xt	70.1-72.5	ME						10												
PTFE	12.1.3	Am	—											TR	1,F1		1,F1	1,F1		MA		1
PMM	12.2.1	Am												TR	1,F1		1,F1	1,F1				
PS	12.3.1	Am													1,F1		1,F1					
PVA	12.4.1	Am												TR	1,F1							

(a) PCTFE = polychlorotrifluoroethylene; PTFE = polytetrafluoroethylene; PE = polyethylene; PMM = polymethylmethacrylate; PS = polystyrene.

(b) xt = crystalline; Am = amorphous.

TABLE 3.4 INDEX TO COMPOSITES, LAYUPS, AND PROPERTIES FOR DATA REPORTED IN THIRD REVISION EDITION

Mechanical Properties																							Thermal-Electrical Properties				
Material	Mat'l Code	Lay Up	Prop Code	Tensile ^(a)								Compression ^(b)			Shear ^(c)			Impact Charpy, IZOD	Fatigue ^(d) S-N	Prop Code	Thermal Conductivity	Thermal Expansion	Specific Heat	Electrical Resistivity			
				TUS	E ₁	SE ₁	E ₂	TPL	Failure Strain	Poisson's Ratio	NTS	CUS	CPL	E	SUS	SPL	G										
Composites	11.0.0																										
Glass Epoxy	11.1.0																										
181/EPON 828	11.1.1	Cloth	ME	1	1	1	1																				
181/EPON 828	11.1.1	Cloth	ME																								
181/EPON 828	11.1.1	Cloth																									
1581/E-787(58-68R)	11.1.2	Cloth	ME	1	1																						
1581/E-787(58-68R)	11.1.2	Cloth	ME																								
1581/E-787(58-68R)	11.1.2	Cloth																									
S-901/NASA Resin 2	11.1.3	Tape	ME	1	1			1	1	1																	
S-901/NASA Resin 2	11.1.3	Tape																									
Boron-Epoxy	11.2.0																										
4 Mil B/2387	11.2.1	Tape	ME	1		1		1	1	1																	
4 Mil B/2387	11.2.1	Tape																									
5.6 Mil B/2387	11.2.2	Tape	ME	1	1			1	1	1																	
5.6 Mil B/2387	11.2.2	Tape																									
Graphite-Epoxy	11.3.0																										
AS/NASA Resin 2	11.3.1	Tape	ME	1	1			1	1	1																	
HT-S/X-904	11.3.2	Tape	ME	1	1																						
HT-S/X-904	11.3.2	Tape																									
Boron-Aluminum	11.4.0																										
5.6 Mil B/6061	11.4.1	Tape	ME	1	1			1	1	1																	
5.6 Mil B/6061	11.4.1	Tape																									

- (a) TUS = tensile ultimate strength
 E₁ = initial Young's modulus
 SE₁ = strength at transition between E₁ and E₂
 E₂ = secondary Young's modulus
 TPL = tensile proportional limit
 NTS = notched tensile strength
 (b) CUS = compressive ultimate strength
 CPL = compressive proportional limit
 E = elastic modulus
 (c) SUS = shear ultimate strength
 SPL = shear proportional limit
 G = shear modulus
 (d) S-N Curves = plots of stress against number of cycles to failure on testing

**INDEX TO MATERIAL CODES FOR
SECTION 4.0**

ALUMINUM AND ALUMINUM ALLOYS

<u>MATERIALS</u>	<u>MATERIAL CODE</u>
ALUMINUM	4.1.1
1099	4.1.4
1100	4.1.4
2014	4.2.1
2024	4.2.3
2219	4.2.2
5083	4.3.1
5456	4.3.2
6061	4.4.1
7005	4.5.2
7006	4.5.3
7039	4.5.1

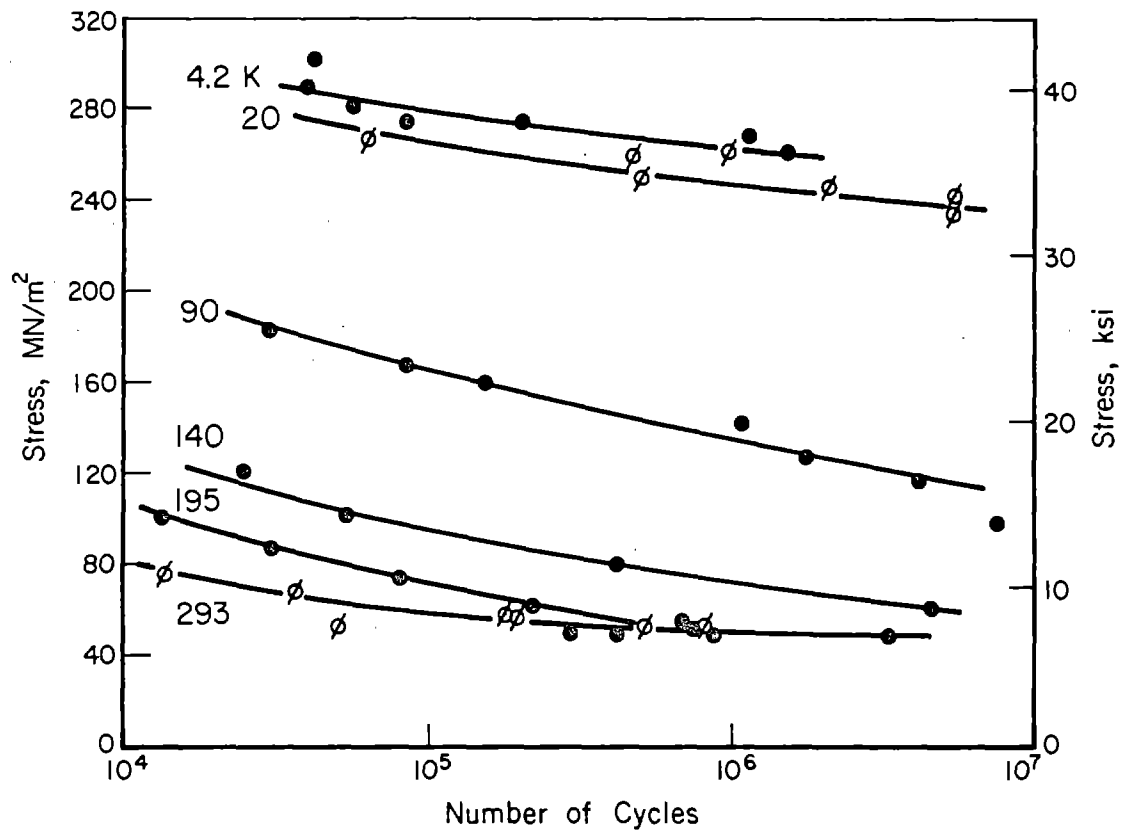


FIGURE 4.1.1-ME0.1. FATIGUE LIFE CURVES FOR AXIAL LOADING ON SPECIMENS OF 99.99% ALUMINUM ROD 0.160 cm (0.056 in.) DIAMETER AT CYCLE FREQUENCIES OF 225 HERTZ AT R = -1 [90214]

TABLE 4.1.1-TR1

Al

Alloy Designation: Aluminum

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity⁽¹⁾						
RRR-30000 Watts m ⁻¹ K ⁻¹	236 (136)	302	1230	14000	59500	96400
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(136)	(175)	(711)	(8090)	(34400)	(55700)
RRR-10000 Watts m ⁻¹ K ⁻¹	236 (136)	302 (175)	1230 (711)	13200 (7630)	39000 (22500)	36500 (21100)
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(136)	(175)	(711)	(6420)	(11000)	(6710)
RRR-3000 Watts m ⁻¹ K ⁻¹	236 (136)	302 (175)	1230 (711)	11100 (6420)	19100 (11000)	11600 (6710)
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(136)	(175)	(711)	(4060)	(4710)	(2290)
RRR-1000 Watts m ⁻¹ K ⁻¹	236 (136)	301 (174)	1210 (700)	7020 (4060)	8150 (4710)	3960 (2290)
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(136)	(173)	(659)	(2060)	(1600)	(694)
RRR-300 Watts m ⁻¹ K ⁻¹	235 (136)	299 (173)	1140 (659)	3570 (2060)	2770 (1600)	1200 (694)
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(136)	(169)	(532)	(902)	(557)	(230)
RRR-100 Watts m ⁻¹ K ⁻¹	234 (135)	293 (169)	920 (532)	1560 (902)	963 (557)	398 (230)
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(135)	(169)	(532)	(902)	(557)	(230)
No. of Spec.						
References: 90170, 90224						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.325	-0.361	-0.368	-0.368	-0.368
No. of Spec.	5	5	6	6	2	2
References: 40911, 48571, 90208, 90458, 90323, 90366						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	860	480	142	8.8	1.5	0.33
Btu lb ⁻¹ F ⁻¹	(0.206)	(0.115)	(0.0339)	(0.00210)	(0.00036)	(0.000079)
No. of Spec.	3	3	3	2	4	5
References: 49011, 42219, 90223, 90328						
Electrical Resistivity⁽¹⁾						
RRR-30000 Ohm m	2.43 x 10 ⁻⁸	4.60 x 10 ⁻⁹	4.96 x 10 ⁻¹⁰	7.02 x 10 ⁻¹²	1.00 x 10 ⁻¹²	8.15 x 10 ⁻¹³
Ohm circular mil ft ⁻¹	(14.6)	(2.77)	(2.98 x 10 ⁻¹)	(4.31 x 10 ⁻³)	(6.02 x 10 ⁻⁴)	(4.90 x 10 ⁻⁴)
RRR-10000 Ohm m	2.43 x 10 ⁻⁸	4.60 x 10 ⁻⁹	4.97 x 10 ⁻¹⁰	8.64 x 10 ⁻¹²	2.62 x 10 ⁻¹²	2.43 x 10 ⁻¹²
Ohm circular mil ft ⁻¹	(14.6)	(2.77)	(2.99 x 10 ⁻¹)	(5.20 x 10 ⁻³)	(1.58 x 10 ⁻³)	(1.46 x 10 ⁻³)
RRR-3000 Ohm m	2.43 x 10 ⁻⁸	4.61 x 10 ⁻⁹	5.03 x 10 ⁻¹⁰	1.43 x 10 ⁻¹¹	8.29 x 10 ⁻¹²	8.10 x 10 ⁻¹²
Ohm circular mil ft ⁻¹	(14.6)	(2.77)	(3.03 x 10 ⁻¹)	(8.60 x 10 ⁻³)	(4.99 x 10 ⁻³)	(4.87 x 10 ⁻³)
RRR-1000 Ohm m	2.43 x 10 ⁻⁸	4.63 x 10 ⁻⁹	5.19 x 10 ⁻¹⁰	3.05 x 10 ⁻¹¹	2.45 x 10 ⁻¹¹	2.43 x 10 ⁻¹¹
Ohm circular mil ft ⁻¹	(14.6)	(2.78)	(3.12 x 10 ⁻¹)	(1.83 x 10 ⁻²)	(1.47 x 10 ⁻²)	(1.46 x 10 ⁻²)
RRR-300 Ohm m	2.44 x 10 ⁻⁸	4.68 x 10 ⁻⁹	5.76 x 10 ⁻¹⁰	8.74 x 10 ⁻¹¹	8.14 x 10 ⁻¹¹	8.12 x 10 ⁻¹¹
Ohm circular mil ft ⁻¹	(14.7)	(2.82)	(3.46 x 10 ⁻¹)	(5.26 x 10 ⁻²)	(4.90 x 10 ⁻²)	(4.88 x 10 ⁻²)
RRR-100 Ohm m	2.45 x 10 ⁻⁸	4.85 x 10 ⁻⁹	7.40 x 10 ⁻¹⁰	2.52 x 10 ⁻¹⁰	2.45 x 10 ⁻¹⁰	2.45 x 10 ⁻¹⁰
Ohm circular mil ft ⁻¹	(14.7)	(2.92)	(4.45 x 10 ⁻¹)	(1.52 x 10 ⁻¹)	(1.47 x 10 ⁻¹)	(1.47 x 10 ⁻¹)
No. of Spec.						
References: 90178, 90209, 90224, 96886						

(1) Interpolated from numerous data using theoretical correlations.

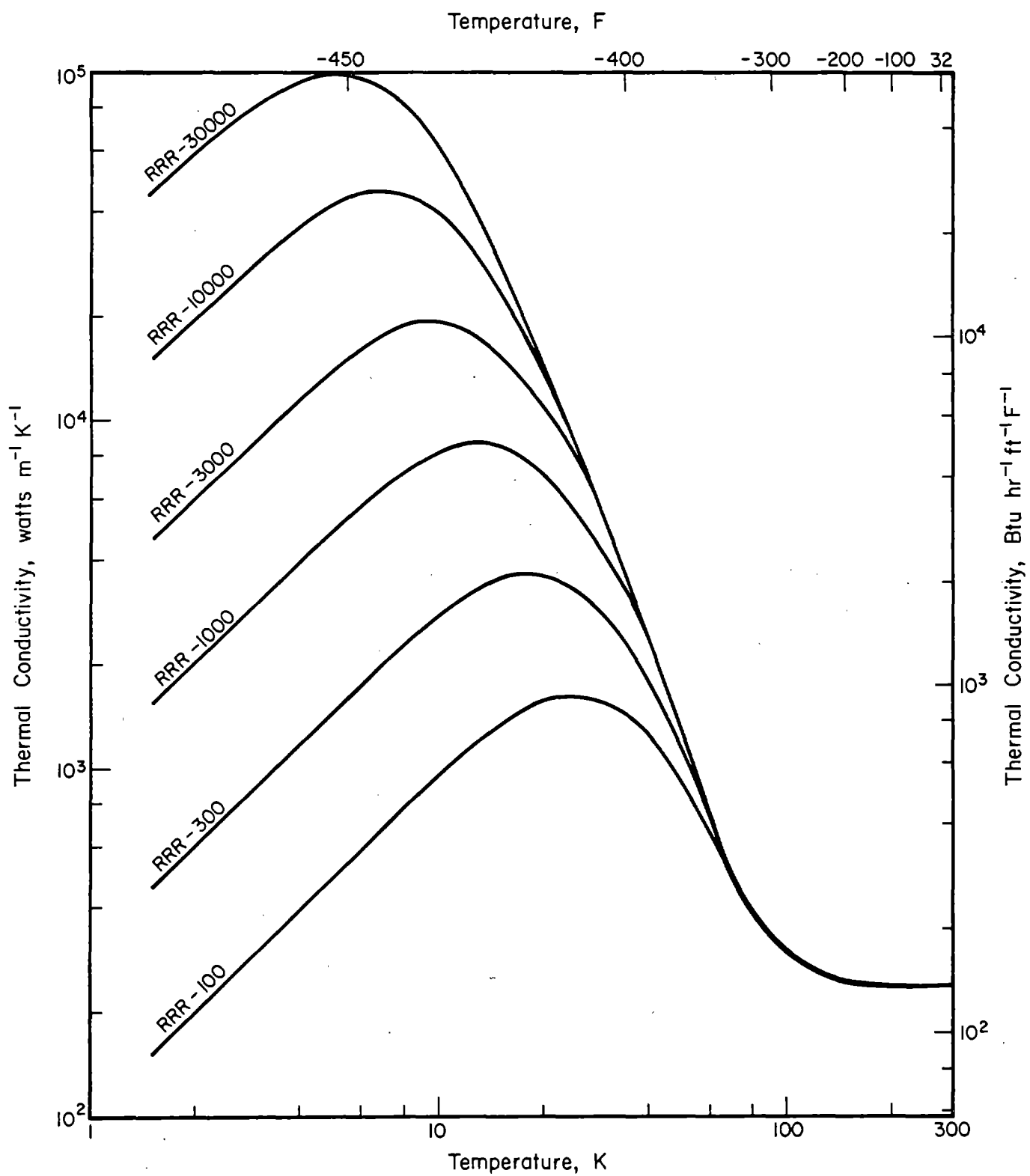


FIGURE 4.1.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM

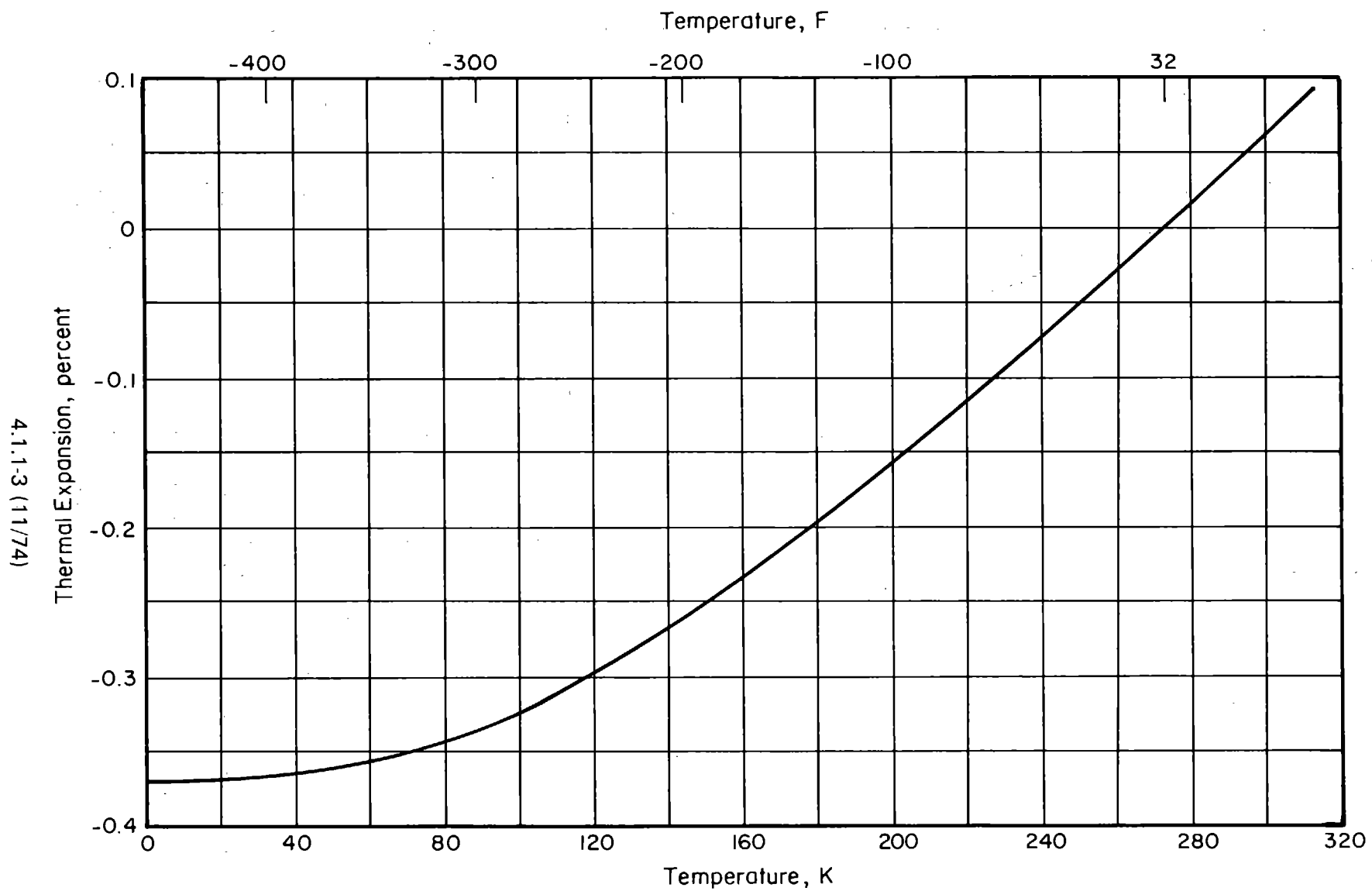


FIGURE 4.1.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM

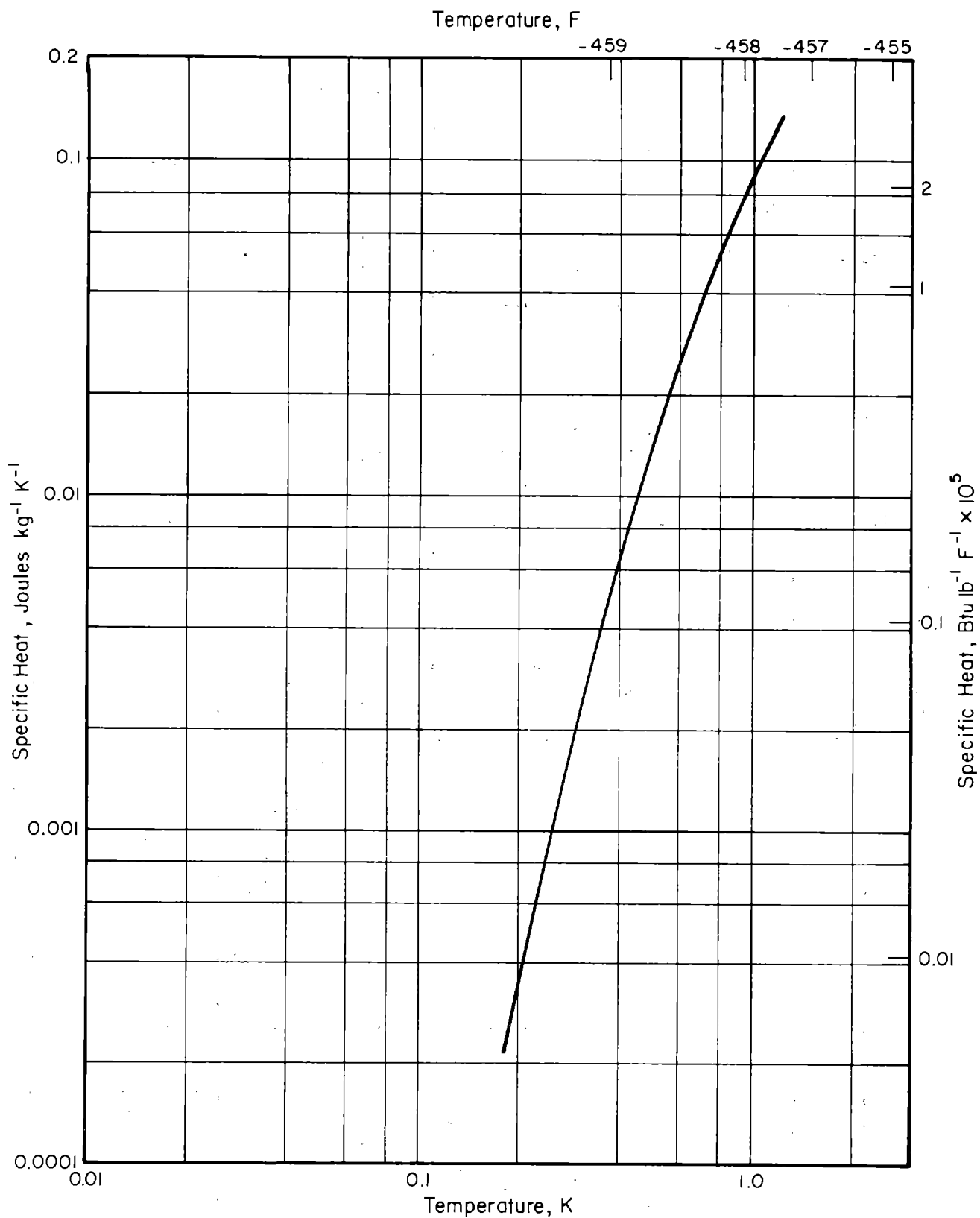


FIGURE 4.1.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR ALUMINUM - SUPERCONDUCTING STATE

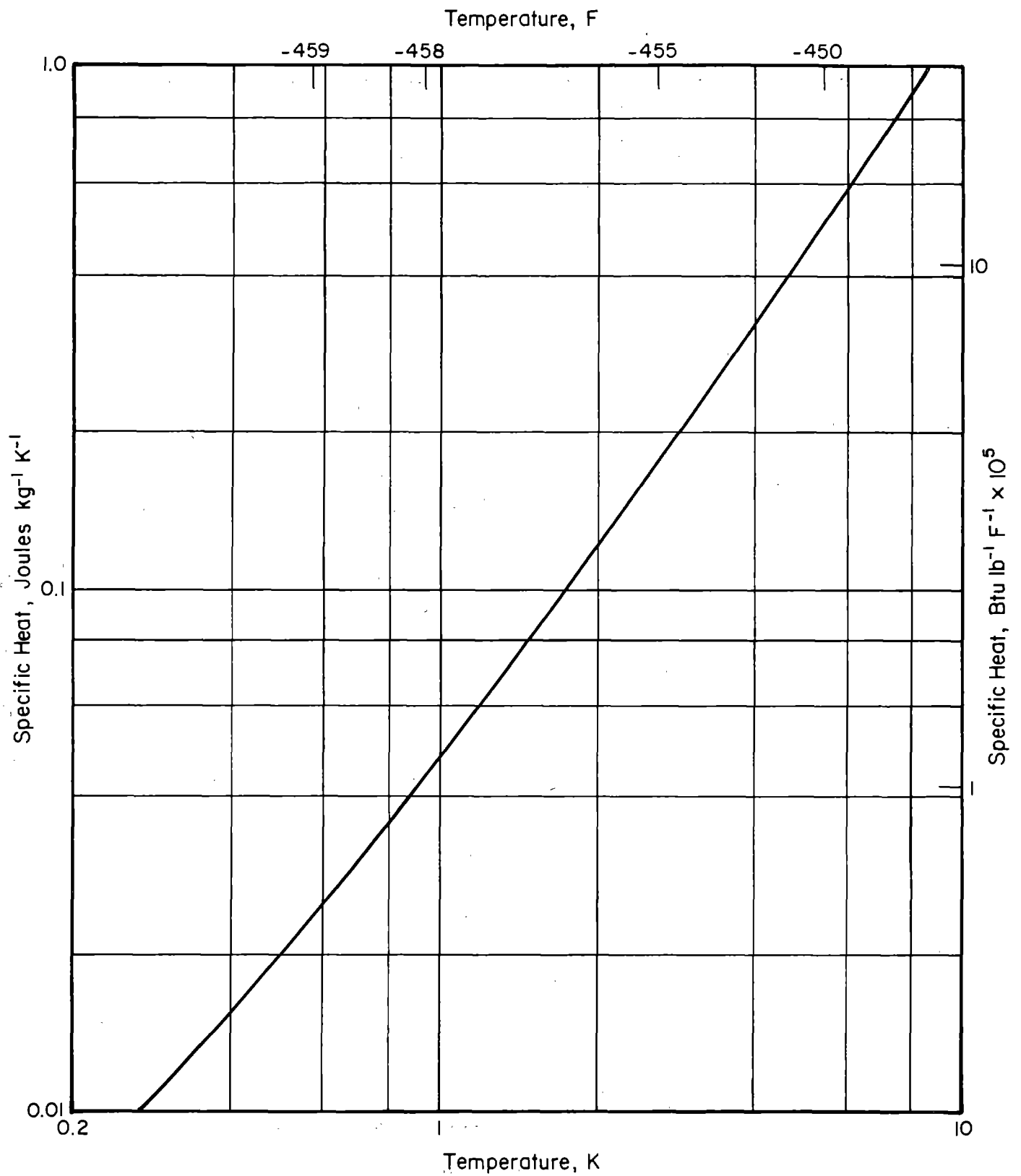


FIGURE 4.1.1-S2. SPECIFIC HEAT VERSUS TEMPERATURE
FOR ALUMINUM - NORMAL STATE

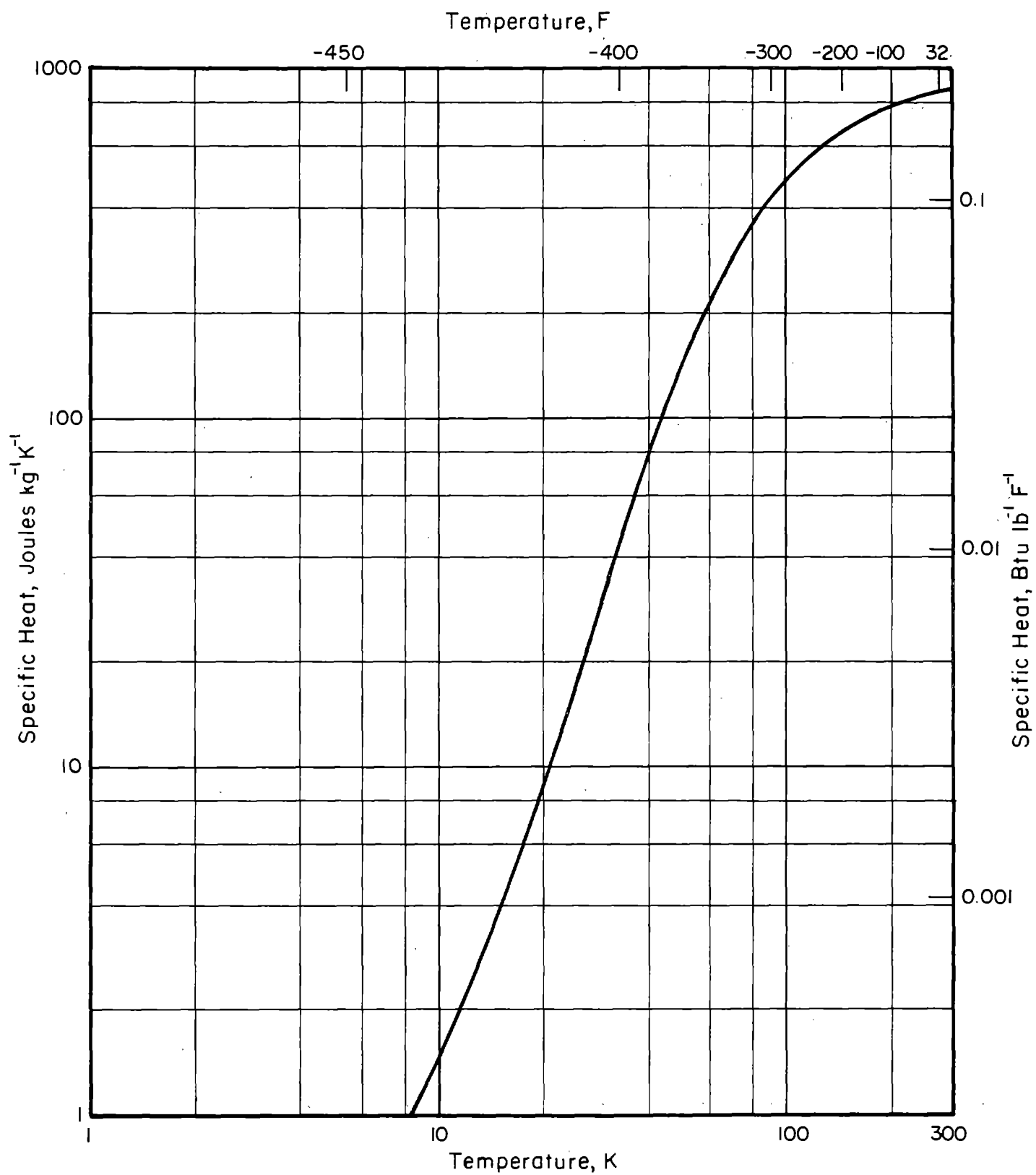


FIGURE 4.1.1-S3. SPECIFIC HEAT VERSUS TEMPERATURE FOR ALUMINUM

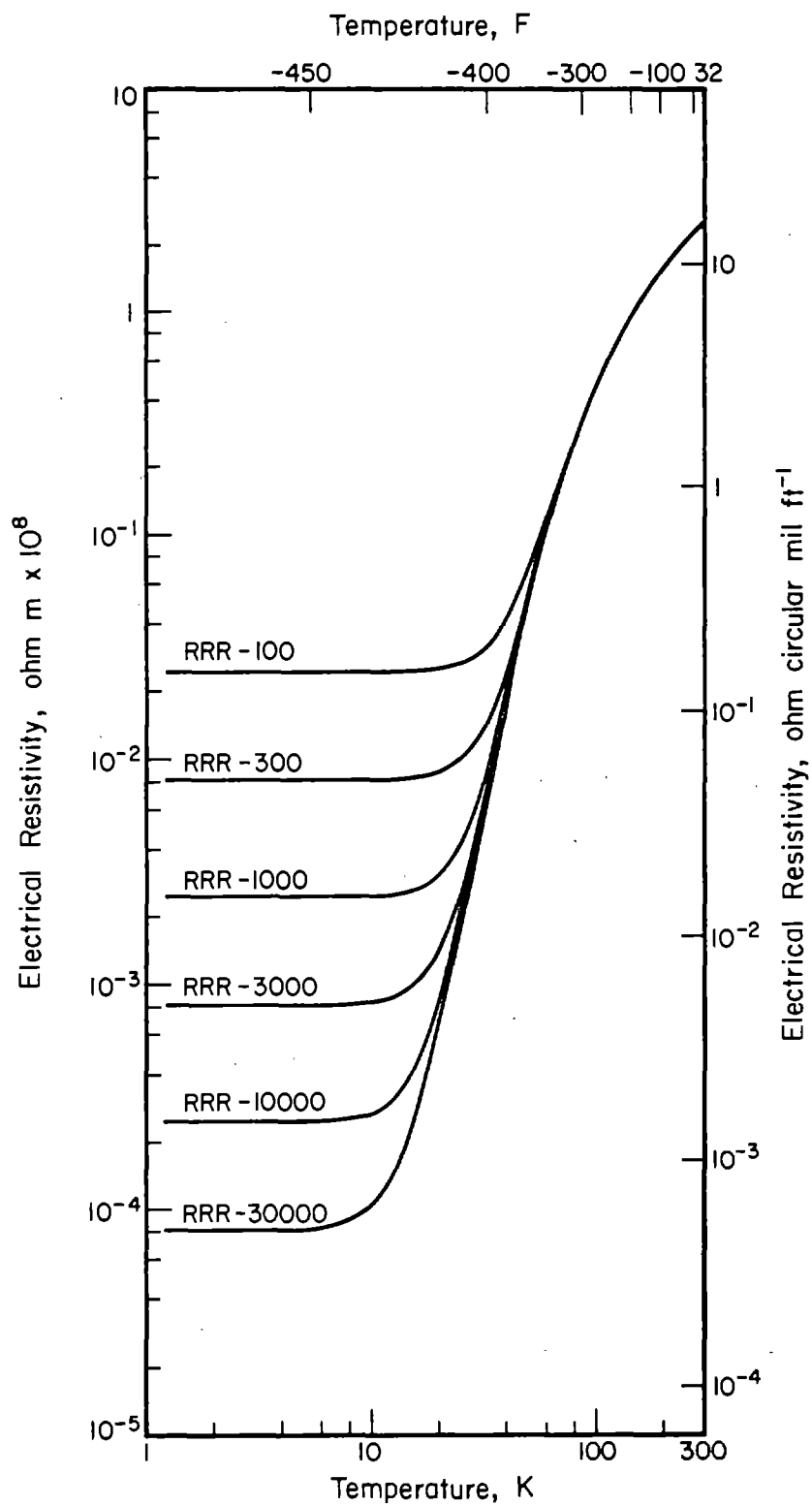


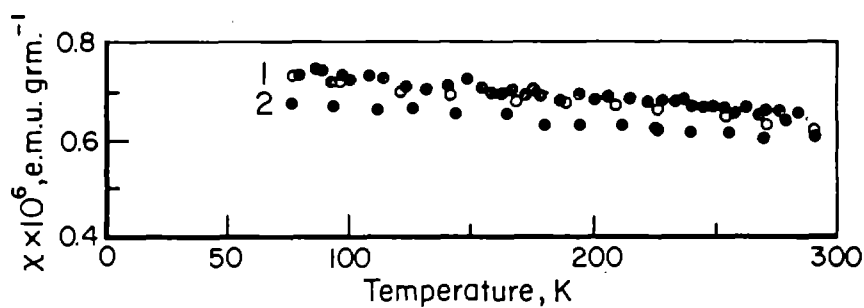
FIGURE 4.1.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM

TABLE 4.1.1—MA1

Alloy Designation: High-Purity Aluminum

Specification: Impurities, ppm: 30Mg, 5Fe, 3Si, 2Cd, 1Cu, 1Na, 1Ag
 Form: Cylindrical rod
 Diameter, cm (in.): 0.4 (0.0157)
 Condition: Argon arc melted, vacuum homogenized at a temperature just below the solidus for about 7 days and quenched in ice water. Machined specimens were vacuum strain annealed for about 24 hours.

The temperature dependence of the magnetic susceptibilities (χ) of pure aluminum and an aluminum-silicon alloy is shown in the figure.



(a)

- : Pure aluminum, Taylor (1961).
- 1. ● : Pure aluminum.
- 2. ● : Aluminum + 0.85% silicon.

Reference: 90493

TABLE 4.1.4—ME1

Alloy Designation: 1099-H14 Aluminum

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: H14

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	91.0 (13.2)	102 (14.8)	159 (23.1)	289 (41.9)	332 (48.1)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	86.2 (12.5)	86.9 (12.6)	98.6 (14.3)	106 (15.4)	130 (18.9)	
	Min						
Std. Deviation							
Elong, percent	Avg	22.6	38.4	57.2	60.5	46.7	
	Min						
RA, percent	Avg	84	83	81	79	56	
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 72563

TABLE 7.1.4-ME1.1

1100-H112
Plate-Weld Metal

Alloy Designation: 1100-Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 1100 Al filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate: H112; weld metal tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	80.0 (11.6)		157 (22.8)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	42 (6.1)		55 (8.0)			
	Min						
Std. Deviation							
Elong, percent	Avg	26.5		31.0			
	Min						
RA, percent	Avg	5.0		9.0			
	Min						
No. of Spec. (No. of Heats)		1		1			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	123 (17.8)		222 (32.2)			
K _t = 16	Min						
No. of Spec. (No. of Heats)		1		1			
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 63362

TABLE 4.1.4—ME2

Alloy Designation: 1100-O Aluminum

Specification:

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Annealed (O) (ASTM Grain size 3.5)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	93.1 (13.5)	114 (16.5)	191 (27.7)	328 (47.6)		
	Min	92.4 (13.4)	111 (16.1)	188 (27.3)	327 (47.4)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	48 (6.9)	50 (7.2)	62 (9.0)	65 (9.4)		
	Min	45 (6.5)	49 (7.1)	61 (8.9)	64 (9.3)		
Std. Deviation							
Elong, percent	Avg	45.9	50.0	56.4	54.2		
	Min	44.1	47.4	55.8	52.6		
RA, percent	Avg	88.4	85.6	81.2	60.0		
	Min	86.8	85.6	79.7	57.8		
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 54986

TABLE 4.1.4—ME3

Alloy Designation: 1100-0 Aluminum

Specification:

Form: Rod

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Annealed (0) 620 K (650 F), FC

Testing Temperature, K (F)		297 (75)	200 (-103)	100 (-280)	"0" (-460)		
Compression, Longitudinal							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear^(a)							
SUS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Dynamic Modul:							
E, GN/m ² (10 ⁶ psi)	Avg	69.4 (10.1)	72.8 (10.6)	75.8 (11.0)	76.9 (11.2)		
	Min						
G, GN/m ² (10 ⁶ psi)	Avg	25.9 (3.76)	27.3 (3.96)	28.5 (4.13)	28.9 (4.14)		
	Min						
B, GN/m ² (10 ⁶ psi)	Avg	72.4 (10.5)	73.8 (10.7)	74.9 (10.9)	75.1 (10.9)		
	Min						
Poisson's Ratio	Avg	0.340	0.336	0.331	0.329		
	Min						
No. of Spec.		1	1	1	1		
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness^(b)							
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg						
(From PTSC spec.)(—)Min							
No. of Spec. (No. of Heats)							

References: 94206C

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

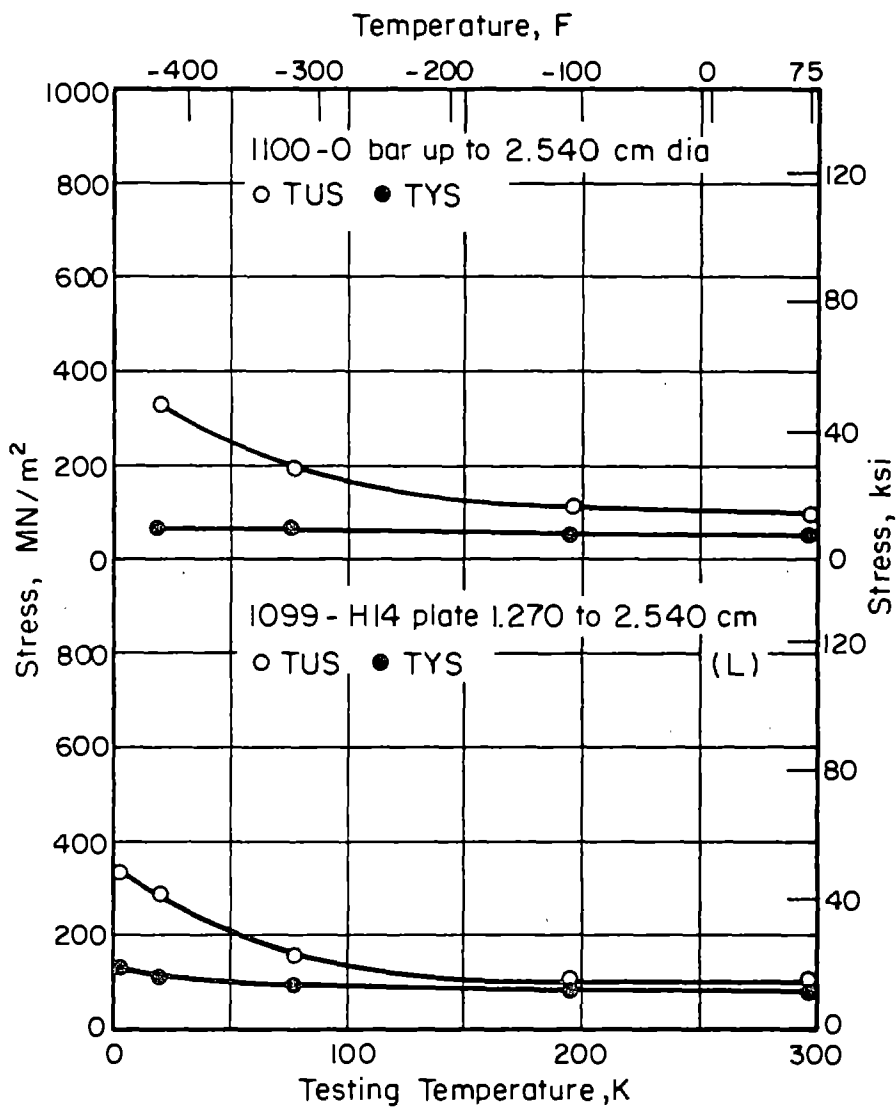


FIGURE 4.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF UNALLOYED ALUMINUM

TABLE 4.1.4-TR1

AL

Alloy Designation: Aluminum 1100-0

Specification:

Form:

Dimension:

Condition: Annealed (0)

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
RRR-32.6 Watts m ⁻¹ K ⁻¹	225*	310*	520*	493	270	117
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(130)*	(179)*	(301)*			
RRR-14 Watts m ⁻¹ K ⁻¹	205	228	315	225	113	45
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(119)	(132)	(182)	(130)	(65)	(26.0)
No. of Spec.	1	2	2	3	3	3
References: 90111, 90225, 96888						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.315	-0.355	-0.364		
No. of Spec.	1	1	1	1		
References: 48134						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
RRR-32.6 Ohm m	2.67 x 10 ⁻⁸	5.10 x 10 ⁻⁹	1.70 x 10 ⁻⁹	8.40 x 10 ⁻¹⁰	8.20 x 10 ⁻¹⁰	8.20 x 10 ⁻¹⁰
Ohm circular mil ft ⁻¹	(16.1)	(3.07)	(1.02)	(0.505)	(0.493)	(0.493)
RRR-14 Ohm m	2.80 x 10 ⁻⁸	6.43 x 10 ⁻⁹	2.87 x 10 ⁻⁹	2.11 x 10 ⁻⁹	2.03 x 10 ⁻⁹	2.00 x 10 ⁻⁹
Ohm circular mil ft ⁻¹	(16.8)	(3.87)	(1.73)	(1.27)	(1.22)	(1.20)
No. of Spec.	2	2	2	2	2	2
References: 79561, 90111						
Magnetothermal Conductivity						
RRR-32.6	H					
	tesla					
Watts m ⁻¹ K ⁻¹	0	225*	310*	520*	493	270
Btu hr ⁻¹ ft ⁻¹ F ⁻¹		(130)*	(179)*	(301)*	(285)	(156)
Watts m ⁻¹ K ⁻¹	1	224*	260*	340*	377	247
Btu hr ⁻¹ ft ⁻¹ F ⁻¹		(130)*	(150)*	(196)*	(218)	(143)
Watts m ⁻¹ K ⁻¹	4	222*	240*	275*	273	215
Btu hr ⁻¹ ft ⁻¹ F ⁻¹		(128)*	(139)*	(159)*	(158)	(124)
Watts m ⁻¹ K ⁻¹	8	220*	230*	240*	243	198
Btu hr ⁻¹ ft ⁻¹ F ⁻¹		(127)*	(133)*	(139)*	(141)	(114)
No. of Spec.	--	--	--	1	1	1
References: 96888						

* Extrapolated and Interpolated.

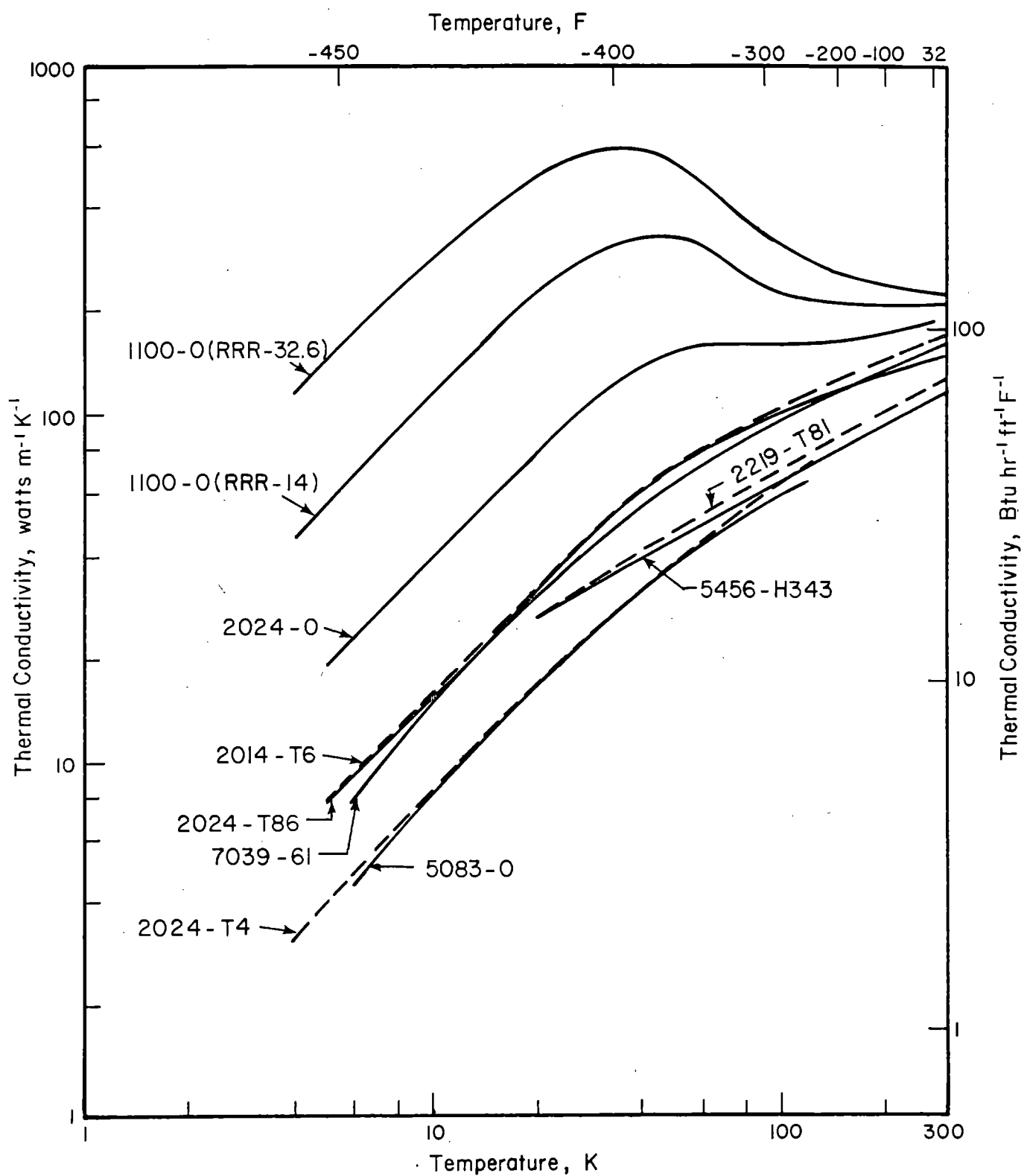


FIGURE 4.1.4-C0.1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOYS

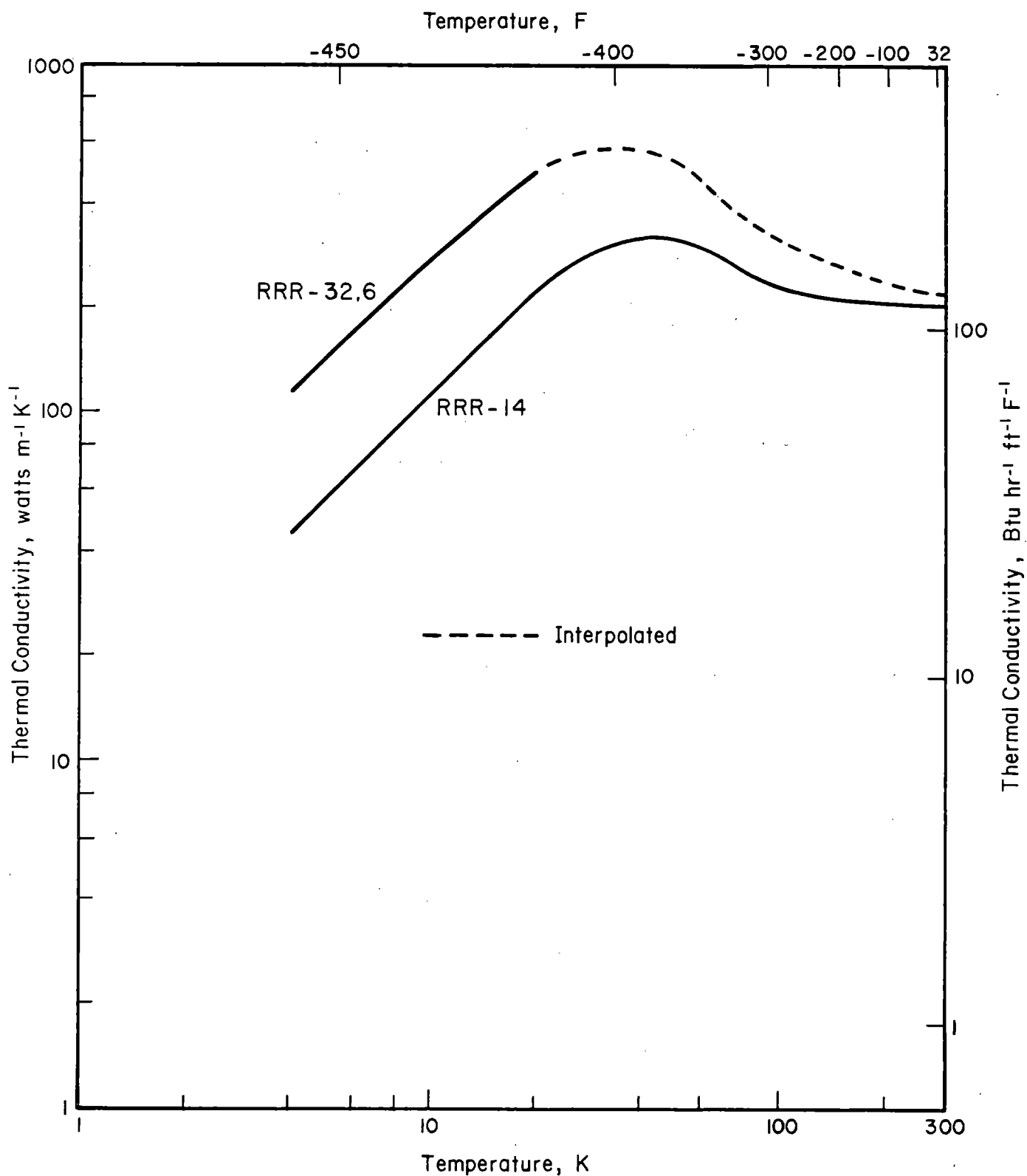


FIGURE 4.1.4-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 1100-0

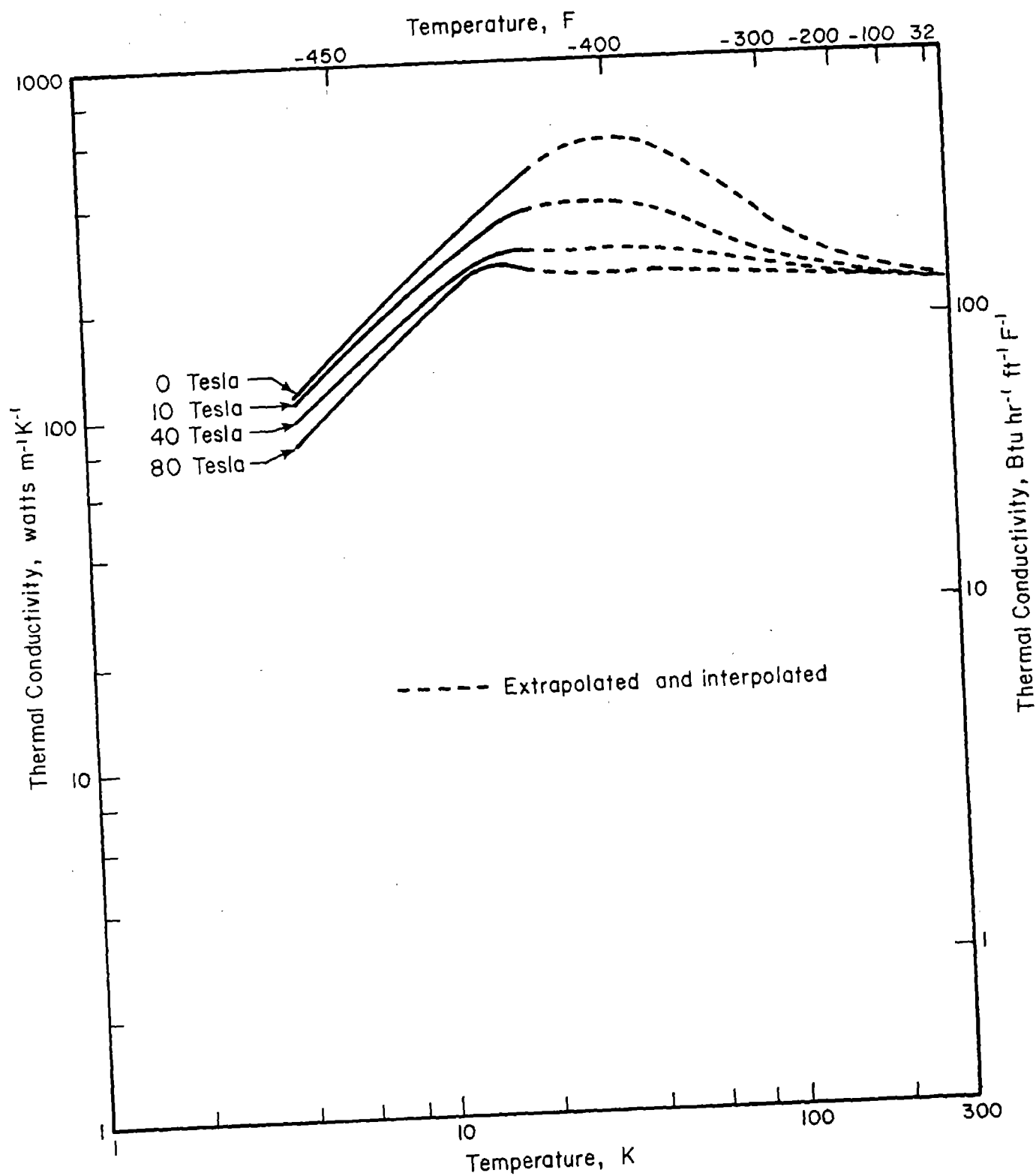


FIGURE 4.1.4-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 1100-0 AT SEVERAL MAGNETIC FIELD STRENGTHS (RRR-32.6)

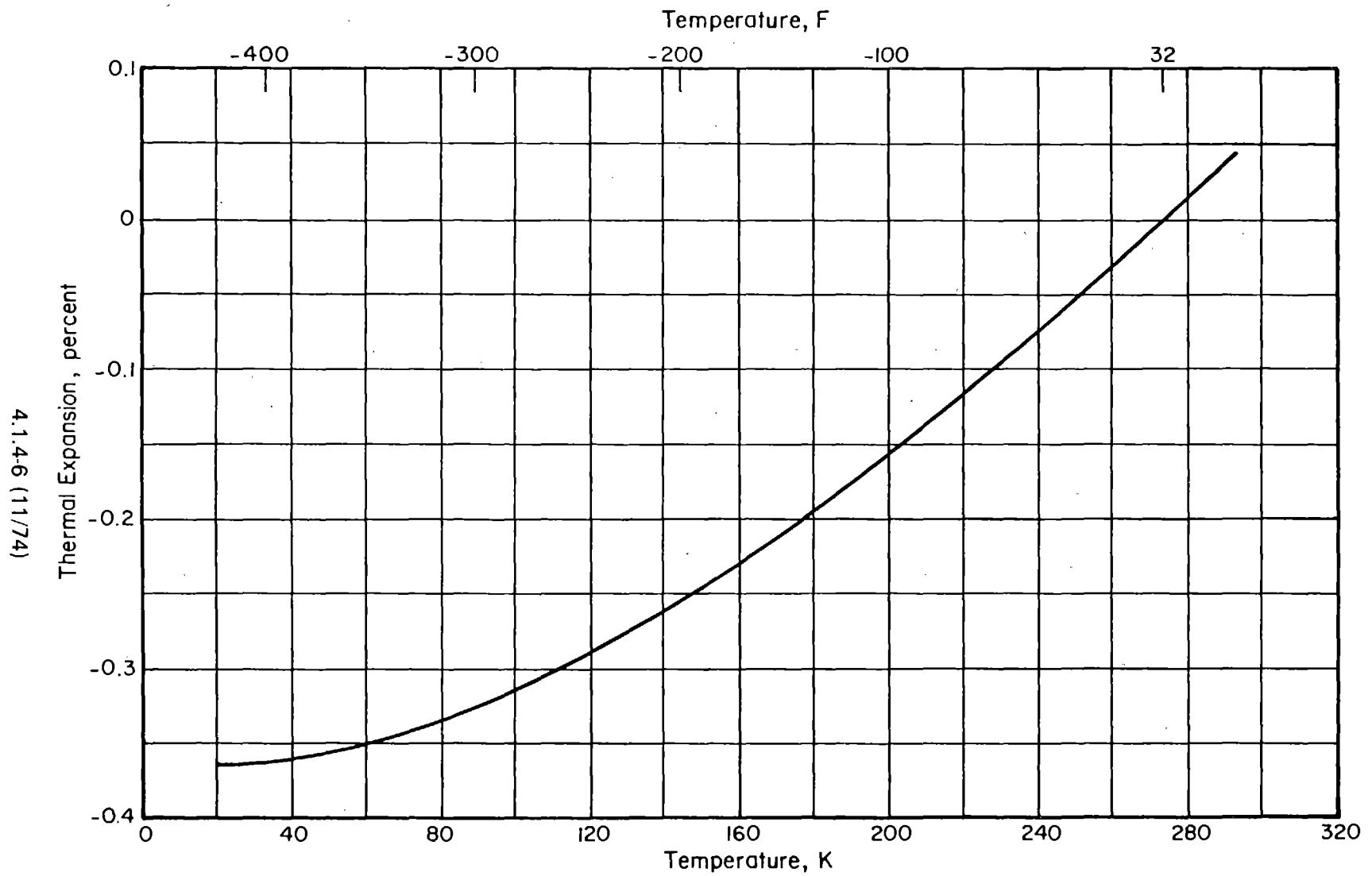


FIGURE 4.1.4-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 1100-0

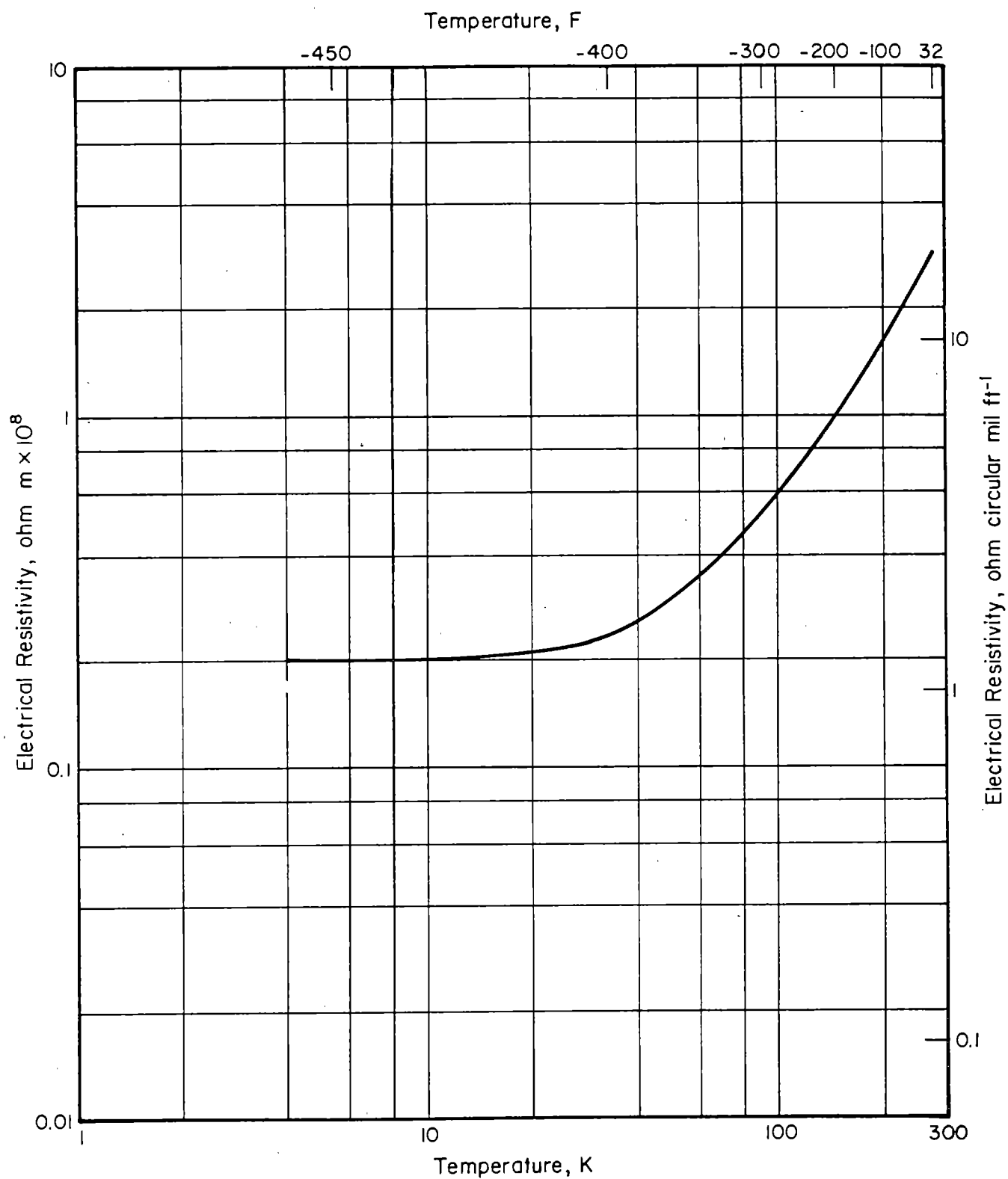


FIGURE 4.1.4-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE
FOR ALUMINUM ALLOY 1100-0

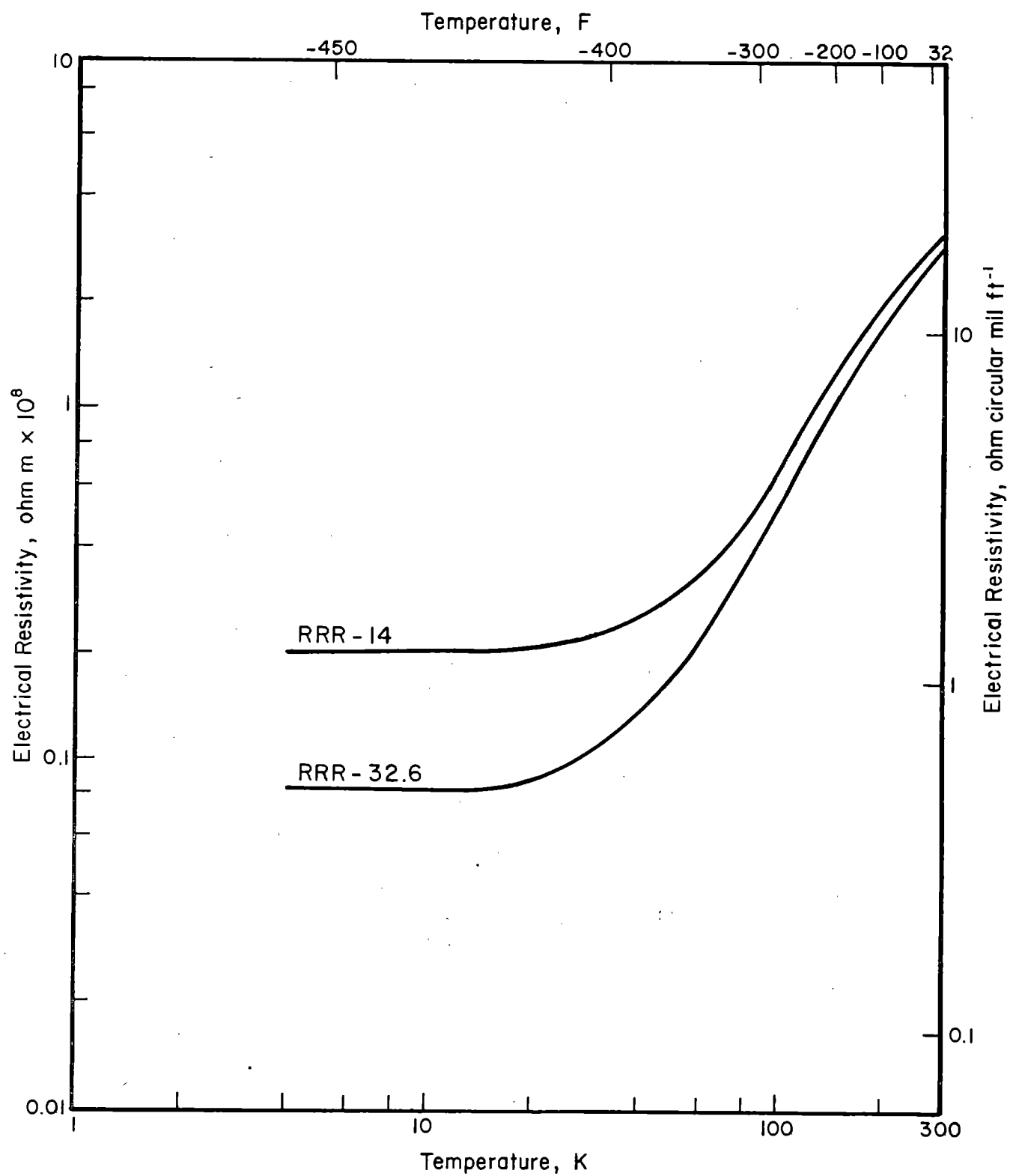


FIGURE 4.1.4-R2. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 1100-0

4.1.4-7.1 (11/76)

TABLE 4.2.1-ME1

Alloy Designation: 2014-T6 Aluminum Alloy

Specification: AMS-4029A, ASTM B209

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: T6

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	483 (70.0)		562 (81.5)	681 (98.8)		
	Min				669 (97.0)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	427 (62.0)		510 (74.0)	543 (78.8)		
	Min				517 (75.0)		
Std. Deviation							
Elong, percent	Avg	9.0		10.8	14		
	Min				13		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	476 (69.0)		559 (81.1)	674 (97.8)		
	Min				661 (95.8)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	421 (61.0)		485 (70.4)	520 (75.4)		
	Min				517 (75.0)		
Std. Deviation							
Elong, percent	Avg	9.0		11.3	15		
	Min				15		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 42002

TABLE 4.2.1-ME2

Alloy Designation: 2014-T6 Aluminum Alloy
 Specification: AMS-4029A, ASTM B209
 Form: Sheet
 Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
 Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	490 (71.1)	515 (74.7)	524 (76.0)	585 (84.9)	687 (99.7)	669 (97.0)
	Min	461 (66.8)	489 (70.9)		558 (81.0)	664 (93.9)	
	Std. Deviation	12.6 (1.83)	1.10 (1.59)		13.0 (1.88)	18.2 (2.64)	
TYS, MN/m ² (ksi)	Avg	445 (64.6)	472 (68.8)	490 (71.0)	52.0 (75.4)	572 (85.0)	
	Min	413 (59.9)	447 (64.9)		496 (72.0)	534 (77.4)	
	Std. Deviation	12.7 (1.87)	9.3 (1.35)		13.6 (1.97)	18.4 (2.67)	
Elong, percent	Avg	9.8	9.6	9.3	11.6	12.8	10.4
	Min	6.5	5.5		7.0	8.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		22 (11)	12 (6)	(1)	23 (11)	19 (9)	(1)
E, GN/m ² (10 ⁶ psi)	Avg	70.5 (10.2)	74.5 (10.8)		80.7 (11.7)	83.4 (12.1)	
	Min	66.2 (9.6)	66.9 (9.7)		74.5 (10.8)	75.8 (11.0)	
	No. of Spec. (No. of Heats)	0.29	0.32		0.25	0.25	
Poisson's Ratio		0.29	0.32		0.25	0.25	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	518 (75.1)	537 (77.9)		581 (84.2)	652 (94.5)	
	Min	511 (74.1)	528 (76.6)		549 (79.6)	581 (84.2)	
	No. of Spec. (No. of Heats)	7 (2)	7 (2)		7 (2)	7 (2)	
NTS, MN/m ² (ksi)	Avg	446 (64.7)	418 (60.7)		392 (56.9)	512 (74.2)	
	Min	431 (62.5)	363 (52.6)		354 (79.6)	454 (65.8)	
	No. of Spec. (No. of Heats)	6 (2)	5 (1)		6 (2)	6 (2)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	489 (71.0)	511 (74.1)		587 (85.1)	693 (100.5)	
	Min	457 (66.3)	485 (70.3)		550 (79.7)	648 (94.0)	
	Std. Deviation	10.1 (1.46)	10.6 (1.54)		15.2 (2.20)	18.6 (2.70)	
TYS, MN/m ² (ksi)	Avg	439 (63.7)	451 (65.4)		501 (72.6)	565 (82.0)	
	Min	403 (58.4)	429 (62.2)		460 (66.7)	505 (73.2)	
	Std. Deviation	13.4 (1.95)	11.0 (1.59)		26.8 (3.88)	22.5 (3.26)	
Elong, percent	Avg	10.2	9.8		11.6	12.9	
	Min	6.5	6.5		4.5	7.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		15 (7)	11 (4)		16 (7)	15 (6)	
E, GN/m ² (10 ⁶ psi)	Avg	71.4 (10.4)	73.8 (10.7)		80.0 (11.6)	82.1 (11.9)	
	Min	66.9 (9.7)	66.2 (9.6)		71.0 (10.3)	71.7 (10.4)	
	No. of Spec. (No. of Heats)	9 (3)	7 (2)		10 (3)	8 (3)	
Poisson's Ratio		0.27	0.32		0.26	0.23	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	491 (71.2)	502 (72.8)		543 (78.7)	608 (88.2)	
	Min	465 (67.5)	491 (71.2)	522	522 (75.7)	564 (81.8)	
	No. of Spec. (No. of Heats)	8 (2)	8 (2)		8 (2)	8 (2)	
NTS, MN/m ² (ksi)	Avg	412 (59.7)	372 (53.9)		430 (62.4)	478 (69.4)	
	Min	398 (57.7)	352 (51.0)		366 (53.1)	403 (58.4)	
	No. of Spec. (No. of Heats)	6 (2)	5 (1)		6 (2)	6 (2)	

References: 42002, 47334, 51156, 58024, 58060, 69310, 69800, 70906, 80104, 90073, 90076, 90188, 48652

TABLE 4.2.1-ME1
Alloy Designation: 2014-T6 Aluminum Alloy

Specification: AMS-4029A, ASTM B209

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: T6

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	483 (70.0)		562 (81.5)	681 (98.8)		
	Min				669 (97.0)		
Std. Deviation							
TYS, MN/m² (ksi)	Avg	427 (62.0)		510 (74.0)	543 (78.8)		
	Min				517 (75.0)		
Std. Deviation							
Elong, percent	Avg	9.0		10.8	14		
	Min				13		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	3 (1)		
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg	476 (69.0)		559 (81.1)	674 (97.8)		
	Min				661 (95.8)		
Std. Deviation							
TYS, MN/m² (ksi)	Avg	421 (61.0)		485 (70.4)	520 (75.4)		
	Min				517 (75.0)		
Std. Deviation							
Elong, percent	Avg	9.0		11.3	15		
	Min				15		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	2 (1)		
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
K_t =	Min						
No. of Spec. (No. of Heats)							

References: 42002

TABLE 4.2.1-ME2

Alloy Designation: 2014-T6 Aluminum Alloy

Specification: AMS-4029A, ASTM B209

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	490 (71.0)	515 (74.7)	524 (76.0)	584 (84.7)	691 (100.2)	669 (97.0)
	Min	461 (66.8)	489 (70.9)		558 (81.0)	664 (96.3)	
Std. Deviation		12.8 (1.86)	12.1 (1.75)		12.8 (1.86)	15.7 (2.28)	
TYS, MN/m ² (ksi)	Avg	444 (64.5)	470 (68.2)	490 (71.0)	517 (75.0)	569 (82.5)	
	Min	413 (59.9)	447 (64.9)		496 (72.0)	534 (77.4)	
Std. Deviation		12.2 (1.77)	9.4 (1.37)		11.9 (1.73)	16.7 (2.42)	
Elong, percent	Avg	10.0	10.3	9.3	12.1	13.2	10.4
	Min	8.0	8.0		9.5	8.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		21 (10)	10 (5)	(1)	21 (10)	17 (8)	(1)
E, GN/m ² (10 ⁶ psi)	Avg	70.5 (10.2)	72.9 (10.6)		79.4 (11.5)	82.5 (12.0)	
	Min	66.2 (9.6)	66.9 (9.7)		74.5 (10.8)	75.8 (11.0)	
No. of Spec. (No. of Heats)		9 (3)	5 (1)		9 (3)	9 (3)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	518 (75.1)	537 (77.9)		581 (84.2)	652 (94.5)	
	Min	511 (74.1)	528 (76.6)		549 (79.6)	581 (84.2)	
K _t = 6.3							
No. of Spec. (No. of Heats)		7 (2)	7 (2)		7 (2)	7 (2)	
NTS, MN/m ² (ksi)	Avg	446 (64.7)	418 (60.7)		392 (56.9)	512 (74.2)	
	Min	431 (62.5)	363 (52.6)		354 (51.4)	454 (65.8)	
K _t = 19+							
No. of Spec. (No. of Heats)		6 (2)	5 (1)		6 (2)	6 (2)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	489 (70.9)	507 (73.6)		584 (84.7)	693 (100.6)	
	Min	457 (66.3)	485 (70.3)		550 (79.7)	648 (94.0)	
Std. Deviation		10.5 (1.52)	8.7 (1.27)		15.9 (2.31)	20.0 (2.90)	
TYS, MN/m ² (ksi)	Avg	438 (63.5)	448 (65.0)		496 (72.0)	561 (81.4)	
	Min	403 (58.4)	429 (62.2)		460 (66.7)	505 (73.2)	
Std. Deviation		14.0 (2.03)	9.4 (1.36)		27.6 (4.01)	20.8 (3.02)	
Elong, percent	Avg	10.6	10.5		13.0	13.9	
	Min	9.7	9.2		11.5	7.6	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		13 (5)	9 (3)		13 (5)	13 (5)	
E, GN/m ² (10 ⁶ psi)	Avg	71.4 (10.4)	71.3 (10.3)		77.9 (11.3)	80.9 (11.7)	
	Min	66.9 (9.7)	66.2 (9.6)		71.0 (10.3)	71.7 (10.4)	
No. of Spec. (No. of Heats)		8 (2)	5 (1)		8 (2)	6 (2)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	491 (71.2)	502 (72.8)		543 (78.7)	608 (88.2)	
	Min	465 (67.5)	491 (71.2)		522 (75.7)	564 (81.8)	
K _t = 6.3							
No. of Spec. (No. of Heats)		8 (2)	8 (2)		8 (2)	8 (2)	
NTS, MN/m ² (ksi)	Avg	412 (59.7)	372 (53.9)		430 (62.4)	478 (69.4)	
	Min	398 (57.7)	352 (51.0)		366 (53.1)	403 (58.4)	
K _t = 19+							
No. of Spec. (No. of Heats)		6 (2)	5 (1)		6 (2)	6 (2)	

References: 42002, 47334, 51156, 58024, 58060, 69310, 70906, 80104, 84652, 90073, 90076

4.2.1-2 (11/74)

TABLE 4.2.1-ME3

Alloy Designation: 2014-T6 Aluminum Alloy
 Specification: AMS-4029 A, ASTM B209
 Form: Sheet
 Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
 Condition: T6

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	228 (33)		276 (40)	400 (58)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^5 cycles	0.46		0.47	0.59		
S_N at 10^6 cycles, MN/m ² (ksi)	117 (17)		172 (25)	317 (46)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.24		0.29	0.47		
S_N at 10^6 cycles, MN/m ² (ksi)	214 (31)		324 (47)	434 (63)		
Loading frequency Hz						
with $R = 0.01$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.44		0.55	0.65		
Fatigue, Axial Loading, Notched Specimens						
S_N at 10^5 cycles, MN/m ² (ksi)	86.2 (12.5)		79.3 (11.5)	103 (15.0)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.5$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
S_N at 10^6 cycles, MN/m ² (ksi)	58.6 (8.5)		69.0 (10.0)	51.7 (7.5)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.5$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
S_N at 10^5 cycles, MN/m ² (ksi)	86.2 (12.5)		96.5 (14.0)	86.2 (12.5)		
Loading frequency Hz						
with $R = -1$ and $K_t = 8$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
S_N at 10^6 cycles, MN/m ² (ksi)	41.4 (6.0)		55.2 (8.0)	48.3 (7.0)		
Loading frequency Hz						
with $R = -1$ and $K_t = 8$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		

References: 53308, 56753, 58024, 61996

TABLE 4.2.1-ME4

Alloy Designation: 2014-T62 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T62

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	477 (69.2)	501 (72.6)	570 (82.6)	650 (94.2)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	424 (61.5)	463 (67.1)	504 (73.1)	540 (78.3)		
	Min						
Std. Deviation							
Elong, percent	Avg	10.8	9.3	13.0	14.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	473 (68.6)	449 (65.1)	439 (63.7)	578 (83.8)		
	Min						
K _t = 8							
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	476 (69.0)	495 (71.8)	571 (82.8)	665 (96.4)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	422 (61.2)	454 (65.9)	499 (72.4)	530 (76.9)		
	Min						
Std. Deviation							
Elong, percent	Avg	11.0	11.5	12.2	14.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	445 (64.6)	441 (63.9)	454 (65.8)	494 (71.7)		
	Min						
K _t = 8							
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 51156

TABLE 4.2.1-ME4.1

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-MIG welded, 4043 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Sheet: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	319 (46.3)		420 (60.9)	414 (60.0)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	261 (37.8)		323 (46.8)	352 (51.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	2.8		2.0	1.2		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	296 (42.9)		315 (45.7)	351 (50.9)		
K _t = 15	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	355 (51.5)		421 (61.1)	410 (59.4)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	260 (37.7)		328 (47.6)	360 (52.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	2.0		2.1	1.2		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90076

TABLE 4.2.1-ME4.2

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 2014 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Sheet: T6; weld metal tested as welded

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)		
Tension, Longitudinal					
TUS, MN/m ² (ksi)	Avg 290 (42.0)	330 (47.9)	314 (45.6)		
	Min				
Std. Deviation					
TYS, MN/m ² (ksi)	Avg 234 (34.0)	240 (34.8)	218 (31.6)		
	Min				
Std. Deviation					
Elong, percent	Avg 1.2	1.0	1.0		
	Min				
RA, percent	Avg				
	Min				
No. of Spec. (No. of Heats)					
E, GN/m ² (10 ⁶ psi)	Avg 74.5 (10.8)	84.1 (12.2)	96.5 (14.0)		
	Min				
No. of Spec. (No. of Heats)	1				
Poisson's Ratio	0.31	0.31	--		
Work Hardening Coef					
NTS, MN/m ² (ksi)	Avg				
K _t =	Min				
No. of Spec. (No. of Heats)					
NTS, MN/m ² (ksi)	Avg				
K _t =	Min				
No. of Spec. (No. of Heats)					
Tension, Transverse					
TUS, MN/m ² (ksi)	Avg				
	Min				
Std. Deviation					
TYS, MN/m ² (ksi)	Avg				
	Min				
Std. Deviation					
Elong, percent	Avg				
	Min				
RA, percent	Avg				
	Min				
No. of Spec. (No. of Heats)					
E, GN/m ² (10 ⁶ psi)	Avg				
	Min				
No. of Spec. (No. of Heats)					
Poisson's Ratio					
Work Hardening Coef					
NTS, MN/m ² (ksi)	Avg				
K _t =	Min				
No. of Spec. (No. of Heats)					
NTS, MN/m ² (ksi)	Avg				
K _t =	Min				
No. of Spec. (No. of Heats)					

References: 69800

TABLE 4.2.1-ME4.3

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 2319 Al filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Sheet: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)	200 (-100)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	379 (54.9)	390 (56.5)	393 (57.0)	440 (63.8)	499 (72.4)	552 (80.0)
	Min	353 (51.2)	368 (53.4)		416 (60.3)	430 (62.3)	
	Std. Deviation	17.7 (2.56)	15.2 (2.21)		15.8 (2.29)	34.6 (5.02)	
TYS, MN/m ² (ksi)	Avg	290 (42.1)	284 (41.2)	292 (42.4)	332 (48.1)	448 (65.0)	422 (61.2)
	Min						
	Std. Deviation						
Elong, percent	Avg	2.3	1.6	1.1	1.4	1.4	2.4
	Min	1.5	1.0		0.5	1.0	
	Std. Deviation						
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	12 (4)	9 (3)	1	12 (4)	15 (4)	1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	404 (58.6)	401 (58.2)		453 (65.7)	509 (73.8)	
	Min	396 (57.5)	400 (58.0)		439 (63.6)	483 (70.1)	
	Std. Deviation						
TYS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
Elong, percent	Avg	1.8	1.5		1.0	1.3	
	Min	1.5	1.0		1.0	1.0	
	Std. Deviation						
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 48652, 53308, 58060, 90078

TABLE 4.2.1-ME4.4

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 4043 filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Sheet: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	363 (52.7)	372 (54.0)	42.5 (61.7)	479 (69.4)		
	Min	352 (51.1)	363 (52.7)	406 (58.9)	471 (68.3)		
	Std. Deviation	9.58 (1.39)		15.3 (2.22)			
TYS, MN/m ² (ksi)	Avg	241 (34.9)		395 (57.3)			
	Min	234 (34.0)		392 (56.9)			
	Std. Deviation						
Elong, percent	Avg	1.7	1.4	0.7	0.6		
	Min	1.0	1.0	0.5	0.0		
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	11 (3)	5 (1)	11 (2)	5 (3)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	365 (53.0)	371 (53.8)	439 (63.7)	480 (69.6)		
	Min	357 (51.8)	365 (52.9)	425 (61.7)	463 (67.2)		
	Std. Deviation						
TYS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
Elong, percent	Avg	1.8	1.3	0.8	0.9		
	Min	1.5	1.0	0.5	0.5		
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	9 (3)	8 (2)	9 (3)	8 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 42002, 51156, 51527, 69310

TABLE 4.2.1-ME4.5

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 4043 filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Sheet: T62; weld metal tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal (to transverse)							
TUS, MN/m ² (ksi)	Avg	368 (53.4)	345 (50.0)	421 (61.1)	454 (65.8)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 51156

TABLE 4.2.1-ME5

Alloy Designation: 2014-T6 Aluminum Alloy

Specification: AMS-4029A, ASTM B209

Form: Sheet

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: T6

Testing Temperature, K (F)	297 (76)		77 (-320)	20 (-423)		
Tension, Longitudinal				20		
TUS, MN/m² (ksi)	Avg 498 (72.3)		590 (85.5)	662 (96.0)		
	Min 487 (70.7)		578 (83.9)	630 (91.4)		
Std. Deviation	5.0 (0.72)		7.6 (1.10)	16.5 (2.40)		
TYS, MN/m² (ksi)	Avg 443 (64.2)		505 (73.2)	573 (83.0)		
	Min 418 (60.6)		483 (70.1)	550 (79.7)		
Std. Deviation	13.4 (1.95)		24.0 (3.48)	13.0 (1.89)		
Elong, percent	Avg 9.8		11.6	9.8		
	Min 7.0		9.0	8.8		
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	65		65	24		
E, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m² (ksi)	Avg					
K_t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m² (ksi)	Avg					
K_t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m² (ksi)	Avg					
K_t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m² (ksi)	Avg					
K_t =	Min					
No. of Spec. (No. of Heats)						

References: 69310, 79301

TABLE 4.2.1-ME5.1

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 4043 filler
 Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)
 Condition: Sheet: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	334 (48.5)		396 (57.4)			
	Min	324 (47.0)		384 (55.7)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	236 (34.3)		393 (57.0)			
	Min	236 (34.2)		386 (56.0)			
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		5 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 69310

TABLE 4.2.1-ME5.2

2014-T6
Plate-Weld Metal

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 716 filler
 Thickness, cm (in.): 0.635 to 1.219 (0.250 to 0.449)
 Condition: Plate: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	301 (43.7)			341 (49.5)		
	Min	294 (42.6)			336 (48.7)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	213 (30.9)			239 (34.6)		
	Min	205 (29.7)			237 (34.4)		
Std. Deviation							
Elong, percent	Avg	1.5			1.5		
	Min	1.5			1.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 55021

TABLE 4.2.1-ME5.3

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 2319 filler
Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.449)
Condition: Plate: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	283 (41.0)			344 (49.9)		
	Min	234 (34.0)			334 (48.4)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	197 (28.6)			264 (38.3)		
	Min	188 (27.3)			259 (37.6)		
Std. Deviation							
Elong, percent	Avg	2.4			1.5		
	Min	1.0			1.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 55021

TABLE 4.2.1-ME5.4

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 4043 filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.449)

Condition: Plate: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	256 (37.2)			310 (45.0)		
	Min	248 (36.0)			303 (43.9)		
	Std. Deviation	4.4 (0.64)					
TYS, MN/m ² (ksi)	Avg	(23.1)			201 (29.2)		
	Min	(19.4)			171 (24.8)		
	Std. Deviation	(2.95)					
Elong, percent	Avg	2.4			1.6		
	Min	2.0			1.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		10 (2)			4 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							

References: 55021

TABLE 4.2.1-ME5.5

2014-T6
Plate-Weld Metal

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5356 filler
 Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.449)
 Condition: Plate: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	243 (35.3)			333 (48.3)		
	Min	156 (22.6)			332 (48.1)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	177 (25.6)			205 (29.8)		
	Min	169 (24.5)			190 (27.6)		
Std. Deviation							
Elong, percent	Avg	1.9			2.5		
	Min	1.0			1.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 55021

TABLE 4.2.1-ME5.6

2014-T6
Plate-Weld Metal

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 556 filler
 Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.449)
 Condition: Plate: T6; weld metal tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	225 (32.6)			323 (46.9)		
	Min	160 (23.2)			314 (45.5)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	(25.4)			219 (31.7)		
	Min	(24.3)			205 (29.7)		
Std. Deviation							
Elong, percent	Avg	1.6			2.0		
	Min	1.0			2.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 55021

TABLE 4.2.1-ME6

Alloy Designation: 2014-T62 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T62

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	476 (69.0)		572 (83.0)	648 (94.0)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	427 (62.0)		496 (72.0)	524 (76.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	9		11			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 79816

TABLE 4.2.1-ME7

Alloy Designation: 2014-T62 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T62

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg	44.0 (40.3)	43.1 (39.4)	53.3 (48.8)		
(From PTSC spec.)(L — S)Min			42.0 (38.4)			
No. of Spec. (No. of Heats)		1 (1)	2 (1)	1 (1)		

References: 79816

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 4.2.1-ME8

Alloy Designation: 2014-T651 Aluminum Alloy

Specification: AMS-4014, ASTM B209

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T651

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		4 (-452)
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 456 (66.2)		579 (84.0)	659 (95.6)		658 (95.4)
	Min 430 (62.4)					656 (95.1)
Std Deviation						
TYS, MN/m ² (ksi)	Avg 420 (60.9)		525 (76.1)	553 (80.2)		564 (81.8)
	Min 396 (57.5)					563 (81.7)
Std Deviation						
Elong, percent	Avg 12.2		12.0	15.0		12.8
	Min 11.0		#			12.5
RA, percent	Avg 33.2		22	23		19.5
	Min 24.0					19
No. of Spec. (No. of Heats)	6 (2)		(1)	(1)		2 (1)
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 548 (79.5)					
	Min 529 (76.7)					
K _t = 6.4						
No. of Spec. (No. of Heats)	5 (1)					
NTS, MN/m ² (ksi)	Avg 571 (82.8)		687 (99.6)	710 (103)		712 (103)
	Min					
K _t = 16						
No. of Spec. (No. of Heats)	(1)		(1)	(1)		
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg 479 (69.5)		587 (85.1)	665 (96.4)		668 (96.9)
	Min					668 (96.9)
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 432 (62.7)		513 (74.4)	534 (77.4)		585 (84.8)
	Min					
Std. Deviation						
Elong, percent	Avg 8.8		9.0	11.0		10.2
	Min					10.0
RA, percent	Avg 16		12	15		12
	Min					12
No. of Spec. (No. of Heats)	(1)		(1)	(1)		2 (1)
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 550 (79.8)		573 (83.1)			646 (93.7)
	Min					
K _t = 16						
No. of Spec. (No. of Heats)	(1)		(1)			(1)
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 64373, 72563

TABLE 4.2.1-ME9

Alloy Designation: 2014-T651 Aluminum Alloy
Specification: AMS-4014, ASTM B209
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: T651

Testing Temperature, K (F)	297 (75)		77 (-320)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg	23.2 (21.2)	28.5 (26.1)			
	Min	22.6 (20.7)				
Orientation: T — L						
No. of Spec. (No. of Heats)		5 (1)	(1)			
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 80995

- (a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{Ic} data: Notched bend specimens

TABLE 4.2.1-ME9.1

2014-T62
Plate-Weld Metal

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 2319 alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 2614-T62: Plate, tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 330 (47.8)* Min 326 (47.3)			383 (55.5) 376 (54.6)	437 (63.4) 432 (62.7)	
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 179 (26.0) Min 179 (26.0)			228 (33.1) 226 (32.8)	300 (43.5) 296 (42.9)	
Std. Deviation						
Elong, percent	Avg 15 Min 14			10 10		
RA, percent	Avg Min					
No. of Spec. (No. of Heats)	2			2	2	
E, GN/m ² (10 ⁶ psi)	Avg Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg Min					
K _t =						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg Min					
Std. Deviation						
Elong, percent	Avg Min					
RA, percent	Avg Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 75531

* Both specimens broke in HAZ outside weld metal.

TABLE 4.2.1-ME9.2

Alloy Designation: 2014 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 4043 alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 2014-T62: Plate; tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	317 (46.0)			382 (55.4)	436 (63.2)	
	Min	303 (43.9)			366 (53.1)	419 (60.8)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	198 (28.7)			244 (35.4)	261 (37.8)	
	Min	197 (28.5)			242 (35.1)	252 (36.5)	
Std. Deviation							
Elong, percent	Avg	10			8		
	Min	6			6		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2			2	2	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 75531

TABLE 4.2.1-ME9.3

Alloy Designation: 2014-T651 Aluminum Alloy

Specification:

Form: Plate
 Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
 Condition: T651

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	476 (69.0)			579 (84.0)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	438 (63.5)			525 (76.1)		
	Min						
Std. Deviation							
Elong, percent	Avg	10.2			12.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	603 (87.4)			537 (103)		
	Min	521 (75.6)			619 (89.8)		
K _t = 2.4							
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m ² (ksi)	Avg	538 (78.1)			638 (92.6)		
	Min	506 (75.6)			619 (89.8)		
K _t = 13.3							
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	479 (69.5)			587 (85.1)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	432 (62.7)			513 (74.4)		
	Min						
Std. Deviation							
Elong, percent	Avg	8.8			9.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	590 (85.5)			695 (100.8)		
	Min	521 (75.6)			610 (88.4)		
K _t = 2.4							
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m ² (ksi)	Avg	527 (76.4)			581 (84.2)		
	Min	503 (72.9)			573 (83.1)		
K _t = 13.3							
No. of Spec. (No. of Heats)							

References: 90188

TABLE 4.2.1-ME10

Alloy Designation: 2014-T6 Aluminum Alloy

Specification: AMS-4121C, QQ-A-225, ASTM B211

Form: Bar

Diameter: Up to 2.54 (1.000)

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)		4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	513 (74.4)	520 (75.4)	581 (84.2)		814 (118)	
	Min	481 (69.8)	506 (73.4)	555 (80.5)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	458 (66.4)	456 (66.1)	498 (72.2)		703 (102)	
	Min	415 (60.2)	443 (64.3)	474 (68.7)			
Std. Deviation							
Elong, percent	Avg	16	13	15			
	Min	15		15			
RA, percent	Avg	32.7	28.2	29.3			
	Min	32.5		27.5			
No. of Spec. (No. of Heats)		5 (2)	3 (1)	6 (2)		3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	72.2 (10.5)	81.4 (11.8)	79.2 (11.5)		82.0 (11.9)	
	Min	66.2 (9.6)	80.0 (11.6)	73.8 (10.7)			
No. of Spec. (No. of Heats)		5 (2)	3 (1)	6 (2)		3 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 47735, 89543

TABLE 4.2.1-ME11

Alloy Designation: 2014-T6 Aluminum Alloy

Specification: AMS-4135, MIL-A-22771B, QQ-A-367F, ASTM B247

Form: Forgings

Thickness, cm (in.):

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	466 (67.6)	509 (73.8)	612 (88.8)	717 (104)		
	Min	458 (66.5)	503 (73.0)	600 (87.0)	690 (100)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	412 (59.8)	462 (67.0)	533 (77.3)	590 (85.5)		
	Min	407 (59.0)	451 (65.4)	512 (74.3)	576 (83.5)		
Std. Deviation							
Elong, percent	Avg	12.5	14.0	11	7.2		
	Min	12	13	11	7.0		
RA, percent	Avg	24	23.2	22.2	22		
	Min	23	22	21	20		
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 35611

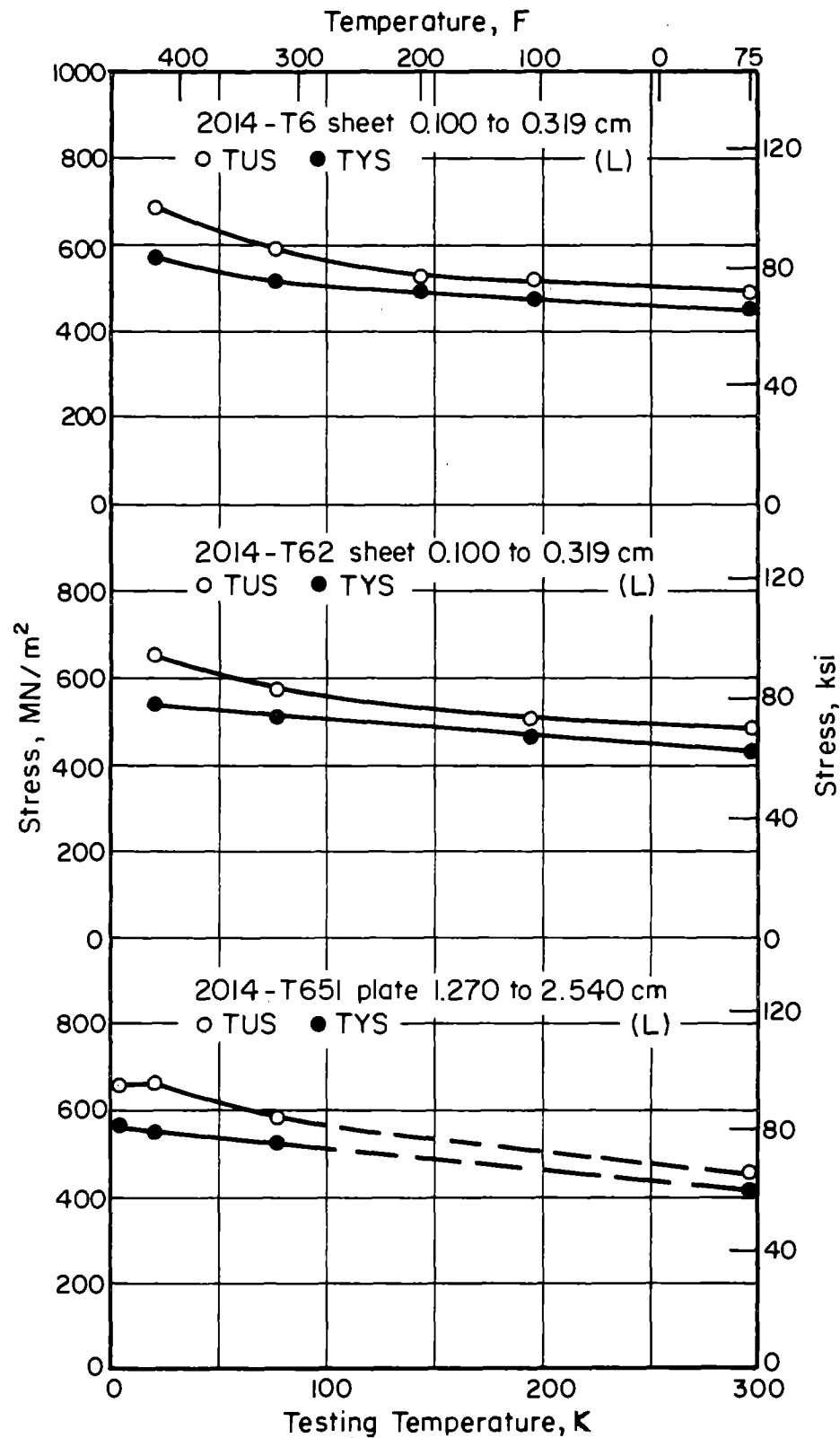


FIGURE 4.2.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 2014 ALUMINUM ALLOY

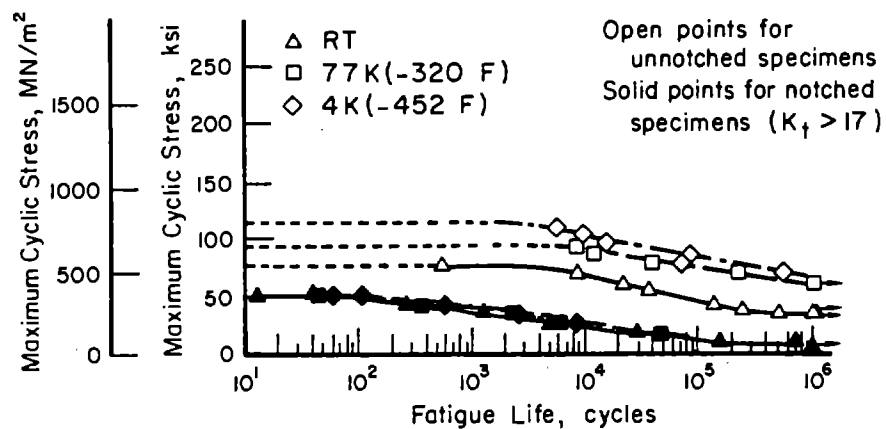


FIGURE 4.2.1-ME2. FATIGUE LIFE CURVES FOR AXIAL LOADING OF LONGITUDINAL SPECIMENS OF 2014-T6 ALUMINUM ALLOY SHEET 0.152 CM (0.060 IN.) THICK AT CYCLIC FREQUENCIES OF 3.3 AND 0.27 HERTZ AT $R = 0.14$

Reference: 70906

4.2.1-13.1 (11/76)

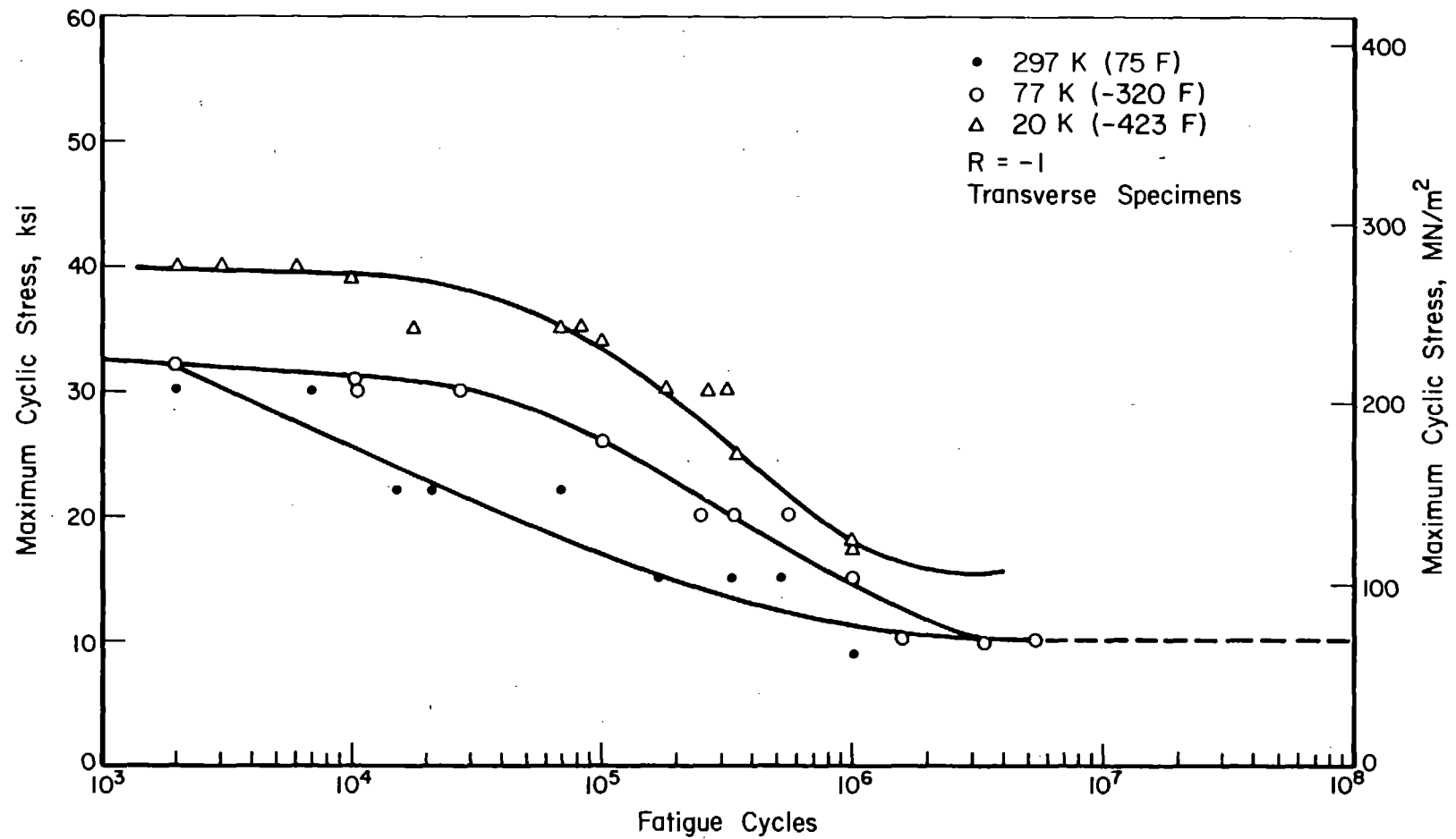


FIGURE 4.2.1-ME3. FATIGUE LIFE CURVES FOR AXIAL LOADING ON WELD METAL SPECIMENS FROM TIG-WELDED 2014-T6 ALUMINUM ALLOY 0.254 cm (0.100 in.) THICK SHEET AT R = -1

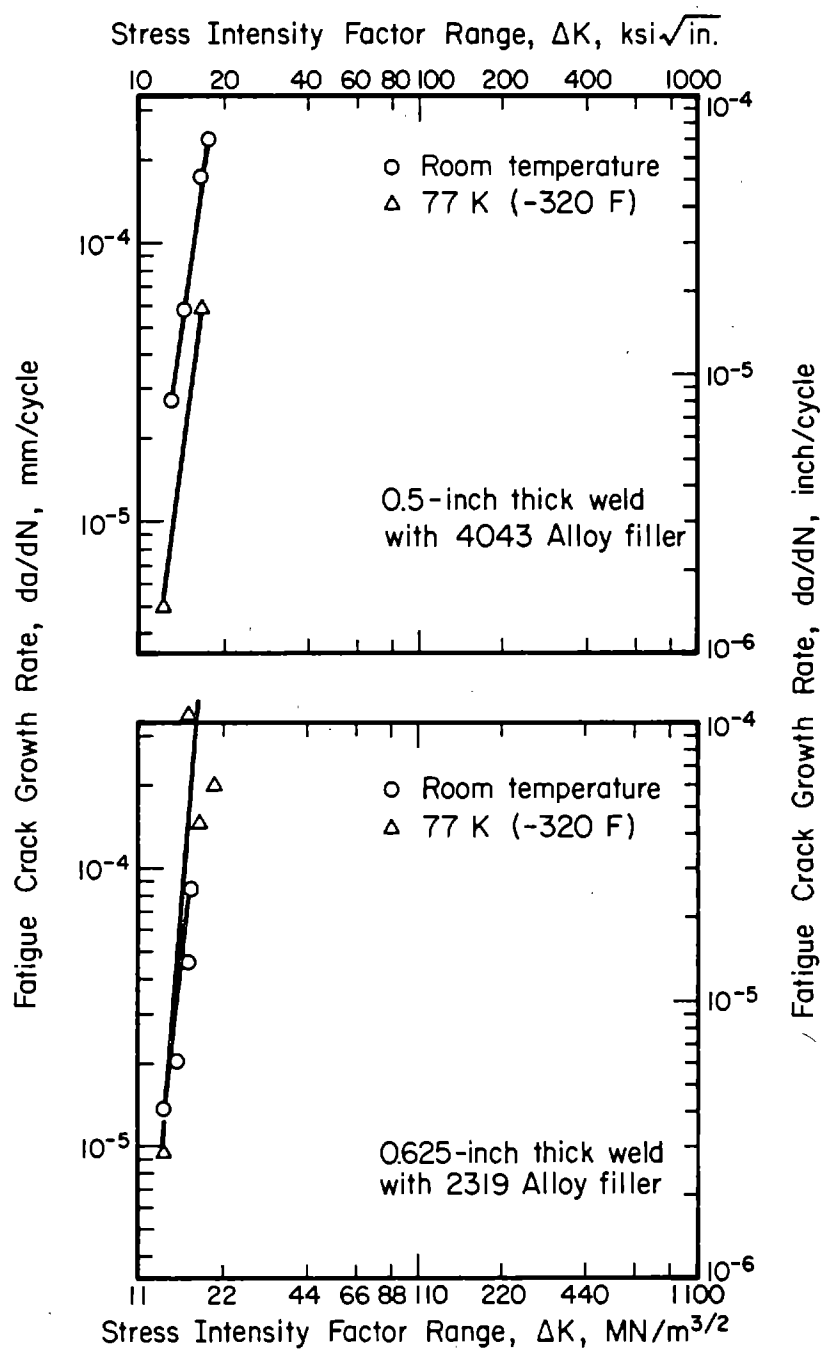


FIGURE 4.2.1-ME4. FATIGUE CRACK GROWTH RATE OF 2014-T62 ALUMINUM ALLOY PLATE, TIG-WELDED [75531] [Plate thickness 2.540 cm (1.000 in.), machined to 1.27 cm (0.500 in.) or 1.59 cm (0.625 in.) in vicinity of weld before welding]

TABLE 4.2.1-TR1

Alloy Designation: 2014-T6 Aluminum Alloy

Specification:

Form:

Dimension:

Condition: -T6

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	160	103	72	32	16	6.3
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(92.5)	(59.6)	(41.6)	(18.5)	(9.25)	(3.64)
No. of Spec.	1	1	3	3	1	1
References: 90218						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.312	-0.335			
No. of Spec.	1	1	1			
References: 48571						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity (1)						
Ohm m	4.25 x 10 ⁻⁸	2.15 x 10 ⁻⁸	1.65 x 10 ⁻⁸	1.51 x 10 ⁻⁸	1.50 x 10 ⁻⁸	1.50 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(25.6)	(12.9)	(9.92)	(9.14)	(9.02)	(9.02)
No. of Spec.	1	1	1	1	1	1
References: 79561						

(1) T-651 Temper

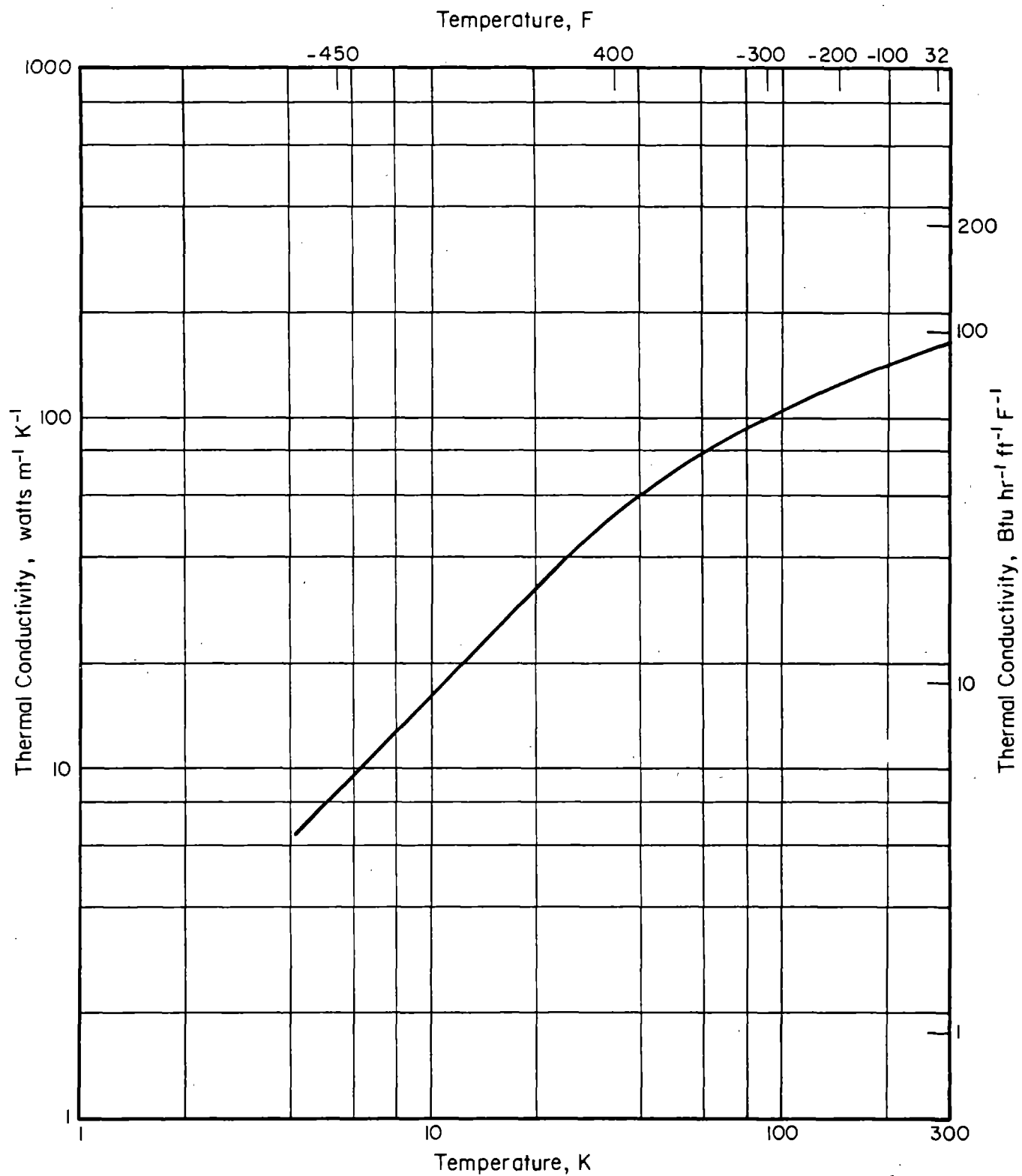


FIGURE 4.2.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2014-T6

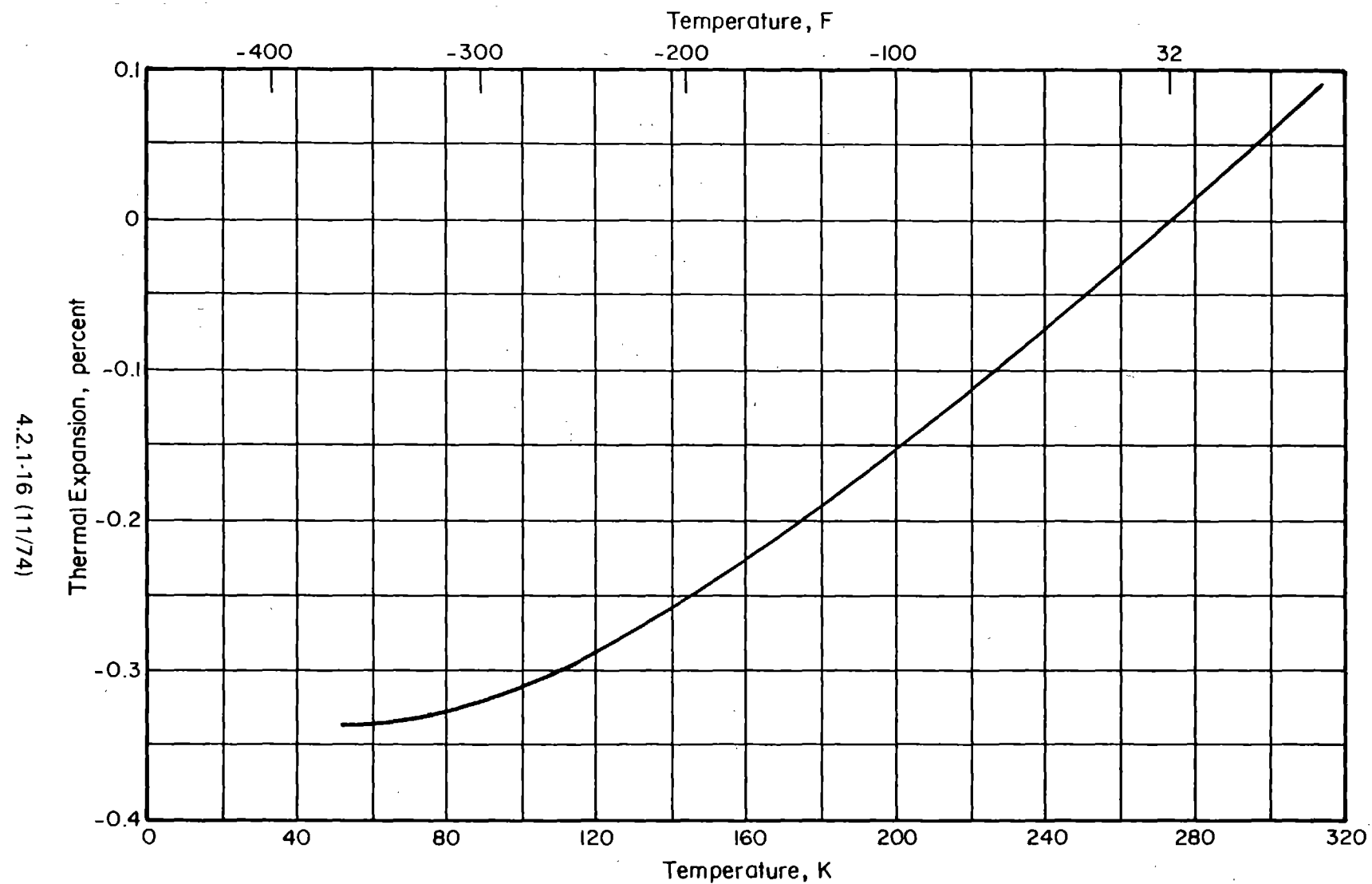


FIGURE 4.2.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2014-T6

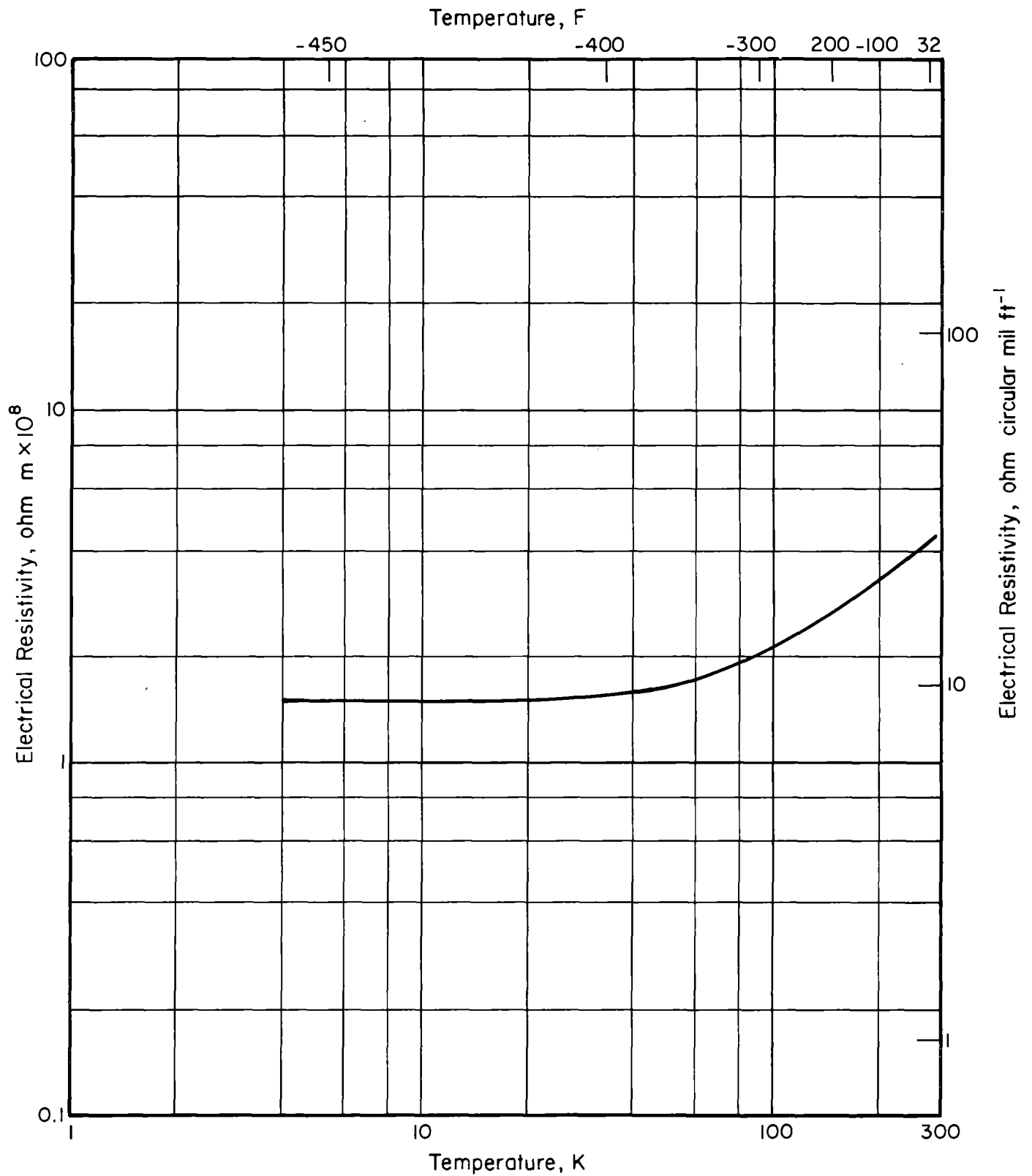


FIGURE 4.2.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2014-T651

TABLE 4.2.2-ME1

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: T87

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	485 (70.4)			702 (101.8)		
	Min	483 (70.0)			700 (101.5)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	409 (59.3)			518 (75.1)		
	Min	405 (58.8)			506 (73.4)		
Std. Deviation							
Elong, percent	Avg	8			16		
	Min	8			16		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	494 (71.7)			696 (101)		
	Min	490 (71.0)			683 (99.1)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	412 (59.8)			513 (74.4)		
	Min	405 (58.7)			505 (73.2)		
Std. Deviation							
Elong, percent	Avg	8			15		
	Min	8			13		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 66103

TABLE 4.2.2-ME2

Alloy Designation: 2219-T6 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	451 (65.4)	479 (69.5)	501 (72.7)	567 (82.3)	665 (96.4)	650 (94.2)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	360 (52.2)	381 (55.2)	402 (58.3)	441 (64)	546 (79.2)	476 (69.1)
	Min						
Std. Deviation							
Elong, percent	Avg	9.8	9.3	10	12.1	15.3	12
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	418 (60.6)	447 (64.8)	467 (67.8)	505 (73.2)	543 (78.8)	552 (80.1)
	Min						
K _t = 10							
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	456 (66.1)	485 (70.3)	503 (72.9)	571 (82.8)	653 (94.7)	661 (95.9)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	359 (52.1)	376 (54.6)	393 (57.0)	430 (62.4)	536 (77.8)	474 (68.7)
	Min						
Std. Deviation							
Elong, percent	Avg	10.3	10.0	10.5	12.5	14.0	11.3
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90183

TABLE 4.2.2-ME3

Alloy Designation: 2219-T62 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T62

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	415 (60.2)	458 (66.5)	530 (76.8)	652 (94.5)		
	Min	402 (58.3)		511 (74.1)	636 (92.2)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	289 (41.9)	346 (50.2)	370 (53.6)	388 (56.3)		
	Min	269 (39.0)		347 (50.3)	372 (54.0)		
Std. Deviation							
Elong, percent	Avg	10.5	11.2	14.1	23.3		
	Min	8.4		13.0	14.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (4)	(1)	7 (4)	5 (3)		
E, GN/m ² (10 ⁶ psi)	Avg	70.3 (10.2)		76.5 (11.1)	80.7 (11.7)		
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	390 (56.5)	392 (56.8)	463 (67.1)	502 (72.8)		
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
NTS, MN/m ² (ksi)	Avg	330 (47.9)		400 (58.1)	465 (67.4)		
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	405 (58.8)	440 (63.9)	527 (76.4)	633 (91.8)		
	Min	396 (57.4)		512 (74.3)	625 (90.6)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	280 (40.6)	317 (46.0)	358 (52.0)	383 (55.6)		
	Min	263 (38.2)		340 (49.3)	361 (52.4)		
Std. Deviation							
Elong, percent	Avg	11.8	11.5	14.2	16.9		
	Min	11.5		14.0	16.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (2)	(1)	2 (2)	2 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	388 (56.3)	410 (59.5)	467 (67.8)	505 (73.3)		
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
NTS, MN/m ² (ksi)	Avg	318 (46.1)		386 (56.0)	401 (58.2)		
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		

References: 51156, 58024, 87612, 90076

TABLE 4.2.2-ME4

Alloy Designation: 2219-T62 Aluminum Alloy

Specification: MIL-A-8920 A, ASTM B209

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T62

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency Hz with R = -1 and K_t = 1 No. of S-N Curves (No. of Heats)	131 (19) 1 (1)		152 (22) 1 (1)	255 (37) 1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.32		0.29	0.38		
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						
Fatigue, Axial Loading, Notched Specimens						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency Hz with R = -1 and K_t = 3.5 No. of S-N Curves (No. of Heats)	89.6 (13.0) 1 (1)		69.0 (10.0) 1 (1)	89.6 (13.0) 1 (1)		
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency Hz with R = -1 and K_t = 3.5 No. of S-N Curves (No. of Heats)	51.7 (7.5) 1 (1)		44.8 (6.5) 1 (1)	62.0 (9.0) 1 (1)		
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with R = and K_t = No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 61996

TABLE 4.2.2-ME5

Alloy Designation: 2219-T81 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T81

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	447 (64.8)	481 (69.8)	566 (82.1)	667 (96.8)		
	Min	43.8 (63.6)	460 (66.8)	553 (80.2)	600 (87.0)		
	Std. Deviation	9.03 (1.31)	14.3 (2.07)	12.3 (1.79)	27.1 (3.93)		
TYS, MN/m ² (ksi)	Avg	348 (50.4)	374 (54.3)	423 (61.3)	476 (69.0)		
	Min	339 (49.2)	362 (52.5)	413 (59.9)	439 (63.7)		
	Std. Deviation	6.69 (0.97)	10.9 (1.58)	8.13 (1.18)	20.7 (3.00)		
Elong, percent	Avg	8.8	9.1	10.7	13.4		
	Min	4.3	6.5	8.8	7.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		12 (5)	10 (4)	10 (4)	14 (6)		
E, GN/m ² (10 ⁶ psi)	Avg	68.5 (9.94)	72.4 (10.5)	80.0 (11.6)	82.0 (11.9)		
	Min	64.1 (9.3)	66.9 (9.7)	73.1 (10.6)	76.5 (11.1)		
	No. of Spec. (No. of Heats)	8 (2)	7 (2)	7 (2)	5 (2)		
Poisson's Ratio		0.327	0.335	0.335	0.33		
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	427 (62.0)	459 (66.6)	514 (74.5)	565 (82.0)		
	Min	416 (60.4)	442 (64.1)	498 (72.2)	483 (70.1)		
	No. of Spec. (No. of Heats)	11 (3)	7 (2)	7 (2)	9 (3)		
NTS, MN/m ² (ksi) K _t = 19	Avg	363 (52.6)	351 (50.9)	414 (60.0)	467 (67.8)		
	Min	349 (50.6)	335 (48.6)	399 (57.9)	458 (66.4)		
	No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)	5 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	450 (65.2)	488 (70.8)	563 (81.6)	673 (97.6)		
	Min	436 (63.2)	478 (69.3)	555 (80.5)	625 (90.7)		
	Std. Deviation	8.07 (1.17)	7.31 (1.06)	13.2 (1.92)	22.0 (3.19)		
TYS, MN/m ² (ksi)	Avg	341 (49.5)	367 (53.2)	414 (60.0)	466 (67.6)		
	Min	322 (46.7)	330 (47.9)	405 (58.8)	452 (65.6)		
	Std. Deviation	10.5 (1.52)	14.8 (2.15)	12.7 (1.84)	10.8 (1.57)		
Elong, percent	Avg	9.7	9.6	10.1	12.1		
	Min	7.3	8.0	7.0	6.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		11 (4)	10 (4)	10 (4)	9 (4)		
E, GN/m ² (10 ⁶ psi)	Avg	69.0 (10.0)	73.8 (10.7)	79.3 (11.5)	81.4 (11.8)		
	Min	66.2 (9.6)	70.3 (10.2)	73.8 (10.7)	74.5 (10.8)		
	No. of Spec. (No. of Heats)	8 (2)	7 (2)	7 (2)	5 (2)		
Poisson's Ratio		0.325	0.325	0.335	0.34		
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	432 (62.6)	449 (65.2)	514 (74.5)	590 (85.6)		
	Min	412 (60.9)	440 (63.8)	504 (73.1)	567 (82.3)		
	No. of Spec. (No. of Heats)	7 (2)	7 (2)	7 (2)	7 (2)		
NTS, MN/m ² (ksi) K _t = 19	Avg	363 (52.6)	322 (46.7)	392 (56.9)	423 (61.2)		
	Min	353 (51.2)	318 (46.1)	354 (51.4)	392 (56.8)		
	No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)	5 (1)		

References: 42002, 51156, 51527, 56755, 61688, 90078

4.2.2-5 (11/74)

TABLE 4.2.2-ME6

2219-T87
Sheet

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T87

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	471 (68.3)	504 (73.1)	513 (74.4)	589 (85.4)	665 (99.4)	
	Min	458 (66.4)	489 (70.9)		562 (81.5)	647 (93.9)	
	Std. Deviation	9.1 (1.32)			18.2 (2.64)	19.7 (2.85)	
TYS, MN/m ² (ksi)	Avg	388 (56.3)	410 (59.5)	427 (61.9)	474 (68.8)	501 (72.6)	
	Min	372 (53.9)	379 (55.0)		421 (61.0)	469 (68.0)	
	Std. Deviation	8.6 (1.24)			36.5 (5.30)	4.0 (3.05)	
Elong, percent	Avg	9.5	9.8	12.5	11.5	14.8	
	Min	6	6		7.0	8.5	
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	24 (10)	7 (3)	3 (1)	20 (8)	20 (10)	
E, GN/m ² (10 ⁶ psi)	Avg	73.8 (10.7)	(10.5)		80.7 (11.7)	85.5 (12.4)	
	Min	70.3 (10.2)	(10.1)		73.8 (10.7)	75.2 (10.9)	
	No. of Spec. (No. of Heats)	5 (4)	2 (1)		6 (4)	8 (4)	
Poisson's Ratio		0.30	0.24		0.28	0.27	
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	480 (69.7)	514 (74.6)		589 (85.4)	658 (95.5)	
	Min	475 (68.9)	512 (74.2)		586 (85.0)	656 (95.1)	
	No. of Spec. (No. of Heats)	2 (1)	2 (1)		2 (1)	2 (1)	
NTS, MN/m ² (ksi) K _t = 10	Avg	441 (64.0)			523 (75.8)	532 (77.2)	
	Min	437 (63.4)			519 (75.3)	508 (73.7)	
	No. of Spec. (No. of Heats)	2 (2)			2 (2)	2 (2)	
NTS, MN/m ² (ksi) K _t = 22	Avg	321 (46.5)	378 (54.8)	354 (51.3)	426 (61.8)	461 (67.0)	
	Min						
	No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	473 (68.9)	506 (73.4)		598 (86.7)	701 (101.8)	
	Min	452 (65.5)	483 (70.1)		571 (82.8)	648 (94.0)	
	Std. Deviation	12.5 (1.81)			17.2 (2.49)	23.4 (3.39)	
TYS, MN/m ² (ksi)	Avg	388 (56.3)	404 (58.6)		467 (67.8)	507 (73.5)	
	Min	356 (51.7)	374 (54.3)		432 (62.7)	463 (67.2)	
	Std. Deviation	15.7 (2.28)			22.0 (3.20)	23.7 (3.43)	
Elong, percent	Avg	9.0	7.9		9.9	12.8	
	Min	7.0	6.5		6.0	7.5	
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	13 (7)	4 (2)		10 (6)	15 (8)	
E, GN/m ² (10 ⁶ psi)	Avg	73.8 (10.7)	(11.9)		84.8 (12.3)	83.4 (12.1)	
	Min	67.6 (9.8)	(11.7)		77.2 (11.2)	75.8 (11.0)	
	No. of Spec. (No. of Heats)	4 (3)	2 (1)		6 (3)	7 (3)	
Poisson's Ratio		0.31	0.30		0.24	0.27	
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	480 (69.7)	507 (73.6)		577 (83.7)	656 (95.2)	
	Min	474 (68.8)	500 (72.5)		576 (83.6)	656 (95.1)	
	No. of Spec. (No. of Heats)	2 (1)	2 (1)		2 (1)	2 (1)	
NTS, MN/m ² (ksi) K _t = 10	Avg	433 (62.8)			505 (73.3)	554 (80.3)	
	Min	432 (62.6)			503 (72.9)	528 (76.6)	
	No. of Spec. (No. of Heats)	2 (2)			2 (2)	2 (2)	

References: 58024, 58060, 64658, 66103, 69310, 69759, 69800, 80104, 84319, 90078

4.2.2-6 (11/76)

TABLE 4.2.2-ME7

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920 A, ASTM B209

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T87

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	207 (30)		221 (32)	358 (52)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.45		0.38	0.53		
S_N at 10^6 cycles, MN/m ² (ksi)	152 (22)		117-172 (17 to 25)	276 (40)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.32		0.22 to 0.29	0.40		
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Axial Loading, Notched Specimens						
S_N at 10^5 cycles, MN/m ² (ksi)	75.8 (11.0)		75.8 (11.0)	100 (14.5)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.5$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
S_N at 10^6 cycles, MN/m ² (ksi)	51.7 (7.5)		48.2 (7.0)	55.2 (8.0)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.5$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						

References: 53308, 56753, 58024, 61996

TABLE 4.2.2-ME7.1

2219-T6E46
Sheet

Alloy Designation: 2219-T6E46

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T6E46

Testing Temperature, K (F)		297 (75)	77 (-320)			
<u>Tension, Longitudinal</u>						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
<u>Tension, Transverse</u>						
TUS, MN/m ² (ksi)	Avg	455 (66)	558 (81)			
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	331 (48)	393 (57)			
	Min					
Std. Deviation						
Elong, percent	Avg	12	13			
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		1	1			
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 87195

TABLE 4.2.2-ME7.2

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 2319 Al filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: Sheet-T31, weld metal tested as welded

Testing Temperature, K (F)		297 (75)	77 (-320)	20 (-423)		
<u>Tension, Longitudinal</u>						
TUS, MN/m ² (ksi)	Avg	320 (46.4)	381 (55.3)	446 (64.7)		
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
<u>Tension, Transverse</u>						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 51156

TABLE 4.2.2-ME7.3

2219-T6
Sheet-Weld Metal

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 2319 Al filler
 Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
 Condition: Sheet-T6, weld metal tested as welded

Testing Temperature, K (F)		297 (75)	200 (-100)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	296 (43.0)	319 (46.3)	351 (50.9)	427 (62.0)	510 (73.9)	518 (75.1)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	209 (30.3)	210 (30.4)	234 (33.9)	273 (39.6)	362 (52.5)	349 (50.6)
	Min						
Std. Deviation							
Elong, percent	Avg	2.0	2.0	2.0	2.0	3.3	2.3
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 58060

TABLE 4.2.2-ME7.4

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-MIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Sheet-T62; Re-heat treated and aged to T62 after welding

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal (grain)						
TUS, MN/m ² (ksi)	Avg 418 (60.6)	459 (66.5)	521 (75.6)			
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 289 (41.9)	321 (46.5)	361 (52.3)			
	Min					
Std. Deviation						
Elong, percent	Avg 7.9	9.2	8.9			
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	4 (2)	2 (1)	4 (2)			
E, GN/m ² (10 ⁶ psi)	Avg 79.3 (11.5)		84.8 (12.3)			
	Min 75.8 (11.0)		77.2 (11.2)			
No. of Spec. (No. of Heats)	2 (1)		2 (1)			
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 583 (84.5)	529 (90.8)	681 (98.7)			
	Min					
K _t = 23.4						
No. of Spec. (No. of Heats)	2 (1)	2 (1)	2 (1)			
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 87612, 90069

TABLE 4.2.2-ME7.5

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-MIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T62 Sheet, tested as welded, heat treated [808 K (995 F) 4 hr, WQ; and aged RT-96 hr, 463 K (375 F)-36 hr]

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	415 (60.2)			508 (73.7)		
	Min	412 (59.8)			501 (72.7)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	285 (41.4)			355 (51.5)		
	Min	283 (41.0)			355 (51.5)		
Std. Deviation							
Elong, percent	Avg	7.5			8.0		
	Min	6.6			6.3		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	79.3 (11.5)			84.8 (12.3)		
	Min	75.8 (11.0)			77.2 (11.2)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 87612

TABLE 4.2.2-ME7.6

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Sheet-T62, tested as welded

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)		
Tension, Longitudinal (grain)					
TUS, MN/m ² (ksi)	Avg 313 (45.4)	372 (54.0)	436 (63.2)		
	Min				
Std. Deviation					
TYS, MN/m ² (ksi)	Avg 210 (30.5)	274 (39.7)	345 (50.0)		
	Min				
Std. Deviation					
Elong, percent	Avg 2.7	2.3	6.0		
	Min				
RA, percent	Avg				
	Min				
No. of Spec. (No. of Heats)	6 (2)	6 (2)	6 (2)		
E, GN/m ² (10 ⁶ psi)	Avg				
	Min				
No. of Spec. (No. of Heats)					
Poisson's Ratio					
Work Hardening Coef					
NTS, MN/m ² (ksi)	Avg 326 (47.3)	390 (56.5)	408 (59.2)		
	Min				
K _t = 30.3					
No. of Spec. (No. of Heats)					
NTS, MN/m ² (ksi)	Avg				
	Min				
K _t =					
No. of Spec. (No. of Heats)					
Tension, Transverse (grain)					
TUS, MN/m ² (ksi)	Avg 312 (45.2)	401 (58.1)	414 (60.0)		
	Min				
Std. Deviation					
TYS, MN/m ² (ksi)	Avg 212 (30.8)	245 (35.6)	286 (41.5)		
	Min				
Std. Deviation					
Elong, percent	Avg				
	Min				
RA, percent	Avg				
	Min				
No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg				
	Min				
No. of Spec. (No. of Heats)					
Poisson's Ratio					
Work Hardening Coef					
NTS, MN/m ² (ksi)	Avg 310 (44.9)	391 (56.7)	412 (59.8)		
	Min				
K _t = 30.3					
No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg				
	Min				
K _t =					
No. of Spec. (No. of Heats)					

References: 61996, 90076

TABLE 4.2.2-ME7.7

2219-T62
Sheet-Weld Metal

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T62 sheet, welded, re-heat treated to T62, tested

Testing Temperature, K (F)		297 (75)	77 (-320)	20 (-423)		
<u>Tension, Longitudinal (grain)</u>						
TUS, MN/m ² (ksi)	Avg	417 (60.5)	518 (75.2)	563 (81.6)		
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	300 (43.5)	357 (51.8)	403 (58.5)		
	Min					
Std. Deviation						
Elong, percent	Avg	7.5	7.5	4.0		
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg	410 (59.5)	503 (73.0)	543 (78.7)		
K _t = 30.3	Min					
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
<u>Tension, Transverse (grain)</u>						
TUS, MN/m ² (ksi)	Avg	415 (60.2)	509 (73.8)	547 (79.4)		
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	295 (42.8)	352 (51.1)	394 (57.1)		
	Min					
Std. Deviation						
Elong, percent	Avg	9.2	6.2	4.3		
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg	400 (58.0)	483 (70.0)	513 (74.4)		
K _t = 30.3	Min					
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 90076

TABLE 4.2.2-ME7.8

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T62 Sheet welded, re-heat treated to T62, tested

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, L to T (grain)							
TUS, MN/m ² (ksi)	Avg	349 (50.6)	321 (46.5)	423 (61.3)	459 (66.6)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 51156

TABLE 4.2.2-ME7.9

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-MIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T81 Sheet- tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse (grain)</u>							
TUS, MN/m ² (ksi)	Avg	321 (46.6)	335 (48.6)	467 (67.8)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	229 (33.2)	232 (33.6)	269 (39.0)			
	Min						
Std. Deviation							
Elong, percent	Avg	1.8	2.2	3.2			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	391 (56.7)	416 (60.3)	470 (68.2)			
K _t = 23.4	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

TABLE 4.2.2-ME7.10

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-MIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T81 Sheet- welded, aged, tested

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse (grain)							
TUS, MN/m ² (ksi)	Avg	334 (48.4)	348 (50.4)	463 (67.2)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	277 (40.2)	331 (48.0)	344 (49.9)			
	Min						
Std. Deviation							
Elong, percent	Avg	1.5	0.8	2.2			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	396 (57.5)	447 (64.8)	470 (68.1)			
K _t = 23.4	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

TABLE 4.2.2-7.11

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T81 Sheet, tested as welded

Testing Temperature, K (F)		297 (75)	200 (-100)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	325 (47.1)	332 (48.1)	425 (61.6)	474 (68.7)		
	Min	316 (45.8)	316 (45.9)	405 (58.7)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	2.4	3.3	2.5	1.7		
	Min	2.0	2.5	2.0	1.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)	8 (2)	8 (2)	11 (3)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	328 (47.5)	313 (45.4)	397 (57.6)	462 (67.0)		
	Min	313 (45.4)	310 (44.9)	388 (56.3)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	2.0	1.7	2.5	0.8		
	Min	2.0	1.0	2.5	0.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	8 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 51156, 51527, 90078

TABLE 4.2.2-7.12

Alloy Designation: 2219 Aluminium Alloy (Weld Metal)

Specification:

Form: Sheet- TIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T81 Sheet, tested as welded

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)
Tension, L to T (grain)			
TUS, MN/m² (ksi)	324 (47.0)	405 (58.8)	451 (65.4)
Avg			
Min			
Std. Deviation			
TYS, MN/m² (ksi)			
Avg			
Min			
Std. Deviation			
Elong, percent			
Avg			
Min			
RA, percent			
Avg			
Min			
No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)
E, GN/m² (10⁶ psi)			
Avg			
Min			
No. of Spec. (No. of Heats)			
Poisson's Ratio			
Work Hardening Coef			
NTS, MN/m² (ksi)			
Avg			
Min			
K _t =			
No. of Spec. (No. of Heats)			
NTS, MN/m² (ksi)			
Avg			
Min			
K _t =			
No. of Spec. (No. of Heats)			
Tension, Transverse			
TUS, MN/m² (ksi)			
Avg			
Min			
Std. Deviation			
TYS, MN/m² (ksi)			
Avg			
Min			
Std. Deviation			
Elong, percent			
Avg			
Min			
RA, percent			
Avg			
Min			
No. of Spec. (No. of Heats)			
E, GN/m² (10⁶ psi)			
Avg			
Min			
No. of Spec. (No. of Heats)			
Poisson's Ratio			
Work Hardening Coef			
NTS, MN/m² (ksi)			
Avg			
Min			
K _t =			
No. of Spec. (No. of Heats)			
NTS, MN/m² (ksi)			
Avg			
Min			
K _t =			
No. of Spec. (No. of Heats)			

References: 51156

TABLE 4.2.2-ME7.13

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T81 Sheet, welded, re-heat treated to T81, tested

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, L to T (grain)							
TUS, MN/m ² (ksi)	Avg	339 (49.1)	328 (47.5)	428 (62.1)	449 (65.1)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 51156

TABLE 4.2.2-ME7.14

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-MIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T87 Sheet, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	319 (46.2)	334 (48.5)	463 (67.2)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	219 (31.8)	23.9 (34.6)	256 (37.0)			
	Min						
Std. Deviation							
Elong, percent	Avg	2.2	2.0	3.5			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	368 (53.4)	445 (64.6)	476 (69.1)			
K _t = 23.4	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

TABLE 4.2.2-ME7.15

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-MIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T87 Sheet, welded, aged, tested

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
Std. Deviation						
Elong, percent	Avg					
RA, percent	Avg					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg	363 (52.6)	376 (54.6)	482 (69.9)		
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	279 (40.4)	281 (40.7)	310 (45.0)		
Std. Deviation						
Elong, percent	Avg					
RA, percent	Avg	2.0	1.5	2.0		
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg	381 (55.2)	414 (60.1)	445 (64.6)		
K _t = 23.4						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =						
No. of Spec. (No. of Heats)						

References: 90069

TABLE 4.2.2-ME7.16

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 2319 Al filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T87 Sheet, tested as welded

Testing Temperature, K (F)		297 (75)	200 (-100)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	312 (45.3)	341 (49.5)	402 (58.3)	482 (69.9)		
	Min	258 (37.4)	334 (48.5)	361 (52.3)	441 (64.0)		
	Std. Deviation	35.3 (5.12)		30.8 (4.47)	30.3 (4.40)		
TYS, MN/m ² (ksi)	Avg	202 (29.3)		286 (41.5)	276 (40.1)		
	Min	172 (25.0)		200 (29.0)	184 (26.7)		
	Std. Deviation	20.1 (2.93)		77.9 (11.3)			
Elong, percent	Avg	2.4	3.7	3.2	2.1		
	Min	1.3	3.0	2.0	0.5		
RA, percent	Avg	28.5		23.2			
	Min						
No. of Spec. (No. of Heats)		21 (7)	3 (1)	18 (6)	16 (5)		
E, GN/m ² (10 ⁶ psi)	Avg	67 (9.7)		93.8 (13.6)	102 (14.8)		
	Min	61 (8.9)		1	1		
No. of Spec. (No. of Heats)							
Poisson's Ratio		0.21		0.26	0.29		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 53308, 69310, 69800, 84318, 84319, 89983, 90078

TABLE 4.2.2-ME7.17

2219-T87
Sheet-Weld Metal

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 2319 Alloy filler

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: T87 Sheet, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	312 (45.3)			411 (59.6)		
	Min	310 (45.0)			407 (59.0)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	184 (26.7)			338 (49.0)		
	Min	178 (25.8)			335 (48.6)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			5 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 69310

TABLE 4.2.2-ME8

Alloy Designation: 2219-T81 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Plate

Thickness, cm (in.): 0.635 to 1.27 (0.250 to 0.499)

Condition: T81

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	442 (64.1)			652 (94.6)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	343 (49.8)			483 (70.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	8.5			13		
	Min						
RA, percent	Avg	20.5			25.6		
	Min				25.1		
No. of Spec. (No. of Heats)		1 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	420 (61)			483 (70.1)		
K _t = 6.3	Min	394 (57.1)			480 (69.7)		
No. of Spec. (No. of Heats)		4 (1)			2 (1)		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 66080

TABLE 4.2.2-ME9

Alloy Designation: 2219-T81 Aluminum Alloy

Specification: MIL-A-8920 A, ASTM B209

Form: Plate

Thickness, cm (in.): 0.635 to 1.27 (0.250 to 0.499)

Condition: T81

Testing Temperature, K (F)	297	(75)			20	(-423)		
<u>Compression, Longitudinal</u>								
CYS, MN/m ² (ksi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Ec, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
<u>Compression, Transverse</u>								
CYS, MN/m ² (ksi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Ec, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
<u>Shear^(a)</u>								
SUS, MN/m ² (ksi)	Avg		256	(37.2)		498	(72.3)	
	Min							
No. of Spec. (No. of Heats)								
G, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
<u>Impact, Charpy V</u>								
Long., Nm(ft-lb)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Trans., Nm(ft-lb)	Avg							
	Min							
No. of Spec. (No. of Heats)								
<u>Fracture Toughness^(b)</u>								
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg							
	Min							
Orientation: —								
No. of Spec. (No. of Heats)								
K _I E, MN/m ^{3/2} (ksi√in.)	Avg							
(From PTSC spec.)(—)Min								
No. of Spec. (No. of Heats)								

References: 56754

- (a) Indicate specimen design and orientation for shear specimens:
- (b) Indicate specimen design for K_{IC} data:

TABLE 4.2.2-ME10

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: T87

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	463 (67.2)		578 (83.8)	671 (97.3)		
	Min	458 (66.4)		576 (83.5)	665 (96.5)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	380 (55.1)		458 (66.4)	487 (70.6)		
	Min	376 (54.5)		454 (65.9)	485 (70.3)		
Std. Deviation							
Elong, percent	Avg	10.8		12.5	14.2		
	Min	10.7		12.2	12.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(2)		(2)	(2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	454 (65.8)		547 (79.4)	578 (83.8)		
	Min	452 (65.6)		540 (78.3)	574 (83.2)		
No. of Spec. (No. of Heats)		(2)		(2)	(2)		
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	467 (67.8)		590 (85.6)	684 (99.2)		
	Min	464 (67.3)		585 (84.9)	678 (98.4)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	378 (54.8)		454 (65.9)	480 (69.7)		
	Min	374 (54.3)		449 (65.1)	476 (69.0)		
Std. Deviation							
Elong, percent	Avg	10.4		11.6	14.6		
	Min	9.8		11.2	14.3		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(2)		(2)	(2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	448 (65.0)		544 (78.9)	567 (82.2)		
	Min	447 (64.8)		540 (78.3)	564 (81.8)		
No. of Spec. (No. of Heats)		(2)		(2)	(2)		
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 64658

TABLE 4.2.2-ME10.1

Alloy Designation: 2219-T6E46

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.449)

Condition: T6E46, Aged from T42 condition at 450 K (350 F), 12 hr.

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	432 (62.7)	450 (65.3)	539 (78.2)	625 (90.6)		
	Min	430 (62.4)	429 (62.2)	517 (75.0)	580 (84.1)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	312 (45.3)	330 (47.8)	370 (53.6)	405 (58.8)		
	Min	309 (44.9)	303 (44.0)	361 (52.4)	391 (56.7)		
Std. Deviation							
Elong, percent	Avg	16.5	21.7	24.3	(24.0)		
	Min	14.0	21.0	22.0	(21.0)		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	4 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	71.0 (10.3)	75.2 (10.9)	80.7 (11.7)	77.9 (11.3)		
	Min	64 (9.3)	73.1 (10.6)	77.9 (11.3)	73.1 (10.6)		
No. of Spec. (No. of Heats)		3 (1)	3 (1)	4 (1)	3 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	453 (65.7)	479 (69.5)	549 (79.6)	655 (95.0)		
	Min	449 (65.1)	463 (67.2)	543 (78.7)	627 (90.9)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	332 (48.1)	350 (50.7)	394 (57.1)	435 (63.1)		
	Min	325 (47.2)	344 (49.9)	389 (56.4)	430 (62.4)		
Std. Deviation							
Elong, percent	Avg	14.3	16.5	16.8	16.5		
	Min	14.0	15.0	16.0	16.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	75.8 (11.0)	76.5 (11.1)	80.0 (11.6)	78.6 (11.4)		
	Min	74.5 (10.8)	69.0 (10.0)	76.5 (11.1)	67.6 (9.8)		
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 58761

TABLE 4.2.2-ME10.2

2219-0
Plate-Weld Metal

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 2319 Alloy filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.449)

Condition: 2219-0 Plate: tested as welded and heat treated to T6E46 [T42 + 450 K (350 F), 12 hr.

Testing Temperature, K (F)		297 (75)		77 (-320)		20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	473	(68.6)	522	(75.7)	652	(94.6)
	Min	470	(68.2)	500	(72.5)	613	(88.9)
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	348	(50.4)	380	(55.1)	452	(65.5)
	Min	343	(49.8)	378	(54.8)	431	(62.5)
Std. Deviation							
Elong, percent	Avg	11.0		10.5		10.9	
	Min	10.5		7.5		7.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3	(1)	3	(1)	4	(1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							

References: 58761

TABLE 4.2.2-ME11

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Plate

Thickness, cm (in.): 1.27 to 2.54 (0.500 to 1.000)

Condition: T87

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	460 (66.8)	496 (72.0)	513 (74.4)	578 (83.8)	676 (98.1)	674 (97.8)
	Min	432 (62.6)	483 (70.1)	507 (73.5)	559 (81.1)	655 (95.0)	672 (97.5)
	Std. Deviation	13.5 (1.96)	9.6 (1.40)		11.8 (1.72)	17.5 (2.54)	
TYS, MN/m ² (ksi)	Avg	376 (54.6)	409 (59.3)	427 (61.9)	456 (66.2)	496 (71.9)	512 (74.2)
	Min	350 (50.8)	393 (57.0)	420 (60.9)	434 (62.9)	470 (68.1)	505 (73.2)
	Std. Deviation	11.9 (1.73)	9.8 (1.43)		12.5 (1.82)	15.5 (2.25)	
Elong, percent	Avg	13.4	13.8	12.5	15.2	16.3	15.2
	Min	9.7	12.5	12.0	11.0	12.0	15.0
RA, percent	Avg	30.4	27.8		29.2	26.2	23
	Min	24.0	26.5		28.0	25.5	22
	No. of Spec. (No. of Heats)	31 (12)	7 (4)	2 (1)	26 (11)	24 (10)	2 (1)
E, GN/m ² (10 ⁶ psi)	Avg	68.1 (9.88)			77.2 (11.2)	84.1 (12.2)	
	Min	63.4 (9.2)			71.0 (10.3)	72.4 (10.5)	
	No. of Spec. (No. of Heats)	14 (3)			12 (3)	11 (3)	
Poisson's Ratio		0.33			0.33	0.37	
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 10	Avg	463 (67.2)			558 (81.0)	583 (84.5)	
	Min	459 (66.6)			556 (80.7)		
	No. of Spec. (No. of Heats)	2 (2)			2 (2)	2 (2)	
NTS, MN/m ² (ksi) K _t = 16	Avg	567 (82.3)	571 (82.8)		631 (91.5)	707 (102.5)	690 (100)
	Min						
	No. of Spec. (No. of Heats)						
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	468 (67.9)	494 (71.7)		585 (84.8)	689 (99.9)	
	Min	460 (66.7)	491 (71.2)		565 (81.9)	638 (92.5)	
	Std. Deviation	6.2 (0.90)			12.3 (1.78)	16.9 (2.45)	
TYS, MN/m ² (ksi)	Avg	378 (54.9)	393 (57.0)		455 (66.0)	493 (71.5)	
	Min	365 (53.0)	378 (54.8)		441 (64.0)	458 (66.5)	
	Std. Deviation	(1.21)			10.3 (1.49)	17.5 (2.54)	
Elong, percent	Avg	10.8	12.2		12.0	13.4	
	Min	7.5	11.1		9.3	9.8	
RA, percent	Avg	22.5	19.8		20.7	19.8	
	Min	13.0	16.7		14.0	12.0	
	No. of Spec. (No. of Heats)	29 (12)	4 (2)		28 (12)	25 (10)	
E, GN/m ² (10 ⁶ psi)	Avg	70.3 (10.2)			78.6 (11.4)	88.2 (12.8)	
	Min	64.8 (9.4)			73.1 (10.6)	71.0 (10.3)	
	No. of Spec. (No. of Heats)	16 (4)			15 (4)	13 (3)	
Poisson's Ratio		0.34			0.33	0.38	
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 10	Avg	456 (66.2)			524 (76.0)	554 (80.3)	
	Min	449 (65.1)			520 (75.4)	547 (79.3)	
	No. of Spec. (No. of Heats)	2 (2)			2 (2)	2 (2)	
NTS, MN/m ² (ksi) K _t =	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 62292, 64373, 64658, 66167, 72563, 84319, 90169, 90184
4.2.2-11 (11/74)

TABLE 4.2.2 – ME12

Alloy Designation: 2219-T87 Aluminum Alloy
 Specification: MIL-A-8920 A, ASTM B209
 Form: Plate
 Thickness, cm (in.): 1.27 to 2.54 (0.500 to 1.000)
 Condition: T87

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb)	Avg			8 (5.9)		
	Min			7.4 (5.5)		
No. of Spec. (No. of Heats)				6 (1)		
Trans., J(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{Ic} , MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{Ic} , MN/m ^{3/2} (ksi√in.)	Avg	45.2 (41.4)	48.5 (44.4)			
(From PTSC spec.)(T – S)Min		38.4 (35.1)	36.4 (33.3)			
No. of Spec. (No. of Heats)		8 (3)	7 (3)			

References: 56750, 84319

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{Ic} data:

TABLE 4.2.2-ME12.1

2219-T6E46
Plate

Alloy Designation: 2219-T6E46

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T6E46 [Aged from T42 condition at 450 K (350 F), 12hr.]

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	452 (65.5)		531 (77.0)	638 (92.5)		
	Min	445 (64.6)		507 (73.6)	597 (86.6)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	314 (45.6)		369 (53.5)	419 (60.8)		
	Min	305 (44.2)		350 (50.8)	403 (58.4)		
Std. Deviation							
Elong, percent	Avg	15.2		18.0	18.8		
	Min	15.0		16.5	18.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	79.3 (11.5)		80.0 (11.6)	—		
	Min	72.4 (10.5)		74.5 (10.8)	—		
No. of Spec. (No. of Heats)		3 (1)		2 (1)	—		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 58761

TABLE 4.2.2-ME12.2

Alloy Designation: 2219-T851

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T851

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	466 (67.6)	492 (71.4)	569 (82.5)	659 (95.6)	660 (95.7)	
	Min					657 (95.3)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	371 (53.8)	397 (57.6)	440 (63.8)	474 (68.8)	485 (70.3)	
	Min					476 (69.0)	
Std. Deviation							
Elong, percent	Avg	11.0	11.5	13.8	16.0	15.0	
	Min					14.0	
RA, percent	Avg	27	28	30	28	25.5	
	Min					25.0	
No. of Spec. (No. of Heats)		1	1	1	1	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	547 (79.4)	581 (84.3)	652 (94.5)	714 (103.5)	704 (102.1)	
K _t = 16	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	458 (66.4)	490 (71.0)	572 (83.0)	667 (96.7)	660 (95.7)	
	Min					658 (95.5)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	353 (51.2)	379 (55.0)	421 (61.1)	465 (67.5)	481 (69.8)	
	Min					479 (69.5)	
Std. Deviation							
Elong, percent	Avg	10.2	10.5	12.2	15.8	13.0	
	Min					12.5	
RA, percent	Avg	22	22	24	25	20.5	
	Min					20.0	
No. of Spec. (No. of Heats)						2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	531 (77.0)	562 (81.5)	624 (90.5)	665 (96.5)	665 (96.5)	
K _t = 16	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 72563

TABLE 4.2.2-ME12.3

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 2319 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T6E46* Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	259 (37.5)	273 (39.6)		331 (48.0)	413 (59.9)	
	Min	239 (34.6)	249 (36.1)		274 (39.8)	386 (56.0)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	154 (22.4)	166 (24.0)		184 (26.7)	265 (38.4)	
	Min	147 (21.3)	157 (22.7)		171 (24.8)	249 (36.1)	
Std. Deviation							
Elong, percent	Avg	4.5	4.4		3.9	3.6	
	Min	3.0	3.0		2.0	3.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)	4 (1)		4 (1)	4 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 58761

* T42 + 450 K (350 F), 12 hr.

TABLE 4.2.2-ME12.4

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 2310 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T62 Plate, welded and tested as heat treated to T62

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	395 (57.3)	416 (60.4)		475 (68.9)		496 (72.0)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	277 (40.2)	279 (40.5)		321 (46.6)		355 (51.5)
	Min						
Std. Deviation							
Elong, percent	Avg	7.5	6.5		5.5		3.5
	Min						
RA, percent	Avg	7	8		6		5
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	399 (57.9)	437 (63.4)		512 (74.2)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	287 (41.6)	311 (45.1)		362 (51.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	4.8	8.3		7.0		
	Min						
RA, percent	Avg	4	7		8		
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90069, 90072

TABLE 4.2.2-ME12.5

2219-T81
Plate-Weld Metal

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 2319 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T81 Plate, tested as welded

Testing Temperature, K (F)	297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)						
Avg						
Min						
Std. Deviation						
TYS, MN/m ² (ksi)						
Avg						
Min						
Std. Deviation						
Elong, percent						
Avg						
Min						
RA, percent						
Avg						
Min						
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)						
Avg						
K _t =						
Min						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)						
Avg						
K _t =						
Min						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	278 (40.3)	285 (41.4)		372 (54.0)		
Avg						
Min						
Std. Deviation						
TYS, MN/m ² (ksi)	172 (25.0)	177 (25.6)		204 (29.6)		
Avg						
Min						
Std. Deviation						
Elong, percent	5.2	5.2		4.0		
Avg						
Min						
RA, percent	3	3		2		
Avg						
Min						
No. of Spec. (No. of Heats)	1	1		1		
E, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)						
Avg						
K _t =						
Min						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)						
Avg						
K _t =						
Min						
No. of Spec. (No. of Heats)						

References: 90069

TABLE 4.2.2-ME12.6

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 2319 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T81 Plate, tested as welded and aged to T81

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	330 (47.8)	357 (51.8)		450 (65.2)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	262 (38.0)	276 (40.0)		323 (46.8)		
	Min						
Std. Deviation							
Elong, percent	Avg	3.0	3.0		4.8		
	Min						
RA, percent	Avg	2	2		—		
	Min						
No. of Spec. (No. of Heats)		1	1		1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

TABLE 4.2.2-12.7

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 2319 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T87 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	282 (40.9)	285 (41.4)	310 (45.0)	393 (57.0)	427 (61.9)	
	Min	259 (37.5)	285 (41.3)	308 (44.7)	365 (53.0)	425 (61.6)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	170 (24.6)	172 (25.0)	196 (28.4)	204 (29.6)	268 (38.8)	
	Min	118 (17.1)	163 (23.6)	189 (27.4)	153 (22.2)	267 (38.7)	
Std. Deviation							
Elong, percent	Avg	5.2	4.5	5.3	7.6	4.0	
	Min	3.0	3.5	5.0	3.0	3.5	
RA, percent	Avg	25.7			18.3		
	Min	6 (2)	2 (1)	2 (1)	8 (2)	2 (1)	
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg		249 (36.1)		299 (43.3)		
	Min						
K _t = 13.2							
No. of Spec. (No. of Heats)			1		1		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	279 (40.4)	287 (41.6)		390 (56.6)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	172 (25.0)	192 (27.8)		201 (29.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	5.2	6.2		3.5		
	Min						
RA, percent	Avg						
	Min				2		
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 76455, 90069, 90184

TABLE 4.2.2-ME12.8

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 2319 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T87 Plate, tested as welded and heat treated to T87

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	324 (47.0)	341 (49.5)		425 (61.7)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	234 (34.0)	239 (34.6)		272 (39.4)		
	Min						
Std. Deviation							
Elong, percent	Avg	3.5	3.8		3.2		
	Min						
RA, percent	Avg	2	2		2		
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90069

TABLE 4.2.2-ME12.9

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 2319 filler
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: T87 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	276 (40.0)	283 (41.0)	301 (43.6)	409 (59.3)		
	Min	172 (25.0)	279 (40.5)	277 (40.2)	383 (55.5)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	163 (23.8)	171 (24.8)	181 (26.2)	192 (27.8)		
	Min	108 (15.8)	165 (24.0)	170 (24.6)	162 (23.5)		
Std. Deviation							
Elong, percent	Avg	6.5	4.5	4.9	9.5		
	Min	4.0	4.0	3.0	4.0		
RA, percent	Avg	25.6			22.1		
	Min	22.2			19.8		
No. of Spec. (No. of Heats)		8 (3)	2 (1)	4 (1)	9 (3)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	266 (38.6)		281 (40.7)	323 (46.8)		
	Min						
K _t = 13.2							
No. of Spec. (No. of Heats)		1		1	1		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	276 (40)			386 (56)	462 (67)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	138 (20)			172 (25)	193 (28)	
	Min						
Std. Deviation							
Elong, percent	Avg	8			9	11	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 62292, 76455, 87195, 90184

TABLE 4.2.2-ME12.10

2219-T87
Plate-Weld Metal

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, no filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T87 Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	282 (40.9)			387 (56.2)	461 (66.8)	
	Min	249 (26.1)			274 (39.7)	432 (62.6)	
Std. Deviation					46.3 (6.72)		
TYS, MN/m ² (ksi)	Avg	141 (20.4)			181 (26.3)	245 (35.5)	
	Min	102 (14.8)			148 (21.4)	213 (30.9)	
Std. Deviation					27.5 (3.99)		
Elong, percent	Avg	12.9			12.7	4.0	
	Min	5.0			6.5		
RA, percent	Avg	21.3			21.7	9	
	Min	12.9			13		
No. of Spec. (No. of Heats)		8 (3)			10 (3)	4 (2)	
E, GN/m ² (10 ⁶ psi)	Avg	66 (9.5)			76.5 (11.1)	67.6 (9.8)	
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)	2 (1)	
Poisson's Ratio		0.33			0.20	0.36	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 76455, 84318, 89983

TABLE 4.2.2-ME13

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T87

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	469 (68.0)	536 (77.7)	573 (83.1)	596 (86.4)	695 (100.8)	
	Min	448 (65.0)			573 (83.1)	680 (98.7)	
	Std. Deviation	15.2 (2.20)			19.2 (2.79)	10.7 (1.56)	
TYS, MN/m ² (ksi)	Avg	383 (55.6)	433 (62.8)	475 (68.9)	469 (68.0)	510 (74.0)	
	Min	361 (52.4)			441 (64.0)	496 (71.9)	
	Std. Deviation	16.0 (2.32)			22.5 (3.26)	9.5 (1.38)	
Elong, percent	Avg	11.2	14	13	14	13.4	
	Min	10			10.5	7.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		10 (4)	3 (1)	3 (1)	10 (4)	10 (4)	
E, GN/m ² (10 ⁶ psi)	Avg	67.7 (9.82)			75.2 (10.9)	77.2 (11.2)	
	Min	65.5 (9.50)			73.1 (10.6)	73.7 (10.7)	
	No. of Spec. (No. of Heats)	5 (1)			5 (1)	3 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	480 (69.6)			561 (81.4)	601 (87.2)	
	Min	478 (69.4)			548 (79.5)	598 (86.7)	
	No. of Spec. (No. of Heats)	2 (1)			2 (1)	2 (1)	
NTS, MN/m ² (ksi)	Avg	363 (52.6)	405 (58.7)	396 (57.4)	449 (65.1)	455 (66.0)	
	Min						
	No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	467 (67.8)	518 (75.2)	540 (78.4)	585 (84.9)	683 (99.0)	
	Min	444 (64.4)			547 (79.4)	659 (95.6)	
	Std. Deviation	14.9 (2.16)			20.9 (3.04)	17.4 (2.53)	
TYS, MN/m ² (ksi)	Avg	381 (55.2)	424 (61.5)	444 (64.4)	459 (66.6)	498 (72.2)	
	Min	353 (51.2)			433 (62.8)	478 (69.4)	
	Std. Deviation	18.5 (2.69)			21.7 (3.15)	18.5 (2.68)	
Elong, percent	Avg	9.4	8.5	9	10.6	10.6	
	Min	8.0			7.0	6.3	
RA, percent	Avg	16			18	22	
	Min					19	
No. of Spec. (No. of Heats)		13 (5)	3 (1)	3 (1)	13 (6)	14 (6)	
E, GN/m ² (10 ⁶ psi)	Avg	70.3 (10.2)			75.8 (11.0)	78.6 (11.4)	
	Min	69.5 (10.1)			72.4 (10.5)	75.2 (10.9)	
	No. of Spec. (No. of Heats)	4 (1)			5 (1)	5 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	448 (65.0)			536 (77.8)	545 (79.1)	
	Min	414 (60.1)			494 (71.7)	514 (74.6)	
	No. of Spec. (No. of Heats)	2 (1)			2 (1)	2 (1)	
NTS, MN/m ² (ksi)	Avg	350 (50.8)	364 (52.8)	356 (51.7)	396 (57.5)	378 (54.8)	
	Min						
	No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	

References: 64658, 84319, 90180

TABLE 4.2.2-ME14

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T87

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Tension, Short Transverse						
TUS, MN/m² (ksi)	Avg	441 (64)		523 (75.9)	544 (78.9)	
	Min					
Std. Deviation						
TYS, MN/m² (ksi)	Avg	374 (54.3)		524 (76.0)	532 (77.1)	
	Min					
Std. Deviation						
Elong, percent	Avg	4.3		2.7	1.3	
	Min	(1)		(1)	(1)	
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m² (ksi)	Avg					
K_t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m² (ksi)	Avg					
K_t =	Min					
No. of Spec. (No. of Heats)						

References: 64658

TABLE 4.2.2-ME15

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T87

Testing Temperature, K (F)	297	(75)		77	(-320)	20	(-423)		
<u>Compression, Longitudinal</u>									
CYS, MN/m ² (ksi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Ec, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
<u>Compression, Transverse</u>									
CYS, MN/m ² (ksi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Ec, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
<u>Shear^(a)</u>									
SUS, MN/m ² (ksi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
G, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
<u>Impact, Charpy V</u>									
Long., Nm(ft-lb)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Trans., Nm(ft-lb)	Avg								
	Min								
No. of Spec. (No. of Heats)									
<u>Fracture Toughness^(b)</u>									
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg								
	Min								
Orientation: —									
No. of Spec. (No. of Heats)									
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg	40.3	(36.9)	45.5	(41.6)	48.2	(44.3)		
(From PTSC spec.)(T — S)Min		39.2	(35.9)	44.3	(40.5)	46.9	(42.9)		
No. of Spec. (No. of Heats)		6	(4)	6	(3)	5	(2)		

References: 84319, 84320

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 5.2.2-ME15.1

2219-T6E46
Plate

Alloy Designation: 2219-T6E46

Specification:

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T6E46 [Aged from T42 condition of 450 K (350 F), 12 hr.]

Testing Temperature, K (°F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	442	(64.1)	541	(78.5)	671	(97.3)
	Min	437	(63.4)	530	(76.7)	665	(96.5)
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	301	(43.7)	352	(51.1)	403	(58.4)
	Min	296	(43.0)	340	(49.3)	388	(56.3)
Std. Deviation							
Elong, percent	Avg	17.3		20.3		16.7	
	Min	16.0		19.0		15.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 58761

TABLE 4.2.2-ME15.2

2219-T62
Plate

Alloy Designation: 2219-T62

Specification:

Form: Plate
 Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
 Condition: T62

Testing Temperature, K (F)		297 (75)		77 (-320)			
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg	423 (61.3)		523 (75.9)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	292 (42.3)		330 (47.9)			
	Min						
Std. Deviation							
Elong, percent	Avg	12.0		14.0			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1		1			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	494 (71.6)		603 (87.5)			
K _t = 6.3	Min						
No. of Spec. (No. of Heats)		1		1			
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90084

TABLE 4.2.2-ME15.3

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 2319 Alloy filler

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T851 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	225 (32.7)	281 (40.8)		356 (51.7)		411 (59.6)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	185 (26.8)	172 (25.0)		193 (28.0)		277 (40.2)
	Min						
Std. Deviation							
Elong, percent	Avg	2.0	4.0		3.5		2.5
	Min						
RA, percent	Avg	5	15		10		10
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.2.2-ME16

Alloy Designation: 2219-T81 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T81

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	445 (64.5)		576 (83.5)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	348 (50.5)		436 (63.3)			
	Min						
Std. Deviation							
Elong, percent	Avg	9		10			
	Min						
RA, percent	Avg	16		17			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	440 (63.9)		511 (74.1)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	337 (48.9)		399 (57.9)			
	Min						
Std. Deviation							
Elong, percent	Avg	6		3			
	Min						
RA, percent	Avg	9		7			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 62292

4.2.2-16 (11/74)

TABLE 4.2.2-ME17

Alloy Designation: 2219-T81 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T81

Testing Temperature, K (F)	297 (75)		77 (-320)			
Tension, Short Transverse						
TUS, MN/m ² (ksi)	Avg 402 (58.3)		487 (70.6)			
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 335 (48.6)		382 (55.4)			
	Min					
Std. Deviation						
Elong, percent	Avg		3			
	Min					
RA, percent	Avg 8		3			
	Min (1)		(1)			
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 62292

TABLE 4.2.2-ME18

2219-T87
Plate

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T87

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)
Tension, Longitudinal			
TUS, MN/m ² (ksi)	Avg 472 (68.5)	591 (85.7)	676 (98.1)
	Min 455 (66.0)	560 (81.2)	576 (83.6)
Std. Deviation	11.9 (1.72)	21.1 (3.06)	47.9 (6.95)
TYS, MN/m ² (ksi)	Avg 383 (55.6)	465 (67.5)	512 (74.3)
	Min 368 (53.4)	428 (62.1)	490 (71.0)
Std. Deviation	10.8 (1.56)	23.8 (3.45)	28.8 (4.18)
Elong, percent	Avg 9.7	10.9	10.4
	Min 6.3	5.8	4.7
RA, percent	Avg 19	23.1	15.9
	Min 15.1	19	13.4
No. of Spec. (No. of Heats)	11 (3)	10 (3)	10 (3)
E, GN/m ² (10 ⁶ psi)	Avg 73.8 (10.7)	92.4 (13.4)	80.0 (11.6)
	Min 70.3 (10.2)	73.8 (10.7)	73.1 (10.6)
No. of Spec. (No. of Heats)	4 (1)	3 (1)	2 (1)
Poisson's Ratio			
Work Hardening Coef			
NTS, MN/m ² (ksi)	Avg 461 (66.8)	547 (79.3)	586 (85.0)
K _t = 10	Min 441 (63.9)	517 (75.0)	556 (80.6)
No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)
NTS, MN/m ² (ksi)	Avg		
K _t =	Min		
No. of Spec. (No. of Heats)			
Tension, Transverse			
TUS, MN/m ² (ksi)	Avg 470 (68.1)	585 (84.8)	664 (96.3)
	Min 443 (64.3)	554 (80.4)	595 (86.3)
Std. Deviation	11.1 (1.61)	15.9 (2.31)	39.7 (5.76)
TYS, MN/m ² (ksi)	Avg 382 (55.4)	451 (65.4)	491 (71.2)
	Min 370 (53.7)	427 (61.9)	474 (68.8)
Std. Deviation	7.0 (1.02)	15.7 (2.27)	20.2 (2.93)
Elong, percent	Avg 8.3	9.1	8.6
	Min 5.0	4.7	4.8
RA, percent	Avg 13.2	15.9	12.5
	Min 9.6	9	11.1
No. of Spec. (No. of Heats)	10 (3)	11 (3)	10 (3)
E, GN/m ² (10 ⁶ psi)	Avg 75.8 (11.0)	83.4 (12.1)	70.3 (10.2)
	Min 73.8 (10.7)	67.6 (9.8)	64.8 (9.4)
No. of Spec. (No. of Heats)	3 (1)	4 (1)	3 (1)
Poisson's Ratio			
Work Hardening Coef			
NTS, MN/m ² (ksi)	Avg 384 (55.7)	435 (63.1)	452 (65.5)
K _t = 10	Min 356 (51.7)	404 (58.6)	438 (63.6)
No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)
NTS, MN/m ² (ksi)	Avg		
K _t =	Min		
No. of Spec. (No. of Heats)			

References: 64658, 84319, 93338

TABLE 4.2.2-ME19
Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T87

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)
Tension, Short Transverse			
TUS, MN/m² (ksi)			
Avg	472 (68.5)	533 (77.3)	545 (79.1)
Min	445 (64.6)	459 (66.6)	449 (65.1)
Std. Deviation			
TYS, MN/m² (ksi)			
Avg	376 (54.5)	452 (65.5)	483 (70.0)
Min	375 (54.4)	413 (59.9)	480 (69.6)
Std. Deviation			
Elong, percent			
Avg	7.8		
Min	7.0		
RA, percent			
Avg	7.4	5.5	
Min	6.7		
No. of Spec. (No. of Heats)	4 (2)	3 (2)	3 (2)
E, GN/m² (10⁶ psi)			
Avg	72.4 (10.5)	64.1 (9.3)	
Min	70.3 (10.2)	55.2 (8.0)	
No. of Spec. (No. of Heats)	4 (1)	2 (1)	
Poisson's Ratio			
Work Hardening Coef			
NTS, MN/m² (ksi)			
Avg	283 (41.1)	322 (46.7)	362 (52.5)
Min			
K_t = 10			
No. of Spec. (No. of Heats)	(1)	(1)	(1)
NTS, MN/m² (ksi)			
Avg			
Min			
K_t =			
No. of Spec. (No. of Heats)			

References: 64658 , 93338

TABLE 4.2.2-ME20

Alloy Designation: 2219-T87 Aluminum Alloy

Results of Boeing program to determine design allowable properties

Form: Sheet and Plate

Thickness, cm (in.): 0.081 to 10.2 (0.032 to 4.00)

Condition: T87

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 474 (68.7)		578 (83.8)	685 (99.3)		
99% P, 95% C, F _{TU} ^(a)	443 (64.3)		537 (77.9)	625 (90.5)		
TYS, MN/m ² (ksi)	Avg 391 (56.7)		454 (65.9)	498 (72.2)		
99% P, 95% C, F _{TY} ^(a)	354 (51.4)		410 (59.4)	454 (65.8)		
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg 476 (69.0)		585 (84.8)	692 (100.4)		
99% P, 95% C, F _{TU} ^(a)	445 (64.6)		543 (78.7)	649 (94.1)		
TYS, MN/m ² (ksi)	Avg 388 (56.2)		454 (65.9)	495 (71.8)		
99% P, 95% C, F _{TY} ^(a)	350 (50.7)		412 (59.8)	446 (64.7)		
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 84319

(a) "A" values corresponding to 99 percent probability, 95 percent confidence level.

TABLE 4.2.2-ME21

Alloy Designation: 2219-T87 Aluminum Alloy

Specification: MIL-A-8920A, ASTM B209

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T87

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg	39.7 (36.3)	46.3 (42.4)	52.5 (48.0)		
	Min	39.6 (36.2)	45.5 (41.6)	51.6 (47.2)		
Bend Specimens						
Orientation: T — S						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)		
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg	28.6 (26.2)	34.3 (31.4)	37.2 (34.0)		
	Min	28.5 (26.1)	34.2 (31.3)	36.1 (33.0)		
Compact Specimens						
Orientation: T — S						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)		
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg	49.5 (45.3)	52.7 (48.2)			
(From PTSC spec.)(T — S)Min		43.0 (39.3)	43.6 (39.9)			
No. of Spec. (No. of Heats)		5 (2)	6 (2)			
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg	53.3 (48.7)	52.7 (55.3)			
(From PTSC spec.)(—)Min		50.3 (46)	59.1 (54)			
No. of Spec. (No. of Heats)		3 (1)	6 (2)			

References: 84319, 93338

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{Ic} data:

TABLE 4.2.2-ME21.1

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 2319 Alloy filler

Thickness, cm (in.): over 5.080 (2.000)

Condition: T81 Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	268 (38.9)			315 (45.7)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	140 (20.3)			164 (23.8)		
	Min						
Std. Deviation							
Elong, percent	Avg	8			7		
	Min						
RA, percent	Avg	15			9		
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 62292

TABLE 4.2.2-ME21.2

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-EB welded, 2319 Alloy filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T87 Plate, tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)			
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	236	(34.2)		361	(52.3)	
	Min	132	(19.2)		254	(36.8)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	132	(19.1)		172	(24.9)	
	Min	116	(16.8)		145	(21.0)	
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		10	(1)		6	(1)	
E, GN/m ² (10 ⁶ psi)	Avg	74.5	(10.8)		84.1	(12.2)	
	Min	63.4	(9.2)		77.9	(11.3)	
No. of Spec. (No. of Heats)		6	(1)		4	(1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							

References: 88109

TABLE 4.2.2-ME21.3

2219-Aged
Plate-Weld Metal

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-EB welded, 2319 Alloy filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T87 Plate, tested as welded and aged at 436 K (325 F) 24 hr.

Testing Temperature, K (F)	297 (75)			77 (-320)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 288 (41.8)			416 (60.2)		
	Min 161 (23.4)			349 (50.6)		
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 187 (27.1)			254 (36.9)		
	Min 163 (23.6)			242 (35.1)		
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	8 (1)			5 (1)		
E, GN/m ² (10 ⁶ psi)	Avg 74.5 (10.8)			81.3 (11.8)		
	Min 73.1 (10.6)			80.0 (11.6)		
No. of Spec. (No. of Heats)	4 (1)			3 (1)		
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 88109

TABLE 4.2.2-ME21.4

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 2319 Alloy filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T87 Plate, tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	236	(34.2)		261	(37.9)	
	Min	196	(28.4)		219	(31.7)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	139	(20.1)		171	(24.8)	
	Min	115	(16.7)		152	(22.0)	
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8	(1)		5	(1)	
E, GN/m ² (10 ⁶ psi)	Avg	71.0	(10.3)		80.7	(11.7)	
	Min	66.2	(9.6)		78.6	(11.4)	
No. of Spec. (No. of Heats)		8	(1)		5	(1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							

References: 88109

TABLE 4.2.2-ME21.5

2219-T87
Plate-Weld Metal

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 2319 Alloy filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T87 plate, tested as welded and aged at 436 K (325 F) 24 hr.

Testing Temperature, K (F)		297 (75)		77 (-320)			
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	276	(40.1)		305	(44.2)	
	Min	243	(35.2)		213	(30.9)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	166	(24.1)		226	(32.8)	
	Min	141	(20.4)		186	(27.0)	
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4	(1)		5	(1)	
E, GN/m ² (10 ⁶ psi)	Avg	66	(9.5)		80.0	(11.6)	
	Min	58	(8.4)		77.9	(11.3)	
No. of Spec. (No. of Heats)		4	(1)		5	(1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 88109

TABLE 4.2.2-ME21.6

2219-T87
Plate-Weld Metal

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 2319 Alloy filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T87 Plate, tested as welded and aged at 436 K (325 F) 24 hr.

Testing Temperature, K (F)	297 (75)			77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{Ic} , MN/m ^{3/2} (ksi√in.)	Avg	33.7 (30.9)		33.7 (30.9)		
(From PTSC spec.) (—)Min		30.1 (27.6)		30.7 (28.1)		
No. of Spec. (No. of Heats)		5 (1)		4 (1)		

References: 881G9

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{Ic} data:

TABLE 4.2.2-ME21.7

2219-T87
Plate-Weld Metal

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-Pulse TIG welded, 2319 Alloy filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T87 Plate, tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)			
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	290	(42.0)		375	(54.4)	
	Min	263	(38.2)		320	(46.4)	
Std Deviation							
TYS, MN/m ² (ksi)	Avg	145	(21.0)		189	(27.4)	
	Min	124	(18.0)		161	(23.3)	
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8	(1)		4	(1)	
E, GN/m ² (10 ⁶ psi)	Avg	73.1	(10.6)		84.8	(12.3)	
	Min	71.0	(10.3)		82.1	(11.9)	
No. of Spec. (No. of Heats)		8	(1)		4	(1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 88109

TABLE 4.2.2-21.8

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 2319 Alloy filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T87 Plate, tested as welded and aged at 436 K (325 F) 24 hr.

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	308	(44.7)		337	(48.9)	
	Min	305	(44.2)		231	(33.5)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	192	(27.8)		224	(32.5)	
	Min	178	(25.8)		197	(28.5)	
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4	(1)		4	(1)	
E, GN/m ² (10 ⁶ psi)	Avg	77.2	(11.2)		88.3	(12.8)	
	Min	73.1	(10.6)		78.6	(11.4)	
No. of Spec. (No. of Heats)		4	(1)		3	(1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							

References: 88109

TABLE 4.2.2-ME21.9

2219-T87
Plate-Weld Metal

Alloy Designation: 2219 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-Pulse TIG welded, 2319 Alloy filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T87 Plate, tested as welded and aged at 436 K (325 F) 24 hr.

Testing Temperature, K (F)	297 (75)			77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{Ic} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{Ic} MN/m ^{3/2} (ksi√in.)						
Avg	44.0	(40.3)		41.5	(38.0)	
(From PTSC spec.) (—) Min	39.7	(36.4)		40.7	(37.3)	
No. of Spec. (No. of Heats)	3	(1)		3	(1)	

References: 88109

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{Ic} data:

TABLE 4.2.2-ME22

Alloy Designation: 2219-T852 Aluminum Alloy

Specification: QQ-A-367F

Form: Forgings

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T852

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Radial							
TUS, MN/m ² (ksi)	Avg	446 (64.7)		543 (78.8)			
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	333 (48.3)		395 (57.4)			
	Min						
Std. Deviation							
Elong, percent	Avg	13		15			
	Min						
RA, percent	Avg	25		36			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Tangential							
TUS, MN/m ² (ksi)	Avg	448 (65.0)		540 (78.4)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	345 (50.1)		399 (57.9)			
	Min						
Std Deviation							
Elong, percent	Avg	10		14			
	Min						
RA, percent	Avg	17		25			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 62292

4.2.2-22 (11/74)

TABLE 4.2.2-ME23

Alloy Designation: 2219-T852 Aluminum Alloy

Specification: QQ-A-367F
Form: Forgings
Thickness, cm (in.): Over 5.080 (2.000)
Condition: T852

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Short Transverse							
TUS, MN/m ² (ksi)	Avg	460 (66.7)		534 (77.5)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	368 (53.4)		425 (61.6)			
	Min						
Std. Deviation							
Elong, percent	Avg	4		6			
	Min						
RA, percent	Avg	6		4			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 62292

TABLE 4.2.2-ME24

Alloy Designation: 2219-T81 Aluminum Alloy

Specification:

Form: Extrusion

Thickness, cm (in.): 1.27 to 2.54 (0.500 to 1.000)

Condition: T81

Testing Temperature, K (F)	297 (75)		77 (-320)		4 (-452)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 470 (68.2)		564 (81.8)		664 (96.3)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 361 (52.4)		414 (60.0)		461 (66.9)	
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (1)		3 (1)		3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg 71.0 (10.3)		78.6 (11.4)		82.0 (11.9)	
	Min					
No. of Spec. (No. of Heats)	3 (1)		3 (1)		3 (1)	
Poisson's Ratio	0.313		0.355		0.341	
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 89543

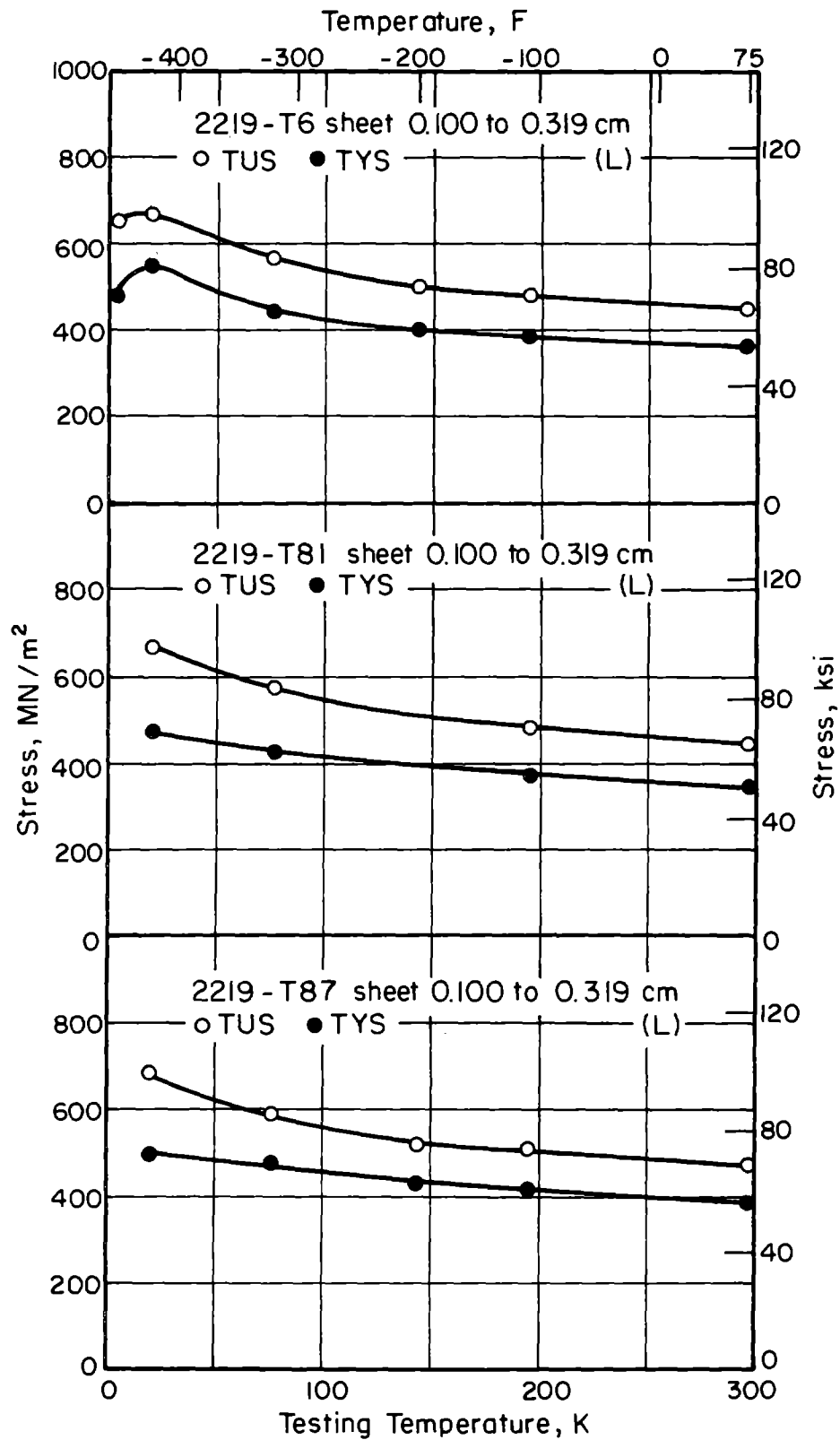


FIGURE 4.2.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 2219 ALUMINUM ALLOY SHEET

4.2.2-25 (11/74)

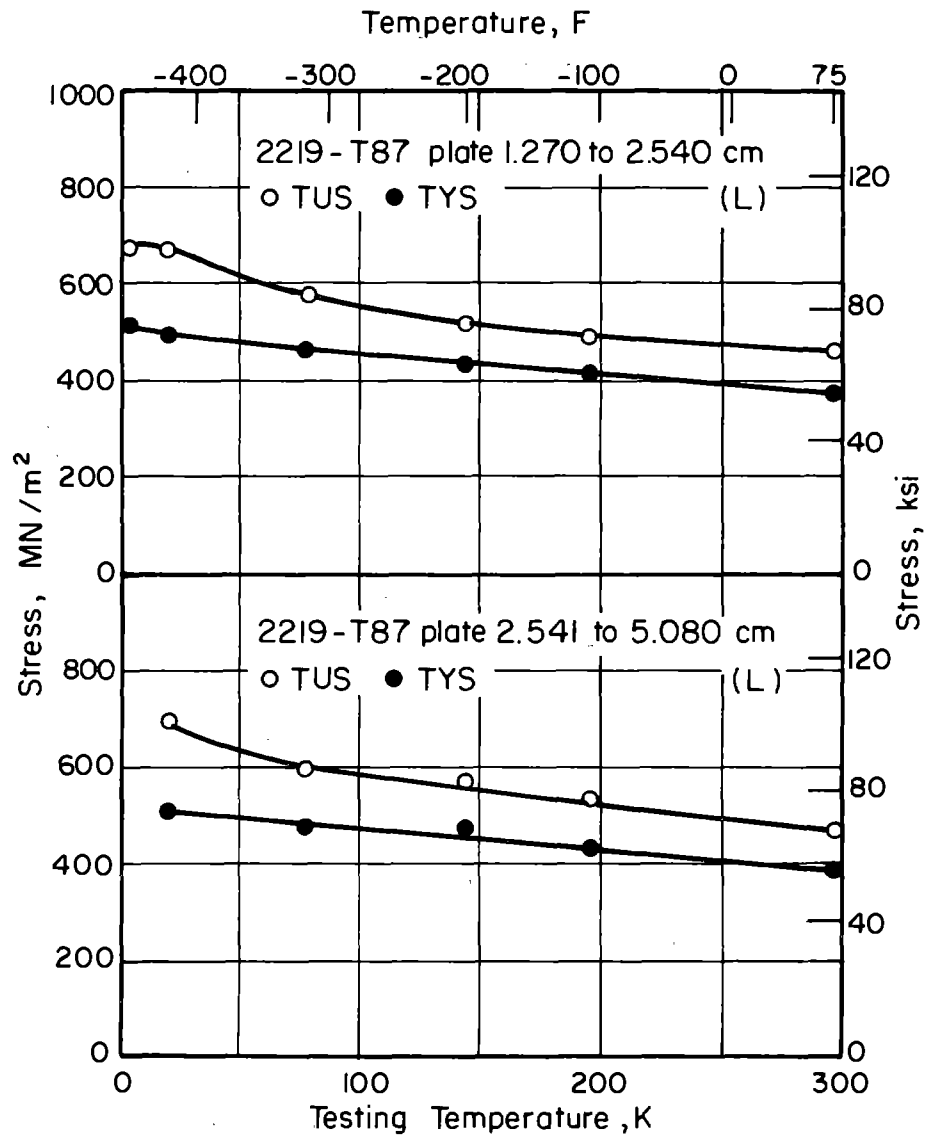


FIGURE 4.2.2-ME2. EFFECT OF TEMPERATURE ON THE STRENGTH OF 2219 ALUMINUM ALLOY PLATE

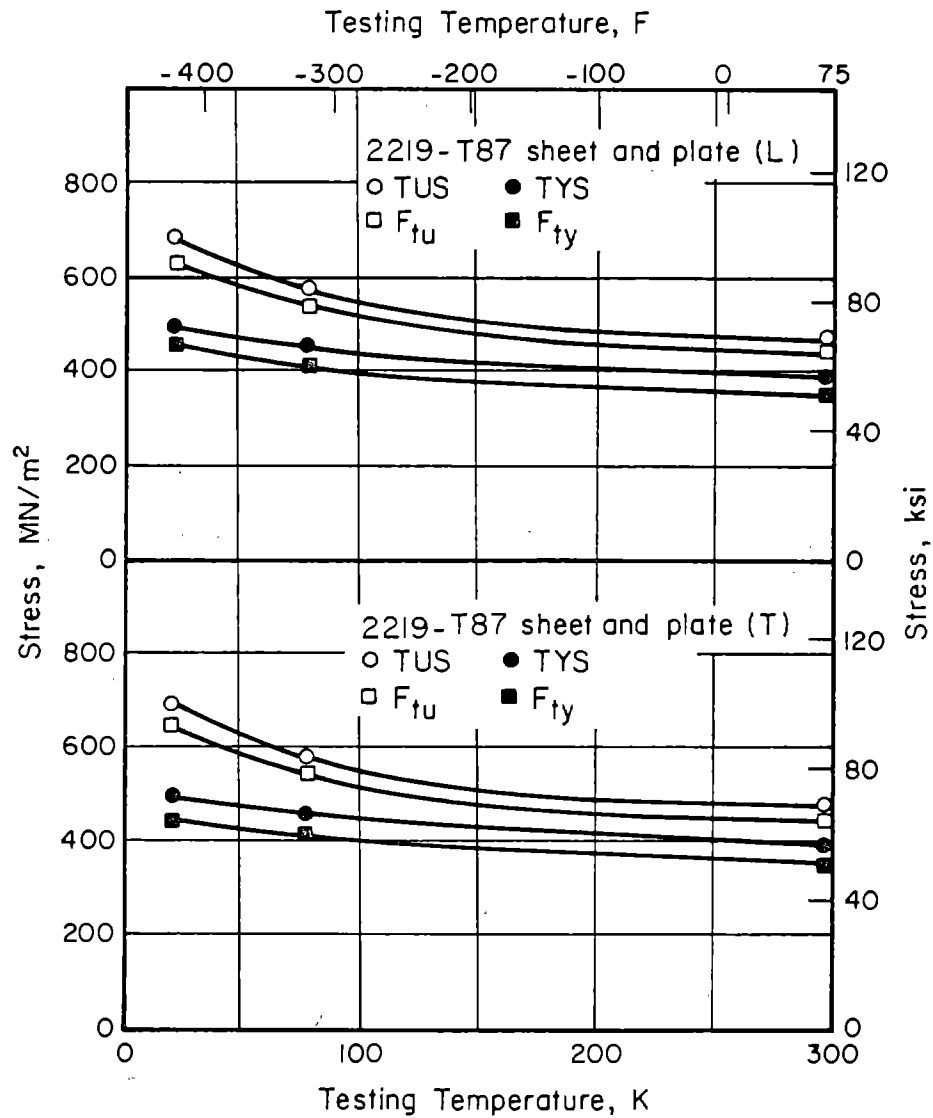


FIGURE 4.2.2-ME3. EFFECT OF TEMPERATURE ON THE STRENGTH OF 2219-T87 SHEET AND PLATE FROM BOEING PROGRAM TO DETERMINE DESIGN ALLOWABLE PROPERTIES (84319)

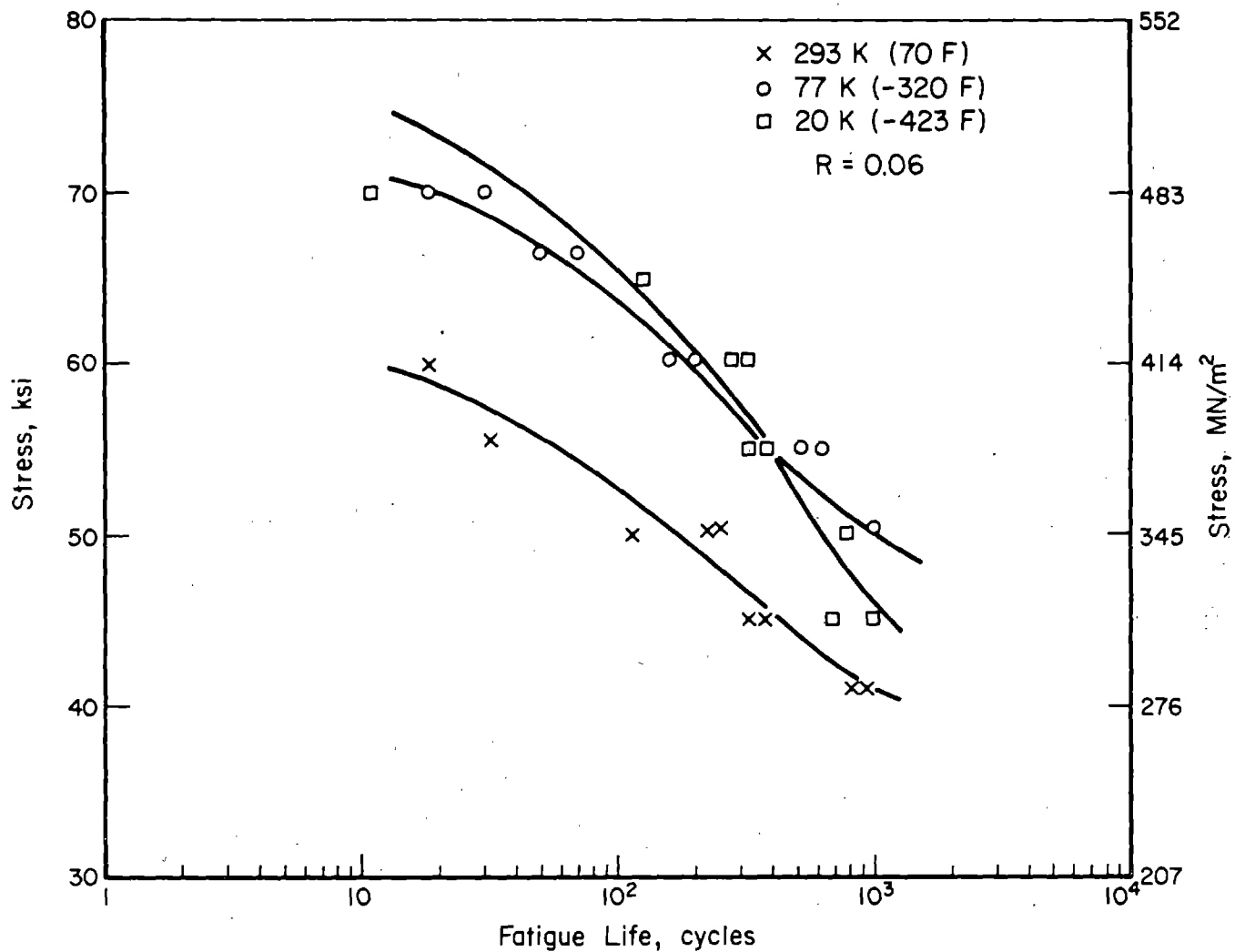


FIGURE 4.2.2-ME4. FATIGUE LIFE CURVES FOR AXIAL LOADING ON NOTCHED SPECIMENS FROM ALUMINUM 2219-T6E46 PLATE 1.9 cm (1.25 in.) THICK [58761]

4.2.2-27.1 (11/76)

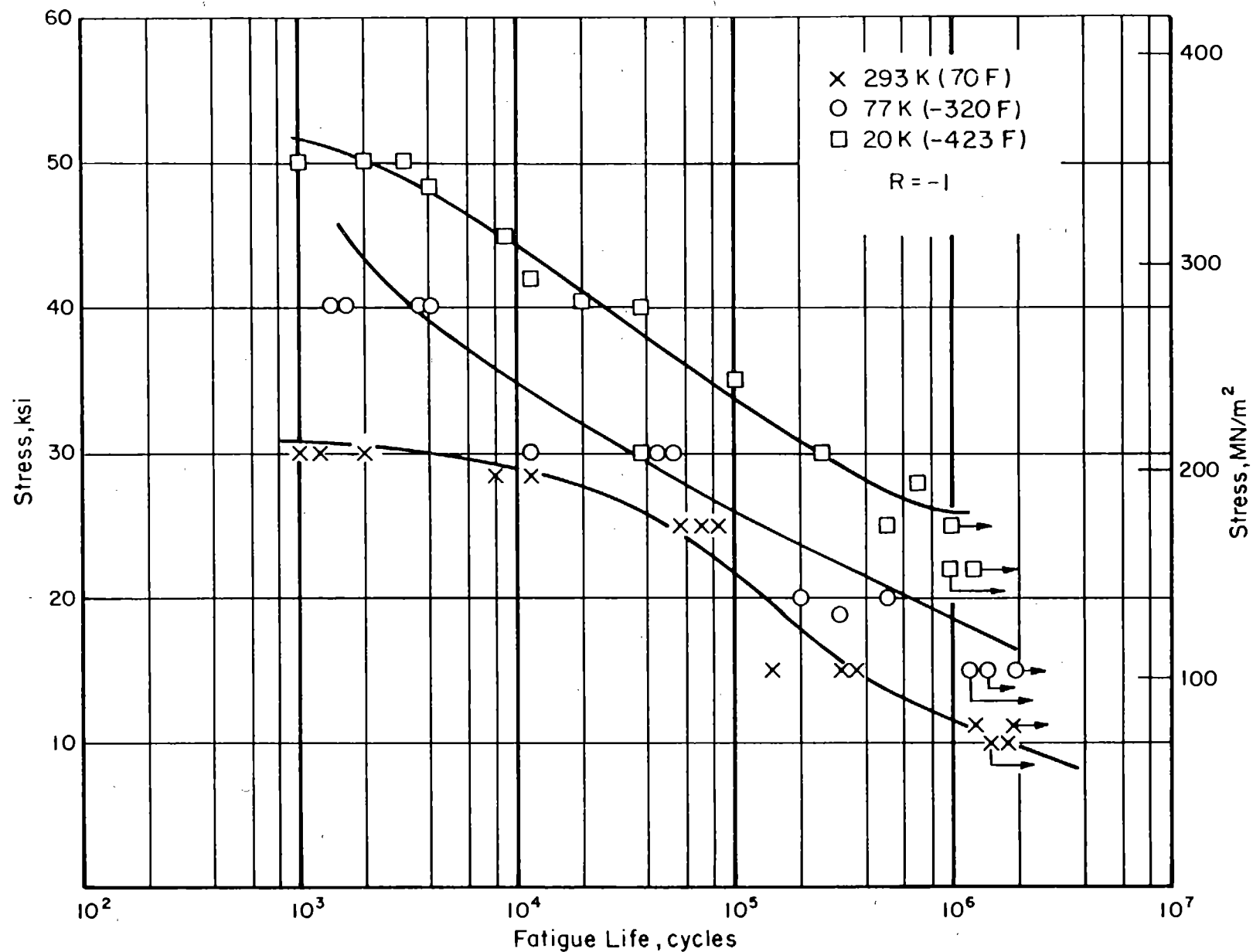


FIGURE 4.2.2-ME4.1. AXIAL FATIGUE LIFE CURVES FOR LOADING ON WELD METAL SPECIMENS FROM TIG WELDED 2219-T62 ALUMINUM ALLOY 0.100 to 0.319 cm (0.040 to 0.125 in.) THICK SHEET AT R = -1 (2319 ALLOY FILLER) [Transverse weld orientation] [61996]

4.2.2-27.2 (11/76)

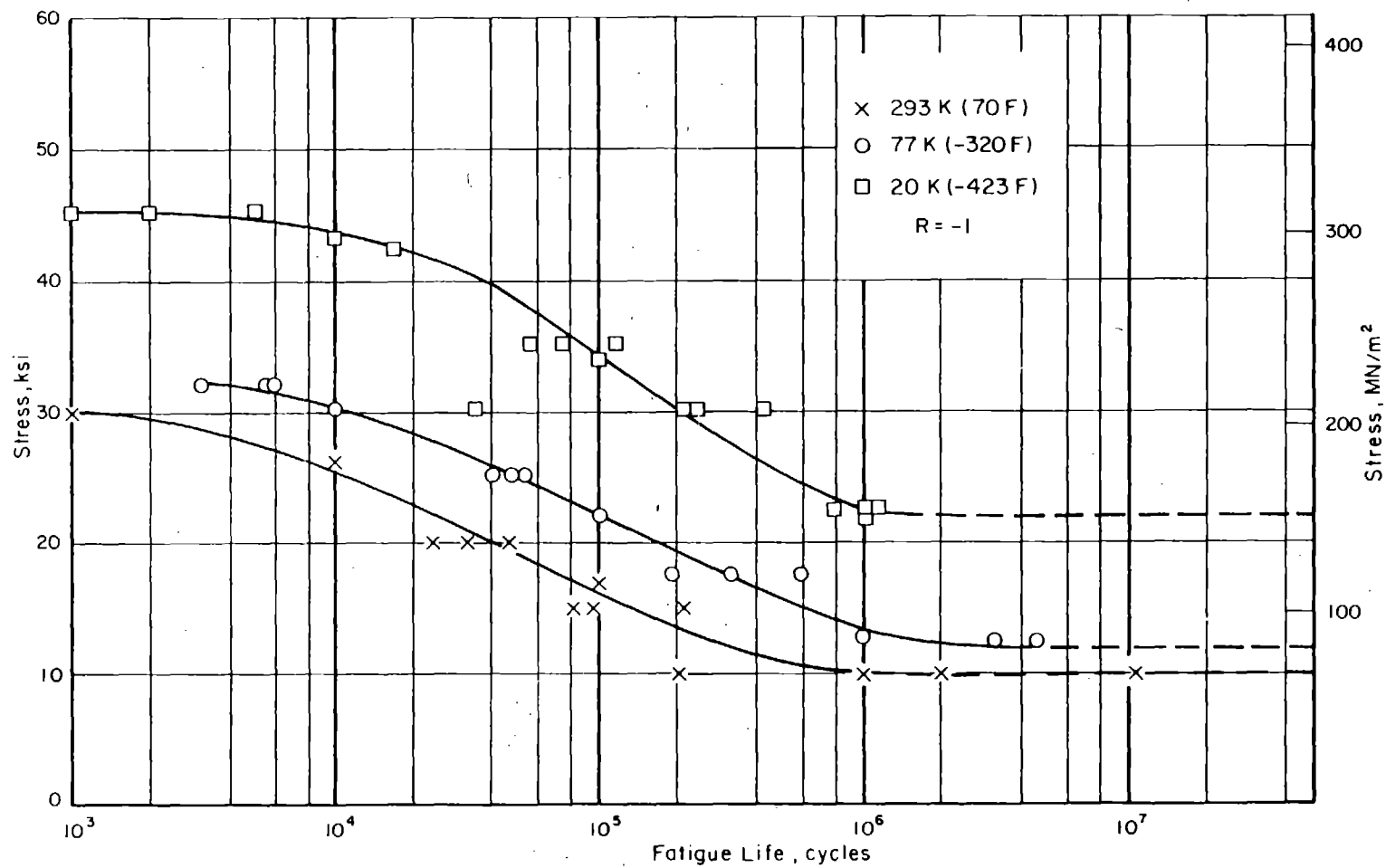


FIGURE 4.2.2-ME5. FATIGUE LIFE CURVES FOR AXIAL LOADING ON WELD METAL SPECIMENS FROM TIG WELDED 2219-T87 ALUMINUM ALLOY 0.254 cm (0.100 in.) THICK SHEET AT R = -1(2319 ALLOY FILLER) [Transverse weld orientation] [53308]

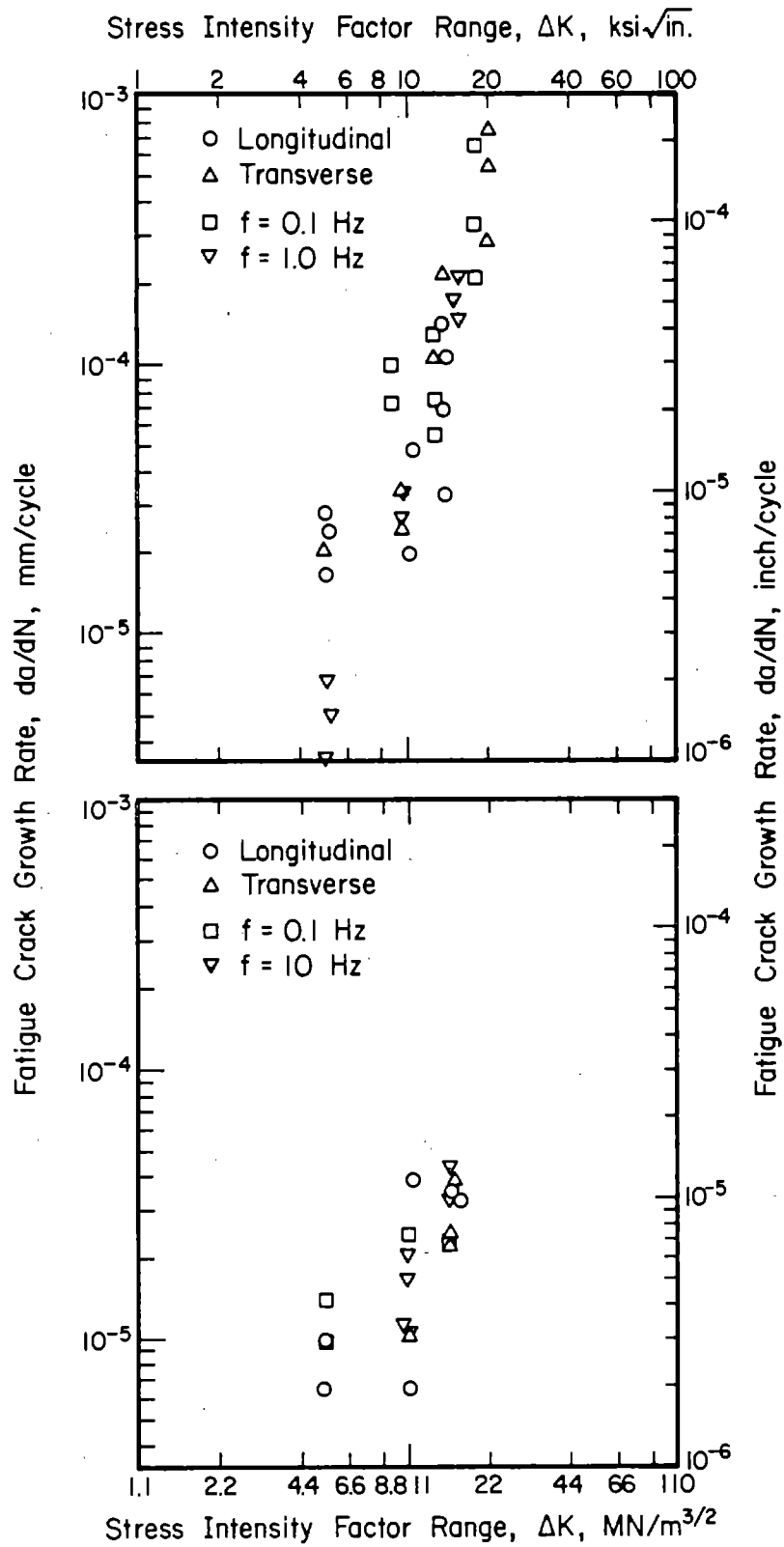


FIGURE 4.2.2-ME6. FATIGUE CRACK GROWTH RATE OF 2219-T87 ALUMINUM ALLOY PLATE
[Crack oriented to propagate in plane of longitudinal rolling direction and long
transverse direction] [93338]

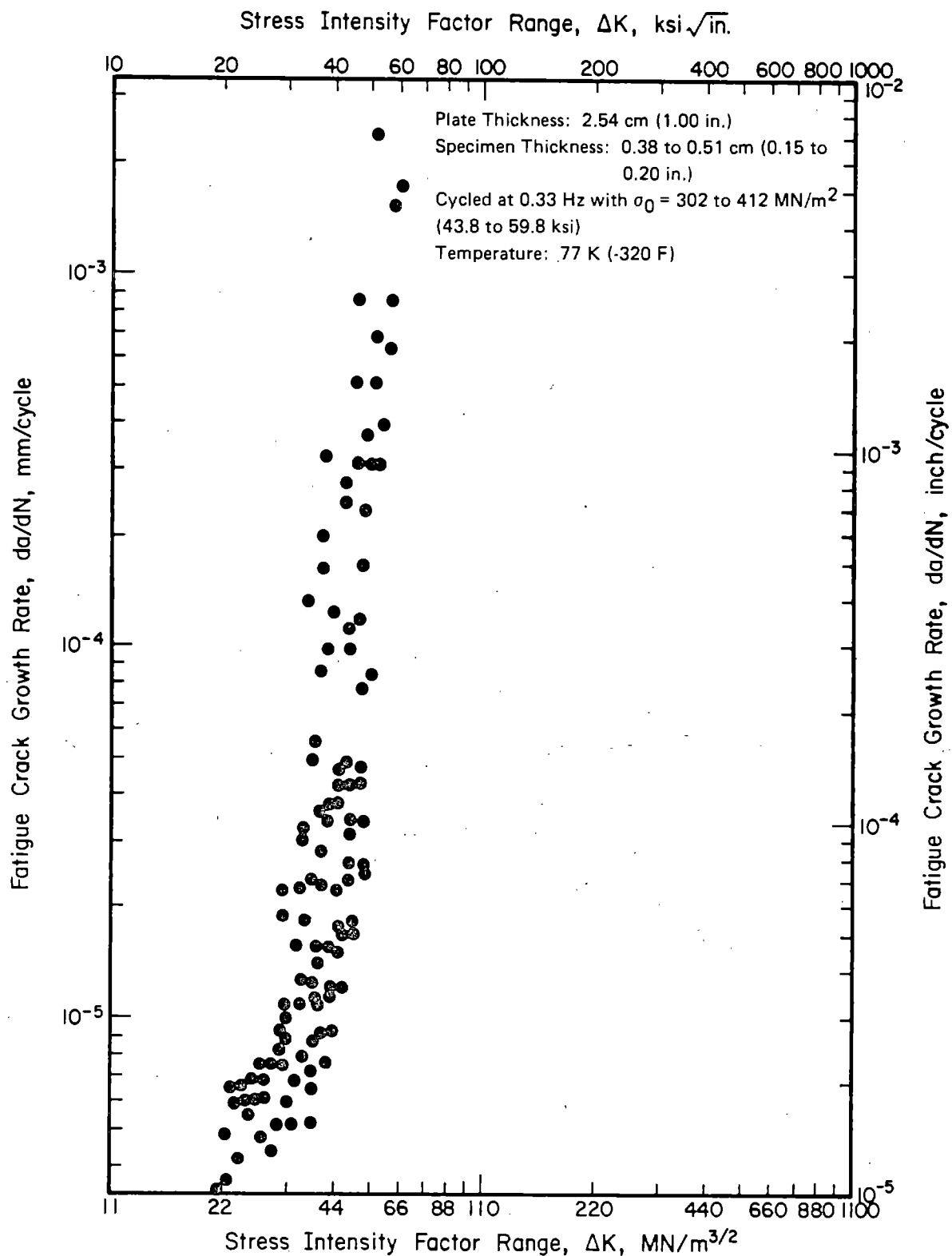


FIGURE 4.2.2-ME7. FATIGUE CRACK GROWTH RATE OF 2219-T87 ALUMINUM ALLOY PLATE
 [Crack orientation T-S: crack plane parallel to rolling direction; propagation
 through the plate thickness] [89716]

4.2.2-27.4 (11/76)

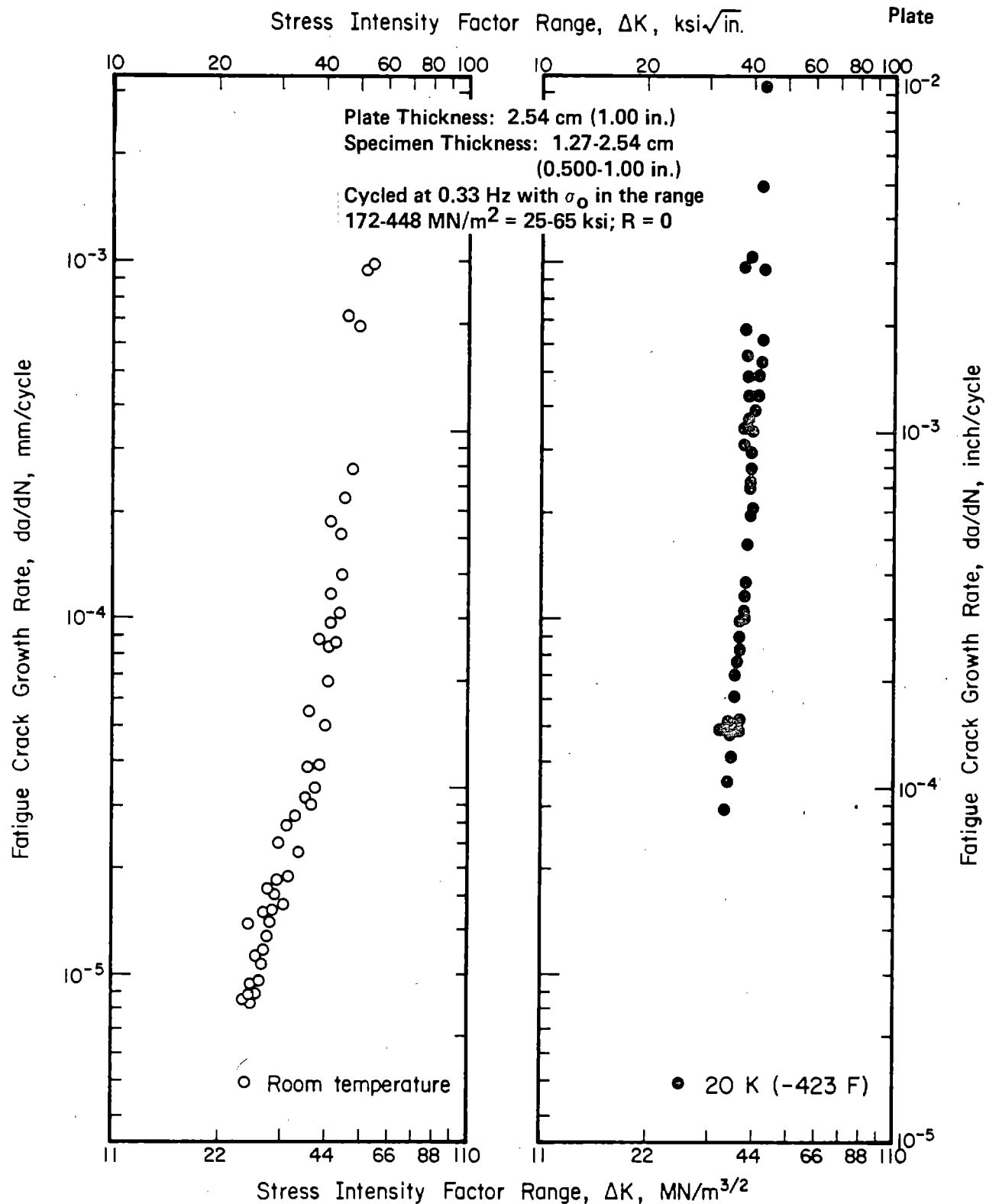


FIGURE 4.2.2-ME8. FATIGUE CRACK GROWTH RATE OF 2219-T87 ALUMINUM ALLOY PLATE AT ROOM TEMPERATURE AND -20 K (-423 F) [Crack orientation T-S: crack plane parallel to rolling direction, propagation through the plate thickness] [86296]

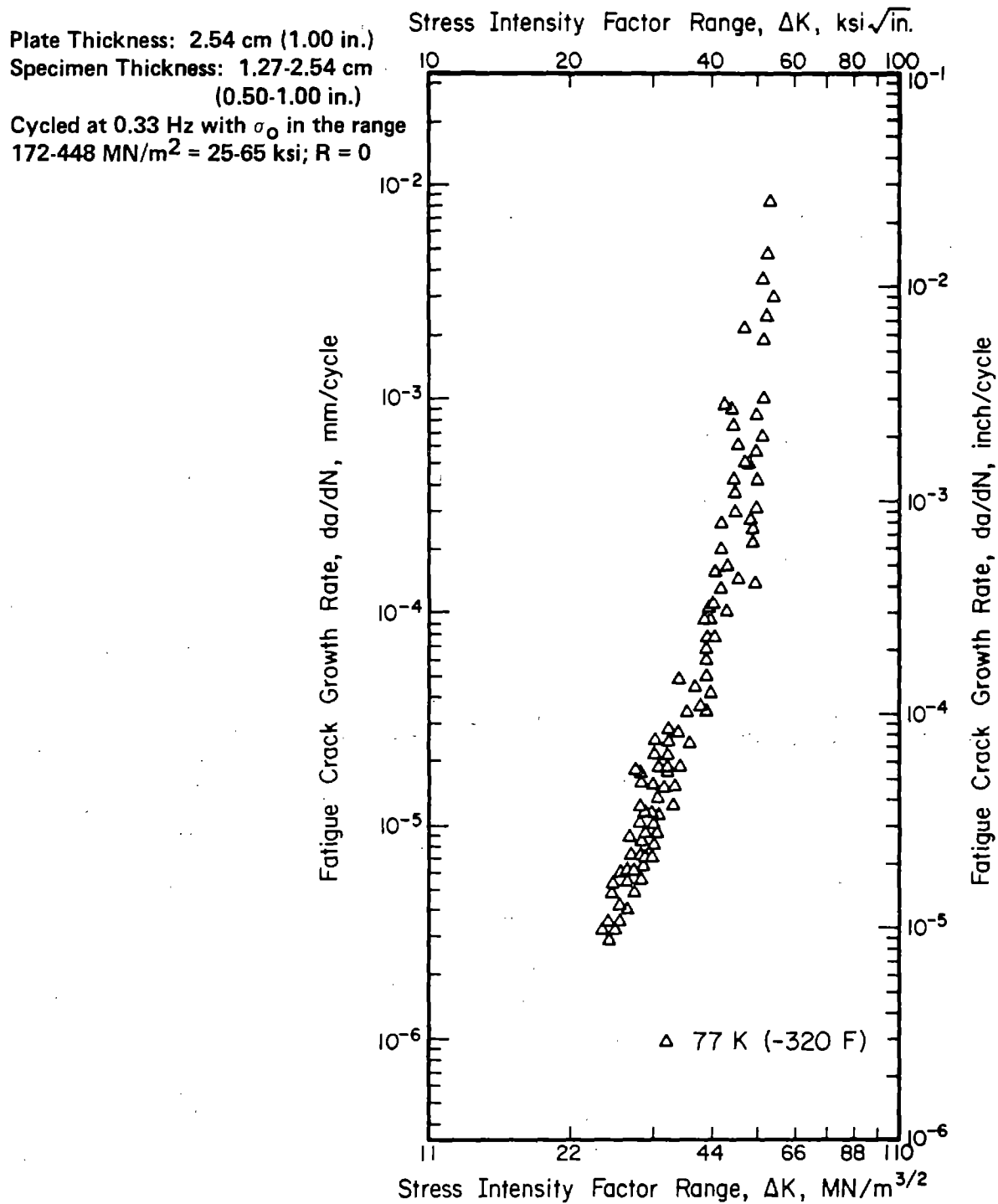


FIGURE 4.2.2-ME9. FATIGUE CRACK GROWHT RATE OF 2219-T87 ALUMINUM ALLOY
 PLATE AT 77 K (-320 F) [Crack orientation T-S: crack plane parallel
 to rolling direction, propagation through the plate thickness] [89716]

4.2.2-27.6 (11/76)

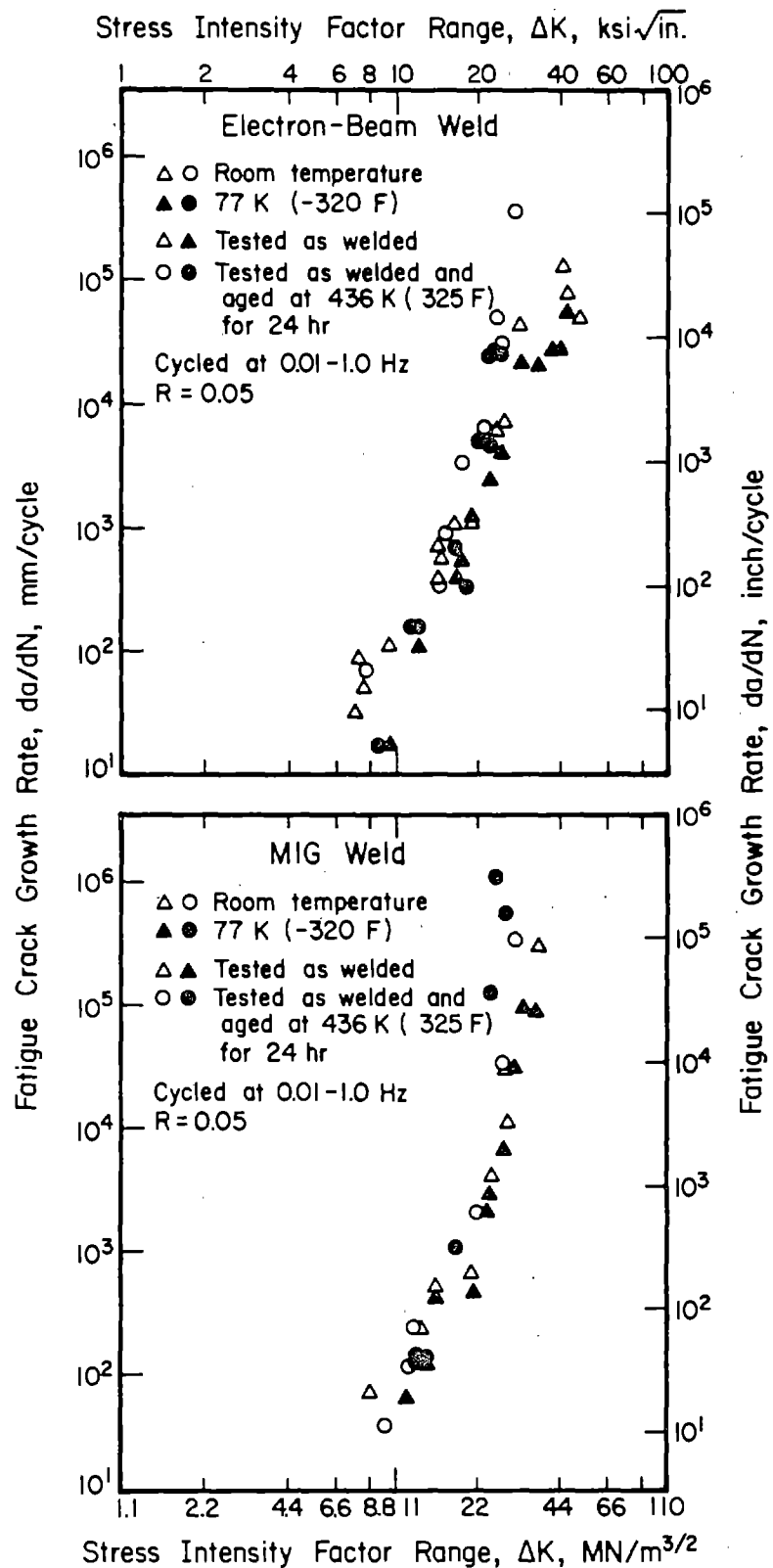


FIGURE 4.2.2-ME10. FATIGUE CRACK GROWTH RATE OF 2219-T87 ALUMINUM ALLOY PLATE EB AND MIG WELDED (2319 ALLOY FILLER) [Transverse weld orientation] [88109]
 Plate thickness=8.25 cm (3.25 in.); Specimen thickness=5.08 cm (2.00 in.)

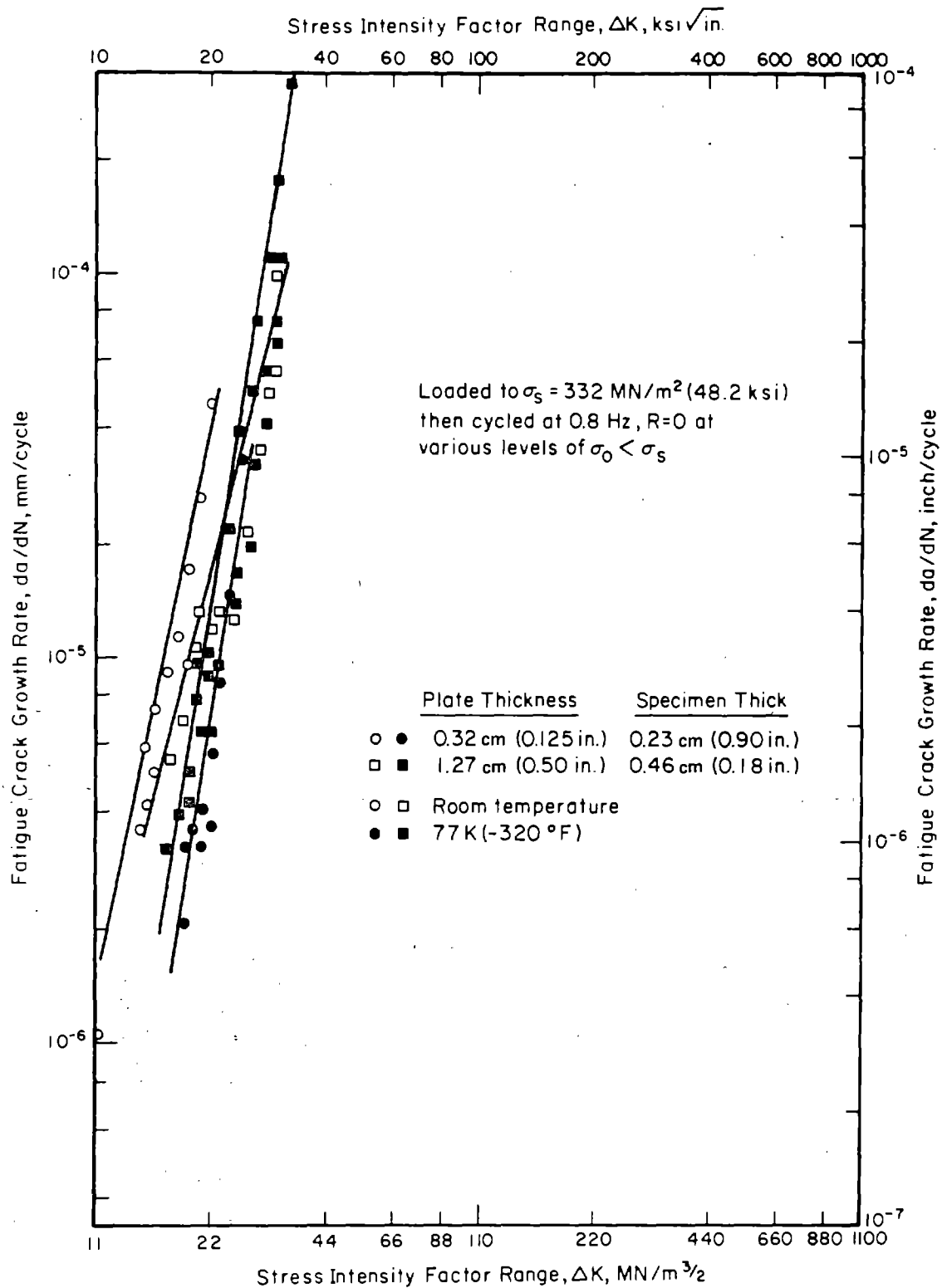


FIGURE 4.2.2-ME11. FATIGUE CRACK GROWTH RATE OF 2219-T62 ALUMINUM ALLOY
[Crack orientation L-S: crack plane transverse to rolling direction,
propagation through the plate thickness] [87612]

4.2.2-27.8 (11/76)

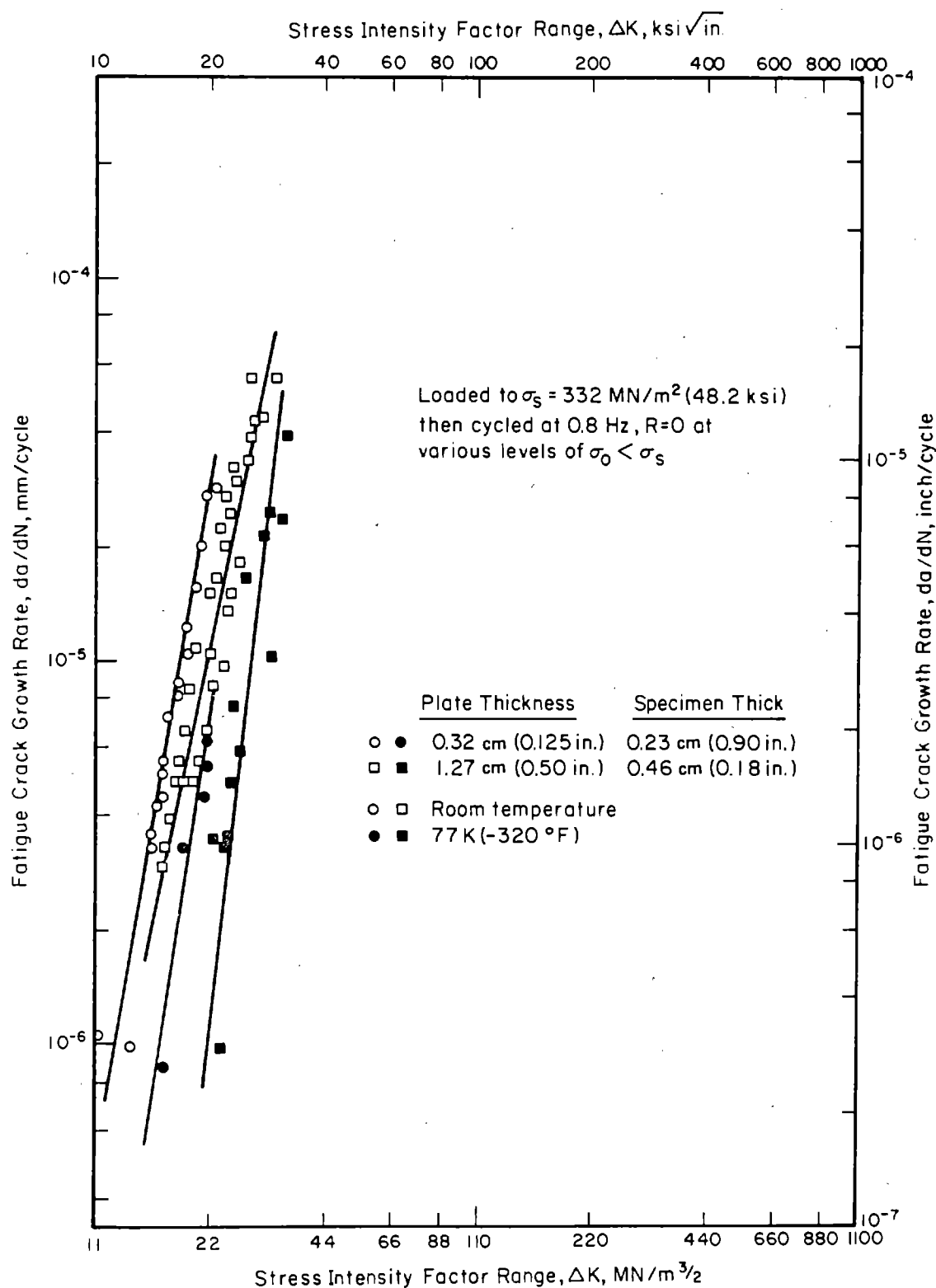


FIGURE 4.2.2-ME12. FATIGUE CRACK GROWTH RATE OF 2219 ALUMINUM ALLOY PLATE MIG WELDED (2319 ALLOY FILLER), HEAT TREATED TO T62, AND TESTED [Transverse weld orientation] [87612]

TABLE 4.2.2-TR1

Alloy Designation: 2219-T81 Aluminum Alloy

Specification:

Form:

Dimension:

Condition: -T81

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	118	68	45.5	26.3		
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(68.2)	(39.3)	(26.3)	(15.2)		
No. of Spec.	1	1	1	1		
References: 90218						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.313	-0.346	-0.350		
No. of Spec.	1	1	1	1		
References: 48571						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

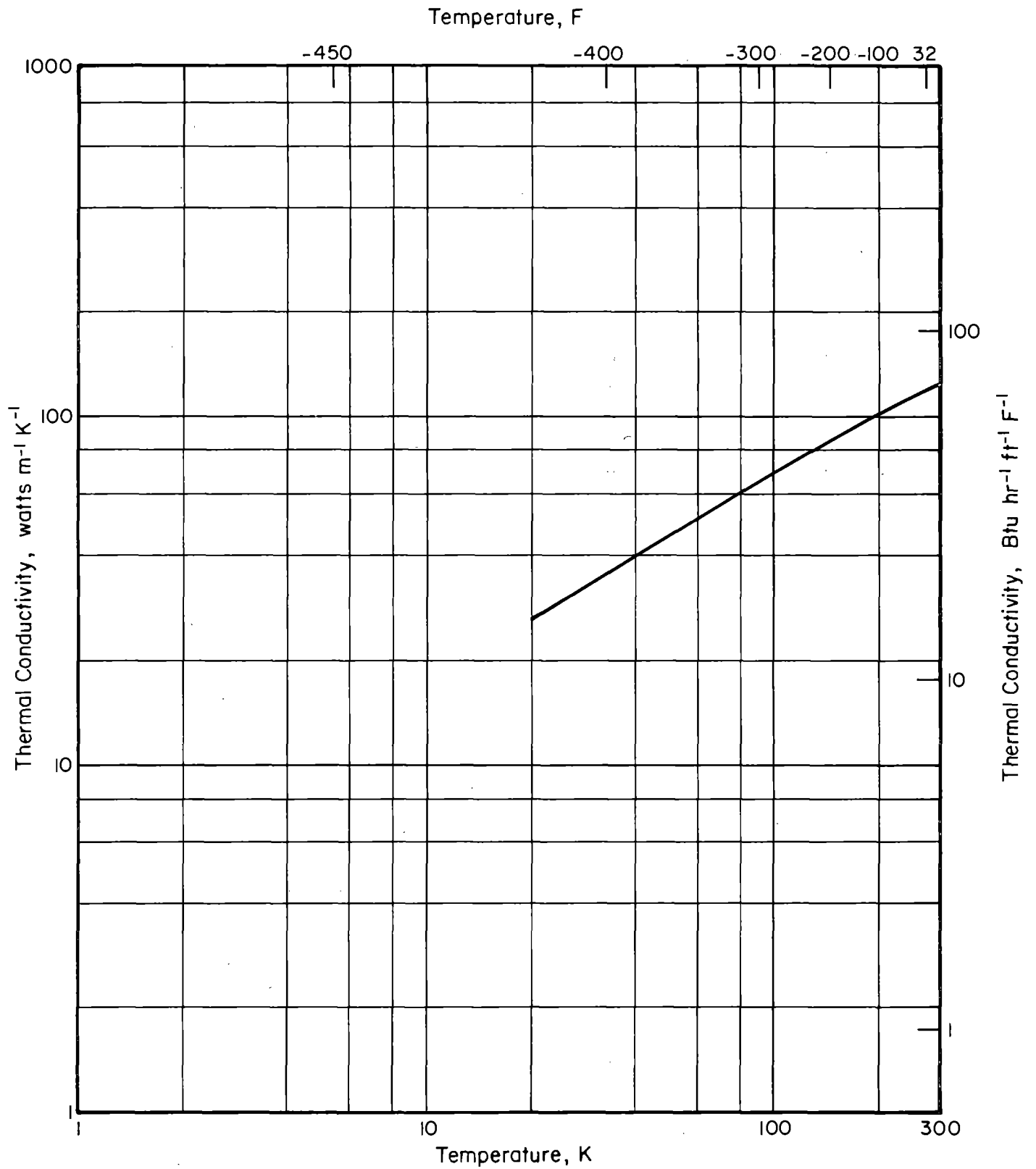


FIGURE 4.2.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2219-T81

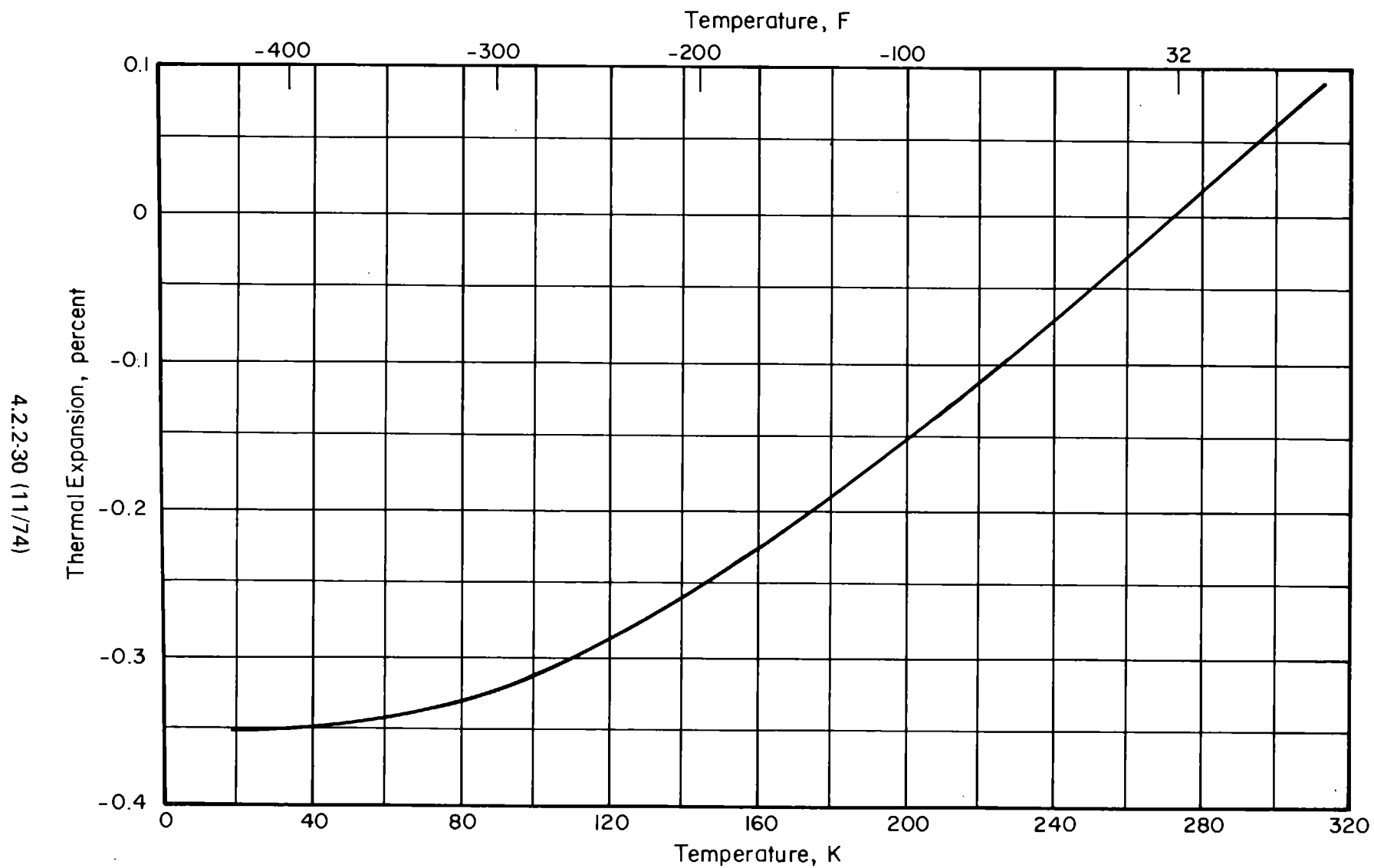


FIGURE 4.2.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2219-T81

TABLE 4.2.3-ME1

Alloy Designation: 2024-T3 Aluminum Alloy

Specification: QQ-A-355
 Form: Sheet
 Thickness, cm (in.): Up to 0.099 (0.039)
 Condition: T3

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	468 (67.9)	484 (70.2)		600 (87.0)	758 (110)	
	Min	467 (67.8)	482 (69.9)		594 (86.1)	752 (109)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	327 (47.4)	337 (48.9)		420 (60.9)	504 (73.1)	
	Min	324 (47.0)	332 (48.1)		415 (60.2)	489 (70.9)	
Std. Deviation							
Elong, percent	Avg	18	21		22	17	
	Min	18	20		22	14	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)		3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	70.3 (10.2)	72.4 (10.5)		75.2 (10.9)	78.6 (11.4)	
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)		3 (1)	3 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	415 (60.2)	422 (61.2)		525 (76.2)	612 (88.8)	
	Min	412 (59.8)	414 (60.0)		520 (75.4)	585 (84.8)	
K _t = 6.3							
No. of Spec. (No. of Heats)		3 (1)	3 (1)		3 (1)	4 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	454 (65.8)	467 (67.8)		575 (83.4)	738 (107)	
	Min	451 (65.4)	467 (67.7)		574 (83.2)	731 (106)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	303 (43.9)	307 (44.5)		387 (56.1)	476 (69.0)	
	Min	302 (43.8)	303 (44.0)		384 (55.7)	475 (68.9)	
Std. Deviation							
Elong, percent	Avg	18	21		22	18	
	Min	18	21		22	17	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	71.0 (10.3)	73.1 (10.6)		75.8 (11.0)	79.3 (11.5)	
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	434 (62.9)	433 (62.8)		515 (74.7)	598 (86.8)	
	Min	432 (62.6)	432 (62.7)		510 (73.9)	589 (85.4)	
K _t = 6.3							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90073, 90078

TABLE 4.2.3-ME2

Alloy Designation: 2024-T4 Aluminum Alloy

Specification: QQ-A-355

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: T4

Testing Temperature, K (F)		297 (75)		195 (-108)		77 (-320)		20 (-423)	
Tension, Longitudinal									
TUS, MN/m ² (ksi)	Avg	467	(67.7)	481	(69.8)	585	(84.9)	738	(107)
	Min	461	(66.9)	480	(69.6)	578	(83.9)	710	(103)
Std. Deviation									
TYS, MN/m ² (ksi)	Avg	295	(42.8)	301	(43.7)	373	(54.1)	505	(73.3)
	Min	294	(42.6)	296	(43.0)	361	(52.4)	489	(70.9)
Std. Deviation									
Elong, percent	Avg	19		22		27		16	
	Min	19		20		24		12	
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)
E, GN/m ² (10 ⁶ psi)	Avg	73.8	(10.7)	73.7	(10.7)	77.2	(11.2)	80.0	(11.6)
	Min								
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg	407	(59.0)	419	(60.7)	496	(71.9)	609	(88.3)
K _t = 6.3	Min	402	(58.3)	414	(60.1)	491	(71.2)	588	(85.3)
No. of Spec. (No. of Heats)		3	(1)	3	(1)	3	(1)	3	(1)
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m ² (ksi)	Avg	463	(67.1)	469	(68.0)	564	(81.8)	669	(97.1)
	Min	447	(64.8)	463	(67.2)	561	(81.3)	650	(94.3)
Std. Deviation									
TYS, MN/m ² (ksi)	Avg	286	(41.5)	294	(42.7)	370	(53.6)	465	(67.5)
	Min	279	(40.5)	292	(42.4)	369	(53.5)	461	(66.8)
Std. Deviation									
Elong, percent	Avg	20		24		19		10	
	Min	20		23		16		10	
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		2	(1)	2	(1)	2	(1)	2	(1)
E, GN/m ² (10 ⁶ psi)	Avg	71.7	(10.4)	73.7	(10.7)	75.8	(11.0)	80.0	(11.6)
	Min								
No. of Spec. (No. of Heats)		2	(1)	3	(1)	2	(1)	2	(1)
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg	396	(57.5)	406	(58.9)	470	(68.2)	589	(85.4)
K _t = 6.3	Min	396	(57.5)			453	(65.7)	587	(85.1)
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									

References: 90073, 90078

TABLE 4.2.3-ME3

Alloy Designation: 2024-T3 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T3

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)		
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	467 (67.8)	490 (71.0)	517 (75.0)	566 (82.1)		
	Min	459 (66.6)			565 (82.0)		
Std Deviation							
TYS, MN/m ² (ksi)	Avg	306 (44.4)	310 (45.0)	345 (50.0)	377 (54.7)		
	Min	303 (44.0)			372 (54.0)		
Std Deviation							
Elong, percent	Avg	20.0	13.0	11.5	18.8		
	Min	20.0			11.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (2)	1	1	2 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	406 (58.9)	427 (62.0)	462 (67.0)	487 (70.6)		
	Min	399 (57.8)			470 (68.2)		
K _t = 11.1							
No. of Spec. (No. of Heats)		2 (2)	1	1	2 (2)		
NTS, MN/m ² (ksi)	Avg	376 (54.6)			445 (64.6)		
	Min						
K _t = 15.0							
No. of Spec. (No. of Heats)		1			1		
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 47334, 90188

TABLE 4.2.3-ME4

2024-T86
Sheet

Alloy Designation: 2024-T86 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T86

Testing Temperature, K (F)	297 (75)			77 (-320)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 523 (75.8)			629 (91.2)		
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 492 (71.3)			576 (83.5)		
	Min					
Std. Deviation						
Elong, percent	Avg 5.2			8.0		
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	1			1		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 444 (64.4)			449 (65.1)		
	Min					
K _t = 11.1						
No. of Spec. (No. of Heats)	1			1		
NTS, MN/m ² (ksi)	Avg 456 (66.2)			488 (70.8)		
	Min					
K _t = 15						
No. of Spec. (No. of Heats)	1			1		
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 90188

TABLE 4.2.3-ME5

Alloy Designation: 2024-T351 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T351

Testing Temperature, K (F)		297 (75)		20 (-423)	
<u>Tension, Longitudinal</u>					
TUS, MN/m ² (ksi)	Avg	463	(67.1)	738	(107)
	Min	456	(66.1)	724	(105)
Std. Deviation					
TYS, MN/m ² (ksi)	Avg	347	(50.3)	532	(77.2)
	Min	343	(49.7)	523	(75.9)
Std. Deviation					
Elong, percent	Avg	21.6		22.3	
	Min	20		17	
RA, percent	Avg	28.2		20.3	
	Min	23		18	
No. of Spec. (No. of Heats)		5	(1)	5	(1)
E, GN/m ² (10 ⁶ psi)	Avg				
	Min				
No. of Spec. (No. of Heats)					
Poisson's Ratio					
Work Hardening Coef					
NTS, MN/m ² (ksi)	Avg	502	(72.8)	659	(95.6)
K _t = 6.4	Min	481	(69.8)	574	(83.2)
No. of Spec. (No. of Heats)		5	(1)	5	(1)
NTS, MN/m ² (ksi)	Avg				
K _t =	Min				
No. of Spec. (No. of Heats)					
<u>Tension, Transverse</u>					
TUS, MN/m ² (ksi)	Avg				
	Min				
Std. Deviation					
TYS, MN/m ² (ksi)	Avg				
	Min				
Std. Deviation					
Elong, percent	Avg				
	Min				
RA, percent	Avg				
	Min				
No. of Spec. (No. of Heats)					
E, GN/m ² (10 ⁶ psi)	Avg				
	Min				
No. of Spec. (No. of Heats)					
Poisson's Ratio					
Work Hardening Coef					
NTS, MN/m ² (ksi)	Avg				
K _t =	Min				
No. of Spec. (No. of Heats)					
NTS, MN/m ² (ksi)	Avg				
K _t =	Min				
No. of Spec. (No. of Heats)					

References: 64373

TABLE 4.2.3-ME6

2024-T4
Plate

Alloy Designation: 2024-T4 Aluminum Alloy

Specification: QQ-A-355

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T4

Testing Temperature, K (°F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	467 (67.7)	480 (69.6)		557 (80.8)	651 (94.4)	
	Min	451 (65.4)	474 (68.7)		546 (79.2)	632 (91.6)	
	Std. Deviation	13.4 (1.45)			11.1 (1.61)	12.6 (1.82)	
TYS, MN/m ² (ksi)	Avg	367 (53.3)	377 (54.7)		459 (66.5)	556 (80.6)	
	Min	359 (52.1)	370 (53.6)		445 (64.6)	550 (79.8)	
	Std. Deviation	10.0 (1.45)			8.07 (1.17)	7.10 (1.03)	
Elong, percent	Avg	17.1	17.2		11.3	7.9	
	Min	11.5	15.5		6	5	
RA, percent	Avg	17	4		11	9	
	Min	12	2		11	5	
No. of Spec. (No. of Heats)		9 (2)	7 (2)		9 (2)	9 (2)	
E, GN/m ² (10 ⁶ psi)	Avg	(72.4) (10.5)	73.1 (10.6)		75.2 (10.9)	80.0 (11.6)	
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)		3 (1)	3 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	478 (69.3)	508 (73.7)		581 (84.3)	672 (97.4)	
	Min	412 (59.8)	437 (63.4)		529 (76.7)	606 (87.9)	
	K _t = 6.3						
No. of Spec. (No. of Heats)		9 (2)	7 (2)		9 (2)	9 (2)	
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	461 (66.9)	458 (66.4)		556 (80.6)	645 (93.6)	
	Min	457 (66.3)	450 (65.3)		554 (80.4)		
	Std. Deviation						
TYS, MN/m ² (ksi)	Avg	314 (45.5)	312 (45.2)		350 (50.7)	479 (69.4)	
	Min	312 (45.3)					
	Std. Deviation						
Elong, percent	Avg	16	16		15	8	
	Min	16			12		
RA, percent	Avg	15	9		12	9	
	Min	15	5				
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	1	
E, GN/m ² (10 ⁶ psi)	Avg	73.1 (10.6)	73.1 (10.6)		76.5 (11.1)	79.3 (11.5)	
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	525 (76.2)	534 (77.4)		620 (89.9)	655 (95)	
	Min	519 (75.3)	513 (74.4)		616 (89.4)	655 (95)	
	K _t = 6.3						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							

References: 51070, 90073, 90078

TABLE 4.2.3-ME7

Alloy Designation: 2024-T851 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T851

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	496 (72.0)	536 (77.8)		688 (99.8)		720 (104.4)
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	454 (65.8)	492 (71.3)		574 (83.3)		625 (90.7)
	Min						
Std Deviation							
Elong, percent	Avg	7.8	6.0		7.7		9.5
	Min						
RA, percent	Avg	17	14		13		14
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	578 (83.8)	581 (84.2)		623 (90.4)		733 (106.3)
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	488 (70.8)	524 (76.0)		605 (87.7)		
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	444 (64.4)	477 (69.2)		545 (79.0)		
	Min						
Std Deviation							
Elong, percent	Avg	7.2	6.8		7.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1	1		1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 72563, 80995

TABLE 4.2.3-ME8

2024-T4
Bar

Alloy Designation: 2024-T4 Aluminum Alloy

Specification:

Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: T4

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	488 (70.8)	502 (72.8)	538 (78.0)	616 (89.4)	752 (109)	738 (107)
	Min	483 (70.0)	488 (70.8)		600 (87.0)	752 (109)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	363 (52.6)	365 (52.9)	379 (55.0)	470 (68.1)	586 (85)	524 (76)
	Min	345 (50.0)	354 (51.4)		441 (64.0)	586 (85)	
Std. Deviation							
Elong, percent	Avg	20.2	20.8	20.0	18.8	17.5	20.0
	Min	19.5	20.0		15.0	15.0	
RA, percent	Avg	29.7	25.8	22.6	18.1	18.6	20.8
	Min	26.6	24.3		16.5	18.0	
No. of Spec. (No. of Heats)		3 (2)	3 (2)	1	3 (2)	2 (1)	1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 35611, 47334

TABLE 4.2.3-ME9

2024-T4
Bar

Alloy Designation: 2024-T4 Aluminum Alloy

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: T4

Testing Temperature, K (F)	297 (75)	195 (-108)	122 (-240)	77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	12.8 (9.4)	12.2 (9.0)	10.1 (7.4)	8.7 (6.4)		
Min						
No. of Spec. (No. of Heats)	1	1	1	1		
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 47334

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 4.2.3-ME10

2024-T86
Bar

Alloy Designation: 2024-T86 Aluminum Alloy

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: T86

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	512 (74.2)	552 (80.0)		633 (91.8)	723 (104.9)	
	Min	510 (73.9)	551 (79.9)		628 (91.1)	720 (104.4)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	494 (71.6)	526 (76.3)		590 (85.6)	643 (93.2)	
	Min	493 (71.5)	525 (76.1)		590 (85.5)	641 (93.0)	
Std. Deviation							
Elong, percent	Avg	9.5	9.4		10.7	15.1	
	Min	9.3	9.1		10.6	14.6	
RA, percent	Avg	26.6	23.2		21.4	24.4	
	Min	25.7	22.3		20.8	23.1	
No. of Spec. (No. of Heats)		4 (1)	2 (1)		2 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 54986

TABLE 4.2.3-ME11

2024-T86
Bar

Alloy Designation: 2024-T86 Aluminum Alloy

Specification:

Form: Bar
 Thickness, cm (in.): Up to 2.540 (1.000)
 Condition: T86

Testing Temperature, K (F)	297 (75)	195 (-108)		77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	4.8 (3.5)	4.1 (3.0)		4.8 (3.5)		
Min	4.1 (3.0)	4.1 (3.0)		4.8 (3.5)		
No. of Spec. (No. of Heats)	4 (1)	4 (1)		3 (1)		
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation. —						
No. of Spec. (No. of Heats)						
K _{IIE} MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 54986

- (a) Indicate specimen design and orientation for shear specimens:
 (b) Indicate specimen design for K_{IC} data:

TABLE 4.2.3-ME12

2024-T351
Bar

Alloy Designation: 2024-T351 Aluminum Alloy

Specification:

Form: Bar
 Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
 Condition: T351

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	479 (69.4)			610 (88.5)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	365 (53.0)			478 (69.3)		
	Min						
Std. Deviation							
Elong, percent	Avg	19.5			19.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	562 (81.5)			682 (98.9)		
K _t = 2.4	Min	507 (73.6)			599 (86.9)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m ² (ksi)	Avg	518 (75.2)			625 (90.6)		
K _t = 13.3	Min	479 (69.5)			553 (80.2)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	472 (68.4)			594 (86.1)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	327 (47.4)			428 (62.1)		
	Min						
Std. Deviation							
Elong, percent	Avg	17.2			14.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	544 (78.9)			654 (94.8)		
K _t = 2.4	Min	499 (72.4)			576 (83.6)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m ² (ksi)	Avg	497 (72.1)			595 (86.3)		
K _t = 13.3	Min	463 (67.2)			545 (79.1)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		

References: 90188

TABLE 4.2.3-TR1

Alloy Designation: 2024-0 Aluminum Alloy

Specification:

Form:

Dimension:

Condition: (0)

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	184	158	150	77.9	39.5	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(106)	(91.4)	(86.7)	(45.0)	(22.8)	
No. of Spec	1	1	1	1	1	
References: 90195						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.303	-0.342	-0.348	-0.348	-0.348
No. of Spec	1	1	1	1	1	1
References: 74405						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec						
References:						
Electrical Resistivity						
Ohm m	3.26 x 10 ⁻⁸	1.15 x 10 ⁻⁸	0.700 x 10 ⁻⁸	0.608 x 10 ⁻⁸	0.605 x 10 ⁻⁸	0.605 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(19.6)	(6.92)	(4.21)	(3.66)	(3.64)	(3.64)
No. of Spec	13	13	13	13	13	13
References: 90164, 90195						

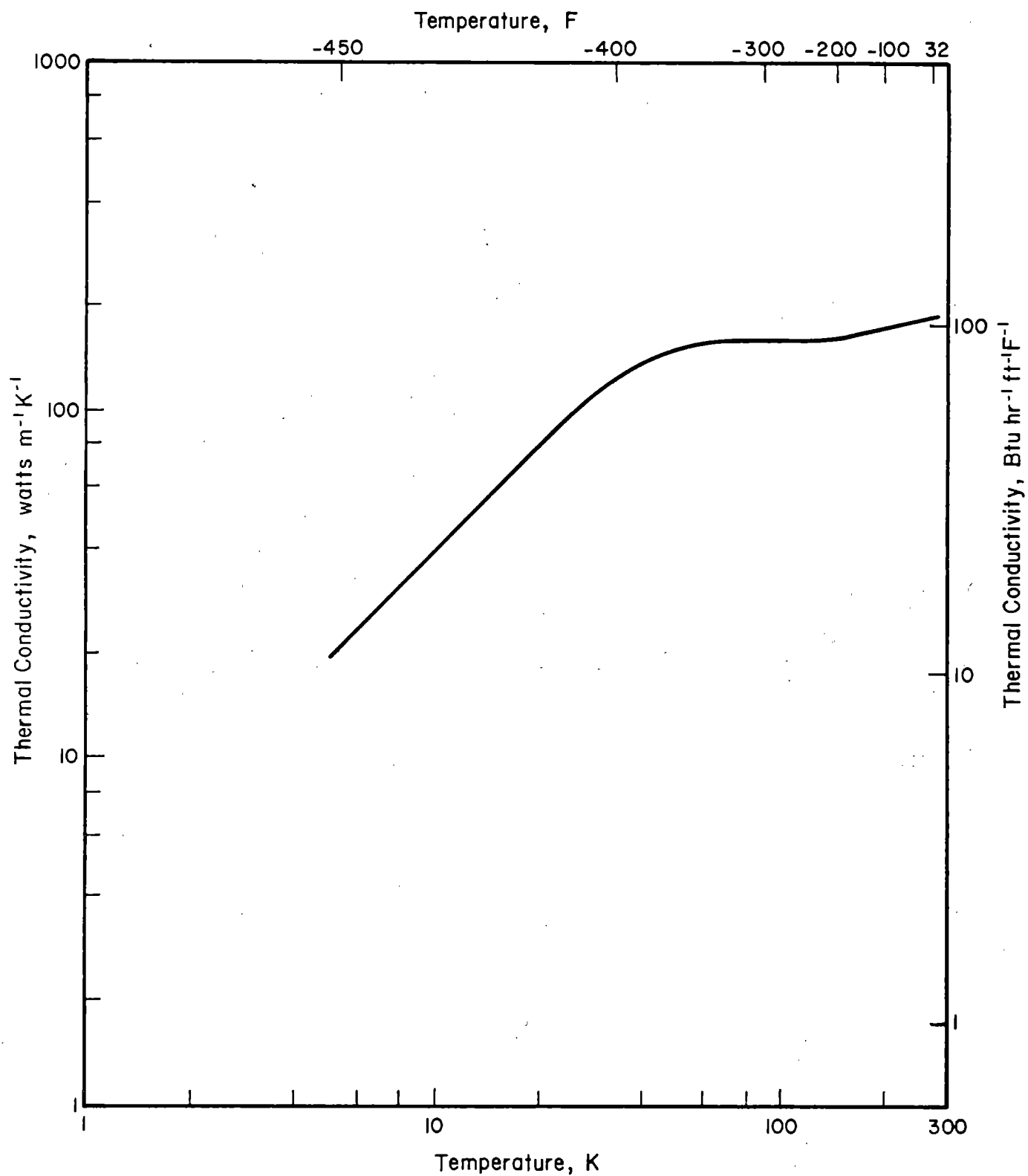


FIGURE 4.2.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-0

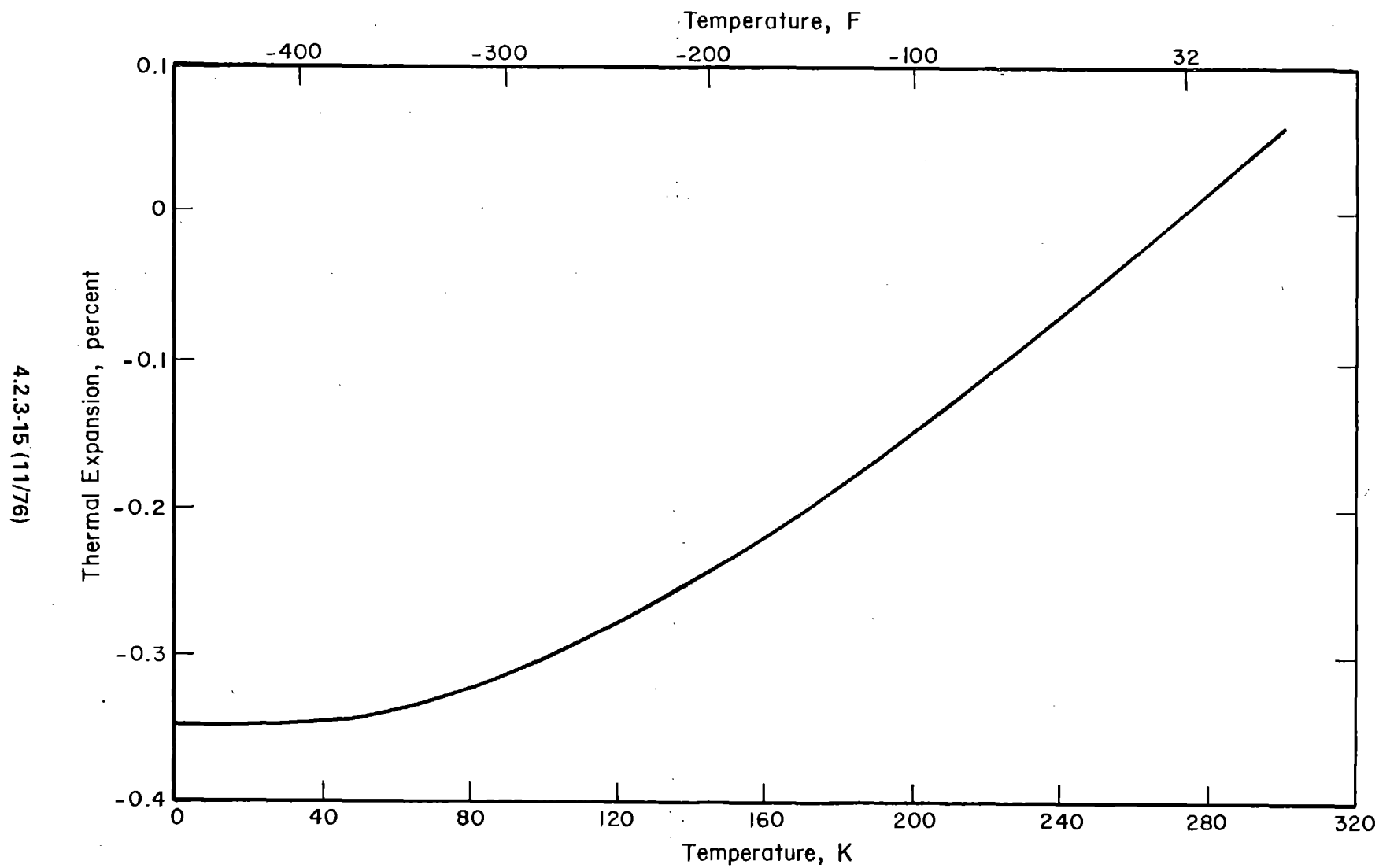


FIGURE 4.2.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-0

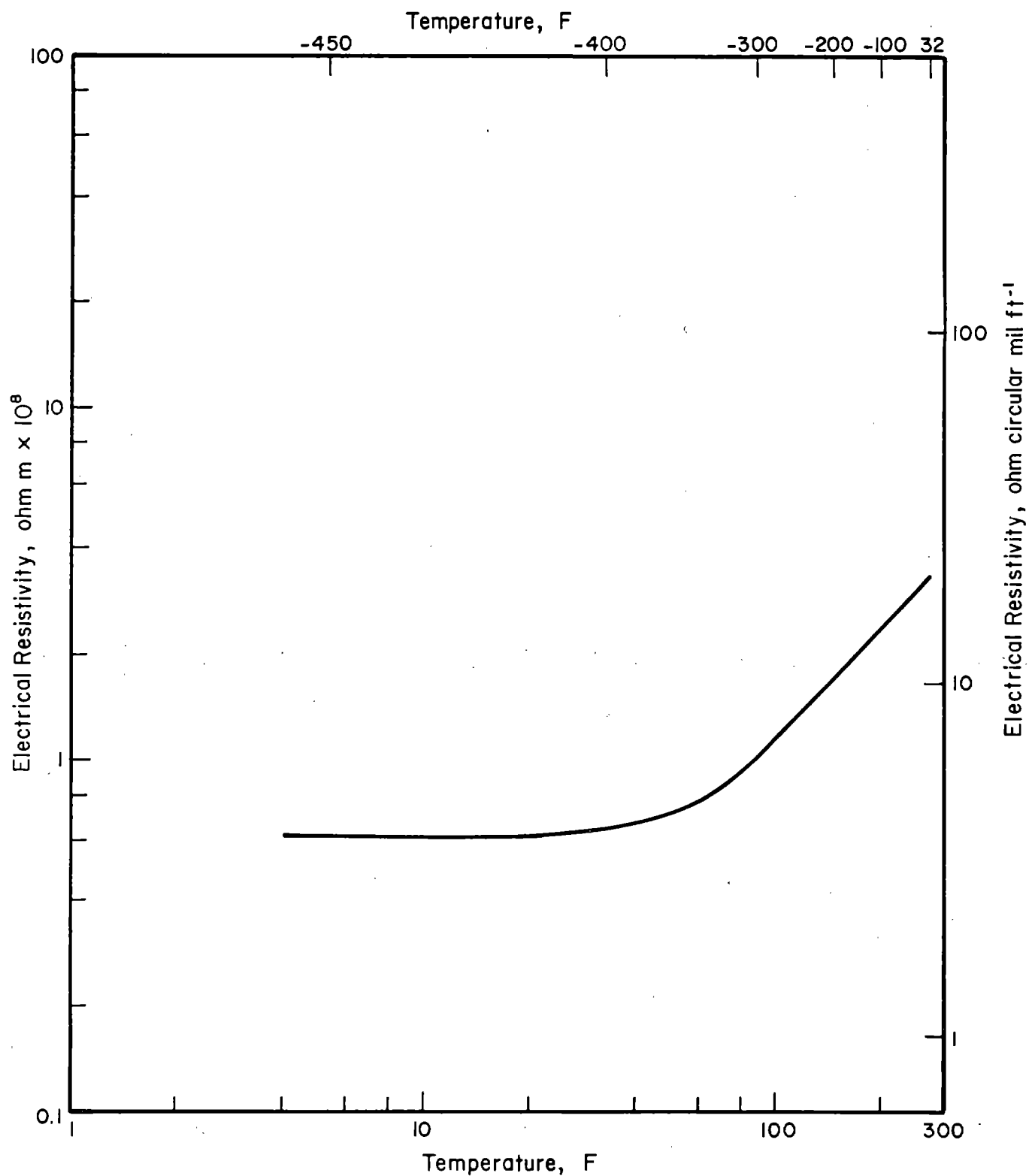


FIGURE 4.2.3-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-0

TABLE 4.2.3-TR2

Alloy Designation: 2024-T4 Aluminum Alloy

Specification:

Form:

Dimension:

Condition: T4

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹		64.5	39.0	17.0	8.32	3.15
Btu hr ⁻¹ ft ⁻¹ F ⁻¹		(37.3)	(22.6)	(9.83)	(4.81)	(1.82)
No. of Spec.		1	1	1	1	1
References: 90225						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	828	530				
Btu lb ⁻¹ F ⁻¹	(0.198)	(0.127)				
No. of Spec.	2	2				
References: 90223						
Electrical Resistivity						
Ohm m	5.54 x 10 ⁻⁸	3.60 x 10 ⁻⁸	3.20 x 10 ⁻⁸	3.08 x 10 ⁻⁸	3.08 x 10 ⁻⁸	3.08 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(33.3)	(21.6)	(19.2)	(18.5)	(18.5)	(18.5)
No. of Spec.	5	5	5	5	5	5
References: 90164						

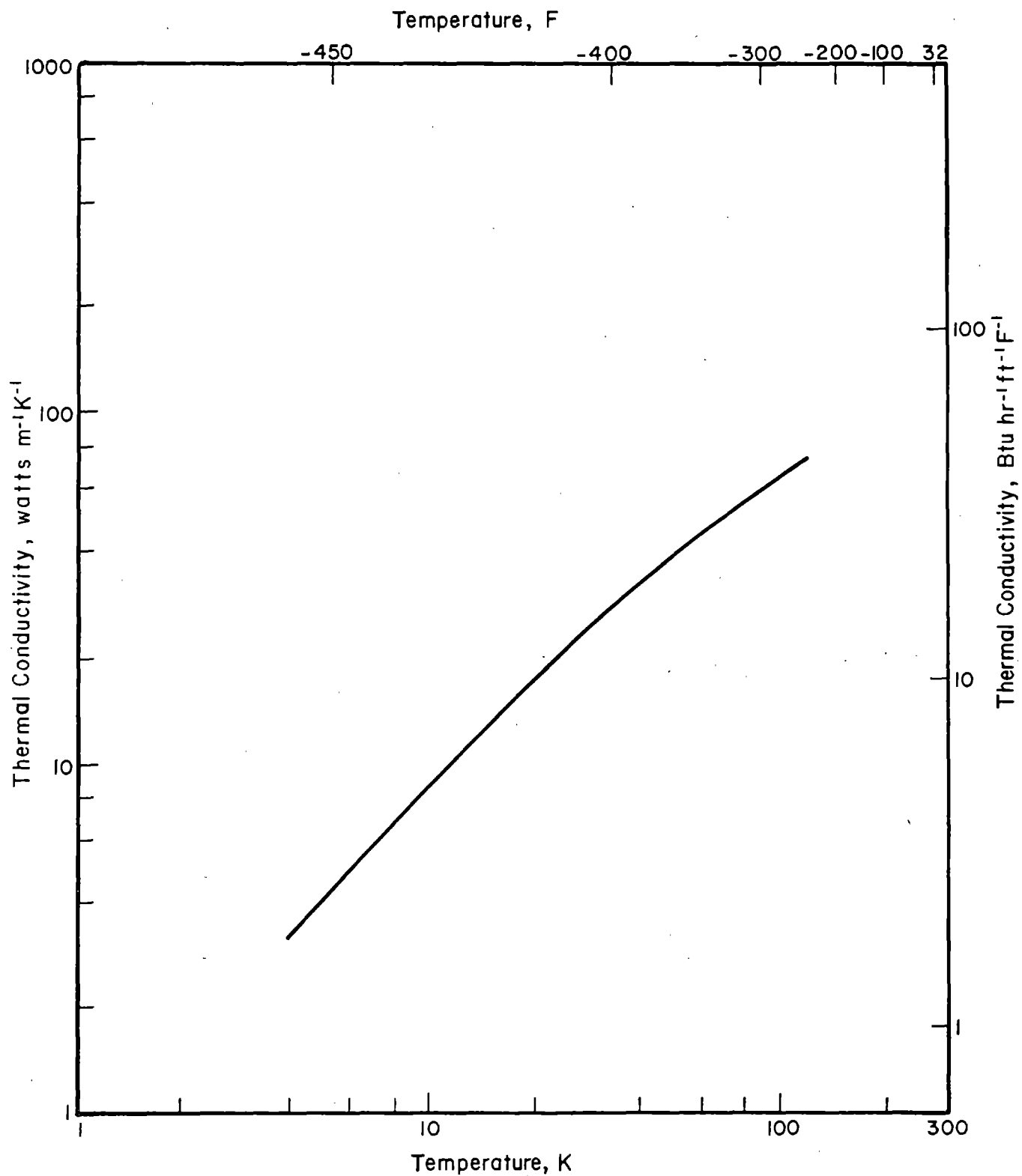


FIGURE 4.2.3-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T4

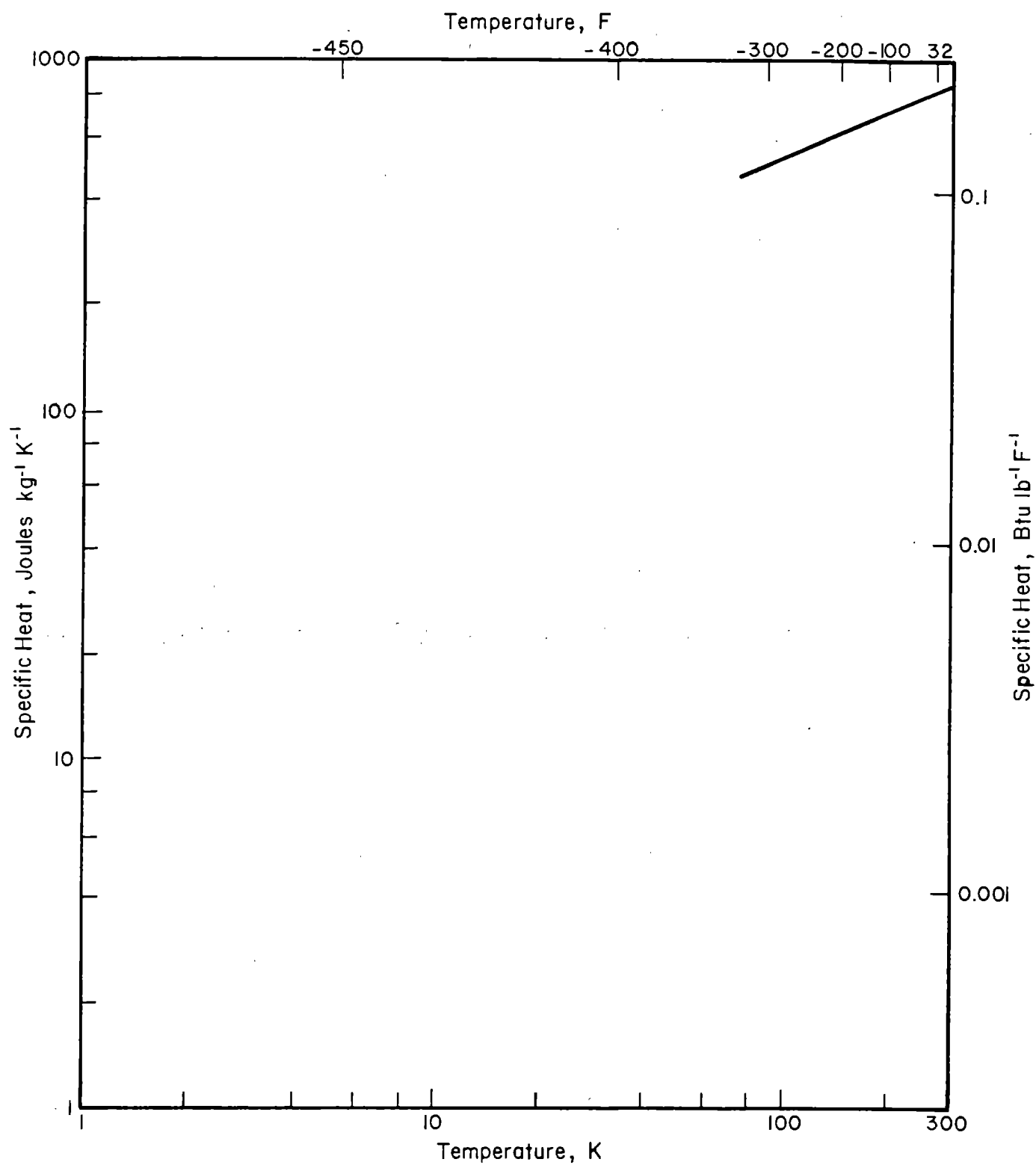


FIGURE 4.2.3-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T4

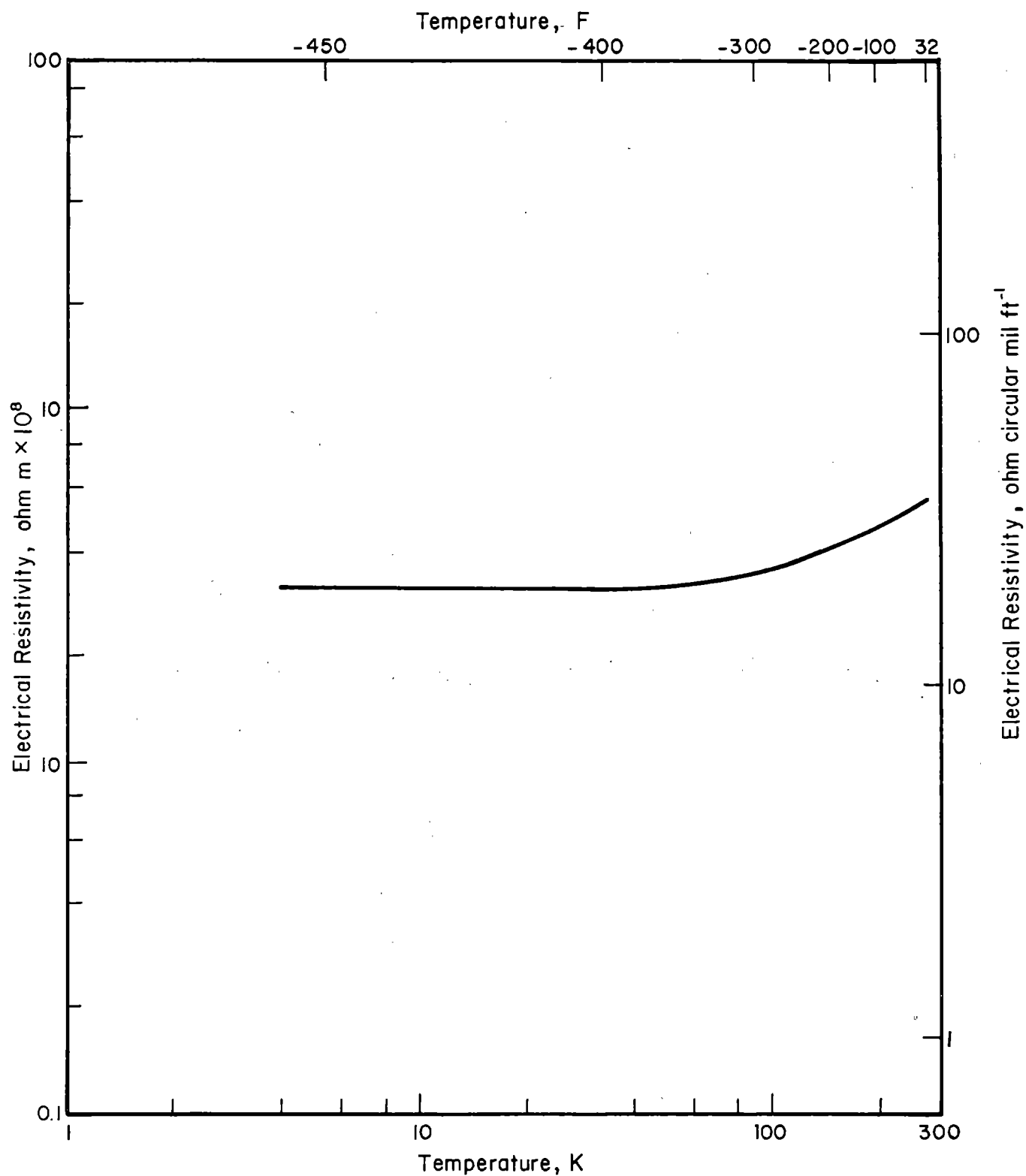


FIGURE 4.2.3-R2. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T4

TABLE 4.2.3-TR3

Alloy Designation: 2024-T6 Aluminum Alloy

Specification:

Form:

Dimension:

Condition: T6

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	4.61 x 10 ⁻⁸	2.47 x 10 ⁻⁸	2.05 x 10 ⁻⁸	1.99 x 10 ⁻⁸	1.98 x 10 ⁻⁸	1.98 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(27.7)	(14.9)	(12.3)	(12.0)	(11.9)	(11.9)
No. of Spec.	3	3	3	3	3	3
References: 90164						

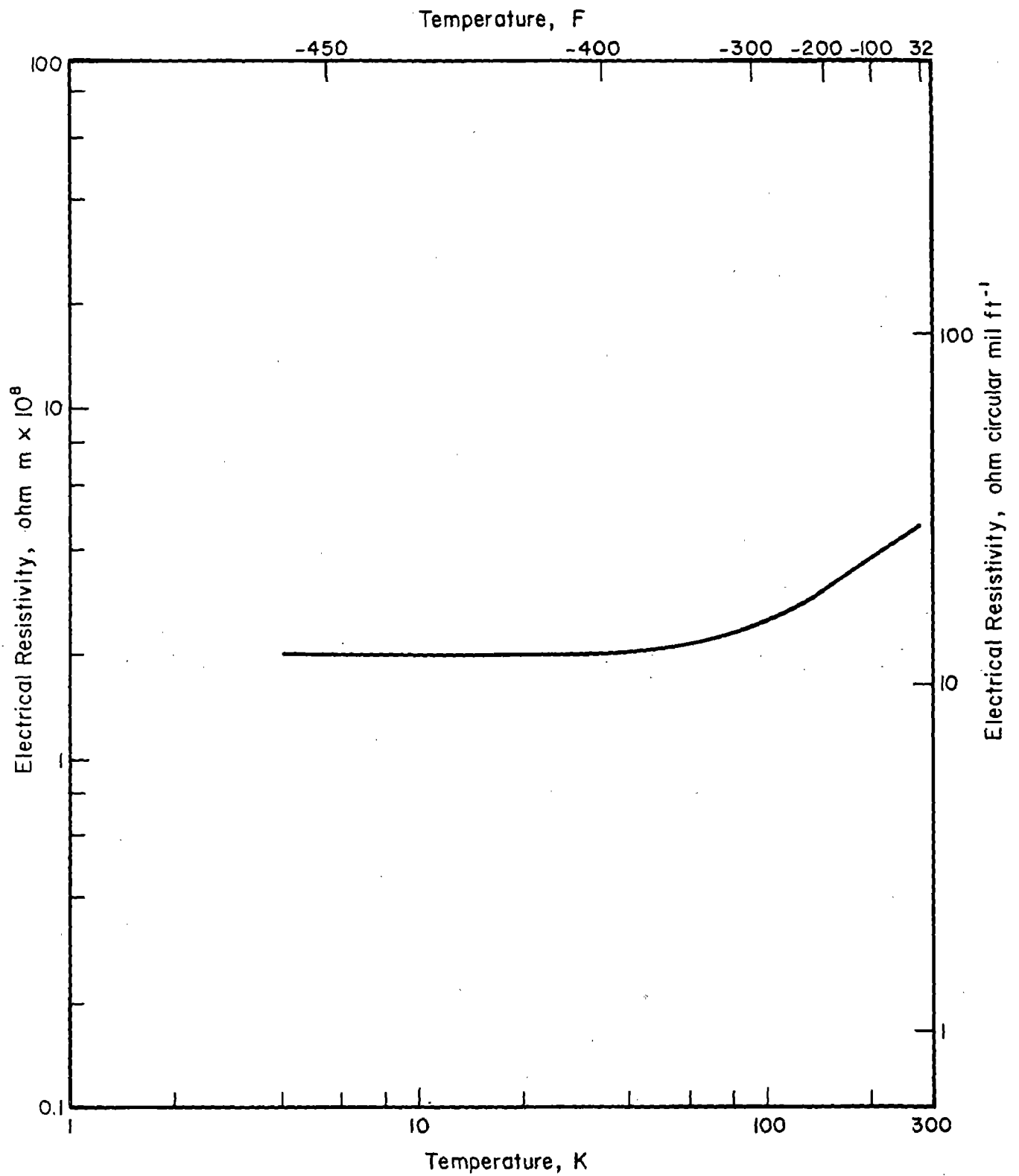


FIGURE 4.2.3-R3. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T6

4.2.3-22 (11/76)

TABLE 4.2.3-TR4

Alloy Designation: 2024-T86 Aluminum Alloy

Specification:

Form:

Dimension:

Condition: T86

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	150	101	71.1	31.8	15.7	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(86.5)	(58.4)	(41.1)	(18.4)	(9.08)	
No. of Spec	1	1	1	1	1	
References: 90195						
Thermal Expansion (T₂₇₃ to T)						
<u>Longitudinal</u>						
Percent	0	-0.308	-0.348	-0.353	-0.353	-0.353
No. of Spec	1	1	1	1	1	1
References: 74405						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec						
References:						
Electrical Resistivity						
Ohm m	4.22 x 10 ⁻⁸	2.13 x 10 ⁻⁸	1.69 x 10 ⁻⁸	1.59 x 10 ⁻⁸	1.59 x 10 ⁻⁸	1.59 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(25.4)	(12.8)	(10.2)	(9.56)	(9.56)	(9.56)
No. of Spec.	2	2	2	2	2	2
References: 90164, 90195						

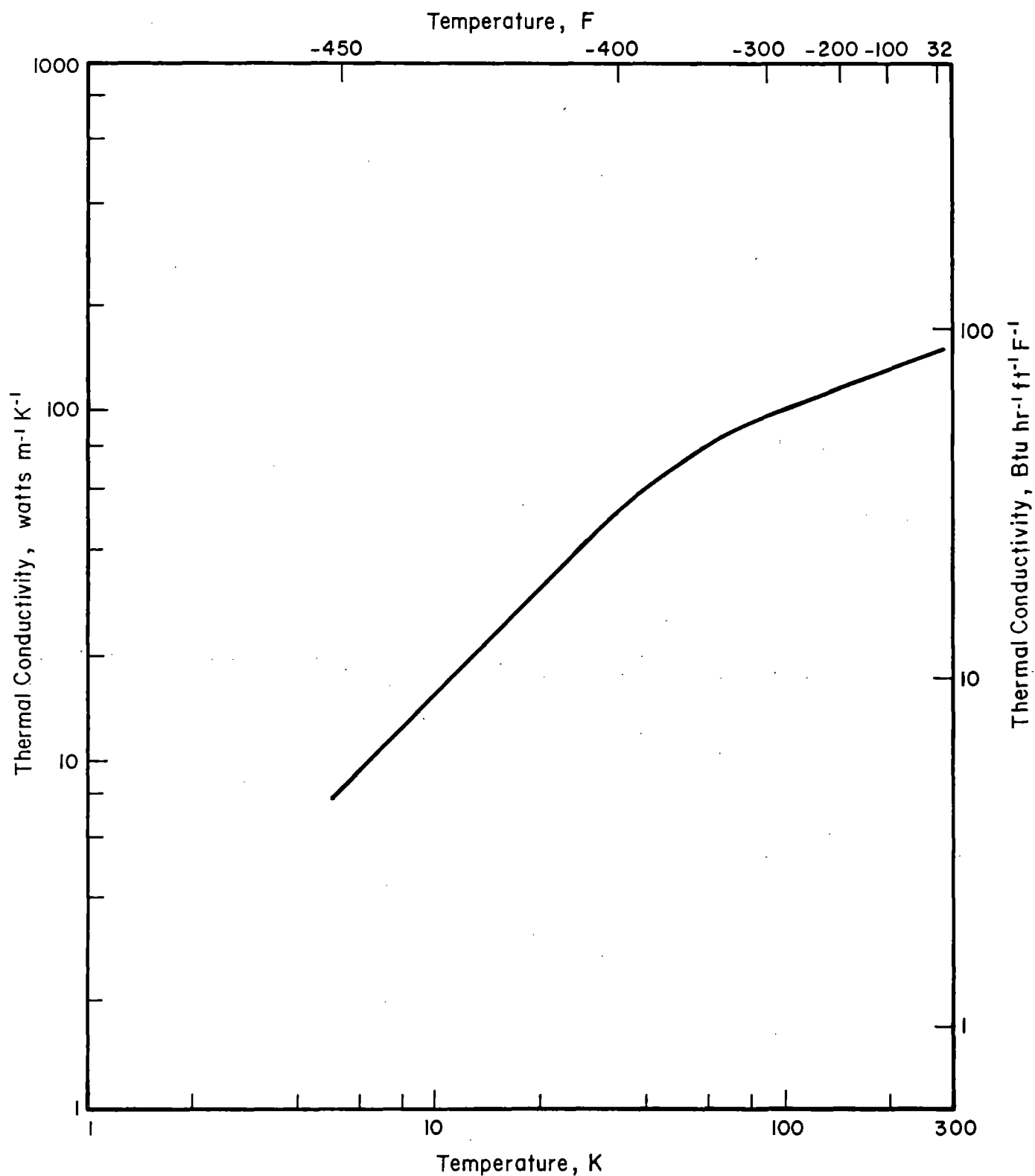


FIGURE 4.2.3-C3. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T86

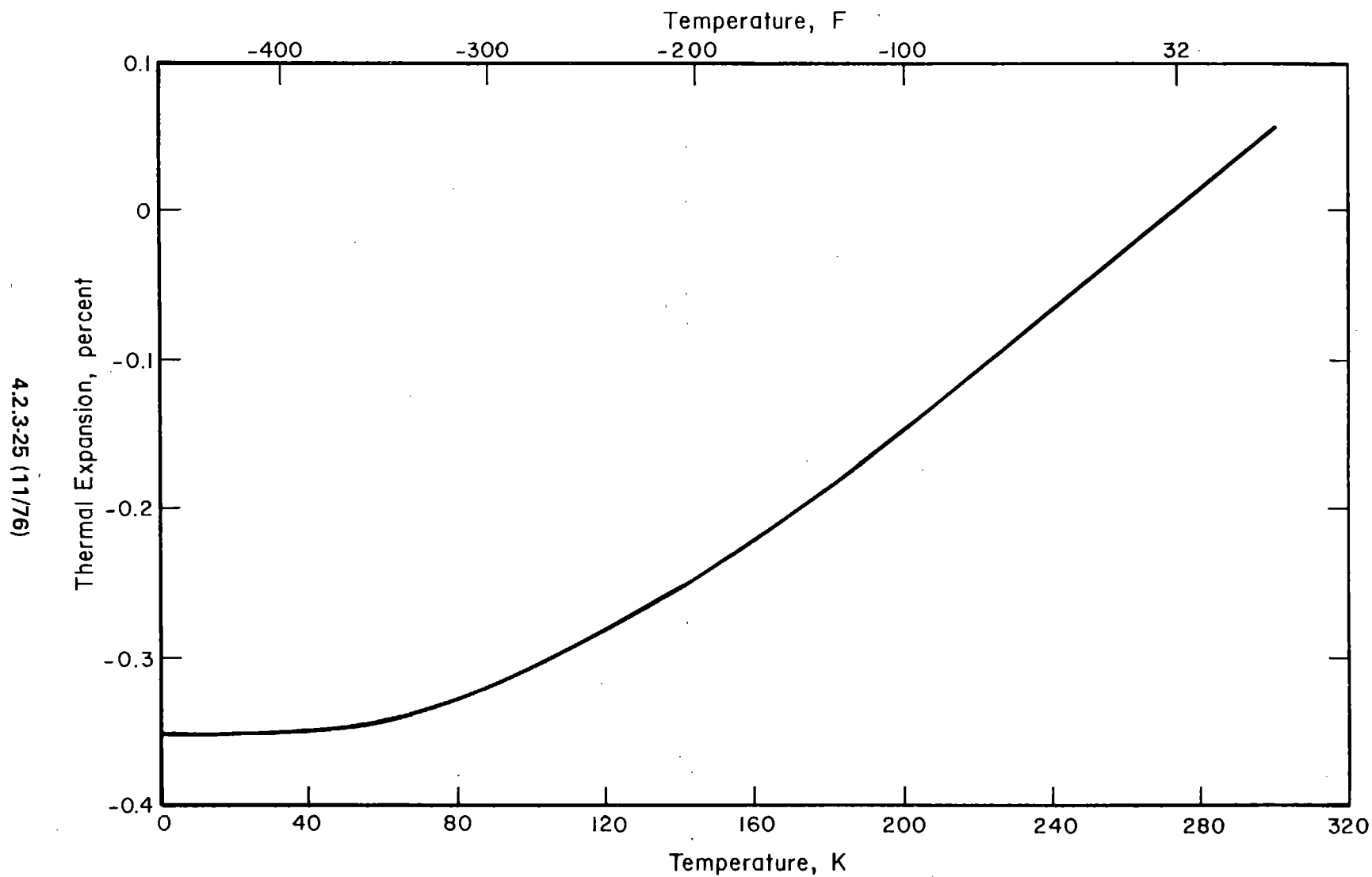


FIGURE 4.2.3-E2. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T86

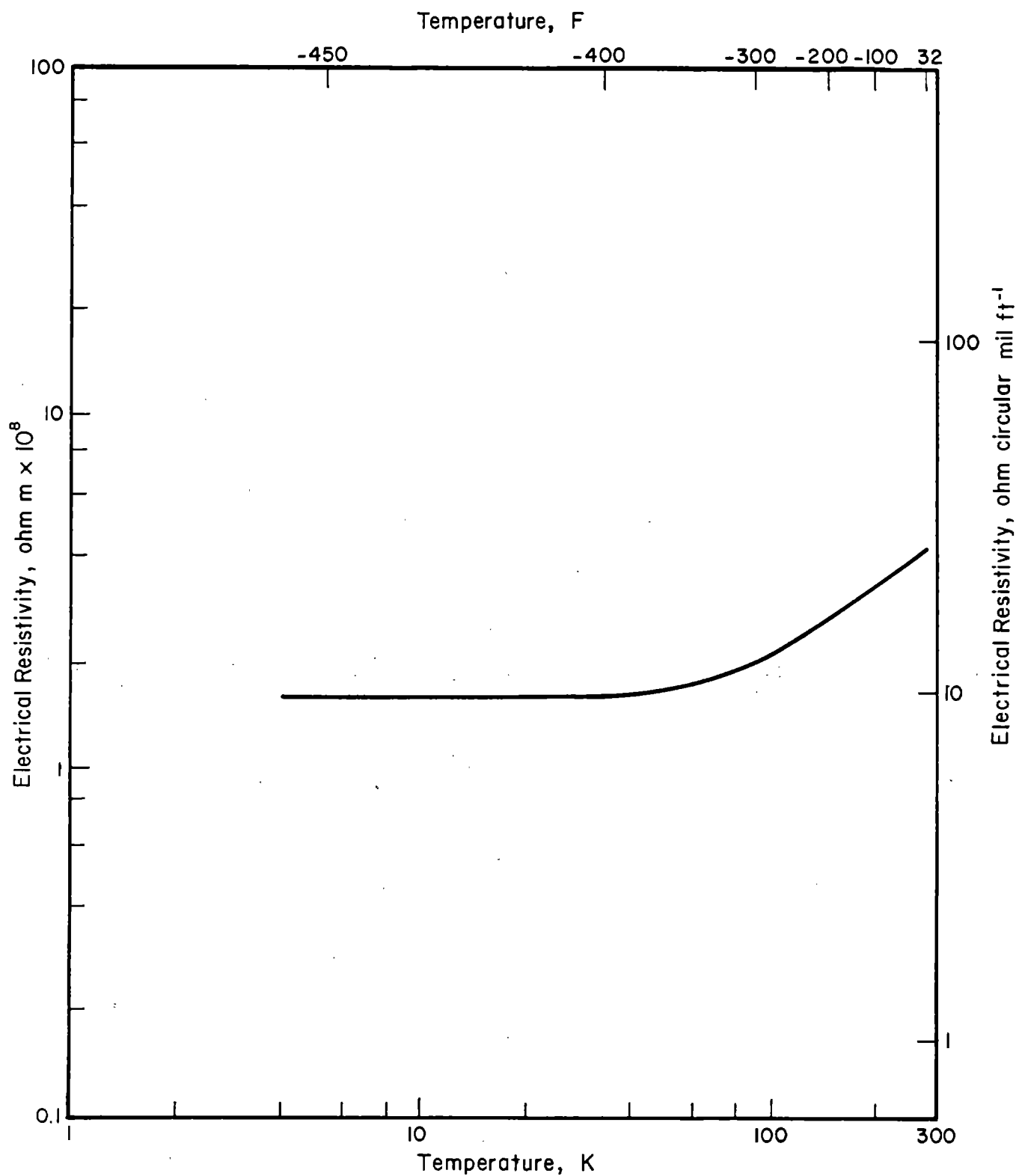


FIGURE 4.2.3-R4. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 2024-T86

TABLE 4.3.0-MA1

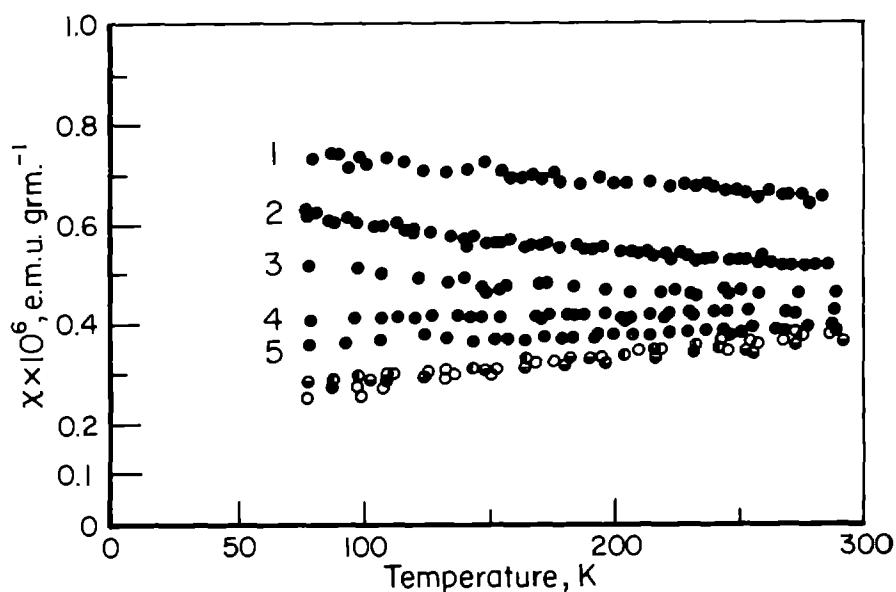
Alloy Designation: Series of Aluminum-Magnesium Alloys

Specification: Prepared from high-purity aluminum

Form: Cylindrical rod

Diameter, cm (in.): 0.4 (0.0157)

Condition: Argon arc melted, vacuum homogenized at a temperature just below the solidus for about 7 days and quenched in ice water. Machined specimens were vacuum strain annealed for about 24 hours.



1. Pure aluminum.
2. Aluminum + 1.60 at. % magnesium.
3. Aluminum + 2.72 at. % magnesium.
4. Aluminum + 3.62 at. % magnesium.
5. Aluminum + 4.70 at. % magnesium.
- . Aluminum + 5.65 at. % magnesium.
- ◐. Aluminum + 7.41 at. % magnesium.
- ◑. Aluminum + 9.25 at. % magnesium.

The temperature dependence of the magnetic susceptibility (χ) of aluminum-magnesium alloys.

Reference: 90493

TABLE 4.3.1-ME1

Alloy Designation: 5083-H38 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: H38

Testing Temperature, K (F)		297 (75)		77 (-320)		20 (-423)		
Tension, Longitudinal								
TUS, MN/m ² (ksi)	Avg	432 (62.7)		565 (82.0)		694 (101)		
	Min	431 (62.5)		563 (81.7)		684 (99.2)		
Std. Deviation								
TYS, MN/m ² (ksi)	Avg	390 (56.6)		448 (65.0)		493 (71.5)		
	Min	387 (56.2)		448 (65.0)				
Std. Deviation								
Elong, percent	Avg	5		14.5		12.5		
	Min	5		13		12		
RA, percent	Avg							
	Min							
No. of Spec. (No. of Heats)		2 (1)		2 (1)		2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Poisson's Ratio								
Work Hardening Coef								
NTS, MN/m ² (ksi)	Avg	428 (62.1)		530 (76.8)		600 (87.0)		
	Min	426 (61.8)		529 (76.7)		598 (86.7)		
K _t = 6.3								
No. of Spec. (No. of Heats)		2 (1)		2 (1)		2 (1)		
NTS, MN/m ² (ksi)	Avg							
	Min							
K _t =								
No. of Spec. (No. of Heats)								
Tension, Transverse								
TUS, MN/m ² (ksi)	Avg	449 (65.1)		556 (80.6)		668 (97.0)		
	Min	448 (65.0)		554 (80.3)		656 (95.2)		
Std. Deviation								
TYS, MN/m ² (ksi)	Avg	385 (55.8)		445 (64.6)		553 (75.8)		
	Min	383 (55.5)		442 (64.1)		501 (72.6)		
Std. Deviation								
Elong, percent	Avg	8.5		15.5		12		
	Min	8		14		12		
RA, percent	Avg							
	Min							
No. of Spec. (No. of Heats)		2 (1)		2 (1)		2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Poisson's Ratio								
Work Hardening Coef								
NTS, MN/m ² (ksi)	Avg	443 (64.2)		534 (77.4)		602 (87.3)		
	Min	441 (64.0)		529 (76.7)		580 (84.1)		
K _t = 6.3								
No. of Spec. (No. of Heats)		2 (1)		2 (1)		2 (1)		
NTS, MN/m ² (ksi)	Avg							
	Min							
K _t =								
No. of Spec. (No. of Heats)								

References: 90078

TABLE 4.3.1-ME2

Alloy Designation: 5083-H113 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: H113

Testing Temperature, K (F)	297 (75)		88 (-300)			
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	179 (26)		241 (35)			
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^5 cycles	0.57		0.54			
S_N at 10^6 cycles, MN/m ² (ksi)	141 (20.5)		190 (27.5)			
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^6 cycles	0.44		0.43			
S_N at 10^7 cycles, MN/m ² (ksi)	124 (18)		158 (23)			
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.39		0.36			

References: 90083

TABLE 4.3.1-ME2.1

5083-H113
Plate-Weld Metal

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5183 Alloy filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: 5083-H113 Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg	285 (41.3)			409 (59.3)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	141 (20.4)			177 (25.7)		
	Min						
Std. Deviation							
Elong, percent	Avg	16.3			21.9		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			9 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90083

TABLE 4.3.1-ME2.2

5083-H113
Plate-Weld Metal

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5183 Alloy filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: 5083-H113 Plate, tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	141	(20.5)		171	(24.8)	
Loading frequency Hz						
with $R = .1$ and $K_t =$						
No. of S-N Curves (No. of Heats)	2	(1)		2	(1)	
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)	89.6	(13.0)		130	(18.8)	
Loading frequency Hz						
with $R = .1$ and $K_t =$						
No. of S-N Curves (No. of Heats)	2	(1)		2	(1)	
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)	60.3	(8.75)		98.6	(14.3)	
Loading frequency Hz						
with $R = .1$ and $K_t =$						
No. of S-N Curves (No. of Heats)	2	(1)		2	(1)	
Ratio S_N/TUS at 10^7 cycles						

References: 90083

TABLE 4.3.1-ME3

5083-O
Plate

Alloy Designation: 5083-O Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed (O)

Testing Temperature, K (F)		297 (75)	144 (-200)	116 (-250)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	319 (46.3)	347 (50.3)	376 (54.6)	436 (63.3)	587 (85.2)	557 (80.8)
	Min	314 (45.5)			425 (61.7)	582 (84.4)	556 (80.6)
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	143 (20.7)	142 (20.6)	150 (21.7)	159 (23.0)	174 (25.2)	179 (25.8)
	Min	138 (20.0)			154 (22.4)	172 (25.0)	179 (25.8)
Std. Deviation							
Elong, percent	Avg	20.2	31.4	33.1	34.4	32	32
	Min	18.0			31.0	30	32
RA, percent	Avg	29.3	45.6	43.2	36.2	24.3	33.1
	Min	22			29	24	31.7
No. of Spec. (No. of Heats)		13 (4)	6 (1)	6 (1)	12 (4)	3 (1)	3 (1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	354 (51.4)			409 (59.4)	409 (59.3)	430 (62.3)
	Min	330 (47.8)			393 (57.0)	406 (59.0)	419 (60.8)
K _t = 14							
No. of Spec. (No. of Heats)		6 (2)			5 (2)	3 (1)	3 (1)
NTS, MN/m ² (ksi)	Avg	336 (48.8)	376 (54.5)	387 (56.2)	408 (59.2)		
	Min						
K _t = 15							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	316 (45.8)	340 (49.3)	367 (53.3)	426 (62.8)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	143 (20.7)	144 (20.9)	150 (21.8)	160 (23.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	23.3	31.3	32.9	34.1		
	Min						
RA, percent	Avg	32.7	40.4	38.8	34.3		
	Min						
No. of Spec. (No. of Heats)		7 (2)	6 (1)	6 (1)	7 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	323 (46.8)	359 (52.0)	372 (53.9)	388 (56.3)		
	Min						
K _t = 15							
No. of Spec. (No. of Heats)		6 (1)	6 (1)	6 (1)	6 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 39134, 48561, 90187, 90190

TABLE 4.3.1-ME3.1

5083-0
Plate-Weld Metal

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5183 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 5083-O Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	116 (-250)	77 (-320)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	301 (43.7)	303 (43.9)	337 (48.9)	372 (54.0)	416 (60.4)	381 (55.3)
	Min	293 (42.5)				401 (58.2)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	151 (21.9)	143 (20.7)	161 (23.4)	169 (24.5)	175 (25.4)	174 (25.2)
	Min	139 (28.1)				154 (22.4)	
Std. Deviation							
Elong, percent	Avg	18.4	31.0	21.6	29.5	20.8	27.0
	Min	17.4				19.0	
RA, percent	Avg	33.7	44	31.3	37.5	22.0	37
	Min					20	
No. of Spec. (No. of Heats)		4 (2)	1	3 (1)	3 (1)	4 (2)	1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	314 (45.5)	344 (49.9)	349 (50.6)	370 (53.6)	365 (52.9)	372 (53.9)
	Min	308 (44.7)				345 (50.1)	
K _t = 15-16							
No. of Spec. (No. of Heats)		4 (2)	1	3 (1)	3 (1)	4 (2)	1
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90072, 90187

TABLE 4.3.1-ME3.2

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5556 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 5083-H113 Plate, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	284 (41.2)			414 (60.1)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	146 (21.2)			170 (24.7)		
	Min						
Std. Deviation							
Elong, percent	Avg	12.5			20.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 48787

TABLE 4.3.1-ME3.3

5083-H113
Plate-Weld Metal

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5556 Alloy filler
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: 5083-H113 Plate, tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
<u>Fatigue, Axial Loading</u>						
S_N at 10^5 cycles, MN/m ² (ksi)	193 (28.0)			221 (32.0)		
Loading frequency Hz						
with R = 0 and K_t =						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)	138 (20.0)			179 (26.0)		
Loading frequency Hz						
with R = 0 and K_t =						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						
<u>Fatigue, Flexural Loading</u>						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 48787

TABLE 4.3.1-ME3.4

5083-H321
Plate-Weld Metal

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5183 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 5083-H321 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	305 (44.2)	324 (47.0)		446 (64.7)		456 (66.1)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	179 (26.0)	181 (26.2)		217 (31.4)		246 (35.7)
	Min						
Std. Deviation							
Elong, percent	Avg	14.0	19.0		19.0		9.0
	Min						
RA, percent	Avg	39	48		23		14
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	376 (54.5)	410 (59.5)		430 (62.4)		405 (58.8)
$K_t = 16$	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.3.1-ME3.5

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5356 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 5083-H321 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	286 (41.5)	303 (43.9)		427 (61.9)		455 (66.0)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	168 (24.3)	186 (27.0)		201 (29.1)		235 (34.1)
	Min						
Std. Deviation							
Elong, percent	Avg	13.5	14.5		15.5		9.0
	Min						
RA, percent	Avg	47	52		33		17
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	371 (53.8)	396 (57.5)		418 (60.6)		398 (57.7)
K _t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.3.1-ME3.6

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5556 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 5083-H321 Plate, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	306 (44.4)	319 (46.3)		450 (65.3)		474 (68.8)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	177 (25.6)	184 (26.7)		211 (30.6)		239 (34.6)
	Min						
Std. Deviation							
Elong, percent	Avg	14.0	18.5		20.5		13.0
	Min						
RA, percent	Avg	36	46		26		17
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	370 (53.7)	401 (58.1)		417 (60.5)		399 (57.9)
	Min						
K _t = 16							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.3.1-ME3.7

Alloy Designation: 5083-O Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5183 Alloy filler

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: 5083-O Plate, tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	295	(42.8)		419	(60.8)	
	Min	280	(40.6)		405	(58.8)	
Std. Deviation							
TYS, MN/m² (ksi)	Avg	146	(21.2)		177	(25.6)	
	Min	129	(18.7)		160	(23.2)	
Std. Deviation							
Elong, percent	Avg	22.5			24.5		
	Min	17.7			20.8		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		10	(1)		10	(1)	
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
	Min						
K_t =							
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
	Min						
K_t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
	Min						
K_t =							
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
	Min						
K_t =							
No. of Spec. (No. of Heats)							

References: 96694

TABLE 4.3.1-ME3.8

5083-O
Plate-Weld Metal

Alloy Designation: 5083-O Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5356 Alloy filler

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: 5083-O Plate, tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)			
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	291	(42.2)		407	(59.1)	
	Min	288	(41.7)		387	(66.2)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	145	(21.2)		172	(24.9)	
	Min	142	(20.6)		171	(24.8)	
Std. Deviation							
Elong, percent	Avg	17.9			23.2		
	Min	16.1			20.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4	(1)		4	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 96694

TABLE 4.3.1-ME4. RESULTS OF ALCOA ANALYSIS FOR DEVELOPMENT OF MAXIMUM ALLOWABLE DESIGN STRESSES^(a) FOR 5083-0 SHEET AND PLATE AT CRYOGENIC TEMPERATURES (90174)

Testing Temperature		Min. TUS		Min. TUS/4		Min. TYS		Min. TYS x 2/3		Design Stress	
K	F	MN/m ²	Ksi	MN/m ²	Ksi	MN/m ²	Ksi	MN/m ²	Ksi	MN/m ²	Ksi
Thickness 0.130 to 3.810 cm (0.051 to 1.500 in.)											
297	75	276	40.0	69.0	10.0	124	18.0	82.7	12.0	69.0	10.0
255	0	276	40.0	69.0	10.0	124	18.0	82.7	12.0	69.0	10.0
227	-50	276	40.0	69.0	10.0	124	18.0	82.7	12.0	69.0	10.0
200	-100	278	40.4	69.6	10.1	124	18.0	82.7	12.0	69.6	10.1
172	-150	285	41.4	71.7	10.4	126	18.3	84.1	12.2	71.7	10.4
144	-200	302	43.8	75.8	11.0	129	18.7	86.2	12.5	75.8	11.0
117	-250	332	48.2	82.7	12.0	133	19.3	88.9	12.9	82.7	12.0
111	-260	340	49.3	84.8	12.3	134	19.4	88.9	12.9	84.8	12.3
89	-300	368	53.3	91.7	13.3	136	19.8	91.0	13.2	91.0	13.2
77	-320	381	55.2	95.2	13.8	138	20.1	92.4	13.4	92.4	13.4
Thickness 3.811 to 7.620 cm (1.501 to 3.000 in.)											
297	75	269	39.0	66.9	9.7	117	17.0	77.9	11.3	66.9	9.7
255	0	269	39.0	66.9	9.7	117	17.0	77.9	11.3	66.9	9.7
227	-50	270	39.1	67.6	9.8	117	17.0	77.9	11.3	67.6	9.8
200	-100	272	39.4	67.6	9.8	117	17.0	77.9	11.3	67.6	9.8
172	-150	278	40.4	69.6	10.1	118	17.2	79.3	11.5	69.6	10.1
144	-200	294	42.7	73.8	10.7	121	17.6	80.7	11.7	73.8	10.7
117	-250	324	47.0	81.4	11.8	125	18.2	83.4	12.1	81.4	11.8
111	-260	332	48.1	82.7	12.0	126	18.3	84.1	12.2	82.7	12.0
89	-300	358	52.0	89.6	13.0	129	18.7	86.2	12.5	86.2	12.5
77	-320	371	53.8	92.4	13.4	130	18.9	86.9	12.6	86.9	12.6
Thickness 7.621 to 12.700 cm (3.001 to 5.000 in.)											
297	75	262	38.0	65.5	9.5	110	16.0	73.8	10.7	65.5	9.5
255	0	262	38.0	65.5	9.5	110	16.0	73.8	10.7	65.5	9.5
227	-50	263	38.1	65.5	9.5	110	16.0	73.8	10.7	65.5	9.5
200	-100	265	38.4	66.2	9.6	110	16.0	73.8	10.7	66.2	9.6
172	-150	272	39.4	67.6	9.8	112	16.2	74.5	10.8	67.2	9.8
144	-200	287	41.6	71.7	10.4	114	16.6	76.5	11.1	71.7	10.4
117	-250	316	45.8	78.6	11.4	118	17.1	78.6	11.4	78.6	11.4
111	-260	323	46.8	80.7	11.7	118	17.2	79.3	11.5	79.3	11.5
89	-300	350	50.7	87.6	12.7	121	17.6	80.7	11.7	80.7	11.7
77	-320	362	52.5	90.3	13.1	123	17.8	82.0	11.9	82.0	11.9

(a) Allowable design stresses are determined on the basis of the lower of (1) one-fourth of the minimum tensile strength or (2) two-thirds of the minimum yield strength. Classical statistical methods were not used in reduction of the data.

TABLE 4.3.1-ME4. (Continued)

Testing Temperature		Min. TUS		Min. TUS/4		Min. TYS		Min. TYS x 2/3		Design Stress	
K	F	MN/m ²	Ksi	MN/m ²	Ksi	MN/m ²	Ksi	MN/m ²	Ksi	MN/m ²	Ksi
Thickness 12.701 to 17.800 cm (5.001 to 7.000 in.)											
297	75	255	37.0	63.4	9.2	103	15.0	69.0	10.0	63.4	9.2
255	0	255	37.0	63.4	9.2	103	15.0	69.0	10.0	63.4	9.2
227	-50	256	37.1	64.1	9.3	103	15.0	69.0	10.0	64.1	9.3
200	-100	258	37.4	64.8	9.4	103	15.0	69.0	10.0	64.8	9.4
172	-150	264	38.3	66.2	9.6	105	15.2	69.6	10.1	66.2	9.6
144	-200	279	40.5	69.6	10.1	108	15.6	71.7	10.4	69.6	10.1
117	-250	308	44.6	77.2	11.2	111	16.1	73.8	10.7	73.8	10.7
111	-260	314	45.6	78.6	11.4	111	16.1	73.8	10.7	73.8	10.7
89	-300	340	49.3	84.8	12.3	114	16.5	75.8	11.0	75.8	11.0
77	-320	352	51.1	88.2	12.8	115	16.7	76.5	11.1	76.5	11.1
Thickness 17.801 to 20.320 cm (7.001 to 8.000 in.)											
297	75	248	36.0	62.0	9.0	96.5	14.0	64.1	9.3	62.0	9.0
255	0	248	36.0	62.0	9.0	96.5	14.0	64.1	9.3	62.0	9.0
227	-50	249	36.1	62.0	9.0	96.5	14.0	64.1	9.3	62.0	9.0
200	-100	251	36.4	62.7	9.1	96.5	14.0	64.1	9.3	62.7	9.1
172	-150	257	37.3	64.1	9.3	97.9	14.2	65.5	9.5	64.1	9.3
144	-200	272	39.4	67.6	9.8	100	14.5	66.9	9.7	66.9	9.7
117	-250	299	43.4	74.5	10.8	103	15.0	69.0	10.0	69.0	10.0
111	-260	306	44.4	76.5	11.1	104	15.1	69.6	10.1	69.6	10.1
89	-300	331	48.0	82.7	12.0	106	15.4	71.0	10.3	71.0	10.3
77	-320	343	49.7	85.5	12.4	108	15.6	71.7	10.4	71.7	10.4

TABLE 4.3.1-ME5

Alloy Designation: 5083-H113 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: H113

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 335 (48.6)		463 (67.1)	620 (90.0)	592 (85.8)	
	Min 327 (47.4)		450 (65.3)	618 (89.6)	586 (85.0)	
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 235 (34.2)		273 (39.6)	303 (43.9)	279 (40.5)	
	Min 226 (32.8)		264 (38.3)	303 (43.9)	277 (40.2)	
Std. Deviation						
Elong, percent	Avg 15.4		31.3	30	28.6	
	Min 13		27	28	27	
RA, percent	Avg 23.2		31.6	24.0	28.5	
	Min 21		28	21	26.0	
No. of Spec. (No. of Heats)	8 (4)		7 (4)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 421 (61.1)		486 (70.4)	502 (72.8)	508 (73.7)	
K _t = 14	Min 412 (59.7)		476 (69.1)	501 (72.7)	499 (72.4)	
No. of Spec. (No. of Heats)	6 (2)		5 (2)	3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg 426 (61.8)		505 (73.3)			
K _t = 6.3	Min					
No. of Spec. (No. of Heats)	(1)		(1)			
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg 345 (50.1)		458 (66.4)			
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 236 (34.3)		278 (40.3)			
	Min					
Std. Deviation						
Elong, percent	Avg 16.1		24.0			
	Min					
RA, percent	Avg 24		25			
	Min					
No. of Spec. (No. of Heats)	(1)		(1)			
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 39134, 48561, 90189, 90190

TABLE 4.3.1-ME5.1

Alloy Designation: 5083-0 Aluminum Alloy

Specification:

Form: Plate
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: Annealed (0) 686 K (775 F) 0.5hr, FC

Testing Temperature, K (F)		297 (75)	200 (-103)	100 (-280)	"0" (-460)		
Compression, Longitudinal							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Dynamic Modul:							
E, GN/m ² (10 ⁶ psi)	Avg	71.5 (10.4)	75.8 (11.0)	79.6 (11.5)	80.9 (11.7)		
	Min						
G, GN/m ² (10 ⁶ psi)	Avg	26.8 (3.89)	28.6 (4.15)	30.1 (4.37)	30.7 (4.45)		
	Min						
B, GN/m ² (10 ⁶ psi)	Avg	71.6 (10.4)	72.9 (10.6)	73.9 (10.7)	74.2 (10.8)		
	Min						
Poisson's Ratio	Avg	0.333	0.327	0.321	0.318		
	Min						
No. of Spec.		1	1	1	1		
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness(b)							
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg						
(From PTSC spec.)(—)Min							
No. of Spec. (No. of Heats)							

References: 94206C

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 4.3.1-ME6

Alloy Designation: 5083-H113 Aluminum Alloy

Specification:

Form: Plate
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: H113

Testing Temperature, K (F)	297 (75)		77 (-320)			
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	276 (40.0)		310 (45.0)			
Loading frequency Hz						
with $R = 0$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N /TUS at 10^5 cycles	0.80		0.63			
S_N at 10^6 cycles, MN/m ² (ksi)	241 (35.0)		276 (40.0)			
Loading frequency Hz						
with $R = 0$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N /TUS at 10^6 cycles	0.70		0.56			
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 39134

TABLE 4.3.1-ME7

Alloy Designation: 5083-H321 Aluminum Alloy
Specification: MIL-A-17358 B
Form: Plate
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: H321

Testing Temperature, K (F)		297	(75)				17	(-430)	
Tension, Longitudinal									
TUS, MN/m ² (ksi)	Avg	320	(46.4)				670	(97.2)	
	Min	314	(45.5)				641	(93.0)	
Std. Deviation									
TYS, MN/m ² (ksi)	Avg	222	(32.2)				299	(43.3)	
	Min	217	(31.5)				288	(41.7)	
Std. Deviation									
Elong, percent	Avg	11.4					23.2		
	Min	11					20		
RA, percent	Avg	23.8					24.0		
	Min	18					20		
No. of Spec. (No. of Heats)		5	(1)				5	(1)	
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg	380	(55.1)				529	(76.7)	
	Min	376	(54.6)				481	(69.8)	
K _t = 6.4									
No. of Spec. (No. of Heats)		5	(1)				5	(1)	
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
TYS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)									
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									

References: 64373

TABLE 4.3.1-ME8

Alloy Designation: 5083-O Aluminum Alloy

Specification:

Form: Plate
 Thickness, cm (in.): Over 5.080 (2.000)
 Condition: Annealed (O)

Testing Temperature, K (F)		297 (75)	110 (-260)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	297 (43.1)	383 (55.5)	412 (59.7)			
	Min	273 (39.6)		374 (54.3)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	132 (19.1)	151 (21.9)	148 (21.5)			
	Min	121 (17.6)		141 (20.5)			
Std. Deviation							
Elong, percent	Avg	22.3	31.7	30.1			
	Min	15.0		15			
RA, percent	Avg	26.8	37.0	29.5			
	Min	14		19			
No. of Spec. (No. of Heats)		9 (4)	3 (2)	9 (4)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	294 (42.7)	396 (57.4)	387 (56.1)			
	Min	262 (38.0)		351 (50.9)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	133 (19.3)	157 (22.7)	150 (21.8)			
	Min	121 (17.5)		141 (20.4)			
Std. Deviation							
Elong, percent	Avg	18.3	29.8	22.5			
	Min	14		15.5			
RA, percent	Avg	22.7	28.7	23.2			
	Min	14		17			
No. of Spec. (No. of Heats)		11 (4)	3 (2)	8 (4)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 90176, 96690, 96691

TABLE 4.3.1-ME9

5083-O
Plate

Alloy Designation: 5083-O Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Annealed (O)

Testing Temperature, K (F)		297 (75)	110 (-260)	77 (-320)			
Tension, Short Transverse							
TUS, MN/m ² (ksi)	Avg	268 (38.8)	323 (46.8)	332 (48.1)			
	Min	245 (35.6)		316 (45.8)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	127 (18.4)	156 (22.6)	144 (20.9)			
	Min	116 (16.8)		135 (19.6)			
Std. Deviation							
Elong, percent	Avg	11.0	10.0	11.38			
	Min	10		9.5			
RA, percent	Avg	11.5	11.0	12.0			
	Min	11		11			
No. of Spec. (No. of Heats)		5 (3)	(1)	5 (3)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90176, 96691

TABLE 4.3.1-ME9.1

5083-O
Plate-Weld Metal

Alloy Designation: 5083 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5183 Alloy filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: 5083-O Plate, tested as welded

Testing Temperature, K (F)		297 (75)		111 (-260)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	283 (41.0)		368 (53.4)	394 (57.1)		
	Min	247 (35.8)		339 (49.2)	341 (49.4)		
Std. Deviation		17.7 (2.57)			29.9 (4.34)		
TYS, MN/m ² (ksi)	Avg	159 (23.0)		181 (26.3)	185 (26.8)		
	Min	144 (20.9)		160 (23.2)	167 (24.2)		
Std. Deviation		9.38 (1.36)			12.6 (1.82)		
Elong, percent	Avg	15.4		18.9	18.3		
	Min	6.5		11.0	9.8		
RA, percent	Avg	22.4		24.8	20.1		
	Min	12		16	14		
No. of Spec. (No. of Heats)		12 (3)		6 (2)	12 (3)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90176, 96690

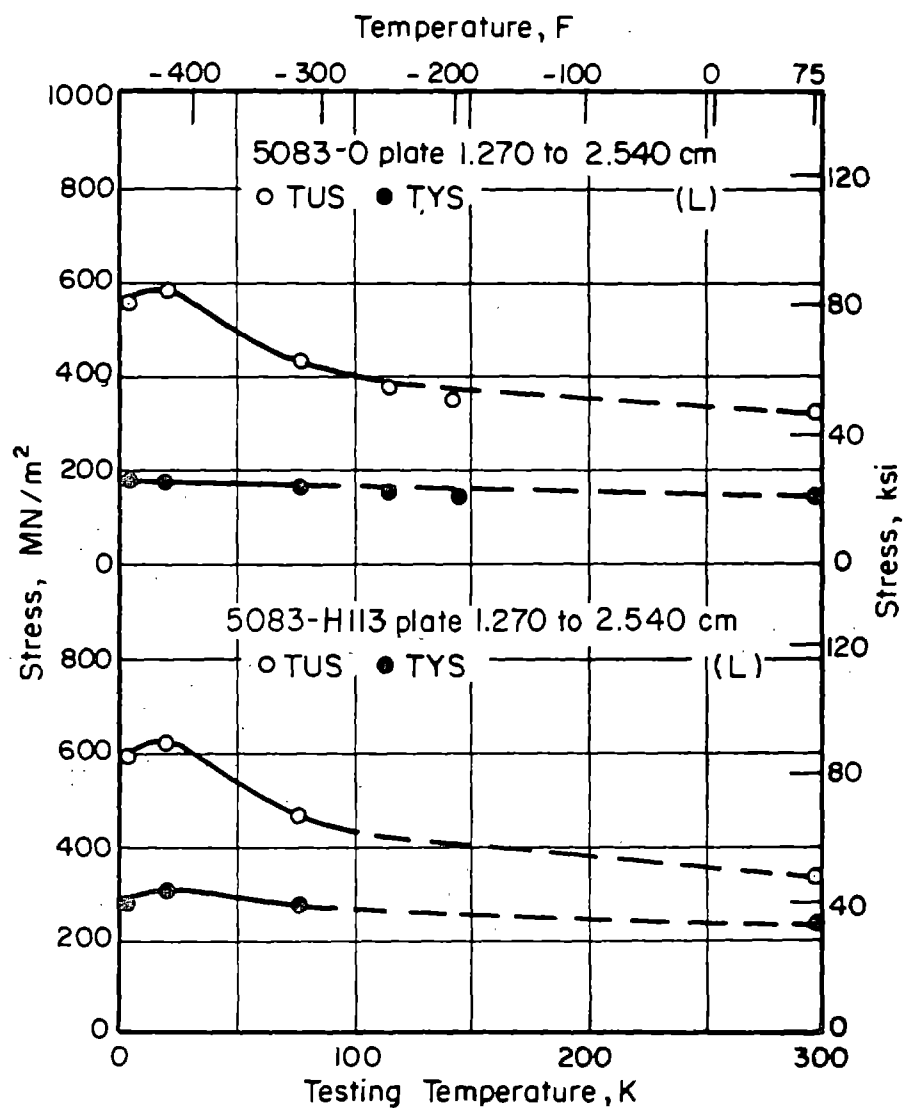


FIGURE 4.3.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 5083 ALUMINUM ALLOY

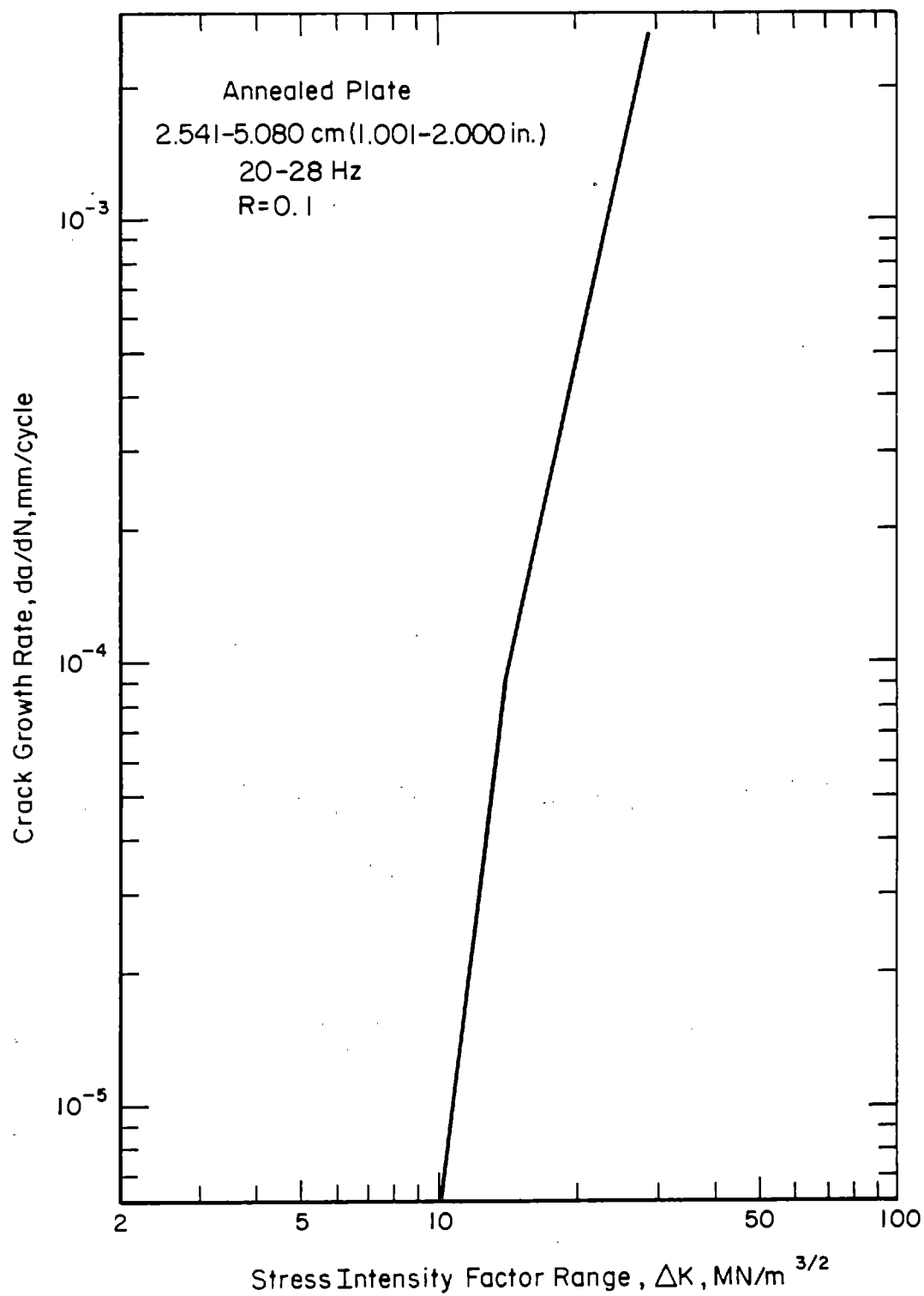


FIGURE 4.3.1-ME2. FATIGUE-CRACK GROWTH RATE OF 5083-O ALUMINUM ALLOY AT 4 K(94208D)

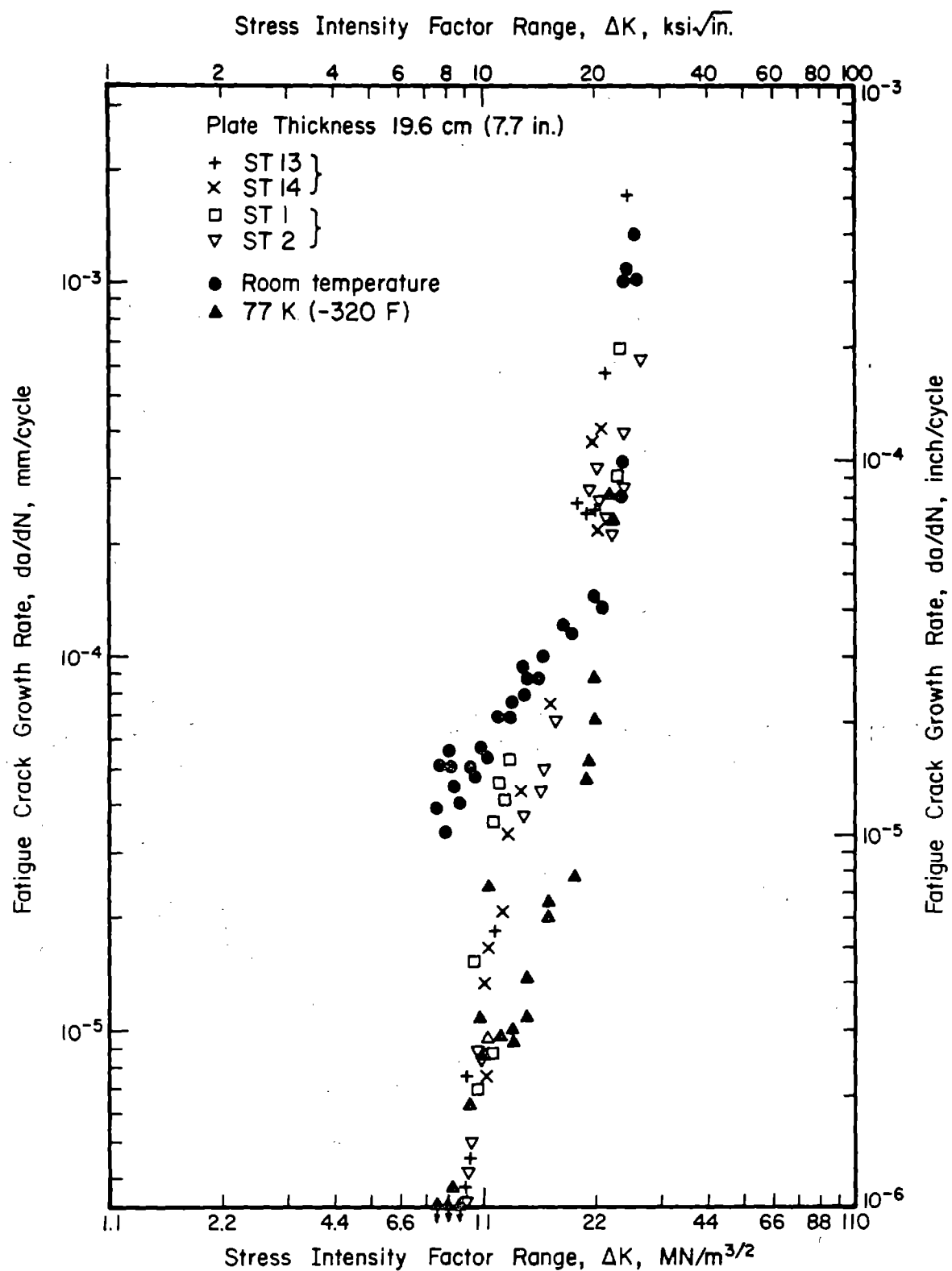


FIGURE 4.3.1-ME3. FATIGUE CRACK GROWTH RATE OF 5083-O ALUMINUM ALLOY PLATE [90175, 96691]

4.3.1-12.1 (11/76)

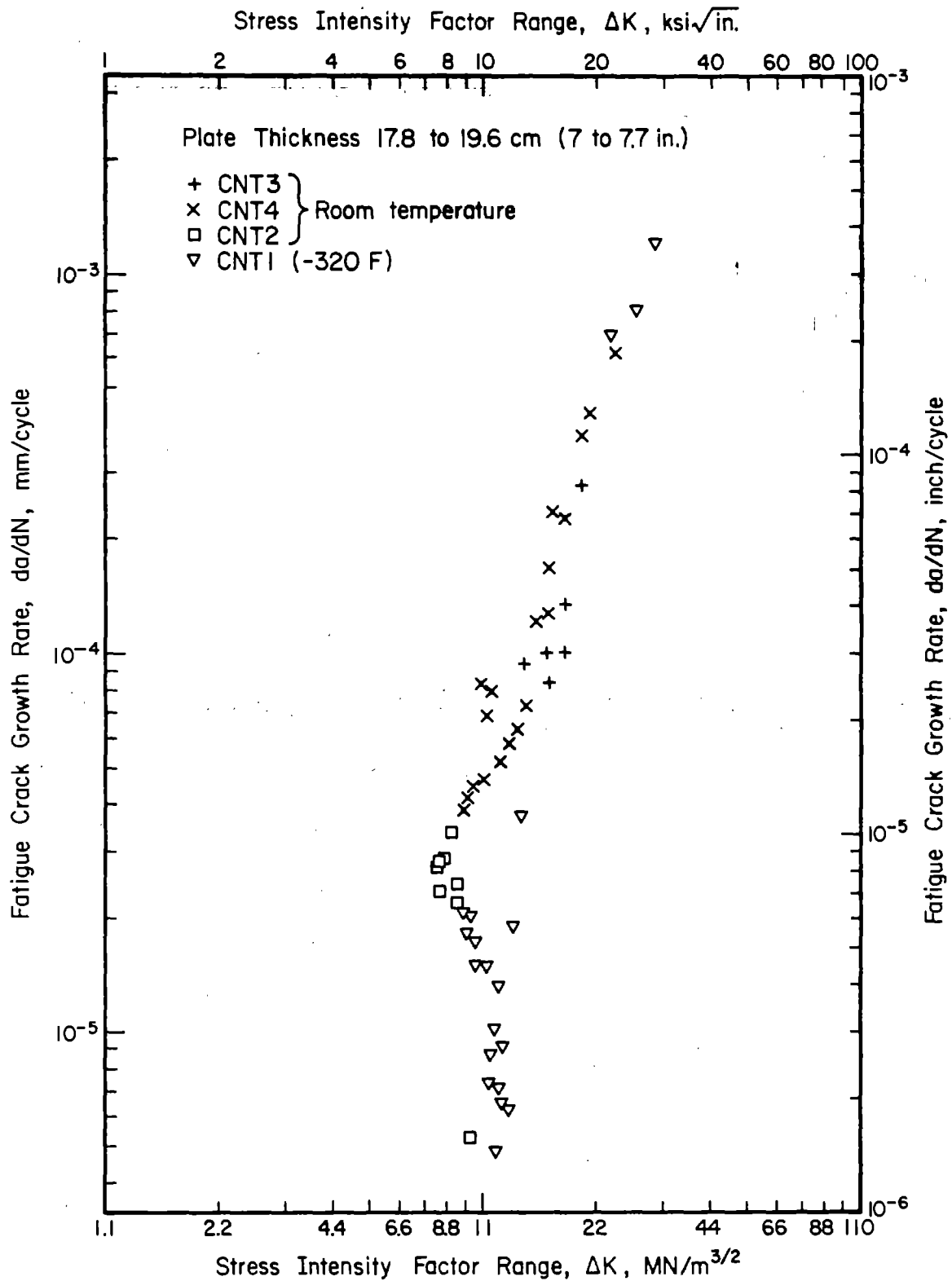


FIGURE 4.3.1-ME4. FATIGUE CRACK GROWTH RATE OF 5083-0 ALUMINUM PLATE
MIG WELDED (5183 ALLOY FILLER) [90175]

TABLE 4.3.1-TR1

Alloy Designation: 5083-O Aluminum Alloy

Specification:

Form:

Dimension:

Condition: Annealed (-O), H113

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity (-O)						
Watts m ⁻¹ K ⁻¹		62	38	17.3	8.5	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹		(35.8)	(22.0)	(10.0)	(4.9)	
No. of Spec.		1	1	1	1	
References: 90225						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal (-H113)						
Percent	0	-0.32	-0.36	-0.365	-0.365	
No. of Spec.	1	1	1	1	1	
References: 74405						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity (-O, -H113)						
Ohm m	5.70 x 10 ⁻⁸	3.80 x 10 ⁻⁸	3.20 x 10 ⁻⁸	3.05 x 10 ⁻⁸	3.05 x 10 ⁻⁸	3.05 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(34.3)	(21.7)	(19.3)	(1.76)	(1.76)	(1.76)
No. of Spec.	4	4	4	4	4	4
References: 79561, 90164						

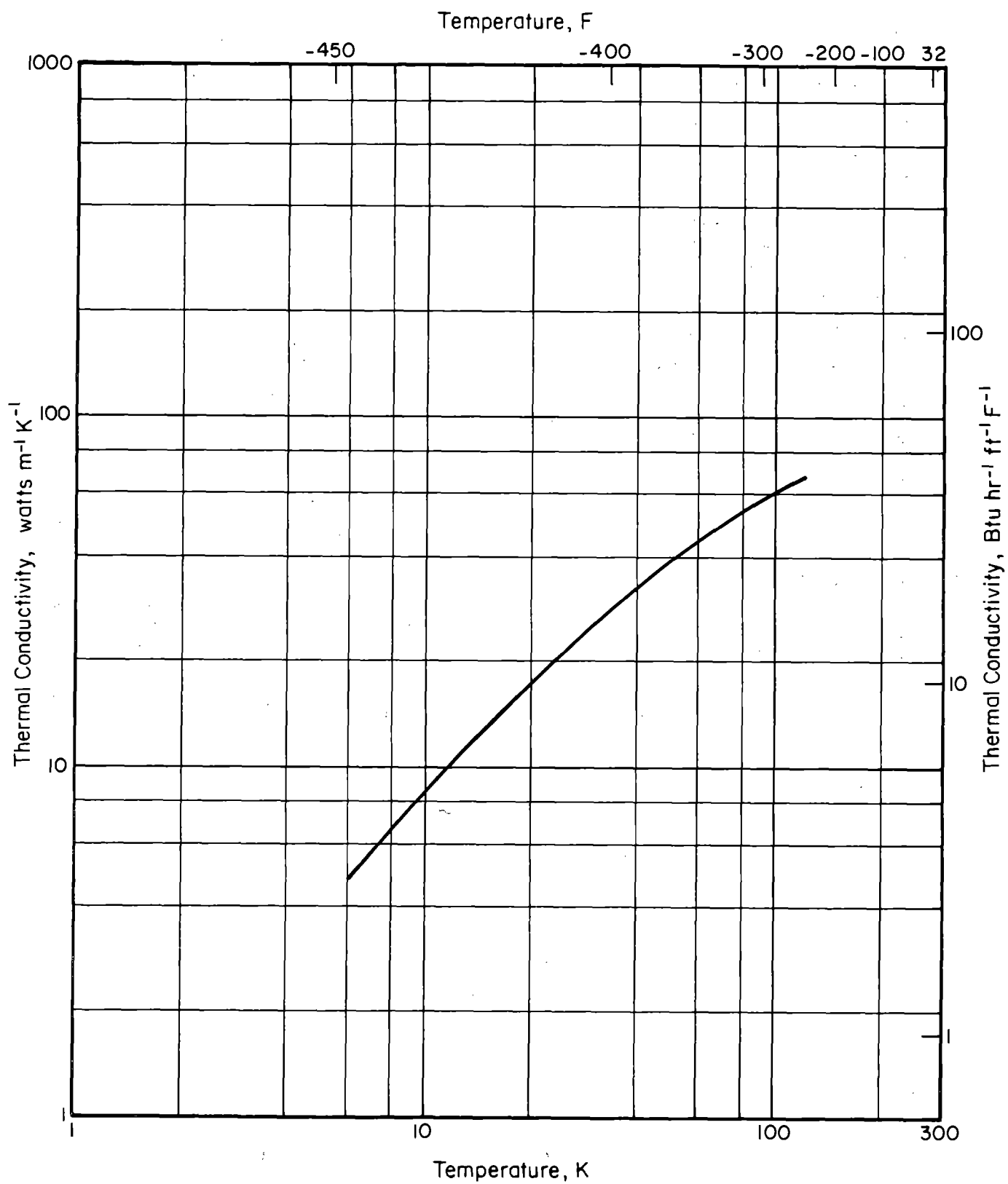


FIGURE 4.3.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 5083-0

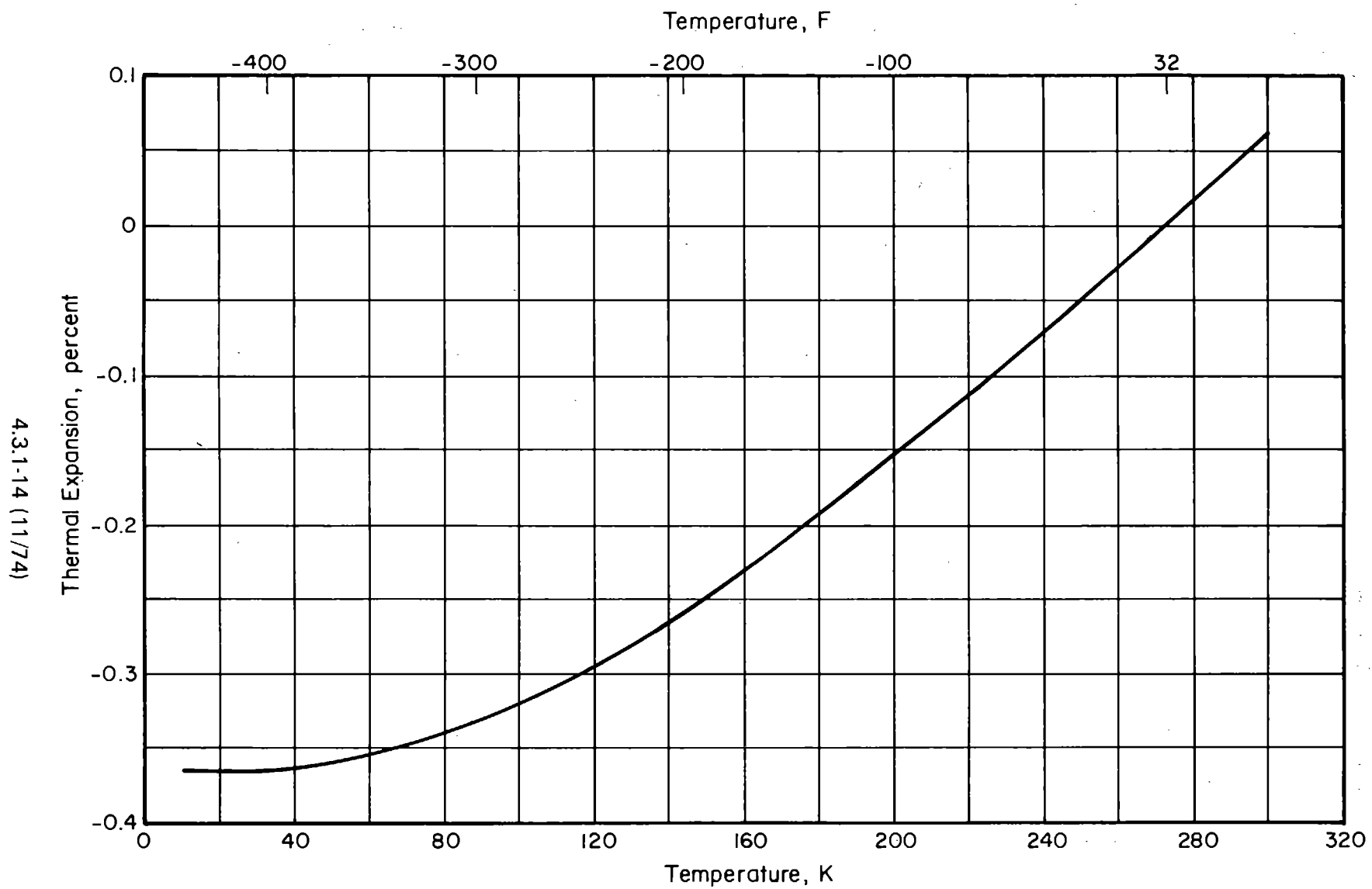


FIGURE 4.3.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 5083-H113

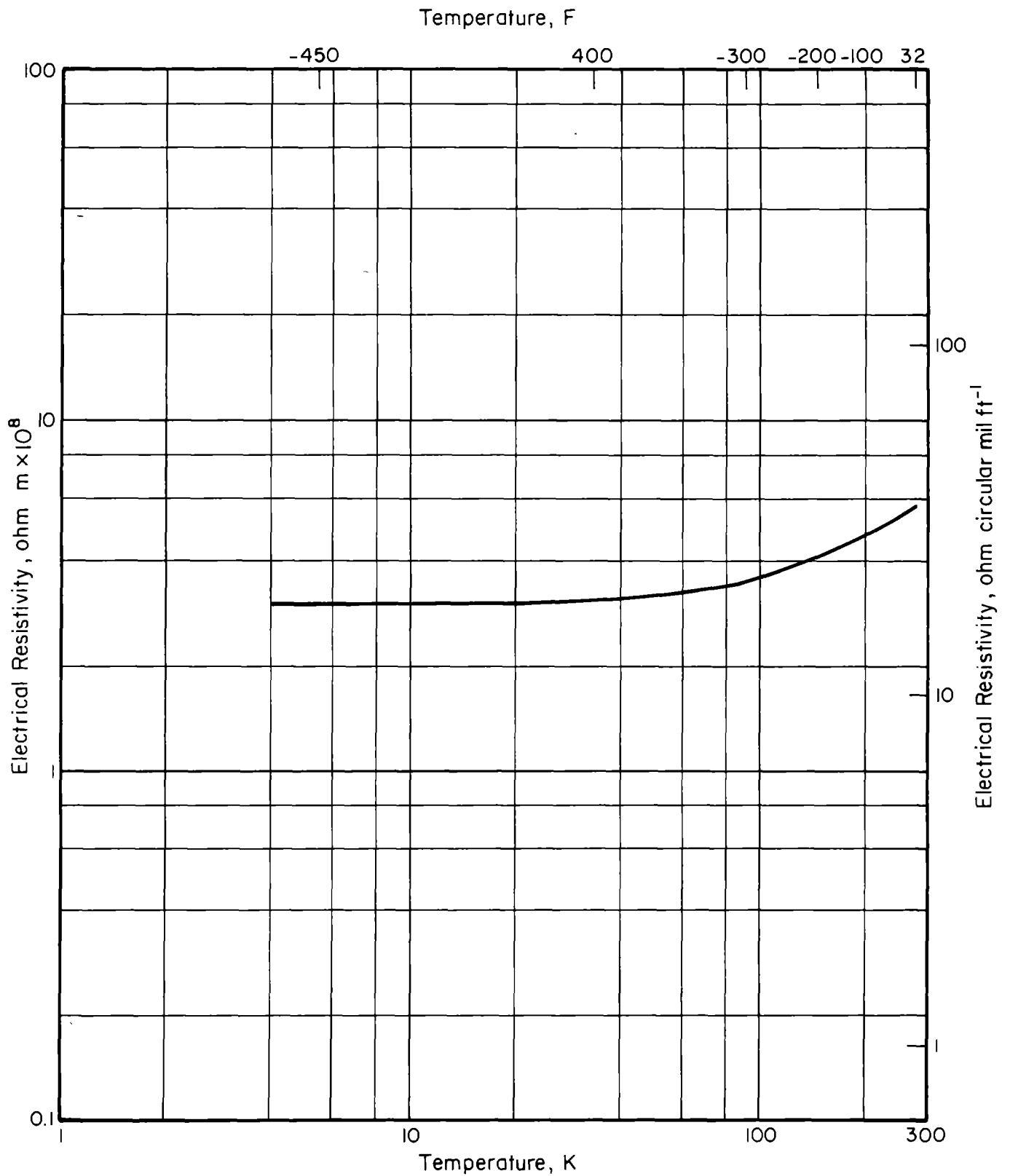


FIGURE 4.3.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 5083-0, -H113

TABLE 4.3.2-ME1

5456-0
Sheet

Alloy Designation: 5456-0 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.318 (0.040 to 0.125)

Condition: 0

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	351 (50.9)				587 (85.1)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	183 (26.5)				210 (30.5)	
	Min						
Std. Deviation							
Elong, percent	Avg	16.8				24.8	
	Min						
RA, percent	Avg	26.1				25.4	
	Min						
No. of Spec. (No. of Heats)		2 (1)				2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	332 (48.1)				307 (44.5)	
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		4 (1)				4 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg	323 (46.9)			440 (63.8)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	177 (25.7)			200 (29.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	24.2			40.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1					
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	287 (41.6)			296 (43.0)		
	Min						
K _t = 11.1							
No. of Spec. (No. of Heats)		1			1		
NTS, MN/m ² (ksi)	Avg	274 (39.7)			305 (44.3)		
	Min						
K _t = 15							
No. of Spec. (No. of Heats)		1			1		

References: 56755, 90188

TABLE 4.3.2-ME2

5456-H24
Sheet

Alloy Designation: 5456-H24 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: H24

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	376 (54.5)			518 (75.1)	596 (86.4)	
	Min					589 (85.4)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	289 (41.9)			382 (55.4)	389 (56.4)	
	Min					379 (55.0)	
Std. Deviation							
Elong, percent	Avg	13.7			13.2	7.7	
	Min					7.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg				80.0 (11.6)	88.3 (12.8)	
	Min						
No. of Spec. (No. of Heats)					1	1	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	376 (54.6)			475 (68.9)	571 (82.8)	
	Min					557 (80.8)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	274 (39.8)			330 (47.9)	384 (55.7)	
	Min					384 (55.7)	
Std. Deviation							
Elong, percent	Avg	11.6			8.9	8.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (2)			2 (2)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	343 (49.7)			331 (48.0)		
K _t = 11.1	Min						
No. of Spec. (No. of Heats)		1			1		
NTS, MN/m ² (ksi)	Avg	313 (45.4)			325 (47.2)		
K _t = 15	Min						
No. of Spec. (No. of Heats)		1			1		

References: 42002, 90188

TABLE 4.3.2-ME3

Alloy Designation: 5456 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 4043 Alloy filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 5456-H24 TIG welded and tested

Testing Temperature, K (F)	297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 341 (49.4)			409 (59.3)	372 (54.0)	
	Min				353 (51.2)	
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	1			1	10 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg 351 (50.9)			411 (59.6)	387 (56.1)	
	Min				372 (54.0)	
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	1			1	4 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 42002

TABLE 4.3.2-ME4

Alloy Designation: 5456-H321 Aluminum Alloy

Specification:

Form: Sheet
 Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
 Condition: H321

Testing Temperature, K (F)	297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 396 (57.4)			528 (76.6)	665 (96.4)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 272 (39.5)			322 (46.7)	363 (52.6)	
	Min					
Std. Deviation						
Elong, percent	Avg 14.5			26.8	21.7	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 328 (47.6)			363 (52.7)	392 (56.9)	
	Min					
K _t = 30.3						
No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg 399 (57.9)			500 (72.5)	613 (88.9)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 273 (39.6)			322 (46.7)	373 (54.1)	
	Min					
Std. Deviation						
Elong, percent	Avg 17.5			23.5	14.8	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 332 (48.2)			366 (53.1)	389 (56.4)	
	Min					
K _t = 30.3						
No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 90076

TABLE 4.3.2-ME5

Alloy Designation: 5456 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 5556 Alloy filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 5456-H321 Sheet, welded and tested

Testing Temperature, K (F)	297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 358 (32.6)			439 (68.7)	407 (59.1)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 225 (32.6)			260 (37.7)	341 (49.5)	
	Min					
Std. Deviation						
Elong, percent	Avg 13.0			15.8	3.5	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 375 (54.4)			412 (59.7)	412 (59.7)	
	Min					
K _t = 30.3						
No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg 375 (51.7)			435 (63.1)	428 (62.1)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 209 (30.3)			247 (35.8)	379 (55.0)	
	Min					
Std. Deviation						
Elong, percent	Avg 8.5			9.5	5.0	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 357 (51.8)			394 (57.1)	384 (55.7)	
	Min					
K _t = 30.3						
No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 90076

TABLE 4.3.2-ME6

5456-H343
Sheet

Alloy Designation: 5456-H343 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: H343

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	395 (57.3)	401 (58.2)	427 (62.0)	510 (73.9)	592 (85.9)	(86.5)
	Min	389 (56.4)	393 (57.0)		488 (70.8)	554 (80.4)	
	Std. Deviation	5.31 (0.77)			10.0 (1.45)	26.6 (3.86)	
TYS, MN/m ² (ksi)	Avg	323 (46.8)	344 (49.9)	324 (47.0)	377 (54.7)	412 (59.8)	(57.0)
	Min	298 (43.2)	310 (45.0)		348 (50.5)	372 (53.9)	
	Std. Deviation	19.9 (2.88)			23.7 (8.43)	33.4 (4.84)	
Elong, percent	Avg	8.4	9.9	11.7	11.5	9.4	9.5
	Min	7.0	9.3		7.0	8.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		9 (3)	6 (2)	1	9 (3)	9 (3)	1
E, GN/m ² (10 ⁶ psi)	Avg	71.7 (10.4)	73.8 (10.7)		73.8 (10.7)	77.9 (11.3)	
	Min	70.3 (10.2)	69.6 (10.1)		70.3 (10.2)	75.2 (10.9)	
	No. of Spec. (No. of Heats)	6 (2)	5 (1)		6 (2)	6 (2)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	405 (58.8)			489 (70.9)	542 (78.6)	
	Min	402 (58.3)			485 (70.4)	535 (77.6)	
	No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg	393 (57.0)	394 (57.2)		444 (64.4)	472 (68.5)	
	Min	390 (56.6)	392 (56.8)		442 (64.1)	463 (67.1)	
	No. of Spec. (No. of Heats)	5 (1)	5 (1)		5 (1)	5 (1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	403 (58.4)	401 (58.1)		499 (72.4)	566 (82.1)	
	Min	401 (58.1)	394 (57.2)		496 (72.0)	527 (76.4)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	297 (43.1)	302 (43.8)		356 (51.7)	390 (56.5)	
	Min	296 (43.0)	299 (43.3)		348 (50.5)	376 (54.5)	
Std. Deviation							
Elong, percent	Avg	9.7	11.2		12.0	7.7	
	Min	9.5	10.5		11.5	5.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	70.3 (10.2)	73.1 (10.6)		73.1 (10.6)	80.7 (11.7)	
	Min	69.0 (56.7)	383 (55.6)		394 (57.2)	413 (59.9)	
	No. of Spec. (No. of Heats)	5 (1)	5 (1)		5 (1)	5 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	395 (57.3)	392 (56.9)		410 (59.4)	422 (61.2)	
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 48652, 58060, 61996

TABLE 4.3.2-ME7

Alloy Designation: 5456 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 5356 Alloy filler
 Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
 Condition: 5456-H343 Sheet, welded and tested

Testing Temperature, K (F)		297 (75)		195 (-108)		77 (-320)		20 (-423)	
Tension, Longitudinal									
TUS, MN/m ² (ksi)	Avg	365	(53.0)	363	(52.6)	471	(68.3)	457	(66.3)
	Min	363	(52.6)	360	(52.2)	469	(68.0)	439	(63.7)
Std. Deviation									
TYS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg	4.9		4.9		9.0		2.5	
	Min	4.5		4.5		9.0		1.5	
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m ² (ksi)	Avg	354	(51.4)	348	(50.4)	450	(65.3)	459	(66.6)
	Min	353	(51.2)	281	(40.8)	441	(64.0)	440	(63.8)
Std. Deviation									
TYS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg	4.2		4.6		7.4		3.2	
	Min	3.5		4.5		6.0		2.5	
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									

References: 48652

TABLE 4.3.2-ME8

Alloy Designation: 5456 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 5556 Alloy filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 5456-H343 welded and tested

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	342 (49.6)	328 (47.5)	368 (53.4)	422 (61.2)	403 (58.5)	443 (64.2)
	Min	330 (47.9)			399 (57.8)	364 (52.8)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	199 (28.7)	207 (30.0)	214 (31.0)	240 (34.8)	272 (39.5)	264 (38.3)
	Min						
Std. Deviation							
Elong, percent	Avg	4.6	5.3	6.3	6.9	3.5	4.3
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)	3 (1)	3 (1)	6 (2)	9 (2)	3 (1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 58060, 61996

TABLE 4.3.2-ME9

5456-0
Plate

Alloy Designation: 5456-0 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.449)

Condition: 0

Testing Temperature, K (F)		297 (75)				20 (-423)	
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	351 (50.9)				587 (85.1)	
	Min	346 (50.2)				583 (84.6)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	183 (26.5)				210 (30.5)	
	Min	179 (25.9)				203 (29.5)	
Std. Deviation							
Elong, percent	Avg	16.8				24.8	
	Min	16.0				23.5	
RA, percent	Avg	26.1				25.5	
	Min	26.0				22.9	
No. of Spec. (No. of Heats)		2 (1)				2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	332 (48.1)				305 (44.3)	
	Min	325 (47.2)				305 (44.3)	
K _t = 6.3							
No. of Spec. (No. of Heats)		4 (1)				2 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 66080

TABLE 4.3.2-ME10

5456-0
Plate

Alloy Designation: 5456-0 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: 0

Testing Temperature, K (F)	297 (75)				20 (-423)	
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg	210 (30.4)			407 (59.0)	
	Min					
No. of Spec. (No. of Heats)		7 (1)			7 (1)	
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 56754

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 4.3.2-ME11

5456-H321
Plate

Alloy Designation: 5456-H321 Aluminum Alloy

Specification:

Form: Plate
 Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
 Condition: H321

Testing Temperature, K (F)	297 (75)				20 (-423)	
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg	228 (33.0)			443 (64.3)	
	Min					
No. of Spec. (No. of Heats)		7 (1)			7 (1)	
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 56754

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 4.3.2-ME12

5456-0
Plate

Alloy Designation: 5456-0 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 0

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	338 (49.0)	339 (49.1)		455 (66.0)		203 (29.5)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	160 (23.2)	163 (23.6)		180 (26.1)		203 (29.5)
	Min						
Std. Deviation							
Elong, percent	Avg	21.8	26.5		34.5		30.7
	Min						
RA, percent	Avg	31	43		35		24
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	351 (50.9)			411 (59.6)		420 (60.9)
K _t = 16	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 72563

TABLE 4.3.2-ME13

Alloy Designation: 5456-H321 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: H321

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	353 (51.2)	379 (55.0)		492 (71.3)	636 (92.2)	638 (92.6)
	Min	339 (49.2)			475 (68.9)	622 (90.2)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	235 (34.1)	236 (34.3)		275 (39.9)	303 (43.9)	321 (46.5)
	Min	225 (32.7)			273 (39.6)	273 (39.6)	
Std. Deviation							
Elong, percent	Avg	13.5	20.5		25.8	18.2	23.6
	Min	11			24.5	14	
RA, percent	Avg	11.3	31		28	16.8	25
	Min	7				15	
No. of Spec. (No. of Heats)		7 (3)	1		2 (2)	5 (1)	1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	411 (59.6)				461 (66.8)	
	Min	403 (58.4)				392 (56.8)	
No. of Spec. (No. of Heats)		5 (1)				5 (1)	
NTS, MN/m ² (ksi)	Avg	412 (59.7)			456 (66.2)		523 (75.8)
	Min						
No. of Spec. (No. of Heats)		1			1		1
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 48787, 64373, 72563

TABLE 4.3.2-ME14

Alloy Designation: 5456-H321 Aluminum Alloy

Specification:

Form: Plate
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: H321

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	290 (42.0)			324 (47.0)		
Loading frequency Hz						
with $R = 0$ and $K_t =$						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)	248 (36.0)			283 (41.0)		
Loading frequency Hz						
with $R = 0$ and $K_t =$						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 48787

TABLE 4.3.2-ME15

Alloy Designation: 5456 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5556 Alloy filler
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: 5456-H321 Plate, welded and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	308 (44.6)			407 (59.0)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	155 (22.5)			181 (26.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	13.0			14.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 48787

TABLE 4.3.2-ME16

5456-H321
Plate-Weld Metal

Alloy Designation: 5456 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5556 Alloy filler
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: 5456-H321 Plate, welded and tested

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	207 (30.0)			241 (35.0)		
Loading frequency Hz						
with $R = 0$ and $K_t =$						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)	159 (23.0)			209 (30.0)		
Loading frequency Hz						
with $R = 0$ and $K_t =$						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 48787

TABLE 4.3.2-ME17

Alloy Designation: 5456-H343 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: H343

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	387 (56.1)	383 (55.6)	416 (60.3)	497 (72.1)	516 (74.8)	
	Min	385 (55.9)			491 (71.2)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	306 (44.4)	308 (44.6)	326 (47.3)	361 (52.3)	378 (54.8)	
	Min	305 (44.2)			360 (52.2)		
Std. Deviation							
Elong, percent	Avg	10.2	12.5	15.5	13.9	7.0	
	Min	10.0			11.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
		3 (1)	1	1	3 (1)	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	367 (53.3)	360 (52.2)	373 (54.1)	422 (61.2)		
	Min			372 (54.0)			
K _t = 13.2							
No. of Spec. (No. of Heats)							
		1	1	2 (1)	1		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)							
Avg							
Min							
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90184

TABLE 4.3.2-ME18

5456-H343
Plate-Weld Metal

Alloy Designation: 5456 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5356 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 5456-H343 Plate, welded and tested

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	270 (39.1)	269 (39.0)	300 (43.5)	319 (46.3)	319 (46.2)	
	Min	242 (35.1)	250 (36.2)	275 (39.9)	304 (44.1)	290 (42.1)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	177 (25.6)	184 (26.7)	194 (28.1)	210 (30.5)	228 (33.1)	
	Min	170 (24.6)	184 (26.7)	183 (26.5)	200 (29.0)	217 (31.5)	
Std. Deviation							
Elong, percent	Avg	4.5	5.8	6.0	4.9	4.0	
	Min	3.5	5.5	5.0	4.8	3.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	2 (1)	2 (1)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90184

TABLE 4.3.2-ME19

Alloy Designation: 5456 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 5356 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 5456-H343 Plate, welded and tested

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	287 (41.6)	315 (45.7)	299 (43.4)	352 (51.1)	345 (50.0)	
	Min	251 (36.4)	314 (45.5)	283 (41.1)	296 (42.9)	326 (47.3)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	181 (26.3)	179 (25.9)	192 (27.8)	214 (31.0)	228 (33.0)	
	Min	178 (25.8)	172 (25.0)	185 (26.8)	206 (29.9)	223 (32.4)	
Std. Deviation							
Elong, percent	Avg	6.5	8.5	6.3	5.5	4.0	
	Min	5.0	7.0	6.0	3.0	3.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)	2 (1)	4 (1)	4 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90184

TABLE 4.3.2-ME20

Alloy Designation: 5456-H321 Aluminum Alloy

Specification:

Form: Plate
 Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
 Condition: H321

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	382 (55.4)			506 (73.4)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	247 (35.8)			288 (41.8)		
	Min						
Std. Deviation							
Elong, percent	Avg	13.2			26.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	430 (62.4)			558 (81.0)		
	Min						
K _t = 2.4							
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m ² (ksi)	Avg	412 (59.7)			486 (70.5)		
	Min						
K _t = 13.3							
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	382 (55.4)			483 (70.0)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	230 (33.3)			259 (37.5)		
	Min						
Std. Deviation							
Elong, percent	Avg	16.5			25.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	430 (62.3)			541 (78.4)		
	Min						
K _t = 2.4							
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
NTS, MN/m ² (ksi)	Avg	405 (58.7)			472 (68.4)		
	Min						
K _t = 13.3							
No. of Spec. (No. of Heats)		2 (1)			2 (1)		

References: 90188

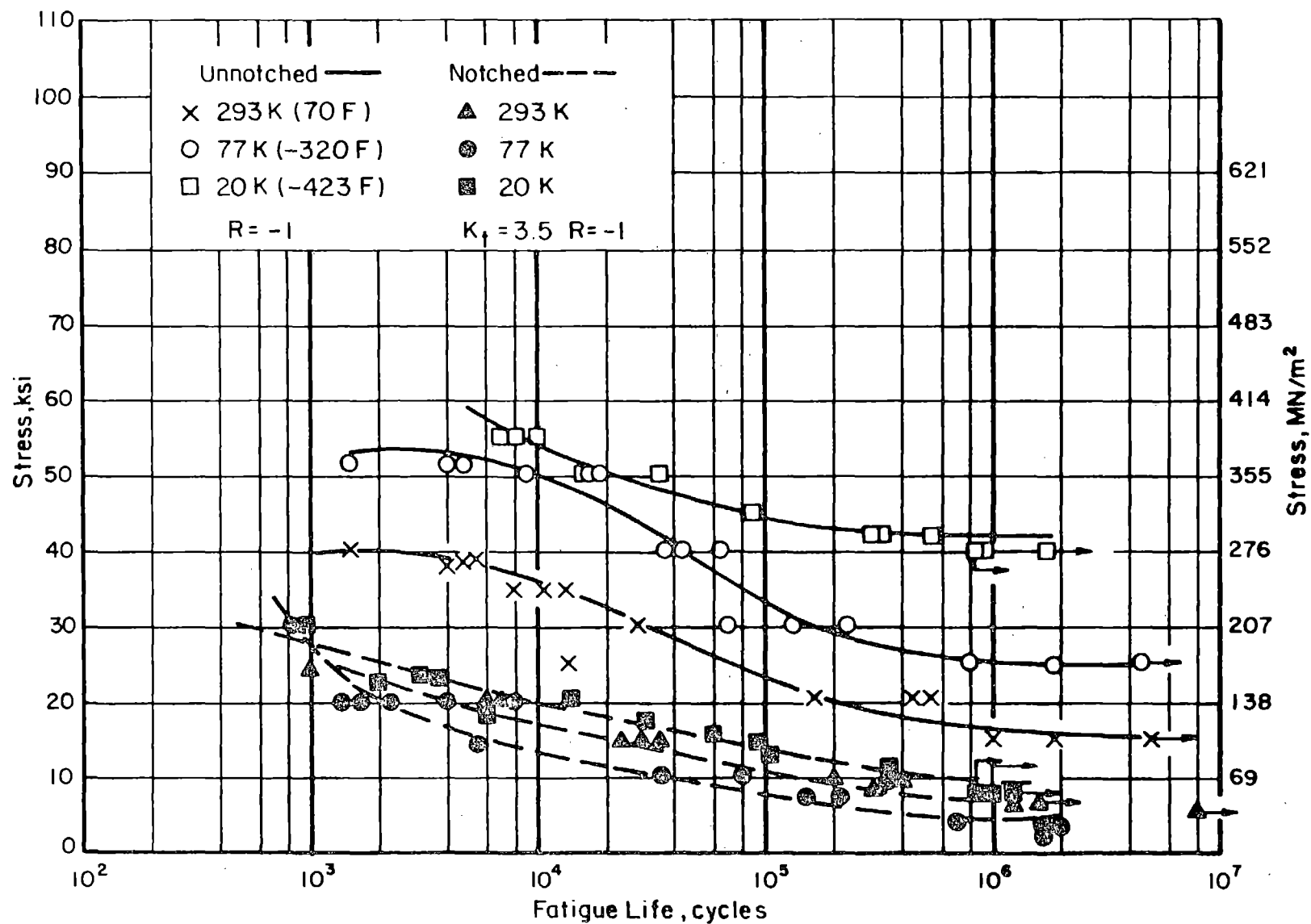


FIGURE 4.3.2-ME1. FATIGUE LIFE CURVES FOR AXIAL LOADING ON SMOOTH SPECIMENS OF 5456-H343 ALUMINUM ALLOY SHEET 0.254 cm (0.100 in.) THICK AT CYCLIC FREQUENCY OF 1833 Hz AT R = -1 [61996]

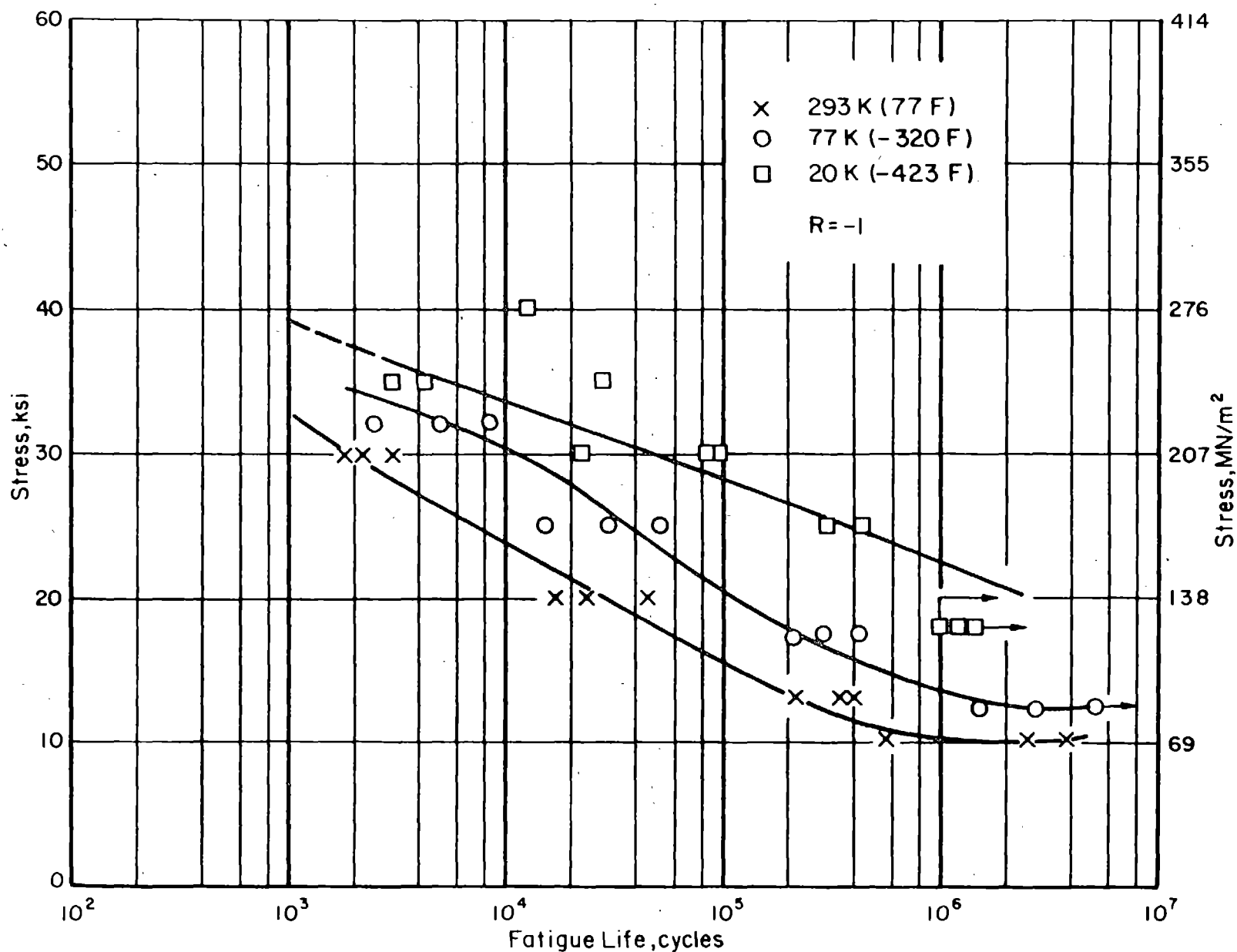


FIGURE 4.3.2-ME2. FATIGUE LIFE CURVES FOR AXIAL LOADING ON SPECIMENS OF 5456-H343 ALUMINUM ALLOY SHEET 0.254 cm (0.100 in.) THICK, TIG WELDED (5556 ALLOY FILLER) AND TESTED AT CYCLIC FREQUENCY OF 1833 Hz [61996]

TABLE 4.3.2-TR1

Alloy Designation: 5456-H343 Aluminum Alloy

Specification:

Form:

Dimension:

Condition: H343

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	109	64.0	44.0	27.0		
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(63.0)	(37.0)	(25.4)	(15.6)		
No. of Spec.	1	1	1	1		
References: 90218						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0.00	-0.332	-0.364	-0.367	-0.367	-0.367
No. of Spec.	1	1	1	1	1	1
References: 48571						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	5.92 x 10 ⁻⁸	3.80 x 10 ⁻⁸	3.35 x 10 ⁻⁸	3.26 x 10 ⁻⁸	3.26 x 10 ⁻⁸	3.26 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(35.6)		(22.9)	(19.6)	(19.6)	(19.6)
No. of Spec.	1	1	1	1	1	1
References: 90164						

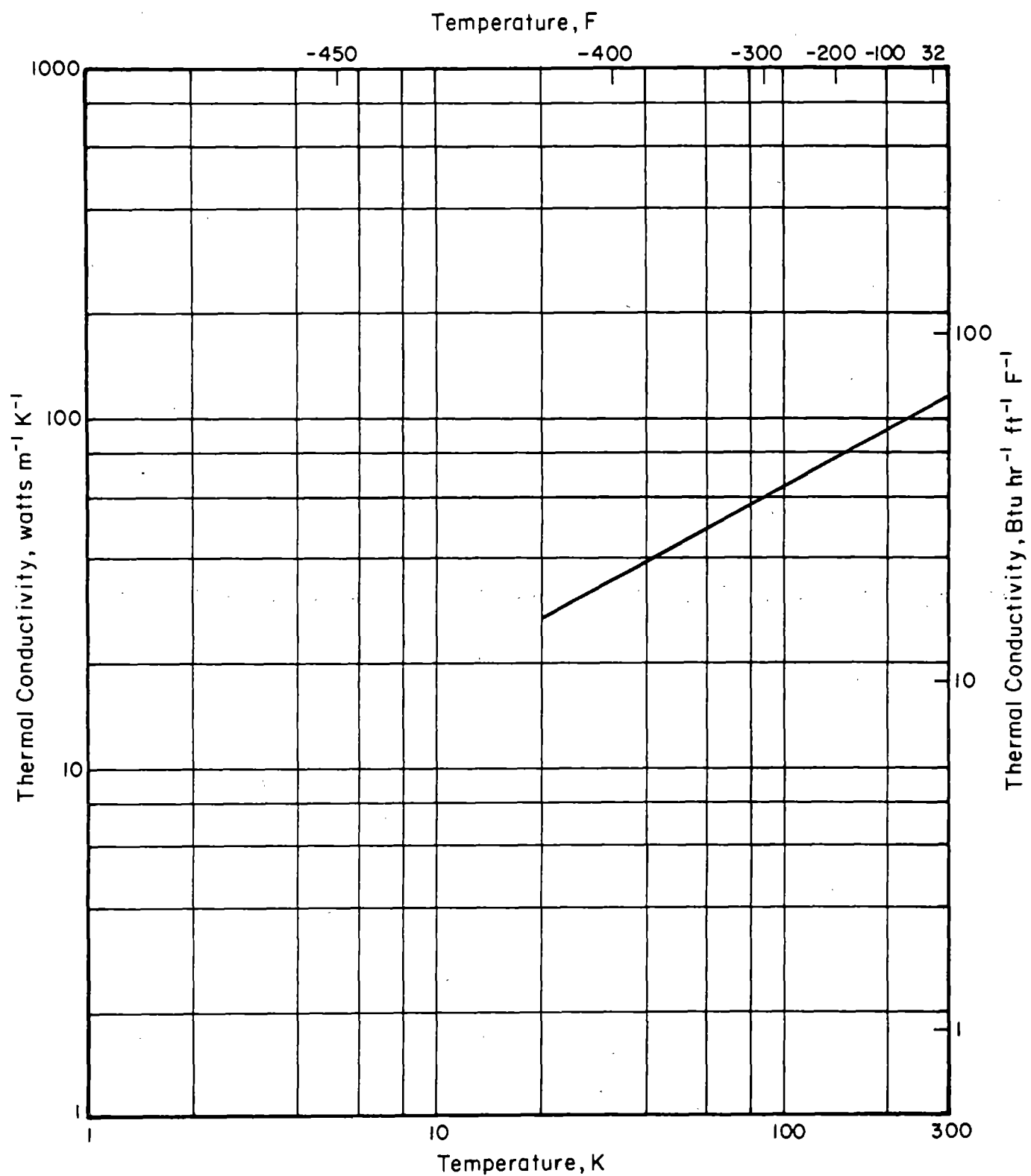


FIGURE 4.3.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 5456-H343

4.3.2-25 (11/76)

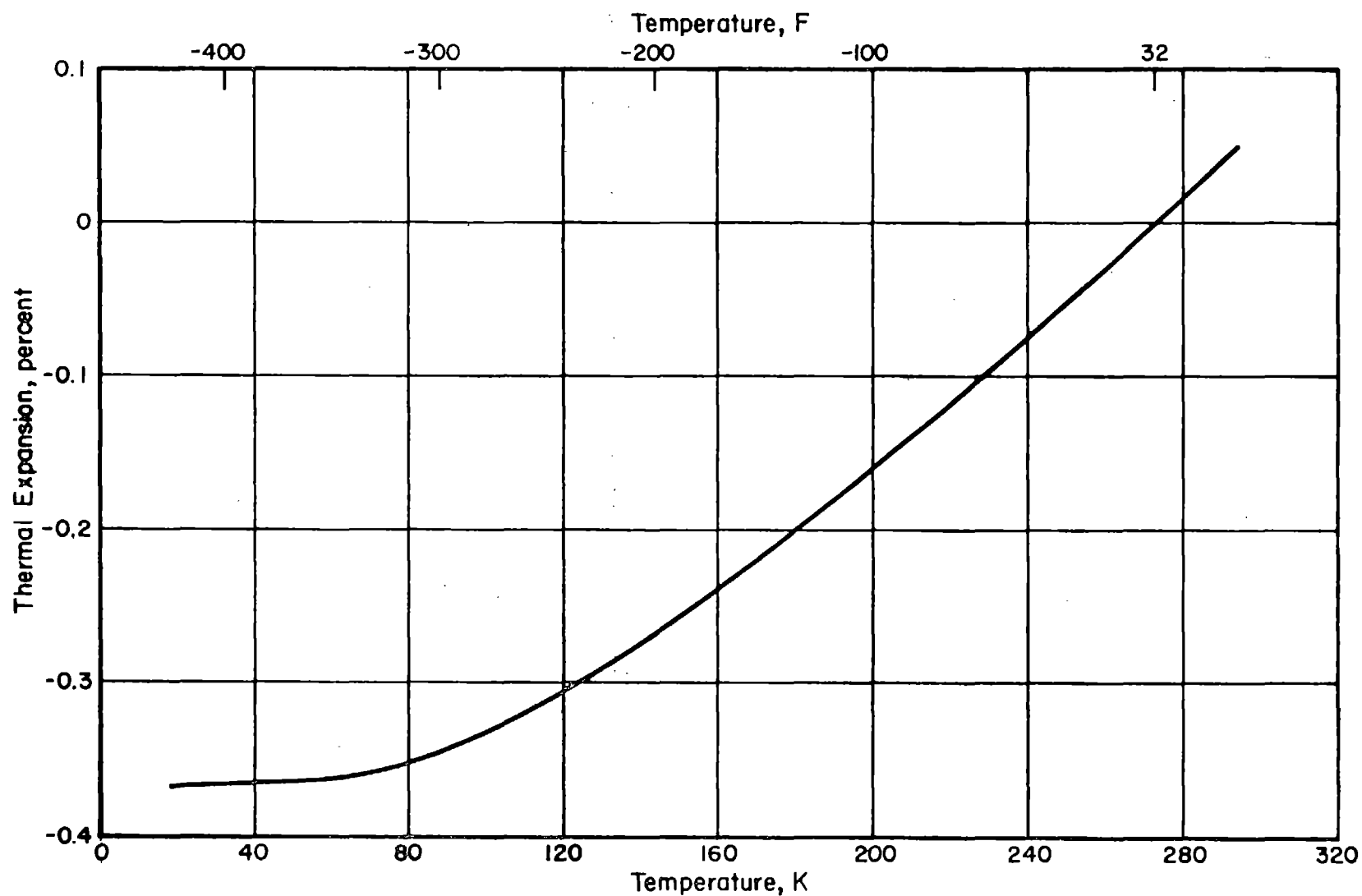


FIGURE 4.2.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 5456-H343

5456-H343

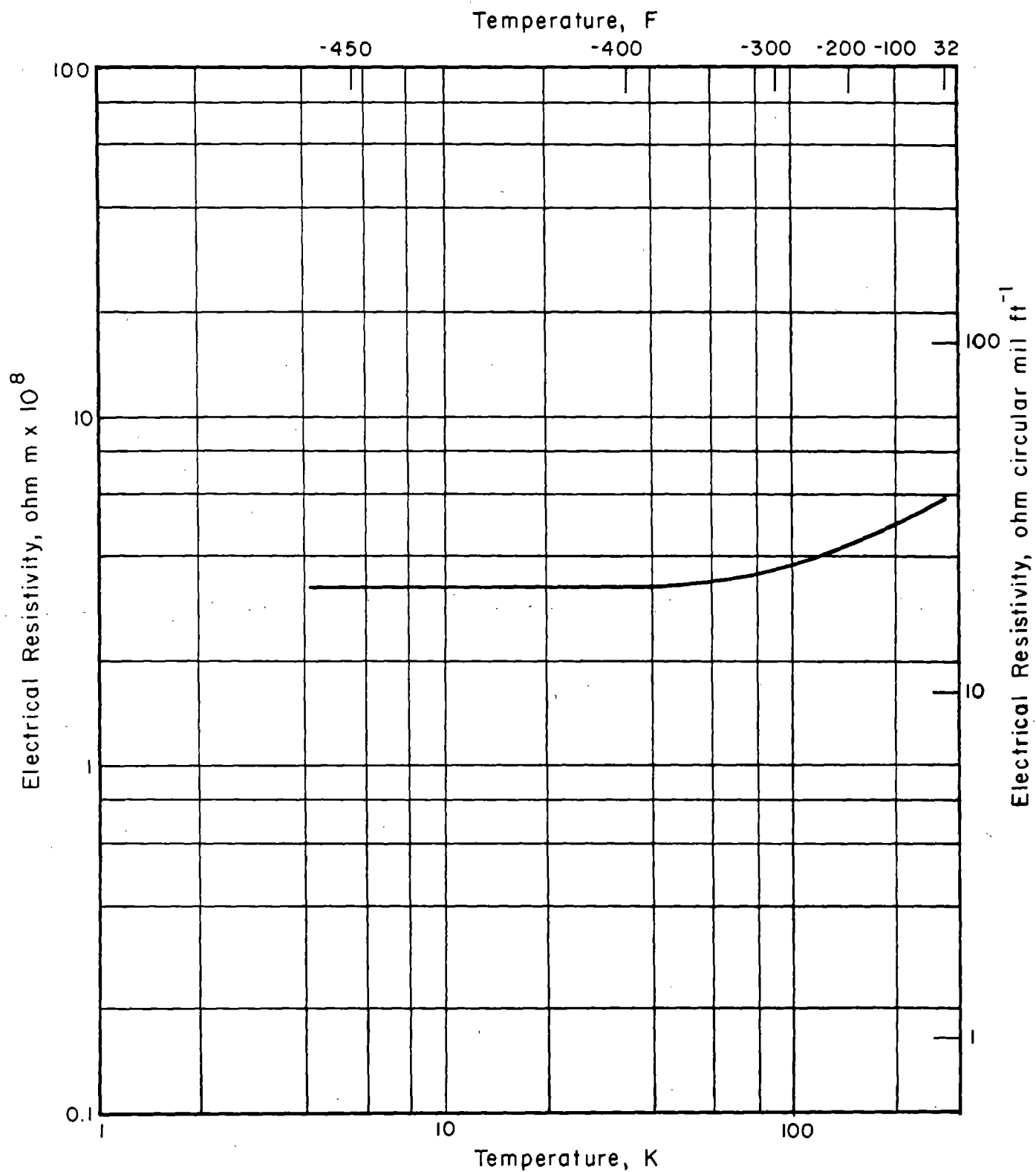


FIGURE 4.2.3-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 5456

TABLE 4.4.1-ME0.1

6061-T4
Sheet

Alloy Designation: 6061-T4 Aluminum Alloy

Specification: QQ-A-327

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: T4

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	279 (40.5)	305 (44.2)		400 (58.0)	598 (86.8)	
	Min	277 (40.2)	301 (43.6)		399 (57.9)	597 (86.6)	
Std Deviation							
TYS, MN/m ² (ksi)	Avg	211 (30.6)	221 (32.0)		259 (37.5)	325 (47.2)	
	Min	210 (30.4)	217 (31.5)		256 (37.2)	320 (46.4)	
Std Deviation							
Elong, percent	Avg	17.2	20.3		28.7	31.2	
	Min	17.0	20.0		27.5	31.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)		3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	283 (41.0)	292 (42.4)		353 (51.2)	427 (62.0)	
	Min	276 (40.1)	290 (42.1)		345 (50.0)	423 (61.8)	
K _t = 6.3							
No. of Spec. (No. of Heats)		2 (1)	3 (1)		3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	274 (39.7)	300 (43.5)		392 (56.9)	636 (92.3)	
	Min	272 (39.4)	299 (43.3)		390 (56.5)	635 (92.1)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	181 (26.3)	201 (29.1)		217 (31.5)	294 (42.6)	
	Min	180 (26.1)	200 (29.0)		211 (30.6)	290 (42.0)	
Std Deviation							
Elong, percent	Avg	17.3	21.0		29.0	34.3	
	Min	17.0	20.0		28.0	34.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	271 (39.3)	288 (41.8)		352 (51.1)	432 (62.6)	
	Min	265 (38.4)	284 (41.2)		348 (50.5)	427 (62.0)	
K _t = 6.3							
No. of Spec. (No. of Heats)		3 (1)	2 (1)		2 (1)	2 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 40988

TABLE 4.4.1-ME0.2

Alloy Designation: 6061-T4 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T4

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	282	(40.9)		419	(60.7)	
	Min	265	(38.4)		394	(57.1)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	159	(23.0)		209	(30.3)	
	Min	146	(21.2)		192	(27.8)	
Std. Deviation							
Elong, percent	Avg	21.3			33.8		
	Min	17			25		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6	(2)		6	(2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	297	(43.1)		414	(60.0)	
	Min	288	(41.7)		403	(58.5)	
K _t = 3							
No. of Spec. (No. of Heats)		6	(2)		6	(2)	
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	279	(40.5)		403	(58.4)	
	Min	265	(38.4)		396	(57.5)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	155	(22.5)		197	(28.5)	
	Min	146	(21.2)		194	(28.1)	
Std. Deviation							
Elong, percent	Avg	23.8			34.3		
	Min	23			32		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6	(2)		6	(2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	293	(42.5)		392	(56.8)	
	Min	285	(41.4)		350	(50.7)	
K _t = 3							
No. of Spec. (No. of Heats)		6	(2)		6	(2)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 52862

TABLE 4.4.1-ME1

Alloy Designation: 6061-T6 Aluminum Alloy

Specification: QQ-A-327

Form: Sheet

Thickness, cm (in.): Up to 0.10 (0.039)

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	327 (47.4)	356 (51.7)	430 (62.3)	538 (78.1)		
	Min	325 (47.2)	355 (51.5)	423 (61.4)	522 (75.7)		
Std. Deviation					15.6 (2.27)		
TYS, MN/m ² (ksi)	Avg	300 (43.5)	314 (45.6)	353 (51.2)	380 (55.1)		
	Min	299 (43.4)	311 (45.1)	350 (50.7)	365 (53.0)		
Std. Deviation					10.7 (1.55)		
Elong, percent	Avg	10.7	11	16	27.6		
	Min	10.0	11	12	19		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	4 (1)	10 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	342 (49.6)	369 (53.5)	430 (62.3)	514 (74.6)		
	Min	339 (49.2)	367 (53.2)	425 (61.6)	501 (72.7)		
K _t = 6.3							
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	4 (3)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	320 (46.4)	354 (51.3)	420 (60.9)	517 (75.0)		
	Min		352 (51.0)	418 (60.6)	490 (71.0)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	287 (41.6)	307 (44.5)	334 (48.5)	363 (52.7)		
	Min		306 (44.4)	325 (47.2)	347 (50.3)		
Std. Deviation							
Elong, percent	Avg	10	11	16	25.2		
	Min	10	11	12	25		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	3 (1)	4 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	334 (48.5)	322 (46.7)	402 (58.3)	488 (70.8)		
	Min	331 (48.0)	284 (41.2)	372 (53.9)	484 (70.2)		
K _t = 6.3							
No. of Spec. (No. of Heats)		2 (1)	4 (1)	4 (1)	2 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90078

TABLE 4.4.1-ME2

Alloy Designation: 6061-T6 Aluminum Alloy

Specification: AMS-4027G, QQ-A-250/11D

Form: Sheet

Thickness, cm (in.): 0.100 to 0.318 (0.040 to 0.125)

Condition: T6

Testing Temperature, K.(F)		297 (75)	219 (-65)	195 (-108)	122 (-240)	77 (-320)	20 (-423)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	312 (45.2)	357 (51.8)	345 (50.0)	386 (56.0)	422 (61.2)	497 (72.1)
	Min	283 (41.0)	341 (49.4)			386 (56.0)	469 (68.0)
	Std. Deviation	44.1 (6.40)	15.4 (2.23)			26.0 (3.77)	24.0 (3.48)
TYS, MN/m ² (ksi)	Avg	282 (40.9)	313 (45.4)	303 (44.0)	324 (47.0)	332 (48.1)	345 (50.0)
	Min	234 (34.0)	301 (43.6)			296 (43.0)	310 (45.0)
	Std. Deviation	20.1 (2.92)	8.48 (1.23)			20.7 (3.00)	31.8 (4.61)
Elong, percent	Avg	12.8	15.4	14	14	20.5	24.8
	Min	9.5	14			14	18.3
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		27 (6)	8 (2)	1 (1)	1 (1)	20 (6)	10 (3)
E, GN/m ² (10 ⁶ psi)	Avg	68 (9.9)				78.6 (11.4)	86.9 (12.6)
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 3	Avg	365 (53.0)	390 (56.5)			485 (70.4)	
	Min	356 (51.6)	385 (55.9)			475 (68.9)	
	No. of Spec. (No. of Heats)	10 (2)	6 (2)			6 (2)	
NTS, MN/m ² (ksi) K _t = 11.1	Avg	331 (48.0)		358 (52.0)	265 (53.0)	393 (57.0)	
	Min						
	No. of Spec. (No. of Heats)	1 (1)		1 (1)	1 (1)	1 (1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	325 (47.1)	355 (51.5)			426 (61.8)	493 (71.5)
	Min	305 (44.3)	339 (49.2)			408 (59.2)	471 (68.3)
	Std. Deviation	15.2 (2.21)	15.1 (2.20)			17.7 (2.57)	13.6 (1.98)
TYS, MN/m ² (ksi)	Avg	276 (40.1)	296 (42.9)			321 (46.5)	338 (49.1)
	Min	241 (35.0)	284 (41.2)			303 (44.0)	324 (47.0)
	Std. Deviation	11.7 (1.70)	8.68 (1.26)			15.9 (2.31)	9.31 (1.35)
Elong, percent	Avg	13.4	15.1			21.9	24.3
	Min	10	14			20.8	14.3
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		20 (4)	9 (2)			12 (4)	12 (2)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 3	Avg	364 (52.8)	389 (56.4)			476 (69.1)	
	Min	357 (51.8)	386 (56.0)			472 (68.4)	
	No. of Spec. (No. of Heats)	10 (2)	6 (2)			6 (2)	
NTS, MN/m ² (ksi) K _t =	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 42002, 47311, 52862, 83417, 90076

TABLE 4.4.1-ME3

Alloy Designation: 6061-T6 Aluminum Alloy
 Specification: AMS-4027G, QQ-A-250/11D
 Form: Sheet
 Thickness, cm (in.): 0.100 to 0.318 (0.040 to 0.125)
 Condition: T6

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Flexural Loading, Surface Finish 150 rms, Rockwell B 39						
S_N at 10^5 cycles, MN/m ² (ksi)	172 (25)		255 (37)	275 (40)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.60		0.66	0.58		
S_N at 10^6 cycles, MN/m ² (ksi)	158 (23)		220 (32)	234 (34)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.55		0.57	0.49		
S_N at 10^7 cycles, MN/m ² (ksi)	152 (22)		214 (31)			
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.52		0.55			
Fatigue, Flexural Loading, Surface Finish 20 rms, Rockwell B 44						
S_N at 10^5 cycles, MN/m ² (ksi)	186 (27)		255 (37)	290 (42)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.63		0.65	0.60		
S_N at 10^6 cycles, MN/m ² (ksi)	165 (24)		228 (33)	228 (33)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.57		0.58	0.47		
S_N at 10^7 cycles, MN/m ² (ksi)	152 (22)		200 (29)			
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^7 cycles	0.51		0.51			

References: 83417

TABLE 4.4.1-ME3.1

6061-T4
Sheet-Weld Metal

Alloy Designation: 6061 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-MIG welded, 4043 Alloy filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 6061-T4 Sheet, welded and tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	248	(35.9)		375	(54.4)	
	Min	240	(34.8)		367	(53.2)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	138	(20.0)		179	(25.9)	
	Min	128	(18.5)		167	(24.2)	
Std. Deviation							
Elong, percent	Avg	12.3			19.4		
	Min	10			18		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6	(2)		5	(2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	176	(25.5)		224	(54.5)	
	Min	161	(23.4)		195	(29.3)	
K _t = 3							
No. of Spec. (No. of Heats)		4	(2)		3	(2)	
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	236	(34.2)		376	(54.5)	
	Min	225	(32.6)		369	(53.5)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	136	(19.7)		197	(28.5)	
	Min	129	(18.7)		181	(26.2)	
Std. Deviation							
Elong, percent	Avg	11.5			16		
	Min	8			5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6	(2)		5	(2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	189	(27.4)		223	(32.3)	
	Min	179	(26.0)		213	(30.9)	
K _t = 3							
No. of Spec. (No. of Heats)		6	(2)		6	(2)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 52862

TABLE 4.4.1-ME3.2

6061-T4
Sheet-Weld Metal

Alloy Designation: 6061 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-MIG welded, 4043 Alloy filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 6061-T4 Sheet, welded, aged to T6, and tested

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	304	(44.1)		397	(57.6)	
	Min	274	(39.7)		386	(56.0)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	277	(40.2)		326	(47.3)	
	Min	254	(36.8)		316	(45.9)	
Std. Deviation							
Elong, percent	Avg	4.5			5.2		
	Min	3			2		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8	(2)		7	(2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	249	(36.1)		284	(41.2)	
	Min	225	(32.7)		263	(38.1)	
K _t = 3							
No. of Spec. (No. of Heats)		5	(2)		6	(2)	
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	301	(43.6)		399	(57.9)	
	Min	283	(41.0)		349	(50.6)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	262	(38.0)		332	(48.2)	
	Min	208	(30.1)		348	(50.5)	
Std. Deviation							
Elong, percent	Avg	4.4			5.9		
	Min	3			1.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7	(2)		8	(2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	250	(36.2)		290	(42.0)	
	Min	232	(33.6)		259	(37.5)	
K _t = 3							
No. of Spec. (No. of Heats)		5	(2)		5	(2)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 52862

TABLE 4.4.1-ME3.3

Alloy Designation: 6061 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-MIG welded, 4043 Alloy filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 6061-T6 Sheet, welded and tested

Testing Temperature, K (F)	297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 222 (32.2)			327 (47.4)	452 (65.5)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 160 (23.2)			199 (28.8)	221 (32.0)	
	Min					
Std. Deviation						
Elong, percent	Avg 5.3			10.5	10.8	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 235 (34.1)			262 (38.0)	288 (41.8)	
	Min					
K _t = 30.3						
No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg 216 (31.3)			325 (47.2)	413 (59.9)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 171 (24.8)			196 (28.4)	413 (59.9)	
	Min					
Std. Deviation						
Elong, percent	Avg 5.0			8.5	6.5	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 90076

TABLE 4.4.1-ME3.4

Alloy Designation: 6061 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 4043 Alloy filler
Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
Condition: 6061-T6 Sheet, welded and tested

Testing Temperature, K (F)	297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 203 (29.4)			308 (44.6)	412 (59.7)	
	Min				410 (59.4)	
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	1			1	6* (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg 201 (29.2)			310 (44.9)		
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	1			1		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 42002

* 6 specimens tested at 20 K (-423 F) each had longitudinal grain orientation on one side of the weld, transverse on the other.

TABLE 4.4.1-ME4

Alloy Designation: 6061-T6 Aluminum Alloy

Specification: AMS-4027G, QQ-A-250/11D

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: T6

Testing Temperature, K (F)		297	(75)			20	(-423)		
Tension, Longitudinal									
TUS, MN/m ² (ksi)	Avg	310	(45.0)			496	(72.0)		
	Min	309	(44.8)			494	(71.6)		
Std. Deviation									
TYS, MN/m ² (ksi)	Avg	288	(41.9)			362	(52.5)		
	Min	288	(41.8)			358	(52.0)		
Std. Deviation									
Elong, percent	Avg	11.5				23.8			
	Min	11				22.5			
RA, percent	Avg	33.6				33.6			
	Min	32.4				33.1			
No. of Spec. (No. of Heats)		2	(1)			2	(1)		
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg	303	(44.0)			421	(61.0)		
	Min	292	(42.3)			414	(60.0)		
K _t = 6.3									
No. of Spec. (No. of Heats)		4	(1)			2	(1)		
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
TYS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)									
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									

References: 66080

TABLE 4.4.1-ME5

Alloy Designation: 6061-T6 Aluminum Alloy

Specification: AMS-4027G, QQ-A-250/11D

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: T6

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)						
Avg	184	(26.7)	239	(34.7)	290	(42.0)
Min					343	(49.8)
No. of Spec. (No. of Heats)		(1)	(1)	(1)		(1)
G, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb)						
Avg					18.4	(13.6)
Min					17.6	(13.0)
No. of Spec. (No. of Heats)					6	(1)
Trans., J(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K_{IE} MN/m^{3/2}(ksi√in.)						
Avg						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 65182, 56750

(a) Indicate specimen design and orientation for shear specimens: 0.394 cm (0.155 in.) diameter specimens

(b) Indicate specimen design for K_{IC} data:

TABLE 4.4.1-ME6

Alloy Designation: 6061-T6 Aluminum Alloy

Specification: QQ-A-327

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	332 (48.1)	362 (52.5)	443 (64.2)	553 (80.3)		
	Min	330 (47.8)	360 (52.2)	440 (63.8)	550 (79.8)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	303 (44.0)	32.3 (46.8)	361 (52.3)	384 (55.8)		
	Min	302 (43.8)	320 (46.4)	360 (52.1)	378 (54.8)		
Std. Deviation							
Elong, percent	Avg	19.3	21.3	24.6	28.6		
	Min	19	21	24	28		
RA, percent	Avg	37.6	43.7	40	37.3		
	Min	31	43	37	33		
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90078

TABLE 4.4.1-ME6.1

Alloy Designation: 6061 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 4043 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 6061-T6 Plate, welded and tested

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	214 (31.0)	239 (34.6)		303 (44.0)		339 (49.1)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	144 (20.9)	163 (23.6)		178 (25.8)		259 (37.6)
	Min						
Std. Deviation							
Elong, percent	Avg	6.0	6.0		5.5		4.5
	Min						
RA, percent	Avg	19	19		12		9
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	234 (34.0)	266 (38.6)		273 (39.6)		275 (39.9)
	Min						
K _t = 16							
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.4.1-ME6.2

Alloy Designation: 6061 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 4043 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 6061-T6 Plate, welded, heat treated to T6, and tested

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	299 (43.3)	330 (47.8)		395 (57.3)		452 (65.6)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	248 (35.9)	264 (38.3)		292 (42.3)		309 (44.8)
	Min						
Std. Deviation							
Elong, percent	Avg	11.0	21.5		16.5		15.0
	Min						
RA, percent	Avg	44	38		12		16
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	396 (57.5)	424 (61.5)		447 (64.8)		463 (67.2)
K _t = 16	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.4.1-ME6.3

Alloy Designation: 6061 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5356 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 6061-T6 Plate, welded and tested

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	225 (32.7)	256 (37.1)		324 (47.0)		398 (57.7)
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	156 (22.6)	170 (24.7)		188 (27.3)		243 (35.3)
	Min						
Std Deviation							
Elong, percent	Avg	8.0	9.0		13.5		13.5
	Min						
RA, percent	Avg	31	36		39		24
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	323 (46.9)	345 (50.1)		373 (54.1)		367 (53.3)
	Min						
K _t = 16							
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.4.1-ME6.4

Alloy Designation: 6061 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5356 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 6061-T6 Plate, welded, heat treated to T6, and tested

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	279 (40.5)	320 (46.4)		394 (57.1)		476 (69.1)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	202 (29.3)	242 (35.1)		234 (33.9)		307 (44.5)
	Min						
Std. Deviation							
Elong, percent	Avg	9.5	12.0		20.0		19.0
	Min						
RA, percent	Avg	33	44		29		24
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg		399 (57.8)		458 (66.4)		419 (60.8)
K _t = 16	Min						
No. of Spec. (No. of Heats)			1		1		1
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90072

TABLE 4.4.1-ME7

Alloy Designation: 6061-T651 Aluminum Alloy

Specification: AMS-4027G, QQ-A-250/11D

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T651

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)		4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	310 (44.9)		402 (58.3)		483 (70.1)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	291 (42.2)		337 (48.9)		379 (55.0)	
	Min						
Std. Deviation							
Elong, percent	Avg	16.5		23.0		25.5	
	Min						
RA, percent	Avg	50		48		42	
	Min						
No. of Spec. (No. of Heats)		(1)		(1)		(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	477 (69.2)		575 (83.4)		620 (89.9)	
	Min						
K _t = 16							
No. of Spec. (No. of Heats)		(1)		(1)		(1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	331 (48.0)	345 (50.1)	402 (58.3)		484 (70.2)	
	Min	310 (44.9)		399 (57.9)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	289 (41.9)	314 (45.5)	323 (46.9)		369 (53.5)	
	Min	278 (40.4)		321 (46.6)			
Std. Deviation							
Elong, percent	Avg	13.6	12	18.6		22.5	
	Min	12		16.8			
RA, percent	Avg	42		39		34	
	Min						
No. of Spec. (No. of Heats)		(2)	(1)	(2)		(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	467 (67.8)		555 (80.5)		601 (87.2)	
	Min						
K _t = 16							
No. of Spec. (No. of Heats)		(1)		(1)		(1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 72563, 80995

TABLE 4.4.1-ME8

Alloy Designation: 6061-T651 Aluminum Alloy

Specification: AMS-4027G, QQ-A-250/11D

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.000 to 2.000)

Condition: T651

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)			
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)	Avg	29.0 (26.5)	32.9 (30.1)	41.4 (37.9)		
	Min	27.8 (25.4)	30.8 (28.2)	40.7 (37.2)		
Orientation: T — L						
No. of Spec. (No. of Heats)	2 (1)	3 (1)	3 (1)			
K_{IE}, MN/m^{3/2}(ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 80995

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data: Notched bend specimens

TABLE 4.4.1-ME9

Alloy Designation: 6061-T6 Aluminum Alloy

Specification: QQ-A-325B

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	523 (46.8)	344 (49.9)	407 (59)	429 (61.5)	522 (75.7)	572 (83.0)
	Min	305 (44.2)	332 (48.1)		412 (59.7)	520 (75.4)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	288 (41.8)	294 (42.6)	338 (49.0)	339 (49.2)	370 (53.7)	400 (58.0)
	Min	270 (39.2)	277 (40.2)		310 (45.0)	356 (51.7)	
Std. Deviation							
Elong, percent	Avg	17.6	19.6	19.0	23.8	29.9	22.0
	Min	15.3	16.5		19.0	29.0	
RA, percent	Avg	53.8	52.5	45.5	47.2	44.6	39.2
	Min	50	50		41.6	43.4	
No. of Spec. (No. of Heats)		8 (4)	5 (3)	(1)	8 (4)	5 (2)	(1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 47311, 47334, 54986, 83417, 90203

TABLE 4.4.1-ME10

Alloy Designation: 6061-T6 Aluminum Alloy

Specification: QQ-A-325B

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: T6

Testing Temperature, K (F)	297 (75)	195 (-108)	122 (-240)	77 (-320)		10 (-441)
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg Min						
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)						
Avg Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb)	17.1 (12.6)	17.6 (13.0)	17.5 (12.9)	17.2 (12.7)		17 (12.6)
Avg Min						
No. of Spec. (No. of Heats)						
Trans., J(ft-lb)						
Avg Min						
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg Min						
Orientation —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)						
Avg (From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 47311, 47334

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 4.4.1-ME11

Alloy Designation: 6061-T6 Aluminum Alloy

Specification: QQ-A-325 B
Form: Bar
Diameter: Up to 2.54 cm (1.000 in.)
Condition: T6

Testing Temperature, K (F)	297 (75)		77 (-320)			
<u>Fatigue, Axial Loading</u>						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)	193 (28)		331 (48)			
Loading frequency 28 Hz						
with $R = 0$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^6 cycles	0.58		0.76			
S_N at 10^7 cycles, MN/m ² (ksi)	145 (21)		296 (43)			
Loading frequency 28 Hz						
with $R = 0$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.44		0.68			
<u>Fatigue, Flexural Loading</u>						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 83417

TABLE 4.4.1-ME11.1

6061-0
Rod

Alloy Designation: 6061-0 Aluminum Alloy

Specification:

Form: Rod
 Thickness, cm (in.): Up to 2.540 (1.000)
 Condition: 0

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	123 (17.8)	138 (20.0)		228 (33.1)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	43 (6.2)	50 (7.2)		58 (8.4)		
	Min						
Std. Deviation							
Elong, percent	Avg		40.5		48.5		
	Min						
RA, percent	Avg	72	74		67		
	Min						
No. of Spec. (No. of Heats)		1	1		1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90203

TABLE 4.4.1-ME11.2

Alloy Designation: 6061-T4 Aluminum Alloy

Specification:

Form: Rod
 Thickness, cm (in.): Up to 2.540 (1.000)
 Condition: T4

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	278 (40.3)	304 (44.1)		399 (57.9)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	150 (21.8)	160 (23.2)		203 (29.4)		
	Min						
Std. Deviation							
Elong, percent	Avg		32.5		36.6		
	Min						
RA, percent	Avg	57	54		41		
	Min						
No. of Spec. (No. of Heats)		1	1		1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90203

TABLE 4.4.1-ME11.3

6061-T91
Rod

Alloy Designation: 6061-T91 Aluminum Alloy

Specification:

Form: Rod
 Thickness, cm (in.): Up to 2.540 (1.000)
 Condition: T91

Testing Temperature, K (F)		297 (75)		195 (-108)		77 (-320)			
<u>Tension, Longitudinal</u>									
TUS, MN/m ² (ksi)	Avg	392	(56.8)	431	(62.5)		509	(73.8)	
	Min	381	(55.2)	414	(60.0)		490	(71.1)	
Std. Deviation									
TYS, MN/m ² (ksi)	Avg	387	(56.1)	415	(60.2)		472	(68.4)	
	Min	376	(54.6)	398	(57.7)		448	(65.0)	
Std. Deviation									
Elong, percent	Avg			4.4			15.3		
	Min			4.2			15.3		
RA, percent	Avg	38.5		39.5			38		
	Min	37		37			37		
No. of Spec. (No. of Heats)		2	(1)	2	(1)		2	(1)	
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									
<u>Tension, Transverse</u>									
TUS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
TYS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)									
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									

References: 90203

TABLE 4.4.1-ME12

Alloy Designation: 6061-T6 Aluminum Alloy

Specification: AMS-4127

Form: Forgings, rolled rings and other shapes

Thickness, cm (in.):

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	310 (44.9)	348 (50.6)	434 (63.0)	499 (72.4)		
	Min	285 (41.4)	323 (46.9)	415 (60.2)	440 (63.8)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	275 (39.9)	301 (43.7)	326 (47.3)	379 (54.9)		
	Min	255 (37.0)	295 (42.8)	305 (44.2)	352 (51.1)		
Std. Deviation							
Elong, percent	Avg	19.8	19.8	24.5	24.9		
	Min	19.0	17.0	24.0	23.0		
RA, percent	Avg	51.5	50.8	41.5	38.6		
	Min	34.9	38.0	34.3	32.8		
No. of Spec. (No. of Heats)		6 (2)	6 (2)	6 (2)	6 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	436 (63.3)	463 (67.2)	542 (78.6)	562 (81.5)		
	Min	431 (62.5)	451 (65.4)	536 (77.8)	529 (76.7)		
K _t = 6 to 8							
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 35611, 66080

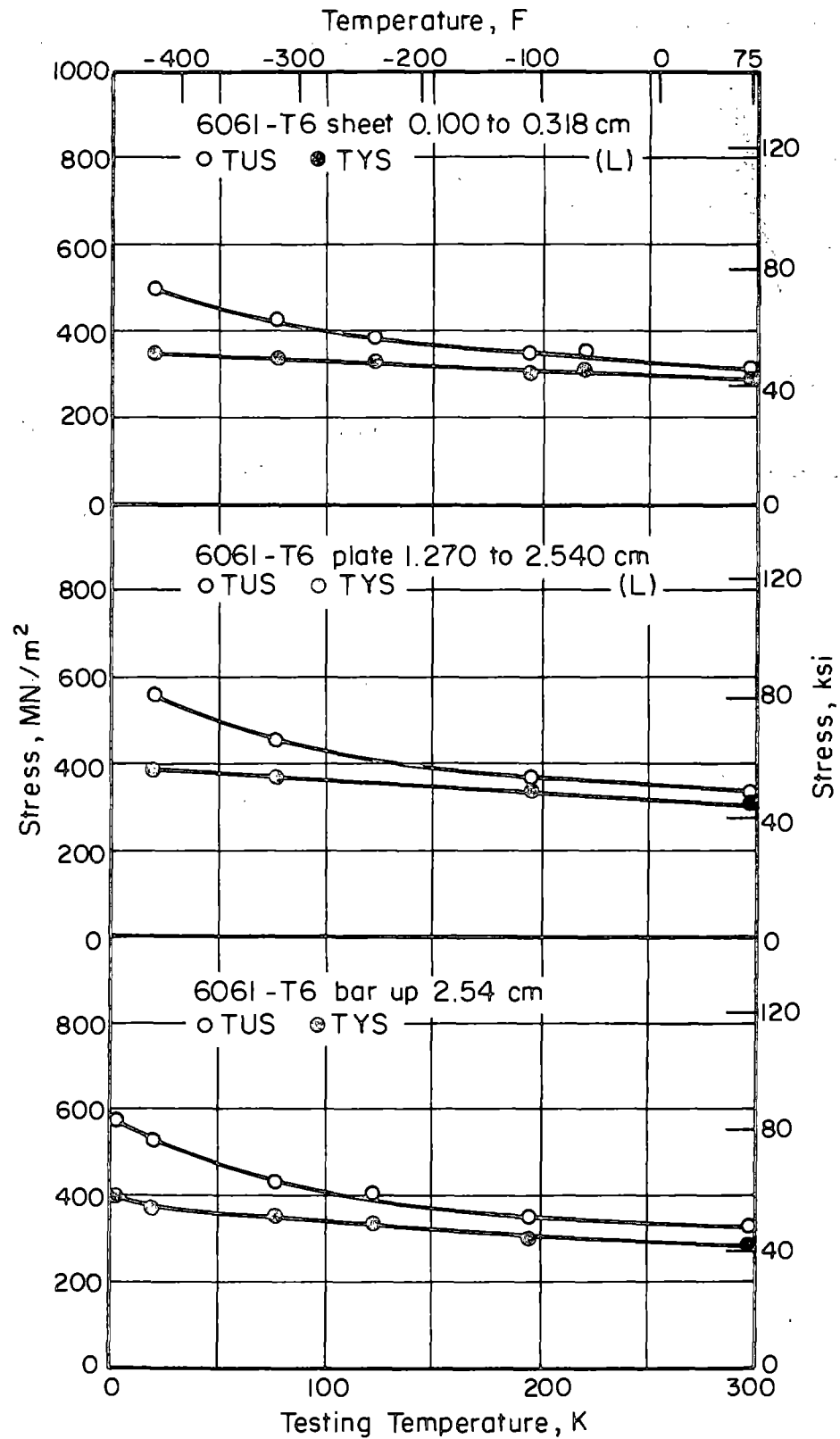


FIGURE 4.4.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 6061 ALUMINUM ALLOY

4.4.1-13 (11/74)

TABLE 4.4.1-TR1

Alloy Designation: 6061-T6 Aluminum Alloy

Specification:

Form:

Dimension:

Condition: -T6

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal (1)						
Percent	0	-0.325	-0.369	-0.373	-0.373	-0.373
No. of Spec.	3	3	3	3	2	2
References: 48134, 69332						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	3.94 x 10 ⁻⁸	1.95 x 10 ⁻⁸	1.55 x 10 ⁻⁸	1.47 x 10 ⁻⁸	1.42 x 10 ⁻⁸	1.40 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(23.7)	(11.7)	(9.32)	(8.84)	(8.54)	(8.42)
No. of Spec.	1	1	1	1	1	1
References: 79561						

(1) T6 and T651

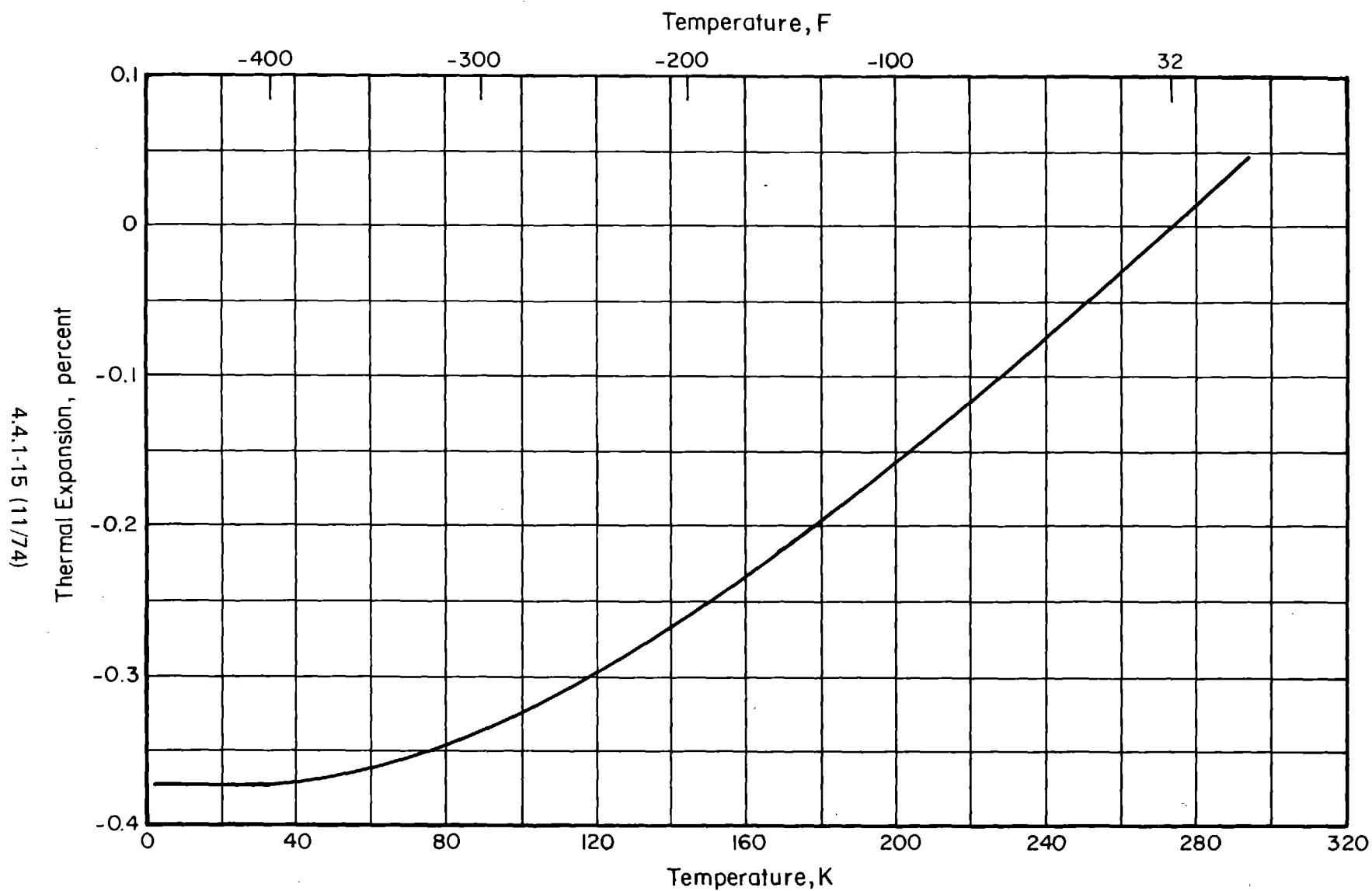


FIGURE 4.4.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 6061-T6, T651

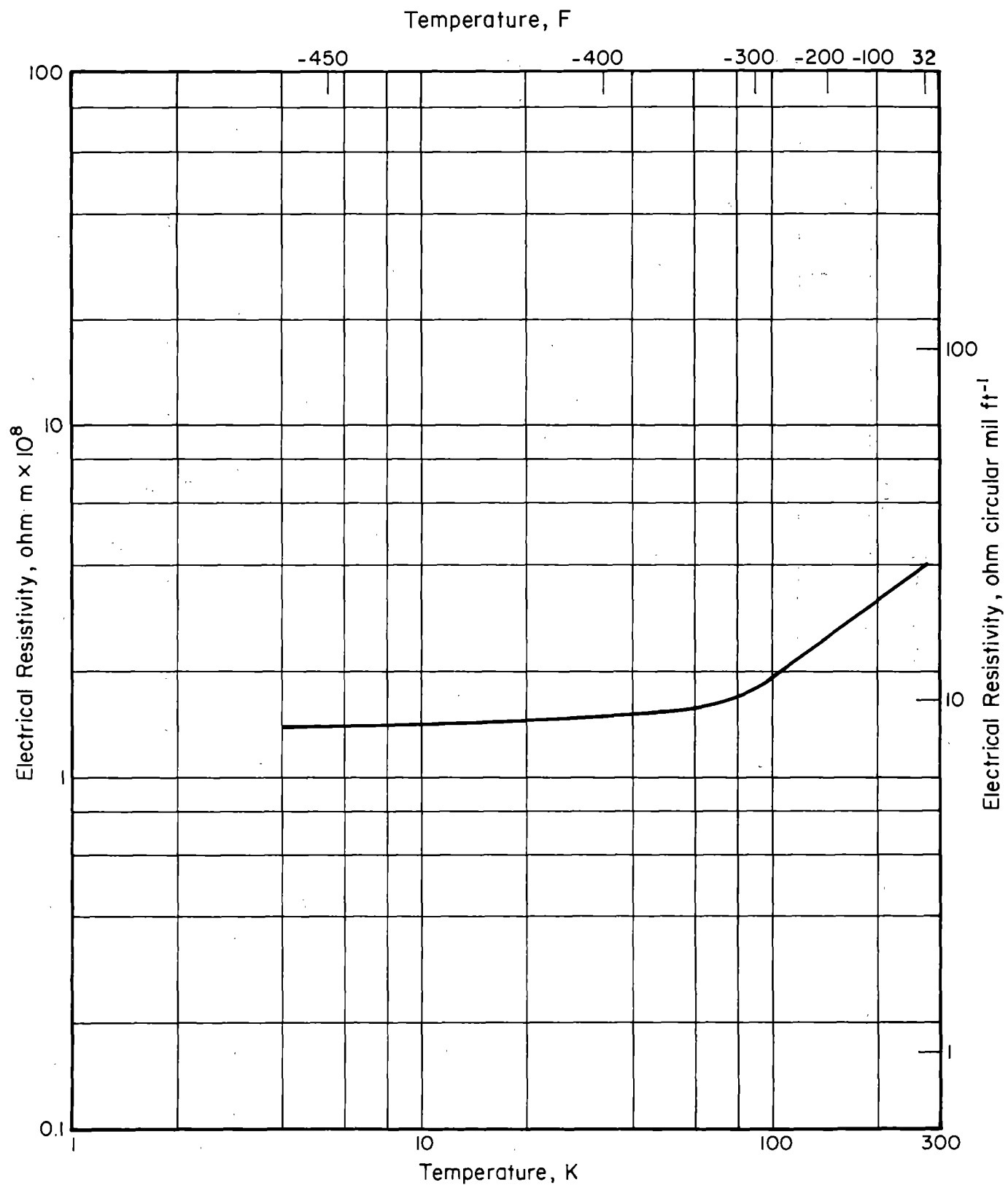


FIGURE 4.4.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 6061-T6

TABLE 4.5.1-ME1

Alloy Designation: 7039-T6 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	455 (66.0)	507 (73.5)	528 (76.6)	579 (84.0)	654 (94.8)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	412 (59.7)	458 (66.5)	467 (67.8)	506 (73.4)	540 (78.4)	
	Min						
Std. Deviation							
Elong, percent	Avg	9.8	11.6	11.5	12.9	8.5	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	462 (67.0)	497 (72.1)	507 (73.6)	468 (67.9)	423 (61.4)	
K _t = 10	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	457 (66.3)	510 (73.9)	534 (77.5)	577 (83.7)	680 (98.7)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	398 (57.8)	443 (64.3)	463 (67.2)	498 (72.3)	530 (76.8)	
	Min						
Std. Deviation							
Elong, percent	Avg	9.3	9.8	11.8	13.4	9.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	450 (65.3)	485 (70.3)	492 (71.4)	446 (64.7)	412 (59.8)	
K _t = 10	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90107

TABLE 4.5.1-ME2

Alloy Designation: 7039-T6 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	455 (66.0)	512 (74.3)	540 (78.4)	568 (82.4)	674 (97.7)	
	Min	437 (63.4)	510 (74.0)		535 (77.7)	651 (94.5)	
	Std. Deviation	16.8 (2.45)			24.0 (3.48)	15.0 (2.17)	
TYS, MN/m ² (ksi)	Avg	413 (59.9)	461 (66.9)	493 (71.5)	487 (70.6)	526 (76.3)	
	Min	385 (55.8)	458 (66.5)		446 (64.7)	504 (73.1)	
	Std. Deviation	16.6 (2.41)			26.9 (3.90)	17.6 (2.56)	
Elong, percent	Avg	11.7	12.3	11.9	17.1	18.6	
	Min	10.5	11.0		12.7	10.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		15 (4)	6 (2)	(1)	15 (4)	12 (3)	
E, GN/m ² (10 ⁶ psi)	Avg	67.7 (9.82)	70.3 (10.2)		78.6 (11.4)	78.6 (11.4)	
	Min	66 (9.6)	67 (9.8)		75.8 (11.0)	75.2 (10.9)	
	No. of Spec. (No. of Heats)	6 (2)	5 (1)		6 (2)	6 (2)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	497 (72.1)	534 (77.5)		563 (81.6)	569 (82.5)	
	Min	470 (68.1)	531 (77.1)		554 (80.3)	518 (75.1)	
	No. of Spec. (No. of Heats)	8 (2)	5 (1)		8 (2)	5 (1)	
NTS, MN/m ² (ksi)	Avg	470 (68.1)	445 (64.5)		346 (50.2)	395 (57.3)	
	Min	466 (67.6)	429 (61.4)		333 (48.3)	370 (53.6)	
	No. of Spec. (No. of Heats)	5 (1)	5 (1)		5 (1)	5 (1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	462 (67.1)	503 (72.9)	530 (76.9)	586 (84.9)	666 (96.6)	
	Min	434 (63.0)	471 (68.3)		557 (80.8)	639 (92.7)	
	Std. Deviation	11.0 (1.60)			9.3 (1.35)		
TYS, MN/m ² (ksi)	Avg	403 (58.4)	446 (64.7)	467 (67.8)	484 (70.2)	514 (74.5)	
	Min	374 (54.2)	443 (64.2)		443 (64.3)	452 (65.5)	
	Std. Deviation	11.2 (1.63)			14.2 (2.06)		
Elong, percent	Avg	11.2	11.7	11.0	14.2	12.0	
	Min	10.0	10.3		12.5	8.8	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		13 (5)	7 (2)	(1)	13 (5)	7 (3)	
E, GN/m ² (10 ⁶ psi)	Avg	69.6 (10.1)	68.7 (9.96)		73.1 (10.6)	75.8 (11.0)	
	Min	68 (9.8)	66 (9.6)		69.6 (10.1)	73.1 (10.6)	
	No. of Spec. (No. of Heats)	5 (1)	5 (1)		5 (1)	5 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	480 (69.7)	526 (76.3)		536 (77.8)	570 (82.6)	
	Min	429 (62.2)	520 (75.5)		449 (65.1)	549 (79.6)	
	No. of Spec. (No. of Heats)	12 (4)	5 (1)		12 (4)	5 (1)	
NTS, MN/m ² (ksi)	Avg	449 (65.1)	412 (59.8)		303 (44.0)	330 (47.8)	
	Min	441 (64.0)	394 (57.2)		288 (41.7)	314 (45.5)	
	No. of Spec. (No. of Heats)	5 (1)	5 (1)		5 (1)	5 (1)	

References: 53885, 56261, 58024, 90082, 90107

TABLE 4.5.1-ME3

Alloy Designation: 7039-T6 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T6

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading (R = -1)						
S_N at 10^6 cycles, MN/m ² (ksi)	138 (20)		214 (31)	276 (40)		
Loading frequency Hz						
with R = -1 and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.31		0.40	0.43		
S_N at 10^6 cycles, MN/m ² (ksi)	48.2 (7)		48.2 (7)	62.1 (9)		
Loading frequency Hz						
with R = -1 and $K_t = 6.3$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
S_N at 10^6 cycles, MN/m ² (ksi)	37.9 (5.5)		73.7 (10.7)	79.3 (11.5)		
Loading frequency Hz						
with R = -1 and $K_t = 8$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Fatigue, Axial Loading (R = 0.01)						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)	228 (33)		331 (48)	441 (64)		
Loading frequency Hz						
with R = 0.01 and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.51		0.61	0.67		
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 58024, 61996

TABLE 4.5.1-ME3.1

7039-T6
Sheet-Weld Metal

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-MIG welded, 5183 Alloy filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 7039-T6 Sheet; welded natural aged 15-30 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	367 (53.2)			391 (56.7)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	240 (34.8)			299 (43.4)		
	Min						
Std. Deviation							
Elong, percent	Avg	7.0			3.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	405 (58.7)			434 (63.0)		
K _t = 6.3	Min						
No. of Spec. (No. of Heats)		1			1		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME3.2

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-"Fusion" welded, filler not specified

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 7039-T6 Sheet, welded and tested

Testing Temperature, K (F)		297 (75)		195 (-108)		77 (-320)		20 (-423)		
Tension, Longitudinal										
TUS, MN/m ² (ksi)	Avg	383	(55.5)	388	(56.3)	405	(58.8)	354	(51.4)	
	Min	372	(53.9)	378	(54.8)	361	(52.9)	303	(43.9)	
Std. Deviation										
TYS, MN/m ² (ksi)	Avg									
	Min									
Std. Deviation										
Elong, percent	Avg	9.1		8.4		7.2		0.9		
	Min	7.5		4.0		6.0		0.5		
RA, percent	Avg									
	Min									
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)	
E, GN/m ² (10 ⁶ psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Poisson's Ratio										
Work Hardening Coef										
NTS, MN/m ² (ksi)	Avg									
	Min									
K _t =										
No. of Spec. (No. of Heats)										
NTS, MN/m ² (ksi)	Avg									
	Min									
K _t =										
No. of Spec. (No. of Heats)										
Tension, Transverse										
TUS, MN/m ² (ksi)	Avg	379	(54.9)	387	(56.2)	404	(58.6)	392	(56.9)	
	Min	375	(54.4)	371	(53.8)	390	(56.6)	381	(55.3)	
Std. Deviation										
TYS, MN/m ² (ksi)	Avg									
	Min									
Std. Deviation										
Elong, percent	Avg	9.4		9.4		6.6		0.7		
	Min	8.0		7.0		6.0		0.5		
RA, percent	Avg									
	Min									
No. of Spec. (No. of Heats)		5	(1)	5	(1)	5	(1)	5	(1)	
E, GN/m ² (10 ⁶ psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Poisson's Ratio										
Work Hardening Coef										
NTS, MN/m ² (ksi)	Avg									
	Min									
K _t =										
No. of Spec. (No. of Heats)										
NTS, MN/m ² (ksi)	Avg									
	Min									
K _t =										
No. of Spec. (No. of Heats)										

References: 56261

TABLE 4.5.1-ME4

Alloy Designation: 7039-T61 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: T61

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	400 (58.0)		494 (71.7)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	326 (47.3)		366 (53.1)			
	Min						
Std. Deviation							
Elong, percent	Avg	14.5		18.1			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	409 (59.3)		532 (77.2)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	328 (47.6)		384 (55.7)			
	Min						
Std. Deviation							
Elong, percent	Avg	12.9		15.5			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90075

TABLE 4.5.1-ME4.1

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler
 Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)
 Condition: 7039-T61 Sheet, welded and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	317 (46.0)			422 (61.2)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	177 (25.6)			209 (30.3)		
	Min						
Std. Deviation							
Elong, percent	Avg	9.6			14.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90075

TABLE 4.5.1-ME4.2

7039-T61
Sheet-Weld Metal

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: 7039-T61 Sheet, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	353 (51.2)			445 (64.6)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	210 (30.4)			254 (36.9)		
	Min						
Std. Deviation							
Elong, percent	Avg	11.4			14		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90075

TABLE 4.5.1-ME5

Alloy Designation: 7039-T6, T61 Aluminum Alloy

Specification: AMS-4024A, MIL-A-8877

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: T6, T61

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	429 (62.3)	478 (69.3)	501 (72.7)	549 (79.7)	654 (94.8)	
	Min	402 (58.3)			523 (75.9)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	372 (53.9)	427 (62.0)	449 (65.1)	438 (63.7)	504 (73.1)	
	Min	328 (47.5)			378 (54.8)		
Std. Deviation							
Elong, percent	Avg	16.3	12.7	12.7	18.4	15.7	
	Min	12.5			14.1		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (3)	(1)	(1)	7 (3)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	503 (72.9)			561 (81.4)		
K _t = 6.3	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)		
NTS, MN/m ² (ksi)	Avg	483 (70.0)	510 (73.9)	521 (75.6)	557 (80.8)	560 (81.2)	
K _t = 10	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	434 (63.0)	479 (69.5)	514 (74.5)	566 (82.1)	651 (94.4)	
	Min	401 (58.2)			539 (78.2)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	369 (53.5)	426 (61.8)	450 (65.2)	439 (63.7)	518 (75.2)	
	Min	325 (47.2)			385 (55.9)		
Std. Deviation							
Elong, percent	Avg	14.5	11.0	12.1	15.4	11.7	
	Min	10.5			11.3		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (3)	(1)	(1)	7 (3)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	504 (73.1)			539 (78.2)		
K _t = 6.3	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)		
NTS, MN/m ² (ksi)	Avg	483 (70.1)	507 (73.5)	516 (74.9)	506 (73.4)	494 (71.6)	
K _t = 10	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	

References: 90082, 90107

TABLE 4.5.1-ME5.1

7039-T6
Plate-Weld Metal

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5083 Alloy filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: 7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	352 (51.1)			433 (62.8)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	203 (29.4)			254 (36.8)		
	Min						
Std. Deviation							
Elong, percent	Avg	14.0			14.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	399 (57.9)			411 (59.6)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME5.2

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 5039 Alloy filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: 7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	361 (52.4)			380 (55.1)		
	Min	348 (50.5)			362 (52.5)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	220 (31.9)			266 (38.6)		
	Min	214 (31.0)			260 (37.7)		
Std. Deviation							
Elong, percent	Avg	10.2			5.0		
	Min	9.3			4.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)			8 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	345 (50.1)			348 (50.4)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		8 (2)			8 (2)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME5.3

7039-T6
Plate-Weld Metal

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, no filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: 7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	368 (53.4)			420 (60.9)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	224 (32.6)			268 (38.9)		
	Min						
Std. Deviation							
Elong, percent	Avg	9.5			7.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	355 (51.5)			354 (51.4)		
K _t = 6.3	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME5.4

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5039 Alloy filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: 7039-T64 Plate, welded and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	359 (52)			448 (65)		
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	224 (32.5)			279 (40.5)		
	Min						
Std Deviation							
Elong, percent	Avg	8.0			6.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 67769

TABLE 4.5.1-ME6

Alloy Designation: 7039-T6, T61 Aluminum Alloy

Specification: AMS-4024A, MIL-A-8877

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T6, T61

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	437 (63.4)	486 (70.5)	507 (73.5)	589 (85.4)	675 (97.9)	
	Min	407 (59.1)	445 (64.6)	467 (67.7)	525 (76.2)	623 (90.4)	
	Std. Deviation	29.3 (4.25)			18.6 (2.70)	34.7 (5.04)	
TYS, MN/m ² (ksi)	Avg	396 (57.4)	429 (62.2)	446 (64.7)	477 (69.2)	516 (74.9)	
	Min	352 (51.0)	381 (55.3)	399 (57.9)	432 (62.7)	466 (67.6)	
	Std. Deviation	31.7 (4.60)			33.8 (4.91)		
Elong, percent	Avg	13.5	14.0	14.5	16.6	14.0	
	Min	11.8	13.3	14.2	15.7	12.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		15 (5)	3 (1)	3 (1)	15 (5)	9 (3)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	634 (91.9)			645 (93.5)		
	Min						
	No. of Spec. (No. of Heats)	(2)			(2)		
NTS, MN/m ² (ksi)	Avg	530 (76.8)	553 (80.2)	563 (81.7)	561 (81.4)	553 (80.2)	
	Min	486 (70.5)	512 (74.2)	532 (77.2)	550 (79.7)	534 (77.5)	
	No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	445 (64.6)	484 (70.2)	510 (73.9)	578 (83.9)	658 (95.5)	
	Min	405 (58.7)	442 (64.1)	467 (67.7)	528 (76.6)	611 (88.6)	
	Std. Deviation	28.7 (4.17)			21.1 (3.06)	19.7 (2.86)	
TYS, MN/m ² (ksi)	Avg	384 (55.7)	416 (60.3)	432 (62.6)	464 (67.3)	491 (71.2)	
	Min	346 (50.2)	377 (54.7)	394 (57.1)	423 (61.4)	441 (63.9)	
	Std. Deviation	31.4 (4.55)			37.4 (5.43)	42.7 (6.20)	
Elong, percent	Avg	13.1	12.6	12.8	13.6	11.8	
	Min	11.8	12.0	10.7	10.0	8.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		15 (5)	3 (1)	3 (1)	15 (5)	9 (3)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	621 (90.0)			607 (88.0)		
	Min	787 (85.2)			594 (86.1)		
	No. of Spec. (No. of Heats)	6 (2)			6 (2)		
NTS, MN/m ² (ksi)	Avg	510 (74.0)	525 (76.2)	534 (77.4)	520 (75.4)	498 (72.3)	
	Min	468 (67.9)	491 (71.2)	512 (74.2)	516 (74.8)	488 (70.8)	
	No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	

References: 90082, 90084, 90107

TABLE 4.5.1-ME6.1

7039-T6
Plate-Weld Metal

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5039 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	356 (51.7)			446 (64.7)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	223 (32.3)			279 (40.4)		
	Min						
Std. Deviation							
Elong, percent	Avg	8.2			6.7		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	413 (59.9)			439 (63.6)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME6.2

7039-T6
Plate-Weld Metal

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5183 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	294 (42.6)			419 (60.8)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	169 (24.5)			205 (29.7)		
	Min						
Std. Deviation							
Elong, percent	Avg	9.8			10.2		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	355 (51.5)			406 (58.9)		
K _t = 6.3	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME6.3

7039-T6
Plate-Weld Metal

Alloy Designation: 7039 Aluminum Alloy

Specification:

Form: Plate-TIG welded, 5039 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)		77 (-320)			
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	347	(50.3)	441	(64.0)		
	Min	343	(49.8)	432	(62.6)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	217	(31.5)	266	(38.6)		
	Min	215	(31.2)	263	(38.2)		
Std. Deviation							
Elong, percent	Avg	11.1		6.7			
	Min	10.1		4.0			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8,	(2)	8	(2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	336	(48.7)	328	(47.6)		
	Min	334	(48.5)	321	(46.6)		
K _t = 6.3							
No. of Spec. (No. of Heats)		8	(2)	8	(2)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME6.4

7039-T6
Plate-Weld Metal

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 5183 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	342 (49.6)			441 (64.0)		
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	200 (29.0)			250 (36.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	12.0			12.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	319 (46.2)			328 (47.6)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		4 (1)			4 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME6.5

7039-T6
Plate-Weld Metal

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, no filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 7039-T6 Plate, welded, natural aged 15 days, and tested

Testing Temperature, K (F)	297 (75)			77 (-320)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 370 (53.7)			443 (64.2)		
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 237 (34.4)			290 (42.1)		
	Min					
Std. Deviation						
Elong, percent	Avg 11.2			9.1		
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	4 (1)			4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 359 (52.0)			365 (52.9)		
	Min					
K _t = 6.3						
No. of Spec. (No. of Heats)	4 (1)			4 (1)		
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 90082

TABLE 4.5.1-ME6.6

7039-T61
Plate-Weld Metal

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5039 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 7039-T61 Plate, welded, natural aged 27 days, and tested

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	357 (51.8)			402 (58.3)	376 (54.5)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	214 (31.1)			249 (36.1)		
	Min						
Std. Deviation							
Elong, percent	Avg	9.3			9.3	2.2	
	Min						
RA, percent	Avg	22.7			12.3	3.5	
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	359 (52.1)			374 (54.2)	327 (47.9)	
	Min						
K _t = 15							
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME6.7

7039-T6151
Plate

Alloy Designation: 7039-T6151 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T6151

Testing Temperature, K (F)		297 (75)	144 (-200)	116 (-250)	77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	405 (58.8)	471 (68.3)	498 (72.2)	550 (79.8)		649 (94.2)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	334 (48.5)	364 (52.8)	380 (55.1)	401 (58.2)		476 (69.0)
	Min						
Std. Deviation							
Elong, percent	Avg	14.9	15.1	15.7	16.3		15.5
	Min						
RA, percent	Avg	38.1	33.0	31.4	28.1		22
	Min						
No. of Spec. (No. of Heats)		7 (2)	6 (1)	6 (1)	7 (2)		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	525 (76.1)	562 (81.5)	576 (83.5)	587 (85.2)		614 (89.1)
	Min						
K _t = 15-16							
No. of Spec. (No. of Heats)		7 (2)	6 (1)	6 (1)	7 (2)		1
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	399 (57.8)	463 (67.1)	490 (71.1)	532 (77.2)		626 (90.8)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	325 (47.2)	360 (52.2)	371 (53.8)	396 (57.5)		455 (66.0)
	Min						
Std. Deviation							
Elong, percent	Avg	14.1	14.3	14.8	15.7		12.5
	Min						
RA, percent	Avg	34.6	29.9	28.3	26.5		15
	Min						
No. of Spec. (No. of Heats)		7 (2)	6 (1)	6 (1)	7 (2)		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	518 (75.1)	554 (80.4)	562 (81.5)	564 (81.8)		586 (85.0)
	Min						
K _t = 15-16							
No. of Spec. (No. of Heats)		7 (2)	6 (1)	6 (1)	7 (2)		1
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90070, 90187

TABLE 4.5.1-ME6.8

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5039 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 7039-T6151 Plate, welded and tested

Testing Temperature, K (F)		297 (75)	144 (-200)	114 (-250)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	357 (51.8)	385 (55.8)	414 (60.1)	422 (61.2)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	236 (34.3)	259 (37.6)	272 (39.4)	279 (40.5)		
	Min						
Std. Deviation							
Elong, percent	Avg	10.0	9.3	11.9	5.7		
	Min						
RA, percent	Avg		18.8	14.7	12.7		
	Min						
No. of Spec. (No. of Heats)		6 (1)	6 (1)	6 (1)	6 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	406 (58.9)	431 (62.5)	422 (61.2)	412 (59.7)		
K _t = 15	Min						
No. of Spec. (No. of Heats)		6 (1)	6 (1)	6 (1)	6 (1)		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90187

TABLE 4.5.1-ME6.9

Alloy Designation: 7039-T6151 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T6351

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	463 (67.2)	520 (75.4)		610 (88.4)		711 (103.1)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	390 (56.5)	428 (62.1)		467 (67.8)		527 (76.4)
	Min						
Std. Deviation							
Elong, percent	Avg	14.5	14.5		17.0		17.5
	Min						
RA, percent	Avg	32	23		20		19
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	611 (88.6)	634 (91.9)		589 (85.9)		617 (89.5)
	Min						
K _t = 16							
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	459 (66.5)	502 (72.8)		601 (87.1)		699 (101.4)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	390 (56.6)	423 (61.4)		476 (69.0)		536 (77.7)
	Min						
Std. Deviation							
Elong, percent	Avg	13.0	12.5		13.5		13.0
	Min						
RA, percent	Avg	33	23		19		15
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	607 (88.0)	584 (84.7)		518 (75.1)		556 (80.6)
	Min						
K _t = 16							
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90070

TABLE 4.5.1-ME6.10

7039-T64
Plate-Weld Metal

Alloy Designation: 7039 Aluminum Alloy (Weld Metal)

Specification:

Form: Plate-MIG welded, 5039 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 7039-T64 Plate, welded and tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	359 (52)			448 (65)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	224 (32.5)			279 (40.5)		
	Min						
Std. Deviation							
Elong, percent	Avg	8.0			6.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 67769

TABLE 4.5.1-ME7

Alloy Designation: 7039-T6, T61 Aluminum Alloy

Specification: AMS-4024A, MIL-A-8877

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T6, T61

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	455 (66.1)	498 (72.2)	516 (74.9)	580 (84.1)	678 (98.4)	
	Min	430 (62.3)			556 (80.7)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	393 (57.1)	434 (63.0)	457 (66.3)	470 (68.1)	510 (73.9)	
	Min	354 (51.4)			420 (60.9)		
Std. Deviation							
Elong, percent	Avg	14.1	15.2	15.0	14.6	13.6	
	Min	12.0			12.3		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (3)	(1)	(1)	7 (3)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	652 (94.6)			687 (99.6)		
	Min	618 (89.6)			680 (98.6)		
No. of Spec. (No. of Heats)		6 (2)			6 (2)		
NTS, MN/m ² (ksi)	Avg	545 (79.0)	574 (83.3)	580 (84.1)	574 (83.2)	572 (83.0)	
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	480 (69.6)	494 (71.6)	516 (74.8)	571 (82.9)	683 (99.0)	
	Min	423 (61.4)			541 (78.4)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	382 (55.3)	427 (61.9)	446 (64.7)	456 (66.1)	522 (75.7)	
	Min	345 (50.0)			409 (59.3)		
Std. Deviation							
Elong, percent	Avg	13.3	13.3	15.0	13.1	11.5	
	Min	10.7			11.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (3)	(1)	(1)	7 (3)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	638 (92.6)			612 (88.8)		
	Min	609 (88.3)			591 (85.7)		
No. of Spec. (No. of Heats)		6 (2)			6 (2)		
NTS, MN/m ² (ksi)	Avg	525 (76.1)	548 (79.5)	552 (80.1)	542 (78.6)	527 (76.4)	
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	

References: 90082, 90107

TABLE 4.5.1-ME8

Alloy Designation: 7039-T6, T61 Aluminum Alloy

Specification: AMS-4024A, MIL-A-8877

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T6, T61

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)			
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC}, MN/m^{3/2}(ksi√in.)	Avg	32.1 (29.4)	32.5 (29.7)	33.3 (30.5)		
	Min	31.7 (29.0)	32.4 (29.6)	32.6 (29.8)		
Orientation: T — L						
No. of Spec. (No. of Heats)	3 (1)	3 (1)	4 (1)			
K_{IE}, MN/m^{3/2}(ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 80994

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data: Bend specimens

TABLE 4.5.1-ME8.1

7039-T64
Plate

Alloy Designation: 7039-T64 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T64

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	448 (65.0)			586 (85.0)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	400 (58.0)			490 (71.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	14			17		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	676 (98)			690 (100)		
K _t = 6.3	Min						
No. of Spec. (No. of Heats)		1			1		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 67769

TABLE 4.5.1-ME9

Alloy Designation: 7039-T6 Aluminum Alloy

Specification: AMS-4024A, MIL-A-8877

Form: Plate

Thickness, cm (in.): 5.081 to 12.70 (2.001 to 5.000)

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	476 (69.1)	479 (72.1)	537 (77.9)	585 (84.8)	638 (92.6)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	431 (62.5)	463 (67.1)	490 (71.0)	534 (77.4)	567 (82.3)	
	Min						
Std. Deviation							
Elong, percent	Avg	8.5	9.2	11.5	7.5	9.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg	579 (84.0)	565 (82.0)	575 (83.4)	562 (81.5)	563 (81.6)	
K _t = 10	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	483 (70.1)	521 (75.6)	522 (75.7)	558 (81.0)	592 (85.8)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	426 (61.8)	474 (68.8)	472 (68.4)	512 (74.2)	530 (76.9)	
	Min						
Std. Deviation							
Elong, percent	Avg	6.5	7.0	4.2	2.5	2.7	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg	532 (77.1)	529 (76.7)	508 (73.7)	439 (63.7)	401 (58.2)	
K _t = 10	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	

References: 90107

4.5.1-9 (11/74)

TABLE 4.5.1-ME10

Alloy Designation: 7039-T6 Aluminum Alloy

Specification: AMS-4024A, MIL-A-8877

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Short Transverse							
TUS, MN/m ² (ksi)	Avg	463 (67.2)	495 (71.8)	496 (72.0)	520 (75.4)	271 (39.3)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	383 (55.5)	410 (59.5)	448 (65.0)	461 (66.8)	176 (25.5)	
	Min						
Std. Deviation							
Elong, percent	Avg	7.5	5.8	3.8	2.5	2.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg	517 (75.0)	452 (65.6)	426 (61.8)	299 (43.3)	161 (23.3)	
K _t = 10	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	

References: 90107

TABLE 4.5.1-ME11

Alloy Designation: 7039-T6, T61 Aluminum Alloy

Specification: AMS-4171A, MIL-A-8825

Form: Extrusions

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T6, T61

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	485 (70.3)		645 (93.6)			
	Min	466 (67.6)		633 (91.8)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	425 (61.6)		535 (77.6)			
	Min	404 (58.6)		510 (73.9)			
Std. Deviation							
Elong, percent	Avg	14.3		12.0			
	Min	13.3		10.0			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)		6 (2)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	678 (98.4)		747 (108.4)			
	Min	663 (96.1)		728 (105.6)			
K _t = 6.3							
No. of Spec. (No. of Heats)		6 (2)		6 (2)			
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	455 (66.0)		576 (83.5)			
	Min	440 (63.8)		570 (82.6)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	392 (56.8)		468 (67.9)			
	Min	375 (54.4)		451 (65.4)			
Std. Deviation							
Elong, percent	Avg	16.2		10.8			
	Min	16.0		10.0			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)		6 (2)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	647 (93.9)		663 (96.2)			
	Min	634 (91.9)		659 (95.6)			
K _t = 6.3							
No. of Spec. (No. of Heats)		6 (2)		6 (2)			
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90082

TABLE 4.5.1-ME12

Alloy Designation: 7039-T6, T61 Aluminum Alloy

Specification: AMS-4171A, MIL-A-8825

Form: Extrusions

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T6, T61

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Short Transverse							
TUS, MN/m² (ksi)	Avg	436 (63.2)		541 (78.5)			
	Min	422 (61.2)		540 (78.4)			
Std. Deviation							
TYS, MN/m² (ksi)	Avg	354 (51.3)		443 (64.3)			
	Min	339 (49.2)		425 (61.6)			
Std. Deviation							
Elong, percent	Avg	12.0		5.6			
	Min	12.0		4.0			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)		6 (2)			
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg	633 (91.8)		574 (83.2)			
	Min	621 (90.0)		569 (82.5)			
No. of Spec. (No. of Heats)		6 (2)		6 (2)			
NTS, MN/m² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 90082

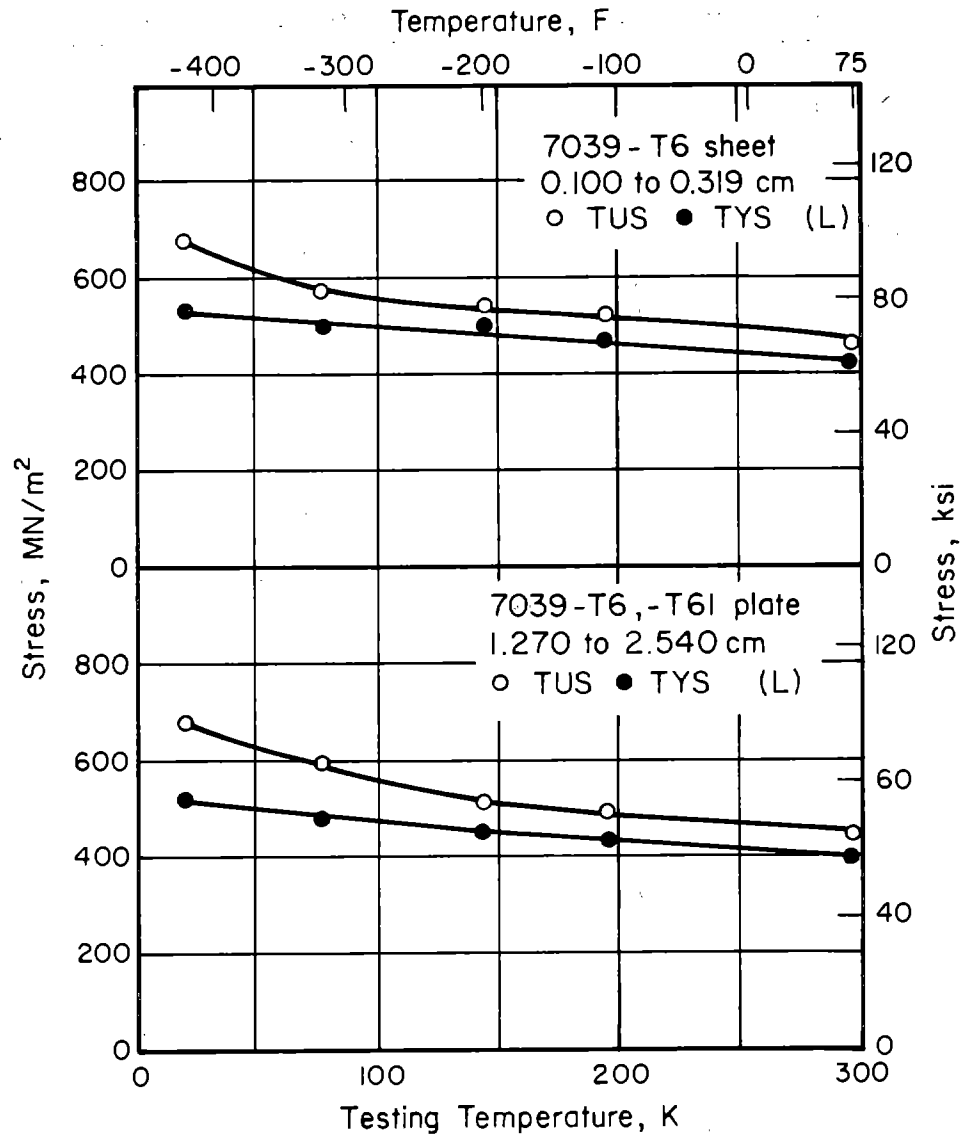


FIGURE 4.5.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 7039 ALUMINUM ALLOY

TABLE 4.5.1-TR1

Alloy Designation: 7039-T61 Aluminum Alloy

Specification:

Form:

Dimension:

Condition: -T61

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	150	96	64	30	14.7	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(86.7)	(55.5)	(37.0)	(17.3)	(8.50)	
No. of Spec.	2	2	2	2	2	
References: 90170, 77044						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.325	-0.366	-0.374	-0.374	-0.374
No. of Spec.	1	1	1	1	1	1
References: 74405						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	4.50 x 10 ⁻⁸	2.40 x 10 ⁻⁸	2.00 x 10 ⁻⁸	1.94 x 10 ⁻⁸	1.92 x 10 ⁻⁸	1.90 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(27.1)	(14.4)	(12.0)	(11.7)	(11.5)	(11.4)
No. of Spec.	3	3	3	3	3	2
References: 79561, 77044						

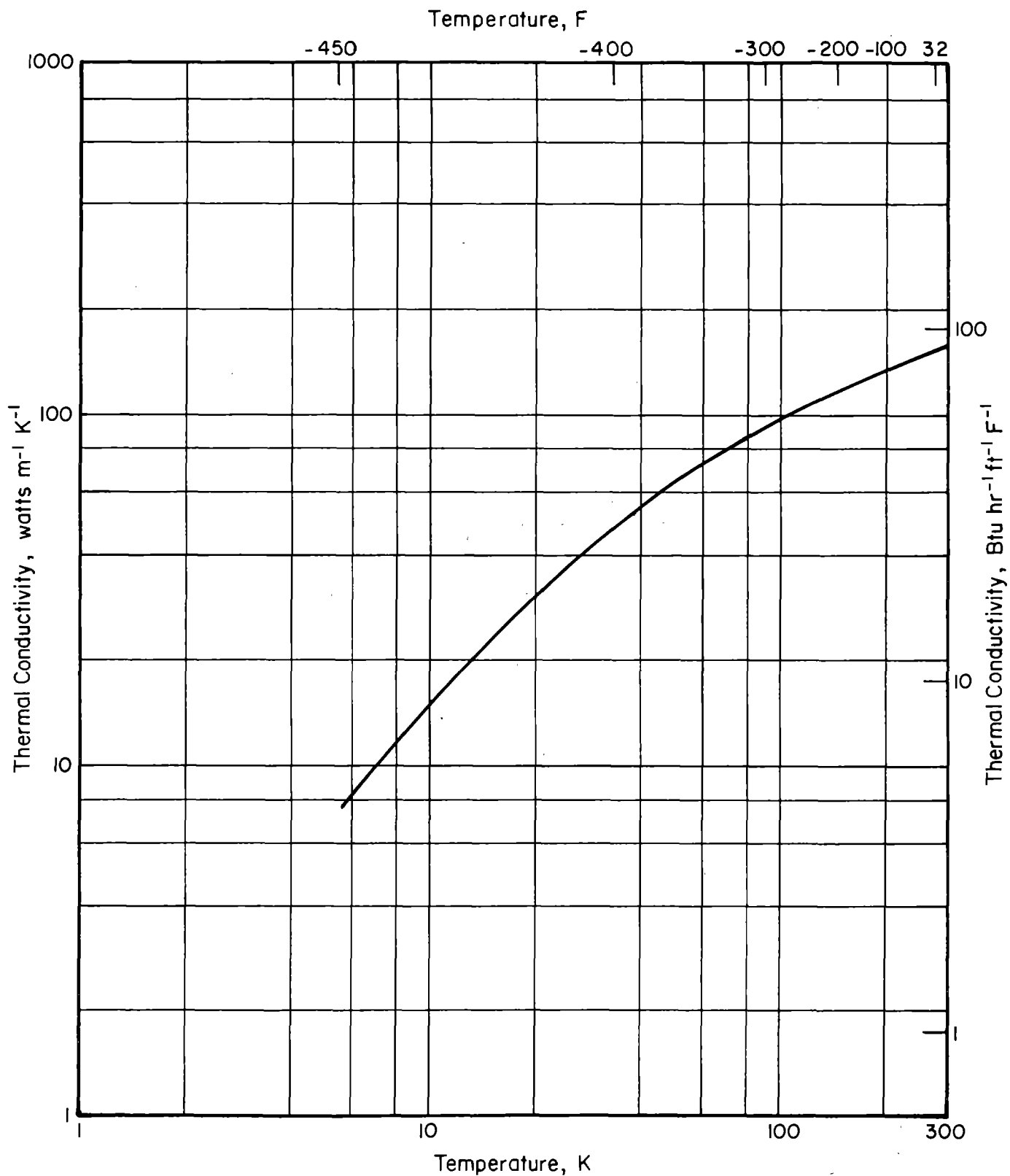


FIGURE 4.5.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 7039-T61

4.5.1-16 (11/74)

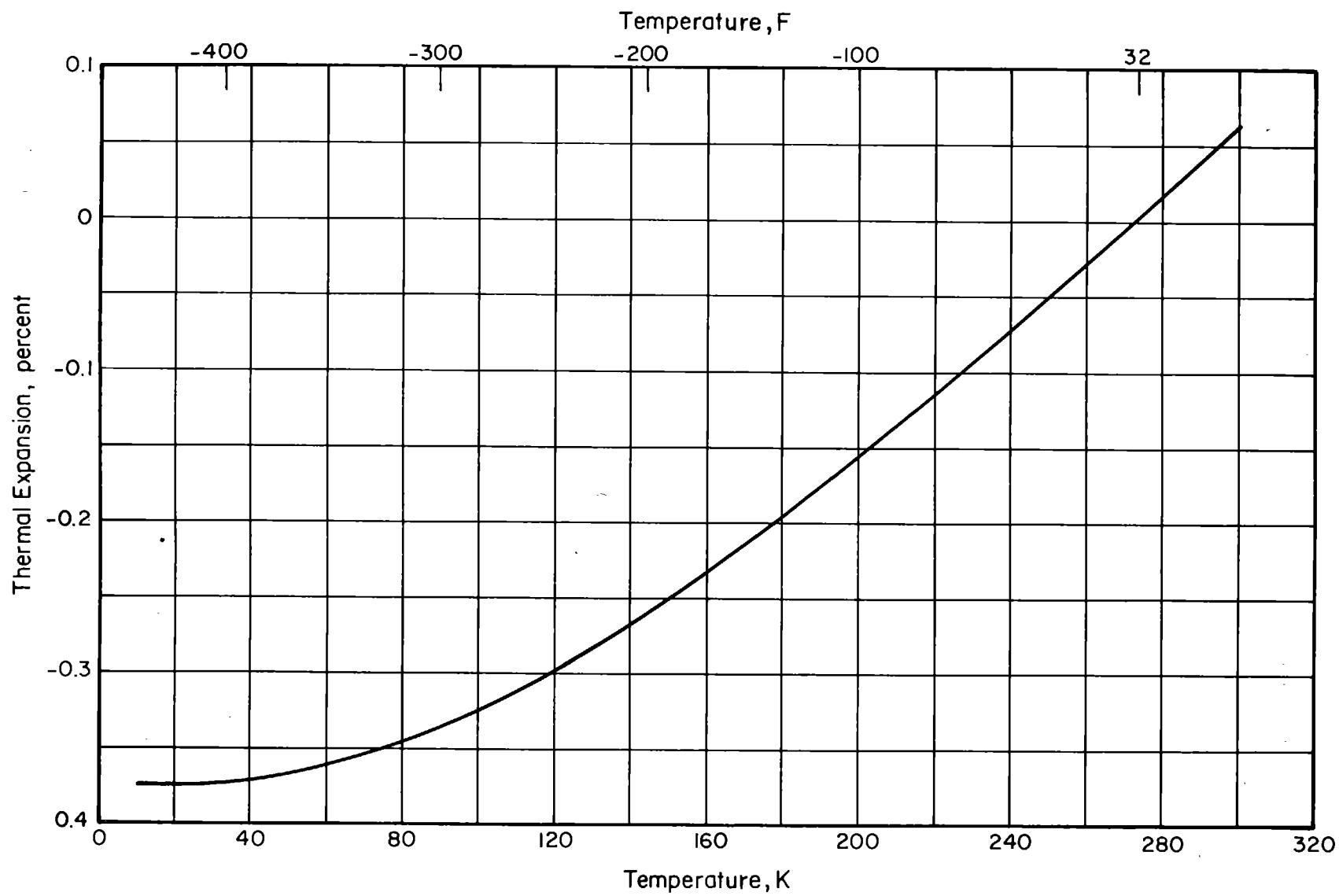


FIGURE 4.5.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR ALUMINUM ALLOY 7039-T61

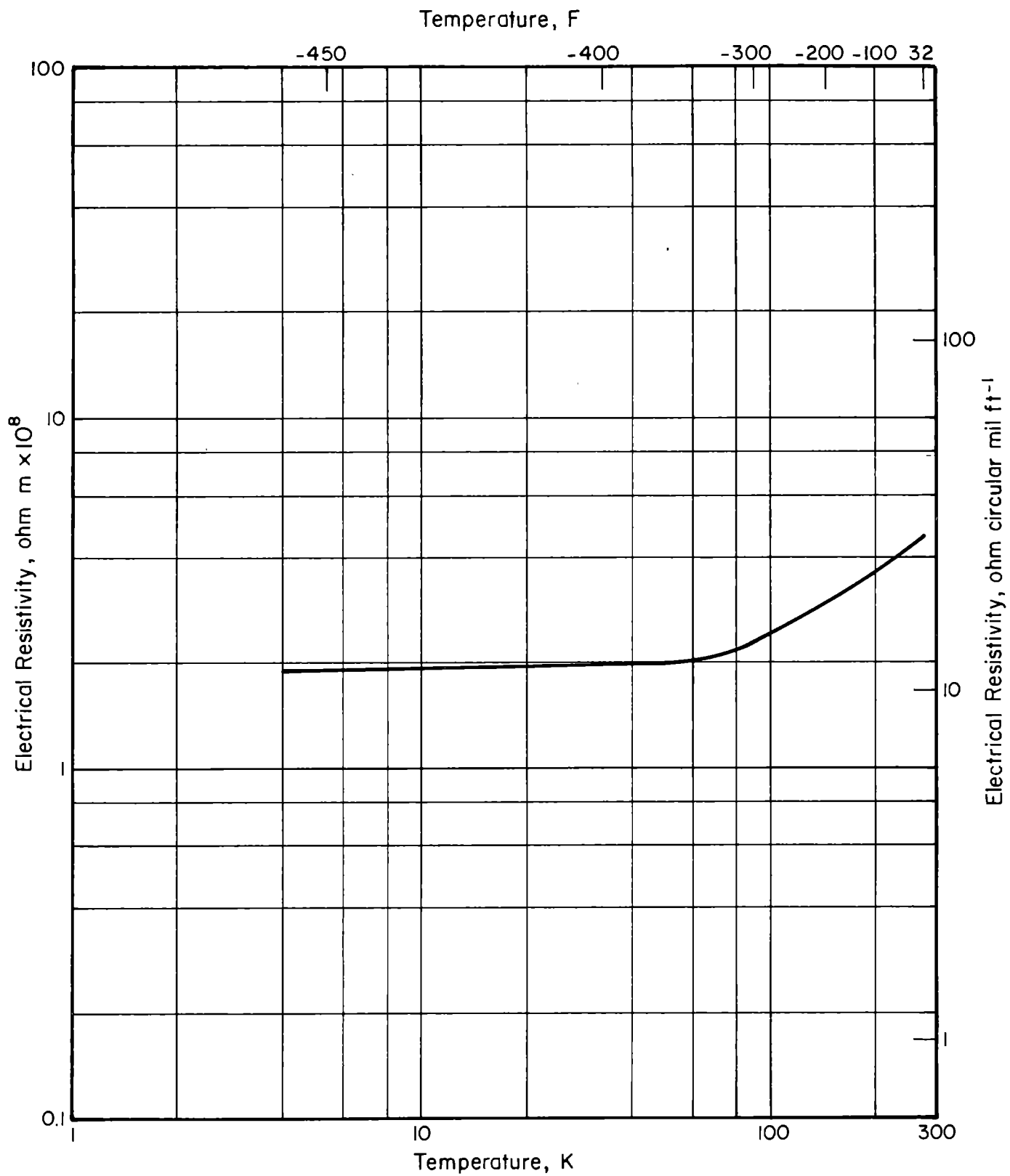


FIGURE 4.5.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ALUMINUM ALLOY 7039-T61

TABLE 4.5.2-ME1

Alloy Designation: 7005-T6 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T6

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg	360 (52.2)	419 (60.7)	485 (70.4)		
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	309 (44.8)	348 (50.5)	380 (55.1)		
	Min					
Std. Deviation						
Elong, percent	Avg	11.8	12.5	16.8		
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		1	1	1		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg	360 (52.2)	401 (58.1)	429 (62.2)		
K _t = >17	Min					
No. of Spec. (No. of Heats)		1	1	1		
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

TABLE 4.5.2-ME2

Alloy Designation: 7005-0 Aluminum Alloy

Specification:

Form: Plate
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: Annealed (0) 673 K (750 F) 3hr, FC

Testing Temperature, K (F)		297 (75)	200 (-103)	100 (-280)	"0" (-460)		
Compression, Longitudinal							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Dynamic Modul:							
E, GN/m ² (10 ⁶ psi)	Avg	70.5 (10.2)	74.3 (10.8)	77.7 (11.3)	78.9 (11.4)		
	Min						
G, GN/m ² (10 ⁶ psi)	Avg	26.2 (3.80)	27.8 (4.03)	29.1 (4.22)	29.6 (4.29)		
	Min						
B, GN/m ² (10 ⁶ psi)	Avg	74.9 (10.9)	76.5 (11.1)	77.7 (11.3)	78.0 (11.3)		
	Min						
Poisson's Ratio	Avg	0.343	0.338	0.333	0.331		
	Min						
No. of Spec.		1	1	1	1		
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness(b)							
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg						
(From PTSC spec.) (—)Min							
No. of Spec. (No. of Heats)							

References: 94206C

- (a) Indicate specimen design and orientation for shear specimens:
 (b) Indicate specimen design for K_{IC} data:

TABLE 4.5.2-ME2.1

7005-T6351
Plate

Alloy Designation: 7005-T6351 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: T6351

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	392 (56.8)	451 (65.4)		538 (78.0)		606 (87.9)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	341 (49.4)	363 (52.7)		409 (59.3)		441 (63.9)
	Min						
Std. Deviation							
Elong, percent	Avg	18.0	16.5		18.0		16.5
	Min						
RA, percent	Avg	50	41		34		29
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	561 (81.3)	610 (88.4)		678 (98.3)		689 (99.9)
	Min						
K _t = 16							
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	378 (54.8)	442 (64.1)		517 (75.0)		583 (84.6)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	329 (47.7)	368 (53.4)		402 (58.3)		421 (61.1)
	Min						
Std. Deviation							
Elong, percent	Avg	17.5	16.2		17.8		18.0
	Min						
RA, percent	Avg	48	42		32		31
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	561 (81.4)	610 (88.4)		663 (96.2)		685 (99.4)
	Min						
K _t = 16							
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90070

TABLE 4.5.2-ME2.2

7005-T6351
Plate

Alloy Designation: 7005-T6351 Aluminum Alloy

Specification:

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: T6351

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	363 (52.6)	423 (61.4)		486 (70.5)		590 (85.6)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	317 (46.0)	351 (50.9)		370 (53.7)		420 (60.9)
	Min						
Std. Deviation							
Elong, percent	Avg	19.8	18.0		19.0		19.5
	Min						
RA, percent	Avg	52	44		34		25
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	546 (79.2)	596 (86.4)		643 (93.2)		652 (94.6)
$K_t = 16$	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	367 (53.3)	427 (61.9)		502 (72.8)		595 (86.3)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	320 (46.4)	353 (51.2)		394 (57.1)		432 (62.7)
	Min						
Std. Deviation							
Elong, percent	Avg	18.0	14.8		16.5		16.5
	Min						
RA, percent	Avg	44	33		25		20
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	547 (79.4)	596 (86.4)		620 (89.9)		632 (91.6)
$K_t = 16$	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							

References: 90070

TABLE 4.5.2-ME3

Alloy Designation: 7005-T5351 Aluminum Alloy

Specification:

Form: Extrusion

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: T5351

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-423)	20 (423)	4 (-452)
<u>Tension, Longitudinal</u>						
TUS, MN/m ² (ksi)	Avg	427 (62.0)	468 (67.8)	578 (83.9)	707 (102.5)	673 (97.6)
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	379 (55.0)	404 (58.6)	465 (67.5)	506 (73.4)	521 (75.6)
	Min					
Std. Deviation						
Elong, percent	Avg	15.0	14.0	17.0	18.5	17.0
	Min					
RA, percent	Avg	43	30	27	28	22
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg	594 (86.2)	635 (92.1)	683 (99.1)	741 (107.5)	737 (106.9)
	Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
<u>Tension, Transverse</u>						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 72563

TABLE 4.5.3-ME1

Alloy Designation: 7006-T6 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T6

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	450 (65.2)	506 (73.4)	578 (83.7)	646 (93.7)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	404 (58.6)	451 (65.4)	485 (70.4)	484 (70.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	10.5	13.0	15.0	14.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	440 (63.8)	458 (66.4)	393 (57.0)	385 (55.8)		
	Min						
K _t = >17							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg	443 (64.2)	456 (66.2)	421 (61.0)			
	Min						
K _t = 10							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg	450 (65.2)	487 (70.6)	472 (68.5)			
	Min						
K _t = 7							
No. of Spec. (No. of Heats)							

References:

TABLE 4.5.3-ME2

Alloy Designation: 7006-T63 Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: T63

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-473)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	405 (58.8)	446 (64.7)	534 (77.5)	621 (90.1)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	348 (50.4)	379 (55.0)	412 (61.6)			
	Min						
Std. Deviation							
Elong, percent	Avg	11.2	11.0	18.5	23.7		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	391 (56.7)	416 (60.3)	414 (60.0)	399 (57.9)		
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 53885

TABLE 4.5.3-ME3

Alloy Designation: 7006-W Aluminum Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: W (Solution heat treated)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	397 (57.6)	416 (60.3)	516 (74.8)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	265 (38.4)	282 (40.9)	314 (45.5)			
	Min						
Std. Deviation							
Elong, percent	Avg	18.5	19.0	26.5			
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	342 (49.6)	353 (51.2)	370 (53.6)			
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 53885

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SECTION 5.0**

COPPER AND COPPER ALLOYS

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TABLE 5.1.1-TR1

Alloy Designation: Copper

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature, K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity⁽¹⁾						
RRR-3000 Watts m ⁻¹ K ⁻¹	401	483	1330	10700	27200	18300
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(232)	(279)	(769)	(6190)	(15700)	(10600)
RRR-1000 Watts m ⁻¹ K ⁻¹	401	482	1250	8370	12500	6230
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(232)	(279)	(723)	(4840)	(7230)	(3600)
RRR-300 Watts m ⁻¹ K ⁻¹	400	479	1130	5010	4350	1880
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(231)	(277)	(653)	(2900)	(2520)	(1090)
RRR-100 Watts m ⁻¹ K ⁻¹	397	469	979	2380	1520	623
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(230)	(271)	(566)	(1380)	(879)	(360)
RRR-30 Watts m ⁻¹ K ⁻¹	389	438	740	834	453	183
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(225)	(253)	(428)	(482)	(262)	(106)
No. of Spec.						
References: 90170, 90224						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.252	-0.290	-0.293	-0.293	-0.293
No. of Spec.	5	5	5	5	3	3
References: 40911, 48571, 90208, 90336, 90458						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	375	248	95	7	0.92	0.11
Btu lb ⁻¹ F ⁻¹	(0.0896)	(0.0593)	(0.0227)	(0.00167)	(0.000220)	(0.0000263)
No. of Spec.	5	5	4	8	6	7
References: 40911, 42219, 90223, 90247, 90249, 90339						
Electrical Resistivity⁽¹⁾						
RRR-30000 Ohm m	1.55 x 10 ⁻⁸	3.50 x 10 ⁻⁹	5.01 x 10 ⁻¹⁰	8.52 x 10 ⁻¹²	7.32 x 10 ⁻¹³	5.19 x 10 ⁻¹³
Ohm circular mil ft ⁻¹	(9.32)	(2.11)	(3.01 x 10 ⁻¹)	(5.12 x 10 ⁻³)	(4.40 x 10 ⁻⁴)	(3.12 x 10 ⁻⁴)
RRR-10000 Ohm m	1.55 x 10 ⁻⁸	3.50 x 10 ⁻⁹	5.02 x 10 ⁻¹⁰	9.55 x 10 ⁻¹²	1.77 x 10 ⁻¹²	1.55 x 10 ⁻¹²
Ohm circular mil ft ⁻¹	(9.32)	(2.11)	(3.02 x 10 ⁻¹)	(5.74 x 10 ⁻³)	(1.06 x 10 ⁻³)	(9.32 x 10 ⁻⁴)
RRR-3000 Ohm m	1.55 x 10 ⁻⁸	3.51 x 10 ⁻⁹	5.05 x 10 ⁻¹⁰	1.32 x 10 ⁻¹¹	5.38 x 10 ⁻¹²	5.17 x 10 ⁻¹²
Ohm circular mil ft ⁻¹	(9.32)	(2.11)	(3.04 x 10 ⁻¹)	(7.94 x 10 ⁻³)	(3.24 x 10 ⁻³)	(3.11 x 10 ⁻³)
RRR-1000 Ohm m	1.55 x 10 ⁻⁸	3.52 x 10 ⁻⁹	5.16 x 10 ⁻¹⁰	2.35 x 10 ⁻¹¹	1.57 x 10 ⁻¹¹	1.55 x 10 ⁻¹¹
Ohm circular mil ft ⁻¹	(9.32)	(2.12)	(3.10 x 10 ⁻¹)	(1.41 x 10 ⁻²)	(9.44 x 10 ⁻³)	(9.32 x 10 ⁻³)
RRR-300 Ohm m	1.56 x 10 ⁻⁸	3.55 x 10 ⁻⁹	5.52 x 10 ⁻¹⁰	5.98 x 10 ⁻¹¹	5.12 x 10 ⁻¹¹	5.18 x 10 ⁻¹¹
Ohm circular mil ft ⁻¹	(9.38)	(2.14)	(3.32 x 10 ⁻¹)	(3.60 x 10 ⁻²)	(3.13 x 10 ⁻²)	(3.12 x 10 ⁻²)
RRR-100 Ohm m	1.57 x 10 ⁻⁸	3.66 x 10 ⁻⁹	6.57 x 10 ⁻¹⁰	1.65 x 10 ⁻¹⁰	1.57 x 10 ⁻¹⁰	1.57 x 10 ⁻¹⁰
Ohm circular mil ft ⁻¹	(9.44)	(2.20)	(3.95 x 10 ⁻¹)	(9.92 x 10 ⁻²)	(9.44 x 10 ⁻²)	(9.44 x 10 ⁻²)
RRR-30 Ohm m	1.60 x 10 ⁻⁸	4.03 x 10 ⁻⁹	1.03 x 10 ⁻⁹	5.42 x 10 ⁻¹⁰	5.35 x 10 ⁻¹⁰	5.34 x 10 ⁻¹⁰
Ohm circular mil ft ⁻¹	(9.62)	(2.42)	(6.20 x 10 ⁻¹)	(3.26 x 10 ⁻¹)	(3.22 x 10 ⁻¹)	(3.21 x 10 ⁻¹)
No. of Spec.						
References: 90111, 90125, 90178, 96886						
Magnetothermal Conductivity						
RRR-1520	H					
Watts m ⁻¹ K ⁻¹	tesla			11700	17300	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	0			(6765)	(10002)	
Watts m ⁻¹ K ⁻¹	1			5500	6500	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	1			(3180)	(3758)	
Watts m ⁻¹ K ⁻¹	2				4800	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	2				(2775)	
Watts m ⁻¹ K ⁻¹	4			3700	4500	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	4			(2139)	(2602)	
Watts m ⁻¹ K ⁻¹	8			3100	3800	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	8			(1792)	(2197)	
No. of Spec.				1	1	
References: 94208						

TABLE 5.1.1-TR1 (Cont.)

Alloy Designation: Copper

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature, K (F)				20 (-423)	10 (-442)	4 (-452)
Magnetoresistance(2)						
H = 1 Tesla						
RRR-30000 Ohm m				5.49×10^{-11}	3.38×10^{-11}	3.12×10^{-11}
Ohm circular mil ft ⁻¹				(3.30×10^{-2})	(2.03×10^{-2})	(1.88×10^{-2})
RRR-10000 Ohm m				5.62×10^{-11}	4.07×10^{-11}	3.96×10^{-11}
Ohm circular mil ft ⁻¹				(3.38×10^{-2})	(2.45×10^{-2})	(2.38×10^{-2})
RRR-3000 Ohm m				6.06×10^{-11}	5.01×10^{-11}	4.97×10^{-11}
Ohm circular mil ft ⁻¹				(3.65×10^{-2})	(3.01×10^{-2})	(2.99×10^{-2})
RRR-1000 Ohm m				7.15×10^{-11}	6.34×10^{-11}	6.32×10^{-11}
Ohm circular mil ft ⁻¹				(4.30×10^{-2})	(3.81×10^{-2})	(3.80×10^{-2})
RRR-300 Ohm m				1.07×10^{-10}	9.96×10^{-11}	9.94×10^{-11}
Ohm circular mil ft ⁻¹				(6.44×10^{-2})	(5.99×10^{-2})	(5.98×10^{-2})
RRR-100 Ohm m				2.09×10^{-10}	2.01×10^{-10}	2.01×10^{-10}
Ohm circular mil ft ⁻¹				(1.26×10^{-1})	(1.21×10^{-1})	(1.21×10^{-1})
RRR-30 Ohm m				5.80×10^{-10}	5.72×10^{-10}	5.72×10^{-10}
Ohm circular mil ft ⁻¹				(3.49×10^{-1})	(3.44×10^{-1})	(3.44×10^{-1})
H = 10 Tesla						
RRR-30000 Ohm m				3.50×10^{-10}	1.75×10^{-10}	1.54×10^{-10}
Ohm circular mil ft ⁻¹				(2.11×10^{-1})	(1.05×10^{-1})	(9.26×10^{-2})
RRR-10000 Ohm m				3.59×10^{-10}	2.33×10^{-10}	2.24×10^{-10}
Ohm circular mil ft ⁻¹				(2.16×10^{-1})	(1.40×10^{-1})	(1.35×10^{-1})
RRR-3000 Ohm m				3.83×10^{-10}	3.15×10^{-10}	3.12×10^{-10}
Ohm circular mil ft ⁻¹				(2.30×10^{-1})	(1.89×10^{-1})	(1.88×10^{-1})
RRR-1000 Ohm m				4.30×10^{-10}	3.97×10^{-10}	3.96×10^{-10}
Ohm circular mil ft ⁻¹				(2.59×10^{-1})	(2.39×10^{-1})	(2.38×10^{-1})
RRR-300 Ohm m				5.14×10^{-10}	5.01×10^{-10}	5.00×10^{-10}
Ohm circular mil ft ⁻¹				(3.09×10^{-1})	(3.01×10^{-1})	(3.01×10^{-1})
RRR-100 Ohm m				6.48×10^{-10}	6.40×10^{-10}	6.40×10^{-10}
Ohm circular mil ft ⁻¹				(3.90×10^{-1})	(3.85×10^{-1})	(3.85×10^{-1})
RRR-30 Ohm m				1.03×10^{-9}	1.02×10^{-9}	1.02×10^{-9}
Ohm circular mil ft ⁻¹				(6.20×10^{-1})	(6.14×10^{-1})	(6.14×10^{-1})
No. of Spec.				8	8	8
References: 96887						

(1) Interpolated from numerous data using theoretical correlations.

(2) The electrical magnetoresistance of pure copper and of OFHC copper can be represented on a universal curve, called a Kohler plot, which is shown in Figure 5.1.1-MR1. The curve can be represented by the equation:

$$\log_e \left(\frac{\rho(H,T) - \rho(O,T)}{\rho(O,T)} \right) = a_0 + a_1 \log_e \left[H \cdot \frac{\rho(O,273 K)}{\rho(O,T)} \right] + a_2 \left\{ \log_e \left[H \cdot \frac{\rho(O,273 K)}{\rho(O,T)} \right] \right\}^2$$

Where $\rho(H,T)$ = electrical resistivity at magnetic field H, and at temperature T. If the field H is given in tesla, then the constants have the values:

$$a_0 = 7.008; a_1 = 1.383; a_2 = -0.0298.$$

The plot is valid over the temperature range 4-35 K, and over the magnetic field range 0-10 tesla.

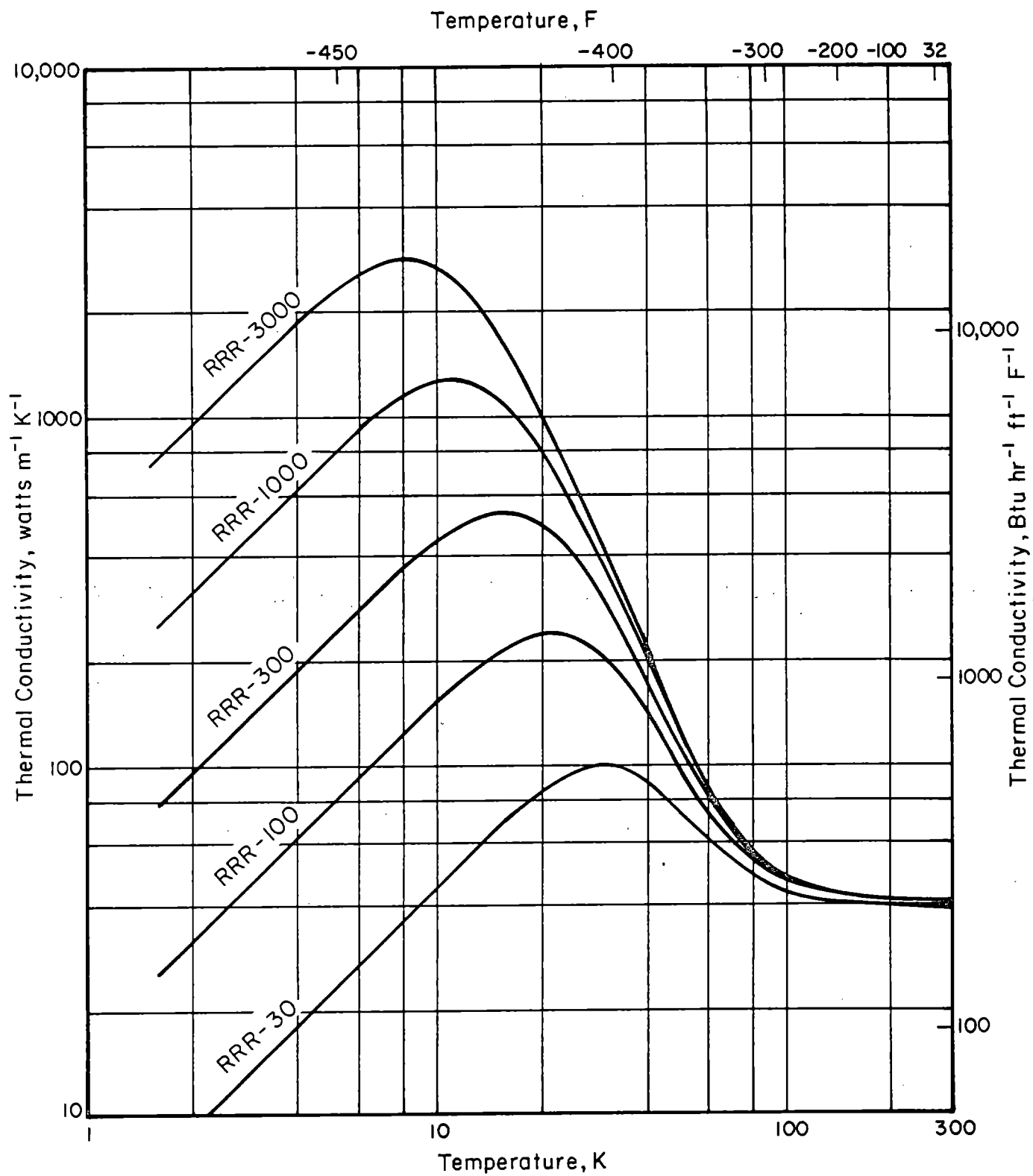


FIGURE 5.1.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATUE FOR COPPER

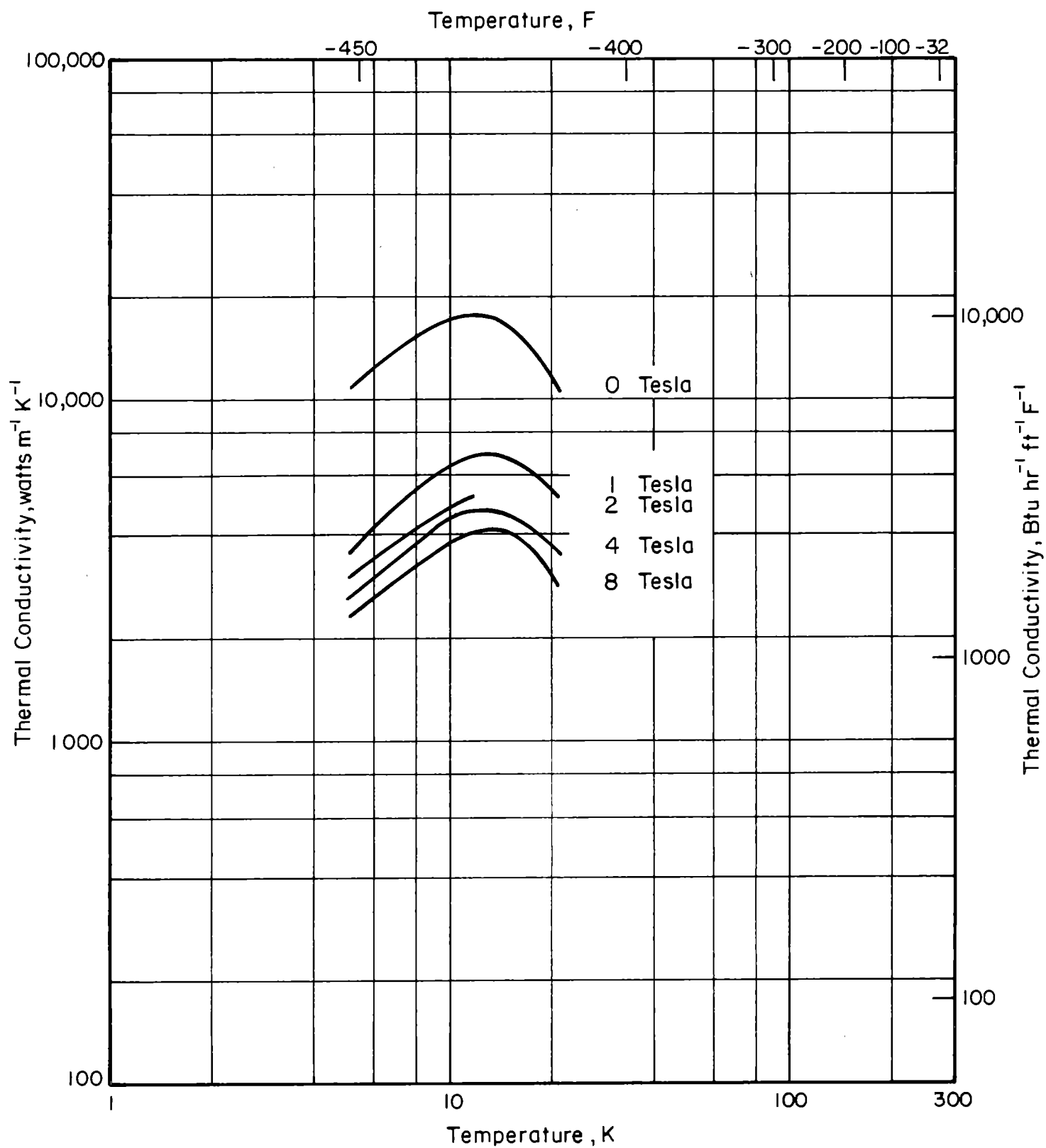


FIGURE 5.1.1-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER AT SEVERAL MAGNETIC FIELD STRENGTHS (RRR-1520)

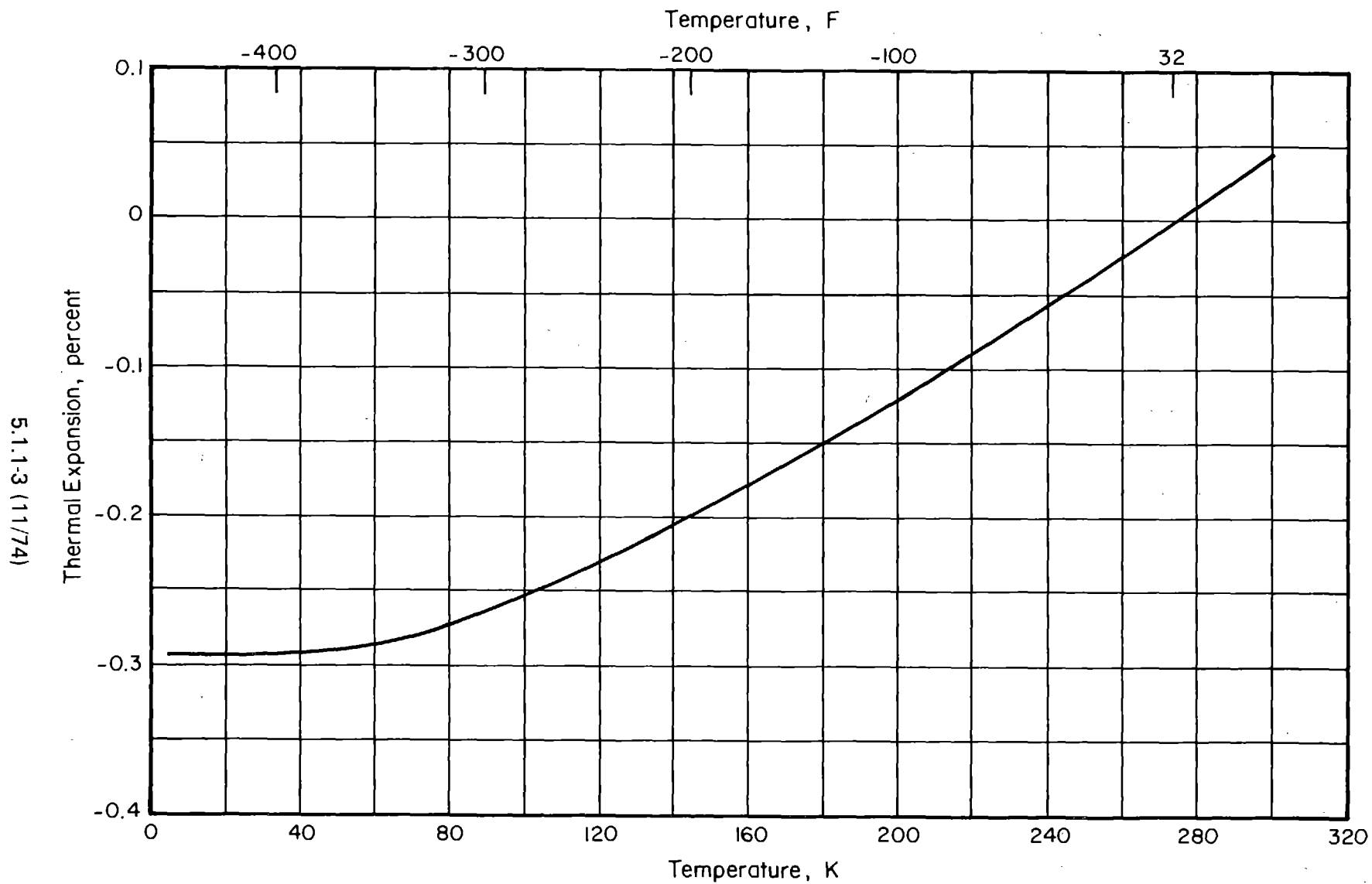


FIGURE 5.1.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE
FOR COPPER

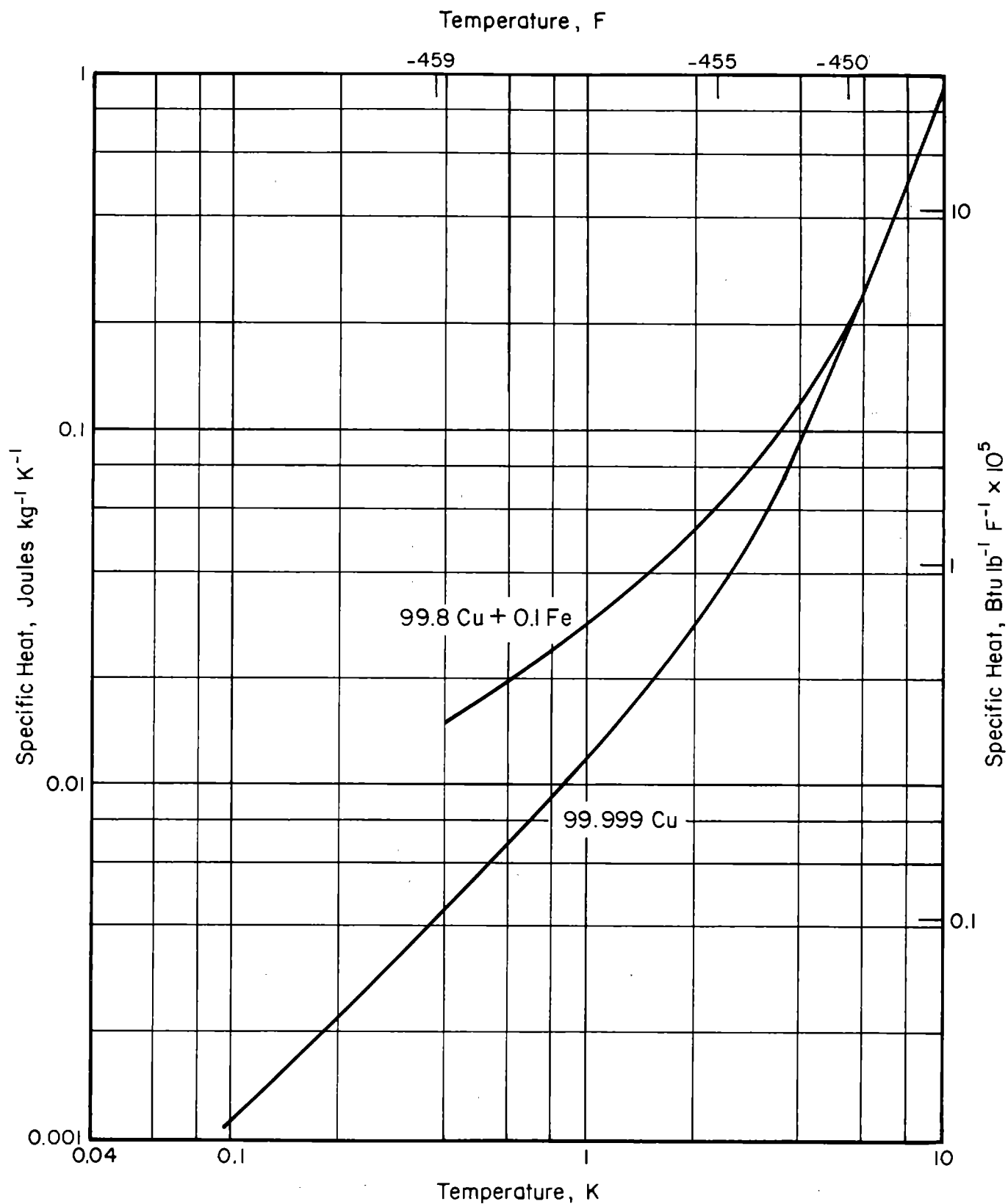


FIGURE 5.1.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE
FOR COPPER

5.1.1-4 (11/74)

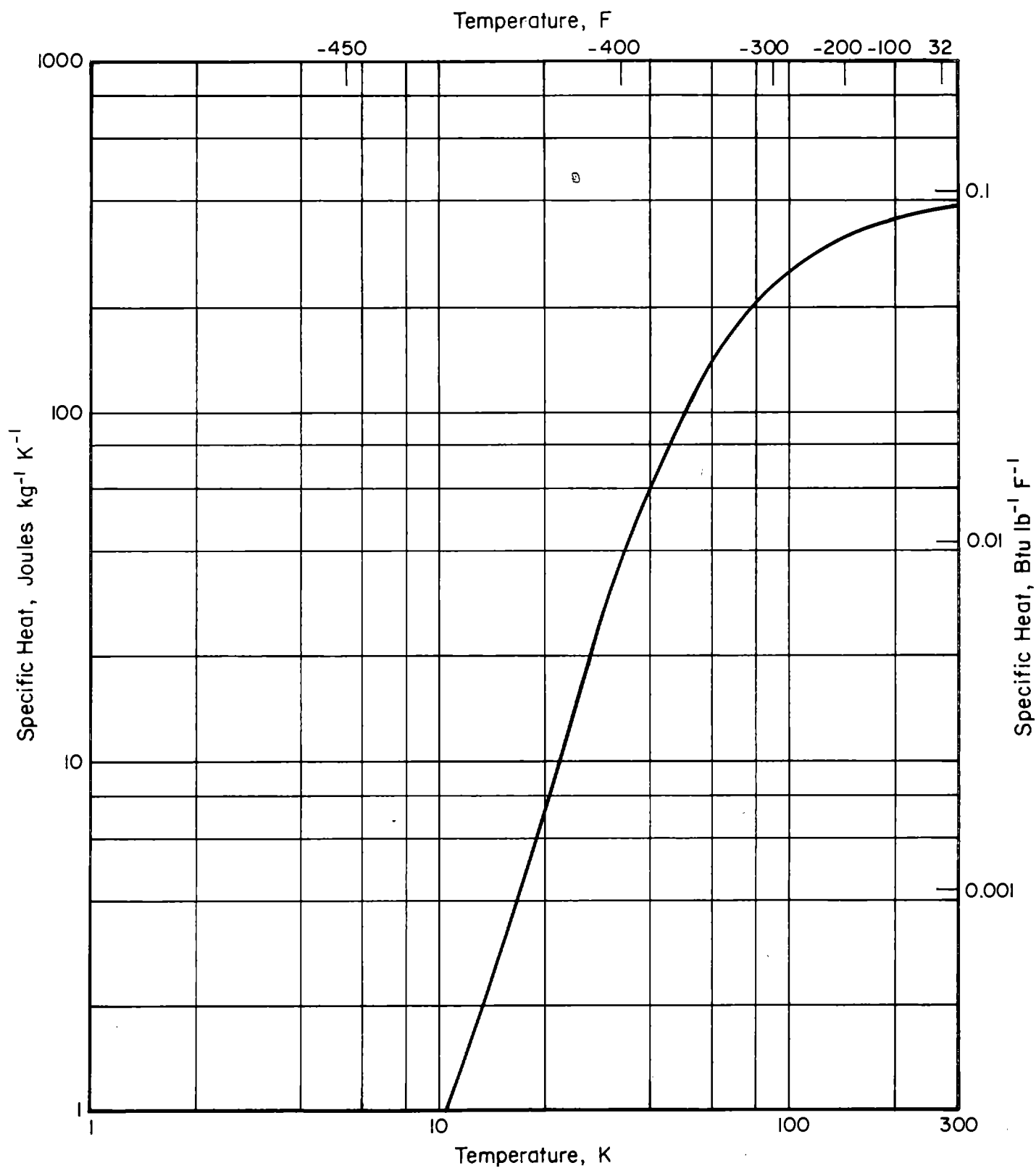


FIGURE 5.1.1-S2. SPECIFIC HEAT VERSUS TEMPERATURE FOR COPPER

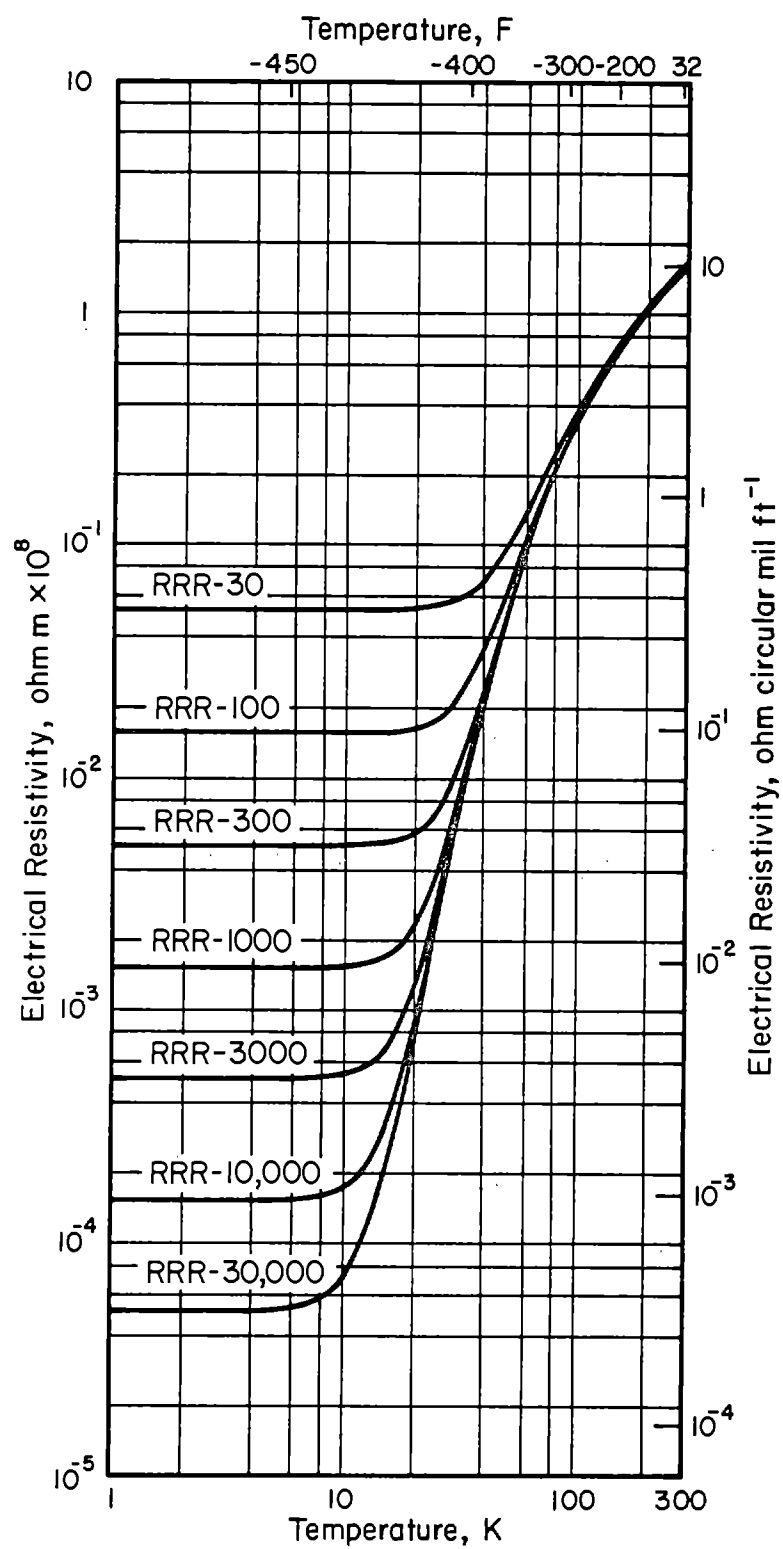


FIGURE 5.1.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER

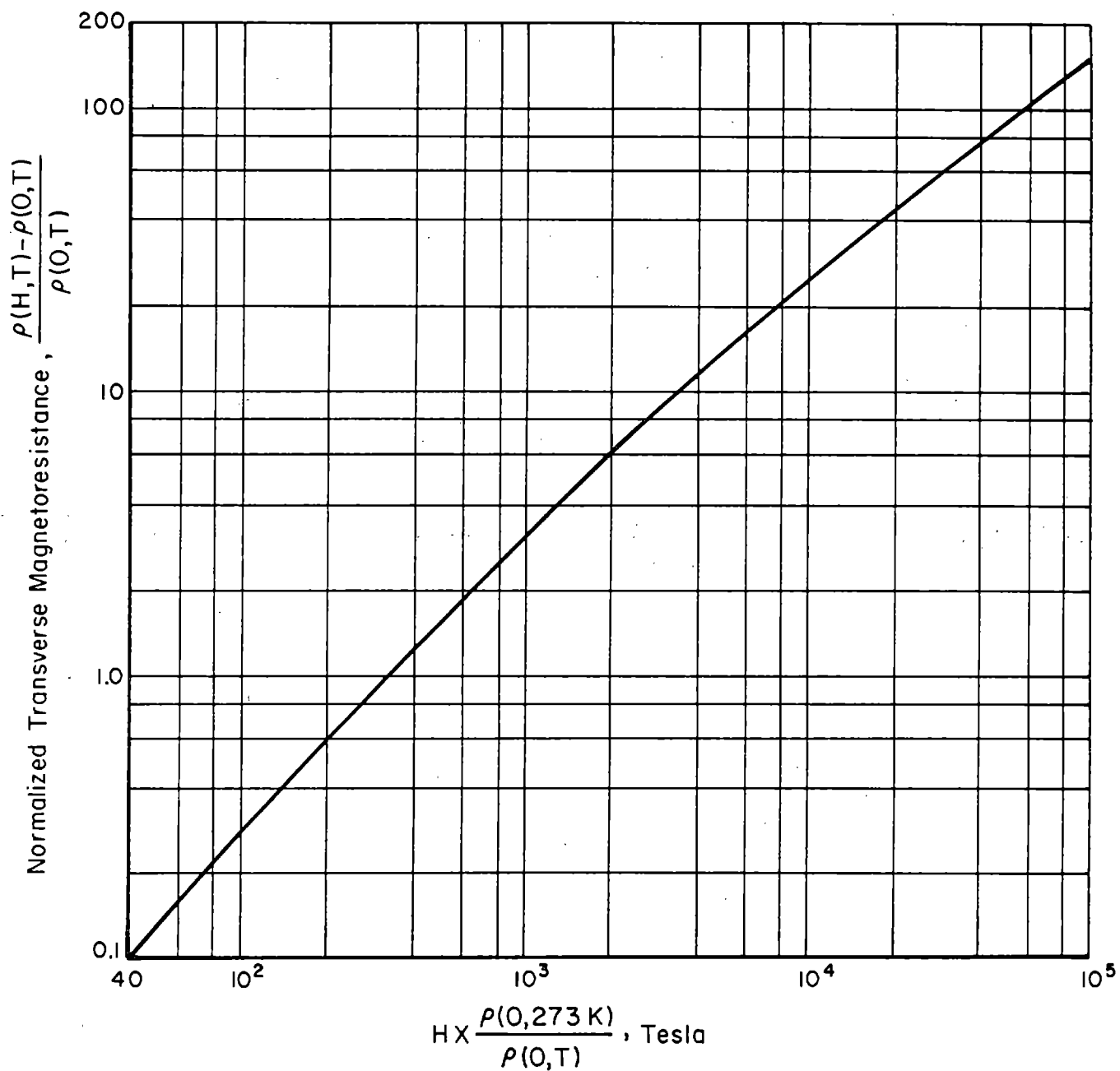


FIGURE 5.1.1-MR1. TRANSVERSE MAGNETORESISTANCE (ELECTRICAL) OF COPPER
(REDUCED KOHLER PLOT)

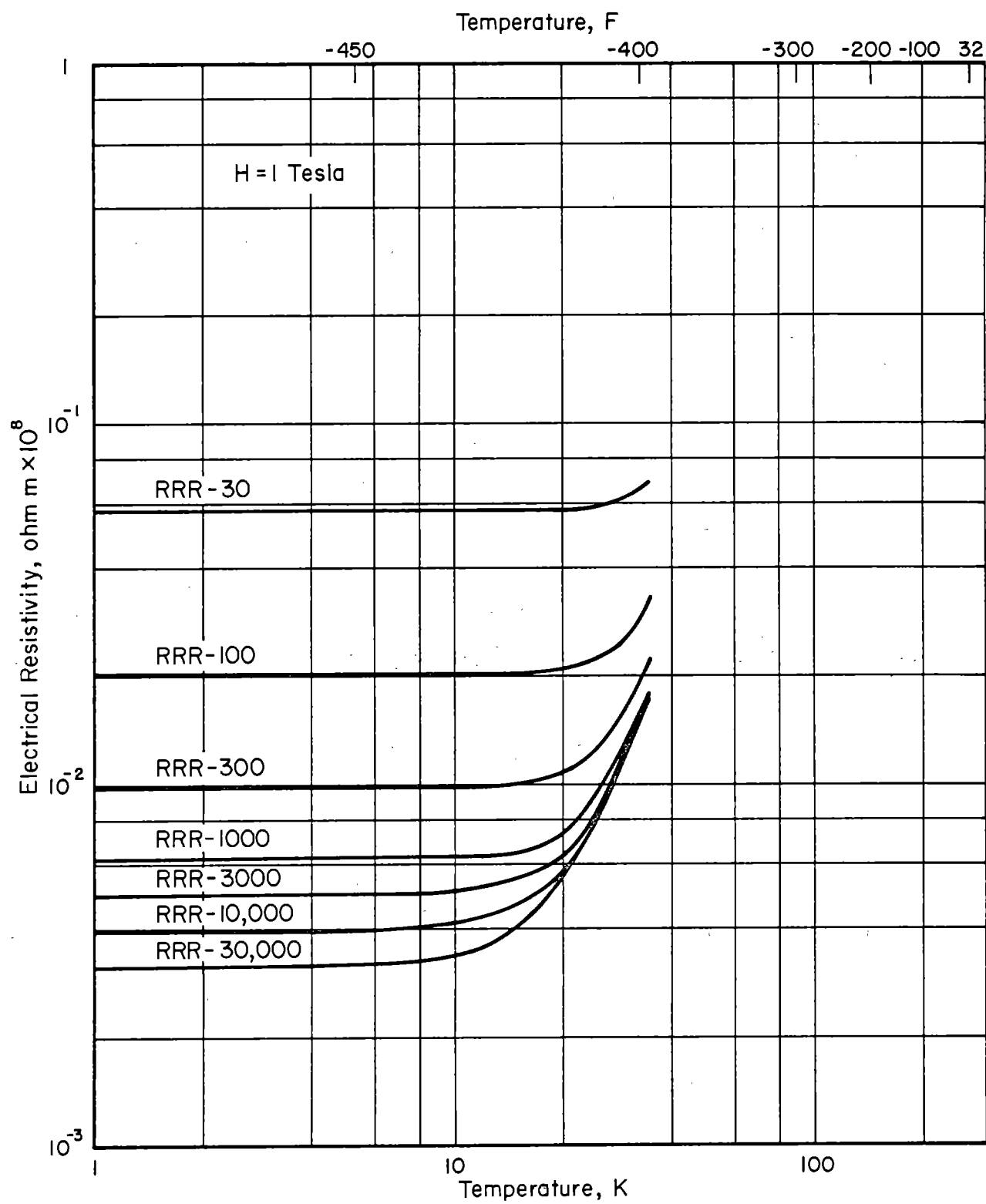


FIGURE 5.1.1-MR2. TRANSVERSE MAGNETORESISTANCE OF COPPER AT 1 TESLA

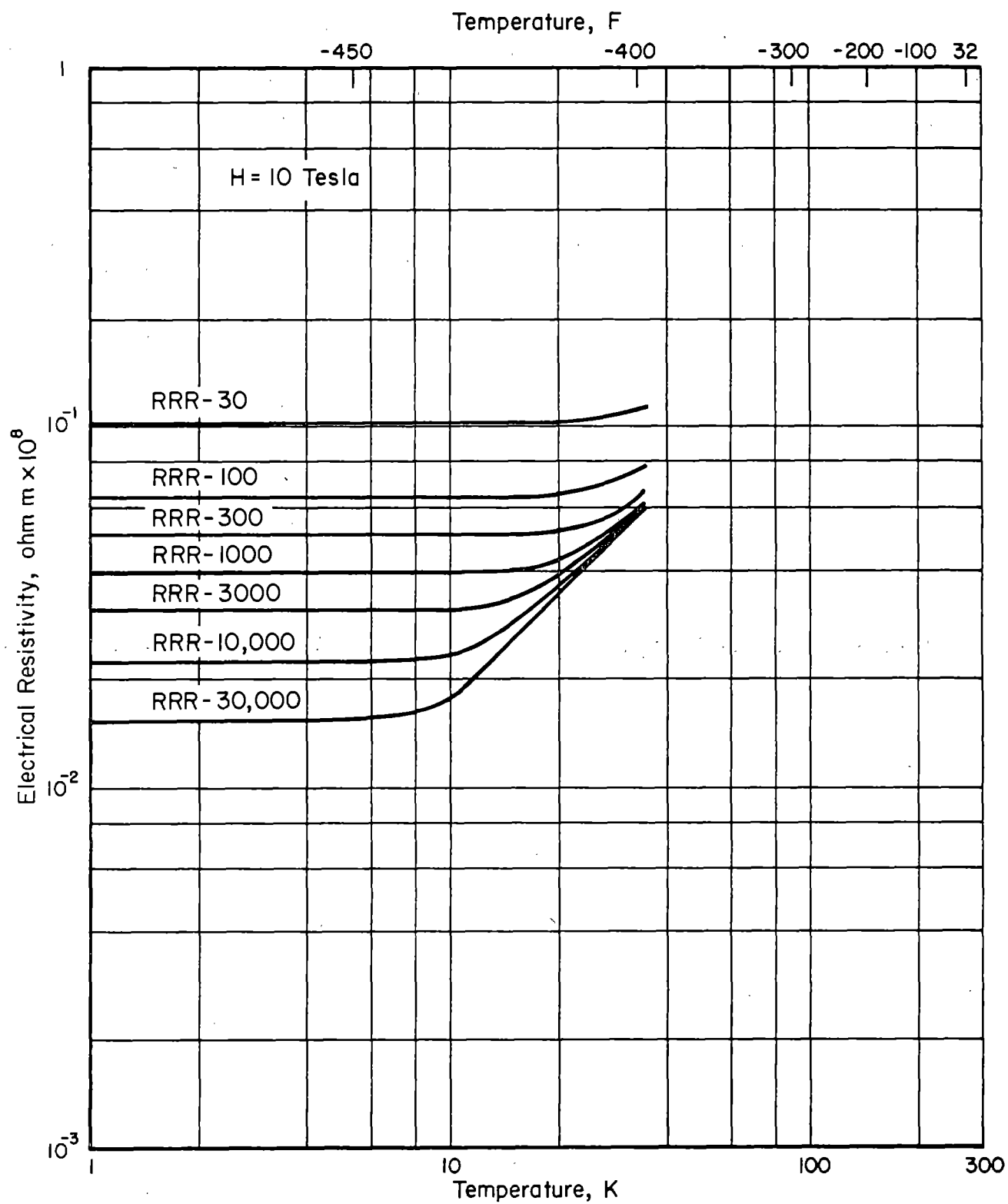


FIGURE 5.1.1-MR3. TRANSVERSE MAGNETORESISTANCE OF COPPER AT 10 TESLA

TABLE 5.1.1-MA1

Alloy Designation: 99.999 Cu (< 1 ppm Fe or Ni)*

Specification:

Form: Wire

Diameter, cm (in.): 0.03 (0.0118)

Condition: Cold drawn, etched, and annealed.

Temperature, K (F)	Mass Susceptibility, χ (cgsem)	Volume Suscepti- bility, k (mksa)	Permeability, μ (mksa)
1.450 (-457)	-0.673×10^{-7}	-75.71×10^{-7}	$\sim 12.57 \times 10^{-7}$
2.155 (-456)	-0.706×10^{-7}	-79.43×10^{-7}	$\sim 12.57 \times 10^{-7}$
3.003 (-454)	-0.735×10^{-7}	-82.69×10^{-7}	$\sim 12.57 \times 10^{-7}$
4.187 (-452)	-0.771×10^{-7}	-86.74×10^{-7}	$\sim 12.57 \times 10^{-7}$
10 $\pm$ 1 (-442)	-0.795×10^{-7}	-89.44×10^{-7}	$\sim 12.57 \times 10^{-7}$
13.8 (-434)	-0.802×10^{-7}	-90.23×10^{-7}	$\sim 12.57 \times 10^{-7}$
16.3 (-430)	-0.812×10^{-7}	-91.35×10^{-7}	$\sim 12.57 \times 10^{-7}$
18.1 (-427)	-0.816×10^{-7}	-91.80×10^{-7}	$\sim 12.57 \times 10^{-7}$
20.2 (-423)	-0.821×10^{-7}	-92.36×10^{-7}	$\sim 12.57 \times 10^{-7}$
77 (-321)	-0.816×10^{-7}	-91.80×10^{-7}	$\sim 12.57 \times 10^{-7}$
300 (80)	-0.830×10^{-7}	-93.38×10^{-7}	$\sim 12.57 \times 10^{-7}$

Reference: 96873

* American Smelting and Refining Company.

TABLE 5.1.1-MA2

Alloy Designation: 99.96 + Cu (0.0003% Fe and Ni present)

Specification:

Form: Cubic block (cut from rod)

Dimension, cm (in.): 0.734 (0.289)

Condition: As formed

Temperature, K (F)	Mass Susceptibility, χ (cgsem)	Volume Suscepti- bility, k (mksa)	Permeability, μ (mksa)
1.62 (-456)	-0.685×10^{-7}	-91.89×10^{-7}	$\sim 12.57 \times 10^{-7}$
4.2 (-452)	-0.800×10^{-7}	-93.17×10^{-7}	$\sim 12.57 \times 10^{-7}$
17.58 (-427)	-0.857×10^{-7}	-93.28×10^{-7}	$\sim 12.57 \times 10^{-7}$
20.4 (-422)	-0.864×10^{-7}	-93.28×10^{-7}	$\sim 12.57 \times 10^{-7}$
56.5 (-357)	-0.873×10^{-7}	-92.31×10^{-7}	$\sim 12.57 \times 10^{-7}$
70.2 (-333)	-0.873×10^{-7}	-91.57×10^{-7}	$\sim 12.57 \times 10^{-7}$
77.3 (-320)	-0.872×10^{-7}	-85.48×10^{-7}	$\sim 12.57 \times 10^{-7}$
293 (68)	-0.860×10^{-7}	-73.19×10^{-7}	$\sim 12.57 \times 10^{-7}$

Reference: 90477

TABLE 5.1.1-MA3

Alloy Designation: G.S. Copper (6N Purity)

Specification:

Form: Rod

Diameter, cm (in.): 0.9 (0.354)

Condition: Heavily etched and air cooled after annealing at 823 K (550 C) for 7 days

Temperature, K (F)	Mass Susceptibility, χ (cgsem)	Volume Suscepti- bility, k (mksa)	Permeability, μ (mksa)
5.9 (-448)	-0.881×10^{-7}	-94.13×10^{-7}	$\sim 12.57 \times 10^{-7}$
15.0 (-432)	-0.882×10^{-7}	-94.23×10^{-7}	$\sim 12.57 \times 10^{-7}$
30.8 (-404)	-0.882×10^{-7}	-94.23×10^{-7}	$\sim 12.57 \times 10^{-7}$
45.6 (-377)	-0.882×10^{-7}	-94.23×10^{-7}	$\sim 12.57 \times 10^{-7}$
60.6 (-350)	-0.882×10^{-7}	-94.23×10^{-7}	$\sim 12.57 \times 10^{-7}$
80.8 (-314)	-0.881×10^{-7}	-94.13×10^{-7}	$\sim 12.57 \times 10^{-7}$
101.0 (-277)	-0.880×10^{-7}	-94.02×10^{-7}	$\sim 12.57 \times 10^{-7}$
134.0 (-228)	-0.877×10^{-7}	-93.70×10^{-7}	$\sim 12.57 \times 10^{-7}$
174.0 (-146)	-0.873×10^{-7}	-93.28×10^{-7}	$\sim 12.57 \times 10^{-7}$
240.4 (-26.7)	-0.866×10^{-7}	-92.53×10^{-7}	$\sim 12.57 \times 10^{-7}$
291.1 (64.6)	-0.858×10^{-7}	-91.67×10^{-7}	$\sim 12.57 \times 10^{-7}$
294.0 (69.8)	-0.858×10^{-7}	-91.67×10^{-7}	$\sim 12.57 \times 10^{-7}$

Reference: 90467

TABLE 5.1.1-MA4

Alloy Designation: ASRCO Copper (5N Purity)

Specification:

Form: Rod

Diameter, cm (in.): 0.9 (0.354)

Condition: Heavily etched and air cooled after annealing at 823 K (550 C) for 7 days

Temperature, K (F)	Mass Susceptibility, χ (cgsem)	Volume Suscepti- bility, k (mksa)	Permeability, μ (mksa)
6.9 (-447)	-0.872×10^{-7}	-93.17×10^{-7}	$\sim 12.57 \times 10^{-7}$
15.7 (-431)	-0.877×10^{-7}	-93.70×10^{-7}	$\sim 12.57 \times 10^{-7}$
30.0 (-405)	-0.881×10^{-7}	-94.13×10^{-7}	$\sim 12.57 \times 10^{-7}$
43.0 (-382)	-0.882×10^{-7}	-94.23×10^{-7}	$\sim 12.57 \times 10^{-7}$
55.2 (-360)	-0.882×10^{-7}	-94.23×10^{-7}	$\sim 12.57 \times 10^{-7}$
81.4 (-313)	-0.882×10^{-7}	-94.23×10^{-7}	$\sim 12.57 \times 10^{-7}$
101.3 (-277)	-0.881×10^{-7}	-94.13×10^{-7}	$\sim 12.57 \times 10^{-7}$
133.0 (-220)	-0.878×10^{-7}	-93.81×10^{-7}	$\sim 12.57 \times 10^{-7}$
180.8 (-134)	-0.874×10^{-7}	-93.38×10^{-7}	$\sim 12.57 \times 10^{-7}$
214.5 (-73.3)	-0.869×10^{-7}	-92.85×10^{-7}	$\sim 12.57 \times 10^{-7}$
243.8 (-20.6)	-0.865×10^{-7}	-92.42×10^{-7}	$\sim 12.57 \times 10^{-7}$
292.0 (66.2)	-0.858×10^{-7}	-91.67×10^{-7}	$\sim 12.57 \times 10^{-7}$

Reference: 90467

TABLE 5.1.2-ME1

Alloy Designation: Electrolytic Tough Pitch Cu

Specification: CDA No. 110

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Hot rolled and annealed 895 K (1150 F) 1/2 hr
(Grain size 0.040 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	218 (31.6)	244 (35.3)	257 (37.3)	348 (50.4)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	65 (9.4)	73.1 (10.6)	70.2 (10.2)	69.3 (10.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	58	53	55	58		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	216 (31.4)	251 (36.4)	261 (37.9)	348 (50.4)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	71.8 (10.4)	79.5 (11.5)	81.2 (11.8)	79.7 (11.6)		
	Min						
Std. Deviation							
Elong, percent	Avg	55	50	55	54		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90265

TABLE 5.1.2-ME2

Alloy Designation: Electrolytic Tough Pitch Cu

Specification: CDA No. 110

Form: Sheet

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: Hot rolled, annealed 895 K (1150 F) 1/2 hr, and cold rolled 5 to 7 percent
(Grain size 0.042 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	238 (34.5)	272 (39.5)	288 (41.8)	383 (55.6)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	216 (31.4)	233 (33.8)	240 (34.8)	256 (37.1)		
	Min						
Std. Deviation							
Elong, percent	Avg	32	34	33	45		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	230 (33.4)	266 (38.6)	278 (40.3)	365 (53.0)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	203 (29.4)	226 (32.8)	223 (32.3)	238 (34.6)		
	Min						
Std. Deviation							
Elong, percent	Avg	34	36	36	50		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90265

TABLE 5.1.2-ME3

Alloy Designation: Electrolytic Tough Pitch Cu

Specification: CDA No. 110

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Hot rolled and annealed 895 K (1150 F) 1/2 hr
(Grain size 0.045 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	211 (30.6)	243 (35.2)	251 (36.4)	340 (49.3)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	51.2 (7.4)	62.6 (9.1)	65.9 (9.6)	61.0 (8.8)		
	Min						
Std. Deviation							
Elong, percent	Avg	60	64	60	69		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	210 (30.5)	227 (33.0)	251 (36.4)	337 (48.9)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	59.8 (8.7)	52.7 (7.6)	66.0 (9.6)	59.4 (8.6)		
	Min						
Std. Deviation							
Elong, percent	Avg	59	60	60	68		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90265

TABLE 5.1.2-ME4

Alloy Designation: Electrolytic Tough Pitch Cu

Specification: CDA No. 110

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Hot rolled, annealed 895 K (1150 F) 1/2 hr, and cold rolled 5 to 7 percent
(Grain size 0.048 to 0.050 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	220 (31.9)	250 (36.2)	268 (39.0)	351 (50.9)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	147 (21.4)	150 (21.8)	160 (23.2)			
	Min						
Std. Deviation							
Elong, percent	Avg	50	51	50	64		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	212 (30.7)	243 (35.2)	257 (37.2)	345 (50.1)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	122 (17.7)	130 (18.9)	133 (19.3)	142 (20.6)		
	Min						
Std. Deviation							
Elong, percent	Avg	48	52	50	55		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90265

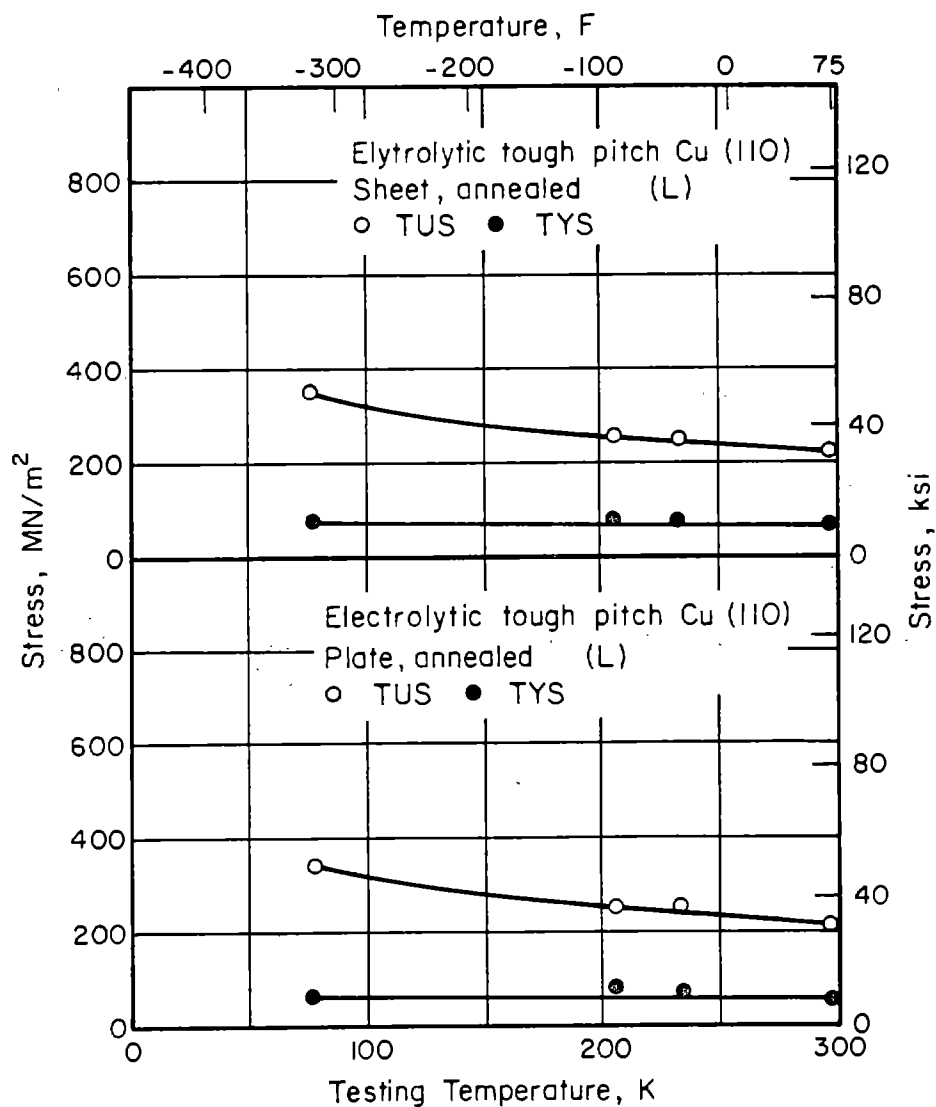


FIGURE 5.1.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF ELECTROLYTIC TOUGH PITCH COPPER

TABLE 5.1.2-TR1

Alloy Designation: Copper-Electrolytic Tough Pitch

Specification: CDA No. 110

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹		445	880	1320	750	325
Btu hr ⁻¹ ft ⁻¹ F ⁻¹		(257)	(509)	(763)	(434)	(188)
No. of Spec.		1	1	2	2	2
References: 90244, 90300						
Thermal Expansion (T₂₇₃ to T)						
<u>Longitudinal</u>						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

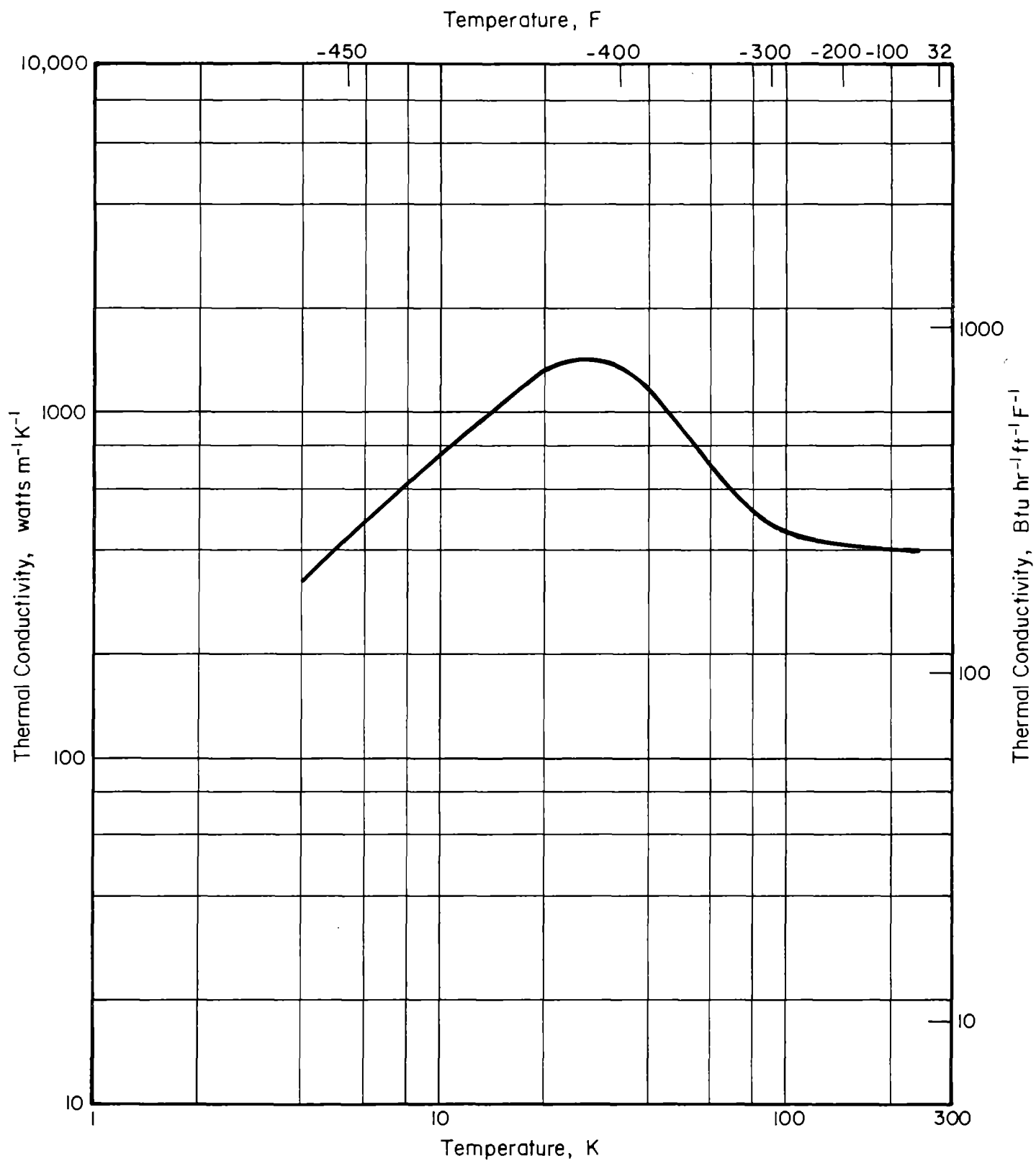


FIGURE 5.1.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ELECTROLYTIC TOUGH PITCH COPPER

TABLE 5.1.3-ME1

Alloy Designation: OFHC Cu

Specification: CDA No. 102

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg Min	220 (32)		390 (56)	450 (65)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg Min	69 (10)		110 (16)	140 (20)		
Std. Deviation							
Elong, percent	Avg Min	40		52	57		
RA, percent	Avg Min						
No. of Spec. (No. of Heats)		4 (1)		4 (1)	4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg Min						
K _t =							
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg Min						
Std. Deviation							
Elong, percent	Avg Min						
RA, percent	Avg Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90302

TABLE 5.1.3-ME2

Alloy Designation: OFHC Cu

Specification: CDA No. 102

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Hot rolled and annealed 895 K (1150 F) 1/2 hr
(Grain size 0.045 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	213 (30.9)	246 (35.8)	261 (37.8)	352 (51.1)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	73 (10.6)	87 (12.6)	76 (11.0)	74 (10.7)		
	Min						
Std. Deviation							
Elong, percent	Avg	54	56	56	58		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	211 (30.6)	244 (35.4)	258 (37.4)	352 (51.0)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	78 (11.3)	86 (12.5)	80 (11.6)	83 (12.0)		
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90265

TABLE 5.1.3-ME3

Alloy Designation: OFHC Cu

Specification: CDA No. 102

Form: Sheet

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: Hot rolled, annealed 895 K (1150 F) 1/2 hr, cold rolled 5 to 7 percent
(Grain size 0.040 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	226 (32.7)	262 (38.0)	276 (40.0)	372 (54.0)		
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	173 (25.1)	183 (26.5)	192 (27.8)	209 (30.4)		
	Min						
Std Deviation							
Elong, percent	Avg	44	47	40	43		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	216 (31.3)	252 (36.5)	270 (39.2)	363 (52.7)		
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	148 (21.5)	157 (22.8)	184 (26.8)	196 (28.4)		
	Min						
Std Deviation							
Elong, percent	Avg	50	52	44	58		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90265

TABLE 5.1.3-ME4

Alloy Designation: OFHC Cu

Specification: CDA No. 102

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Hot rolled and annealed 895 K (1150 F) 1/2 hr
(Grain size 0.048 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	211 (30.6)	241 (34.9)	253 (36.7)	343 (49.8)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	63 (9.2)	78 (11.3)	66 (9.6)	59 (8.5)		
	Min						
Std. Deviation							
Elong, percent	Avg	62	61	63	68		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	210 (30.5)	240 (34.8)	254 (36.8)	342 (49.6)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	79 (11.5)	83 (12.1)	65 (9.5)	63 (9.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	58	59	65	70		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90265

TABLE 5.1.3-ME5

Alloy Designation: OFHC Cu

Specification: CDA No. 102

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Hot rolled, annealed 895 K (1150 F) 1/2 hr, and cold rolled 5 to 7 percent
(Grain size 0.045 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	219 (31.8)	248 (36.0)	267 (38.7)	361 (52.4)		
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	159 (23.1)	225 (23.7)	176 (25.5)	190 (27.6)		
	Min						
Std Deviation							
Elong, percent	Avg	54	51	56	62		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	212 (30.7)	242 (35.2)	257 (37.3)	347 (50.3)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	131 (19.0)	138 (20.1)	152 (22.0)	155 (22.5)		
	Min						
Std. Deviation							
Elong, percent	Avg	55	58	56	68		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90265

TABLE 5.1.3-ME6

Alloy Designation: OFHC Cu

C10200

Specification: CDA No. (102) (99.95% Cu)

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Stress Relieved 477 K (400 F)

Testing Temperature, K (F)		297 (75)	77 (-300)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	203 (29.5)	324 (47.0)	386 (56.0)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	55.2 (8.0)	64.8 (9.4)	63.4 (9.2)			
	Min						
Std. Deviation							
Elong, percent	Avg	60.2	75.5	100.5			
	Min						
RA, percent	Avg	81.8	82.8	79.6			
	Min						
No. of Spec. (No. of Heats)		(1)					
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	288 (41.8)	444 (64.4)	467 (67.7)			
	Min						
K _t = 10							
No. of Spec. (No. of Heats)		(1)					
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 94208G

TABLE 5.1.3-ME6.1

Alloy Designation: OFHC Cu

C10200

Specification: CDA No. 102

Form: Wire

Thickness, cm (in.):

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	250 (36)	300 (43)	390 (57)	500 (72)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	37	39	43	45		
	Min						
RA, percent	Avg	90	85	82	82		
	Min						
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90302

TABLE 5.1.3-ME7

Alloy Designation: OFHC Cu
 Specification: CDA No. 102
 Form: Wire
 Thickness, cm (in.):
 Condition: Hard drawn

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	358 (52)	393 (57)	483 (70)	531 (77)		
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	345 (50)	379 (55)	414 (60)	427 (62)		
	Min						
Std Deviation							
Elong, percent	Avg	20	20	35	55		
	Min						
RA, percent	Avg	75	80	80	80		
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	128 (18.5)	136 (19.8)	139 (20.2)	149 (21.6)		
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90302

TABLE 5.1.3-ME8

Alloy Designation: OFHC Cu

Specification: CDA No. 102 (all specimens were 99.99+ Cu)

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	133 (-220)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	222 (32.2)	269 (39.0)	303 (44.0)	360 (52.2)	418 (60.7)	
	Min	219 (31.8)	262 (38.0)		352 (51.1)	410 (59.4)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	75.2 (10.9)	80.0 (11.6)		88.2 (12.8)	90.3 (13.1)	
	Min	72.4 (10.5)	63.4 (9.2)		69.6 (10.1)	70.3 (10.2)	
Std. Deviation							
Elong, percent	Avg	53.8	53.2		60.1	68.9	
	Min	53.4	53.1		59.7	67.8	
RA, percent	Avg	86.2	84.5		84.1	83.0	
	Min	85.1	83.8		82.6	82.3	
No. of Spec. (No. of Heats)TUS		6 (2)	6 (2)	(1)	7 (2)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 54986, 90159

TABLE 5.1.3-ME9

Alloy Designation: OFHC Cu (with lower TYS than in Table 5.1.3-ME8)

Specification: CDA No. 102 (all specimens were 99.99+ Cu)

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Vacuum annealed 920 K (1200 F) 1 hr

Testing Temperature, K (F)	297 (75)		77 (-320)		4 (-452)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 207 (30.0)		334 (48.4)		420 (61.0)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 30.3 (4.4)		44.1 (6.4)		47.6 (6.9)	
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (1)		3 (1)		3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg 114 (16.5)		116 (16.9)		138 (20.1)	
	Min 3 (1)		3 (1)		3 (1)	
No. of Spec. (No. of Heats)						
Poisson's Ratio	0.299		0.358		0.334	
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 89543

TABLE 5.1.3-ME10

Alloy Designation: OFHC Cu

Specification: CDA No. 102

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Cold drawn 60 percent

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	334 (48.4)	365 (52.9)	458 (66.4)	514 (74.5)	514 (74.6)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	323 (46.8)	343 (49.8)	375 (54.4)	403 (58.5)	404 (58.6)	
	Min						
Std. Deviation							
Elong, percent	Avg	17	20	29	42	41	
	Min						
RA, percent	Avg	77	74	78	76	75	
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	522 (75.7)	567 (82.2)	645 (93.6)	706 (102)	694 (101)	
	Min						
K _t = 5.0							
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90499

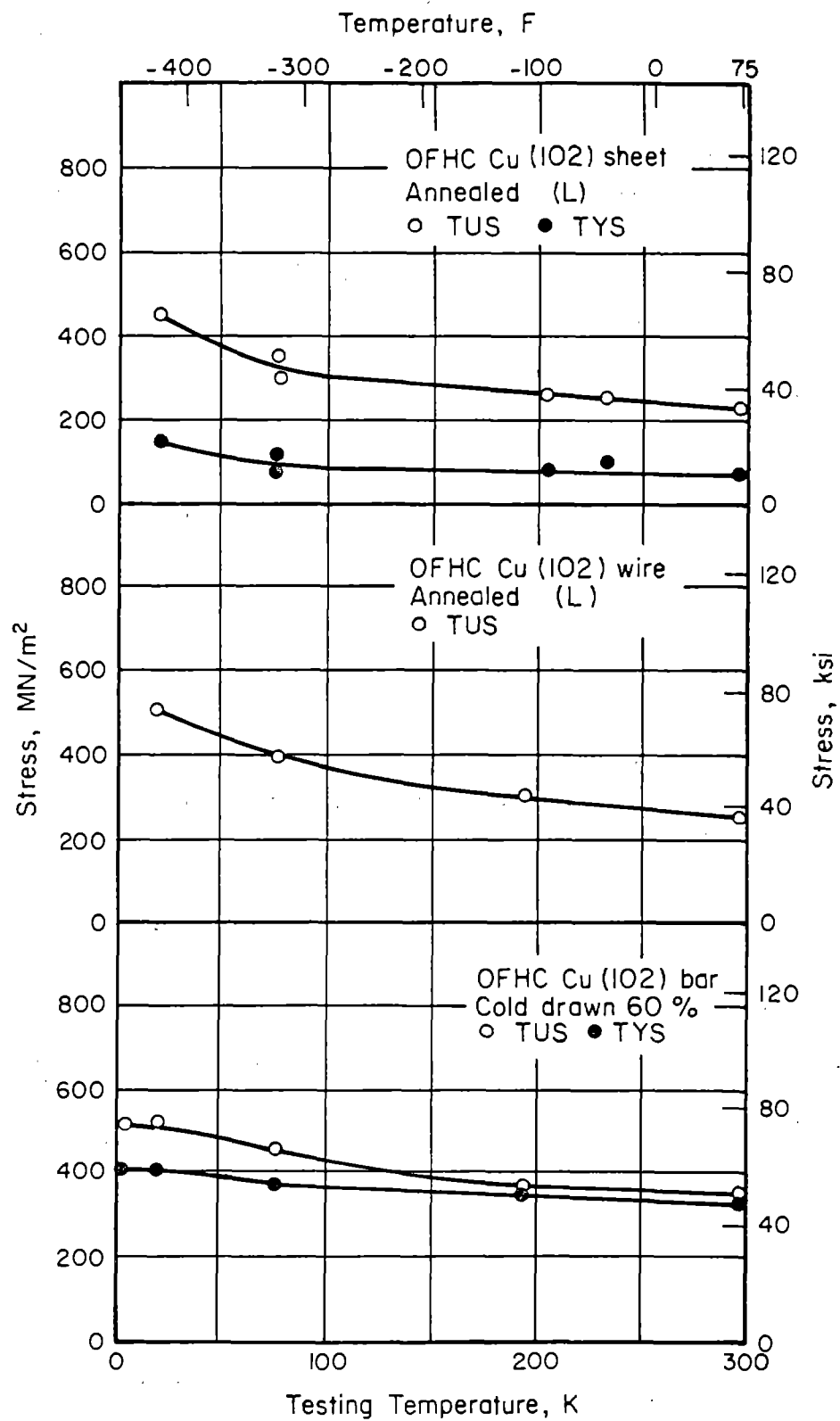


FIGURE 5.1.3-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF OFHC Cu

5.1.3-11 (11/74)

TABLE 5.1.3-TR1

Alloy Designation: Copper-OFHC

Specification: CDA No. 102

Form:

Thickness, cm (in.):

Condition: Annealed

Testing Temperature, K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
RRR-250 Watts m ⁻¹ K ⁻¹	412	480	1150	4050	3230	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(238)	(278)	(665)	(2340)	(1870)	
RRR-107 Watts m ⁻¹ K ⁻¹	406*	460*	1000*	2150	1450	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(235)*	(266)*	(578)*	(1240)	(838)	
RRR-97 Watts m ⁻¹ K ⁻¹	400	440	820	900	460	183
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(231)	(254)	(474)	(520)	(266)	(106)
No. of Spec.	2	2	2	3	3	1
References: 90111, 94206						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.252	-0.288	-0.295	-0.295	
No. of Spec.	3	3	4	4	1	
References: 90202, 90252, 90366, 90459						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	380	245	95	7.2	0.85	0.099
Btu lb ⁻¹ F ⁻¹	(0.091)	(0.0586)	(0.0227)	(0.00172)	(0.000203)	(0.0000239)
No. of Spec.	2	2	1	2	3	3
References: 90223, 90259, 94206						
Electrical Resistivity						
RRR-250 Ohm m	1.55 x 10 ⁻⁸	3.54 x 10 ⁻⁹	5.82 x 10 ⁻¹⁰	8.10 x 10 ⁻¹¹	7.30 x 10 ⁻¹¹	
Ohm circular mil ft ⁻¹	(9.32)	(2.13)	(0.350)	(4.87 x 10 ⁻²)	(4.39 x 10 ⁻²)	
RRR-97 Ohm m	1.55 x 10 ⁻⁸	3.40 x 10 ⁻⁹	5.10 x 10 ⁻¹⁰	1.72 x 10 ⁻¹⁰	1.65 x 10 ⁻¹⁰	1.60 x 10 ⁻¹⁰
Ohm circular mil ft ⁻¹	(9.32)	(2.05)	(0.307)	(0.103)	(0.0992)	(0.0962)
No. of Spec.	3	3	3	3	3	
References: 79561, 90111, 94206						
Magnetothermal Conductivity⁽¹⁾						
H tesla						
Watts m ⁻¹ K ⁻¹	0			2180	1450	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(1260)	(838)	
Watts m ⁻¹ K ⁻¹	1			2060	1250	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(1191)	(723)	
Watts m ⁻¹ K ⁻¹	2			1880	1080	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(1087)	(624)	
Watts m ⁻¹ K ⁻¹	4			1530	940	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(885)	(544)	
Watts m ⁻¹ K ⁻¹	8			1202	730	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(695)	(422)	
No. of Spec.				1		
References: 94206						
Magnetoresistance⁽²⁾						
H tesla						
Ohm m	0			8.32 x 10 ⁻¹¹	7.54 x 10 ⁻¹¹	7.52 x 10 ⁻¹¹
Ohm circular mil ft ⁻¹				(5.00 x 10 ⁻²)	(4.54 x 10 ⁻²)	(4.52 x 10 ⁻²)
Ohm m	1			1.29 x 10 ⁻¹⁰	1.22 x 10 ⁻¹⁰	1.22 x 10 ⁻¹⁰
Ohm circular mil ft ⁻¹				(7.76 x 10 ⁻²)	(7.34 x 10 ⁻²)	(7.34 x 10 ⁻²)
Ohm m	10			5.48 x 10 ⁻¹⁰	5.37 x 10 ⁻¹⁰	5.37 x 10 ⁻¹⁰
Ohm circular mil ft ⁻¹				(0.330)	(0.323)	(0.323)
No. of Spec.				1	1	1
References: 96887						

(1) RRR-107.

(2) RRR-207.

* Extrapolated.

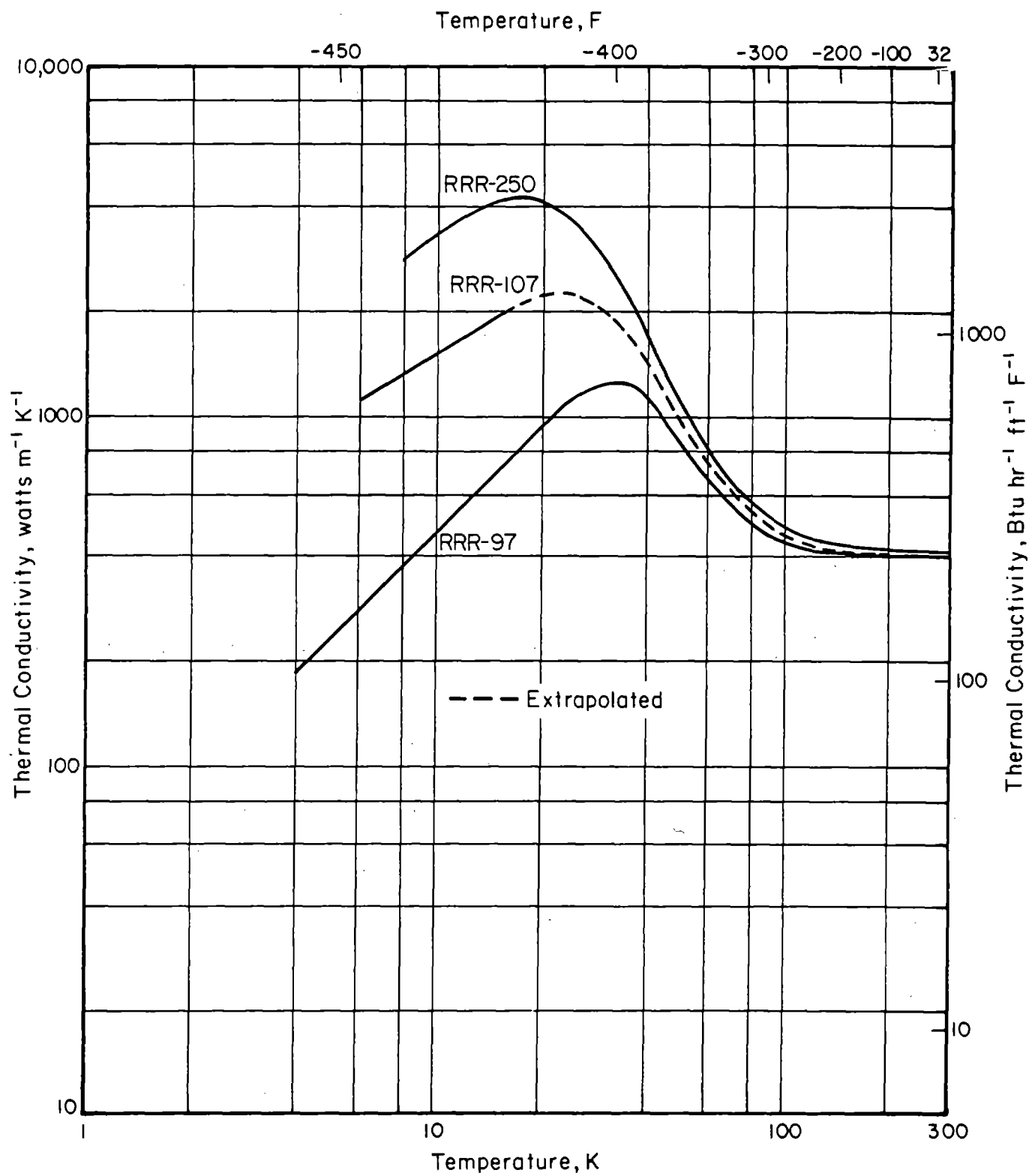


FIGURE 5.1.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR OFHC COPPER

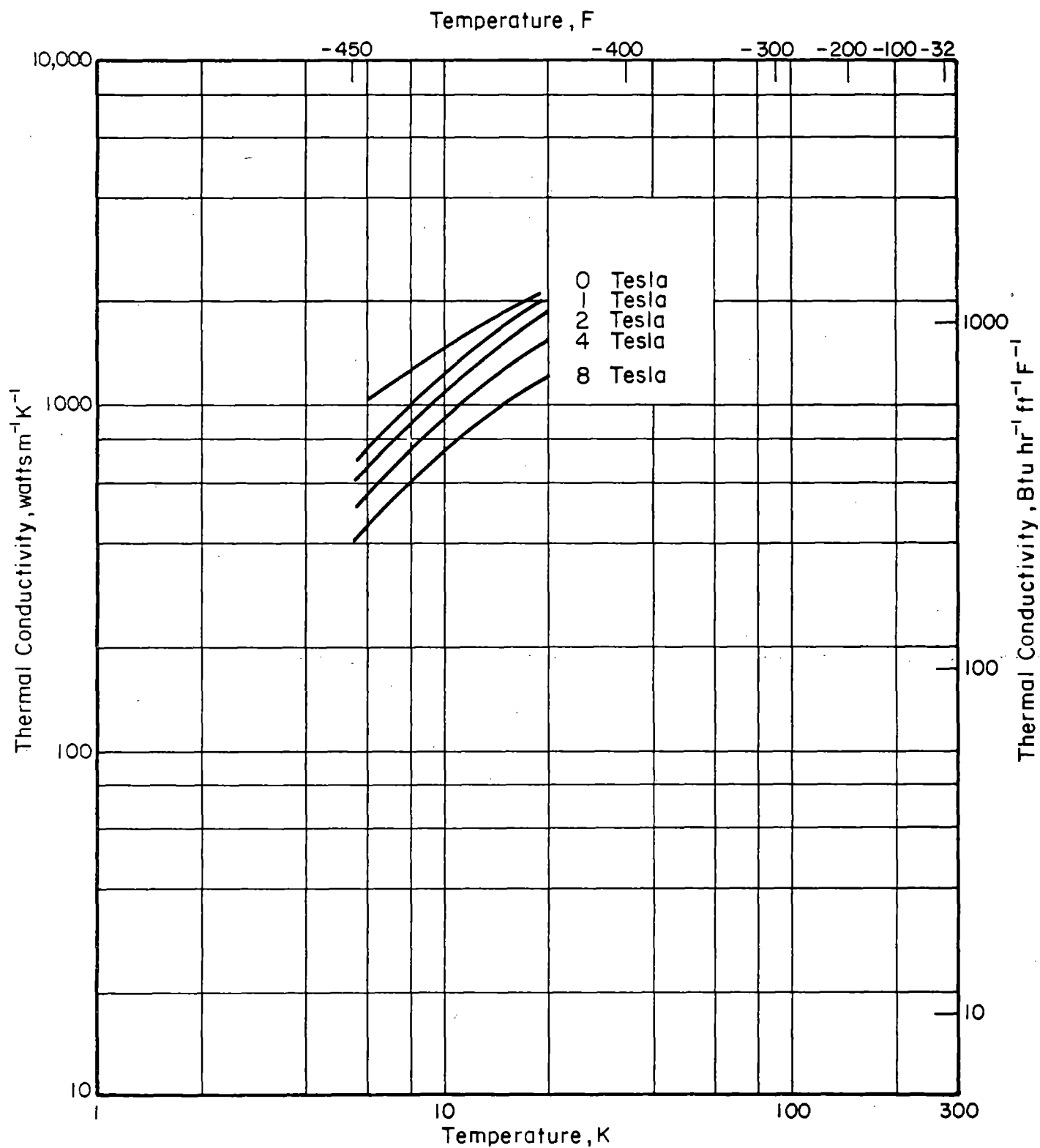


FIGURE 5.1.3-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR OFHC COPPER AT SEVERAL MAGNETIC FIELD STRENGTHS

5.1.3-14 (11/75)

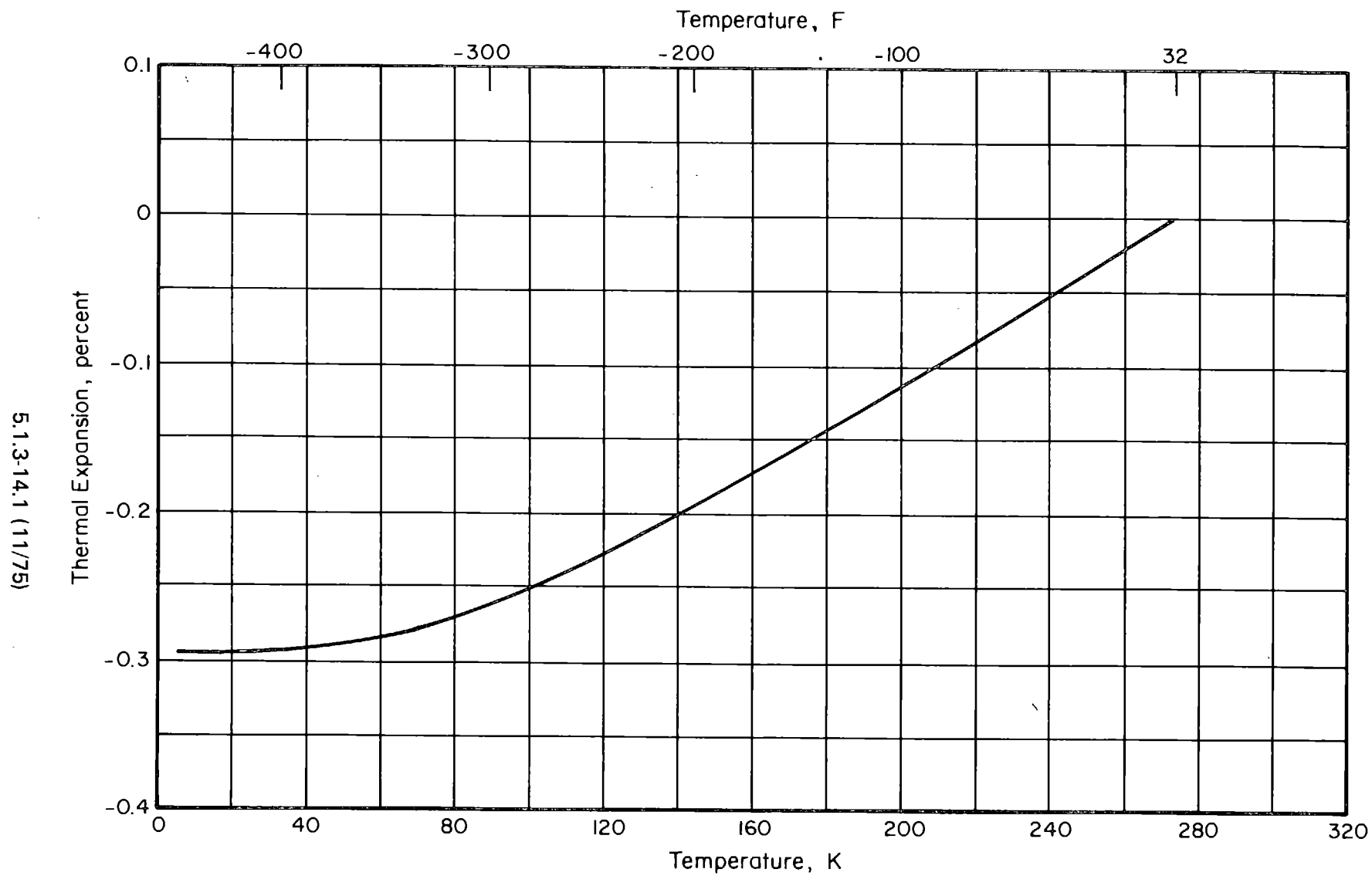


FIGURE 5.1.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE
FOR OFHC COPPER

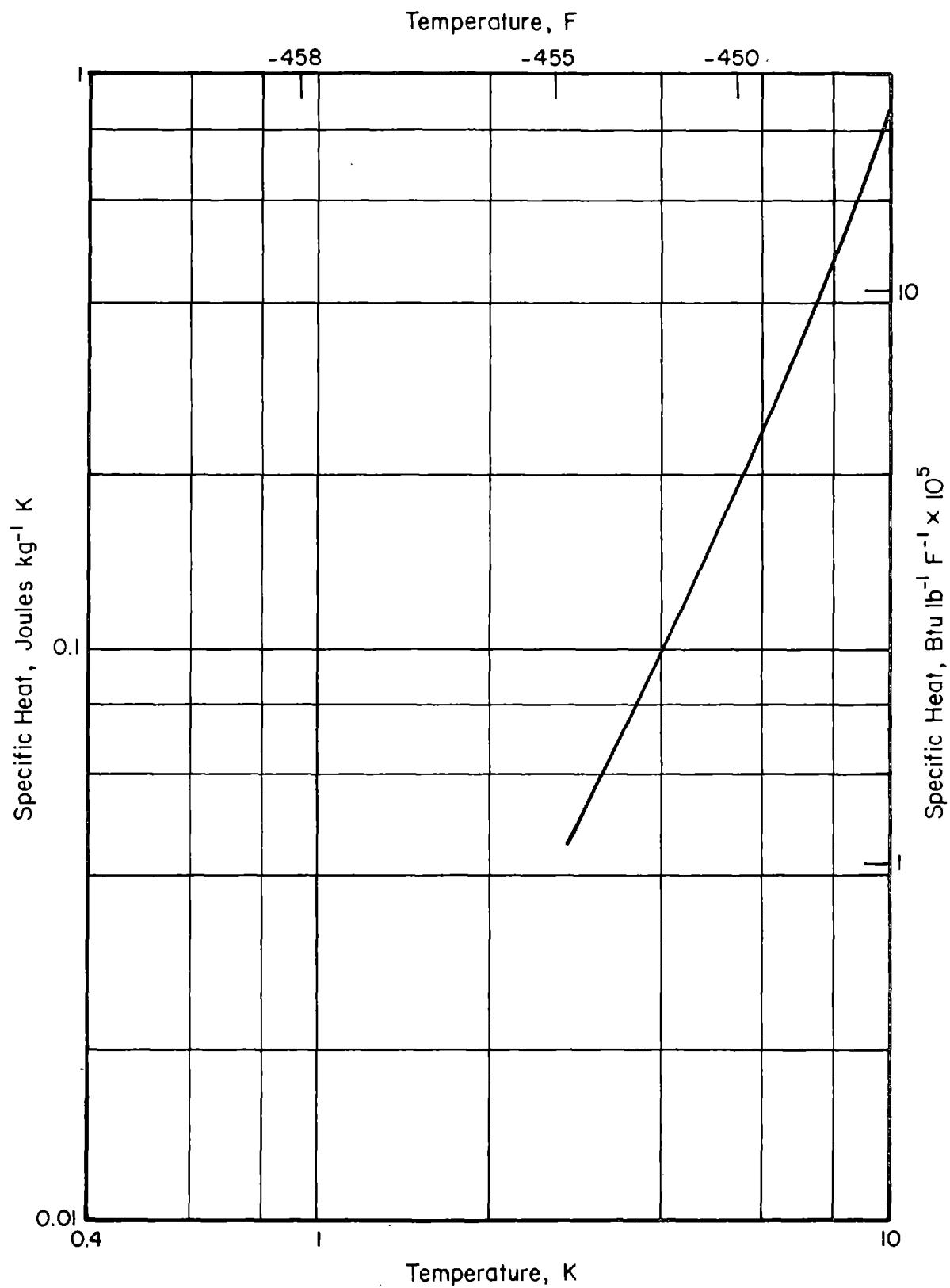


FIGURE 5.1.3-S1. SPECIFIC HEAT VERSUS TEMPERATURE
FOR OFHC COPPER

5.1.3-15 (11/74)

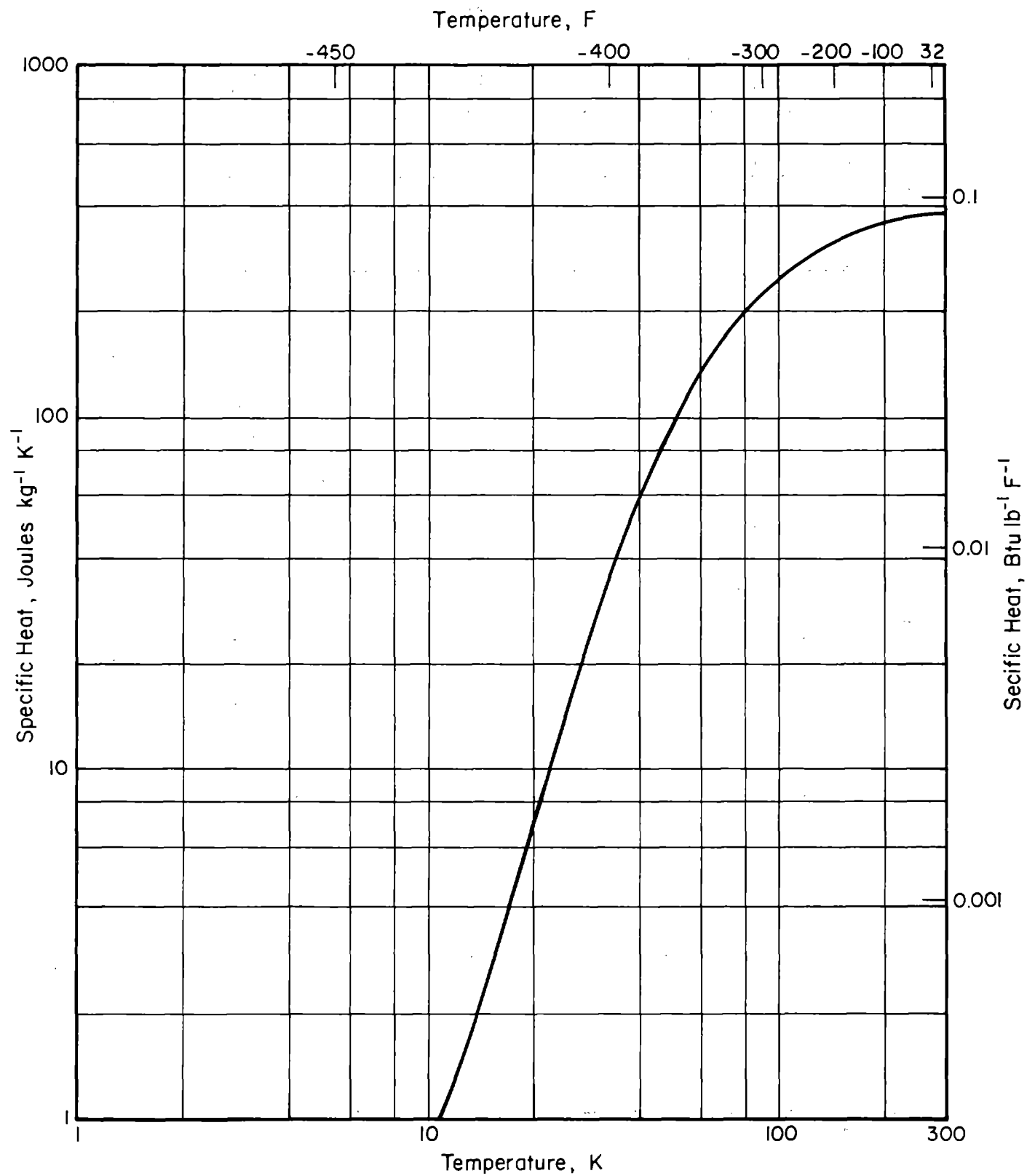


FIGURE 5.1.3-S2. SPECIFIC HEAT VERSUS TEMPERATURE
FOR OFHC COPPER

5.1.3-16 (11/74)

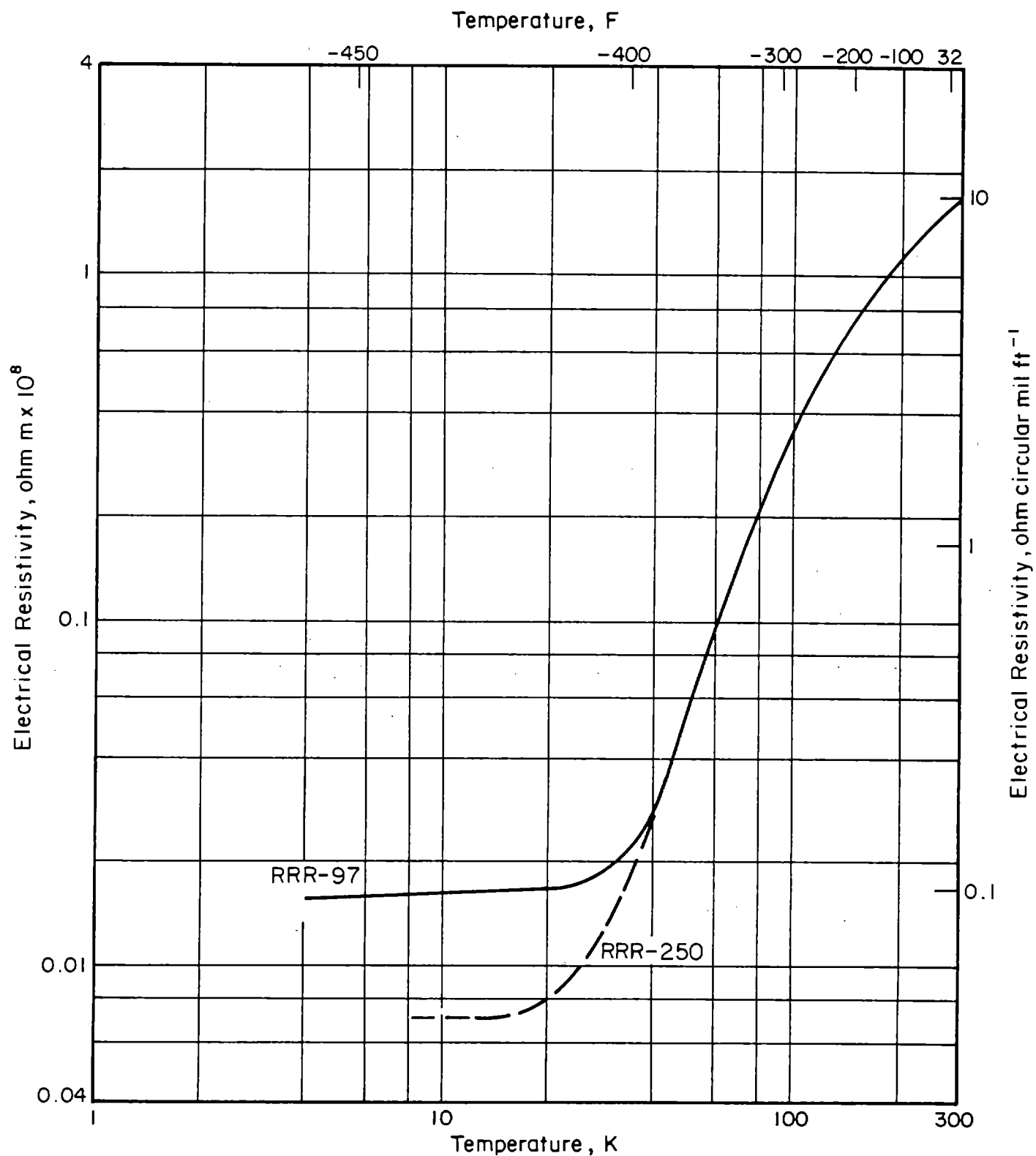


FIGURE 5.1.3-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR OFHC COPPER

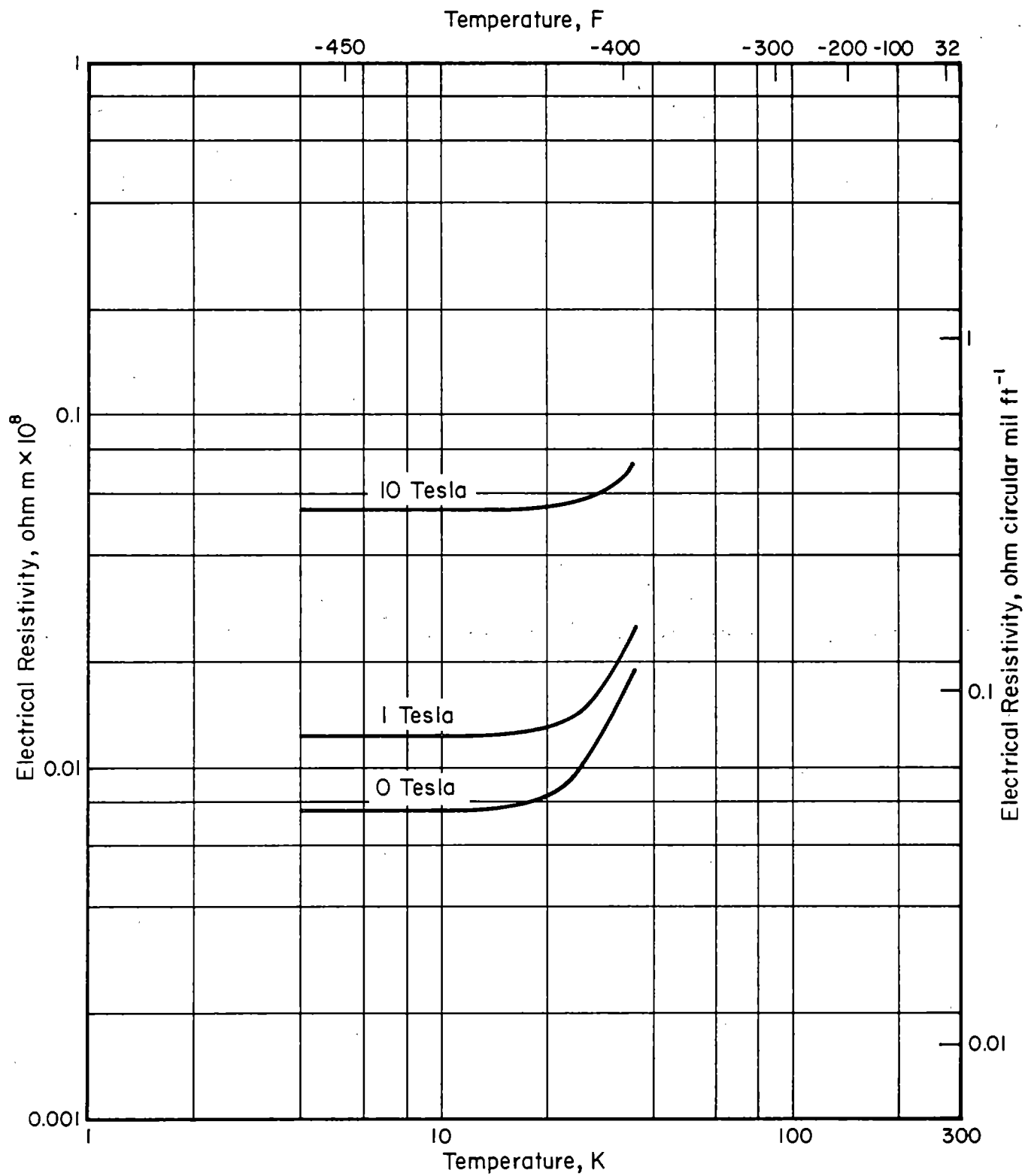


FIGURE 5.1.3-MR1. MAGNETORESISTANCE VERSUS TEMPERATURE FOR OFHC COPPER

TABLE 5.1.3-MA1

Alloy Designation: OFHC Cu

Specification:

Form: Rod

Diameter, cm (in.): 0.9 (0.354)

Condition: Heavily etched and air cooled after annealing at 823 K (550 C) for 7 days

Temperature, K (F)	Mass Susceptibility, χ (cgsem)	Volume Susceptibility, k (mksa)	Permeability, μ (mksa)
6.6 (-447)	-0.836×10^{-7}	-89.32×10^{-7}	$\sim 12.57 \times 10^{-7}$
22.6 (-418)	-0.856×10^{-7}	-91.46×10^{-7}	$\sim 12.57 \times 10^{-7}$
30.8 (-404)	-0.863×10^{-7}	-92.21×10^{-7}	$\sim 12.57 \times 10^{-7}$
40.5 (-386)	-0.869×10^{-7}	-92.85×10^{-7}	$\sim 12.57 \times 10^{-7}$
48.2 (-372)	-0.872×10^{-7}	-93.17×10^{-7}	$\sim 12.57 \times 10^{-7}$
62.0 (-347)	-0.873×10^{-7}	-93.28×10^{-7}	$\sim 12.57 \times 10^{-7}$
80.0 (-315)	-0.872×10^{-7}	-93.17×10^{-7}	$\sim 12.57 \times 10^{-7}$
98.8 (-281)	-0.869×10^{-7}	-92.85×10^{-7}	$\sim 12.57 \times 10^{-7}$
128.0 (-229)	-0.869×10^{-7}	-92.85×10^{-7}	$\sim 12.57 \times 10^{-7}$
160.1 (-171)	-0.867×10^{-7}	-92.63×10^{-7}	$\sim 12.57 \times 10^{-7}$
208.0 (-85.0)	-0.863×10^{-7}	-92.21×10^{-7}	$\sim 12.57 \times 10^{-7}$
247.5 (-13.9)	-0.859×10^{-7}	-91.78×10^{-7}	$\sim 12.57 \times 10^{-7}$
292.0 (66.2)	-0.855×10^{-7}	-91.35×10^{-7}	$\sim 12.57 \times 10^{-7}$

Reference: 90467

TABLE 5.1.4-ME1

Alloy Designation: Cu Phosphorized

Specification: CDA No. 122

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Hot rolled and annealed 895 K (1150 F) 1/2 hr
(Grain size 0.045 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	208 (30.2)	245 (35.6)	259 (37.6)	350 (50.8)		
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	61.9 (9.0)	70.6 (10.2)	78.6 (11.4)	72.5 (10.5)		
	Min						
Std Deviation							
Elong, percent	Avg	51.2	56.5	55.8	55.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	210 (30.4)	229 (33.3)	258 (37.5)	348 (50.5)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	66.9 (9.7)	74.7 (10.8)	78.5 (11.4)	86.7 (12.6)		
	Min						
Std. Deviation							
Elong, percent	Avg	54.8	55.3	57.3	65.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90265

TABLE 5.1.4-ME2

Alloy Designation: Cu Phosphorized

Specification: CDA No. 122

Form: Sheet

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: Hot rolled, annealed 895 K (1150 F) 1/2 hr, and cold rolled 5 to 7 percent
(Grain size 0.047 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	225 (32.6)	260 (37.8)	273 (39.6)	366 (53.1)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	168 (24.4)	181 (26.3)	182 (26.4)	198 (28.7)		
	Min						
Std. Deviation							
Elong, percent	Avg	39.0	41.0	38.8	49.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	218 (31.6)	248 (36.0)	264 (38.3)	354 (51.4)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	149 (21.6)	159 (23.1)	164 (23.7)	173 (25.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	43.9	47.3	47.3	52.3		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90265

TABLE 5.1.4-ME3

Alloy Designation: Cu Phosphorized

Specification: CDA No. 122

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Hot rolled and annealed 895 K (1150 F) 1/2 hr
(Grain size 0.043 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	212 (30.8)	238 (34.6)	261 (37.9)	344 (49.9)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	58.2 (8.4)	58.9 (8.5)	57.4 (8.3)	55.8 (8.1)		
	Min						
Std. Deviation							
Elong, percent	Avg	57.1	55.3	55.8	58.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	209 (30.3)	238 (34.6)	253 (36.8)	341 (49.4)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	52.5 (7.6)	58.5 (8.5)	60.7 (8.8)	56.4 (8.2)		
	Min						
Std. Deviation							
Elong, percent	Avg	50.6	49.3	56.8	60.5		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90265

TABLE 5.1.4-ME4

Alloy Designation: Cu Phosphorized

Specification: CDA No. 122

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.500)

Condition: Hot rolled, annealed 895 K (1150 F) 1/2 hr, and cold rolled 5 to 7 percent
(Grain size 0.045 mm)

Testing Temperature, K (F)		297 (75)	233 (-40)	205 (-90)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	229 (33.2)	261 (37.9)	269 (39.0)	360 (52.3)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	174 (25.2)	178 (25.8)	180 (26.2)	182 (26.4)		
	Min						
Std. Deviation							
Elong, percent	Avg	52.0	51.0	50.5	61.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	218 (31.7)	249 (36.1)	263 (38.2)	351 (50.9)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	154 (22.4)	164 (23.8)	167 (24.2)	206 (30.0)		
	Min						
Std. Deviation							
Elong, percent	Avg	50.5	54.0	57.5	63.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90265

TABLE 5.1.4-ME5

Alloy Designation: Cu Phosphorized

Specification: CDA No. 122

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Annealed (ASTM Grain size 0.051)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	216 (31.3)	264 (38.3)	349 (50.6)	440 (63.8)	416 (60.4)	
	Min	214 (31.1)	262 (38.0)	343 (49.7)	437 (63.4)	412 (59.7)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	46 (6.7)	46 (6.6)	51 (7.4)	58 (8.4)	54 (7.9)	
	Min	46 (6.6)	46 (6.6)	50 (7.2)	57 (8.3)	52 (7.6)	
Std. Deviation							
Elong, percent	Avg	45.3	56.0	62.4	68.6	65.3	
	Min	42.1	55.7	62.3	68.5	65.0	
RA, percent	Avg	76.2	87.3	84.4	83.0	80.8	
	Min	75.8	85.5	84.1	82.9	80.7	
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	104 (15.1)	110 (16.0)	112 (16.2)	112 (16.3)	113 (16.4)	
	Min						
No. of Spec. (No. of Heats)		(1)					
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	298 (43.3)	348 (50.4)	430 (62.3)	496 (72.0)	515 (74.7)	
	Min	297 (43.1)	346 (50.2)	429 (62.2)	494 (71.6)	514 (74.5)	
K _t = 5.0							
No. of Spec. (No. of Heats)		2 (1)	2 (1)				
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90375

TABLE 5.1.4-ME6

Alloy Designation: Cu Phosphorized

Specification: CDA No. 122

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Annealed

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	44.5 (6.46)	47.0 (6.81)	49.6 (7.20)	51.3 (7.44)		
Avg						
Min	(1)	(1)	(1)	(1)		
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K_{IE} MN/m^{3/2}(ksi√in.)						
Avg						
(From PTSC spec) (—)Min						
No. of Spec. (No. of Heats)						

References: 90375

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 5.1.4-ME7

Alloy Designation: Cu Phosphorized

Specification: CDA No. 122

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Cold drawn 26 percent (Grain size 0.10 mm)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	357 (51.8)	392 (56.8)	472 (68.4)	561 (81.4)	558 (81.0)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	341 (49.4)	370 (53.6)	413 (59.9)	442 (64.1)	438 (63.6)	
	Min						
Std. Deviation							
Elong, percent	Avg	17	21	28	46	44	
	Min						
RA, percent	Avg	76	79	76	78	72	
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg	130 (18.9)	137 (19.9)	140 (20.3)	143 (20.8)	145 (21.1)	
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	558 (81.0)	598 (86.8)	688 (99.8)	749 (109)	754 (109)	
$K_t = 5.0$	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)	(1)	
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							

References: 90375

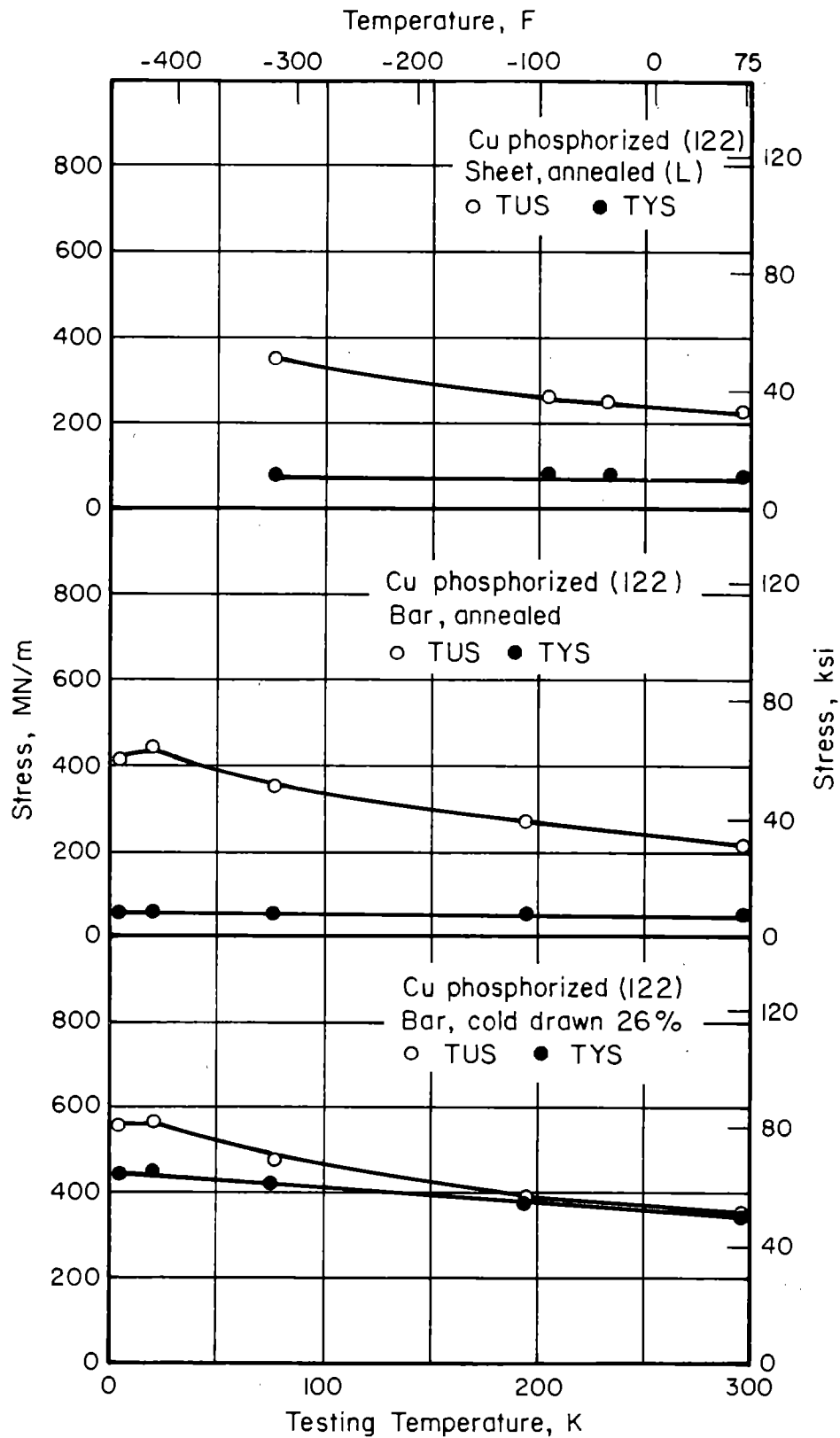


FIGURE 5.1.4-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF PHOSPHORIZED COPPER
5.1.4-8 (11/74)

TABLE 5.1.4-TR1

Alloy Designation: Copper-Phosphorized

Specification: CDA No. 122

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	201	140	92	43	20.2	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(116)	(80.9)	(53.2)	(24.9)	(11.7)	
No. of Spec	1	2	2	2	2	
References: 90224, 90330						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

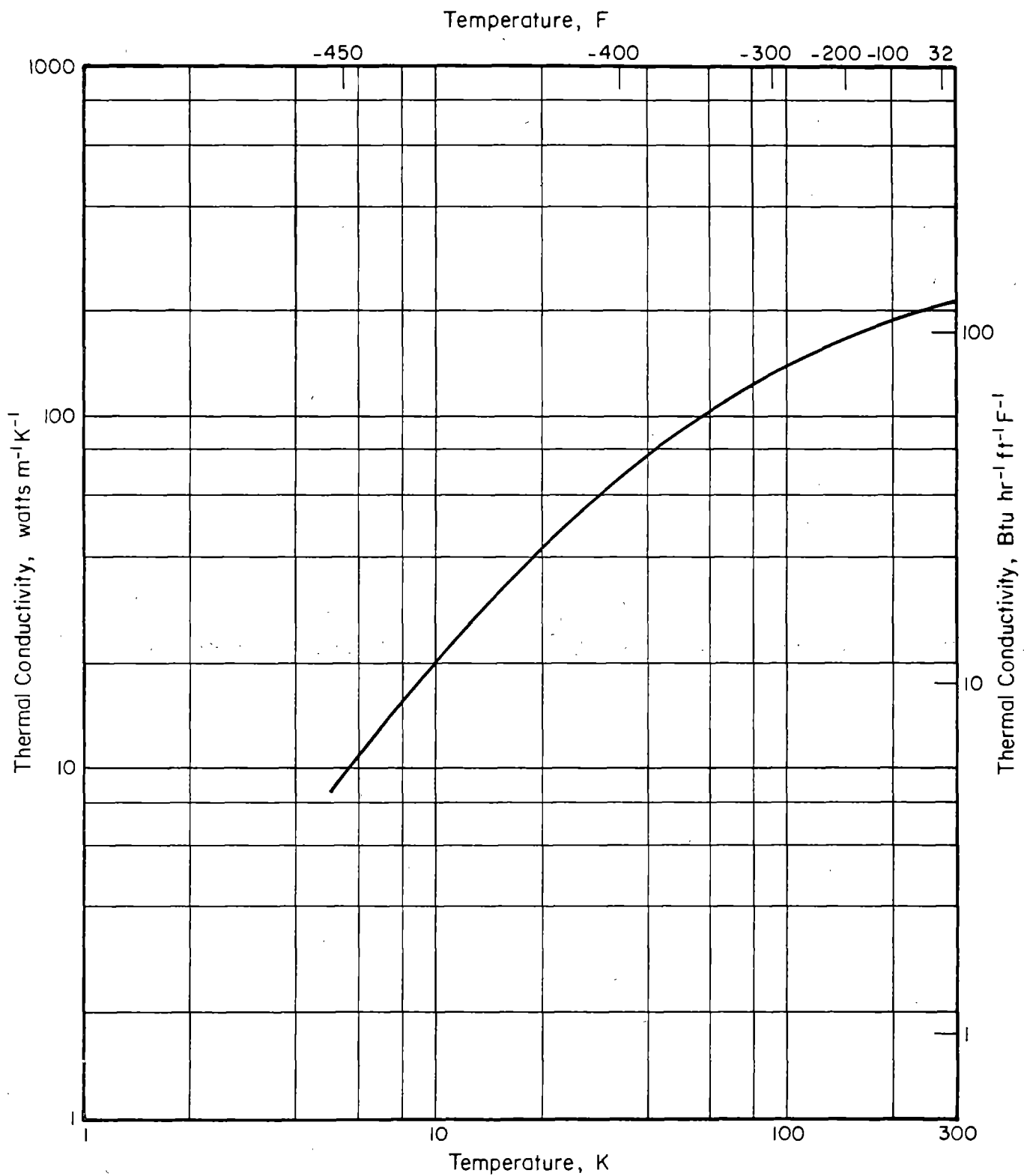


FIGURE 5.1.4-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR PHOSPHORIZED COPPER

5.1.4-10 (11/74)

TABLE 5.2.1-TR1

Alloy Designation: 80Cu-20Zn Alloy

Specification: CDA No. 240

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	140	90	57.5	26.0	13.0	4.4
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(80.9)	(52.0)	(33.2)	(15.0)	(7.52)	(2.54)
No. of Spec.	1	1	1	1	1	1
References: 90224						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹		260	106	9.0		
Btu lb ⁻¹ F ⁻¹		(0.0621)	(0.0253)	(0.00215)		
No. of Spec.		1	1	1		
References: 90223						
Electrical Resistivity						
Ohm m						
Ohm circular mil-ft ⁻¹						
No. of Spec.						
References:						

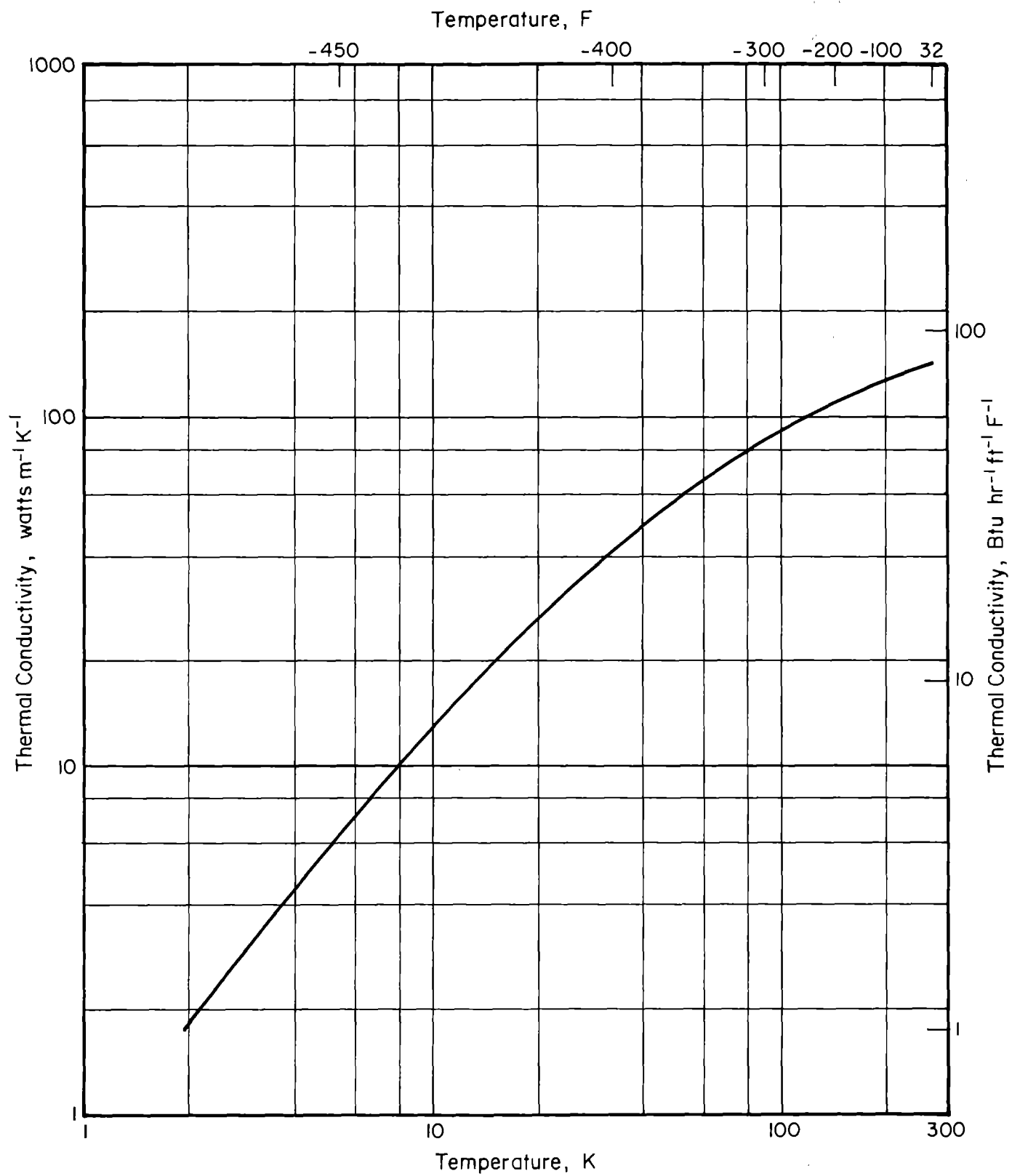


FIGURE 5.2.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE
FOR COPPER ALLOY 80 Cu-20 Zn

5.2.1-2 (11/74)

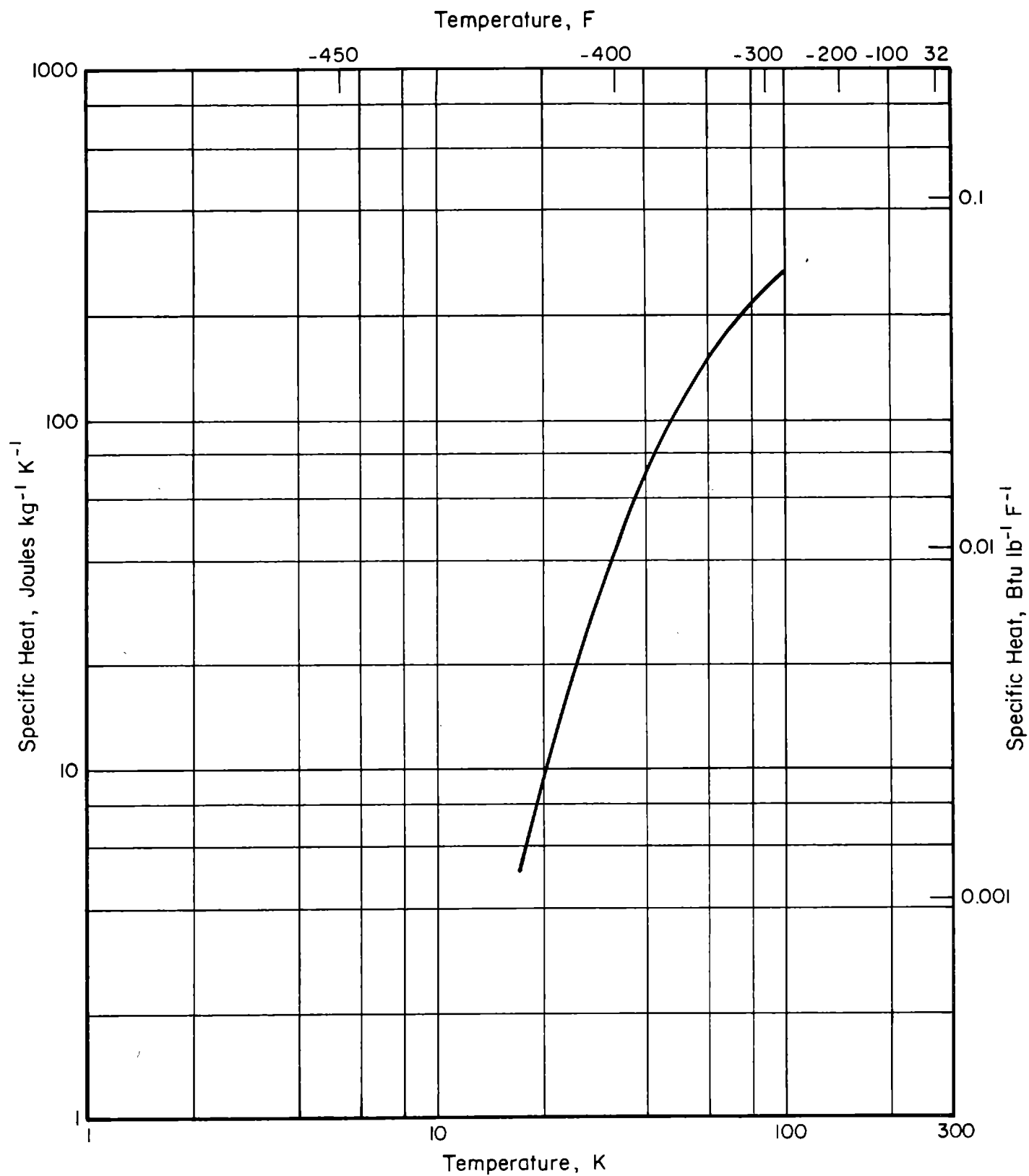


FIGURE 5.2.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE
TEMPERATURE FOR COPPER ALLOY
80 Cu-20 Zn

TABLE 5.2.2-ME1

Alloy Designation: 70Cu-30Zn Alloy

Specification: CDA No. 260

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: No. 8 spring temper stress relieved 478 K (400 F)

Testing Temperature, K (F)		297 (75)		77 (-320)			
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg Min	655 (95.0)		827 (120)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg Min	607 (88.0)		690 (100)			
Std. Deviation							
Elong, percent	Avg Min	2.8		28			
RA, percent	Avg Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg Min	110 (16)		145 (21)			
No. of Spec. (No. of Heats)		(1)		(1)			
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg Min						
K _t =							
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg Min						
Std. Deviation							
Elong, percent	Avg Min						
RA, percent	Avg Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 49048

TABLE 5.2.2-ME2

Alloy Designation: 70Cu-30Zn Alloy

Specification: CDA No. 260

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: No. 8 spring temper followed by stress relieving at 478 K (400 F) 1 hr

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	462 (67)	621 (90)	862 (125)	1186 (172)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.70			0.70		
S_N at 10^5 cycles, MN/m ² (ksi)	317 (46)	372 (54)	441 (64)	545 (79)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
S_N at 10^5 cycles, MN/m ² (ksi)	303 (44)	352 (51)	455 (66)	531 (77)		
Loading frequency Hz						
with $R = -1$ and $K_t = 6.4$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
Fatigue, Flexural Loading						
S_N at 10^6 cycles, MN/m ² (ksi)	234 (34)	372 (54)	496 (72)	703 (102)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)		1 (1)	1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.36			0.85		
S_N at 10^6 cycles, MN/m ² (ksi)	179 (26)	248 (36)	269 (39)	338 (49)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
S_N at 10^6 cycles, MN/m ² (ksi)	172 (25)	234 (34)	283 (41)	324 (47)		
Loading frequency Hz						
with $R = -1$ and $K_t = 6.4$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		

References: 49048

TABLE 5.2.2-ME3

Alloy Designation: 70Cu-30Zn Alloy

Specification: CDA No. 260

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: 3/4 Hard (ASTM Grain size 8.5)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	656 (95.2)	695 (101)	807 (117)	914 (132)		
	Min	652 (94.6)		796 (115)	909 (132)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	420 (60.9)	443 (64.3)	473 (68.6)	506 (73.4)		
	Min	395 (57.3)	416 (60.4)	460 (66.8)	500 (72.6)		
Std. Deviation							
Elong, percent	Avg	14.2	17.3	28.4	32.2		
	Min	14.2	16.6	27.6	32.1		
RA, percent	Avg	58.3	62.3	63.4	58.2		
	Min	58.2	61.2	63.0	58.0		
No. of Spec. (No. of Heats)		4 (1)	5 (1)	2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 54986

TABLE 5.2.2-ME4

Alloy Designation: 70Cu-30Zn Alloy

Specification: CDA No. 260

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: 3/4 Hard (ASTM Grain Size 8.5)

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)			
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb)	Avg	21 (15.5)	21 (15.7)	21 (15.5)		
	Min	19 (14.0)	21 (15.5)	19 (14.0)		
No. of Spec. (No. of Heats)		4 (1)	3 (1)	5 (1)		
Trans., J(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)	Avg					
	Min					
Orientation. —						
No. of Spec. (No. of Heats)						
K_{IE} MN/m^{3/2}(ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 54986

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

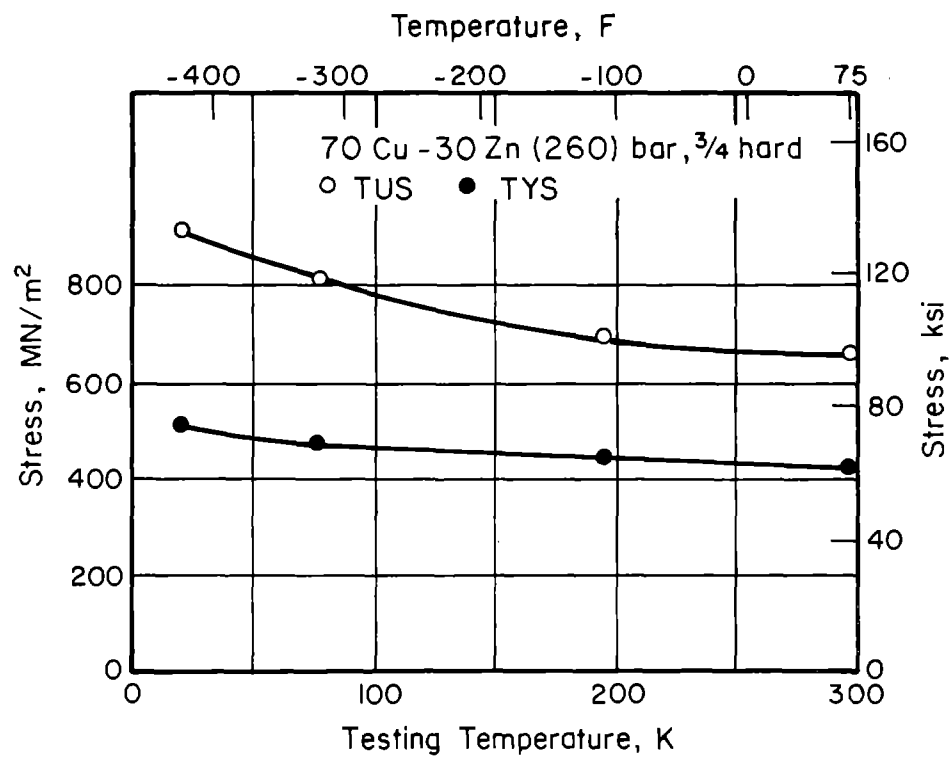


FIGURE 5.2.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 70Cu-30Zn ALLOY

TABLE 5.2.2-TR1

Alloy Designation: 70Cu-30Zn Alloy

Specification: CDA No. 260

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	107	68	44.5	20.5	10.2	3.5
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(61.9)	(39.3)	(25.7)	(11.9)	(5.90)	(2.02)
No. of Spec.	2	2	1	1	1	2
References: 90224						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

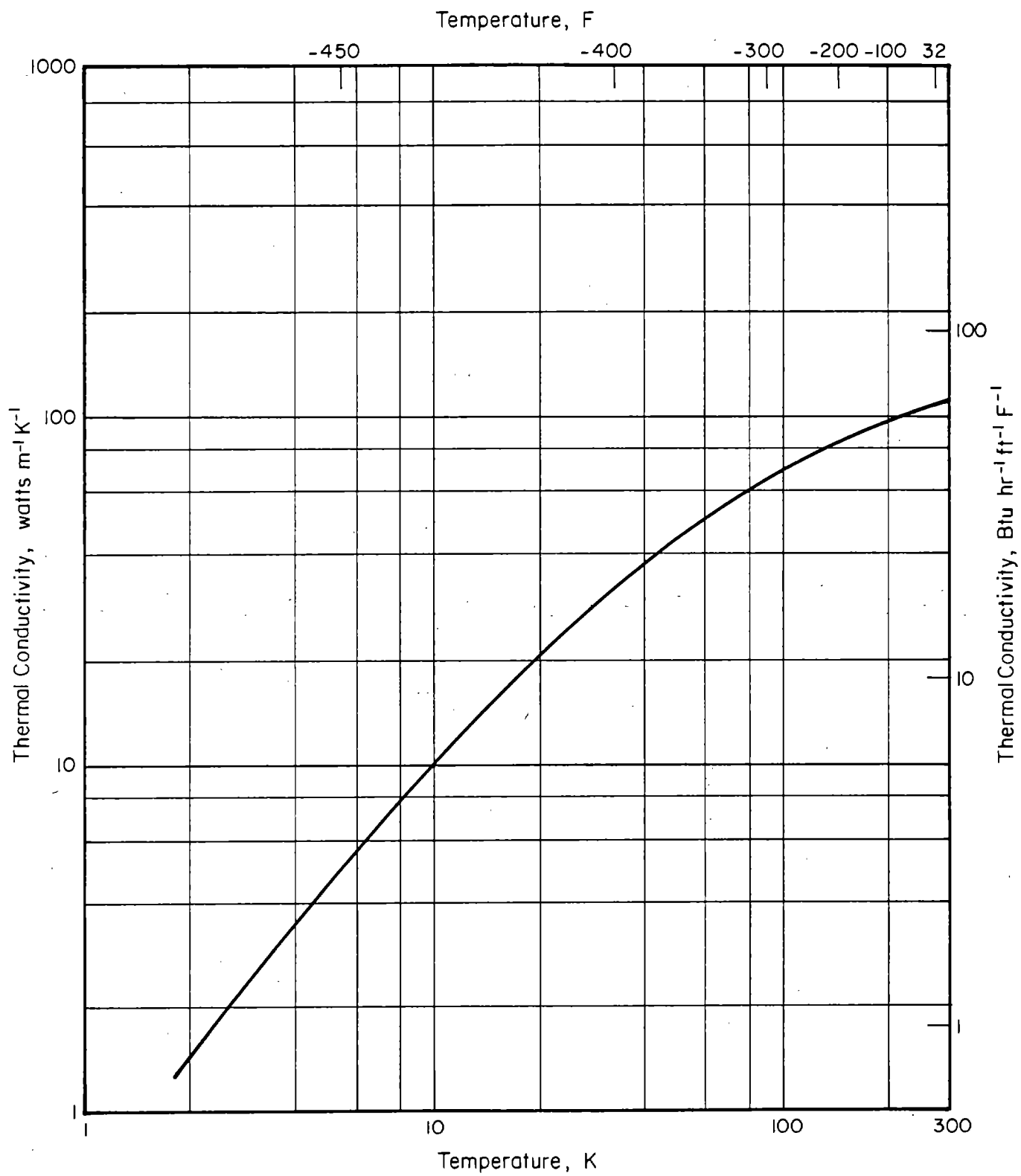


FIGURE 5.2.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE
FOR COPPER ALLOY 70 Cu-30 Zn

5.2.2-7 (11/74)

TABLE 5.2.2-TR2

Alloy Designation: 70Cu-30Ni Alloy

Specification: CDA No. 715

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
<u>Thermal Conductivity</u> Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec. References: 90224				5.02 1 (290)	2.09 1 (1.21)	
<u>Thermal Expansion (T₂₇₃ to T)</u> <u>Longitudinal</u> Percent No. of Spec. References:						
<u>Specific Heat</u> Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec. References:						
<u>Electrical Resistivity</u> Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

70Cu-30Ni

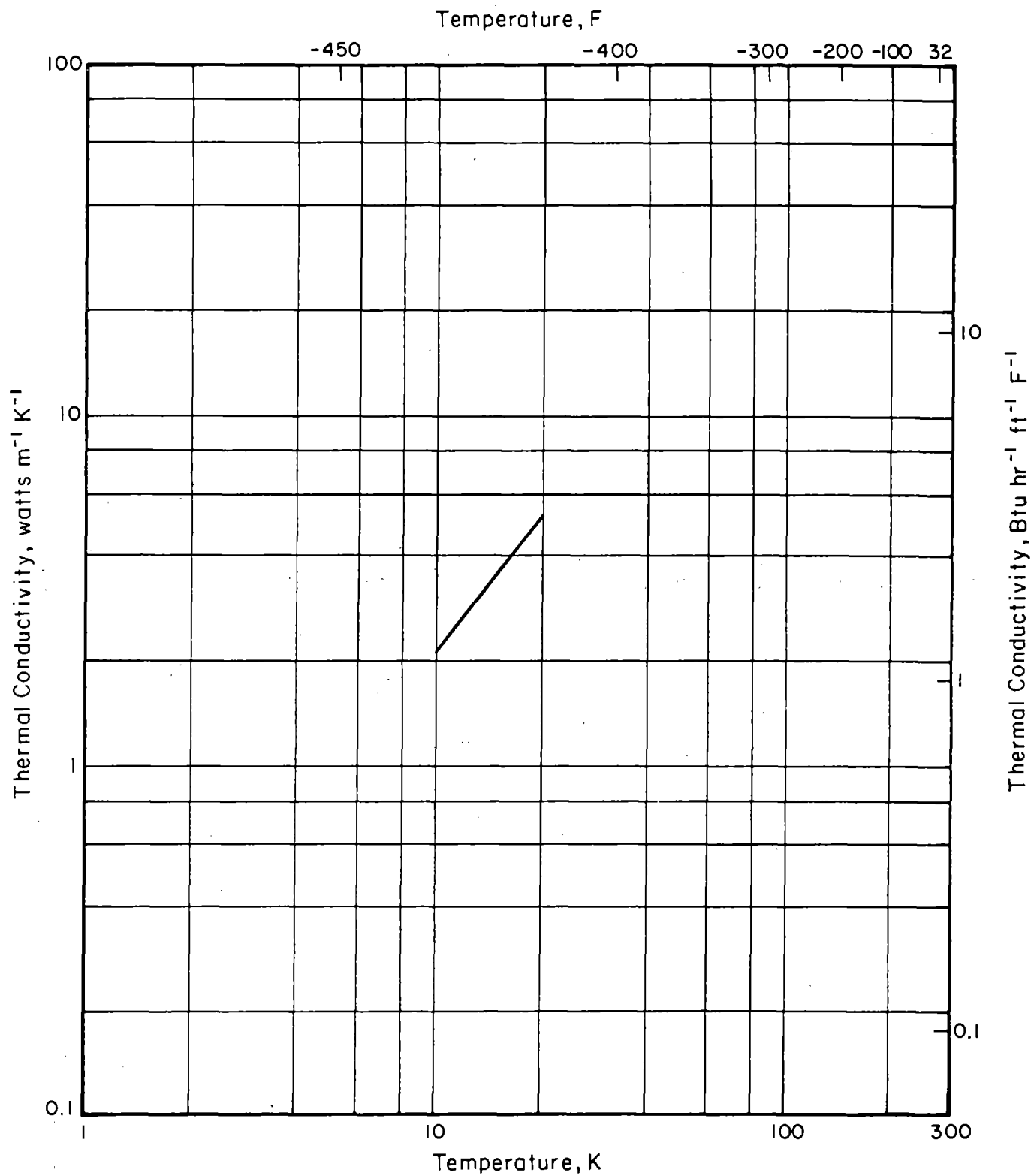


FIGURE 5.2.2-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 70Cu-30Ni

TABLE 5.2.3-TR1

Alloy Designation: 65Cu-35Zn Alloy

Specification: CDA No. 270

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	113	59				
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(65.3)	(34.1)				
No. of Spec.	1	1				
References: 90224						
Thermal Expansion (T₂₇₃ to T)						
<u>Longitudinal</u>						
Percent	0	-0.289	-0.338	-0.347	-0.347	-0.347
No. of Spec.	1	1	1	1	1	1
References: 90208						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	375	265	120	10.5		
Btu lb ⁻¹ F ⁻¹	(0.0896)	(0.0633)	(0.0287)	(0.00251)		
No. of Spec.	1	1	1	1		
References: 90223						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

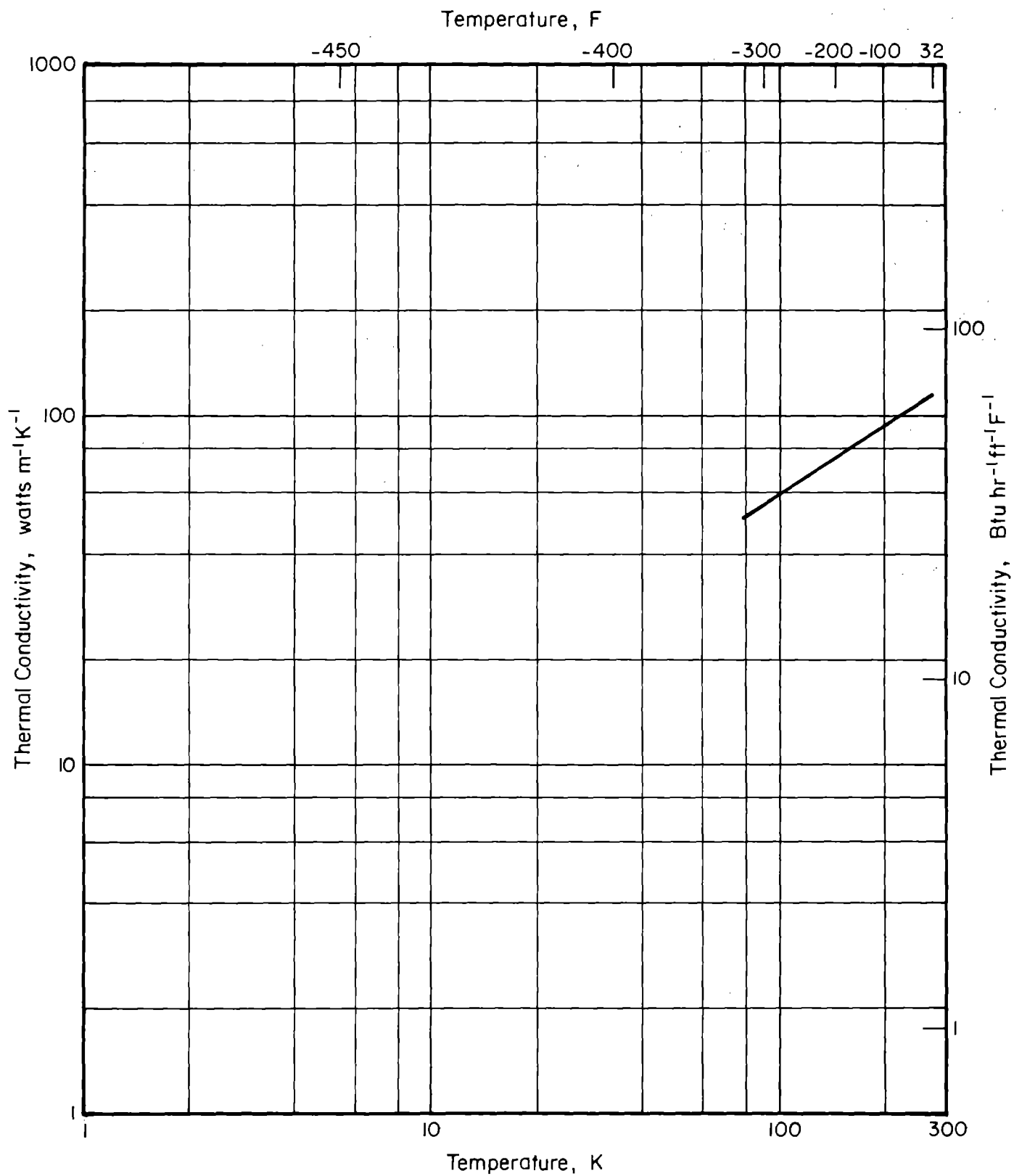


FIGURE 5.2.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE
FOR COPPER ALLOY 65 Cu-35 Zn

5.2.3-2 (11/74)

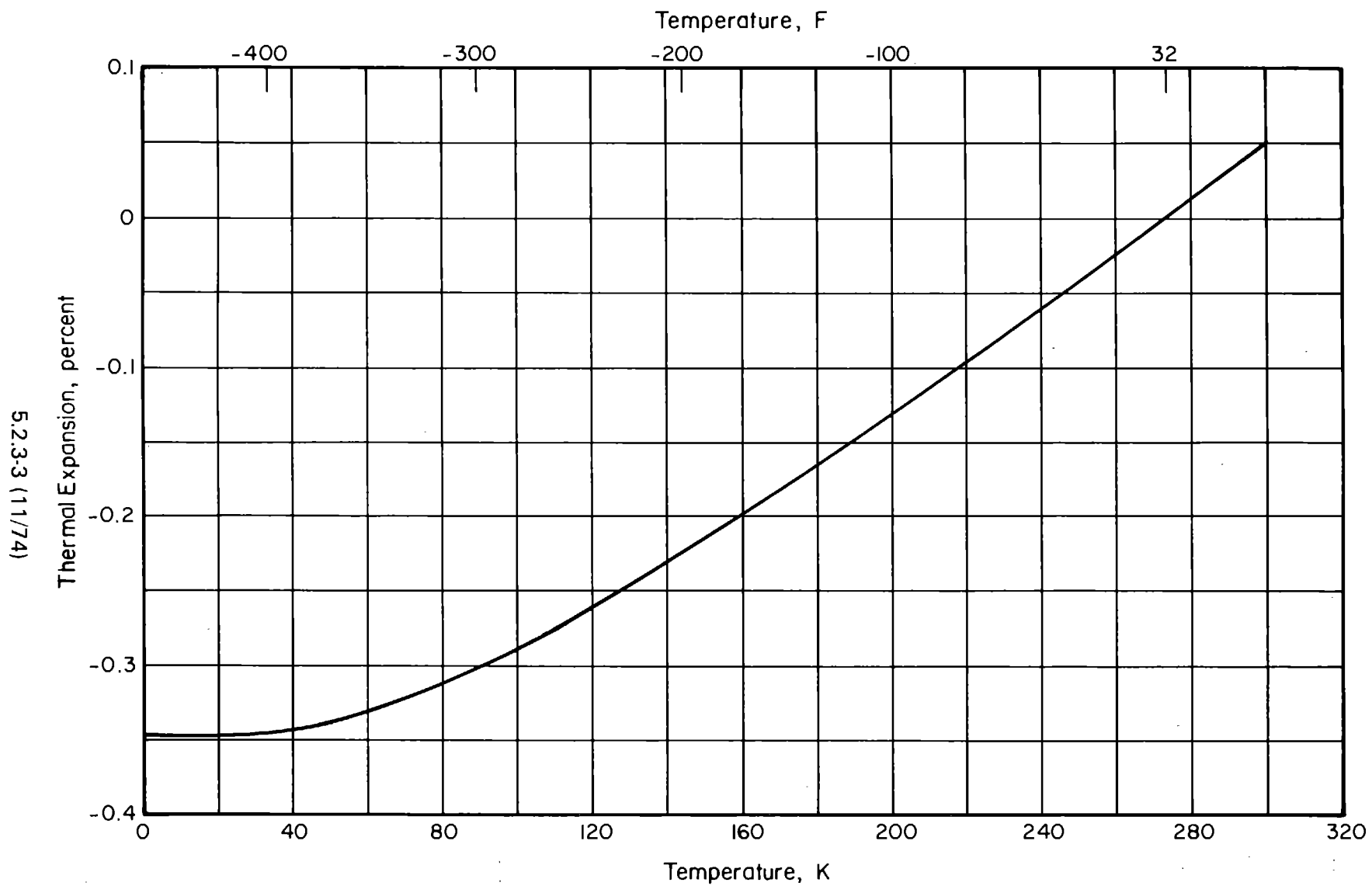


FIGURE 5.2.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE
FOR COPPER ALLOY 65 Cu-35 Zn

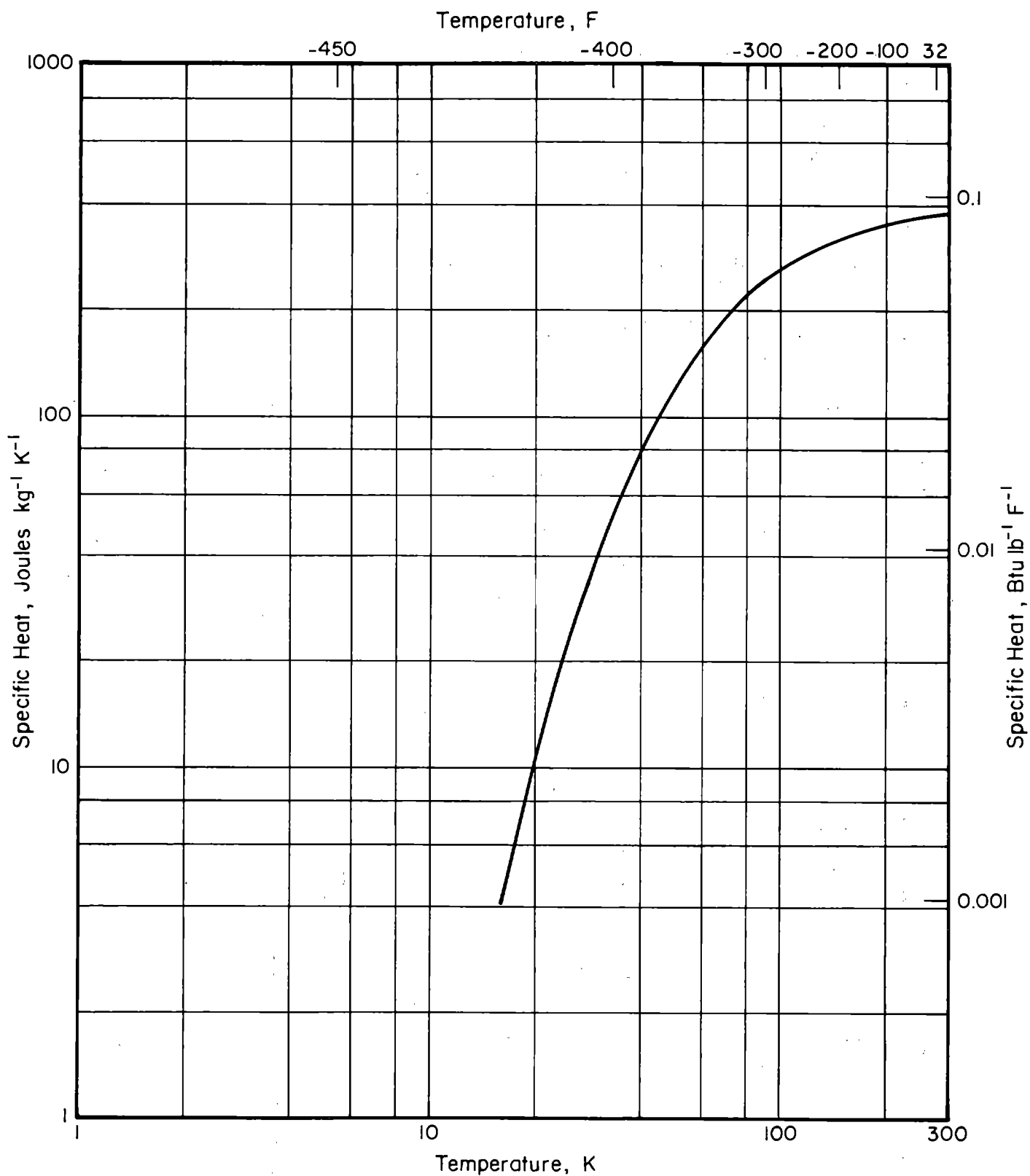


FIGURE 5.2.3-S1. SPECIFIC HEAT VERSUS TEMPERATURE
FOR COPPER ALLOY 65 Cu-35 Zn

5.2.3-4 (11/74)

TABLE 5.2.4-ME1

90Cu-10Zn
Bar

Alloy Designation: 90Cu-10Zn Alloy (Commercial Bronze)

Specification: CDA No. 220

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	265 (38.5)	288 (41.8)		381 (55.2)	505 (73.2)	470 (68.2)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	66.2 (9.6)	70.3 (10.2)		91.0 (13.2)	108 (15.6)	103 (15.0)
	Min						
Std. Deviation							
Elong, percent	Avg	56	57		86	95	91
	Min						
RA, percent	Avg	84	80		78	73	73
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	1
E, GN/m ² (10 ⁶ psi)	Avg	104 (15.1)	113 (16.4)		122 (17.7)	124 (18.0)	125 (18.1)
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	1
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	344 (49.9)	383 (55.6)		477 (69.2)	526 (76.3)	544 (78.9)
K _t = 5.0	Min						
No. of Spec. (No. of Heats)		1	1		1	1	1
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90375

TABLE 5.2.4-ME2

90Cu-10Zn
Bar

Alloy Designation: 90Cu-10Zn Alloy (Commercial Bronze)

Specification: CDA No. 220

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Annealed

Testing Temperature, K (F)	297 (75)	195 (-108)		77 (-320)	20 (-423)	
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg	45.4 (6.59)	48.1 (6.97)		49.9 (7.24)	50.8 (7.37)	
Min						
No. of Spec. (No. of Heats)	1	1		1	1	
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	152 (112)	135 (114)		152 (112)	156 (115)	
Min						
No. of Spec. (No. of Heats)	1	1		1	1	
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 90375

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 5.2.4-TR1

90Cu-10Zn

Alloy Designation: 90Cu-10Zn Alloy

Specification: CDA No. 220

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹			82.0	42.0	19.0	6.10
Btu hr ⁻¹ ft ⁻¹ F ⁻¹			(47.4)	(24.3)	(11.0)	(3.53)
No. of Spec.			2	2	2	2
References: 90224, 90317						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	376	259	105	8.0	0.87	0.096
Btu lb ⁻¹ F ⁻¹	(8.49 x 10 ⁻²)	(6.19 x 10 ⁻²)	(2.51 x 10 ⁻²)	1.91 x 10 ⁻³	(2.08 x 10 ⁻⁴)	(2.29 x 10 ⁻⁵)
No. of Spec.	1	1	1	1	1	1
References: 90223, 90314						
Electrical Resistivity						
Ohm m	3.90 x 10 ⁻⁸	2.45 x 10 ⁻⁸	2.05 x 10 ⁻⁸	1.98 x 10 ⁻⁸	1.98 x 10 ⁻⁸	1.98 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(23.5)	(14.7)	(12.3)	(11.9)	(11.9)	(11.9)
No. of Spec.	3	3	3	3	3	2
References: 79561, 90317, 90348						

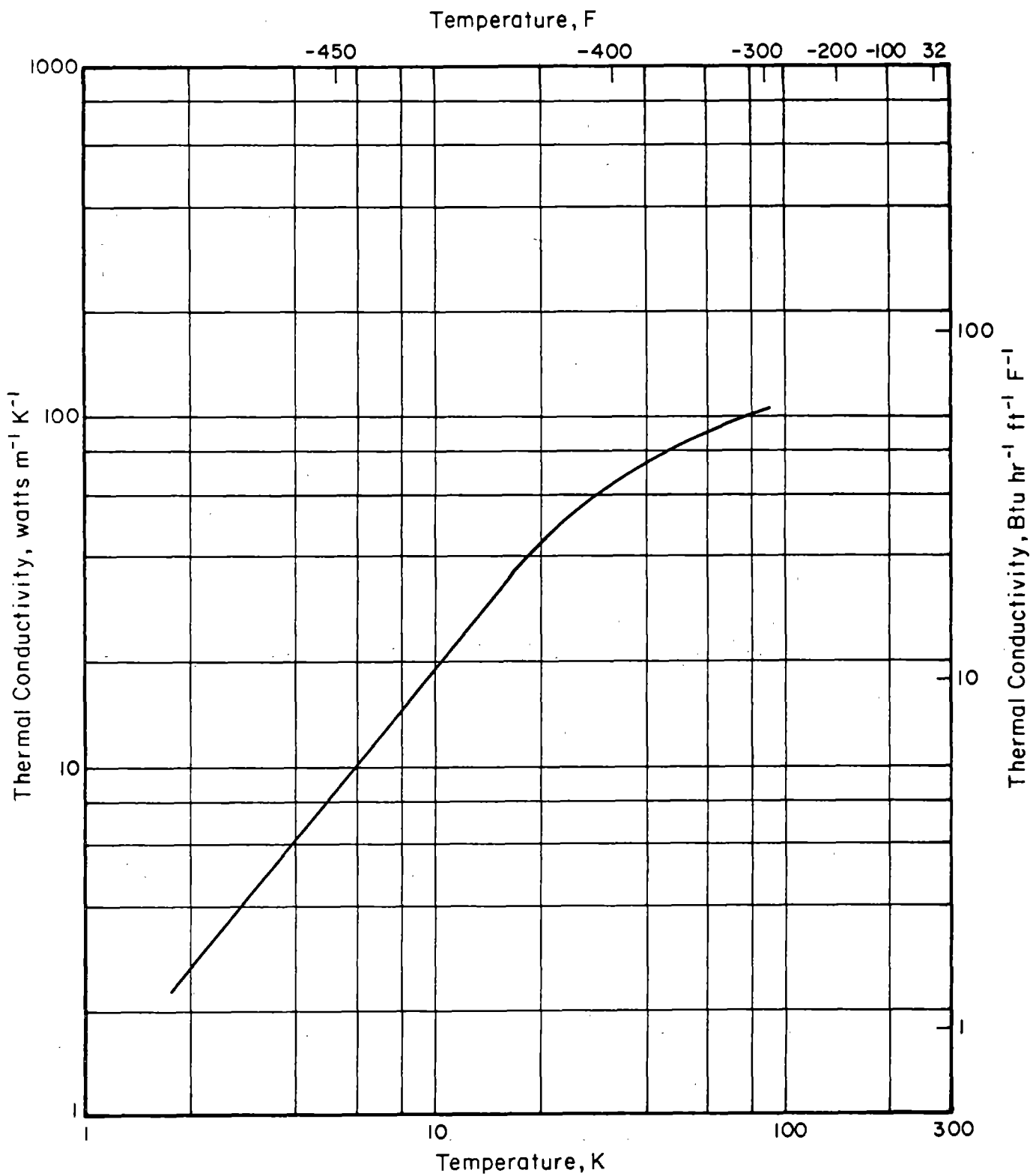


FIGURE 5.2.4-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Zn

90Cu-10Zn

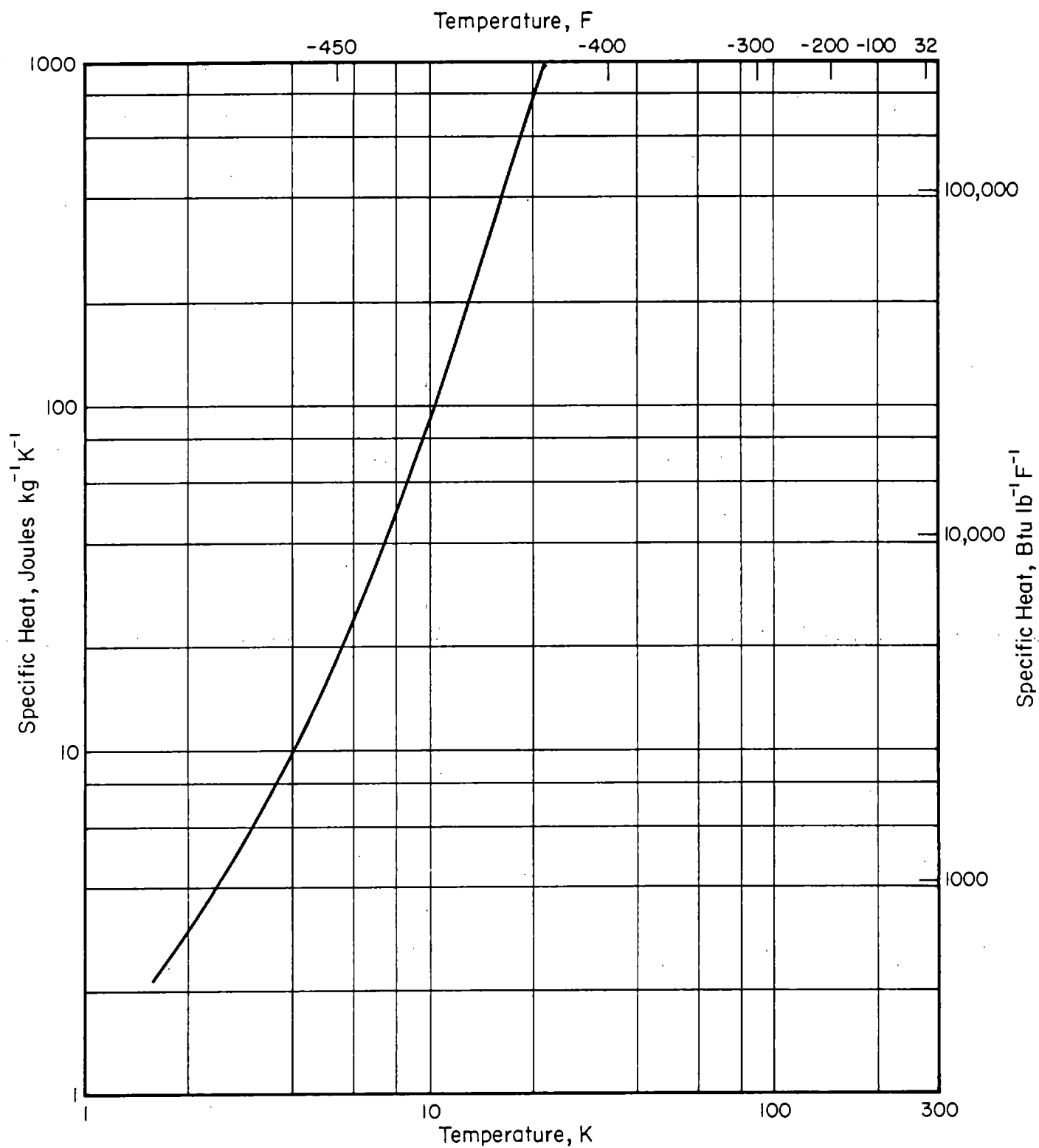


FIGURE 5.2.4-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Zn

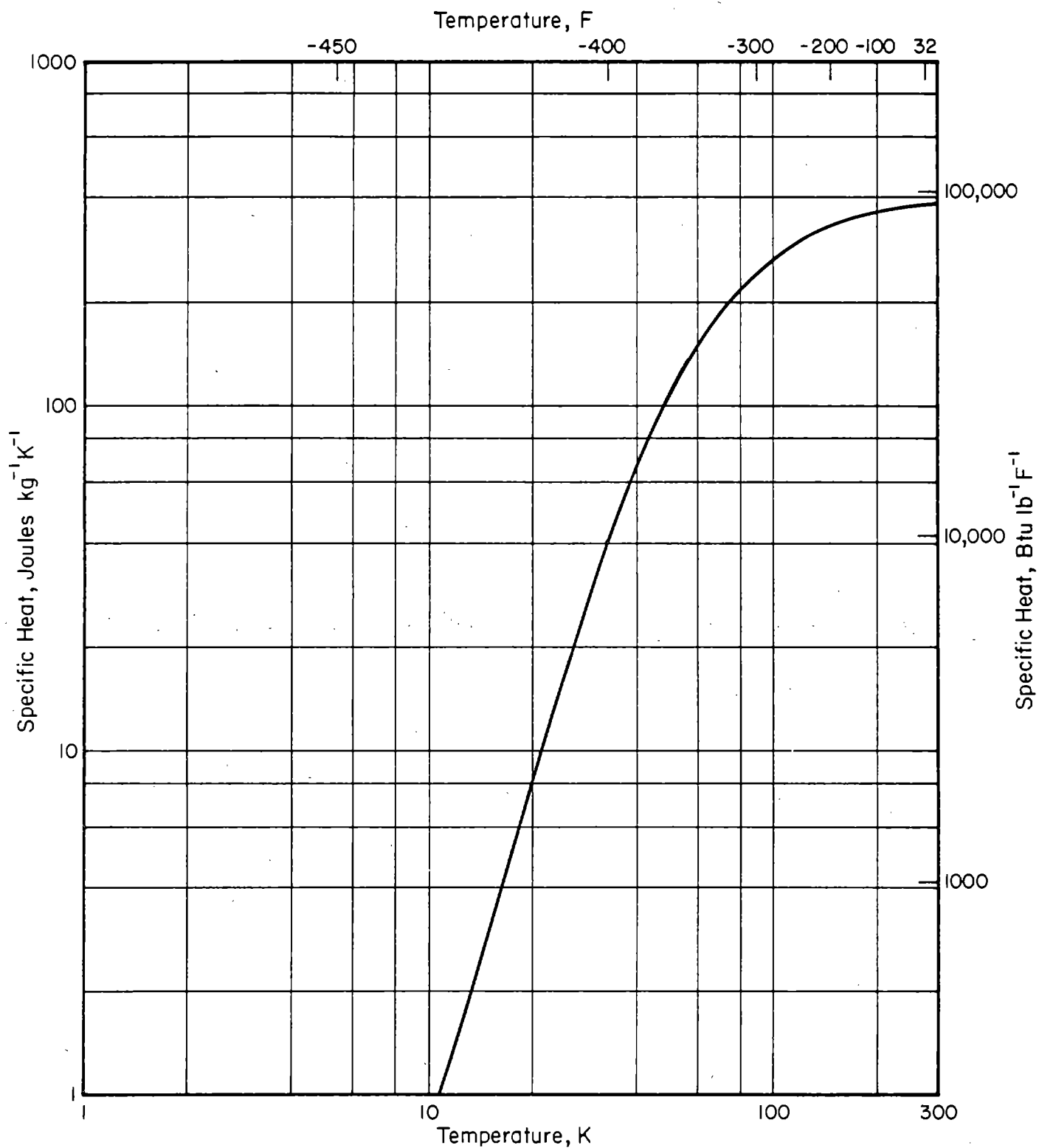


FIGURE 5.2.4-S2. SPECIFIC HEAT VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Zn

90Cu-10Zn

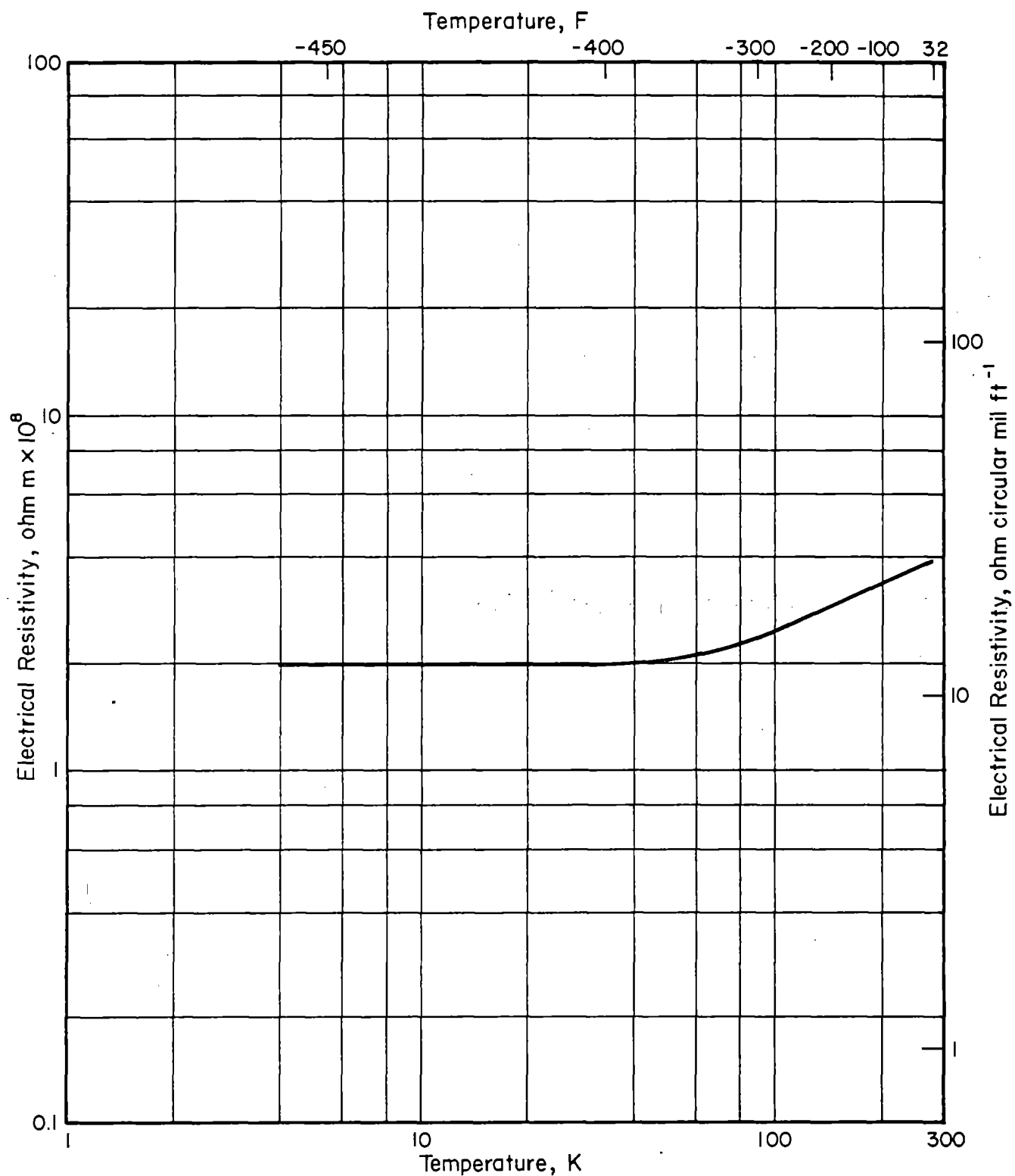


FIGURE 5.2.4-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Zn

TABLE 5.3.0-MA1

Alloy Designation: Cu-Ni Alloys

Specification:

Form: Strip

Dimension, cm (in.): 0.03-0.04 (0.0118-0.01575)

Condition: After homogenization for 6 hr at 1223 K (1740 F) in vacuum, the casts were rolled to strip, which was etched in nitric acid with a final anneal in vacuum at 1073 K (1470 F).

Note: compositions indicated in the figure are: 0.85, 4.30, 8.65, 17.62, 26.82, 36.25, 41.07, 46.03, and 56.16 weight percent Ni (99.99 percent).

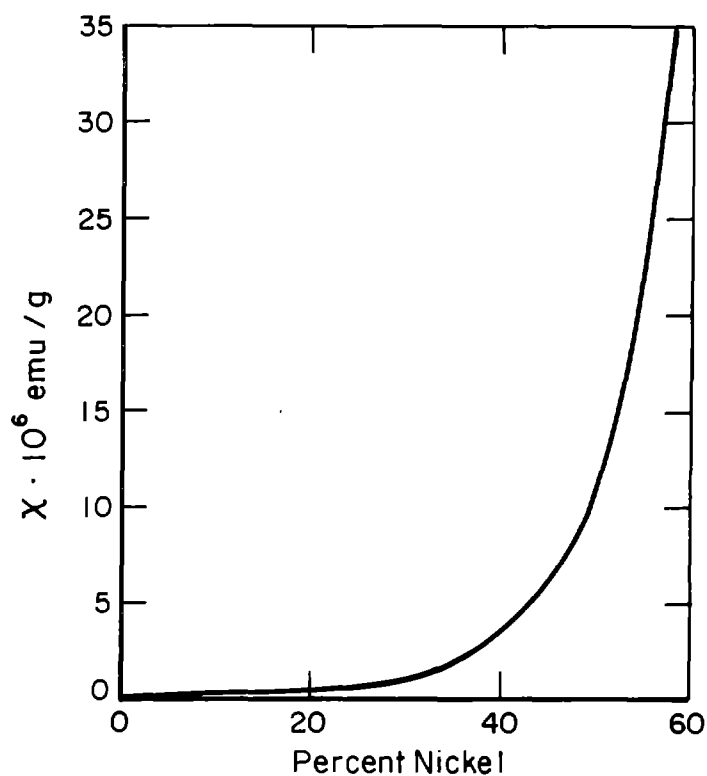


FIGURE 5.3.0-1. CONCENTRATION DEPENDENCE OF THE MAGNETIC SUSCEPTIBILITY AT 0 C (273 K)

Reference: 94195

TABLE 5.3.1-ME0.1

90Cu-10Ni
Plate

Alloy Designation: 90Cu-10Ni Alloy

Specification: CDA No. 706

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed (assumed)

Testing Temperature, K (F)		297 (75)	220 (-60)	173 (-150)	123 (-240)	77 (-320)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	312 (45.3)	331 (48.0)	355 (51.5)	359 (52.1)	437 (63.4)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	278 (40.3)	285 (41.4)	294 (42.7)	299 (43.3)	321 (46.6)	
	Min						
Std. Deviation							
Elong, percent	Avg	37	38	42	42	46	
	Min						
RA, percent	Avg	68.5	65	67.5	64	50.5	
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 96688

TABLE 5.3.1-ME1

Alloy Designation: 90Cu-10Ni Alloy

Specification: CDA No. 706

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed 950 K (1250 F) 40 min, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	342 (49.6)	377 (54.7)	496 (72.0)	569 (82.5)	556 (80.6)	
	Min	341 (49.4)	361 (52.3)	495 (71.9)	565 (82.0)	554 (80.3)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	147 (21.4)	170 (24.7)	171 (24.8)	208 (30.2)	172 (24.9)	
	Min	146 (21.2)	170 (24.7)	170 (24.7)	192 (27.9)	170 (24.7)	
Std. Deviation							
Elong, percent	Avg	37.6	42.0	49.6	50.0	52.7	
	Min	37.0	40.3	49.3	49.6	52.4	
RA, percent	Avg	79.2	76.8	77.4	73.2	72.8	
	Min	78.8	75.8	77.2	72.5	72.6	
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	122 (17.7)		134 (19.5)		141 (20.5)	
	Min						
No. of Spec. (No. of Heats)		(1)		(1)		(1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	448 (65.0)	504 (73.1)	601 (87.2)	669 (97.1)	690 (100)	
	Min	436 (63.3)	503 (72.9)	600 (87.0)	667 (96.8)	680 (98.7)	
K _t = 5.0							
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)	2 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90375

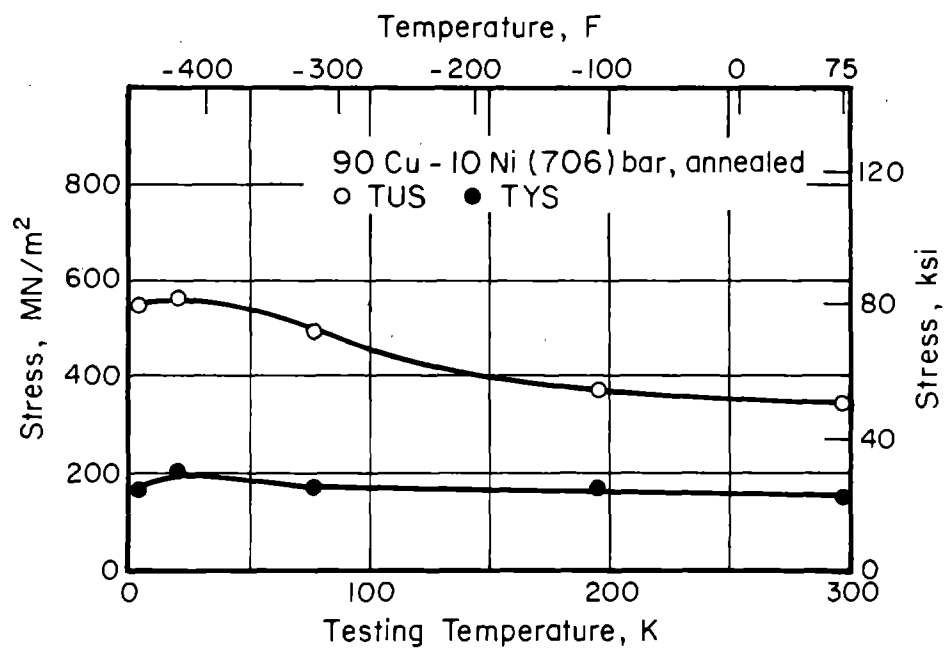


FIGURE 5.3.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 90Cu-10Ni ALLOY

TABLE 5.3.1-TR1

Alloy Designation: 90Cu-10Ni Alloy

Specification: CDA No. 706

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹			32.5	16.7	5.80	1.30
Btu hr ⁻¹ ft ⁻¹ F ⁻¹			(18.8)	(9.66)	(3.35)	(0.752)
No. of Spec.			2	2	2	2
References: 90318, 96875						
Thermal Expansion (T₂₇₃ to T)						
<u>Longitudinal</u>						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						0.112
Btu lb ⁻¹ F ⁻¹						(0.0000268)
No. of Spec.						1
References: 90223						
Electrical Resistivity						
Ohm m	16.4 x 10 ⁻⁸	15.1 x 10 ⁻⁸	14.6 x 10 ⁻⁸	14.1 x 10 ⁻⁸	14.0 x 10 ⁻⁸	14.0 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(98.6)	(90.8)	(87.8)	(84.8)	(84.2)	(84.2)
No. of Spec.	3	3	3	3	1	1
References: 79561, 90224, 90318						

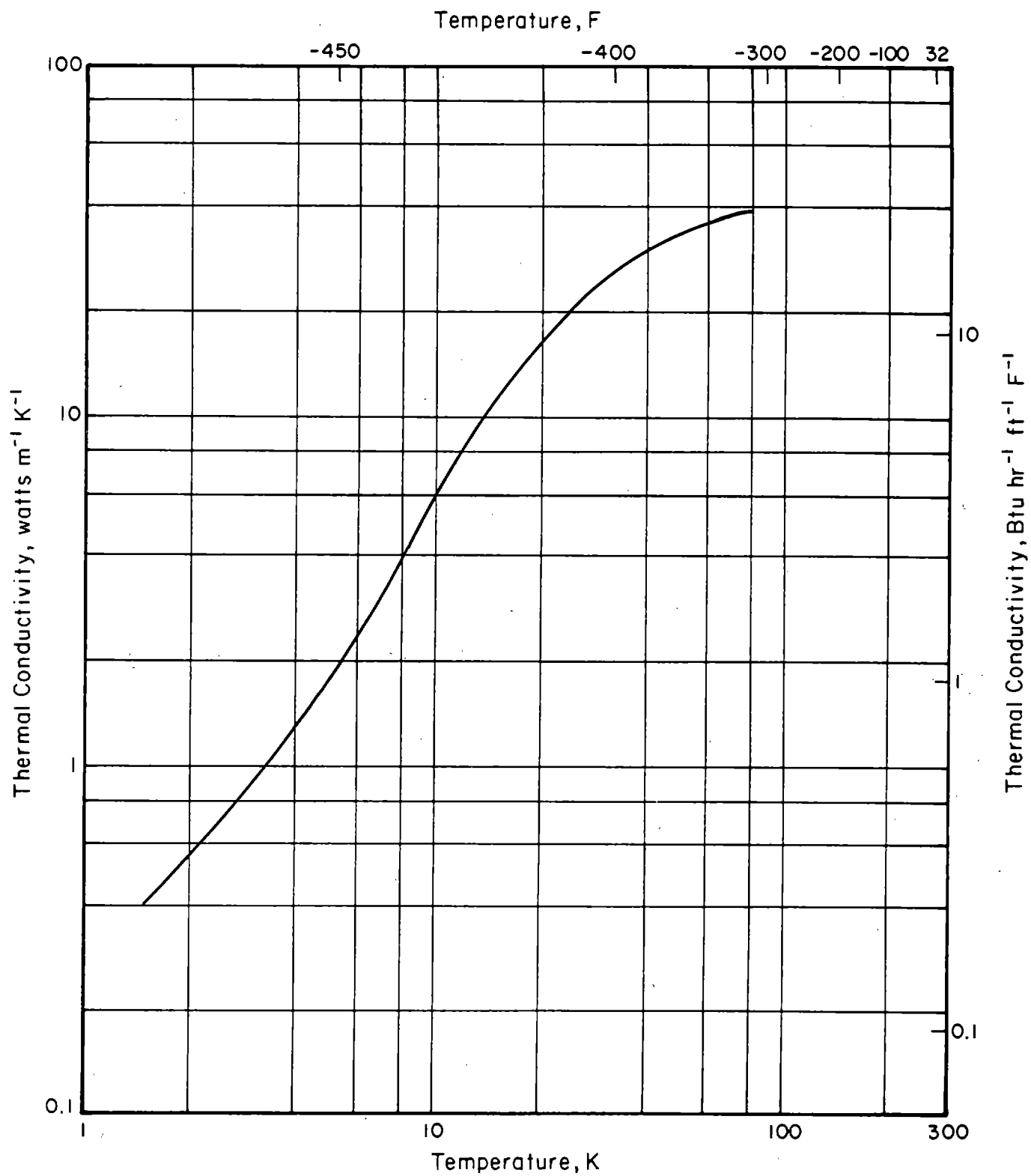


FIGURE 5.3.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Ni

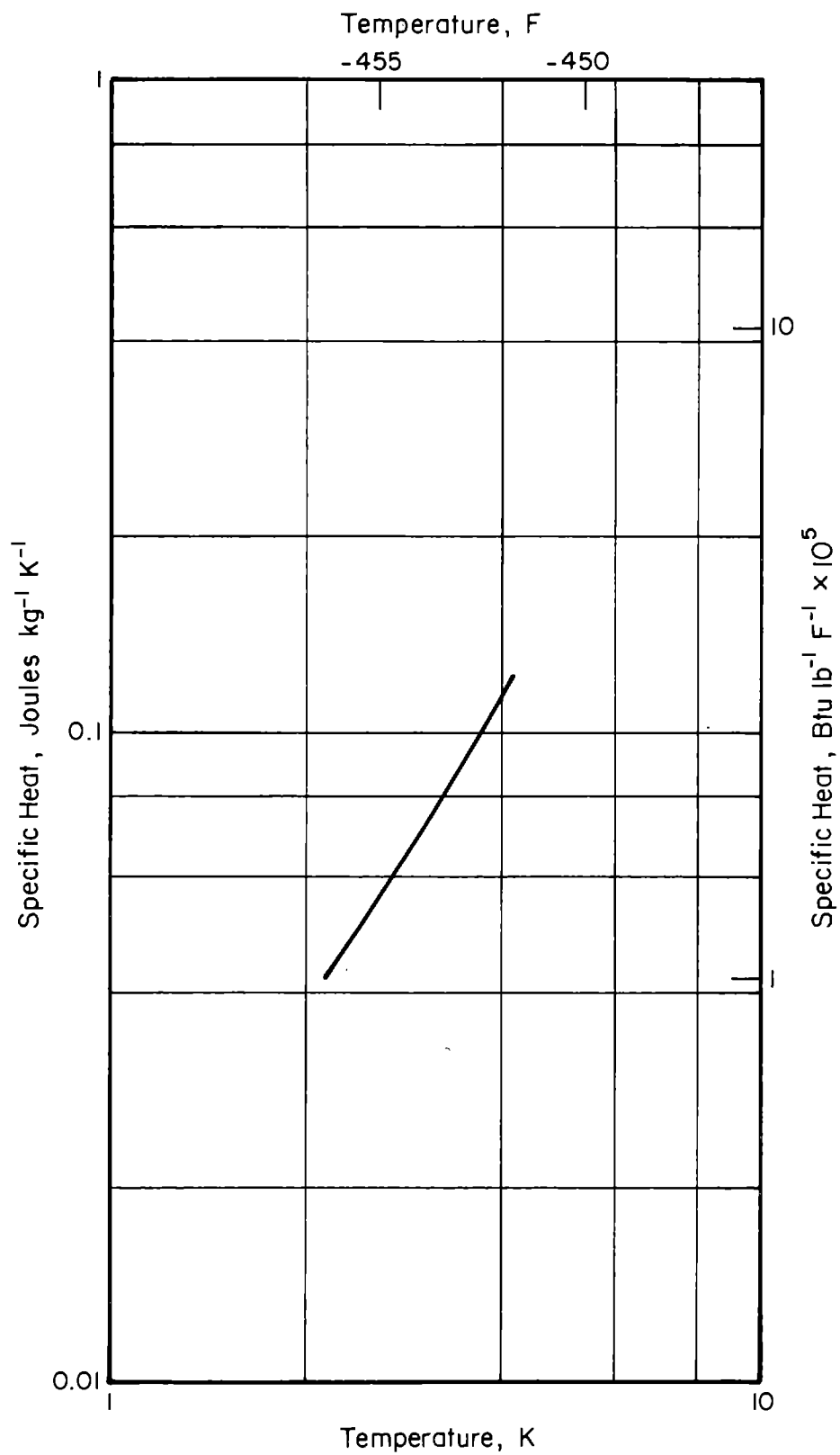


FIGURE 5.3.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE
FOR COPPER ALLOY 90 Cu-10 Ni

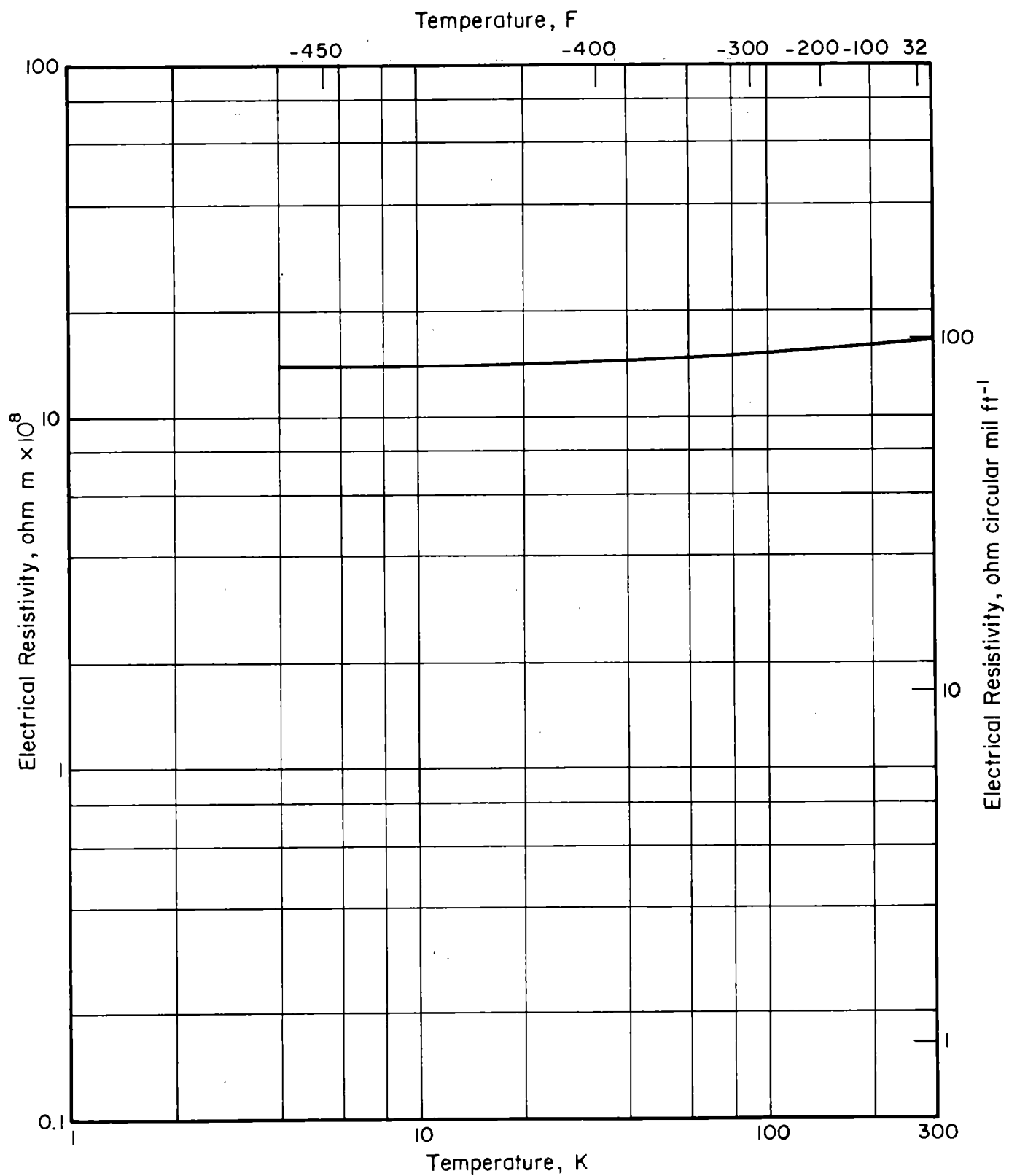


FIGURE 5.3.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 90 Cu-10 Ni
5.3.1-6 (11/74)

TABLE 5.3.1-MA1

Alloy Designation: 90Cu-10Ni (9.89 percent Ni)

Specification: Prepared from 99.999% pure Cu, 99.997% pure Ni

Form: Cylindrical rods

Diameter, cm (in.):

Condition: Heavily etched and homogenized at about 70 K below the solidus for 100 hours

Temperature, K (F)	Mass Susceptibility, χ (cgsem)	Volume Suscepti- bility, k (mksa)	Permeability, μ (mksa)
4.2 (-452)	0.197×10^{-6}	22.14×10^{-6}	12.5703×10^{-7}
20.4 (-423)	0.144×10^{-6}	16.18×10^{-6}	12.5702×10^{-7}
77.0 (-320)	0.140×10^{-6}	15.73×10^{-6}	12.5702×10^{-7}
295.0 (71.6)	0.150×10^{-6}	16.86×10^{-6}	12.5702×10^{-7}

Reference: 90491

TABLE 5.3.2-ME1

80Cu-20Ni
Plate

Alloy Designation: 80Cu-20Ni Alloy

Specification: CDA No. 710

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed (assumed)

Testing Temperature, K (F)		297 (75)	220 (-60)	173 (-150)	123 (-240)	77 (-320)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	299 (43.3)	332 (48.2)	363 (52.6)	387 (56.1)	469 (68.0)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	56	57	57	55	56	
	Min						
RA, percent	Avg	70.0	68.5	66.0	63.0	57.0	
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 96688

TABLE 5.3.2-ME2

80Cu-20Ni
Plate-Weld Metal

Alloy Designation: 80Cu-20Ni Alloy (Weld Metal)

Specification: CDA No. 710
 Form: Plate-MIG welded, 80Cu-20Ni Alloy filler
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: Plate tested as welded

Testing Temperature, K (F)	297 (75)	173 (-150)	123 (-240)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg	92 (68)	92.9 (68.5)			
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 96683

- (a) Indicate specimen design and orientation for shear specimens:
 (b) Indicate specimen design for K_{IC} data:

TABLE 5.3.2-TR1

80Cu-20Ni

Alloy Designation: 80Cu-20Ni Alloy

Specification: CDA No. 710

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec. References: 90170, 96875				10.20 (590) 2	4.10 (2.37) 2	0.950 (0.549) 2
Thermal Expansion (T₂₇₃ to T) <u>Longitudinal</u> Percent No. of Spec. References:						
Specific Heat Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec. References:						
Electrical Resistivity Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

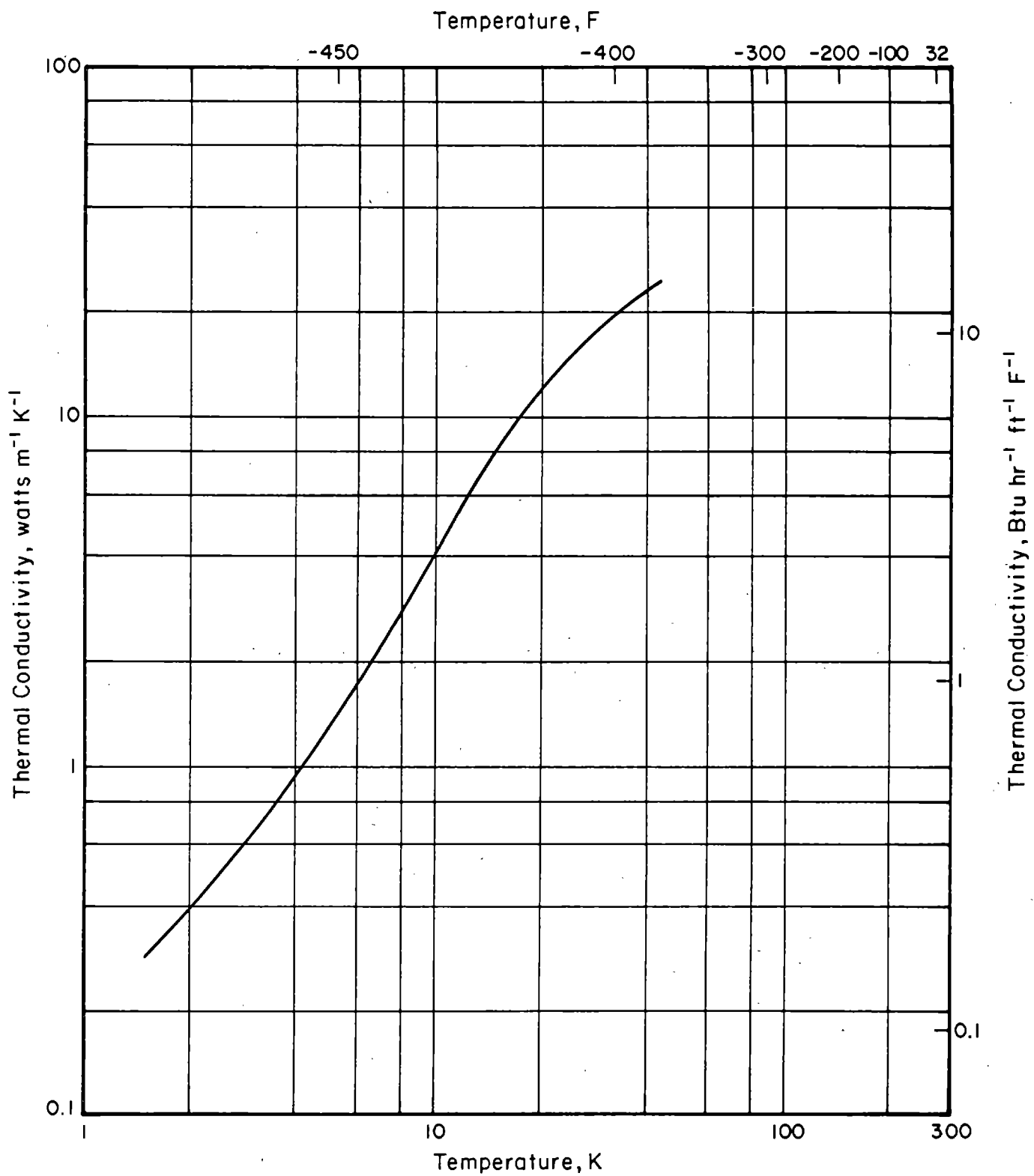


FIGURE 5.3.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 80Cu-20Ni

TABLE 5.3.3-ME0.1

70Cu-30Ni
Plate

Alloy Designation: 70Cu-30Ni Alloy

Specification: CDA No. 715

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed (assumed)

Testing Temperature, K (F)		297 (75)	220 (-60)	173 (-150)	123 (-240)	77 (-320)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	288 (41.8)	321 (46.6)	348 (50.4)	382 (55.4)	435 (63.1)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	57	59	60	63	70	
	Min						
RA, percent	Avg	80.0	79.5	77.5	76.5	76.0	
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 96688

TABLE 5.3.3-ME0.2

70Cu-30Ni
Plate-Weld Metal

Alloy Designation: 70Cu-30Ni Alloy (Weld Metal)

Specification: CDA No. 715
 Form: Plate-MIG welded, 70Cu-30Ni Alloy filler
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: Plate tested as welded

Testing Temperature, K (F)	297 (75)	173 (-150)	123 (-240)			
<u>Compression, Longitudinal</u>						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN /m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Compression, Transverse</u>						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Shear(a)</u>						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Impact, Charpy V</u>						
Long., Nm(ft-lb)	Avg	104 (77)	110 (81)			
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Fracture Toughness(b)</u>						
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{Ic} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 96683

- (a) Indicate specimen design and orientation for shear specimens:
 (b) Indicate specimen design for K_{IC} data:

TABLE 5.3.3-ME1

Alloy Designation: 70 Cu-30 Ni

C71500

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Annealed

Hardness R_B 47, Avg Grain diam. 0.036 mm

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-423)	20 (-320)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	399 (57.8)	469 (68.0)	619 (89.8)	711 (103.1)	721 (104.6)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	129 (18.7)	153 (22.2)	218 (31.6)	263 (38.1)	276 (40.1)	
	Min						
Std. Deviation							
Elong, percent	Avg	46.6	48.4	52.0	51.2	48.5	
	Min						
RA, percent	Avg	68.2	70.1	69.7	65.6	65.0	
	Min						
No. of Spec. (No. of Heats)		2	2	2	2	2	
E, GN/m ² (10 ⁶ psi)	Avg	144 (20.9)	152 (22.1)	130 (18.8)	150 (21.7)	134 (19.5)	
	Min						
No. of Spec. (No. of Heats)		3	1	2	2	2	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	547 (79.4)	624 (90.5)	778 (112.9)	880 (127.6)	900 (130.5)	
$K_t = 5.0$	Min						
No. of Spec. (No. of Heats)		2	2	2	2	2	
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							

References: 90375

TABLE 5.3.3-ME2

Alloy Designation: 70 Cu-30 Ni

C71500

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Annealed

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-422)	4 (-452)	
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
Min						
No. of Spec. (No. of Heats)						
Dynamic Modol:						
E, GN/m ² (10 ⁶ psi)	Avg					
Min						
G, GN/m ² (10 ⁶ psi)	Avg					
Min						
B, GN/m ² (10 ⁶ psi)	Avg					
Min						
Poisson's Ratio	Avg					
Min						
No. of Specimens						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg	156 (115.0)	154 (113.0)	155 (114.1)	154 (113.7)	
Min		153 (113.0)	149 (110.0)	154 (113.5)	151 (111.5)	
No. of Spec. (No. of Heats)		4	4	3	3	
Trans., Nm(ft-lb)	Avg					
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 90375

- (a) Indicate specimen design and orientation for shear specimens:
 (b) Indicate specimen design for K_{IC} data:

TABLE 5.3.3-TR1

70Cu-30Ni

Alloy Designation: 70Cu-30Ni

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹				9.32	4.22	1.1
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(5.39)	(2.44)	(0.64)
No. of Spec.				1	1	1
References: 96888						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.222	-0.248	-0.252	-0.252	-0.252
No. of Spec.	1	1	1	1	1	1
References: 90336						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	38.4 x 10 ⁻⁸	36.9 x 10 ⁻⁸	36.6 x 10 ⁻⁸	36.5 x 10 ⁻⁸	36.4 x 10 ⁻⁸	36.4 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(231)	(222)	(220)	(220)	(219)	(219)
No. of Spec.	1	1	1	1	1	1
References: 79561						
Magnetothermal Conductivity⁽¹⁾						

(1) The application of magnetic fields up to 8 tesla produced no detectable effect on the thermal conductivity.

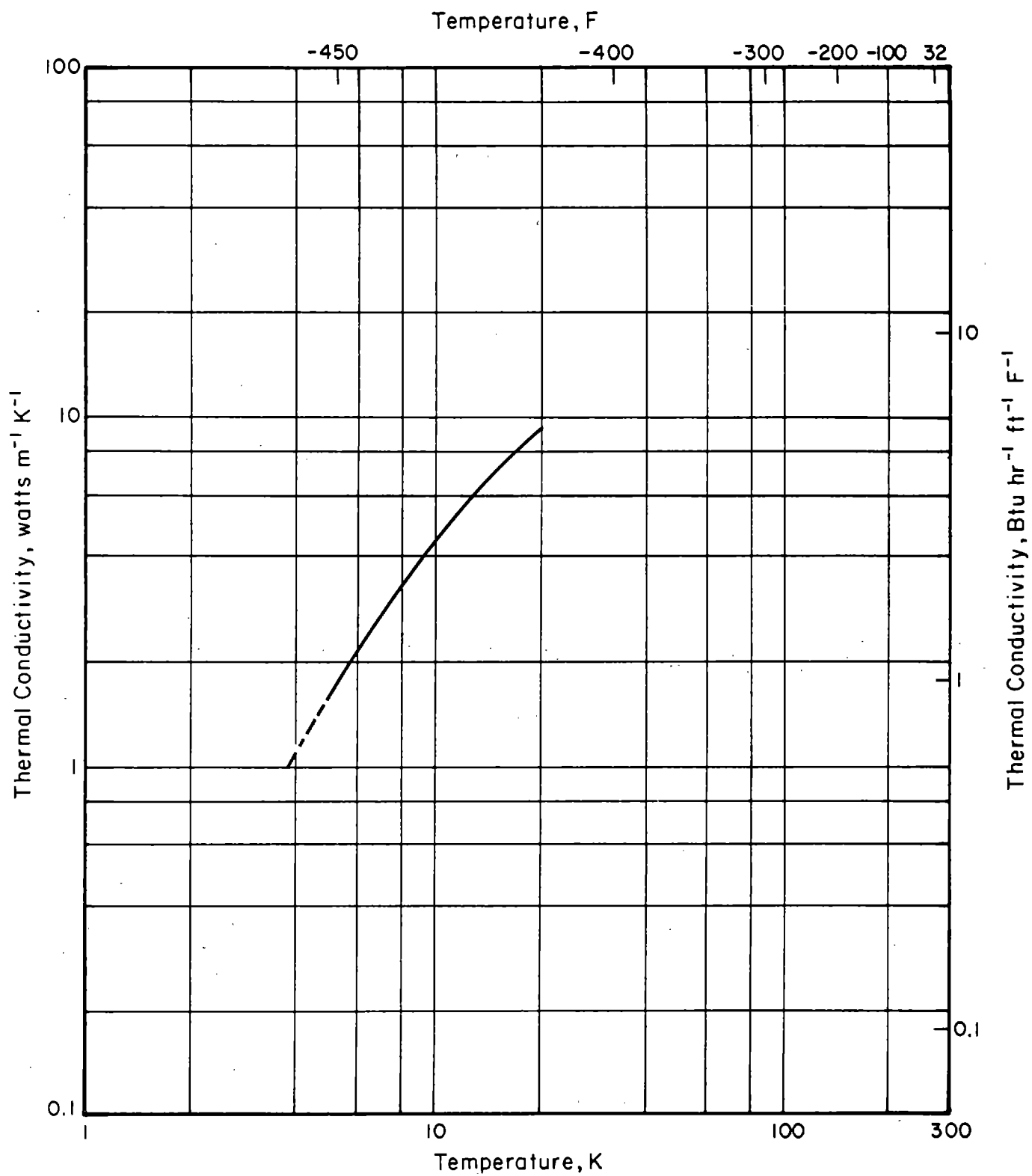


FIGURE 5.3.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 70Cu-30Ni

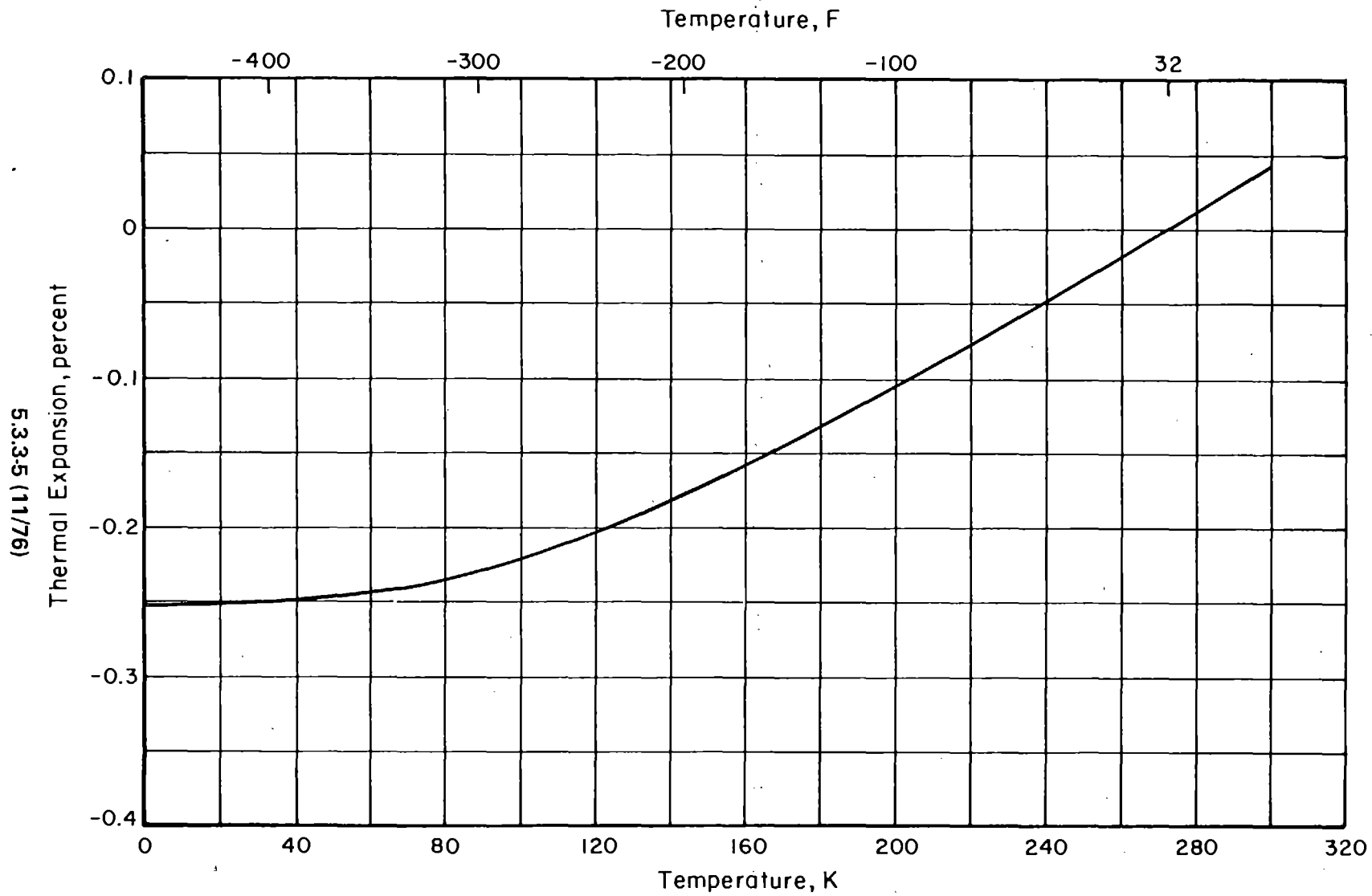


FIGURE 5.3.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR COPPER ALLOY 70Cu-30Ni

70Cu-30Ni

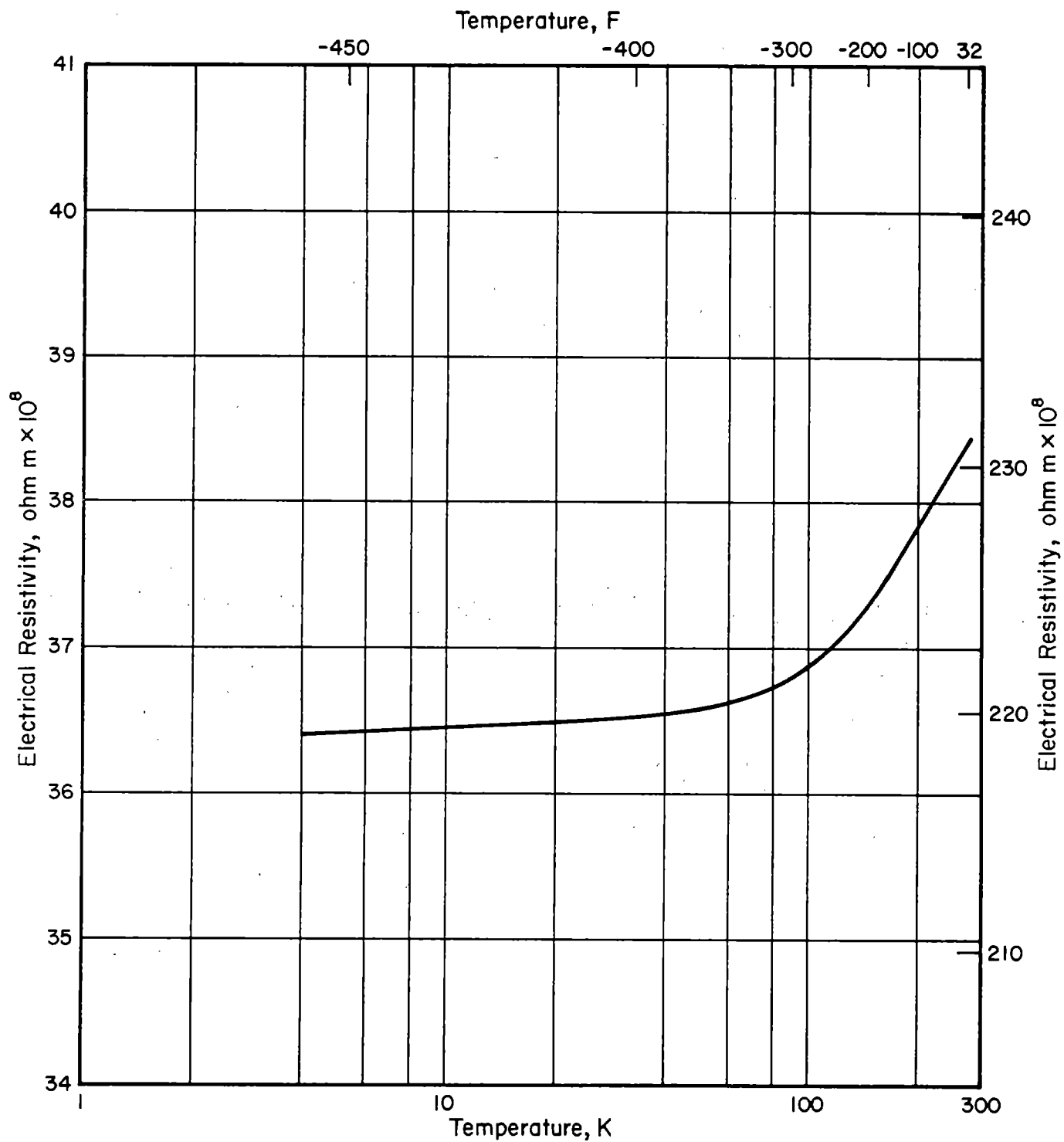


FIGURE 5.3.3-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 70Cu-30Ni

TABLE 5.4.2-ME0.1

Cu-Be
Sheet

Alloy Designation: Cu-Be (1.8-2.0) Alloy

Specification: CDA No. 172

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: AT (600 F, 3 hr, AC)

Testing Temperature, K (°F)	297 (75)	195 (-108)	77 (-320)	20 (-423)
Fatigue, Axial Loading				
S_N at 10^5 cycles, MN/m ² (ksi)				
Loading frequency Hz				
with $R =$ and $K_t =$				
No. of S-N Curves (No. of Heats)				
Ratio S_N/TUS at 10^5 cycles				
S_N at 10^6 cycles, MN/m ² (ksi)				
Loading frequency Hz				
with $R =$ and $K_t =$				
No. of S-N Curves (No. of Heats)				
Ratio S_N/TUS at 10^6 cycles				
S_N at 10^7 cycles, MN/m ² (ksi)				
Loading frequency Hz				
with $R =$ and $K_t =$				
No. of S-N Curves (No. of Heats)				
Ratio S_N/TUS at 10^7 cycles				
Fatigue, Flexural Loading				
S_N at 10^5 cycles, MN/m ² (ksi)	648 (94)	689 (100)	779 (113)	1076 (156)
Loading frequency 30 Hz (a)				
with $R = -1$ and $K_t =$				
No. of S-N Curves (No. of Heats)				
Ratio S_N/TUS at 10^5 cycles				
S_N at 10^6 cycles, MN/m ² (ksi)	414 (60)	469 (68)	517 (75)	724 (105)
Loading frequency 30 Hz (a)				
with $R = -1$ and $K_t =$				
No. of S-N Curves (No. of Heats)				
Ratio S_N/TUS at 10^6 cycles				
S_N at 10^7 cycles, MN/m ² (ksi)				
Loading frequency Hz				
with $R =$ and $K_t =$				
No. of S-N Curves (No. of Heats)				
Ratio S_N/TUS at 10^7 cycles				

References: 45001

(a) Frequency = 58Hz for tests at 20 K

TABLE 5.4.2-ME1

Alloy Designation: Cu-Be Alloy

Specification: CDA No. 172

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Solution treated and aged 590 K (600 F) 3 hr, AC (AT)

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1103	(160)		1510	(219)	
	Min	1080	(157)		1506	(218)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	917	(133)		1317	(191)	
	Min	904	(131)		1305	(189)	
Std. Deviation							
Elong, percent	Avg	4.5			9.8		
	Min	4.5			8.6		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 33262

TABLE 5.4.2-ME2

Alloy Designation: Cu-Be Alloy

Specification: CDA No. 172

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Half hard (1/2 H)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	620 (90)	655 (95)	807 (117)	945 (137)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	552 (80)	600 (87)	690 (100)	752 (109)		
	Min						
Std. Deviation							
Elong, percent	Avg	15	20	37	45		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	121 (17.5)	121 (17.6)	130 (18.8)	134 (19.5)		
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90302

TABLE 5.4.2-ME3

Alloy Designation: Cu-Be Alloy

Specification: CDA No. 172

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 1/2 Hard, aged 590 K (600 F) 2 hr, AC (1/2 HT)

Testing Temperature, K (F)	297 (75)			20 (-423)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 1320 (191)			1640 (238)		
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 1140 (166)			1230 (178)		
	Min					
Std. Deviation						
Elong, percent	Avg 2.8			3.5		
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	(1)			(1)		
E, GN/m ² (10 ⁶ psi)	Avg 131 (19)			145 (21)		
	Min (1)			(1)		
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 49048

TABLE 5.4.2-ME4

Alloy Designation: Cu-Be Alloy

Specification: CDA No. 172

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Half hard, aged 590 K (600 F) 2 hr, AC (1/2 HT)

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	538 (78)	600 (87)	731 (106)	827 (120)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
Ratio S_N /TUS at 10^5 cycles	0.41					
S_N at 10^5 cycles, MN/m ² (ksi)	296 (43)	345 (50)	462 (67)	545 (79)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
S_N at 10^5 cycles, MN/m ² (ksi)	290 (42)	338 (49)	393 (57)	(496) (72)		
Loading frequency Hz						
with $R = -1$ and $K_t = 6.4$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
Fatigue, Flexural Loading						
S_N at 10^6 cycles, MN/m ² (ksi)	386 (56)	462 (67)	558 (81)	579 (84)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
Ratio S_N /TUS at 10^5 cycles	0.29					
S_N at 10^6 cycles, MN/m ² (ksi)	214 (31)	241 (35)	324 (47)	310 (45)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
S_N at 10^6 cycles, MN/m ² (ksi)	193 (28)	241 (35)	228 (33)	248 (36)		
Loading frequency Hz						
with $R = -1$ and $K_t = 6.4$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		

References: 49048

TABLE 5.4.2-ME5

Alloy Designation: Cu-Be Alloy

Specification: CDA 172

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Solution treated and aged 590 K (600 F) 3 hr (AT)

Testing Temperature, K (F)		297 (75)	213 (-75)	195 (-108)	144 (-200)	89 (-300)	77 (-320)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1260 (182)	1300 (189)	1250 (181)	1340 (195)	1460 (212)	1410 (204)
	Min	1230 (178)		1230 (179)			1380 (200)
Std Deviation							
TYS, MN/m ² (ksi)	Avg	1020 (148)	1110 (161)	1090 (158)	1120 (163)	1180 (172)	1280 (185)
	Min	1010 (146)		1080 (156)			1240 (180)
Std. Deviation							
Elong, percent	Avg	8.3	6	9.0	9	9	14.0
	Min	6		9.0			12.0
RA, percent	Avg	10.3	10	14.8	12	13	22.2
	Min	7		14.5			20
No. of Spec. (No. of Heats)		4 (2)	2 (1)	2 (1)	2 (1)	2 (1)	2 (1)
E, GN/m ² (10 ⁶ psi)	Avg	121 (17.5)	124 (18.0)		128 (18.6)	131 (19.0)	
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
No. of Spec. (No. of Heats)							

References: 35611, 90355

TABLE 5.4.2-ME6

Alloy Designation: Cu-Be Alloy

Specification: CDA No. 172

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Solution treated and aged at 672 K (750 F) 1.5 hr (overaged)
(Grain size 0.025 mm)

Testing Temperature, K (F)		297 (75)	213 (-75)	144 (-200)	89 (-300)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1140 (165)	1130 (164)	1200 (174)	1240 (180)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	862 (125)	903 (131)	1010 (146)	1070 (155)		
	Min						
Std. Deviation							
Elong, percent	Avg	9	12	14	15		
	Min						
RA, percent	Avg	11	20	26	28		
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg	125 (18.2)	128 (18.5)	132 (19.2)	138 (20.0)		
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)			
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90355

TABLE 5.4.2-ME7

Alloy Designation: Cu-Be Alloy

Specification: CDA No. 172

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Cold drawn 33 percent (1/2 H)

Testing Temperature, K (F)		297 (75)	213 (-75)	144 (-200)	89 (-300)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	710 (103)	745 (108)	814 (118)	800 (116)		
	Min						
Std. Deviation							
TSY, MN/m ² (ksi)	Avg	681 (98.8)	681 (98.8)	717 (104)	772 (112)		
	Min						
Std. Deviation							
Elong, percent	Avg	16		21	21		
	Min						
RA, percent	Avg	57		48	50		
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg	113 (16.4)	115 (16.7)	114 (16.6)	117 (17.0)		
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90355

TABLE 5.4.2-ME8

Alloy Designation: Cu-Be Alloy

Specification: CDA No. 172

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Hard drawn

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	702 (102)	747 (108)	909 (132)	1060 (154)		
	Min	702 (102)	742 (108)	903 (131)	1060 (154)		
Std Deviation							
TYS, MN/m ² (ksi)	Avg	667 (96.7)	690 (100)	819 (119)	820 (119)		
	Min	663 (96.1)	684 (99.2)	808 (117)	813 (118)		
Std Deviation							
Elong, percent	Avg	19.2	22.9	31.0	31.4		
	Min	18.8	22.1	30.5	31.4		
RA, percent	Avg	68.0	69.8	66.0	60.0		
	Min	68.0	69.6	65.8	60.0		
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 54986

TABLE 5.4.2-ME9

Alloy Designation: Cu-Be Alloy

Specification: CDA No. 172

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Cold drawn 33 percent and aged at 590 K (600 F) 2 hr (1/2 HT)

Testing Temperature, K (F)		297 (75)	213 (-75)	144 (-200)	89 (-300)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1340 (194)	1340 (195)	1410 (204)	1490 (216)		
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	1160 (169)	1230 (178)	1340 (194)	1360 (197)		
	Min						
Std. Deviation							
Elong, percent	Avg	4.0	4.5	4.5	5.0		
	Min						
RA, percent	Avg	12	12.5	14	10		
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg	125 (18.2)	128 (18.5)	128 (18.5)	130 (18.9)		
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90355

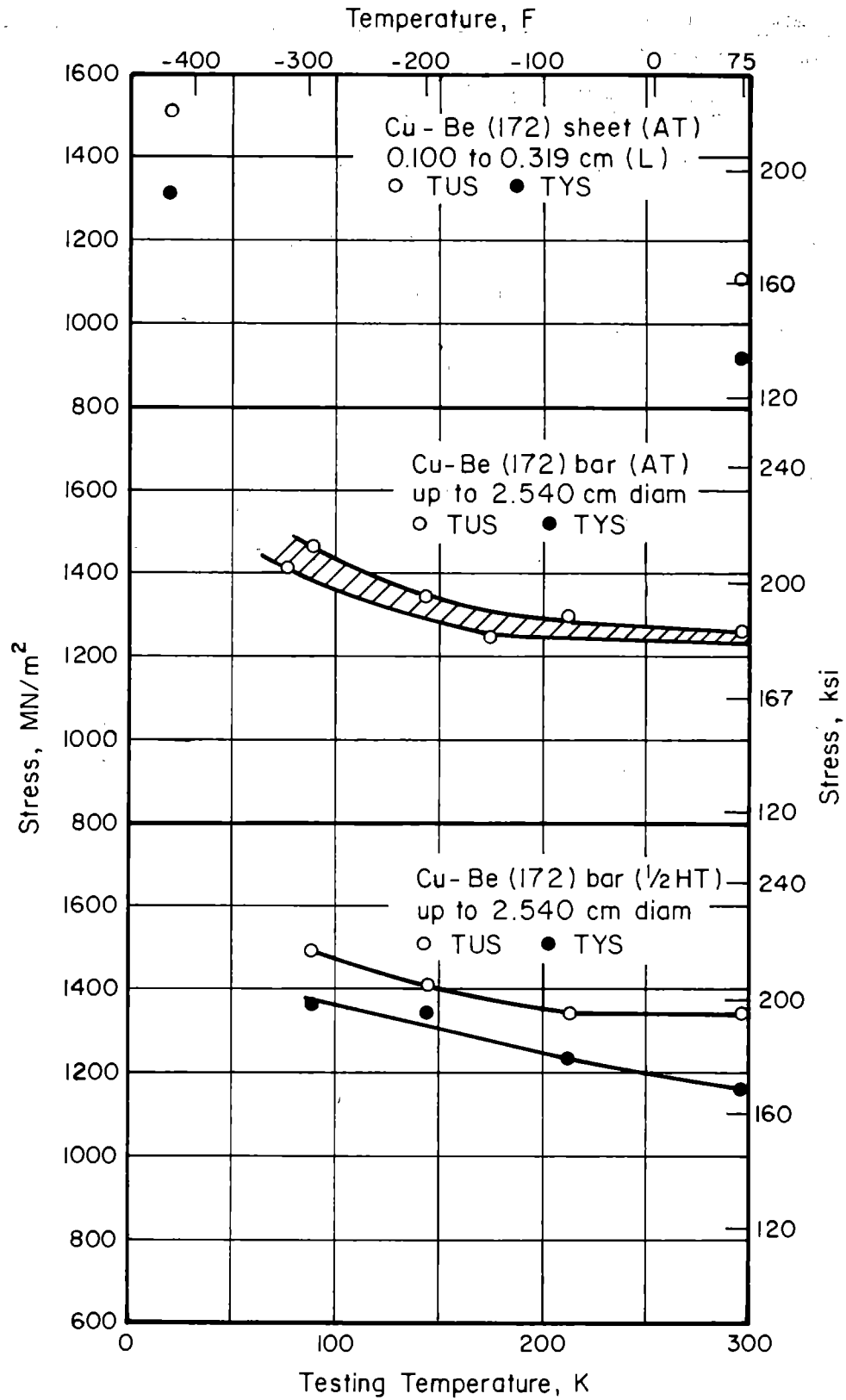


FIGURE 5.4.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF Cu-2Be ALLOY

TABLE 5.4.2-TR1

Alloy Designation: 98Cu-2Be Alloy

C17200

Specification: CDA No. 172

Form:

Dimension:

Condition: Age hardened

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity⁽¹⁾						
Watts m ⁻¹ K ⁻¹			24	10.3	5.1	1.9
Btu hr ⁻¹ ft ⁻¹ F ⁻¹			(13.9)	(5.96)	(2.95)	(1.10)
No. of Spec.			2	2	2	2
References: 40911, 90224						
Thermal Expansion (T₂₇₃ to T) Longitudinal⁽²⁾						
Percent	0	-0.243	-0.278	-0.284	-0.284	-0.284
No. of Spec.	2	2	2	2	2	2
References: 90208, 90336						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity⁽¹⁾						
Ohm m	8.1 x 10 ⁻⁸	6.4 x 10 ⁻⁸	6.0 x 10 ⁻⁸	5.7 x 10 ⁻⁸	5.6 x 10 ⁻⁸	
Ohm circular mil ft ⁻¹	(48.7)	(38.5)	(36.1)	(34.9)	(33.7)	
No. of Spec.	1	1	1	1	1	
References: 90224						

(1) Aged 570 K (570 F) 2 hr

(2) Aged 470 K (390 F) 2 hr

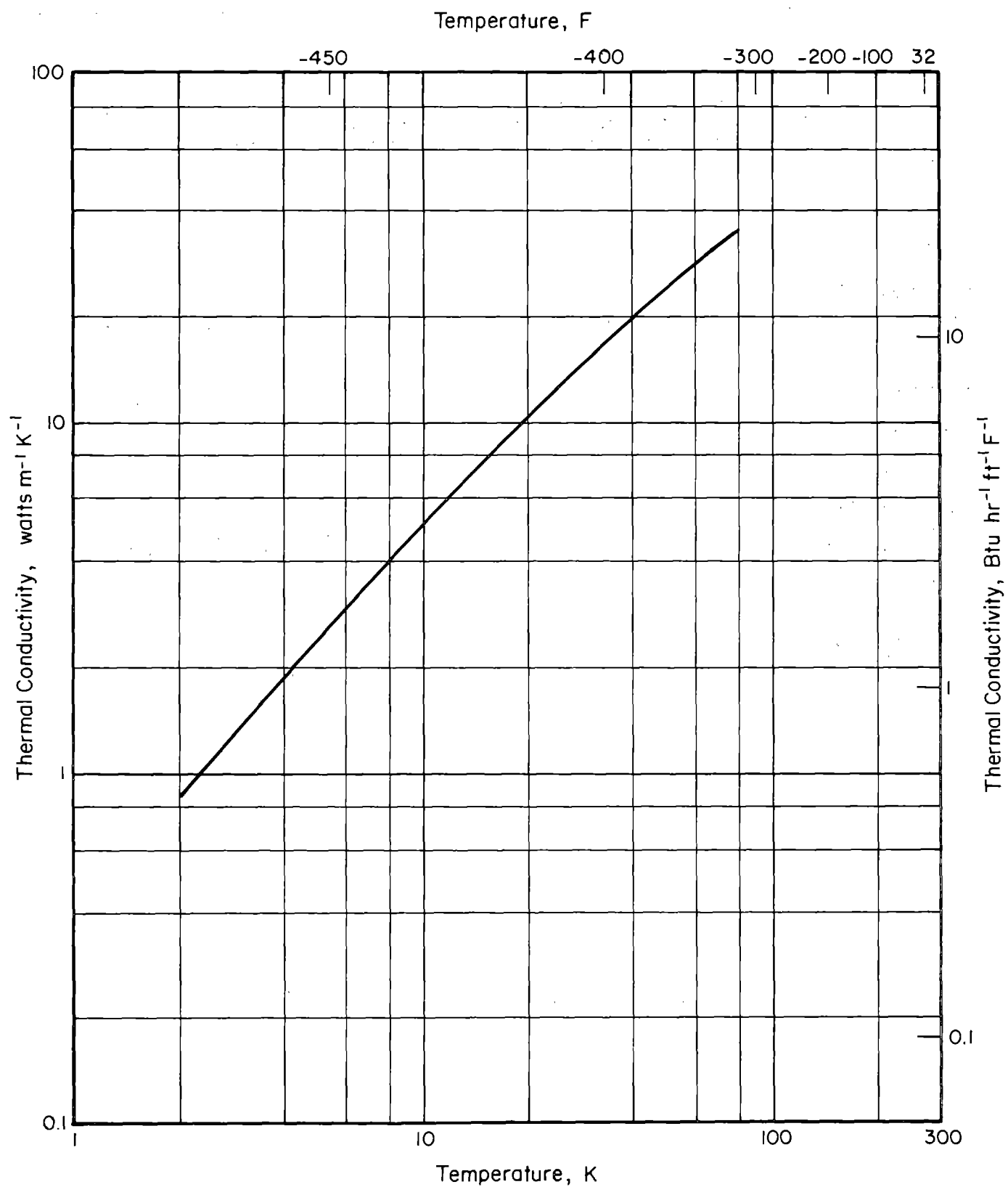


FIGURE 5.4.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE
FOR COPPER ALLOY 98 Cu-2 Be

5.4.2-12 (11/74)

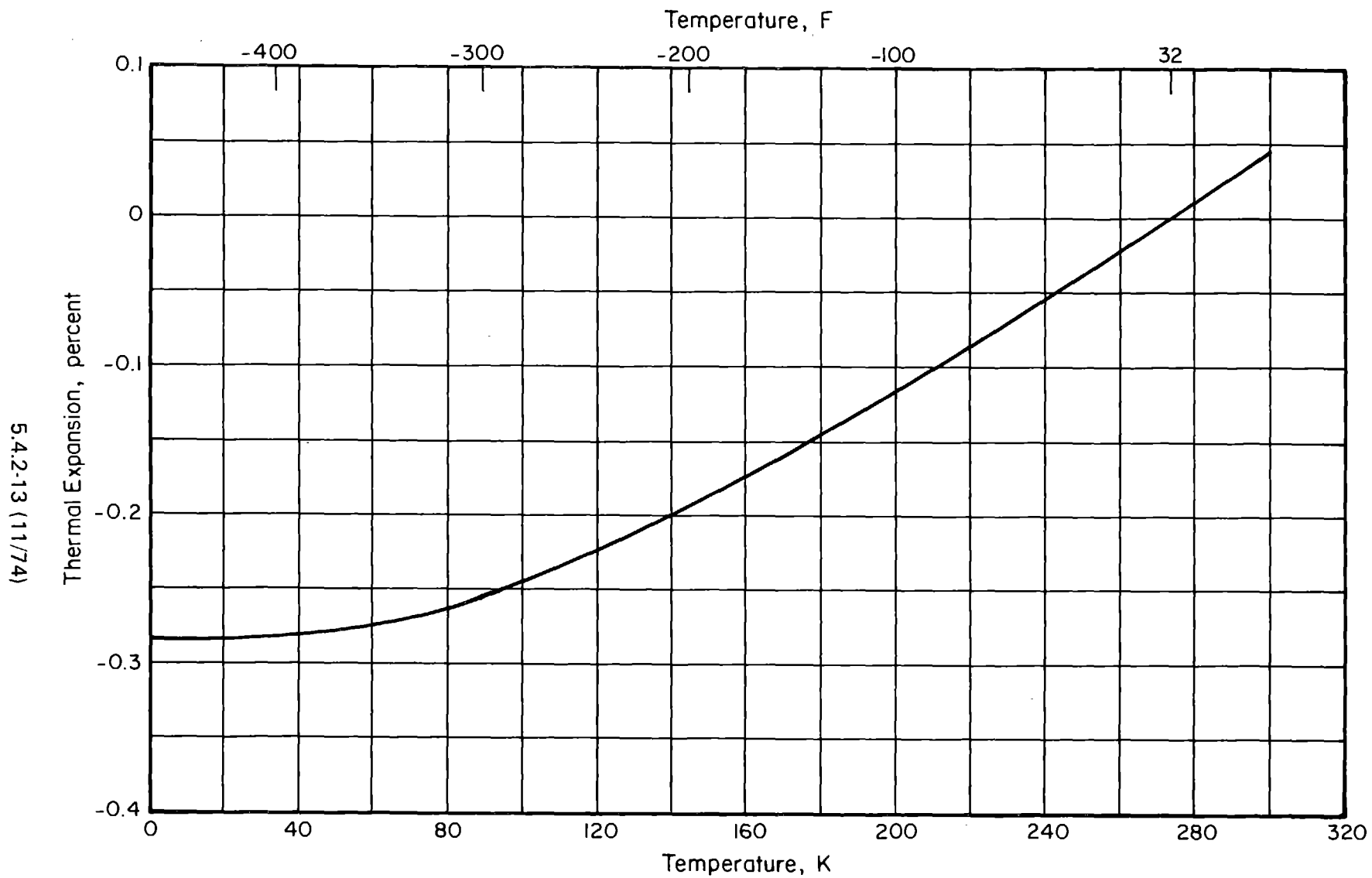


FIGURE 5.4.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE
FOR COPPER ALLOY 98 Cu-2 Be

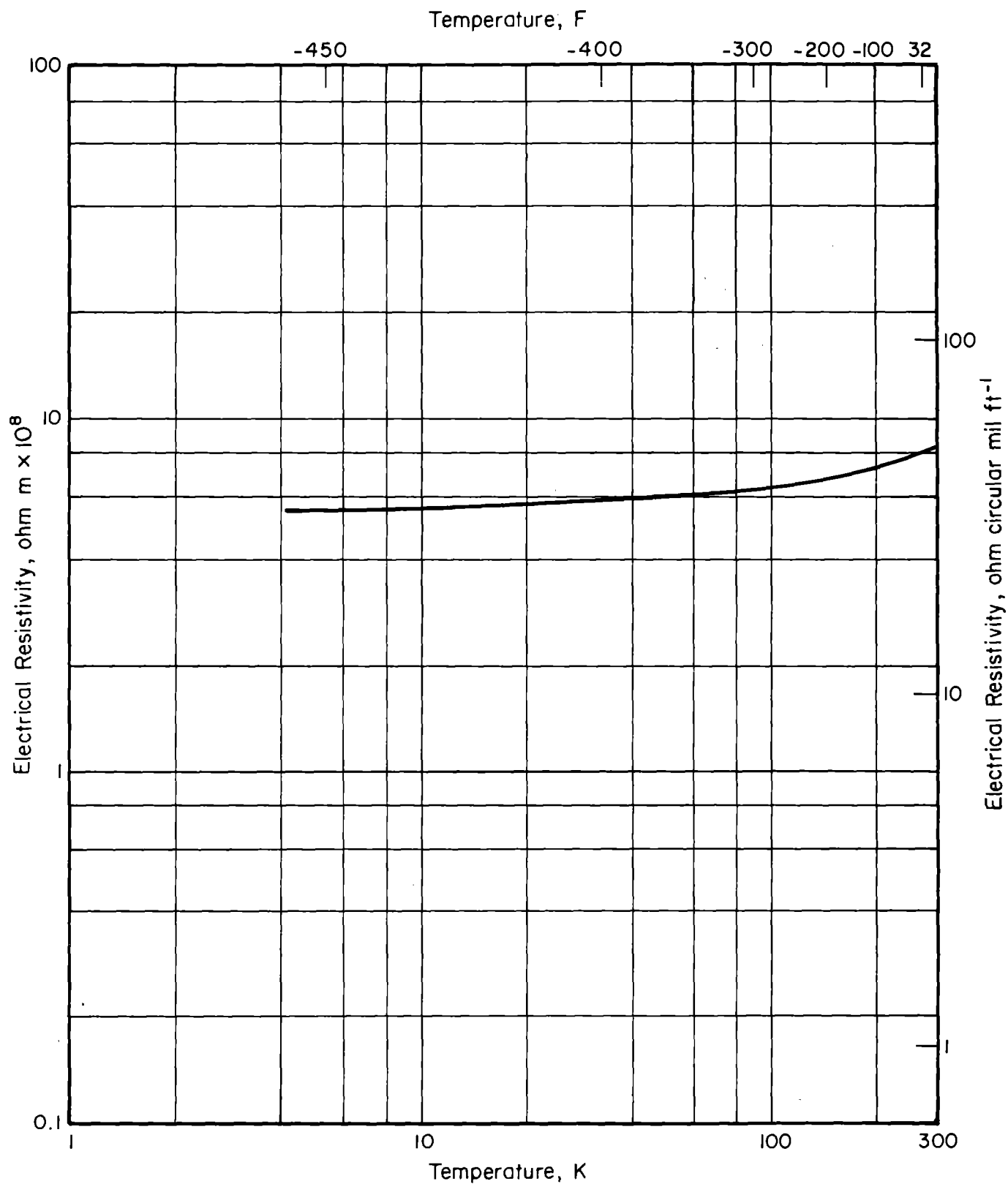


FIGURE 5.4.2-R1. ELECTRICAL RESISTIVITY VERSUS
TEMPERATURE FOR COPPER
ALLOY 98 Cu-2 Be
5.4.2-14 (11/74)

TABLE 5.5.1-ME1

Alloy Designation: 95Cu-5Sn (Phosphor Bronze A)

C51800

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Spring cold drawn 85%

Hardness RB 94, Ave grain diam 0.101 mm

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	534 (77.4)	590 (85.6)	725 (105.2)	903 (131.0)	803 (116.4)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	496 (72.0)	543 (78.7)	615 (89.2)	723 (104.8)	692 (100.4)	
	Min						
Std. Deviation							
Elong, percent	Avg	18	70	34	39	34	
	Min						
RA, percent	Avg	78	78	67	62	58	
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m ² (10 ⁶ psi)	Avg	108 (15.6)	113.8 (16.5)	115.1 (16.7)	113.8 (16.5)	113 (16.4)	
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	941 (136.5)	1014 (147.1)	1151 (167.0)	1276 (185.0)	1278 (185.4)	
	Min						
K _t = 5.0							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90375

TABLE 5.5.1-ME2

Alloy Designation: 95Cu-5Sn (Phosphor Bronze A) C51800

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Spring cold drawn 85%

Hardness R_B 94, Ave grain diam 0.101 mm

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m² (ksi)						
Avg Min						
No. of Spec. (No. of Heats)						
E_c, GN/m² (10⁶ psi)						
Avg Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)						
Avg Min						
No. of Spec. (No. of Heats)						
E_c, GN/m² (10⁶ psi)						
Avg Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)						
Avg Min						
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)						
Avg Min						
No. of Spec. (No. of Heats)						
Dynamic Modol:						
E, GN/m² (10⁶ psi)						
Avg Min						
G, GN/m² (10⁶ psi)						
Avg Min						
B, GN/m² (10⁶ psi)						
Avg Min						
Poisson's Ratio						
Avg Min						
No. of Specimens						
Impact, Charpy V						
Long., Nm(ft-lb)	144 (106)	111 (82)	73 (54)	69 (51)		
Avg Min						
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)						
Avg Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)						
Avg Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K_{IE}, MN/m^{3/2}(ksi√in.)						
Avg (From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 90375

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 5.5.1-TR1

95Cu-5Sn

Alloy Designation: 95Cu-5Sn Alloy (Phosphor Bronze A)

Specification: CDA No. 518

Form:

Dimension:

Condition: Annealed except as noted

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal ⁽¹⁾						
Percent	0	-0.252	-0.291	-0.297	-0.297	-0.297
No. of Spec.	1	1	1	1	1	1
References: 74405						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	10.48 x 10 ⁻⁸	9.08 x 10 ⁻⁸	8.70 x 10 ⁻⁸	8.58 x 10 ⁻⁸	8.58 x 10 ⁻⁸	8.59 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(63.0)	(54.6)	(52.3)	(51.6)	(51.6)	(51.7)
No. of Spec.	1	1	1	1	1	1
References: 79561						

(1) Spring, cold drawn 85%

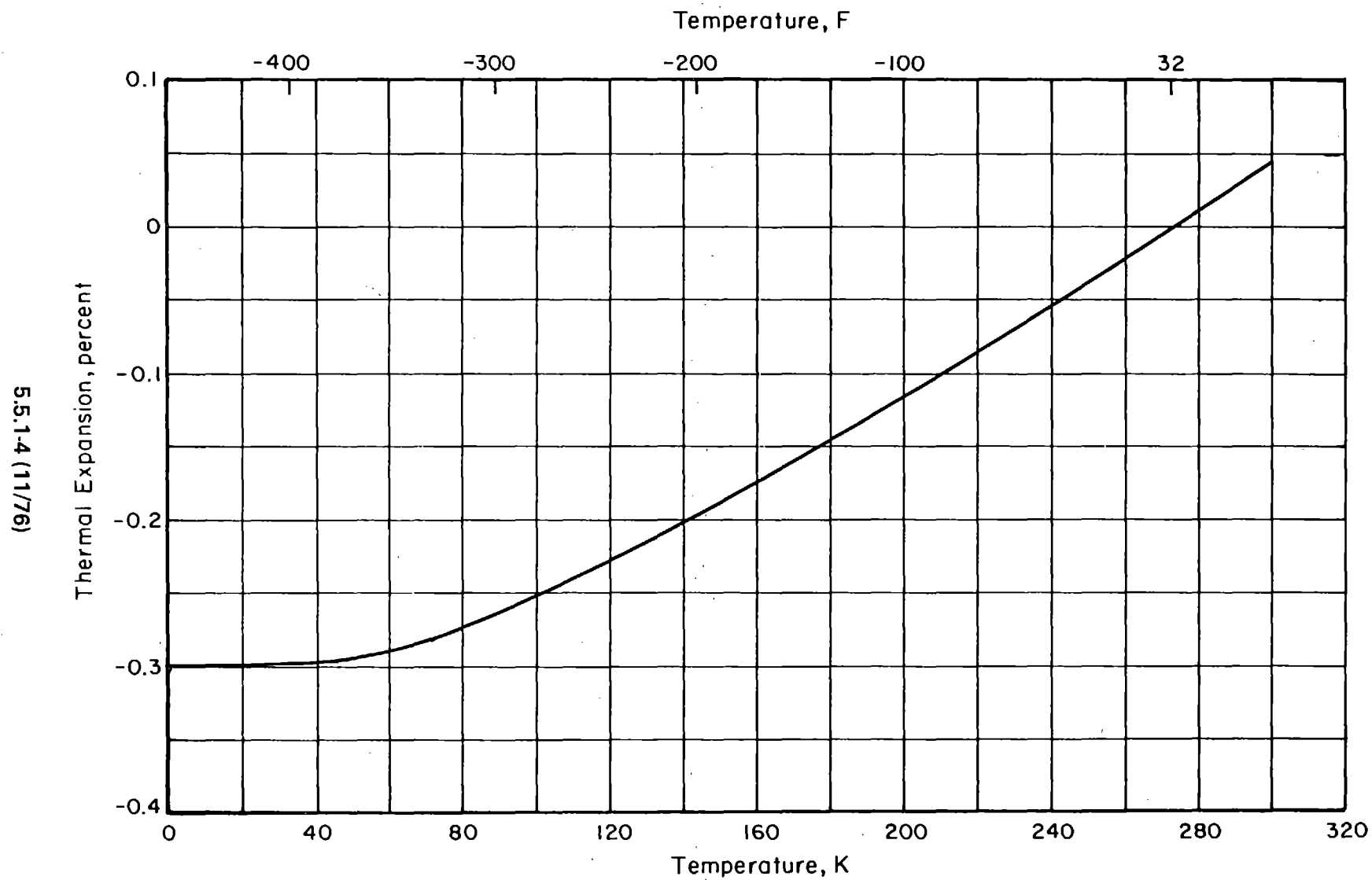


FIGURE 5.5.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR COPPER ALLOY 95Cu-5Sn

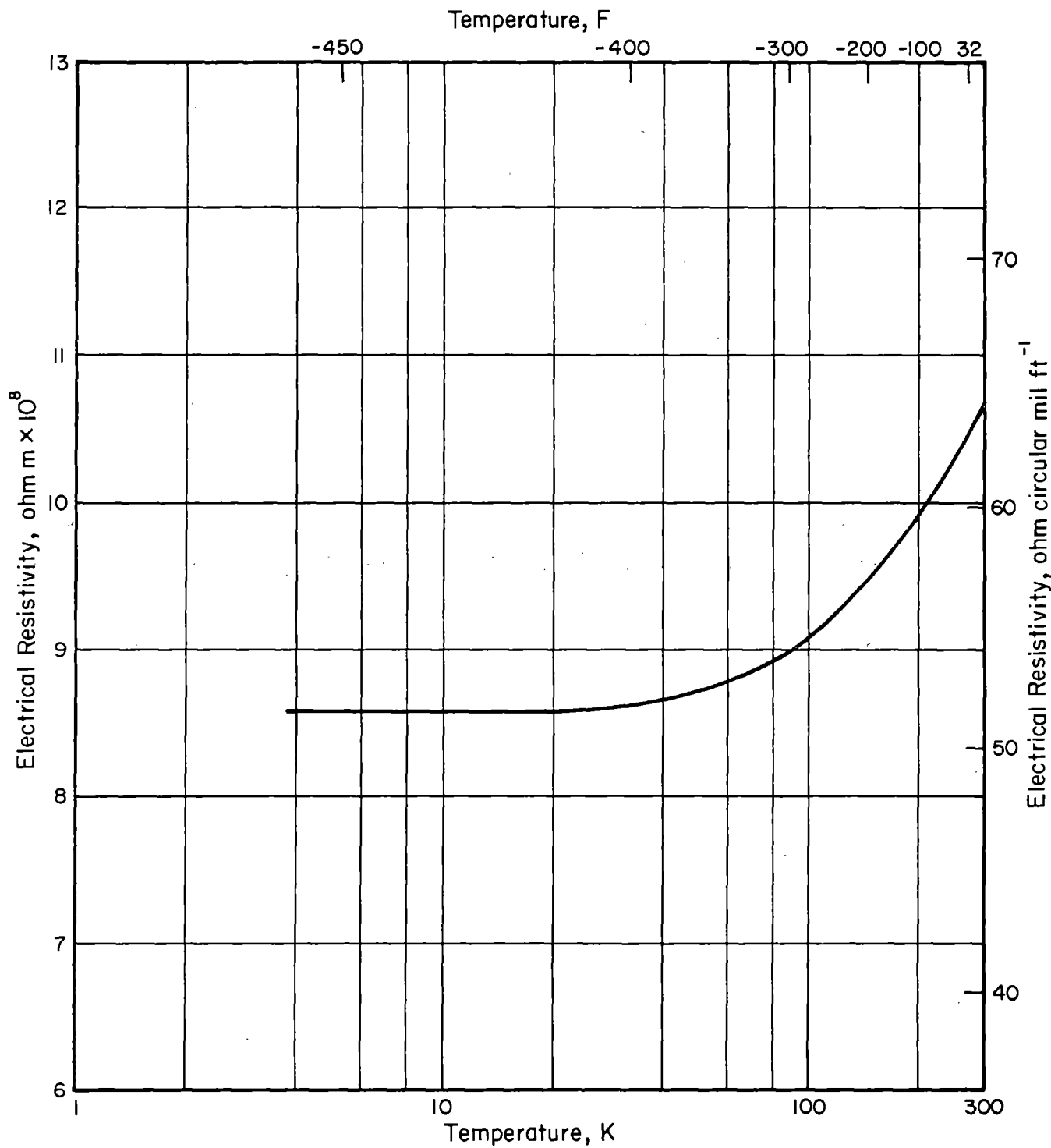


FIGURE 5.5.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY 95Cu-5Sn

TABLE 5.5.2-ME1

Alloy Designation: 92Cu-8Sn (Phosphor Bronze C) C52100

Specification:

Form: Bar
 Thickness, cm (in.): Up to 2.540 (1.000)
 Condition: Full Hard

Testing Temperature, K (F)		297 (75)	77 (-320)	20 (-423)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg Min	814 (118)	1041 (151)	1151 (167) 1124 (163)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg Min	765 (111)	958 (139)	1062 (154) 1034 (150)			
Std. Deviation							
Elong, percent	Avg Min	19	30	25			
RA, percent	Avg Min						
No. of Spec. (No. of Heats)		2	3	3			
E, GN/m ² (10 ⁶ psi)	Avg Min	110 (16)	121 (17.6) 110 (16)	124 (18)			
No. of Spec. (No. of Heats)		2	4	2			
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg Min						
K _t = No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg Min						
K _t = No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg Min						
Std. Deviation							
Elong, percent	Avg Min						
RA, percent	Avg Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg Min						
K _t = No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg Min						
K _t = No. of Spec. (No. of Heats)							

References: 90302

TABLE 5.5.2-TR1

Alloy Designation: 92Cu-8Sn Alloy

C52100

Specification: CDA-521

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
<u>Thermal Conductivity</u> Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec. References:						
<u>Thermal Expansion (T₂₇₃ to T)</u> <u>Longitudinal</u> Percent No. of Spec. References:						
<u>Specific Heat</u> Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec. References: 94206					1.08 (0.000258) 1	0.07 (0.0000167) 1
<u>Electrical Resistivity</u> Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

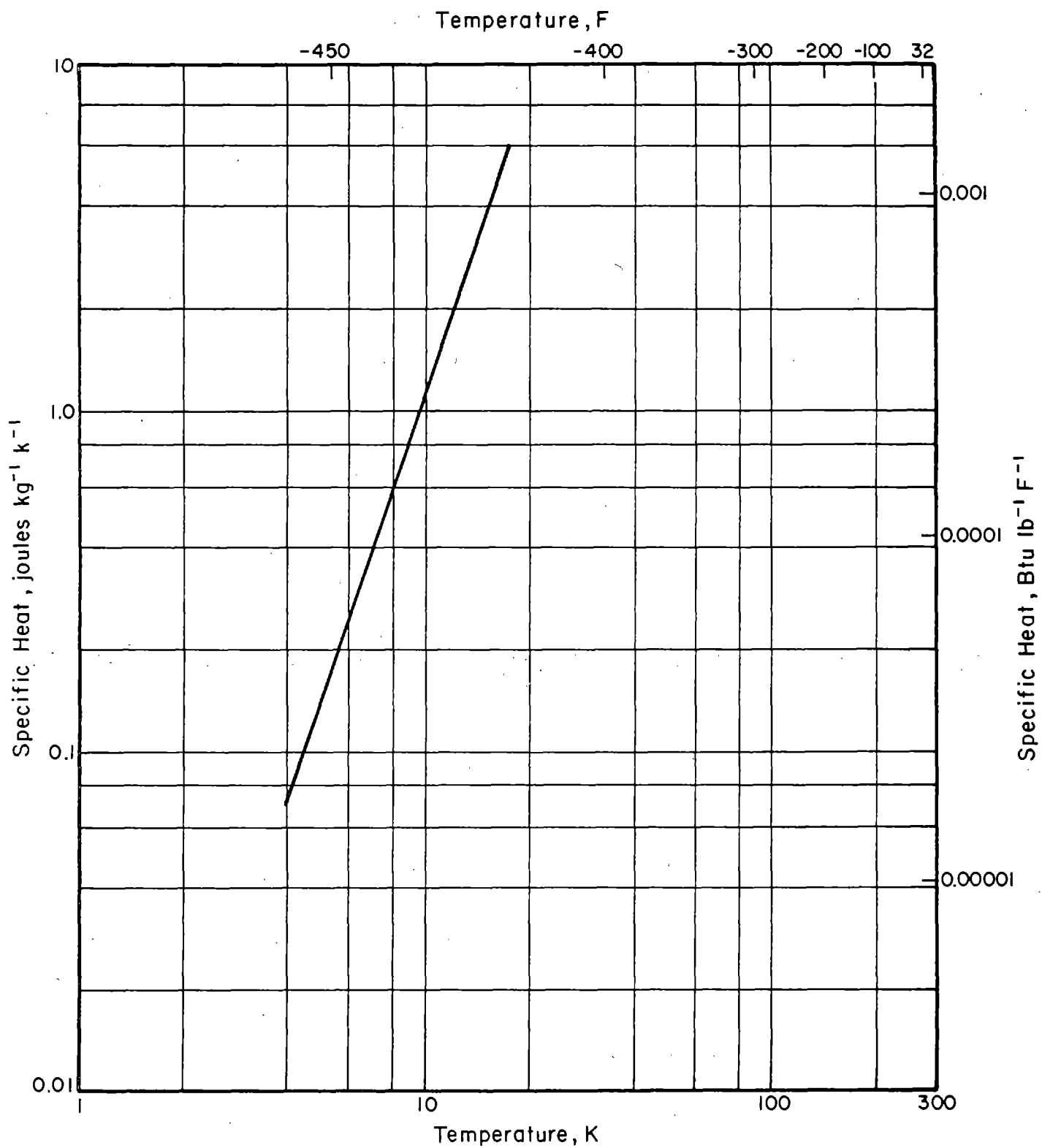


FIGURE 5.5.2-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR
COPPER ALLOY 92Cu-8Sn

5.5.2-4 (11/75)

TABLE 5.5.3-TR1

90Cu-10Sn

Alloy Designation: 90Cu-10Sn Alloy

Specification: CDA No. 524

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.263	-0.314	-0.330	-0.332	-0.333
No. of Spec.	1	1	1	1	1	1
References: 94206						
Specific Heat						
Joules kg ⁻¹ K ⁻¹					1.2	
Btu lb ⁻¹ F ⁻¹					(2.86 x 10 ⁻⁴)	
No. of Spec.					1	
References: 94206						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

(1) 89Cu-11Sn, as cast

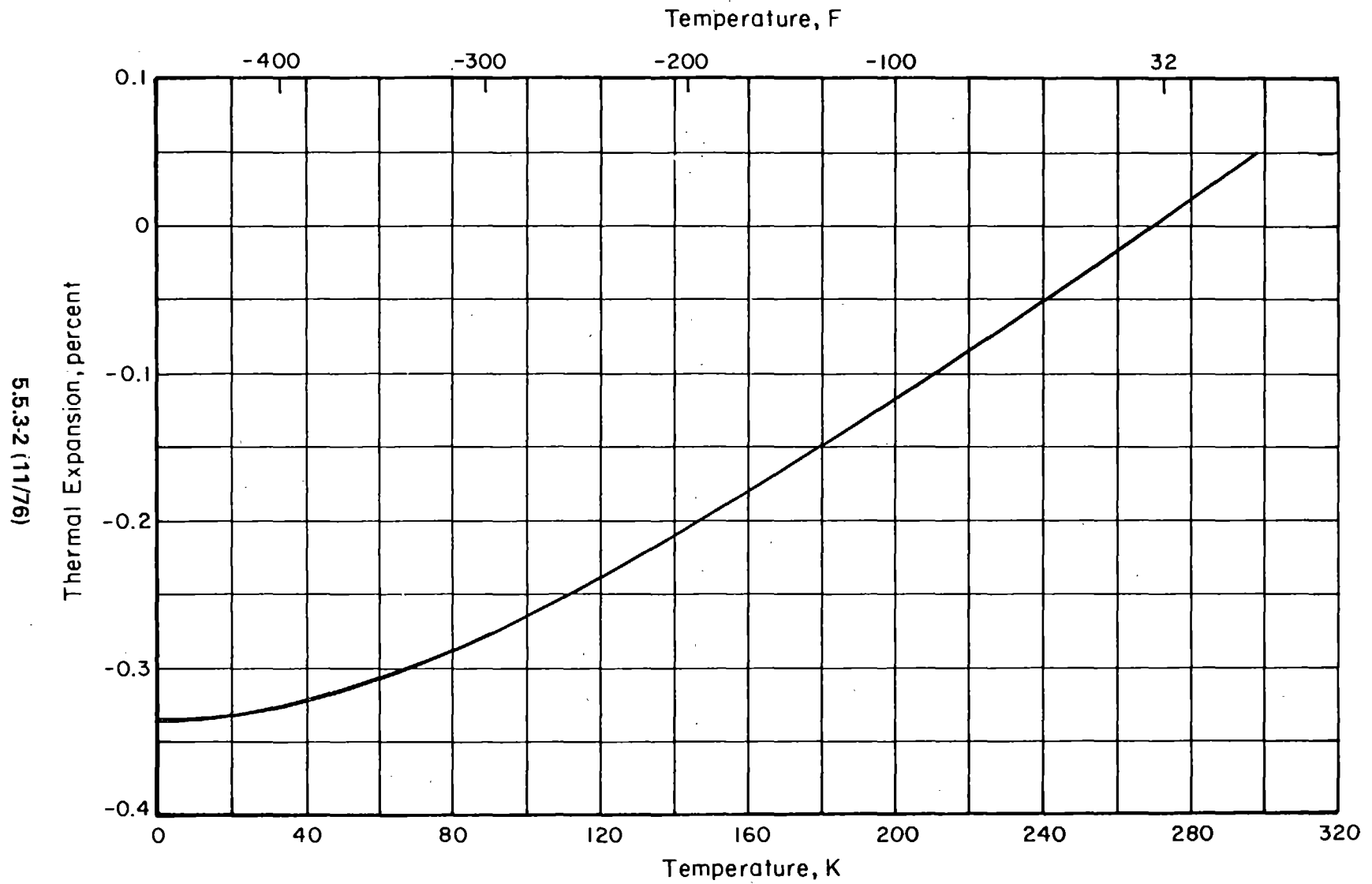


FIGURE 5.5.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Sn

90Cu-10Sn

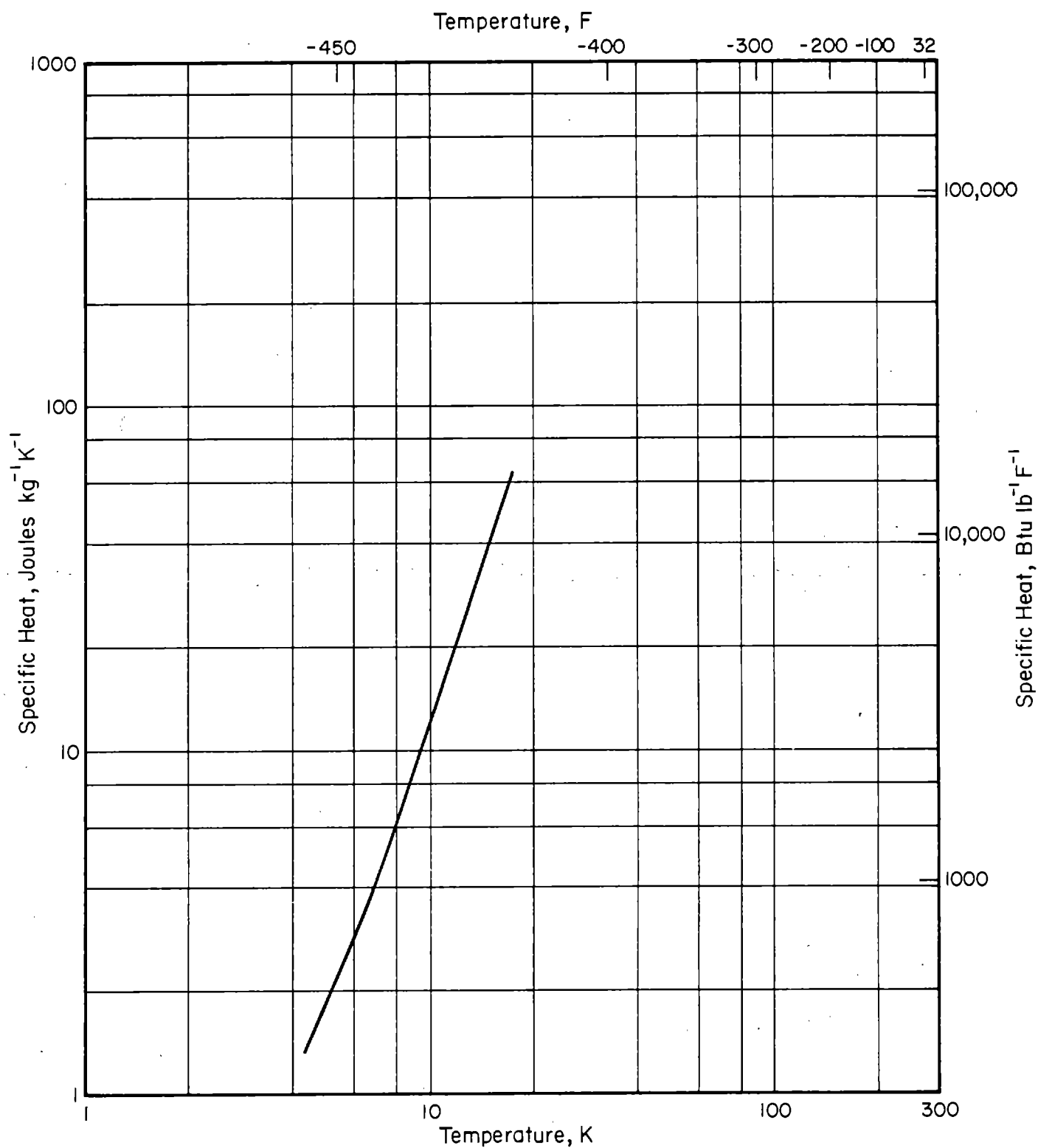


FIGURE 5.5.3-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR COPPER ALLOY 90Cu-10Sn

TABLE 5.6.1-ME1

Alloy Designation: Cu-0.2Zr ("Am Zirc")

C15000

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.54 (1.000)

Condition: Annealed 1125 K (1740 F), Cold drawn 85 to 90%, Aged 725 K (840 F) 1 hr

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	444 (64.5)	464 (67.3)	534 (77.4)	588 (85.3)	591 (85.7)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	411 (59.6)	400 (58.0)	435 (63.1)	458 (66.4)	446 (64.7)	
	Min						
Std. Deviation							
Elong, percent	Avg	16.3	19.6	25.7	36.8	55.5	
	Min						
RA, percent	Avg	62.3	66.2	70.4	71.5	69.2	
	Min						
No. of Spec. (No. of Heats)		2	2	2	2	3	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	673 (97.6)	711 (103.1)	775 (112.4)	820 (119.0)	838 (171.6)	
	Min						
K _t = 5.0							
No. of Spec. (No. of Heats)		2	2	2	2	2	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90375

TABLE 5.6.1-ME2

Alloy Designation: Cu-0.2Zr ("Am Zirc") C15000

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.54 (1.000)

Condition: Annealed 1125 K (1740 F), Cold drawn 85 to 90%, Aged 725 K (840 F) 1 hr

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Dynamic Modol:						
E, GN/m ² (10 ⁶ psi)						
Avg						
Min						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
B, GN/m ² (10 ⁶ psi)						
Avg						
Min						
Poisson's Ratio						
Avg						
Min						
No. of Specimens						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	121 (89.4)	142 (105.0)	154 (113.5)	155 (114.3)		
Min						
No. of Spec. (No. of Heats)	3	3	3	3		
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _I E, MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 90375

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 5.7.1-ME1

Alloy Designation: Cu-Cr-Cd/PHT (PD-135)

Specification:

Form: Extrusion

Thickness, cm (in.): 1.59 (0.625) to 2.54 (1.000)

Condition: Extruded from 20.3 cm (8-inch) billet at 1227 K (1750 F),
Precipitation hardened 1 hr at 866 K (1100 F)

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	350 (50.8)	478 (69.3)	523 (75.8)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	243 (35.3)	263 (38.1)	255 (37.0)			
	Min						
Std. Deviation							
Elong, percent	Avg	32.0	40.2	59.8			
	Min						
RA, percent	Avg	73.4	71.2	67.8			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	436 (63.3)	622 (90.2)	694 (100.7)			
$K_t =$	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							

References: 94208G

TABLE 5.7.1-TR1

Alloy Designation:

Cu-Cr-Cd (PD-135)

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
<u>Thermal Conductivity</u> Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec. References:						
<u>Thermal Expansion (T₂₇₃ to T)</u> <u>Longitudinal</u> Percent No. of Spec. References: 95168	0 1	-0.249 1				
<u>Specific Heat</u> Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec. References:						
<u>Electrical Resistivity</u> Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

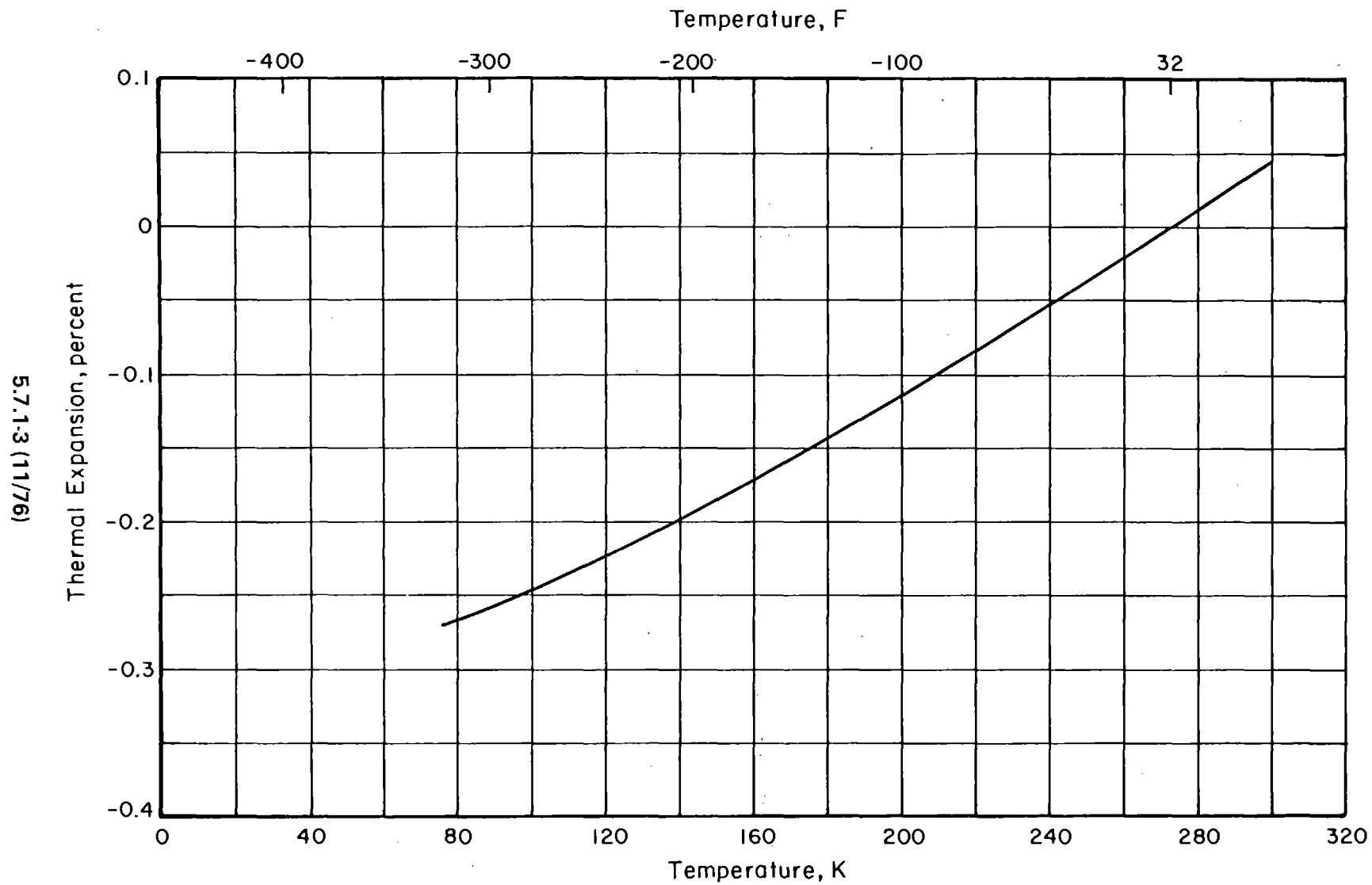


FIGURE 5.7.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR Cu-Cr-Cd (PD-135) ALLOY

Cu-Cr-Cd

TABLE 5.9.1-ME1

Cu-Al
Bar

Alloy Designation: Cu-Al Alloy (Aluminum Bronze D)

Specification: CDA No. 614

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	574 (83.2)	617 (89.5)		729 (105.8)	872 (126.4)	927 (134.5)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	410 (59.4)	447 (64.8)		479 (69.5)	556 (80.6)	568 (82.4)
	Min						
Std. Deviation							
Elong, percent	Avg	40	45		52	48	52
	Min						
RA, percent	Avg	66	71		64	58	59
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	1
E, GN/m ² (10 ⁶ psi)	Avg	109 (15.8)	111 (16.1)		112 (16.3)	112 (16.3)	112 (16.3)
	Min						
No. of Spec. (No. of Heats)		1	1		1	1	1
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	845 (122.5)	919 (133.3)		1021 (148.1)	1202 (174.3)	1109 (160.8)
	Min						
K _t = 5.0							
No. of Spec. (No. of Heats)		1	1		1	1	1
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90375

TABLE 5.9.1-ME2

Cu-Al
Bar

Alloy Designation: Cu-Al Alloy (Aluminum Bronze D)

Specification: CDA No. 614
 Form: Bar
 Thickness, cm (in.): Up to 2.540 (1.000)
 Condition: Annealed

Testing Temperature, K (F)	297 (75)	195 (-108)		77 (-320)	20 (-423)	
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	149 (110)	136 (100)		98 (72)	89 (66)	
Min						
No. of Spec. (No. of Heats)	1	1		1	1	
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 90375

- (a) Indicate specimen design and orientation for shear specimens:
 (b) Indicate specimen design for K_{IC} data:

TABLE 5.9.1-TR1

Alloy Designation: Aluminum Bronze

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹ (1)						2.10
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						(1.21)
No. of Spec.						3
References: 90170						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent (2)	0	0.240	-0.277	-0.282	-0.283	
No. of Spec.	1	1	1	1	1	
References: 74405						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m (3)	18.4 x 10 ⁻⁸	16.2 x 10 ⁻⁸	15.8 x 10 ⁻⁸	15.6 x 10 ⁻⁸	15.7 x 10 ⁻⁸	15.7 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(111)	(97.4)	(95.0)	(93.8)	(94.4)	(94.4)
Ohm m (4)	16.2 x 10 ⁻⁸	14.2 x 10 ⁻⁸	13.8 x 10 ⁻⁸	13.8 x 10 ⁻⁸	13.8 x 10 ⁻⁸	12.9 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(97.4)	(85.4)	(83.0)	(83.0)	(83.0)	(83.6)
No. of Spec. (No. of Heats)	2	2	2	2	2	2
References: 79561						

(1) Cu + 4.5-6.1Al.

(2) 90.95Cu, 6.57Al, 2.13Fe.

(3) 81Cu, 9.95Al, 5.20Ni, 3.35Fe, 0.3Mn

(4) 91Cu, 6.57Al, 2.13Fe

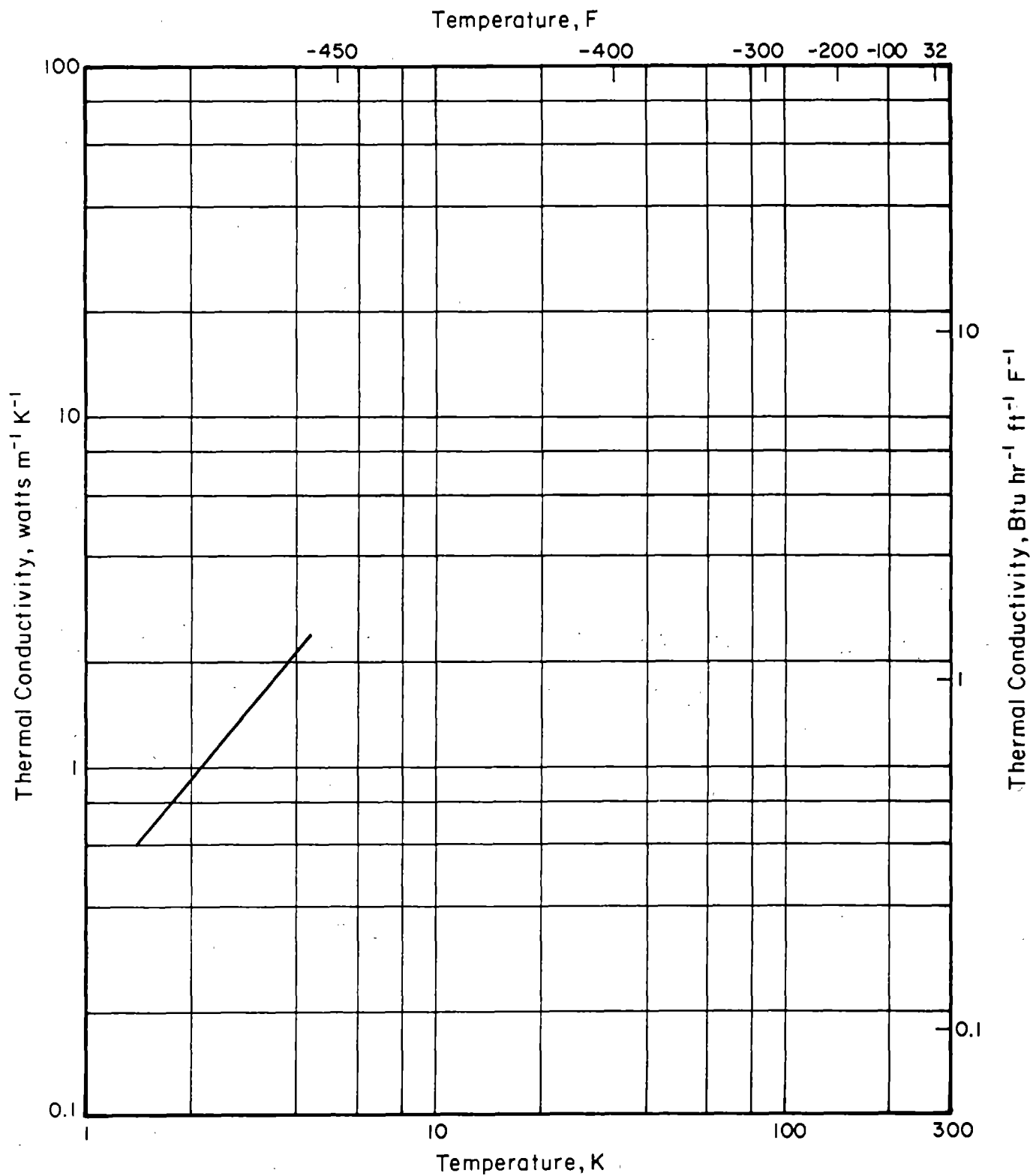


FIGURE 5.9.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY ALUMINUM BRONZE (Cu + 4.0-7.0Al)

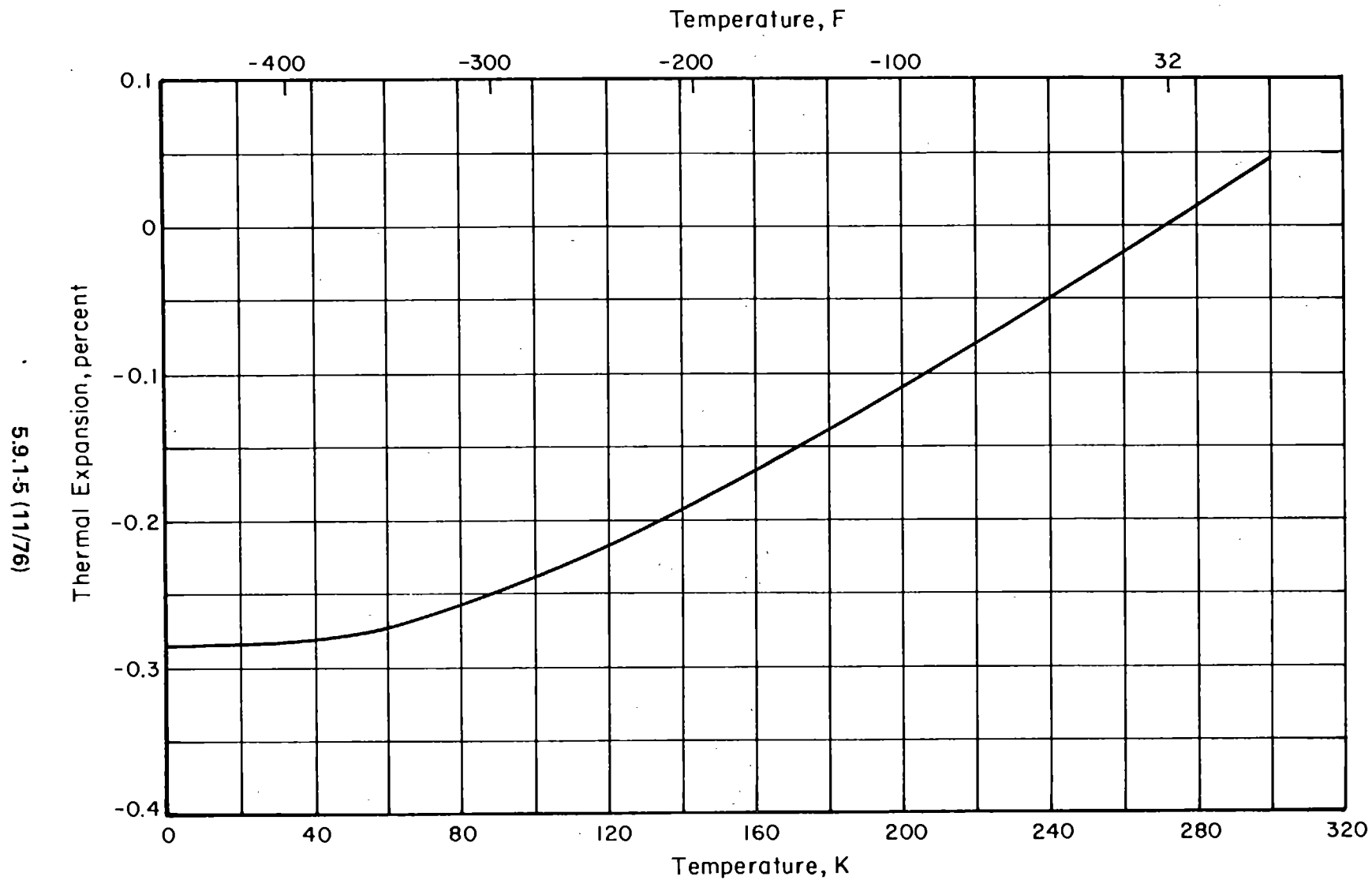


FIGURE 5.9.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR COPPER ALLOY ALUMINUM BRONZE
(90.95Cu, 6.57Al, 2.13Fe)

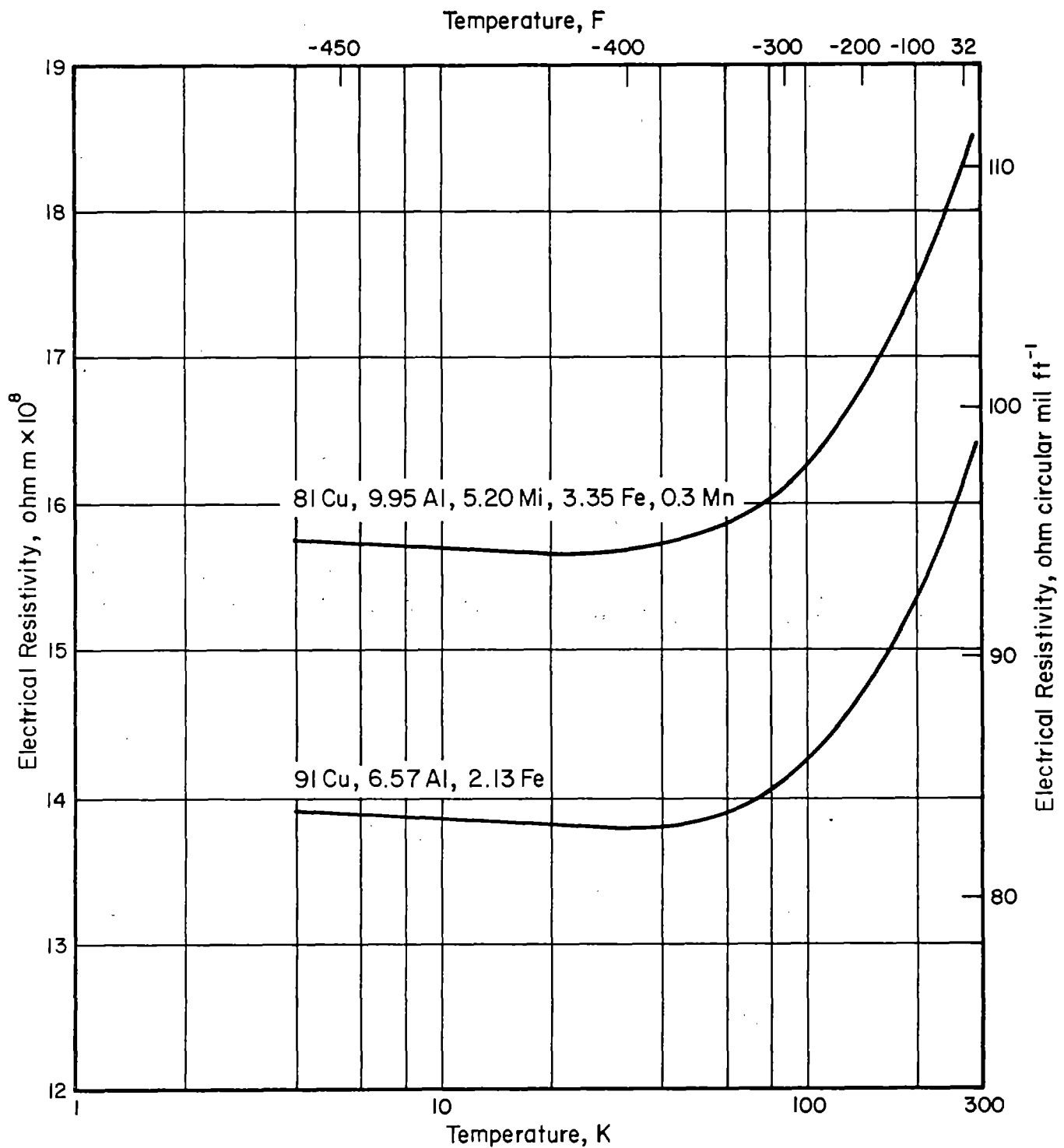


FIGURE 5.9.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR COPPER ALLOY ALUMINUM BRONZE

INDEX TO MATERIAL CODES FOR
SECTION 6.0

NICKEL AND NICKEL ALLOYS

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INCONEL 600	6.2.1
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INCO LEA	6.3.3
NICKEL	6.4.1
"A" NICKEL	6.4.2

TABLE 6.1.1-ME1

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification: QQ-N-286

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Aged 856 K (1080 F) 16 hr + controlled cooling cycle

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1058 (153)	1142 (166)	1263 (183)	1380 (200)		
	Min	1048 (152)	1138 (165)	1248 (181)	1351 (196)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	671 (97.3)	738 (107)	823 (119)	938 (136)		
	Min	665 (96.4)	724 (105)	814 (118)	924 (134)		
Std. Deviation							
Elong, percent	Avg	22.4	24.3	29.4	27.8		
	Min	22	24	27	26		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
		5 (1)	3 (1)	5 (1)	5 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1037 (150)	1110 (161)	1271 (184)	1433 (208)		
	Min	1034 (150)	1103 (160)	1255 (182)	1413 (205)		
K _t = 3.2							
No. of Spec. (No. of Heats)							
		5 (1)	5 (1)	5 (1)	5 (1)		
NTS, MN/m ² (ksi)	Avg	994 (144)	1064 (154)	1204 (175)	1362 (198)		
	Min	986 (143)	1055 (153)	1186 (172)	1331 (193)		
K _t = 6.3							
No. of Spec. (No. of Heats)							
		5 (1)	3 (1)	5 (1)	5 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)							
	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 49088

TABLE 6.1.1-ME2

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification: QQ-N-286

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Aged 867 K (1100 F) 16 hr + controlled cooling cycle

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1033 (150)	1077 (156)	1136 (165)	1228 (178)	1338 (194)	
	Min	1020 (148)			1218 (177)	1331 (193)	
	Std. Deviation	14.1 (2.05)			12.4 (1.80)	14.4 (2.09)	
TYS, MN/m ² (ksi)	Avg	713 (103)	767 (111)	820 (119)	854 (124)	923 (134)	
	Min	696 (101)			827 (120)	896 (130)	
	Std. Deviation	14.3 (2.08)			22.9 (3.32)	17.4 (2.53)	
Elong, percent	Avg	21.7	24	24.7	30.3	29.9	
	Min	19			28	28.3	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		9 (2)	3 (1)	3 (1)	9 (2)	9 (2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	938 (136)	1000 (145)	1055 (153)	1124 (163)	1193 (173)	
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1017 (148)	1098 (159)	1144 (166)	1259 (183)	1358 (197)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	719 (104)	782 (114)	827 (120)	912 (132)	936 (136)	
	Min						
Std. Deviation							
Elong, percent	Avg	22.3	23.5	24.7	30.5	29.2	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							

References: 58060, 83417

TABLE 6.1.1-ME3

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification: QQ-N-286

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 – 0.125)

Condition: Aged 867 K (1100 F) 16 hr + controlled cooling cycle

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Flexural Loading, Surface Finish 90 rms						
S_N at 10^5 cycles, MN/m ² (ksi)	517 (75)		607 (88)	634 (92)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.50		0.50	0.47		
S_N at 10^6 cycles, MN/m ² (ksi)	379 (55)		393 (57)	476 (69)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.37		0.32	0.36		
S_N at 10^7 cycles, MN/m ² (ksi)	345 (50)		352 (51)			
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.34		0.29			
Fatigue, Flexural Loading, Surface Finish 16 rms						
S_N at 10^5 cycles, MN/m ² (ksi)	586 (85)		662 (96)	745 (108)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.56		0.53	0.55		
S_N at 10^6 cycles, MN/m ² (ksi)	379 (55)		469 (68)	579 (84)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.36		0.38	0.43		
S_N at 10^7 cycles, MN/m ² (ksi)	324 (47)		448 (65)			
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.31		0.36			

References: 83417

TABLE 6.1.1-ME3.1

K-500
Sheet

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	656 (95.1)	72.81 (105.6)	789.5 (114.5)	919.8 (13.34)	1048 (152.0)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	314 (45.6)	349 (50.6)	390 (56.6)	448 (65.0)	515 (74.7)	
	Min						
Std. Deviation							
Elong, percent	Avg	38.8	40.0	41.0	48.0	43.3	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	623 (90.3)	690.2 (100.1)	754.3 (109.4)	832.9 (120.8)	897.7 (130.3)	
	Min						
K _t = 10							
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	656 (95.2)	737.1 (106.9)	992.9 (144.0)	913.6 (132.5)	105.5 (153.0)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	316 (45.8)	360 (52.2)	395 (57.3)	439 (63.6)	574 (83.2)	
	Min						
Std. Deviation							
Elong, percent	Avg	36.5	40.5	40.5	44.7	42.5	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90181

TABLE 6.1.1-ME3.2

Alloy Designation: K Monel (K-500) Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, K-Monel filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed Sheet, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	652 (94.6)	729.5 (105.8)	788.1 (114.3)	941.8 (136.6)	1106 (160.4)	
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	328 (47.5)	376 (54.5)	399 (57.9)	481 (69.8)	610 (88.5)	
	Min						
Std Deviation							
Elong, percent	Avg	32.2	35.7	35.5	41.0	36.8	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90181

TABLE 6.1.1-ME3.3

Alloy Designation: K Monel (K-500) Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, K-Monel filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed sheet, welded, then age hardened and tested

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1049 (152.1)	1114 (161.5)	1138 (165.0)	1252 (181.6)	1364 (197.9)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	759.1 (110.1)	828.8 (120.2)	841.9 (122.1)	924.6 (134.1)	1007 (146.1)	
	Min						
Std. Deviation							
Elong, percent	Avg	19.0	21.2	20.7	26.0	24.3	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90181

TABLE 6.1.1-ME3.4

K-500
Sheet

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Cold rolled, ½ hard and age hardened

Testing Temperature, K (F)		297 (75)				20 (-423)	
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	1250 (182)				1640 (238)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1120 (163)				1430 (208)	
	Min						
Std. Deviation							
Elong, percent	Avg	8.5				15.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1				1	
E, GN/m ² (10 ⁶ psi)	Avg	180 (26)				219 (30)	
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 49048

TABLE 6.1.1-ME3.5

K-500
Sheet

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Cold rolled, ½ hard and age hardened

Testing Temperature, K (F)	297 (75)	195 (-108)		77 (-320)	20 (-423)	
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency 30 ^(a) Hz with $R = -1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	620 (90)	690 (100)		720 (105)	979 (142)	
Ratio S_N /TUS at 10^5 cycles	380 (55)	460 (67)		480 (69)	696 (101)	
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency 30 ^(a) Hz with $R = -1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	380 (55)	460 (67)		480 (69)	696 (101)	
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency 30 ^(a) Hz with $R = -1$ and $K_t = 3.1$ No. of S-N Curves (No. of Heats)	460 (66)	510 (74)		570 (82)	660 (95)	
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency 30 ^(a) Hz with $R = -1$ and $K_t = 3.1$ No. of S-N Curves (No. of Heats)	270 (39)	300 (43)		330 (48)	330 (48)	
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 49048

(a) Frequency = 58 Hz for tests at 20 K (-423 F)

TABLE 6.1.1-ME3.6

Alloy Designation: K Monel (K-500) Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, K-Monel filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Age-hardened sheet, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	683 (99.0)	757.7 (109.9)	819.1 (118.8)	921.8 (133.7)	1096 (158.9)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	432 (62.7)	516 (74.9)	585 (84.9)	643 (93.2)	743.9 (107.9)	
	Min						
Std. Deviation							
Elong, percent	Avg	8.2	8.7	8.7	9.5	10.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90181

TABLE 6.1.1-ME4

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification: QQ-N-286A

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Aged 867 K (1100 F) 21 hr, 811 K (1000 F) 8 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1082 (157)	1225 (178)	1295 (188)	1417 (206)		
	Min	1048 (152)	1214 (176)	1255 (182)	1379 (200)		
	Std. Deviation	41.7 (6.05)					
TYS, MN/m ² (ksi)	Avg	703 (102)	893 (130)	865 (125)	939 (136)		
	Min	634 (92)	887 (129)	800 (116)	862 (125)		
	Std. Deviation	65.2 (9.46)					
Elong, percent	Avg	28	28.6	32	36.4		
	Min	24	27.3	28	33.8		
RA, percent	Avg	53.7	54.3	54.3	52.4		
	Min	51	54.2	54.3	52.1		
	No. of Spec. (No. of Heats)	13 (3)	3 (1)	8 (2)	5 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							

References: 54986, 64373, 83417

TABLE 6.1.1-ME5

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification: QQ-N-286A

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Aged 876 K (1100 F) 21 hr, 811 K (1000 F) 8 hr, AC

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)			
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb)	Avg	49.9 (36.8)	46.1 (34)	42.0 (31)		
	Min	43.4 (32)	38.0 (28)	38.6 (28.5)		
No. of Spec. (No. of Heats)		5 (1)	5 (5)	4 (1)		
Trans., J(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K_{IE}, MN/m^{3/2}(ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 54986

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 6.1.1-ME6

Alloy Designation: K Monel (K-500) Nickel-Base Alloy

Specification: QQ-N-286 A

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: 1090 K (1500 F), WQ, 860 K (1090 F) 16 hr, FC to 756 K (900 F), AC

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)	614 (89)		200 (116)	841 (122)		
Loading frequency 28 Hz						
with $R = 0$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.58		0.62	0.61		
S_N at 10^7 cycles, MN/m ² (ksi)	579 (84)		690 (100)			
Loading frequency 28 Hz						
with $R = 0$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.53		0.54			
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 83417

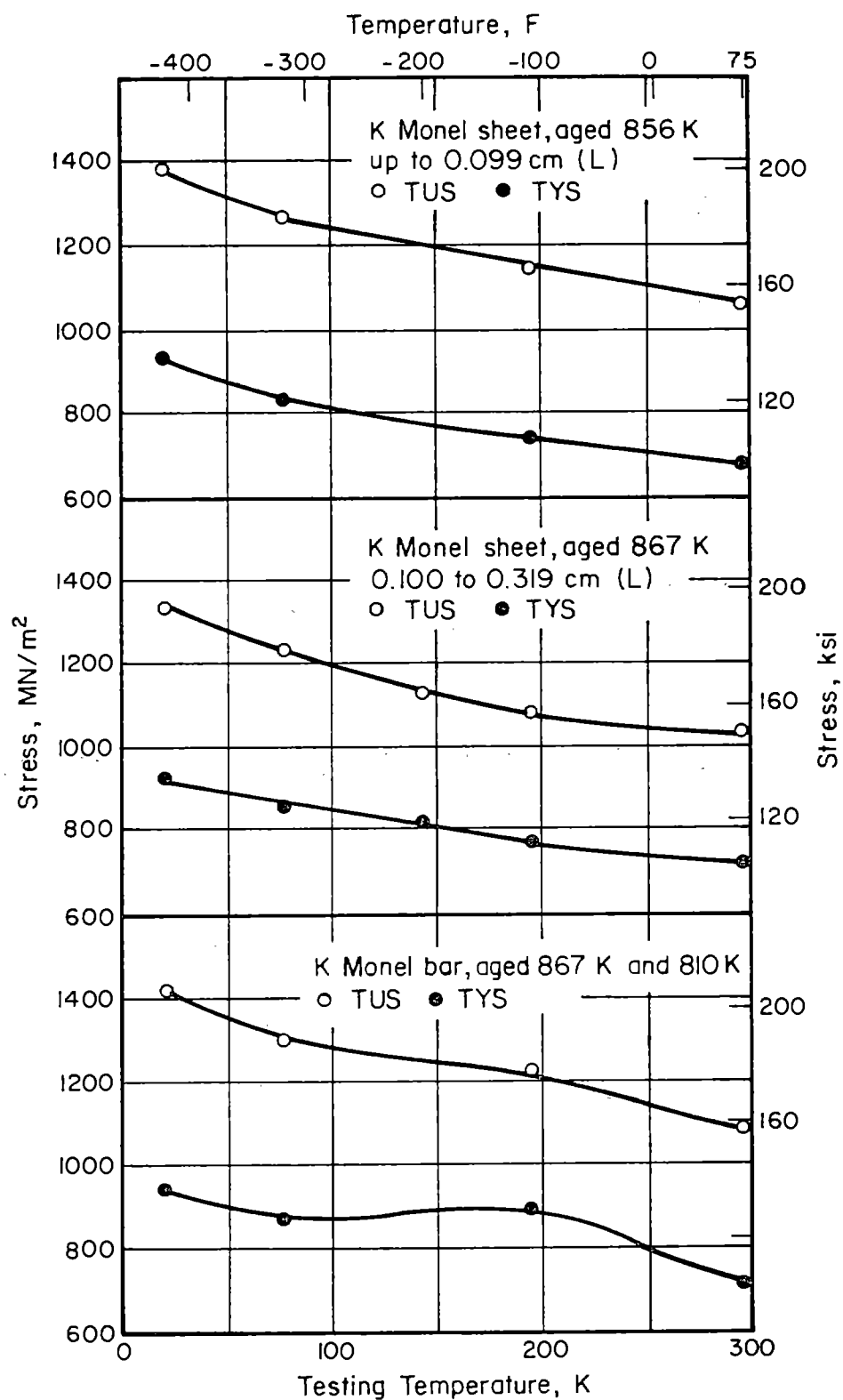


FIGURE 6.1.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF K MONEL (K-500)

TABLE 6.1.1-TR1

Alloy Designation: K-Monel Nickel Alloy

Specification:

Form:

Dimension:

Condition: Age Hardened

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec. References:						
Thermal Expansion (T₂₇₃ to T) Longitudinal Percent No. of Spec. References: 48134	0 1	-0.195 1	-0.220 1	-0.223 1		
Specific Heat Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec. References:						
Electrical Resistivity Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

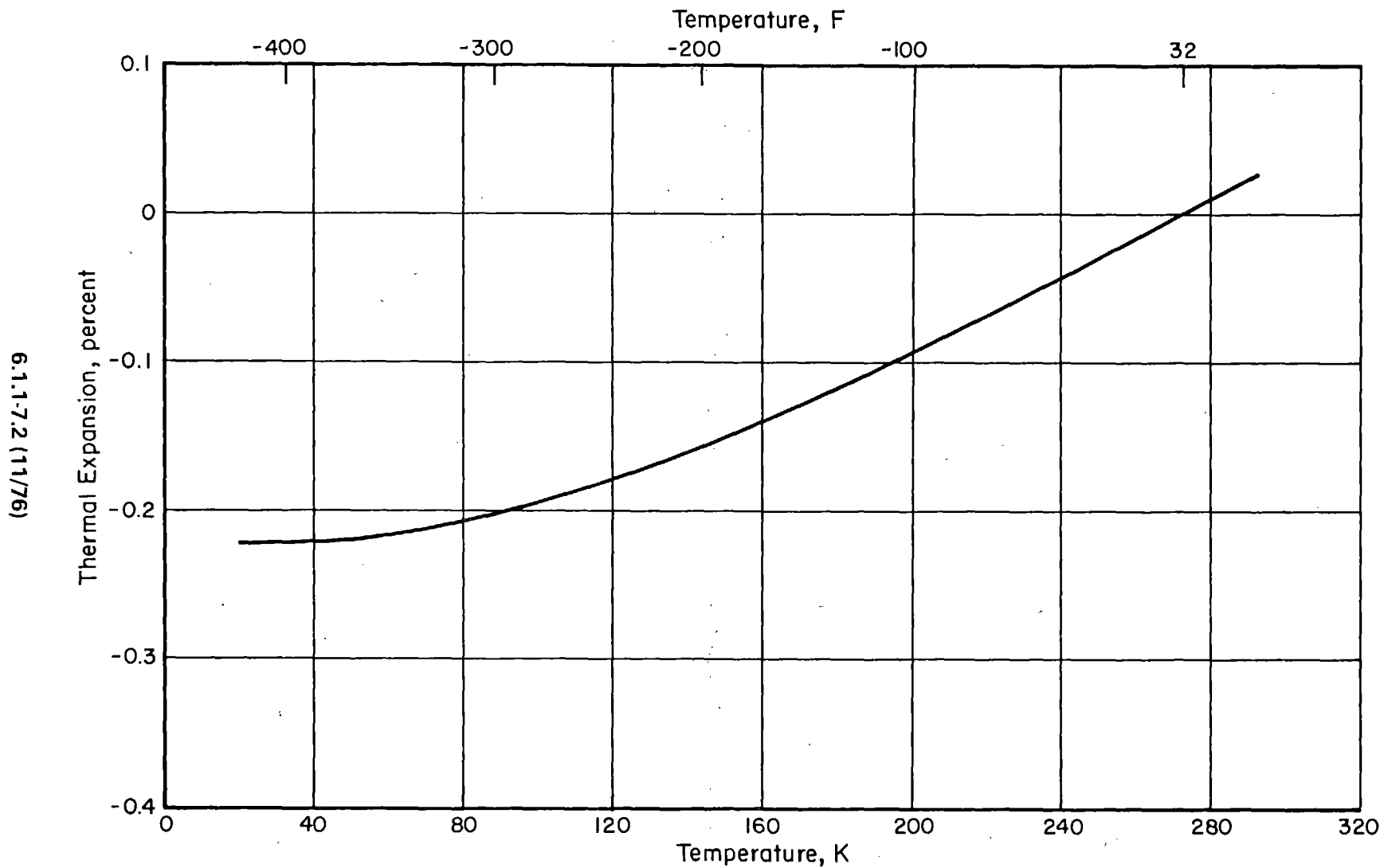


FIGURE 6.1.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR K-MONEL (AGE-HARDENED)

TABLE 6.1.1-MA1

Alloy Designation: "K" Monel N05500
Specification: 66.0Ni—29.0Cu—0.9Fe—0.85Mn—1.0Si—0.15O
Form: Rod
Diameter: Not given
Condition: As indicated in table below

Magnetic Permeability at Room Temperature
(H = 0.2kOe)

<u>Condition</u>	<u>Permeability</u>
Soft*	12.58×10^{-7}
Soft and age hardened**	12.59×10^{-7}
Cold drawn 20 percent	12.58×10^{-7}
Cold drawn 20 percent and age hardened	12.59×10^{-7}
Cold drawn 50 percent	12.58×10^{-7}
Cold drawn 50 percent and age hardened	12.59×10^{-7}

Reference: 90220

* Quenched in water following 45 minutes at 1550 F (1116 K).

** Sixteen hours at 1080 F (855 K), furnace-cooled to 800 F (700 K) at 15deg F per hour and air-cooled.

TABLE 6.2.1-ME1

Alloy Designation: Inconel 600 Nickel-Base Alloy

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Hard cold rolled

Testing Temperature, K (F)	297 (75)			20 (-423)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 910 (132)			1214 (176)		
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 882 (128)			1110 (161)		
	Min					
Std. Deviation						
Elong, percent	Avg 3.8			22.0		
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 49048

TABLE 6.2.1-ME2

Alloy Designation: Inconel 600 Nickel-Base Alloy

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Hard cold rolled (longitudinal specimens)

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	421 (61)	486 (70)	496 (72)	676 (98)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)	269 (39)	276 (40)	276 (40)	324 (47)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 49048

TABLE 6.2.1-ME3

Alloy Designation: Inconel 600 Nickel-Base Alloy

Specification: MIL-N-6710
 Form: Bar, cold drawn
 Diameter: Up to 2.540 cm (1.000 in.)
 Condition: Cold drawn

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	17 (-430)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	939 (136)	987 (143)	1160 (168)	1248 (181)	1285 (186)	
	Min	900 (131)	984 (143)	1156 (168)	1244 (180)	1255 (182)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	888 (129)	910 (132)	1037 (150)	1106 (160)	1212 (176)	
	Min	846 (123)	899 (130)		1103 (160)	1172 (170)	
Std. Deviation							
Elong, percent	Avg	14.8	20.1	26.4	30.5	20	
	Min	13	19.7	26.2	30.4	15	
RA, percent	Avg	55.7	58.4	61.9	55.7	56	
	Min	53	57.8	61.7	55.5	54	
No. of Spec. (No. of Heats)		7 (2)	2 (1)	2 (1)	2 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	172 (25)				221 (32)	
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1234 (179)				1533 (222)	
	Min	1214 (176)				1469 (213)	
K _t = 6.4							
No. of Spec. (No. of Heats)		5 (1)				5 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 54986, 64373

TABLE 6.2.1-ME4

Alloy Designation: Inconel 600 Nickel-Base Alloy

Specification: MIL-N-6710

Form: Bar, cold drawn

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Cold drawn

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb)	Avg	104 (77.1)	121 (89.5)	112 (82.7)		
	Min	84.1 (62)	120 (88.5)	104 (77)		
No. of Spec. (No. of Heats)		5 (1)	3 (1)	3 (1)		
Trans., J(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _I E, MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 54986

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

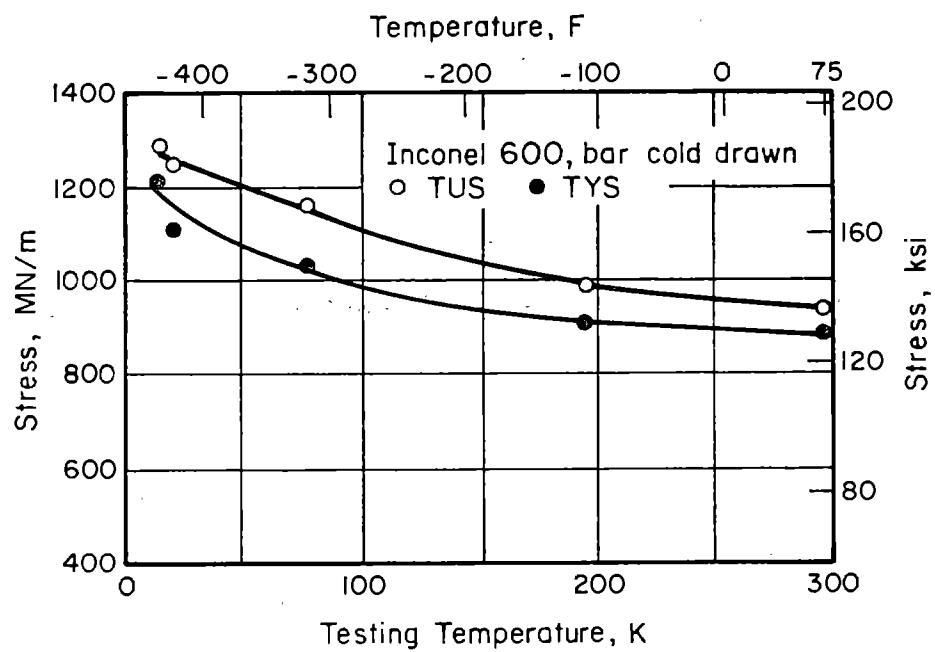


FIGURE 6.2.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF INCONEL 600

Alloy Designation: Inconel 600

Specification:

Form: Rod

Diameter, cm (in.): 0.37 (0.145)

Condition: Solution annealed

Test Temperature: 4.2 K (-452 F)

Measured permeability at room temperature = 12.82×10^{-7}

Curie Temperature: 148.5 K (-192 F)

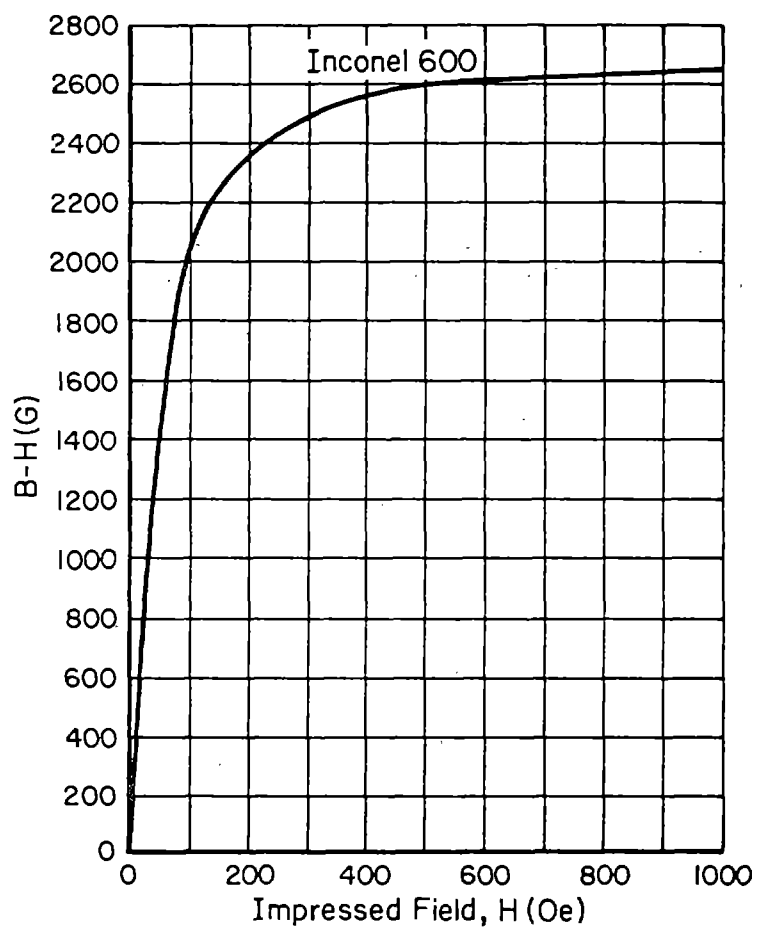


FIGURE 6.2.1-MA1. MAGNETIZATION VALUES FOR INCONEL 600 [96871]

TABLE 6.2.2-ME1

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification: AMS-5542, MIL-N-7786B

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Mill annealed, aged 978 K (1300 F) 20 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1205 (175)	1303 (189)	1476 (214)	1578 (229)		
	Min	1200 (174)			1489 (216)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	820 (119)	841 (122)	895 (130)	927 (134)		
	Min	814 (118)			924 (134)		
Std. Deviation							
Elong, percent	Avg	25.6	30	31	31.1		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (2)	3 (1)	3 (1)	4 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1158 (168)	1200 (174)	1269 (184)	1372 (199)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1200 (174)		1462 (212)	1613 (234)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	813 (118)		896 (130)	958 (139)		
	Min						
Std. Deviation							
Elong, percent	Avg	25		30	31		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1158 (168)	1207 (175)	1269 (184)	1386 (201)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 49048, 90079

TABLE 6.2.2-ME2

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification: AMS-5542, MIL-N-7786 B

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Mill Annealed, aged 978 K (1300 F) 20 hr, AC

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^6 cycles, MN/m ² (ksi)	427 (62)	413 (60)	441 (64)	462 (67)		
Loading frequency 29-86 Hz						
with $R = -1$ and $K_t = 3.1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
S_N at 10^6 cycles, MN/m ² (ksi)	352 (51)	372 (54)	407 (59)			
Loading frequency 29-86 Hz						
with $R = -1$ and $K_t = 6.4$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)			
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 49048

TABLE 6.2.2-ME3

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification: AMS-5542, MIL-N-7786B

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed, aged 978 K (1300 F) 20 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1222 (177)	1322 (192)	1401 (203)	1496 (217)	1589 (230)	
	Min	1200 (174)	1296 (188)		1469 (213)	1543 (224)	
	Std. Deviation	26.1 (3.79)	18.3 (2.66)		23.1 (3.35)	29.8 (4.33)	
TYS, MN/m ² (ksi)	Avg	815 (118)	876 (127)	936 (136)	905 (131)	936 (136)	
	Min	752 (109)	827 (120)		841 (122)	917 (133)	
	Std. Deviation	34.5 (5.00)			37.4 (5.42)	18.6 (2.70)	
Elong, percent	Avg	24.5	28.4	27.2	32.3	32.0	
	Min	23.0	26.7		31.0	28.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		15 (4)	6 (2)	3 (1)	14 (4)	12 (3)	
E, GN/m ² (10 ⁶ psi)	Avg	210 (30.4)			223 (32.4)		
	Min	201 (29.2)			223 (32.3)		
	No. of Spec. (No. of Heats)	3 (1)			2 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1158 (168)	1200 (174)		1271 (184)	1370 (199)	
	Min	1151 (167)	1200 (174)		1248 (181)	1303 (189)	
	No. of Spec. (No. of Heats)	3 (1)	3 (1)		3 (1)	3 (1)	
NTS, MN/m ² (ksi) K _t = 10	Avg	1117 (162)	1165 (169)	1179 (171)	1200 (174)	1269 (184)	
	Min						
	No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1225 (178)	1337 (194)	1403 (204)	1494 (217)	1624 (236)	
	Min	1193 (173)			1462 (212)	1606 (233)	
	Std. Deviation						
TYS, MN/m ² (ksi)	Avg	849 (123)	927 (134)	954 (138)	949 (138)	984 (143)	
	Min	814 (118)			896 (130)	958 (139)	
	Std. Deviation						
Elong, percent	Avg	25.4	26.0	26.5	32.4	32.1	
	Min	25.0			27.0	30.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (2)	3 (1)	3 (1)	5 (2)	5 (2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1158 (168)	1207 (175)		1269 (184)	1386 (201)	
	Min	(168)	(174)		1262 (183)	1358 (197)	
	No. of Spec. (No. of Heats)	2 (1)	2 (1)		2 (1)	2 (1)	
NTS, MN/m ² (ksi) K _t =	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 44291, 58060, 83417, 87612

TABLE 6.2.2-ME4

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification: AMS-5542, MIL-N-7786 B

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed, aged 978 K (1300 F) 20 hr, AC
Longitudinal specimens

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)
Fatigue, Flexural Loading, Surface Finish 54 rms			
S_N at 10^5 cycles, MN/m ² (ksi)	662 (96)	676 (98)	710 (103)
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^5 cycles	0.55	0.46	0.45
S_N at 10^6 cycles, MN/m ² (ksi)	441 (64)	469 (68)	469 (68)
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^6 cycles	0.37	0.32	0.29
S_N at 10^7 cycles, MN/m ² (ksi)	386 (56)	434 (63)	
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^7 cycles	0.32	0.30	
Fatigue, Flexural Loading, Surface Finish 8 rms			
S_N at 10^5 cycles, MN/m ² (ksi)	676 (98)	758 (110)	841 (122)
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^5 cycles	0.55	0.50	0.47
S_N at 10^6 cycles, MN/m ² (ksi)	496 (72)	579 (84)	655 (95)
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^6 cycles	0.41	0.38	0.41
S_N at 10^7 cycles, MN/m ² (ksi)	428 (62)	510 (74)	
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^7 cycles	0.35	0.34	

References: 83417

TABLE 6.2.2-ME4.1

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded Inconel X-750 filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed sheet welded and tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	779.1 (113.0)	857.7 (124.4)	908.0 (131.7)	1033 (149.8)	1107 (160.6)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	372 (54.0)	405 (58.7)	434 (63.0)	478 (69.3)	510 (74.0)	
	Min						
Std. Deviation							
Elong, percent	Avg	40.8	44.2	44.7	49.7	38.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 58060

TABLE 6.2.2-ME4.2

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, Inconel X-750 filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed sheet, welded, weldment aged 20 hr @ 1300 F, then tested

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	1249 (187.1)	1347 (195.4)	915.6 (204.2)	1542 (223.7)	1661 (240.9)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	864.6 (125.4)	915.6 (132.8)	940.4 (136.4)	946.7 (137.3)	1017 (147.5)	
	Min						
Std. Deviation							
Elong, percent	Avg	22.5	24.3	23.5	29.7	28.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 58060

TABLE 6.2.2-ME4.3

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, Inconel X-750 filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed Sheet, aged 20 hr @ 1300 F, welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	825.3 (119.7)	928.0 (134.6)	988.7 (143.4)	1087 (157.7)	1220 (176.9)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	498 (72.3)	592 (85.9)	645 (93.5)	678 (98.3)	793.6 (115.1)	
	Min						
Std. Deviation							
Elong, percent	Avg	8.5	10.2	10.7	14.0	14.5	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 58060

TABLE 6.2.2-ME4.4

Inconel X-750
Sheet-Weld Metal

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, Inco weld 69 filler alloy

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Vacuum annealed 1325 K (1925 F) 30 min + rapid FC with N₂ gas; heated in air 978 K (1300 F) 20 hr, AC, after welding, then tested

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1172 (170.0)			1438 (208.5)		
	Min	1165 (168.9)			1421 (206.1)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	768.8 (111.5)			850.8 (123.4)		
	Min	768.1 (111.4)			846.7 (122.8)		
Std. Deviation							
Elong, percent	Avg	14.0			19.4		
	Min	14.0			18.8		
RA, percent							
	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	211 (30.6)			214 (31.0)		
	Min	205 (29.7)			213 (30.9)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)							
K _t =	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)							
K _t =	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent							
	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)							
K _t =	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)							
K _t =	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 87612

TABLE 6.2.2-ME5

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed, aged 978 K (1300 F) 20 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1190 (173)	1303 (189)	1558 (226)	1579 (229)		
	Min	1177 (171)			1482 (215)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	756 (110)			924 (134)		
	Min	756 (110)			910 (132)		
Std. Deviation							
Elong, percent	Avg	26.5			24.7		
	Min	26.0			23.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1127 (163)			1305 (189)		
	Min	1100 (160)					
K _t = 6.3							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 65182, 66080

TABLE 6.2.2-ME6

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed, aged 978 K (1300 F) 20 hr, AC

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
<u>Compression, Longitudinal</u>						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN /m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Compression, Transverse</u>						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Shear(a)</u>						
SUS, MN/m ² (ksi)	Avg	814 (118)	910 (132)	1034 (148)	1055 (153)	
	Min					
No. of Spec (No. of Heats)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Impact, Charpy V</u>						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Fracture Toughness(b)</u>						
K _{IC} MN/m ^{3/2} (ksi√ in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√ in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 65182

(a) Indicate specimen design and orientation for shear specimens: 0.39 cm (0.155 in.) diameter, longitudinal

(b) Indicate specimen design for K_{IC} data:

TABLE 6.2.2-ME6.1

Alloy Designation: Inconel X-750 Nickel-Base Alloy N07750

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Hot Isostatic Pressed

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1170 (169.7)	1406 (203.9)	1486 (215.5)			
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	743.3 (107.8)	855.6 (124.1)	897.0 (103.1)			
	Min						
Std. Deviation							
Elong, percent	Avg	34.9	29.3	30.5			
	Min						
RA, percent	Avg	38.7	24.2	22.9			
	Min						
No. of Spec. (No. of Heats)		1	1	1			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1379 (200.0)	1533 (222.4)	1611 (233.6)			
K _t = 10	Min						
No. of Spec. (No. of Heats)		1	1	1			
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 94206E
94208G

TABLE 6.2.2-ME6.2

Alloy Designation: Inconel X-750 Nickel-Base Alloy N07750

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Hot Isostatic Pressed; solution treated 1255 K (1800 F) 1 hr., AC; double aged 1005 K (1350 F) 8 hr., FC to 894 K (1150 F), hold 8 hr., AC

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1336 (173.8)	1464 (212.4)	1526 (221.3)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	930.1 (134.9)	1016 (147.3)	1038 (150.5)			
	Min						
Std. Deviation							
Elong, percent	Avg	23.2	17.5	18.8			
	Min						
RA, percent	Avg	18.0	13.9	13.3			
	Min						
No. of Spec. (No. of Heats)		1	1	1			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1602 (232.3)	1702 (246.8)	1698 (246.2)			
K _t = 10	Min						
No. of Spec. (No. of Heats)		1	1	1			
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 94206E
94208G

TABLE 6.2.2-ME7

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification: AMS-5667

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed, aged 978 K (1300 F) 20 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	17 (-430)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1338 (194)	1406 (204)	1575 (228)	1696 (246)	1718 (249)	
	Min	1300 (189)	1400 (203)	1562 (226)	1662 (241)	1710 (248)	
	Std. Deviation	35.2 (5.11)		16.6 (2.41)			
TYS, MN/m ² (ksi)	Avg	986 (143)	990 (144)	1048 (152)	1085 (158)	1082 (157)	
	Min	940 (136)	989 (144)	1036 (150)	1060 (154)	1076 (156)	
	Std. Deviation	47.5 (6.89)		23.2 (3.37)	21.0 (3.05)		
Elong, percent	Avg	25.0	30.0	32.2	32.8	33.0	
	Min	22.0		29.0	29.0	31.0	
RA, percent	Avg	49.0	48.2	45.3	42.3	45.6	
	Min	44.6	47.4	44.6	40.0	44.0	
No. of Spec. (No. of Heats)		15 (3)	2 (1)	10 (2)	7 (2)	4 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							

References: 54986, 64373, 83417

TABLE 6.2.2-ME8

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification: AMS-5667

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed, aged 978 K (1300 F) 20 hr, AC

Testing Temperature, K (F)	297	(75)		77	(-320)			
<u>Compression, Longitudinal</u>								
CYS, MN/m ² (ksi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Ec, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
<u>Compression, Transverse</u>								
CYS, MN/m ² (ksi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Ec, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
<u>Shear(a)</u>								
SUS, MN/m ² (ksi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
G, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
<u>Impact, Charpy V</u>								
Long., J(ft-lb)	Avg	54.5	(40.2)	47.2	(34.8)			
	Min	54.2	(40.0)	46.8	(34.5)			
No. of Spec. (No. of Heats)		3	(1)	3	(1)			
Trans., J(ft-lb)	Avg							
	Min							
No. of Spec. (No. of Heats)								
<u>Fracture Toughness(b)</u>								
K _{IC} MN/m ^{3/2} (ksi√ in.)	Avg							
	Min							
Orientation, —								
No. of Spec. (No. of Heats)								
K _{IE} , MN/m ^{3/2} (ksi√ in.)	Avg							
(From PTSC spec.)(—)Min								
No. of Spec. (No. of Heats)								

References: 54986

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 6.2.2-ME9

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification: AMS-5667

Form: Bar

Diameter, cm (in.): Up to 2.54 cm (1.000 in.)

Condition: 1255 K (1800 F), FC to 978 K (1300 F), held at 978 K (1300 F) 20 hr, AC

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)	745 (108)		1014 (147)	1062 (154)		
Loading frequency 28 Hz						
with R = 0 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.57		0.64	0.62		
S_N at 10^7 cycles, MN/m ² (ksi)	572 (83)		855 (124)			
Loading frequency 28 Hz						
with R = 0 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N /TUS at 10^7 cycles	0.43		0.54			
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 83417

TABLE 6.2.2-ME10

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification: AMS-5668

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed 1423 K (2100 F) 2-4 hr, AC; reheated to 1117 K (1550 F) 24 hr, cooled to 978 K (1300 F) within 2 hr, held at 978 K (1300 F) 20 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1196 (174)	1282 (186)	1438 (208)	1435 (208)		
	Min	1186 (172)	1276 (185)	1434 (208)	1420 (206)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	700 (102)	793 (115)	814 (118)	896 (130)		
	Min	696 (101)	793 (115)	814 (118)	896 (130)		
Std. Deviation							
Elong, percent	Avg	25	22.5	19	14.5		
	Min	24	22	19	13		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 35611

TABLE 6.2.2-ME10.1

Alloy Designation: Inconel X-750 Nickel-Base Alloy

N07750

Specification:

Form: Bar

Thickness, cm (in.): 2.541 to 5.000 (1.001 to 2.000)

Condition: Solution Treated 1255 K (1800 F) 1 hr., AC; double aged 1005 K (1350 F) 8 hr., FC to 894 K (1150 F), hold 8 hr., AC

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg Min	1318 (191.1)	1603 (232.5)	1751 (254.0)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg Min	918 (133.1)	1136 (164.8)	1194 (173.2)			
Std. Deviation							
Elong, percent	Avg Min	23.8	26.2	27.1			
RA, percent	Avg Min	27.7	20.8	19.4			
No. of Spec. (No. of Heats)		1	1	1			
E, GN/m ² (10 ⁶ psi)	Avg Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg Min						
K _t = No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg Min						
K _t = No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg Min						
Std. Deviation							
Elong, percent	Avg Min						
RA, percent	Avg Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg Min	1688 (244.8)	1753 (254.2)	1773 (257.2)			
K _t = 10 No. of Spec. (No. of Heats)		1	1	1			
NTS, MN/m ² (ksi)	Avg Min						
K _t = No. of Spec. (No. of Heats)							

References: 94206E
94208G

TABLE 6.2.2-ME10.3

Alloy Designation: Inconel X-750 Nickel-Base Alloy N07750

Specification:

Form: Bar
 Thickness, cm (in.): Over 5.080 (2.000)
 Condition: Solution Treated 1255 K (1800 F) 1 hr., AC

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	987.3 (143.2)	1086 (157.5)	1018 (147.7)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	663 (96.2)	770.2 (111.7)	736.4 (106.3)			
	Min						
Std. Deviation							
Elong, percent	Avg	17.6	15.6	14.1			
	Min						
RA, percent	Avg	18.2	13.8	12.9			
	Min						
No. of Spec. (No. of Heats)		1	1	1			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1201 (174.2)	1342 (194.7)	1411 (204.6)			
K _t = 10	Min						
No. of Spec. (No. of Heats)		1	1	1			
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 94206E
 94208G

TABLE 6.2.2-ME10.4

Alloy Designation: Inconel X-750 Nickel-Base Alloy N07750

Specification:

Form: Bar

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution Treated 1255 K (1800 F) 1 hr., AC; double aged 1005 K (1350 F) 8 hr., FC to 894 K (1150 F), hold 8 hr., AC

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1176 (170.6)	1302 (188.9)	1314 (190.6)			
	Min	1098 (159.2)	1140 (165.4)	1051 (152.5)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	836.3 (121.3)	906.0 (131.4)	920.5 (133.5)			
	Min	823.9 (119.5)	892.2 (129.4)	866.7 (125.7)			
Std. Deviation							
Elong, percent	Avg	19.5	20.8	16.7			
	Min	12.2	9.2	6.1			
RA, percent	Avg	25.5	18.8	16.5			
	Min	12.4	8.6	6.2			
No. of Spec. (No. of Heats)		2 (2)	2 (2)	2 (2)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1465 (212.2)	1538 (223.0)	1623 (235.4)			
	Min	1382 (200.5)	1408 (204.2)	1480 (214.7)			
No. of Spec. (No. of Heats)		2 (2)	2 (2)	2 (2)			
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 94206E
94208G

TABLE 6.2.2-ME10.5

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Bar-TIG welded, Inco weld 69 filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F), 1 hr, AC, weld, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	838.4 (121.6)			987.3 (143.2)		1003 (145.5)
Std. Deviation	Min						
TYS, MN/m ² (ksi)	Avg	627 (91.0)			717.1 (104.0)		750.2 (108.8)
Std. Deviation	Min						
Elong, percent	Avg	13.3			13.6		12.7
	Min						
RA, percent	Avg	27.0			22.0		17.1
	Min						
No. of Spec. (No. of Heats)		1					1
E, GN/m ² (10 ⁶ psi)	Avg						
No. of Spec. (No. of Heats)	Min						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1098 (159.2)			1393 (202.0)		1475 (214.0)
K _t = 10	Min						
No. of Spec. (No. of Heats)		1					1
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
Std. Deviation	Min						
TYS, MN/m ² (ksi)	Avg						
Std. Deviation	Min						
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
No. of Spec. (No. of Heats)	Min						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

TABLE 6.2.2-ME10.6

Inconel X-750
Bar-Weld Metal

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Bar-TIG welded, Inco weld 69 filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; age 1005 K (1350 F) 8 hr, FC to 994 K (1150 F), 8 hr, AC, weld and tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 840.4 (121.9)			968.7 (140.5)		992.9 (144.0)
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 649 (94.1)			800.5 (116.1)		861.8 (125.0)
	Min					
Std. Deviation						
Elong, percent	Avg 8.2			5.5		4.8
	Min					
RA, percent	Avg 27.0			17.0		14.5
	Min					
No. of Spec. (No. of Heats)	1			1		1
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 1172 (170.0)			1434 (208.0)		1485 (215.4)
	Min					
K _t = 10						
No. of Spec. (No. of Heats)	1			1		1
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 94208

TABLE 6.2.2-ME10.7

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Bar, TIG welded, Inco weld 69 filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; weld, Solution treated weldment 1255 K (1800 F) 1 hr, AC, age 1005 K (1350 F) 8 hr, FC to 994 K (1150 F) 8hr, AC, test

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	1096 (159.0)			1109 (160.8)		1124 (163.0)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	856.3 (124.3)			930.8 (135.0)		958.4 (139.0)
	Min						
Std. Deviation							
Elong, percent	Avg	9.0			5.6		5.5
	Min						
RA, percent	Avg	11.9			9.2		8.7
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1571 (227.8)			1710 (248.0)		1629 (236.2)
$K_t = 10$	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							

References: 94208

TABLE 6.2.2-ME10.8

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Bar, Vac. E.B. Weld, no filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; weld, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	772.2 (112.0)			948.0 (137.5)		966.0 (140.1)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	552 (80.0)			677 (98.2)		730.8 (106.0)
	Min						
Std. Deviation							
Elong, percent	Avg	8.0			11.8		11.6
	Min						
RA, percent	Avg	30.8			25.0		19.6
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1009 (146.3)			1227 (178.0)		1337 (193.9)
K _t = 10	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

TABLE 6.2.2-ME10.9

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Bar, Vac. E. B. Weld, no filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; weld, solution treated weldment 1255 K (1800 F) 1 hr, AC, age 1005 K (1350 F) 8 hr, FC to 994 K (1150 F) 8 hr, AC, tested

Testing Temperature, K (F)		297 (75)		77 (-320)		4 (-452)
<u>Tension, Longitudinal</u>						
TUS, MN/m ² (ksi)	Avg	1089 (157.9)		1082 (156.9)		1062 (154.1)
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	841.9 (122.1)		903.2 (131.0)		913.6 (132.5)
	Min					
Std. Deviation						
Elong, percent	Avg	10.0		6.4		7.1
	Min					
RA, percent	Avg	10.3		8.7		8.7
	Min					
No. of Spec. (No. of Heats)		1		1		1
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg	1496 (217.0)		163.3 (236.9)		1684 (244.2)
K _t = 10	Min					
No. of Spec. (No. of Heats)		1		1		1
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
<u>Tension, Transverse</u>						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 94208

TABLE 6.2.2-ME10.10

Alloy Designation: Inconel X-750 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Bar, Vac. E.B. Weld, no filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; Age 1005 K (1350 F) 8 hr, FC to 994 K (1150 F) 8 hr, AC, weld and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	806.7 (117.0)			920.5 (133.5)		936.3 (135.8)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	594 (86.2)			751.5 (109.0)		770.8 (111.8)
	Min						
Std. Deviation							
Elong, percent	Avg	3.2			2.6		3.0
	Min						
RA, percent	Avg	30.3			11.4		10.3
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1070 (155.2)			1320 (191.5)		1403 (203.5)
	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 94208

TABLE 6.2.2-ME11

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification: AMS-5667 F, AMS-5668D, AMS-5669, AMS-5671, MIL-H-8550

Form: Forgings

Thickness, cm (in.):

Condition: Aged 978 K (1300 F) 20 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension							
TUS, MN/m ² (ksi)	Avg	1179 (171)		1433 (208)			
	Min	1131 (164)		1379 (200)			
	Std. Deviation	23.4 (3.39)		35.0 (5.07)			
TYS, MN/m ² (ksi)	Avg	828 (120)		900 (131)			
	Min	800 (116)		869 (126)			
	Std. Deviation	17.4 (2.52)		15.1 (2.19)			
Elong, percent	Avg	25.2		27.9			
	Min	24		24			
RA, percent	Avg	34.8		32.2			
	Min	30.8		28.1			
No. of Spec. (No. of Heats)		9 (1)		9 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							

References: 70525

TABLE 6.2.2-ME12

Alloy Designation: Inconel X-750 Nickel-Base Alloy

Specification: AMS-5667 F, AMS-5668D, AMS-5669, AMS-5671, MIL-H-8550

Form: Forgings

Thickness, cm (in.):

Condition: Aged 978 K (1300 F) 20 hr, AC

Testing Temperature, K (F)	297	(75)		77	(-320)			
<u>Compression, Longitudinal</u>								
CYS, MN/m ² (ksi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Ec, GN /m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
<u>Compression, Transverse</u>								
CYS, MN/m ² (ksi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Ec, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
<u>Shear(a)</u>								
SUS, MN/m ² (ksi)	Avg	782	(113)	850	(123)			
	Min	774	(112)	826	(120)			
No. of Spec. (No. of Heats)		5	(1)	5	(1)			
G, GN/m ² (10 ⁶ psi)	Avg	56.3	(8.17)	60.9	(8.84)			
	Min	50.8	(7.38)	56.6	(8.21)			
No. of Spec (No. of Heats)		6	(1)	6	(1)			
<u>Impact, Charpy V</u>								
Long., Nm(ft-lb)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Trans., Nm(ft-lb)	Avg							
	Min							
No. of Spec (No. of Heats)								
<u>Fracture Toughness(b)</u>								
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg							
	Min							
Orientation: —								
No. of Spec. (No. of Heats)								
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg							
(From PTSC spec.)(—)Min								
No. of Spec (No. of Heats)								

References: 70525

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 6.2.2-ME12.1

Alloy Designation: Inconel X-750 Nickel-Base Alloy N07750

Specification:

Form: Forgings

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: Solution Treated 1255 K (1800 F) 1 hr., AC; double aged 1144 K (1600 F)
24 hr., AC, 977 K (1300 F) 20 hr., AC

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1179 (171)	1413 (205)	1551 (225)			
	Min	1149 (166.7)	1406 (203.9)	1546 (224.2)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	710 (103)	814 (118)	869 (126)			
	Min	694 (100.7)	798 (115.7)	860 (124.7)			
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2	2	2			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 94206B

TABLE 6.2.2-ME12.2

Alloy Designation:		Inconel X-750 Ncikel-Base Alloy		N07750		
Specification:						
Form:		Forgings				
Thickness, cm (in.):		2.541 to 5.080 (1.001 to 2.000)				
Condition:		Solution Treated 1255 K (1800 F) 1 hr., AC + age 1144 K (1600 F) 24 hr., AC + age 977 K (1300 F) 20 hr., AC				
Testing Temperature, K (F)		297 (75)	77 (-320)			
<u>Compression, Longitudinal</u>						
CYS, MN/m ² (ksi)		Avg				
		Min				
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)		Avg				
		Min				
No. of Spec. (No. of Heats)						
<u>Compression, Transverse</u>						
CYS, MN/m ² (ksi)		Avg				
		Min				
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)		Avg				
		Min				
No. of Spec. (No. of Heats)						
<u>Shear(a)</u>						
SUS, MN/m ² (ksi)		Avg				
		Min				
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)		Avg				
		Min				
No. of Spec. (No. of Heats)						
<u>Dynamic Modul:</u>						
E, GN/m ² (10 ⁶ psi)		Avg				
		Min				
G, GN/m ² (10 ⁶ psi)		Avg				
		Min				
B, GN/m ² (10 ⁶ psi)		Avg				
		Min				
Poisson's Ratio		Avg				
		Min				
No. of Spec.						
<u>Impact, Charpy V</u>						
Long., Nm(ft-lb)		Avg				
		Min				
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)		Avg				
		Min				
No. of Spec. (No. of Heats)						
<u>Fracture Toughness</u>						
K _{Ic} MN/m ^{3/2} (ksi√in.)		Avg				
		Min				
Orientation:						
No. of Spec. (No. of Heats)						
J _{Ic} , kJ/m ² (in.-lb/in.2)(b)		Avg	192 (1100)	154 (880)		
		Min	178 (1020)	133 (760)		
No. of Spec. (No. of Heats)			4	4		

References: 94206B

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for J_{IC} data: Compact specimens

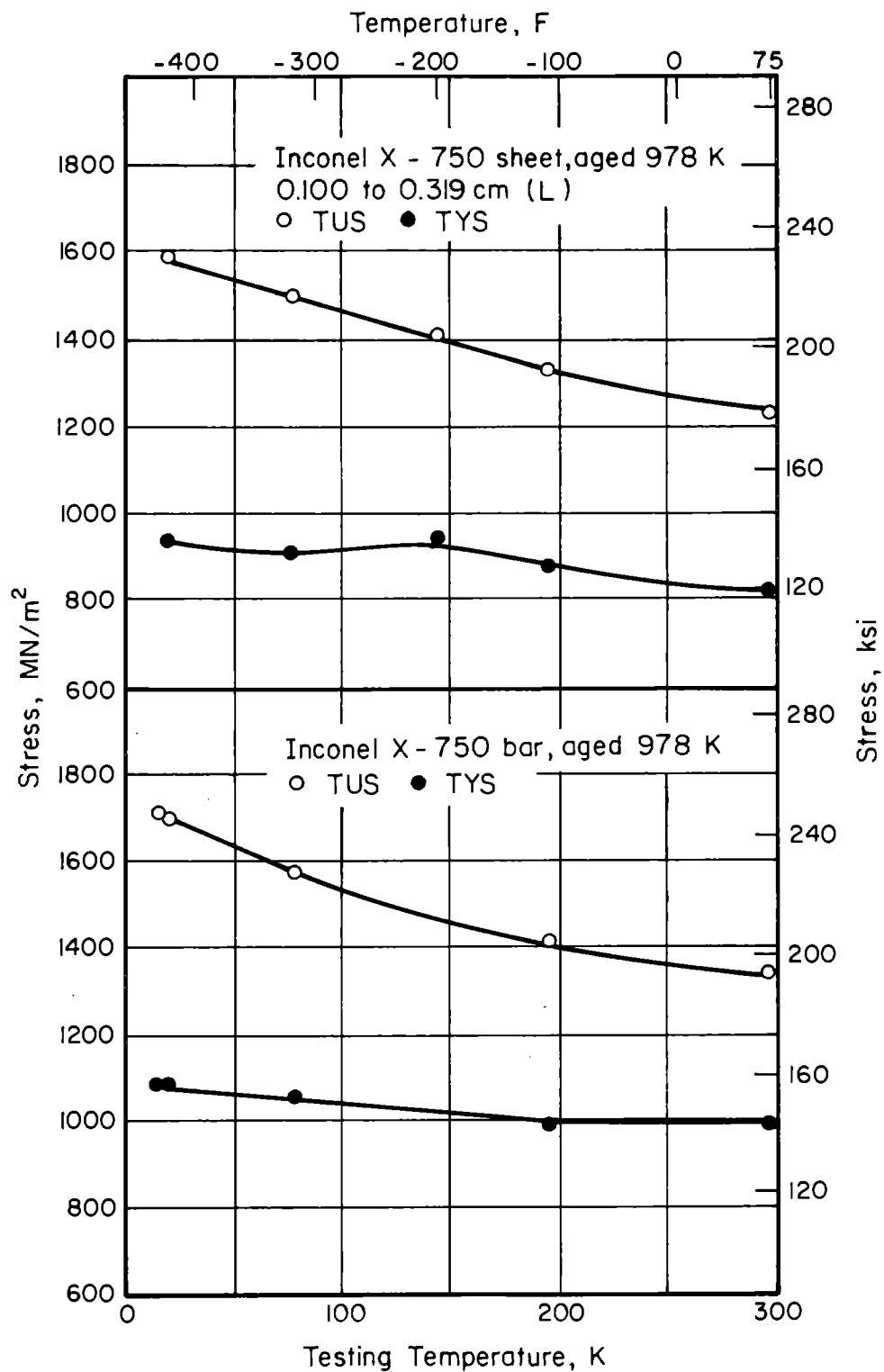


FIGURE 6.2.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF INCONEL X-750

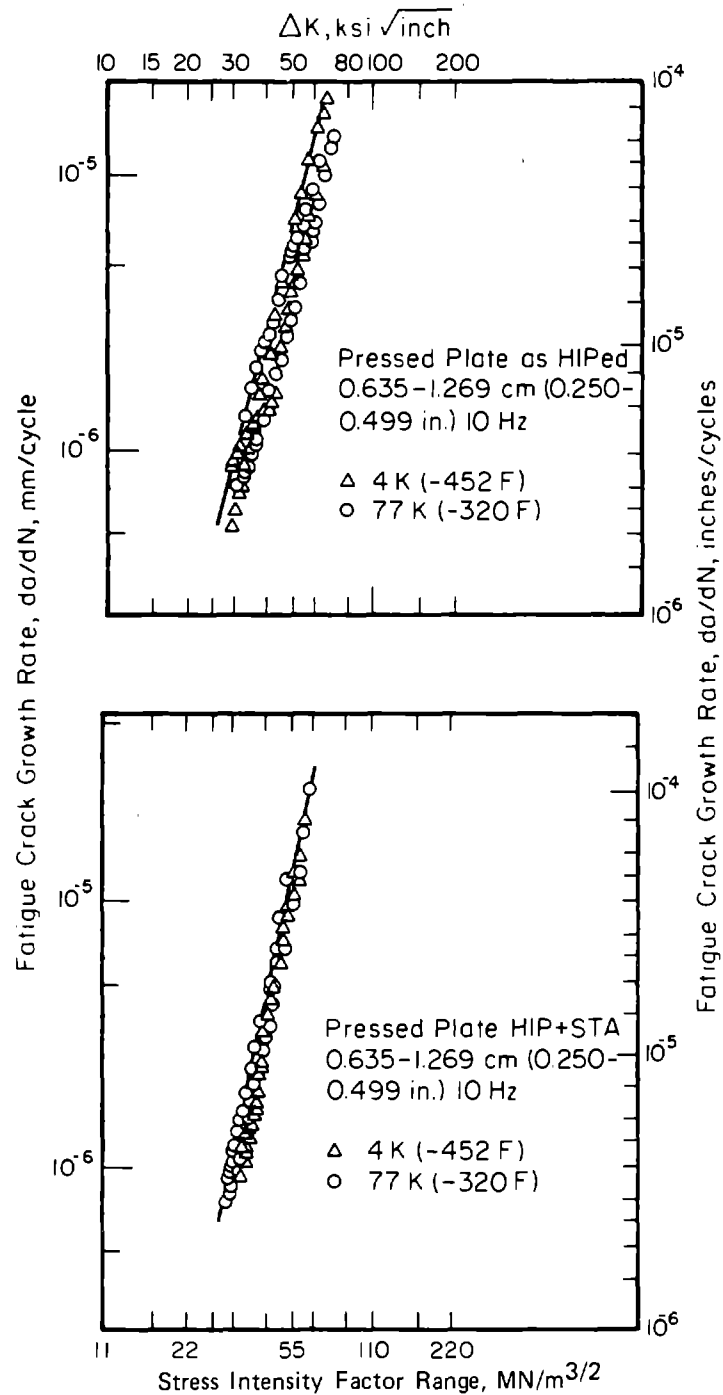


FIGURE 6.2.2-ME2. FATIGUE CRACK GROWTH RATES OF HOT ISOSTATIC PRESSED (HIP) INCONEL X750 IN CRYOGENIC ENVIRONMENTS(94208G)

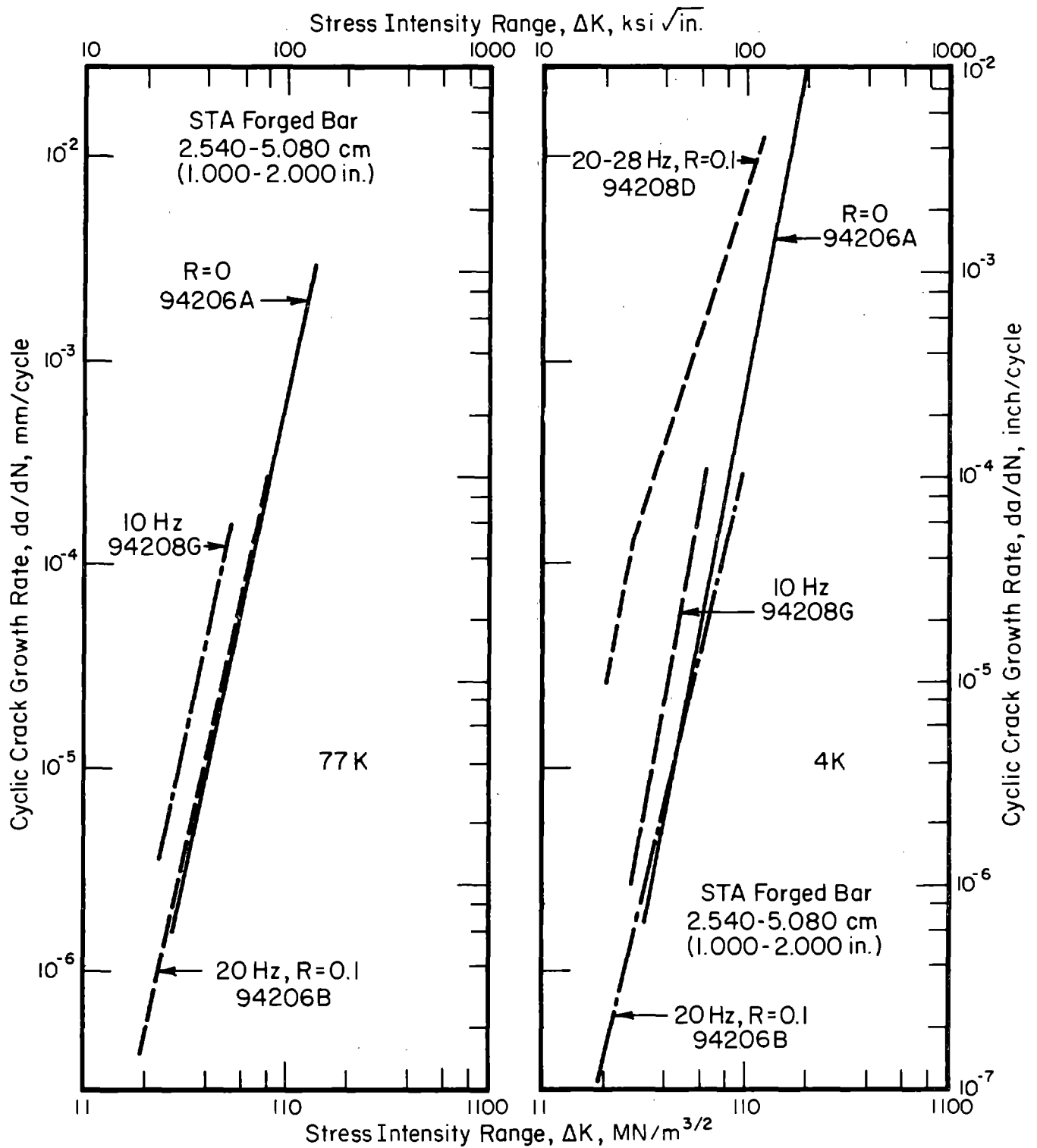


FIGURE 6.2.2-ME3. FATIGUE CRACK GROWTH RATES FOR INCONEL X-750
AT 77 K AND 4 K (-320 F AND -452 F)

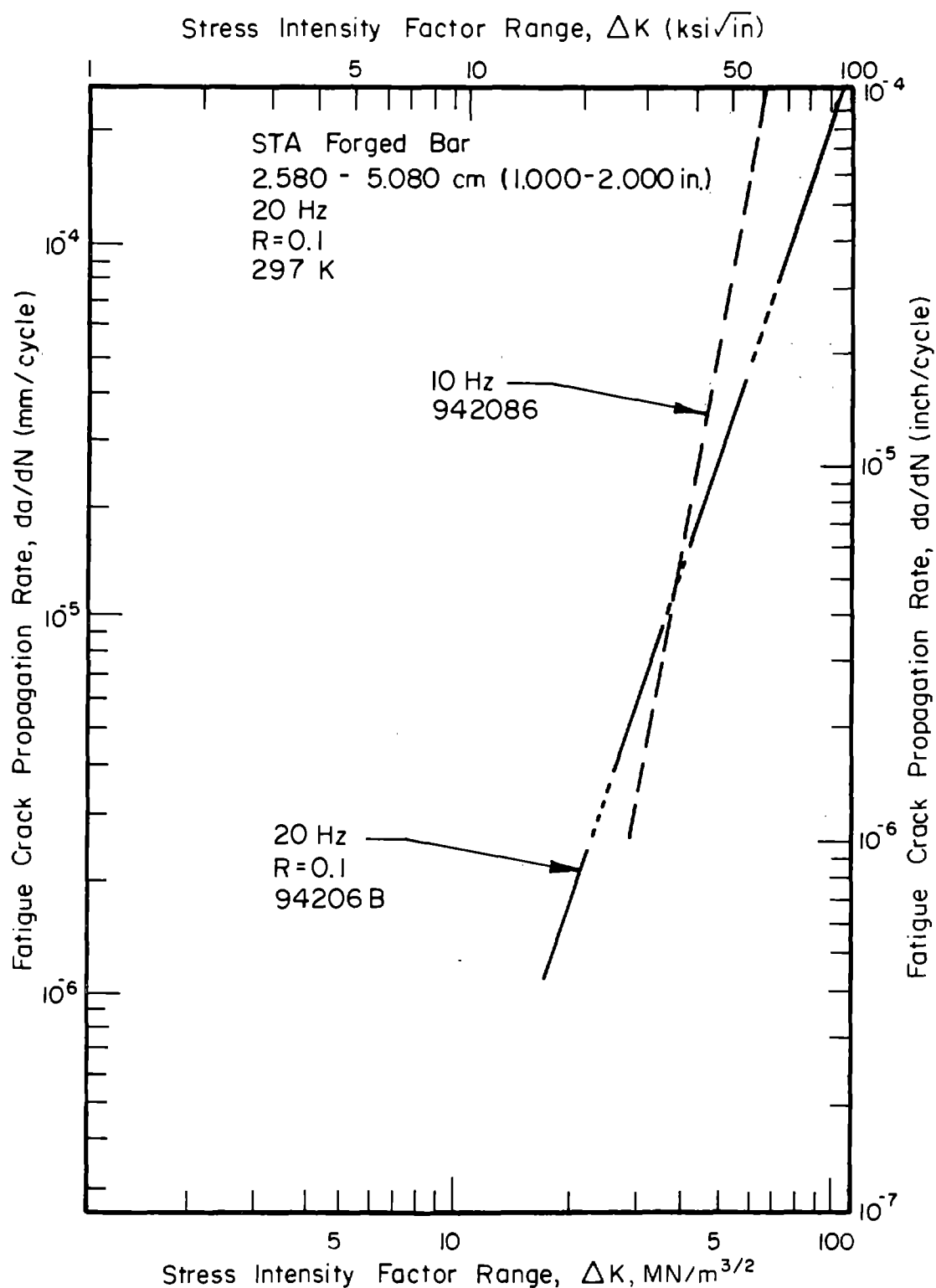


FIGURE 6.2.2-ME4. FATIGUE CRACK GROWTH RATES FOR INCONEL X-750 AT 297 K (75 F)

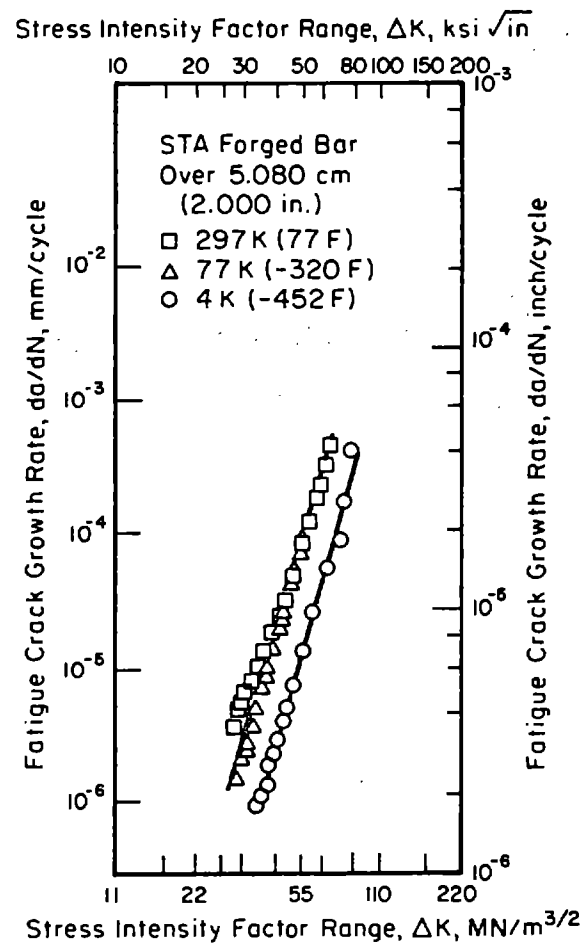


FIGURE 6.2.2-ME5. FATIGUE CRACK GROWTH RATES OF INCONEL X-750(94208G)

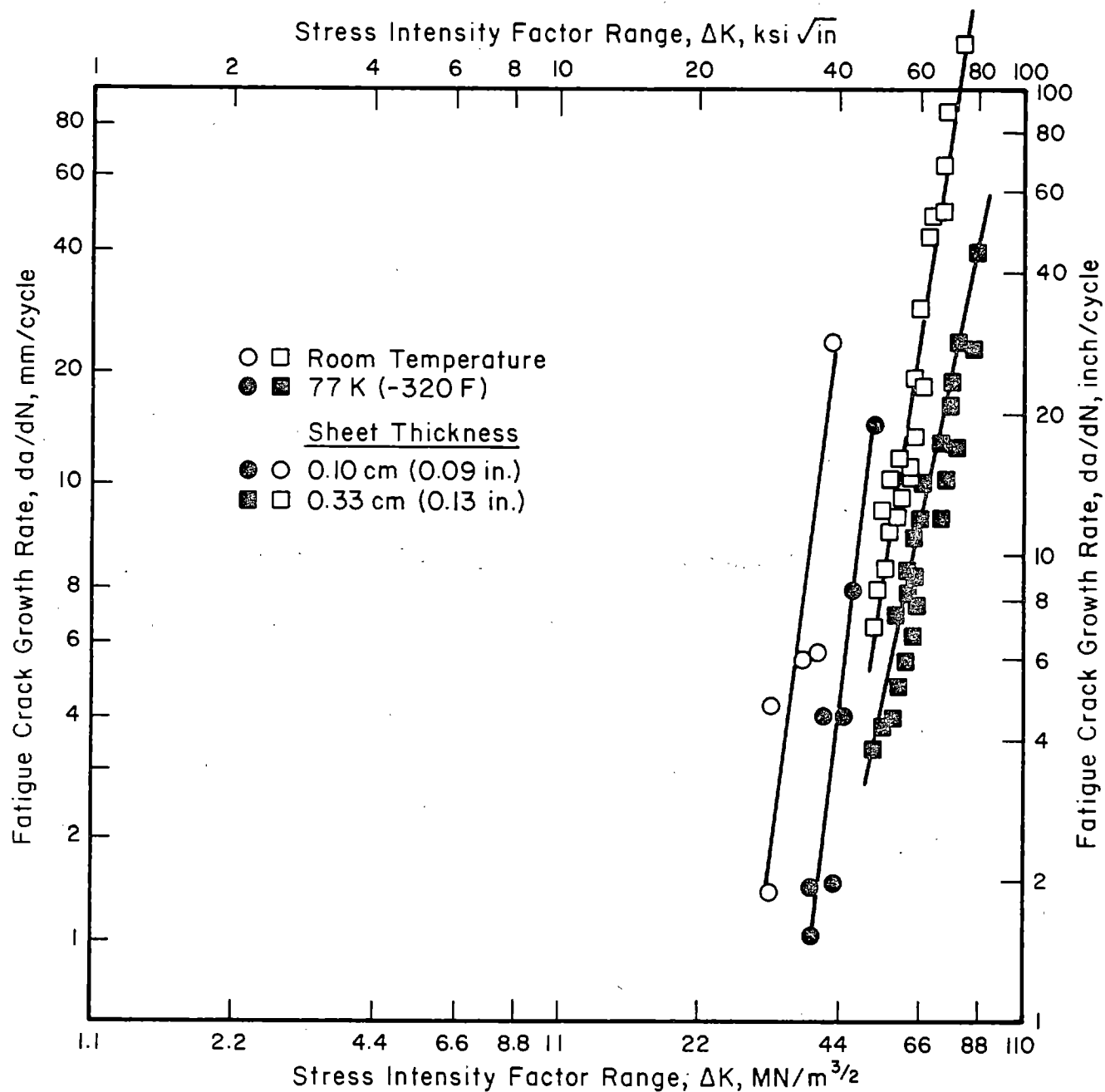


FIGURE 6.2.2-ME6. FATIGUE CRACK GROWTH RATE OF INCONEL X-750 NICKEL-BASE ALLOY SHEET [Annealed in vacuum, 1325 K (1925 F) 30 min + rapid furnace quenched with N₂ gas; heated in air at 978 K (1300 F) 20 hours, air cooled] [87612]

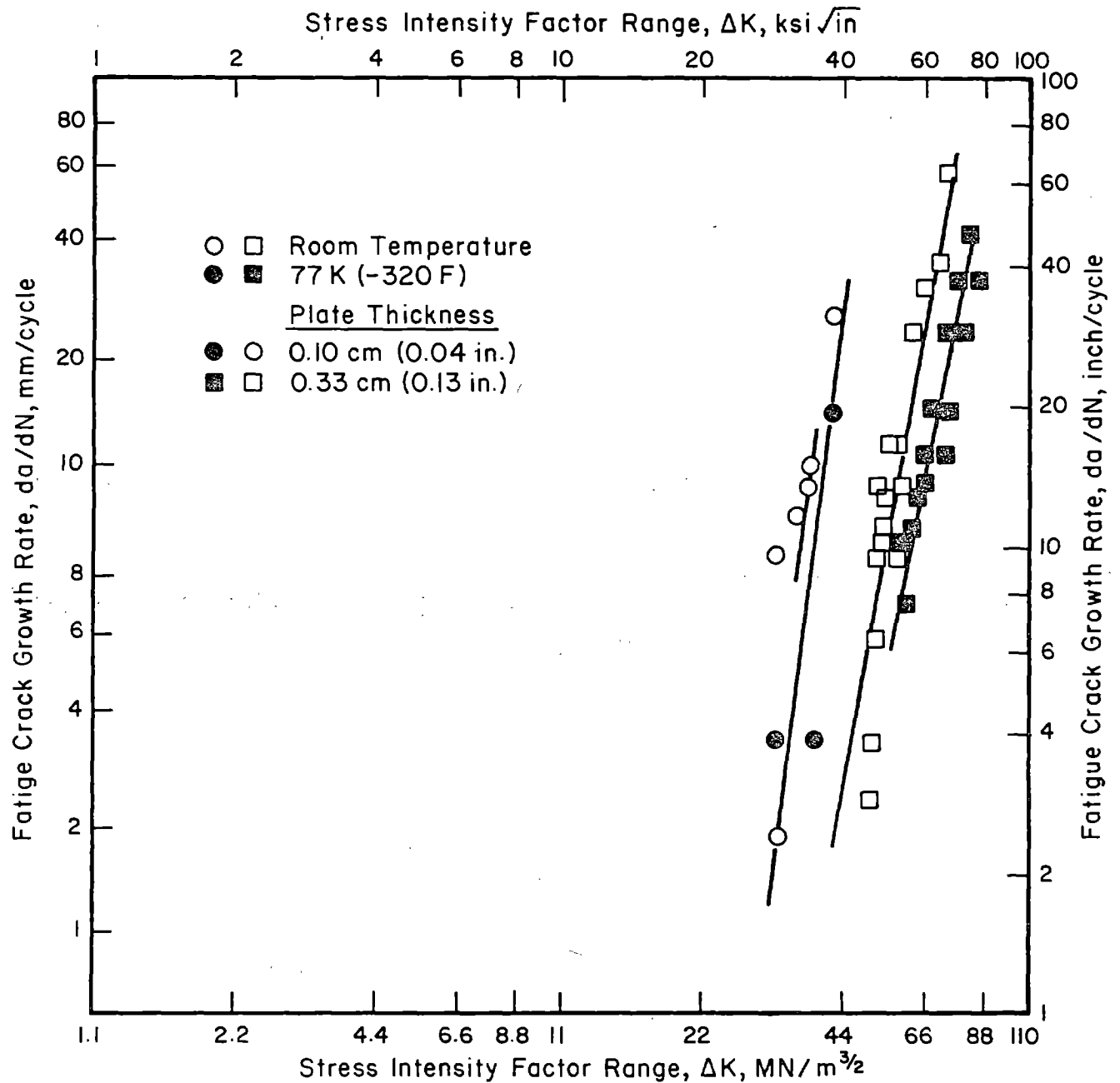


FIGURE 6.2.2-ME7. FATIGUE CRACK GROWTH RATE OF INCONEL X-750 NICKEL-BASE ALLOY SHEET TIG WELDED USING INCO WELD 69 FILLER [Weld specimens annealed in vacuum 1325 K (1925 F) 30 min + rapid furnace quenched with N_2 gas; heated in air at 978 K (1300 F) 20 hours, air cooled prior to testing] [87612]

TABLE 6.2.2-TR1

Alloy Designation: Inconel X-750 Nickel Alloy

Specification:

Form:

Dimension:

Condition: Solution Treated and Double Aged

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	11.4	9.27	7.51	3.62	1.61	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(6.59)	(5.36)	(4.34)	(2.09)	(0.93)	
Watts m ⁻¹ K ⁻¹ (a)	11.4	9.27	7.66	3.93	1.81	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹ (a)	(6.59)	(5.36)	(4.43)	(2.27)	(1.05)	
No. of Spec.	2	2	2	2	2	
References: 94206, 94208						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.186	-0.212	-0.220	-0.222	
No. of Spec.	1	1	1	1	1	
References: 95168						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	440	230	91*	7.10	2.73	1.09
Btu lb ⁻¹ F ⁻¹	(0.105)	(5.50 x 10 ⁻²)	(2.17 x 10 ⁻²)	(1.70 x 10 ⁻³)	(6.52 x 10 ⁻⁴)	(2.61 x 10 ⁻⁴)
No. of Spec.	4	4	0	4	4	4
References: 95168						
Electrical Resistivity						
Ohm m	122.6 x 10 ⁻⁸	118.8 x 10 ⁻⁸	117.3 x 10 ⁻⁸	117.1 x 10 ⁻⁸	117.4 x 10 ⁻⁸	
Ohm circular mil ft ⁻¹	(737)	(715)	(706)	(704)	(706)	
Ohm m (a)	126.7 x 10 ⁻⁸	124.4 x 10 ⁻⁸	123.9 x 10 ⁻⁸	123.8 x 10 ⁻⁸	124.0 x 10 ⁻⁸	
Ohm circular mil ft ⁻¹ (a)	(762)	(748)	(745)	(745)	(746)	
No. of Spec.	2	2	2	2	2	
References: 94206, 94208						

(a) Solution treated.

* Extrapolated.

INCONEL X-750

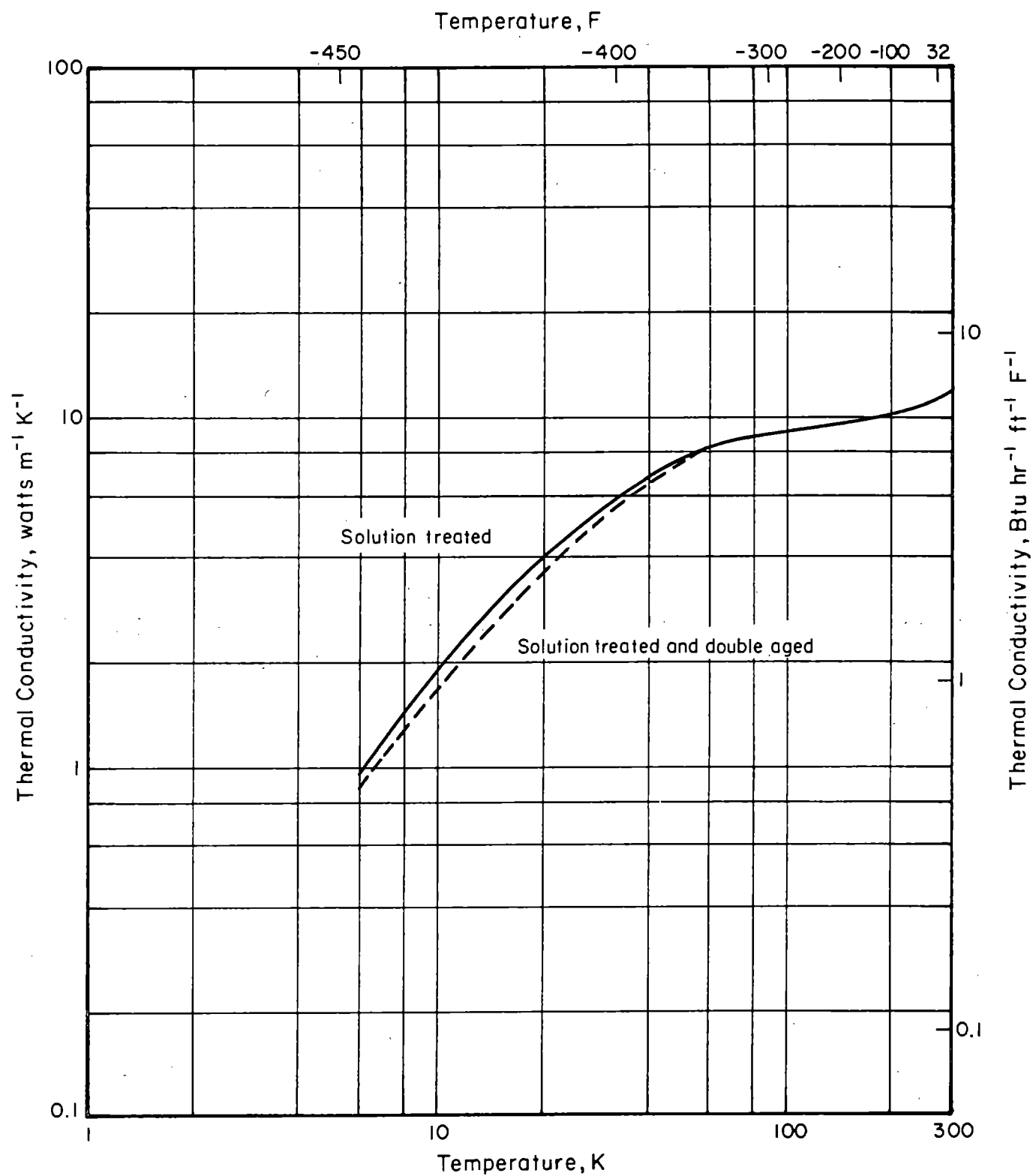


FIGURE 6.2.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR INCONEL X-750
NICKEL-BASE ALLOY

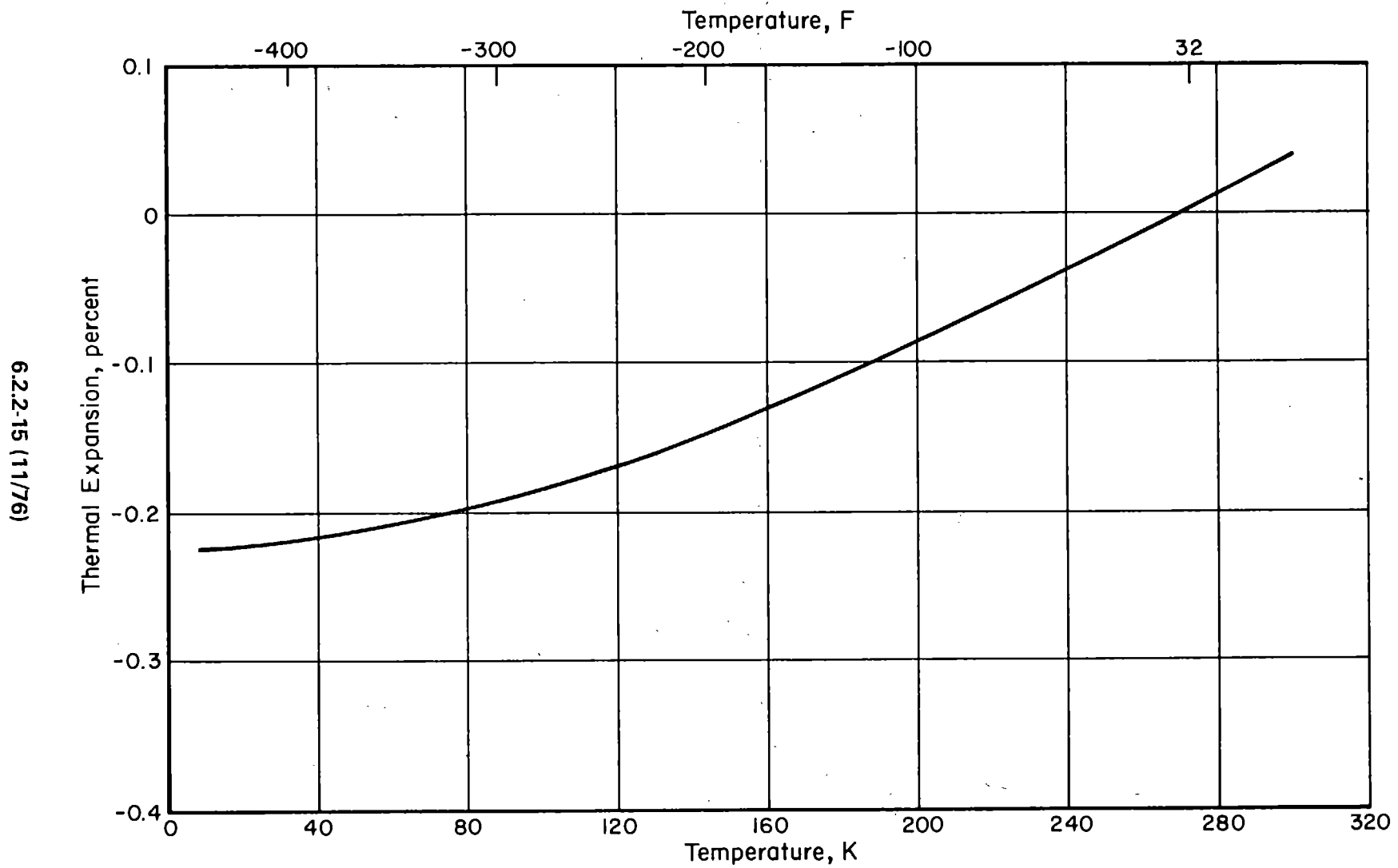


FIGURE 6.2.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR INCONEL X-750 NICKEL-BASE ALLOY

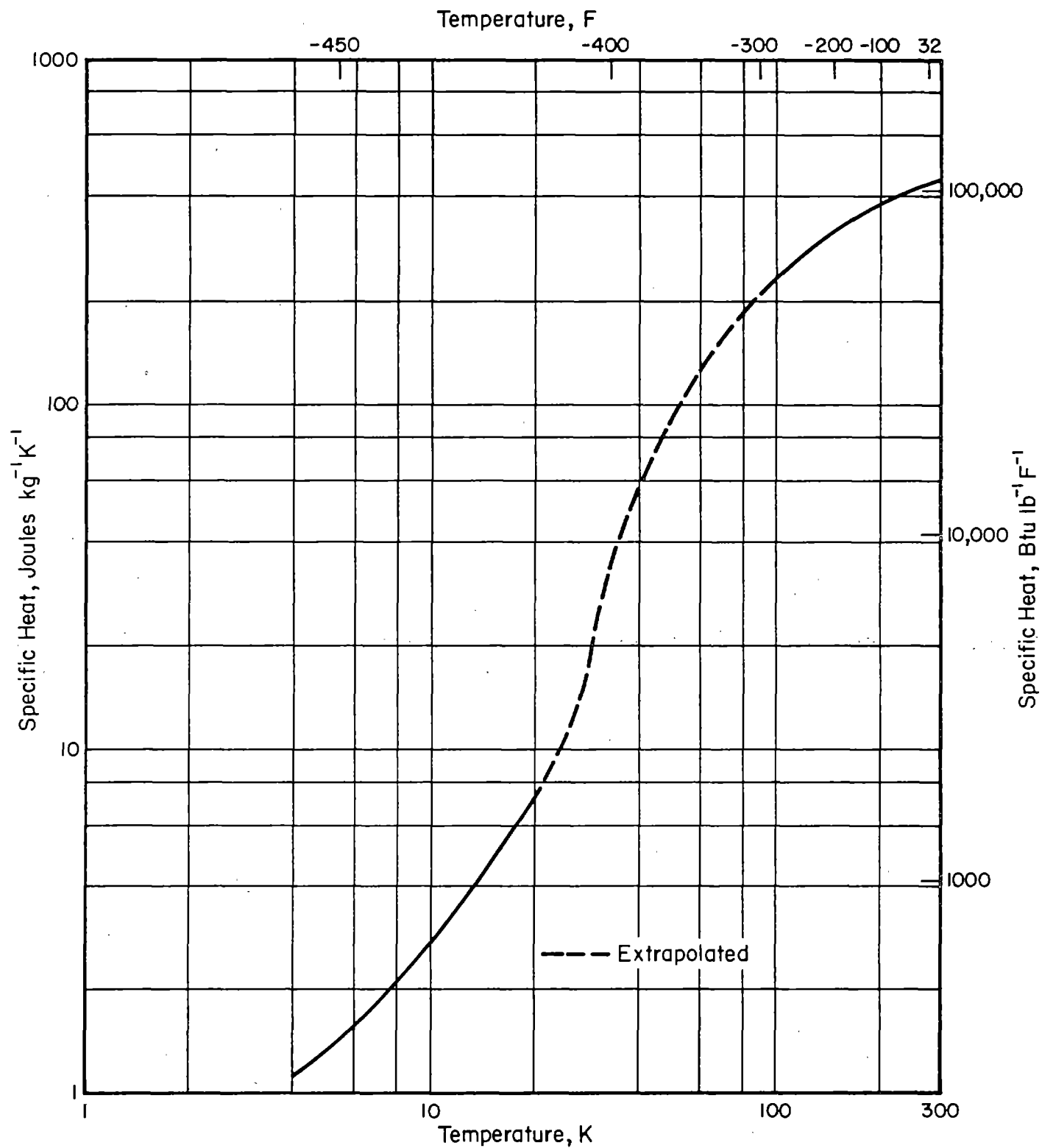


FIGURE 6.2.2-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR INCONEL X-750 NICKEL-BASE ALLOY

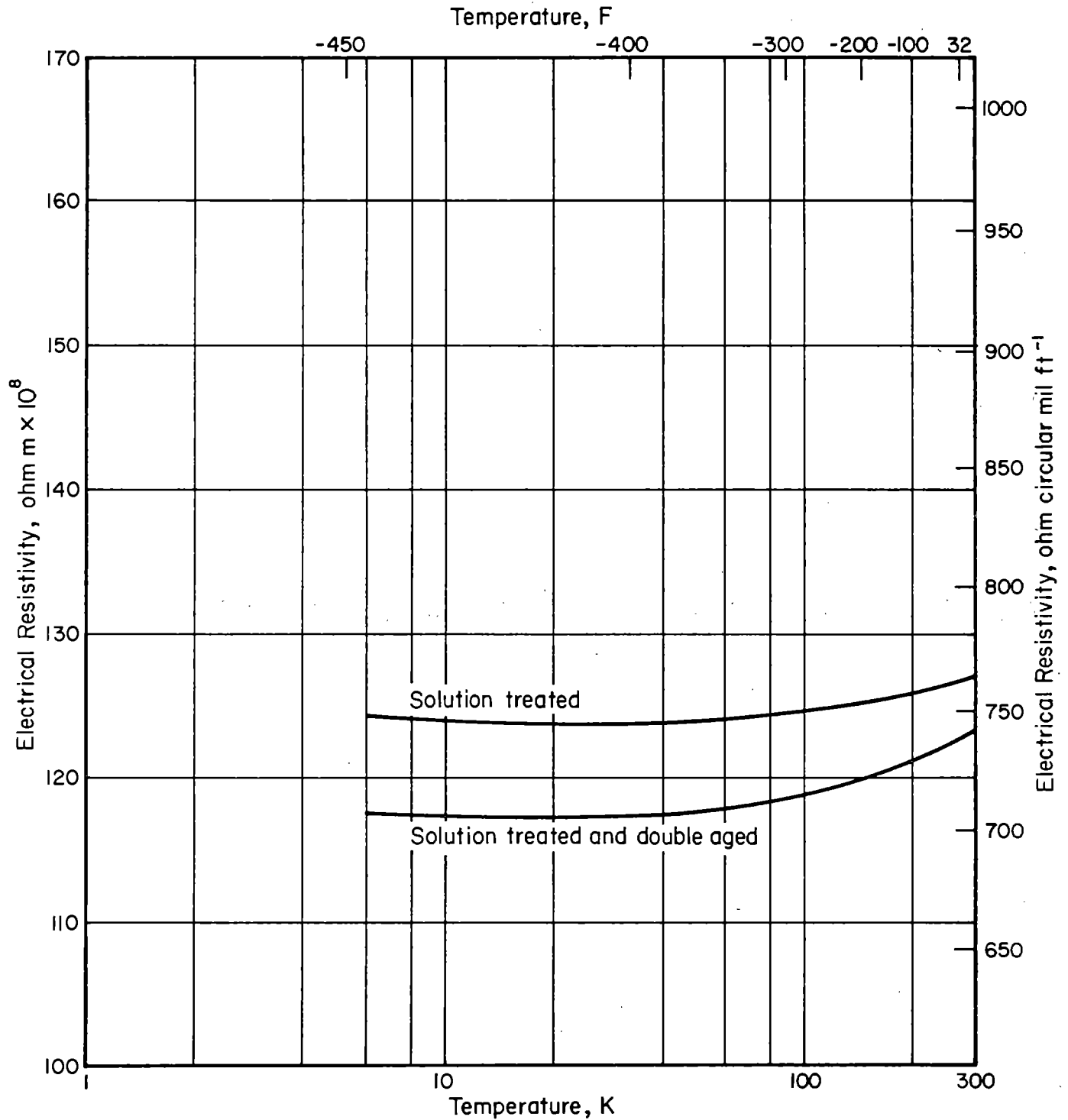
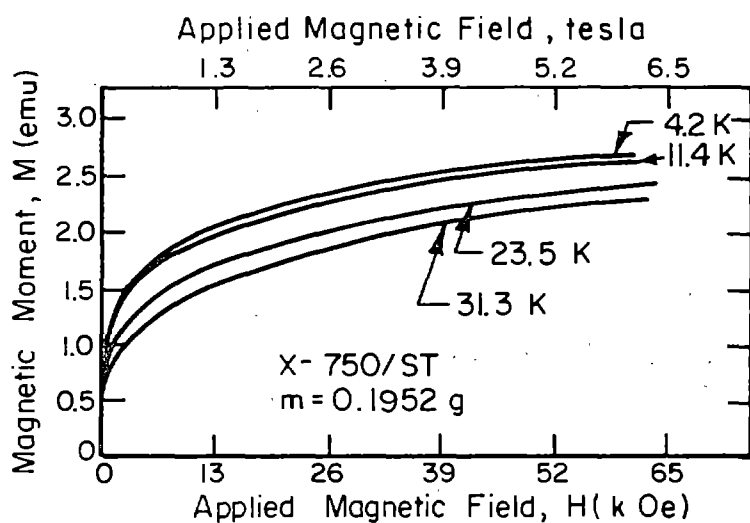


FIGURE 6.2.2-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR INCONEL X-750 NICKEL-BASE ALLOY

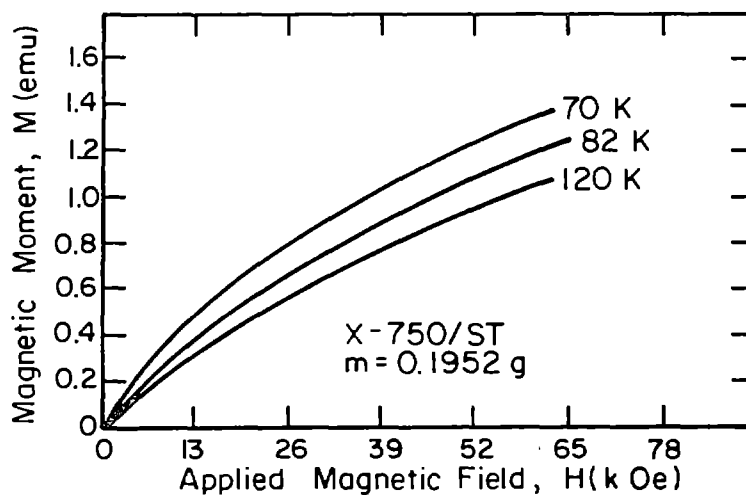
TABLE 6.2.2-MA1

Alloy Designation: Inconel X-750 N07750
Specification: IN X-750 ST
Form: Rod
Dimension, cm(in.): Not given
Condition: ST: Heated at 1800 F (1255 K) for 1 hr. and air cooled
Curie temperature: ~130K (-225 F)
Peak induction, B_s : 0.1433T (tesla)



MAGNETIC MOMENT AS A FUNCTION
OF THE EXTERNAL FIELD AT LOW
LOW TEMPERATURES

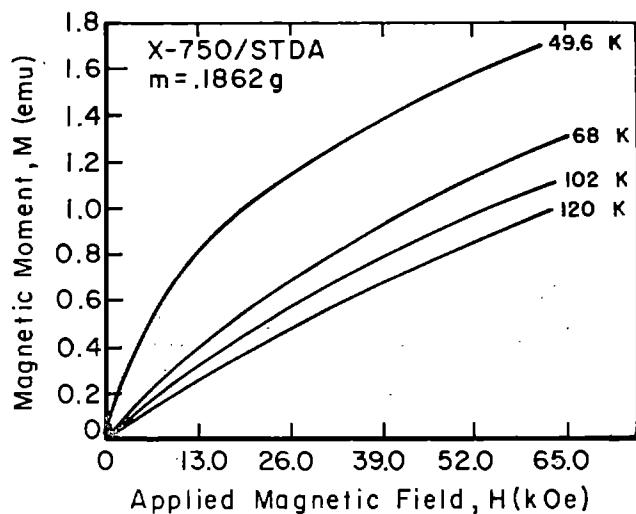
MAGNETIC MOMENT AS A FUNCTION
OF THE EXTERNAL FIELD



Reference: 94206

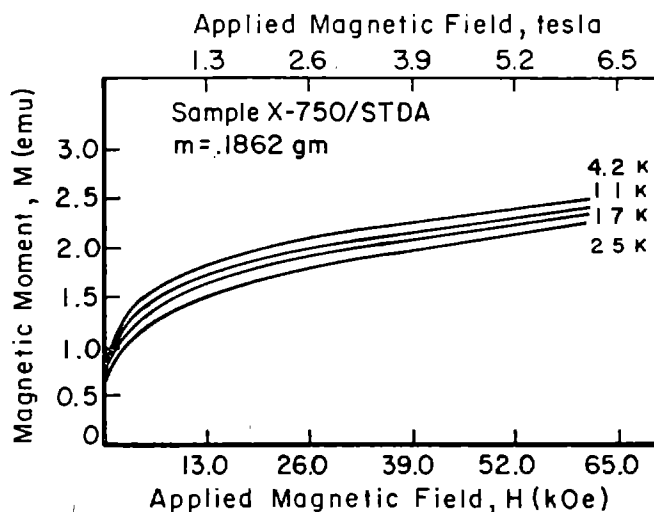
TABLE 6.2.2-MA2

Alloy Designation: Inconel X-750 N07750
 Specification: IN X-750 STDA
 Form: Rod
 Dimension, cm(in.): Not given
 Condition: STDA: solution treated, double aged, strained
 Curie temperature: ~130K (-225 F)
 Peak induction, B_s ,
 at 4.2 K: 0.1477T (tesla)(strained)



MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

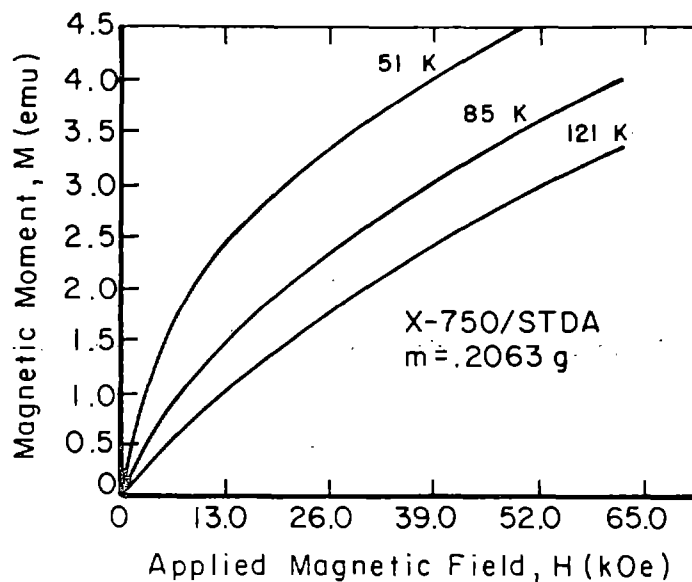
MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD



Reference: 94206

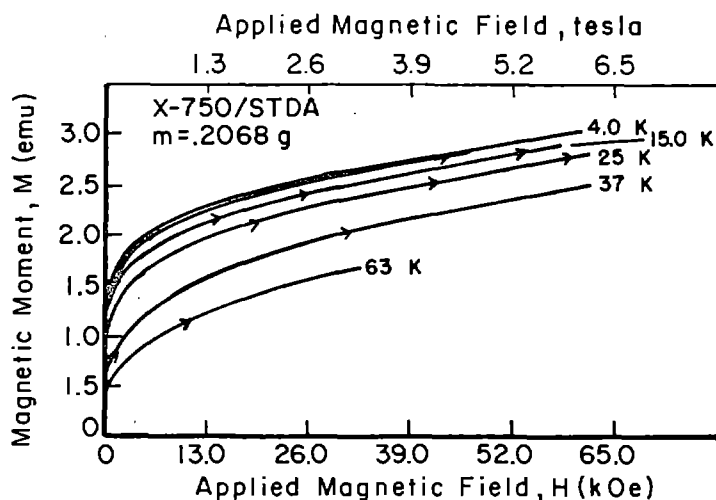
TABLE 6.2.2-MA3

Alloy Designation: Inconel X-750 N07750
 Specification: IN X-750 STDA
 Form: Rod
 Dimension, cm(in.): Not given
 Condition: STDA: solution treated, double aged, unstrained
 Curie temperature: ~130K (-255 F)
 Peak induction, B_s ,
 at 412 K: 0.1552T (tesla)



MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD AT LOW TEMPERATURES



Reference: 94206

6.2.2-16.5 (11/75)

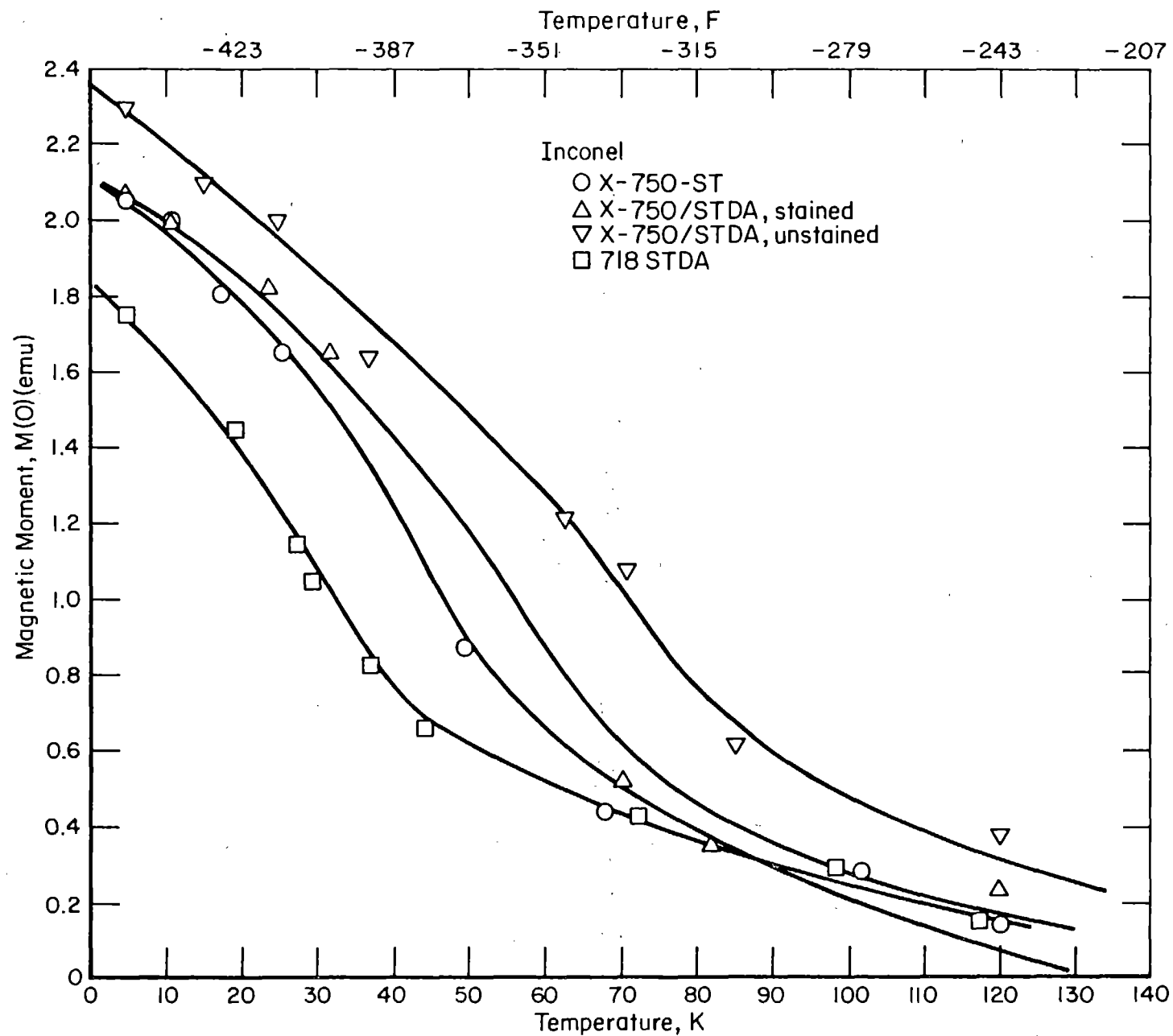


FIGURE 6.2.2-MA1. MAGNETIC MOMENT (EXTRAPOLATED) AS A FUNCTION OF TEMPERATURE

X-750
Rod

TABLE 6.2.3-ME1

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5662B

Form: Sheet

Thickness, cm (in.): Up to 0.099 cm (0.039 in.)

Condition: Annealed, aged 992 K (1325 F) 8 hr, FC, 11 K (20 F) 1 hr to 895 K (1150 F),
held at 895 K (1150 F) for total aging time of 18 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1331 (193)	1476 (214)	1675 (243)	1910 (277)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1089 (158)	1179 (171)	1296 (188)	1420 (206)		
	Min						
Std. Deviation							
Elong, percent	Avg	20.9	23	28.8	25.6		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (3)	3 (1)	8 (3)	8 (3)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1407 (204)	1524 (221)	1593 (231)	1855 (269)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		8 (3)	3 (1)	8 (3)	8 (3)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1320 (192)	1469 (213)	1675 (243)	1855 (269)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1089 (158)	1172 (170)	1286 (186)	1376 (200)		
	Min						
Std. Deviation							
Elong, percent	Avg	20.3	23	24	24		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (3)		3 (1)	6 (2)	6 (2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1400 (203)	1538 (223)	1579 (229)	1820 (264)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		6 (2)	3 (1)	6 (2)	6 (2)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 59345, 65177

TABLE 6.2.3-ME1.1

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed 1260 K (1810 F) 6 min

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	896 (130)			1241 (180)	1351 (196)	
	Min	889 (129)			1241 (180)	1324 (192)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	411 (59.6)			610 (88.4)	687 (99.7)	
	Min	407 (59.1)			607 (88.0)	685 (99.9)	
Std. Deviation							
Elong, percent	Avg	48.5			57.0	48.5	
	Min	47.5			56.5	48.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	752 (109)			993 (144)	1089 (158)	
	Min	738 (107)			972 (141)	1069 (155)	
K _t = 6.3							
No. of Spec. (No. of Heats)		2 (1)			2 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	883 (128)				1096 (159)	
	Min	876 (127)				1096 (159)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	397 (57.6)					
	Min	391 (56.7)					
Std. Deviation							
Elong, percent	Avg	48.8					
	Min	48.0					
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)				2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	752 (109)					
	Min	752 (109)					
K _t = 6.3							
No. of Spec. (No. of Heats)		2 (1)					
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 59345

TABLE 6.2.3-ME1.2

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed Sheet welded, aged^(a), and tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1240 (179.8)			1551 (225.0)		
	Min	1193 (173.0)			1482 (205.0)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1080 (156.6)			1309 (189.8)		
	Min	1041 (151.0)			1262 (183.0)		
Std. Deviation							
Elong, percent	Avg	3.6			6.6		
	Min	3.0			4.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)			6 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 66577

(a) Aging treatment: 990 K (1325 F) 4 hr, FC to 895 K (1150 F) 4 hr, AC

6.2.3.1.2 (11/76)

TABLE 6.2.3-ME1.3

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed sheet, welded, aged^(a), and tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1273 (184.6)			1640 (237.9)		
	Min	1220 (177.0)			1610 (233.5)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1109 (160.9)			1420 (206.0)		
	Min	1048 (152.0)			1379 (200.0)		
Std. Deviation							
Elong, percent	Avg	3.8			7.0		
	Min	3.0			6.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 66577

(a) Aging treatment: 1006 K (1350 F) 8 hr, FC to 922 K (1200 F) 10 hr, AC
6.2.3-1.3 (11/76)

TABLE 6.2.3-ME1.4

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed sheet, welded, aged^(a), and tested as aged

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1291	(187.3)		1657	(240.3)	
	Min	1213	(176.0)		1617	(234.5)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1094	(158.6)		1332	(193.2)	
	Min	1007	(146.0)		1276	(185.0)	
Std. Deviation							
Elong, percent	Avg	4.8			5.5		
	Min	3.0			4.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5	(2)		3	(1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t = Min						
No. of Spec. (No. of Heats)							

References: 66577

(a) Aging treatment: 1034 K (1400 F) 10 hr, FC to 922 K (1200 F) 10 hr, AC
6.2.3-1.4 (11/76)

TABLE 6.2.3-ME1.5

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed sheet, aged^(a), welded, tested as welded

Testing Temperature, K- (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	896.3 (130.0)			1156 (167.7)	1294 (187.7)	
	Min	892.8 (129.5)			1146 (166.2)	1275 (184.9)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	599 (86.9)			783.2 (113.6)	923.2 (133.9)	
	Min	595 (86.3)			779.8 (113.1)	894.9 (129.8)	
Std. Deviation							
Elong, percent	Avg	4.0			3.7	2.8	
	Min	4.0			3.5	2.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	687 (99.7)			890.1 (129.1)	977.7 (141.8)	
	Min	677 (98.3)			841.2 (122.0)	997.3 (137.4)	
K _t = 6.3							
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 59345

(a) Aging treatment: 990 K (1325 F) 8 hr, FC to 895 K (1150 F) 10 hr, AC
6.2.3-1.5 (11/76)

TABLE 6.2.3-ME1.6

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed sheet, aged^(a), welded, weldment aged^(a), and tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1314 (190.6)			1558 (225.9)	1729 (250.7)	
	Min	1302 (188.8)			1534 (222.5)	1664 (241.4)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1151 (166.9)			1290 (187.1)	1413 (204.9)	
	Min	1140 (165.4)			1273 (184.7)	1395 (202.3)	
Std. Deviation							
Elong, percent	Avg	4.8			4.3	5.0	
	Min	4.5			3.0	4.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1196 (173.5)			1321 (191.6)	1441 (209.0)	
	Min	1131 (164.0)			1252 (181.6)	1418 (205.7)	
K _t = 6.3							
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 59345

(a) Aging treatment before and after welding: 990 K (1325 F) 8 hr, FC to 895 K (1150 F) 10 hr, AC

6.2.3-1.6 (11/76)

TABLE 6.2.3-ME1.7

Inconel 718
Sheet

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:

Form: Sheet
 Thickness, cm (in.): Up to 0.099 (0.039)
 Condition: 20% cold worked

Testing Temperature, K (°F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1069 (155)			1407 (204)	1558 (226)	
	Min	1055 (153)			1393 (202)	1551 (225)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	917 (133)			1124 (163)	1227 (178)	
	Min	917 (133)			1096 (159)	1213 (176)	
Std. Deviation							
Elong, percent	Avg	21.5			32.0	36.2	
	Min	21.0			32.0	36.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1117 (162)			1420 (206)	1538 (223)	
	Min	1117 (162)			1420 (206)	1524 (221)	
K _t = 6.3							
No. of Spec. (No. of Heats)		2 (1)			2 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1055 (153)				1538 (223)	
	Min	1055 (153)				1531 (222)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	841 (122)					
	Min	834 (121)					
Std. Deviation							
Elong, percent	Avg	24.0					
	Min	24.0					
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)				2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1103 (160)					
	Min	1082 (157)					
K _t = 6.3							
No. of Spec. (No. of Heats)		2 (1)					
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 59345

TABLE 6.2.3-ME1.8

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 20% cold worked and aged 950 K (1250 F) 8 hr, FC to 894 K (1150 F) 10 hr, AC

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1400 (203)			1848 (268)	2075 (301)	
	Min	1393 (202)			1848 (268)	2062 (299)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1310 (190)			1544 (224)	1710 (248)	
	Min	1310 (190)			1538 (223)	1703 (247)	
Std. Deviation							
Elong, percent	Avg	12.5			20.2	21.8	
	Min	12.0			20.0	21.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	206 (29.9)				224 (32.5)	
	Min	205 (29.7)				217 (31.4)	
No. of Spec. (No. of Heats)		2 (1)				2 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1552 (225)			1931 (280)	2034 (295)	
	Min	1538 (223)			1924 (279)	1979 (287)	
K _t = 6.3							
No. of Spec. (No. of Heats)		2 (1)			2 (1)	2 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1372 (199)					
	Min	1365 (198)					
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1241 (180)					
	Min	1227 (178)					
Std. Deviation							
Elong, percent	Avg	12.0					
	Min	12.0					
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)					
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1524 (221)					
	Min	1510 (219)					
K _t = 6.3							
No. of Spec. (No. of Heats)		2 (1)					
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 59345

TABLE 6.2.3-ME1.9

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 20% cold worked sheet, aged^(a), welded, and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	905.9 (131.4)			1183 (171.6)	1311 (190.1)	
	Min	901.8 (130.8)			1174 (170.3)	1302 (188.9)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	601 (87.1)			786.0 (114.0)	901.8 (130.8)	
	Min	594 (86.1)			775.7 (112.5)	893.6 (129.6)	
Std. Deviation							
Elong, percent	Avg	4.2			3.8	2.8	
	Min	4.0			3.5	2.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	732.2 (106.2)			901.1 (130.7)	1007 (146.0)	
	Min	692.2 (100.4)			868.1 (125.9)	976.3 (141.6)	
K _t = 6.3							
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 59345

(a) Aging treatment: 950 K (1250 F) 8 hr, FC to 895 K (1150 F) 10 hr, AC
6.2.3-1.9 (11/76)

TABLE 6.2.3-ME1.10

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 20% cold worked sheet, aged^(a), welded, weldment aged^(a), and tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1336 (193.8)			1644 (238.4)	1725 (250.2)	
	Min	1311 (190.1)			1631 (236.5)	1689 (244.9)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1196 (173.4)			1370 (198.7)	1447 (209.9)	
	Min	1183 (171.6)			1340 (194.4)	1397 (202.6)	
Std. Deviation							
Elong, percent	Avg	2.2			3.0	2.0	
	Min	2.0			3.0	1.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1254 (181.9)			1370 (198.7)	1440 (203.1)	
	Min	1180 (171.1)			1293 (187.6)	1396 (202.4)	
K _t = 6.3							
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 59345

(a) Aging treatment before and after welding: 950 K (1250 F) 8 hr, FC to 895 K (1150 F) 10 hr, AC

6.2.3-1.10 (11/76)

TABLE 6.2.3-ME1.11

Inconel 718
Sheet

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:

Form: Sheet
 Thickness, cm (in.): Up to 0.099 (0.039)
 Condition: 30% cold rolled and aged

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1586 (230)	1717 (249)		2013 (292)	2130 (309)	
	Min	1572 (228)	1703 (247)		1993 (289)	2089 (303)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1503 (218)	1586 (230)		1786 (259)	1855 (264)	
	Min	1496 (217)	1558 (226)		1779 (258)	1841 (267)	
Std. Deviation							
Elong, percent	Avg	7.1	10.9		15.7	14.6	
	Min	6.5	10.5		15.0	11.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	209 (30.3)	210 (30.5)		221 (32.0)	223 (32.4)	
	Min	206 (29.9)	204 (29.6)		216 (31.3)	221 (32.0)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1710 (248)	1841 (267)		2013 (292)	2130 (309)	
	Min	1696 (246)	1827 (265)		1965 (285)	2089 (303)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
NTS, MN/m ² (ksi) K _t = 19	Avg	1482 (215)	1455 (211)		1579 (229)	1737 (252)	
	Min	1448 (210)	1393 (202)		1531 (222)	1572 (228)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1538 (223)	1669 (242)		1882 (273)	2034 (295)	
	Min	1531 (222)	1662 (241)		1848 (268)	2027 (294)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1420 (206)	1503 (218)		1641 (238)	1731 (251)	
	Min	1407 (204)	1475 (214)		1613 (234)	1703 (247)	
Std. Deviation							
Elong, percent	Avg	7.0	8.4		13.3	16.0	
	Min	6.5	8.0		11.5	12.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	209 (30.3)	210 (30.4)		219 (31.7)	225 (32.6)	
	Min	207 (30.0)	202 (29.3)		217 (31.4)	222 (32.2)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1710 (248)	1806 (262)		1965 (285)	2075 (301)	
	Min	1675 (243)	1800 (261)		1931 (280)	1944 (282)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
NTS, MN/m ² (ksi) K _t = 19	Avg	1455 (211)	1358 (197)		1434 (208)	1662 (241)	
	Min	1407 (204)	1303 (189)		1338 (194)	1538 (223)	
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	

References: 60578

TABLE 6.2.3-ME1.12

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 30% cold rolled and aged, sheet welded and tested as welded

Testing Temperature, K (°F)		297 (75)	195 (-108)		77 (-320-)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	779 (113)	993 (144)		1172 (170)	1062 (154)	
	Min	738 (107)	951 (138)		1131 (164)	951 (138)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	2.1	3.0		1.9	0.6	
	Min	1.5	1.0		1.0	0.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	772 (112)	896 (130)		1000 (145)	1007 (146)	
	Min	729 (105)	827 (120)		979 (142)	958 (139)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	2.7	1.6		0.9	0.9	
	Min	2.5	1.0		0.5	0.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 60578

TABLE 6.2.3-ME1.13

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 30% cold rolled and aged sheet, welded, aged and tested as aged

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1324 (192)	1427 (207)		1600 (232)	1779 (258)	
	Min	1310 (190)	1379 (200)		1503 (218)	1751 (254)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.6	1.5		1.8	1.2	
	Min	1.5	1.5		1.0	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1269 (184)	1386 (201)		1572 (228)	1717 (249)	
	Min	1255 (182)	1358 (197)		1524 (221)	1689 (245)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.6	1.5		1.2	1.0	
	Min	1.5	1.5		1.0	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 60578

TABLE 6.2.3-ME2

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5596C

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed, aged 1034 K (1400 F) 10 hr, FC, 920 K (1200 F) 10 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1330 (193)		1634 (237)	1825 (265)		
	Min	1269 (184)		1448 (210)	1772 (257)		
	Std. Deviation	42.0 (6.10)		110 (16)			
TYS, MN/m ² (ksi)	Avg	1096 (159)		1282 (186)	1422 (206)		
	Min	979 (142)		1148 (166)	1386 (201)		
	Std. Deviation	74.5 (10.8)		98.6 (14.3)			
Elong, percent	Avg	19.2		17.7	15.7		
	Min	17		13	13		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)		9 (2)	6 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							

References: 66577, 83417

TABLE 6.2.3-ME3

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5596 C

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1228 K (1750 F) 1 hr, AC; aged 992 K (1325 F) 8 hr, FC to 895 K (1150 F), held at 895 K (1150 F) for total aging time of 18 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1331 (193)	1488 (216)	1595 (231)	1732 (251)	1737 (252)	
	Min	1301 (189)	1427 (207)		1668 (242)	1627 (236)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1091 (158)	1182 (172)	1291 (187)	1309 (190)	1334 (194)	
	Min	1034 (150)	1117 (162)		1205 (175)	1251 (182)	
Std. Deviation							
Elong, percent	Avg	18.2	16.8	15.2	21.4	15.6	
	Min	15.5	14		9.5	8.2	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (3)	5 (2)	3 (1)	8 (3)	8 (3)	
E, GN/m ² (10 ⁶ psi)	Avg	206 (29.9)	218 (31.7)		224 (32.5)	225 (32.6)	
	Min		214 (31.0)		224 (32.5)	218 (31.7)	
No. of Spec. (No. of Heats)		1 (1)	2 (1)		2 (1)	2 (1)	
Poisson's Ratio		0.28	0.335		0.25	0.24	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1420 (206)			1648 (239)	1657 (240)	
	Min	1386 (201)			1641 (238)	1620 (235)	
No. of Spec. (No. of Heats)		3 (1)			2 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg	1329 (193)	1470 (213)	1498 (217)	1560 (226)	1496 (217)	
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1324 (192)	1476 (214)	1586 (230)	1699 (246)	1765 (256)	
	Min	1292 (187)	1372 (199)		1613 (234)	1696 (246)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1099 (159)	1210 (176)	1305 (189)	1301 (189)	1364 (198)	
	Min	1041 (151)	1080 (157)		1172 (170)	1269 (184)	
Std. Deviation							
Elong, percent	Avg	18	12.1	15.8	20.7	15.9	
	Min	15	4		8.5	4	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (3)	5 (2)	3 (1)	8 (3)	7 (3)	
E, GN/m ² (10 ⁶ psi)	Avg	198 (28.8)	212 (30.8)		231 (33.5)	238 (34.5)	
	Min		205 (29.8)		230 (33.4)	230 (33.4)	
No. of Spec. (No. of Heats)		1 (1)	2 (1)		2 (1)	5 (1)	
Poisson's Ratio		0.29	0.275		0.25	0.295	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1367 (198)			1618 (235)	1599 (232)	
	Min	1351 (196)			1586 (230)	1579 (229)	
No. of Spec. (No. of Heats)		3 (1)			3 (1)	2 (1)	
NTS, MN/m ² (ksi)	Avg	1294 (188)	1444 (210)	1457 (211)	1493 (217)	1503 (218)	
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	

References: 69021, 69800, 90104, 90200

TABLE 6.2.3-ME4

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5596C

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed, aged 1006 K (1350 F) 8 or 9 hr, FC to 920 K (1200 F),
held at 9 or 10 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1268 (184)		1658 (240)	1778 (258)		
	Min	1200 (174)		1634 (237)	1727 (250)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1018 (148)		1296 (188)	1344 (195)		
	Min	924 (134)		1211 (176)			
Std. Deviation							
Elong, percent	Avg	20.8			28.3		
	Min	20			28		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (2)		6 (2)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	211 (30.6)		223 (32.4)			
	Min	209 (30.3)		220 (31.9)			
No. of Spec. (No. of Heats)		2 (1)		3 (1)			
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1260 (183)		1473 (214)	1581 (229)		
	Min	1238 (180)		1440 (209)	1522 (221)		
No. of Spec. (No. of Heats)		3 (1)		4 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 70906, 66577

TABLE 6.2.3-ME5

Alloy Designation: Inconel 718 Nickel-Base Alloy

N07718

Specification: AMS-5596 C

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 - 0.125)

Condition: Annealed 1340 K (1950 F), AC, aged 1034 K (1400 F) 10 hr, FC, 920 K (1200 F) 10 hr, AC

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Flexural Loading, Surface Finish 64 rms						
S_N at 10^5 cycles, MN/m ² (ksi)	607 (88)		662 (96)	807 (117)		
Loading frequency 30-40 Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.46		0.40	0.45		
S_N at 10^6 cycles, MN/m ² (ksi)	400 (58)		455 (66)	524 (76)		
Loading frequency 30-40 Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.30		0.27	0.29		
S_N at 10^7 cycles, MN/m ² (ksi)	324 (47)		427 (62)			
Loading frequency 30-40 Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.24		0.26			
Fatigue, Flexural Loading, Surface Finish 11 rms						
S_N at 10^5 cycles, MN/m ² (ksi)	717 (104)		800 (116)	1020 (148)		
Loading frequency 30-40 Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.52		0.46	0.55		
S_N at 10^6 cycles, MN/m ² (ksi)	496 (72)		579 (84)	703 (102)		
Loading frequency 30-40 Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.36		0.33	0.38		
S_N at 10^7 cycles, MN/m ² (ksi)	434 (63)		476 (69)			
Loading frequency 30-40 Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.32		0.27			

References: 83417

TABLE 6.2.3-ME5.1

Inconel 718
Sheet

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed (solution treated)

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	880.5 (127.7)			1222 (177.2)	1300 (188.5)	
	Min	833.6 (120.9)			1151 (166.9)	1294 (187.7)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	549 (79.6)			745.3 (108.1)	722.6 (104.8)	
	Min	516 (74.8)			681 (98.8)	687 (99.6)	
Std. Deviation							
Elong, percent	Avg	41.8			51.3	56.0	
	Min	37.0			43.0	52.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)			6 (2)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	203 (29.5)			211 (30.6)	211 (30.6)	
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	828.8 (120.2)			1105 (160.3)	1207 (175.1)	
	Min	828.1 (120.1)			1104 (160.1)	1200 (174.0)	
K _t = 3.5							
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	914.2 (132.6)			1242 (180.2)		
	Min	908.0 (131.7)			1223 (177.4)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	590 (85.5)			775.0 (112.4)		
	Min	584 (84.7)			770.8 (111.8)		
Std. Deviation							
Elong, percent	Avg	39.0			47.8		
	Min	38.0			44.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 61996, 69021

TABLE 6.2.3-ME5.2

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 718-Alloy filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Solution treated sheet, TIG welded and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	839.8 (121.8)			1113 (161.4)	1228 (178.1)	
	Min	838.4 (121.6)			1077 (156.2)	1202 (174.4)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 61996

TABLE 6.2.3-ME5.3

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:

Form: Sheet
 Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
 Condition: Annealed 1283 K (1850 F), aged 1075 K (1360 F)

Testing Temperature, K (F)	297 (75)				20 (-423)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 1388 (201.3)				1940 (281.3)	
	Min 1386 (201.0)				1935 (280.7)	
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 1218 (176.6)				1460 (211.7)	
	Min 1213 (176.0)				1454 (210.9)	
Std. Deviation						
Elong, percent	Avg 19.3				18.4	
	Min 18.5				18.6	
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (1)				3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 78611

TABLE 6.2.3-ME5.4

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 718-Alloy filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Sheet annealed at 1283 K (1850 F), aged at 1075 K (1360 F), welded, and tested as welded

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1411 (204.7)				1794 (260.2)	
	Min	1407 (204.0)				1784 (258.7)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1241 (180.0)				1517 (220.0)	
	Min	1234 (179.0)				1483 (215.1)	
Std. Deviation							
Elong, percent	Avg	9.3				4.6	
	Min	8.0				4.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)				3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 78611

TABLE 6.2.3-ME5.5

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Sheet-TIG welded, 718 Alloy filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Sheet annealed 1225 K (1752 F) 1 hr, AC; aged 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; welded, and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	779.1 (113.0)			1050 (152)	869 (126)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	552 (80.0)			807 (117)	493 (71.5)	
	Min						
Std. Deviation							
Elong, percent	Avg	4.0			3.2	4.1	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m ² (10 ⁶ psi)	Avg	201 (29.2)			211 (30.6)	194 (28.2)	
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio		0.25			0.23	0.34	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 69800

TABLE 6.2.3-ME6

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5597A

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed 1340 (1950 F) 1 hr, AC, aged 1034 K (1400 F) 10 hr, FC to 920 K (1200 F), held at 920 K (1200 F) for total aging time of 20 hr, AC

Testing Temperature, K (F)	297 (75)		77 (-320)			
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 1251 (182)		1502 (218)			
	Min 1239 (180)		1467 (213)			
Std. Deviation	9.31 (1.35)		18.5 (2.68)			
TYS, MN/m ² (ksi)	Avg 1014 (147)		1196 (174)			
	Min 995 (144)		1172 (170)			
Std. Deviation	13.1 (1.90)		23.0 (3.34)			
Elong, percent	Avg 16.7		14.6			
	Min 15		13			
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	10 (1)		10 (1)			
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 63649

6.2.3-6 (11/74)

TABLE 6.2.3-ME6.1

Inconel 718
Plate-Weld Metal

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 718 Alloy filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Plate TIG welded, weldment annealed 1340 K (1950 F) 1 hr, AC, aged 1034 K (1400 F) 10 hr, FC to 920 K (1200 F) 10 hr, AC, and tested as aged

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1273 (184.7)				1556 (225.7)	
	Min	1262 (183.0)				1527 (221.4)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1072 (155.5)				1237 (179.4)	
	Min	1055 (153.0)				1207 (175.1)	
Std. Deviation							
Elong, percent	Avg	18				13.8	
	Min	15				11.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (1)(a)				3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 63649

(a) Room-temperature values contain a degree of uncertainty because the precise location of fracture (in or out of weld metal) was not given.

6.2.3-6.1 (11/76)

TABLE 6.2.3-ME6.2

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 718 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate solution treated 1228 K (1750 F) ½ hr, AC; welded, weldment aged at 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1320 (192)			1540 (223)		
	Min	1050 (152)			1410 (205)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1110 (161)			1210 (176)		
	Min	1030 (149)			1170 (169)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (3)			4 (2)		
E, GN/m ² (10 ⁶ psi)	Avg	220 (31.9)			236 (34.2)		
	Min	197 (28.5)			214 (31.1)		
No. of Spec. (No. of Heats)		7 (3)			3 (2)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90717

TABLE 6.2.3-ME6.3

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Plate-EB welded, no filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate solution treated 1228 K (1750 F) ½ hr, AC; welded, weldment aged at 992 K (1325 F) 8 hr, AC; tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1420 (206)			1540 (224)		
	Min	1360 (197)			1450 (211)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1110 (161)			1330 (193)		
	Min	1090 (158)					
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (2)					
E, GN/m ² (10 ⁶ psi)	Avg	212 (30.7)			214 (31.0)		
	Min	203 (29.4)					
No. of Spec. (No. of Heats)		5 (2)			1		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90717

TABLE 6.2.3-ME6.4

Inconel 718
Plate-Weld Metal

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Plate-Plasma-Arc Welded, 718 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate solution treated 1228 K (1750 F) ½ hr, AC; welded, weldment aged at 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1340 (195)			1550 (225)		
	Min	1340 (194)			1500 (218)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1100 (159)			1390 (202)		
	Min	1090 (158)			1380 (200)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	230 (33.4)			221 (32.0)		
	Min	221 (32.1)			201 (29.2)		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 90717

TABLE 6.2.3-ME6.5

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, 718 Alloy filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate annealed 1340 K (1950 F) 1 hr, AC; aged 8-10 hr 970 K (1350 F), FC to 922 K (1200 F) total aging time of 20 hr, AC; welded, tested as welded

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	969.4 (140.6)				1299 (188.4)	
K _t = 6.3	Min	930.8 (135.0)				1245 (180.5)	
No. of Spec. (No. of Heats)		4 (1)				6 (1)	
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 69021

TABLE 6.2.3-ME7

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed 1228 K (1750 F) 1 hr, AC, aged 992 (1325 F) 8 hr, FC to 895 K (1150 F), held at 895 K (1150 F) for total aging time of 18 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1402 (203)		1746 (253)	1853 (269)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1207 (175)		1365 (198)	1416 (205)		
	Min						
Std. Deviation							
Elong, percent	Avg	13.7		19.2	20.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1731 (251)		1891 (274)	1868 (271)		
K _t = 10	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90104

TABLE 6.2.3-ME8

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5663B

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed 1340 K (1950 F) 1 hr, AC, aged 1006-1034 K (1350-1400 F), FC to 920 K (1200 F), held at 920 K (1200 F) for total aging time of 19-20 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1307 (190)		1641 (238)	1846 (268)	1846 (268)	
	Min	1296 (188)		1517 (220)	1834 (266)		
	Std. Deviation	8.48 (1.23)		93.1 (13.5)			
TYS, MN/m ² (ksi)	Avg	1084 (157)		1282 (186)	1367 (198)	1372 (199)	
	Min	1062 (154)		1275 (185)	1365 (198)		
	Std. Deviation	21.2 (3.07)		4.8 (0.70)			
Elong, percent	Avg	25		20.3	27.7		
	Min	24		14	26		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		9 (3)		9 (3)	3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	204 (29.6)		212 (30.8)		211 (30.6)	
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)		3 (1)	
Poisson's Ratio		0.308		0.307		0.297	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							

References: 83417, 89543

TABLE 6.2.3-ME9

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5663 B

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed 1340 K (1950 F) 1 hr, AC, aged 1006 - 1034 K (1350-1400 F),
FC to 920 K (1200 F), held at 920 K (1200 F) for total aging time of 19-20 hr, AC

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)	758 (110)		965 (140)	1076 (156)		
Loading frequency 28 Hz						
with R = 0 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.58		0.57	0.58		
S_N at 10^7 cycles, MN/m ² (ksi)	620 (90)		731 (106)			
Loading frequency 28 Hz						
with R = 0 and K_t = 1						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N /TUS at 10^7 cycles	0.48		0.43			
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 83417

TABLE 6.2.3-ME10

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5663B

Form: Forgings (thin wall)

Thickness, cm (in.): Up to 0.64 cm (0.25 in.)

Condition: Annealed 1255 K (1800 F) 1 hr, AC, aged at 992 K (1325 F) 8 hr, FC to 895 K (1150 F), held at 895 K (1150 F) 10 hr, AC

Testing Temperature, K (F)		297 (75)	150 (-190)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1362 (198)	1573 (228)	1733 (251)			
	Min	1358 (197)	1565 (227)				
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1171 (170)	1304 (189)	1327 (192)			
	Min	1169 (170)	1298 (188)				
Std. Deviation							
Elong, percent	Avg	26.5	20	34			
	Min	26	19				
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	1 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 79857

TABLE 6.2.3-ME11

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5662 B

Form: Forgings (thick section)

Thickness, cm (in.): 2.5 to 10 cm (1.0 to 4.0 in.)

Condition: Annealed 1255 K (1800 F) 45 min, AC, aged 992 K (1325 F) 8 hr, AC to 895 K (1150 F), held at 895 K (1150 F) for total aging time of 18 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1338 (194)	1350 (196)	1634 (237)	1679 (244)	1813 (263)	
	Min	1282 (186)	1340 (194)	1617 (234)	1573 (228)	1800 (261)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1151 (167)	1189 (172)	1296 (188)	1320 (192)	1407 (204)	
	Min	1124 (163)	1178 (171)	1243 (180)	1270 (184)	1372 (199)	
Std. Deviation							
Elong, percent	Avg	23.7	29	26.0	28.2	20.6	
	Min	14.3	28	20.2	26	19.5	
RA, percent	Avg	35.4	44.6	34.3	41.5	20.2	
	Min	16.8	43.5	18.9	38.5	16.3	
No. of Spec. (No. of Heats)		7 (2)	4 (1)	6 (2)	4 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	2034 (295)	2168 (314)	2352 (341)	2392 (347)		
	Min	1988 (288)	2148 (312)	2277 (330)	2352 (341)		
K _t = 6.3							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1288 (187)	1363 (198)	1631 (236)	1743 (253)		
	Min	1248 (181)	1344 (195)	1600 (232)	1736 (252)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1154 (167)	1188 (172)	1287 (187)	1354 (196)		
	Min	1138 (165)	1179 (171)	1272 (184)	1333 (193)		
Std. Deviation							
Elong, percent	Avg	18.5	22.2	27.5	24.5		
	Min	18	20	25	15		
RA, percent	Avg	28	34.8	39.1	29.8		
	Min	27.5	31	36.5	23.5		
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1934 (280)	2062 (299)	2237 (324)	2296 (333)		
	Min	1864 (270)	2056 (298)	2216 (321)	2262 (328)		
K _t = 6.3							
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 82966, 95168

TABLE 6.2.3-ME12

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5662B

Form: Forgings (thick section)

Thickness, cm (in.): 2.5 to 10 cm (1.0 to 4.0 in.)

Condition: Annealed 1255 K (1800 F) 45 min, AC, aged 992 K (1325 F) 8 hr, AC to 895 K (1150 F), held at 895 K (1150 F) for total aging time of 18 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Short Transverse							
TUS, MN/m ² (ksi)	Avg	1289 (187)	1371 (199)	1579 (229)	1635 (237)		
	Min	1274 (185)	1354 (196)	1537 (223)	1573 (228)		
Std Deviation							
TYS, MN/m ² (ksi)	Avg	1144 (166)	1202 (174)	1288 (187)	1344 (195)		
	Min	1124 (163)	1189 (172)	1271 (184)	1326 (192)		
Std. Deviation							
Elong, percent	Avg	17	17.2	14	13.8		
	Min	14	13	12	11		
RA, percent	Avg	23	20	14	11.8		
	Min	17.5	12	12	8		
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1865 (270)	1889 (274)	2057 (298)	1968 (286)		
	Min	1803 (262)	1800 (261)	1995 (289)	1909 (277)		
K _t = 6.3							
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 82966

TABLE 6.2.3-ME13

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5662 B

Form: Forgings (thick section)

Thickness, cm (in.): 2.5 to 10 cm (1.0 to 4.0 in.)

Condition: Annealed 1255 K (1800 F) 45 min, AC, aged 922 K (1325 F) 8 hr, AC to 895 K (1150 F), held at 920 K (1200 F) for total aging time of 20 hr, AC

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN /m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb)	Avg	85.4 (63)	66.4 (49)	66.4 (49)	58.3 (43)	
	Min	82.7 (61)	65.1 (48)	54.2 (40)	56.9 (42)	
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)	
Short Transverse, J(ft-lb)	Avg	36.6 (27)	23.7 (17.5)	28.5 (21)	40.7 (30)	
	Min	35.2 (26)	21.7 (16)	19.0 (14)	35.2 (26)	
No. of Spec. (No. of Heats)		5 (1)	4 (1)	5 (1)	4 (1)	
Fracture Toughness(b)						
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg	96.3 (87.8)	106 (95.6)	103.2 (94)		112.3 (102.3)
	Min	91.5 (83.4)	100 (91.2)	96.5 (88.0)		104 (94.8)
Orientation: T — S						
No. of Spec. (No. of Heats)		3 (1)	2 (1)	3 (1)		3 (1)
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 82966, 95168

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data: CT

TABLE 6.2.3-ME14

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5664 A

Form: Forgings (thick section)

Thickness, cm (in.): 2.5 to 10 cm (1.0 to 4.0 in.)

Condition: Annealed 1340 K (1950 F) 1 hr, AC, aged 1034 K (1400 F) 10 hr, FC to 920 K (1200 F), held at 920 K (1200 F) for total aging time of 20 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1302 (190)	1371 (199)	1640 (238)	1695 (246)		
	Min	1248 (181)	1366 (198)	1627 (236)	1627 (236)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1041 (151)	1132 (164)	1212 (176)	1338 (194)		
	Min	993 (144)	1130 (164)	1200 (174)	1249 (181)		
Std. Deviation							
Elong, percent	Avg	27.4	27.2	31.8	25.6		
	Min	24.5	26	27	23		
RA, percent	Avg	41.7	44.1	36.4	35.8		
	Min	36	41.5	30.5	32.7		
No. of Spec. (No. of Heats)		7 (2)	4 (1)	4 (1)	7 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1898 (275)	2063 (299)	2276 (330)	2295 (333)		
	Min	1800 (261)	2036 (295)	2246 (326)	2223 (322)		
No. of Spec. (No. of Heats)		6 (2)	4 (1)	4 (1)	7 (2)		
NTS, MN/m ² (ksi) K _t =	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1267 (184)	1360 (197)	1622 (235)	1672 (242)		
	Min	1260 (183)	1355 (196)	1613 (234)	1523 (221)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1009 (146)	1139 (165)	1229 (178)	1277 (185)		
	Min	1002 (145)	1125 (163)	1222 (177)	1270 (184)		
Std. Deviation							
Elong, percent	Avg	23.4	19.2	26.2	22.2		
	Min	18.5	16	23	18		
RA, percent	Avg	30.5	22.2	26.1	25.0		
	Min	22	21	24.5	20.5		
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1826 (265)	1961 (284)	2167 (314)	2206 (320)		
	Min	1757 (255)	1933 (280)	2089 (303)	2153 (312)		
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)		
NTS, MN/m ² (ksi) K _t =	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 69021, 82966

6.2.3-14 (11/74)

TABLE 6.2.3-ME15

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5664A

Form: Forgings (thick section)

Thickness, cm (in.): 2.5 to 10 cm (1.0 to 4.0 in.)

Condition: Annealed 1340 K (1950 F) 1 hr, AC, aged 1034 K (1400 F) 10 hr, FC to 920 K (1200 F), held at 920 K (1200 F) for total aging time of 20 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Short Transverse							
TUS, MN/m ² (ksi)	Avg	1251 (182)	1351 (196)	1578 (229)	1684 (244)		
	Min	1247 (181)	1334 (194)	1538 (223)	1668 (242)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1018 (148)	1090 (158)	1218 (177)	1288 (187)		
	Min	1002 (145)	1080 (157)	1208 (175)	1278 (185)		
Std. Deviation							
Elong, percent	Avg	19	14.8	17.8	16.8		
	Min	14	12	11	13		
RA, percent	Avg	24.6	18.5	19.4	17.9		
	Min	17.5	13	14	13.5		
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1708 (248)	1898 (275)	2023 (293)	2041 (296)		
	Min	1638 (238)	1853 (269)	1971 (286)	1888 (274)		
K _t = 6.3							
No. of Spec. (No. of Heats)		4 (1)	4 (1)	4 (1)	4 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 69021, 82966

TABLE 6.2.3-ME16

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification: AMS-5664 A

Form: Forgings (thick section)

Thickness, cm (in.): 2.5 to 10 cm (1.0 - 4.0 in.)

Condition: Annealed 1340 K (1950 F) 1 hr, AC, aged 1034 K (1400 F) 10 hr, FC to 920 K (1200 F), held at 920 K (1200 F) for total aging time of 20 hr, AC

Testing Temperature, K (F)	297	(75)	195	(-108)	77	(-320)	20	(-423)		
<u>Compression, Longitudinal</u>										
CYS, MN/m ² (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m ² (10 ⁶ psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
<u>Compression, Transverse</u>										
CYS, MN/m ² (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
Ec, GN/m ² (10 ⁶ psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
<u>Shear^(a)</u>										
SUS, MN/m ² (ksi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
G, GN/m ² (10 ⁶ psi)	Avg									
	Min									
No. of Spec. (No. of Heats)										
<u>Impact, Charpy V</u>										
Long., J(ft-lb)	Avg		57	(42)	60.1	(44.3)	54	(39.8)	58	(42.8)
	Min		54	(40)	56	(41)	41	(30)	50	(37)
No. of Spec. (No. of Heats)	4		(1)		3	(1)	4	(1)	4	(1)
Short Trans., J(ft-lb)	Avg		20.1	(14.8)	22.8	(16.8)	28	(21)	23.7	(17.5)
	Min		12	(9)	14	(10)	15	(11)	19	(14)
No. of Spec. (No. of Heats)	4		(1)		4	(1)	4	(1)	4	(1)
<u>Fracture Toughness^(b)</u>										
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg									
	Min									
Orientation: —										
No. of Spec. (No. of Heats)										
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg									
(From PTSC spec.) (—)Min										
No. of Spec. (No. of Heats)										

References: 82966

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 6.2.3-ME16.1

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:

Form: Forgings (thick section)

Thickness, cm (in.): Over 10 cm (4.0 in)

Condition: Solution treated 1225 K (1800 F) 1 hr, AC; aged 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1347 (195.4)			1640 (237.8)		1670 (242.2)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1164 (168.8)			1344 (194.9)		1406 (203.9)
	Min						
Std. Deviation							
Elong, percent	Avg	12.0			10.1		9.4
	Min						
RA, percent	Avg	14.8			9.1		10.0
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1749 (253.6)			1876 (272.1)		1927 (279.5)
K _t = 10	Min						
No. of Spec. (No. of Heats)		1			1		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 95168

TABLE 6.2.3-ME16.2

Inconel 718
Forgings

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:

Form: Forgings (thick section)

Thickness, cm (in.): Over 10 (4.0)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; aged 922 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC

Testing Temperature, K (F)	297 (75)					4 (-452)
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
J_{IC} MN/m (in.-lb/in.²)	Avg	0.021 (120)				0.027 (152)
	Min					
Orientation: —						
No. of Spec. (No. of Heats)		1				1
K_{IE}, MN/m^{3/2}(ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 95168

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 6.2.3-ME16.3

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Forgings (thick section), TIG welded, Alloy 718 filler

Thickness, cm (in.): Over 10 (4.0)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; welded, weldment solution treated 1255 K (1800 F) 1 hr, AC; aged 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1259 (182.6)			1436 (208.2)		1651 (239.4)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1094 (158.6)			1281 (185.8)		1273 (184.6)
	Min						
Std. Deviation							
Elong, percent	Avg	1.7			1.8		28.2
	Min						
RA, percent	Avg	5.7			4.3		33.5
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1391 (201.8)			1470 (213.2)		2282 (330.9)
K _t = 10	Min						
No. of Spec. (No. of Heats)		1					
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 95168

TABLE 6.2.3-ME16.4

Inconel 718
Forgings-Weld Metal

Alloy Designation: Inconel 718 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Forgings (thick section) -TIG welded, Alloy 718 filler

Thickness, cm (in.): Over 10 (4.0)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; welded, weldment solution treated 1255 K (1800 F), 1 hr, AC; aged 922 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; tested as aged

Testing Temperature, K (F)	297 (75)			77 (-320)		4 (-452)
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg			51.5 (46.5)		52.1 (47.1)
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 95188

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

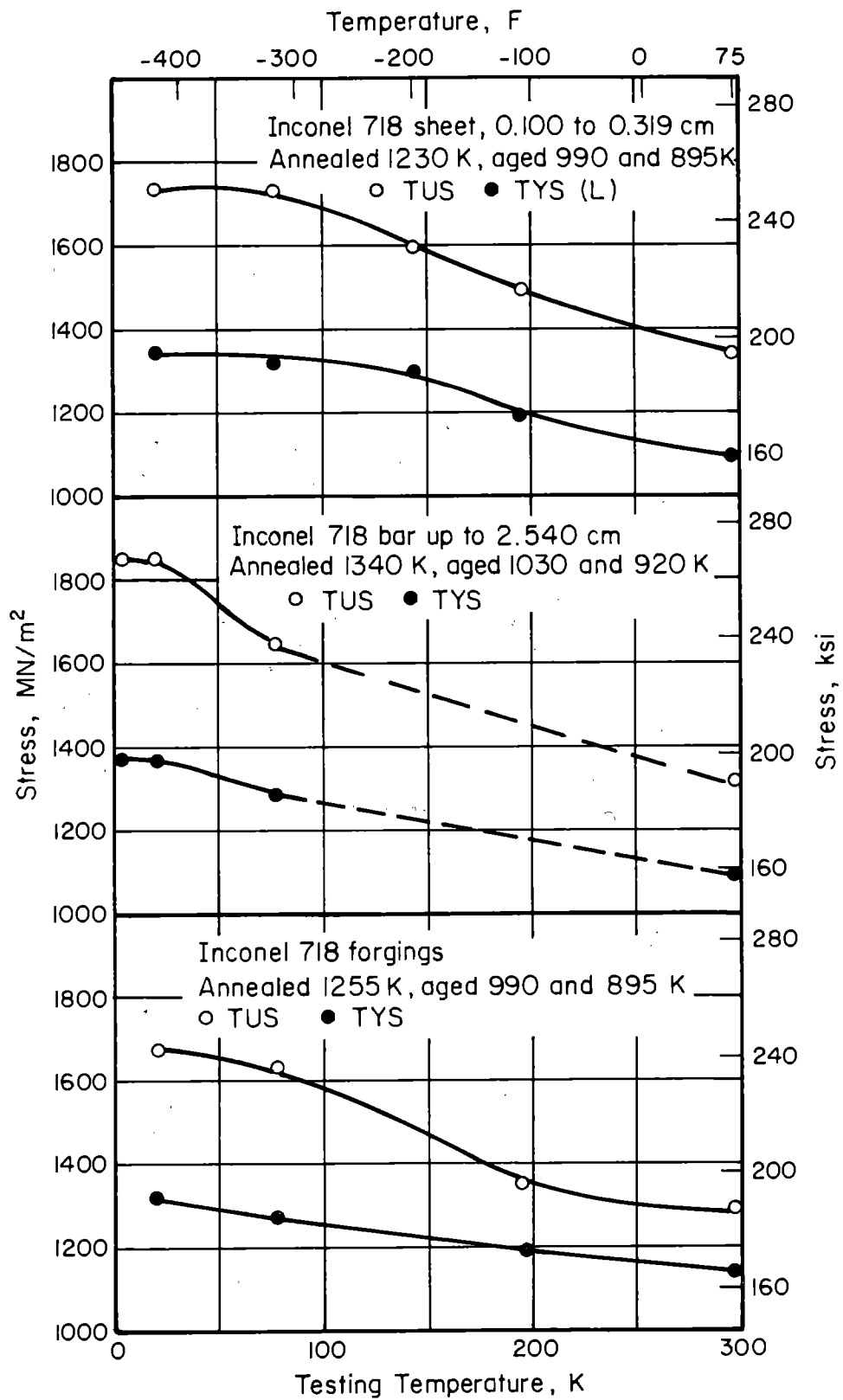


FIGURE 6.2.3-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF INCONEL ALLOY 718

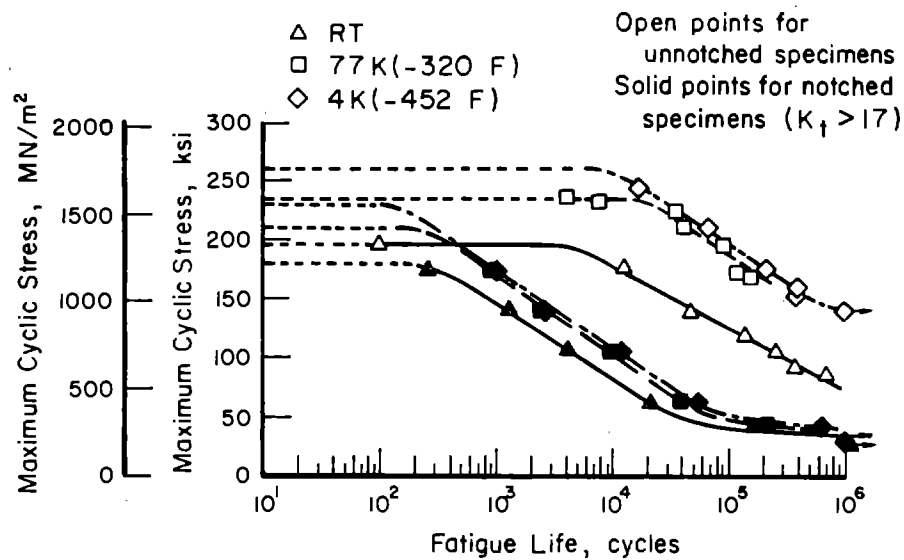


FIGURE 6.2.3-ME2. FATIGUE LIFE CURVES FOR AXIAL LOADING ON LONGITUDINAL SPECIMENS OF INCONEL 718 SHEET 0.203 CM (0.080 IN.) THICK AT FREQUENCIES OF 3.3 AND 0.27 HERTZ AT $R = 0.14$

[Heat Treatment: Annealed 1340 K (1950 F) 1 hr, AC, aged 1000 K (1350 F) 9 hr, FC to 920 K (1200 F), held at 920 K (1200 F) 9 hr, AC]

Reference: 70906

6.2.3-18.1 (11/76)

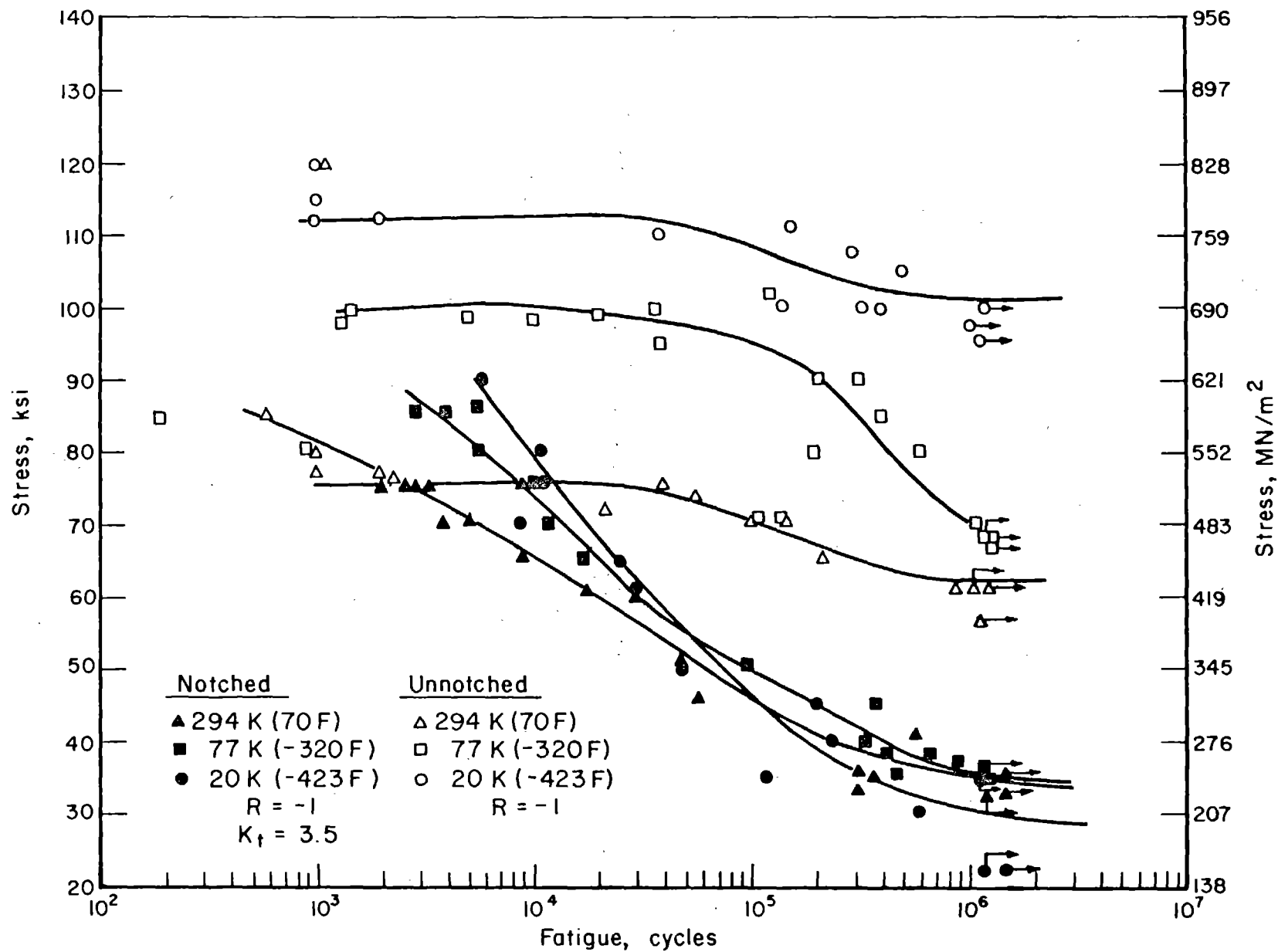


FIGURE 6.2.3-ME3. AXIAL FATIGUE LIFE CURVES FOR LOADING ON SPECIMENS OF SOLUTION TREATED INCONEL 718 NICKEL ALLOY SHEET 0.25 cm (0.100 in.) THICK [61996]

6.2.3-18.2 (11/76)

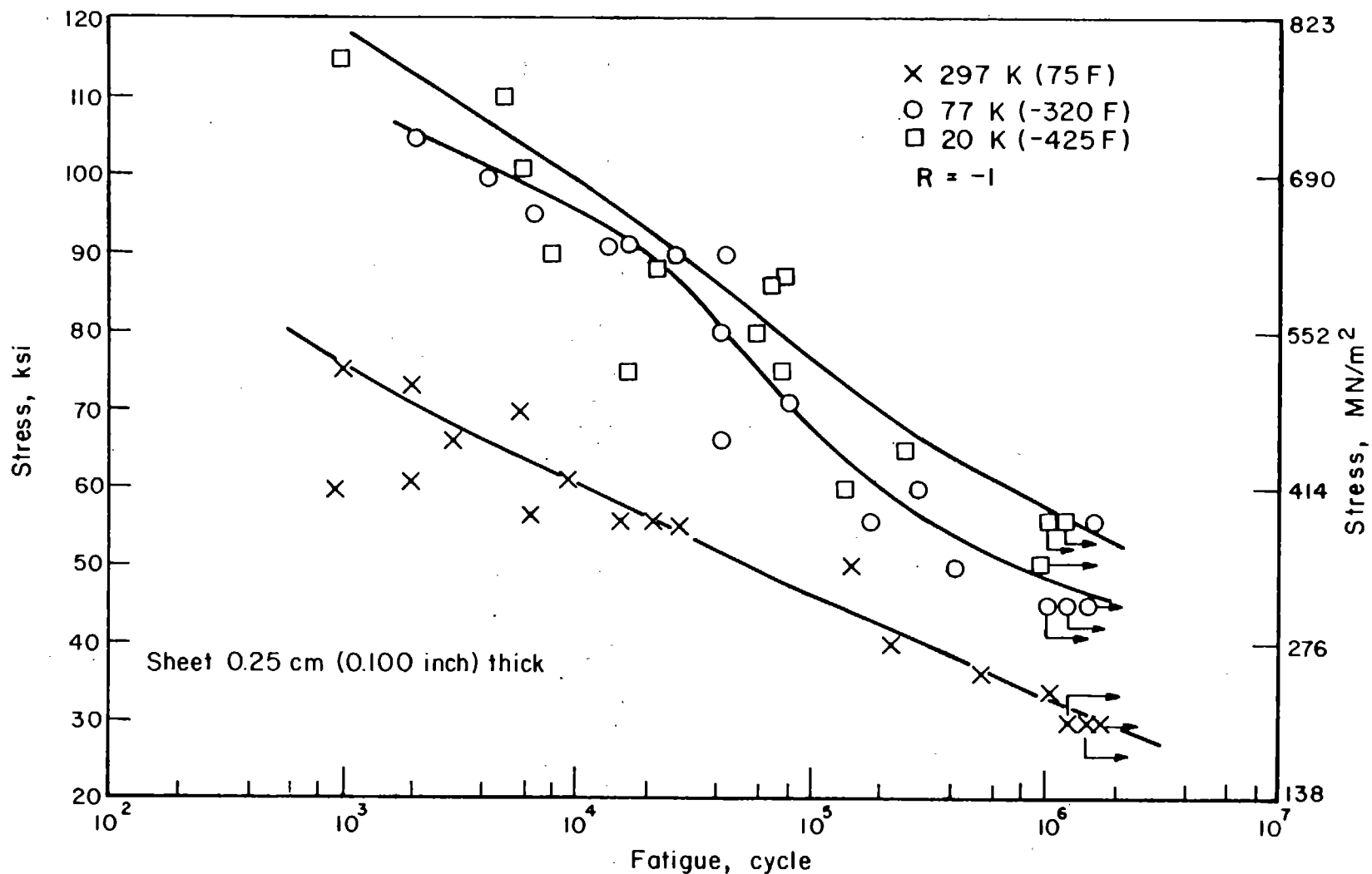


FIGURE 6.2.3-ME4. AXIAL FATIGUE LIFE CURVES FOR LOADING ON SPECIMENS OF INCONEL 718 SHEET ANNEALED, TIG WELDED (718 ALLOY FILLER), AND TESTED AS WELDED [61996]

Inconel 718
Plate

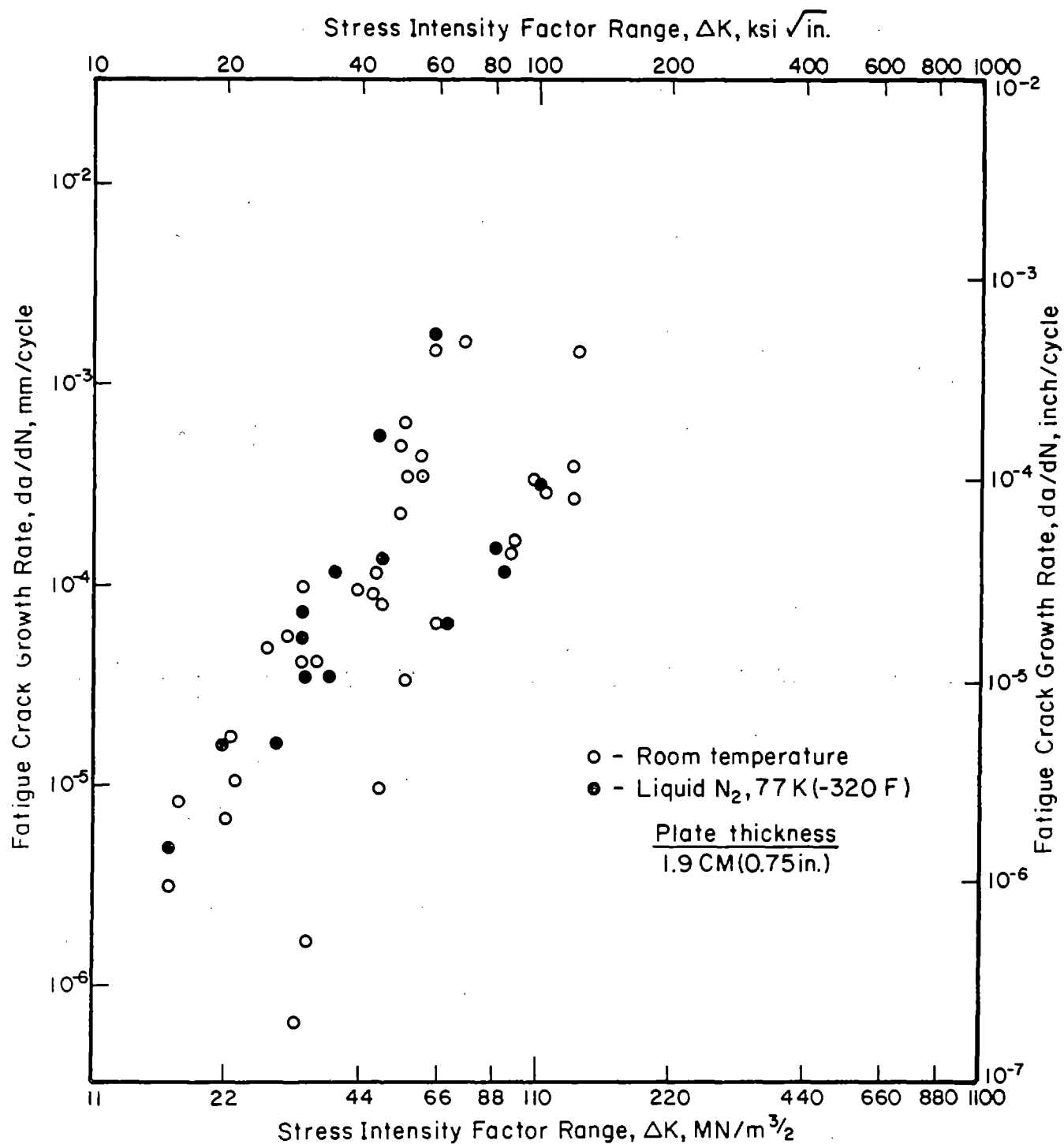


FIGURE 6.2.3-ME5. FATIGUE CRACK GROWTH RATE OF WELDED AND UNWELDED INCONEL 718 NICKEL-BASE ALLOY PLATE [Plate solution treated 1228 K (1750 F) ½ hr, AC; welded, weldment aged at 992 K (1325 F) 8 hr, FC to 895 K (1150 F), AC; tested as aged, unwelded plate aged by same treatment] [90717]

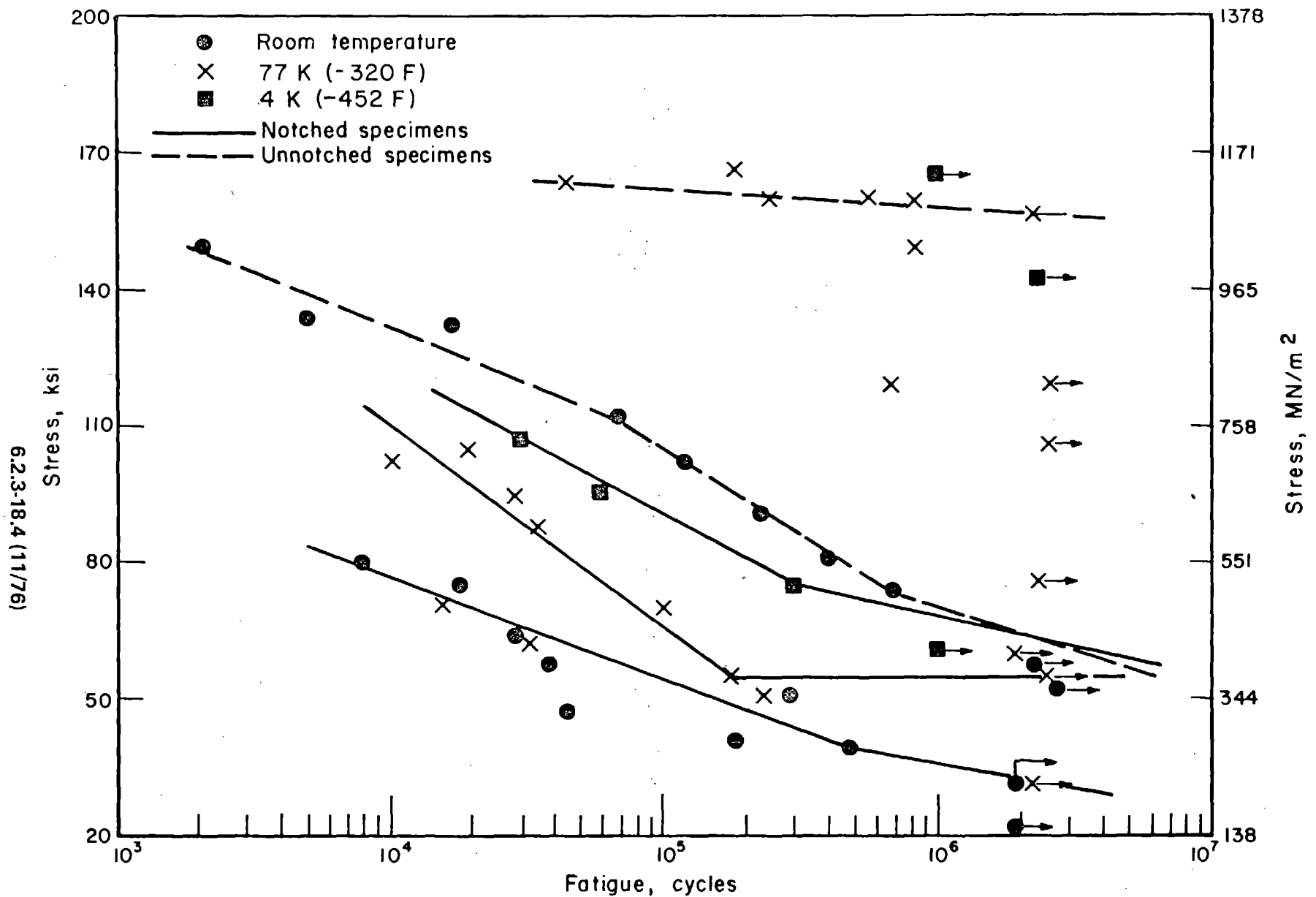


FIGURE 6.2.3-ME6. AXIAL FATIGUE LIFE CURVES FOR LOADING ON SPECIMENS OF NOTCHED AND UNNOTCHED INCONEL 718 BAR, 1.270 cm (0.500 in.) DIAMETER. [Heat treatment: solution treated, then aged 922 K (1324 F) 8 hr, FC 2 hr 895 K (1150 F) 8 hr, AC] [95168]

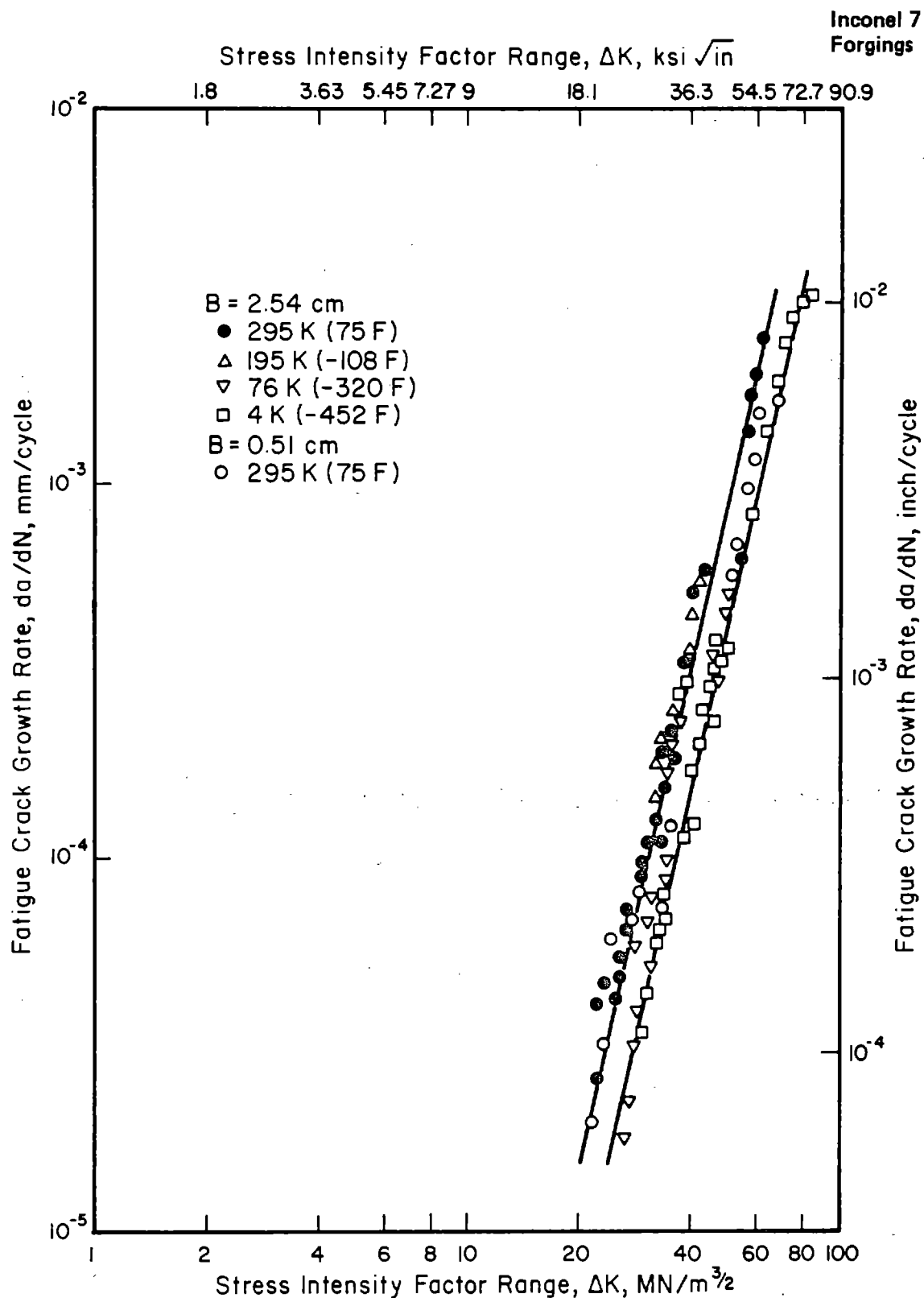


FIGURE 6.2.3-ME7. FATIGUE CRACK GROWTH RATE IN LARGE FORGINGS [2 to 10 cm (1 to 4 in.) DIAMETER] OF INCONEL 718 NICKEL-BASE ALLOY
[Heat treatment: solution treated 1255 K (1800 F) 3/4 hr, AC; aged 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 10 hr, AC]

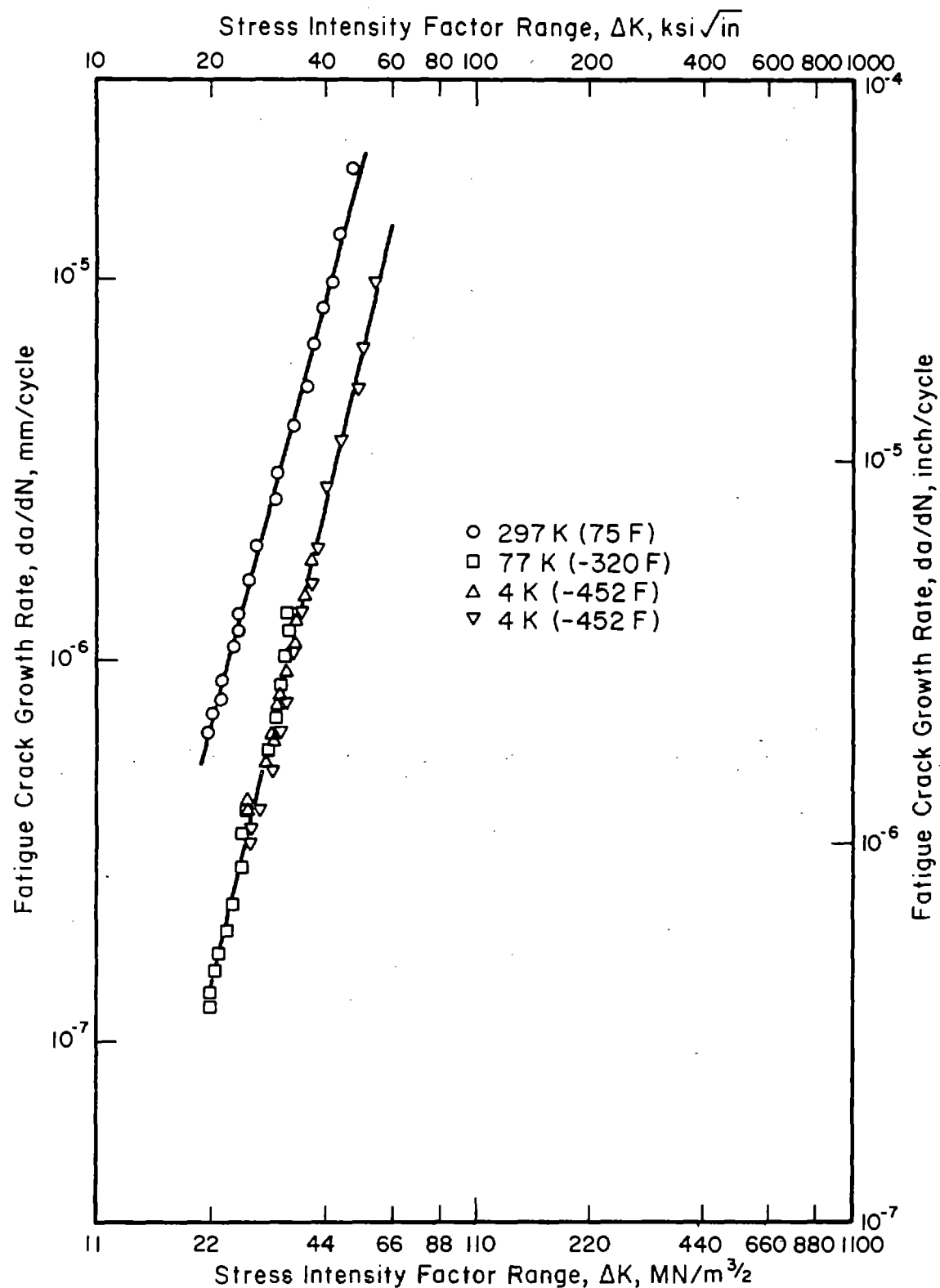


FIGURE 6.2.3-ME8. FATIGUE CRACK GROWTH RATE IN LARGE FORGINGS [OVER 10 cm (4 in.) DIAMETER] OF INCONEL 718 NICKEL-BASE ALLOY [Heat treatment: solution treated 1255 K (1800 F) 1 hr, AC; aged 992 K (1325 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC]

TABLE 6.2.3-TR1

Alloy Designation: Inconel 718 Nickel Alloy

N07718

Specification:

Form:

Dimension:

Condition: Annealed except as noted below

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	9.3	7.0	5.3	2.95	1.48	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(5.38)	(4.05)	(3.06)	(1.71)	(0.856)	
No. of Spec.	2	2	2	2	2	
References: 82097, 77044						
Watts m ⁻¹ K ⁻¹ (1)	10.9	7.09	5.05	2.40	1.08	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(6.30)	(4.10)	(2.92)	(1.39)	(0.624)	
No. of Spec.	1	1	1	1	1	
References: 96885						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal(1)						
Percent	0	-0.183	-0.208	-0.213	-0.213	-0.213
No. of Spec.	3	3	2	2	2	2
References: 74405, 70525, 94208						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	125 x 10 ⁻⁸	120 x 10 ⁻⁸	119 x 10 ⁻⁸	118 x 10 ⁻⁸	118 x 10 ⁻⁸	118 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(752)	(722)	(716)	(710)	(710)	(710)
No. of Spec.	5	5	5	5	5	4
References: 79561, 82097, 90164, 77044, 94206						
Ohm m(1)	1.14 x 10 ⁻⁸	1.09 x 10 ⁻⁸	1.08 x 10 ⁻⁸	1.08 x 10 ⁻⁸	1.08 x 10 ⁻⁸	
Ohm circular mil ft ⁻¹	(686)	(656)	(650)	(650)	(650)	
No. of Spec.	1	1	1	1	1	
References: 96885						
Magnetothermal Conductivity						
Watts m ⁻¹ K ⁻¹						
H Tesla						
Watts m ⁻¹ K ⁻¹					1.15	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹					(0.664)	
Watts m ⁻¹ K ⁻¹					1.10	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹					(0.636)	
No. of Spec.					1	
References: 94208						

(1) Age Hardened

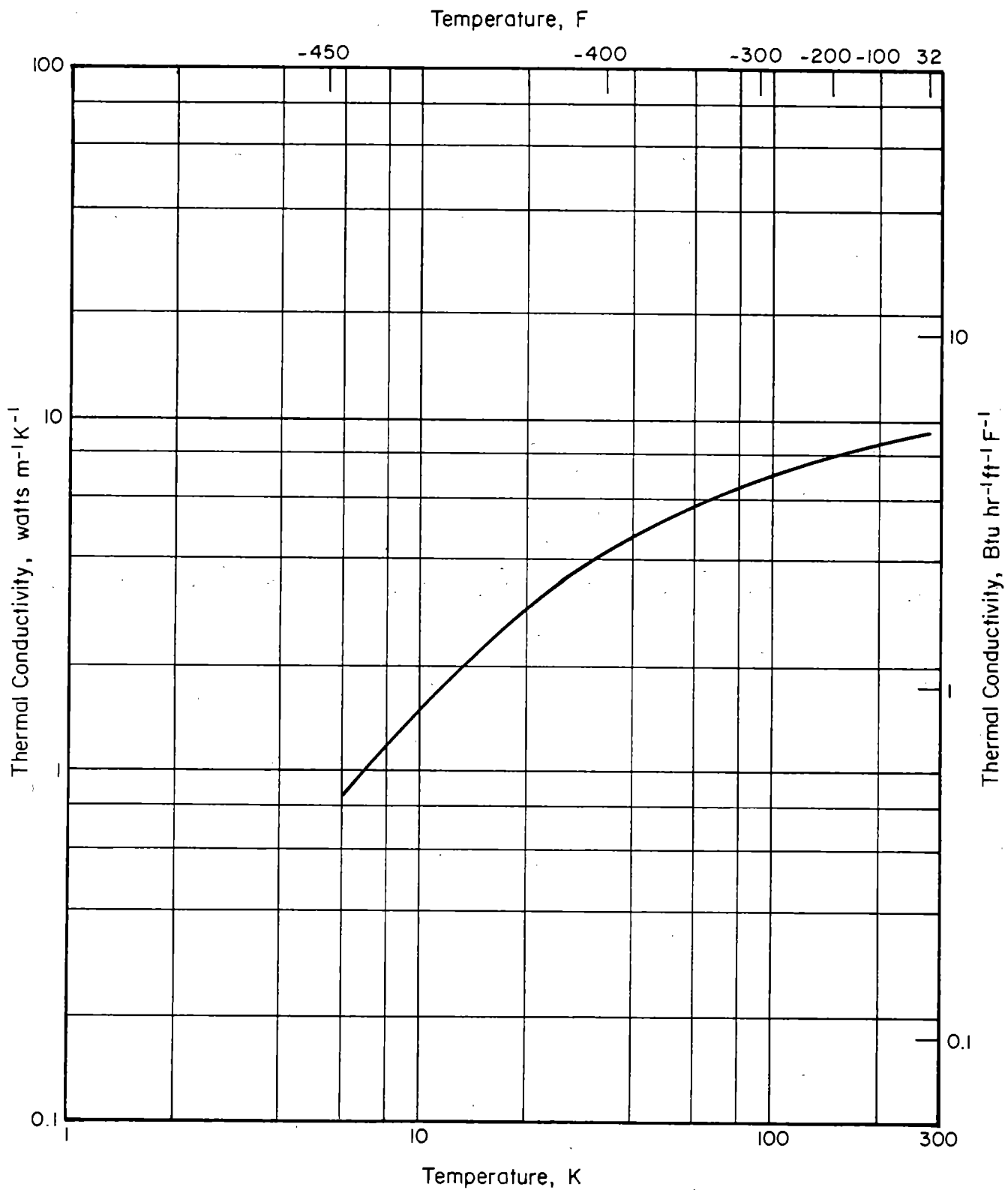


FIGURE 6.2.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE
FOR INCONEL 718 NICKEL ALLOY

6.2.3-20 (11/74)

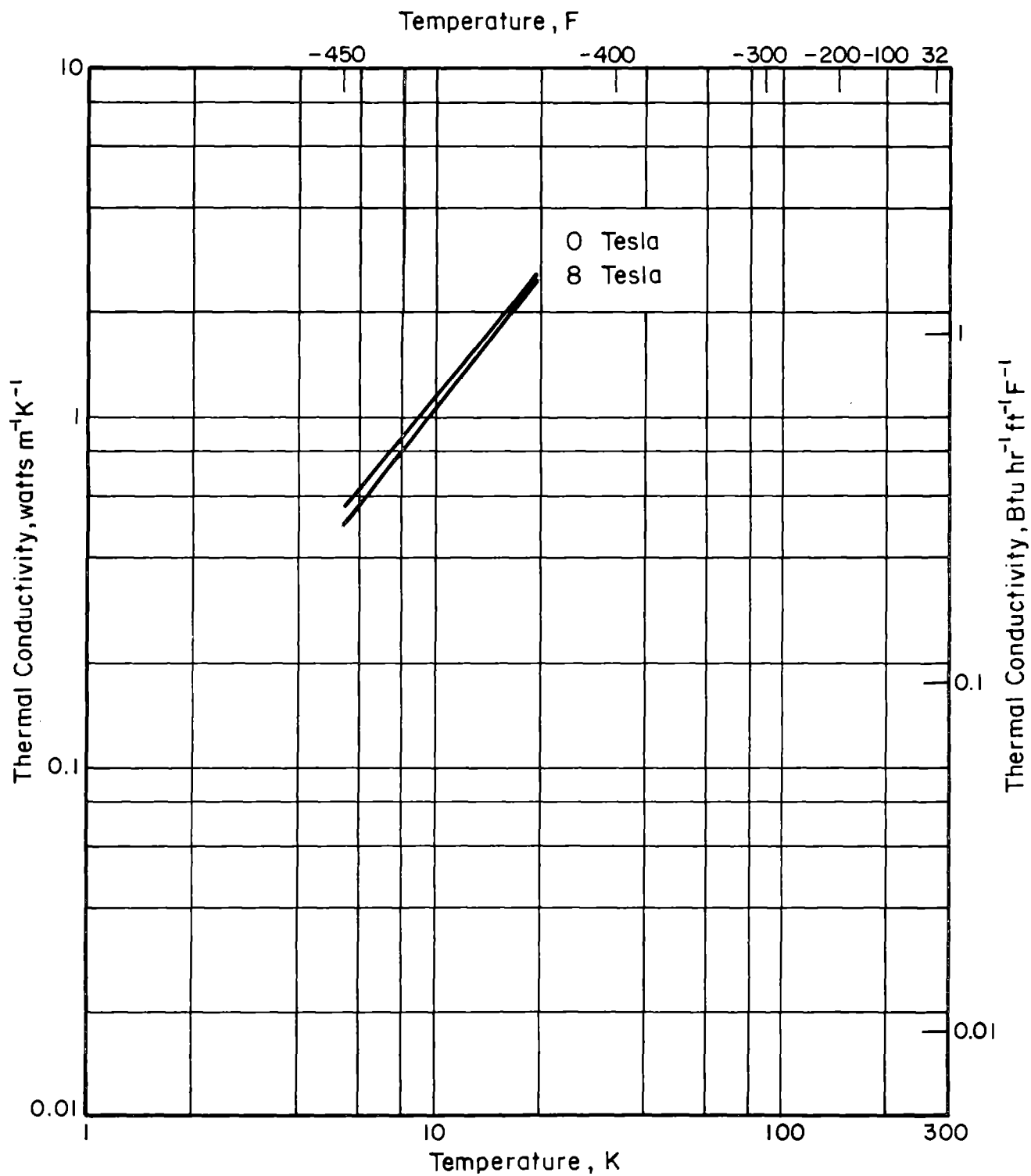


FIGURE 6.2.3-6.2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR INCONEL 718
NICKEL ALLOY AT TWO MAGNETIC FIELD STRENGTHS

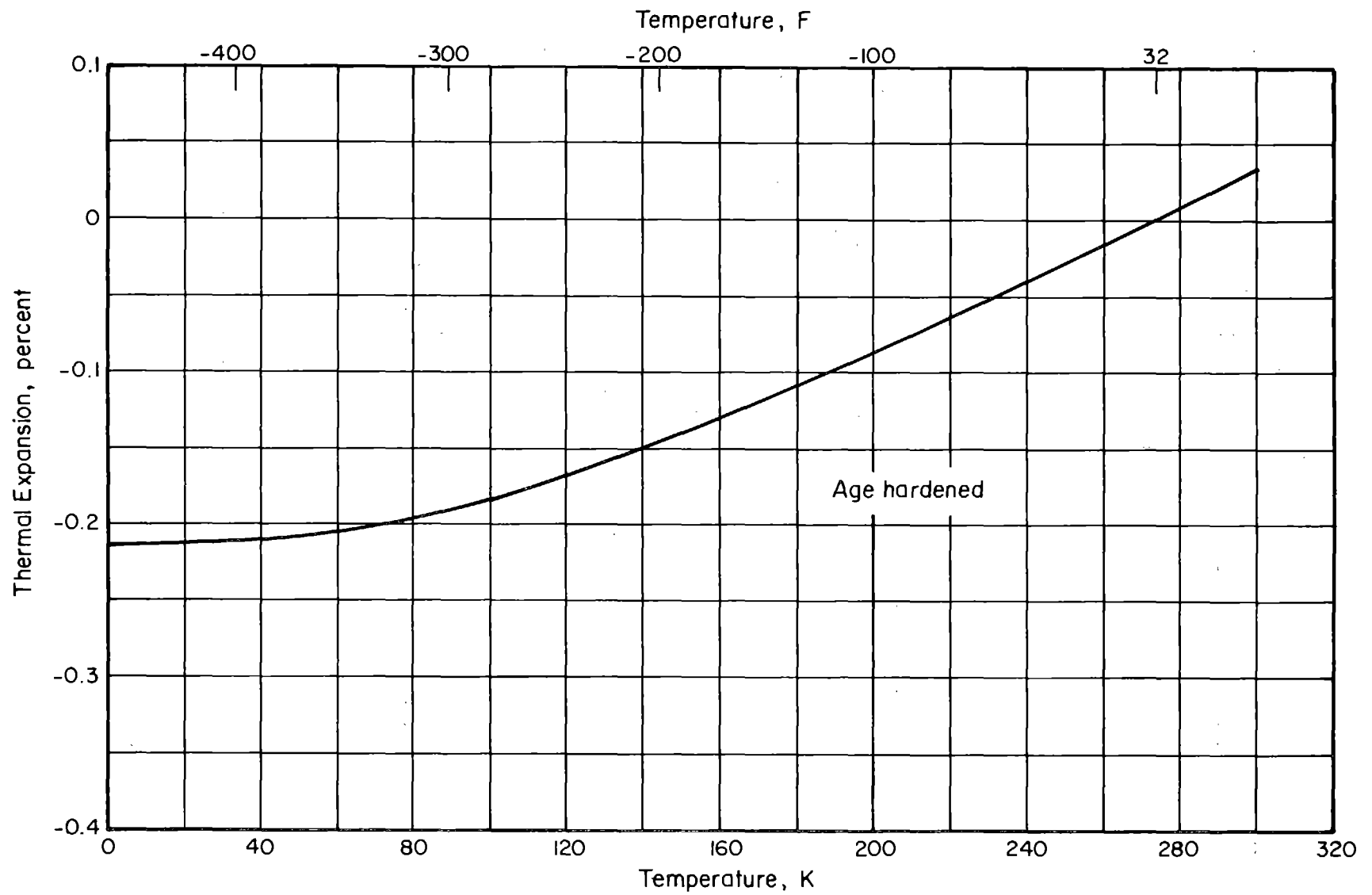


FIGURE 6.2.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR INCONEL 718 NICKEL ALLOY

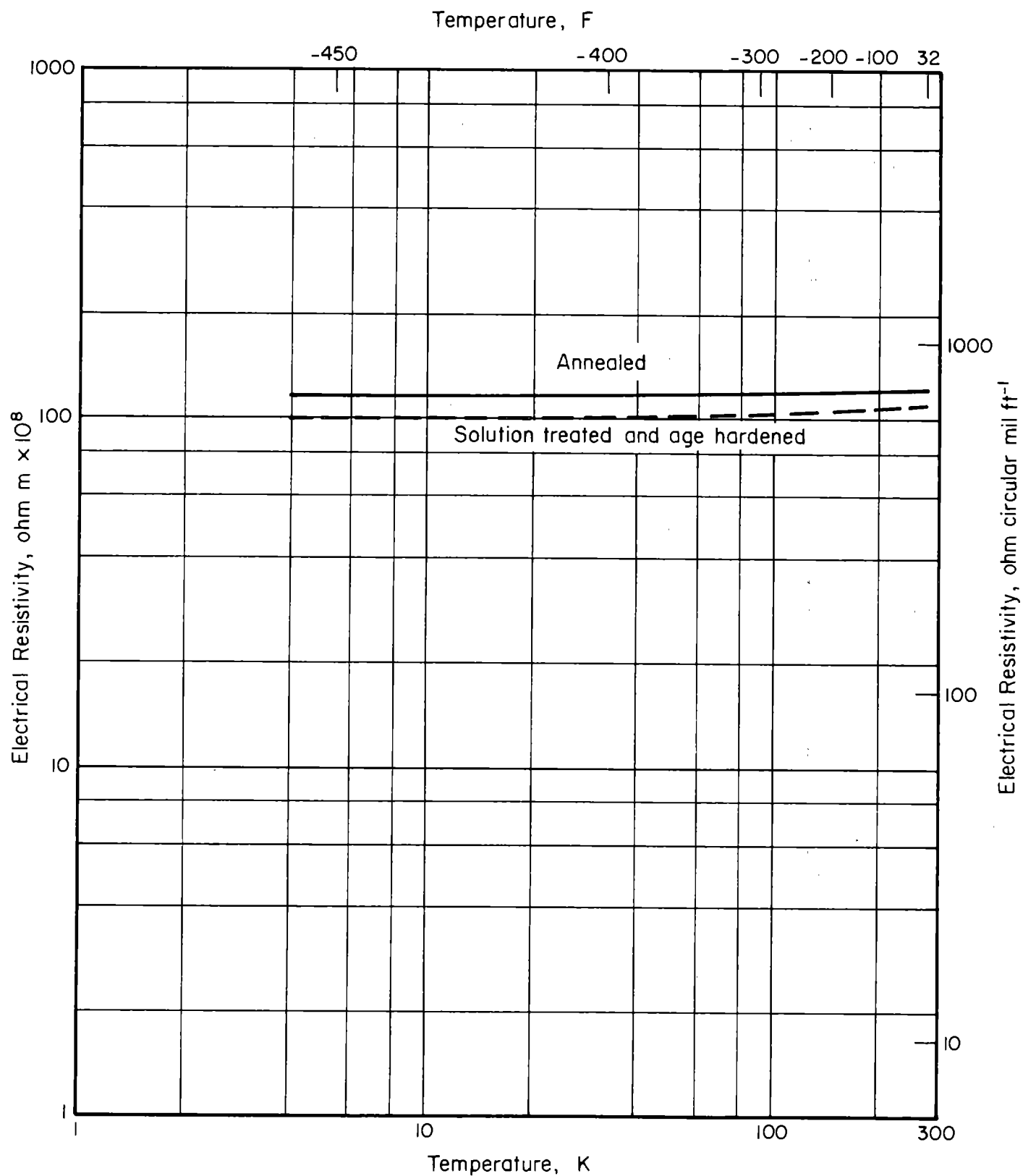
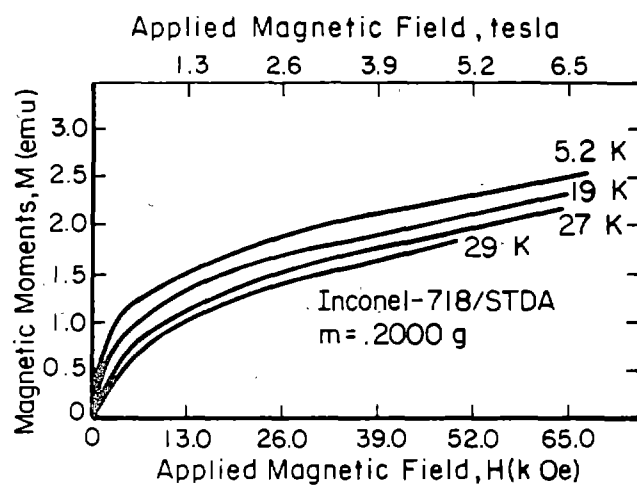


FIGURE 6.2.3-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR INCONEL 718 NICKEL ALLOY

6.2.3-22 (11/74)

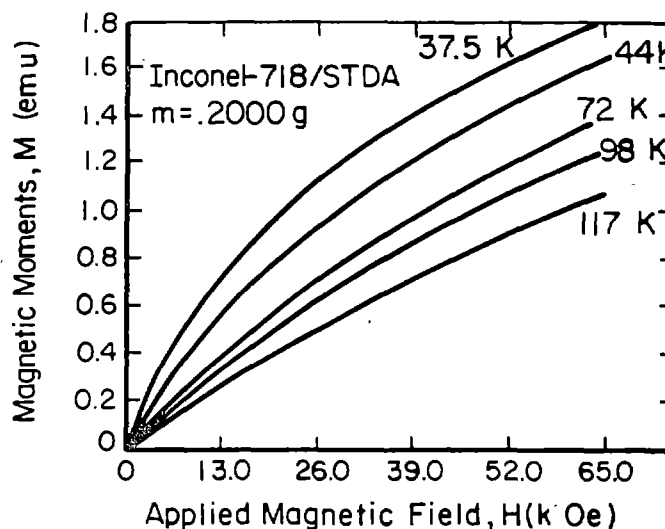
TABLE 6.2.3-MA1

Alloy Designation: Inconel 718
Specification: IN 718 STDA
Form: Rod
Dimension, cm(in.): Not given
Condition: STDA: solution treated, double aged
Peak induction, B_s ,
at 4.2K: 0.1335T (tesla)
Curie Temperature: ~130K (-225 F)



MAGNETIC MOMENT AS A FUNCTION OF
EXTERNAL FIELD AT LOW TEMPERATURES

MAGNETIC MOMENT AS A
FUNCTION OF EXTERNAL FIELD



Reference: 94206

Alloy Designation: Inconel 718 Nickel-Base Alloy

Specification:

Form: Rod

Diameter, cm (in.): 0.37 (0.145)

Condition: Solution annealed

Test Temperature: 4.2 K (-452 F)

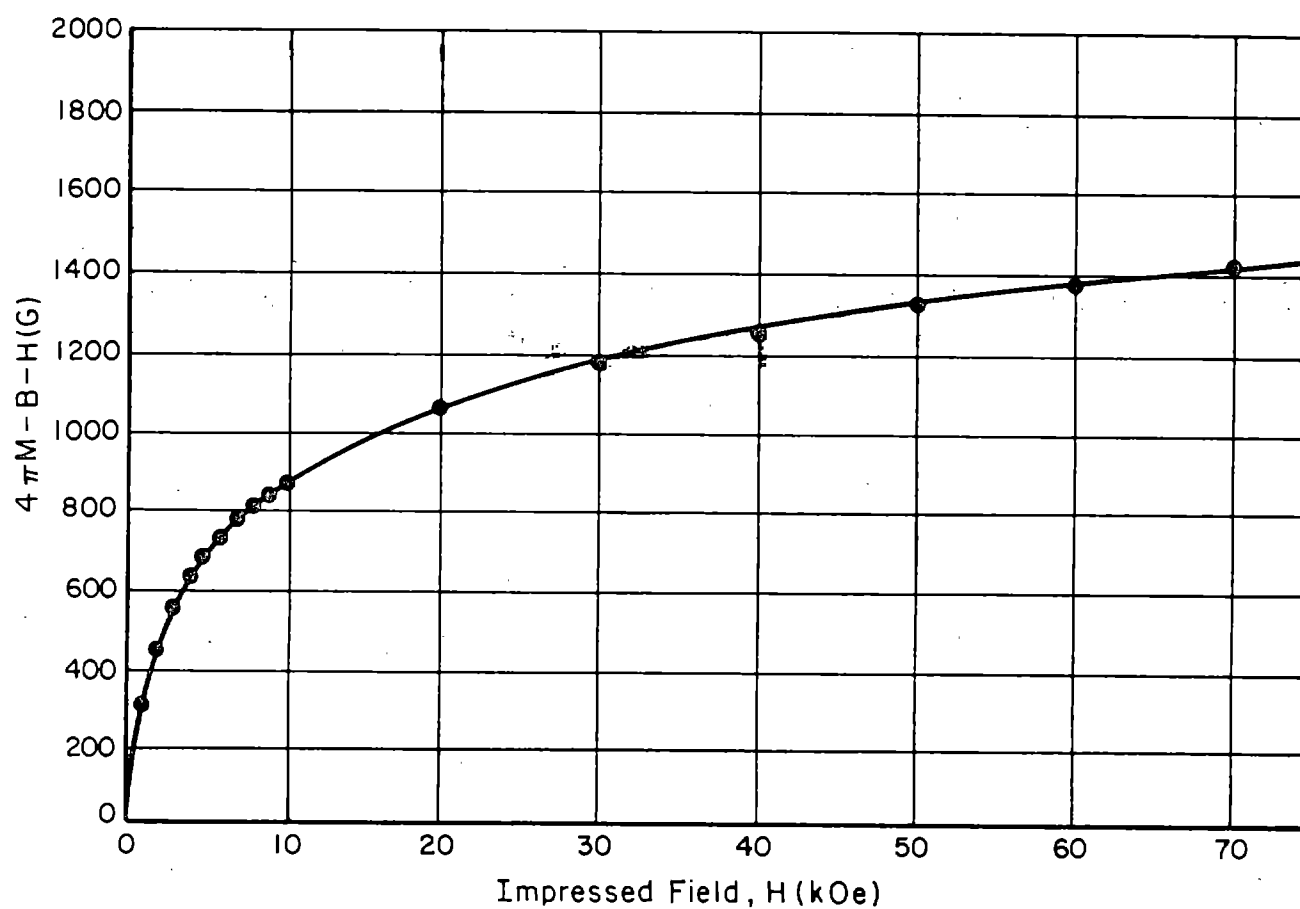


FIGURE 6.2.3-MA2. MAGNETIZATION VERSUS APPLIED MAGNETIC FIELD FOR INCONEL 718 NICKEL-BASE ALLOY [96871]

TABLE 6.2.4-ME1

Inconel 706
Forging

Alloy Designation: Inconel 706 Nickel-Base Alloy

Specification:

Form: Forging

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC, aged 1006 K (1350 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1263 (183.2)			1574 (228.3)		1673 (242.7)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1045 (151.6)			1203 (174.5)		1250 (181.3)
	Min						
Std. Deviation							
Elong, percent	Avg	23.6			28.7		30.2
	Min						
RA, percent	Avg	33.4			33.3		33.3
	Min						
No. of Spec. (No. of Heats)		2 (2)			2 (2)		2 (2)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1876 (272.1)			2175 (315.4)		2250 (326.3)
K _t = .10	Min						
No. of Spec. (No. of Heats)		2 (2)			2 (2)		2 (2)
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 95168

TABLE 6.2.4-ME2

Inconel 706
Forgings

Alloy Designation: Inconel 706 Nickel-Base Alloy

Specification:

Form: Forging

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; aged 1006 K (1350 F) 8 hr, FC to 895 K (1150 F), AC

Testing Temperature, K (F)	297 (75)					4 (-452)
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
J _{IC} MN/m (in.-lb/in. ²)	Avg	0.064 (364)				0.106 (607)
	Min					
Orientation: —						
No. of Spec. (No. of Heats)		2 (1)				2 (1)
K _{IE} , MN/m ^{3/2} (ksi/in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 95168

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 6.2.4-ME3

Alloy Designation: Inconel 706 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Forging-TIG welded, Alloy 718 filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; welded, weldment solution treated 1255 K (1800 F) 1 hr, AC; aged 1006 K (1350 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC; tested as aged

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1111 (161.2)			1295 (187.8)		1370 (198.7)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1000 (145.0)			1174 (170.3)		1222 (177.2)
	Min						
Std. Deviation							
Elong, percent	Avg	1.7			3.8		4.0
	Min						
RA, percent	Avg	5.4			4.4		5.7
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1627 (236.0)			1757 (254.8)		1884 (273.2)
K _t = 10	Min						
No. of Spec. (No. of Heats)		1					
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 95168

TABLE 6.2.4-ME4

Alloy Designation: Inconel 706 Nickel-Base Alloy (Weld Metal)

Specification:

Form: Forging-TIG welded, Alloy 718 filler

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; welded, weldment solution treated 1255 K (1800 F) 1 hr, AC; aged 1006 K (1350 F) 8 hr, FC to 895 K (1150 F), AC, tested as aged

Testing Temperature, K (F)	297 (75)					4 (-452)
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					58.7 (53.0)
	Min					(1)
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 95168

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

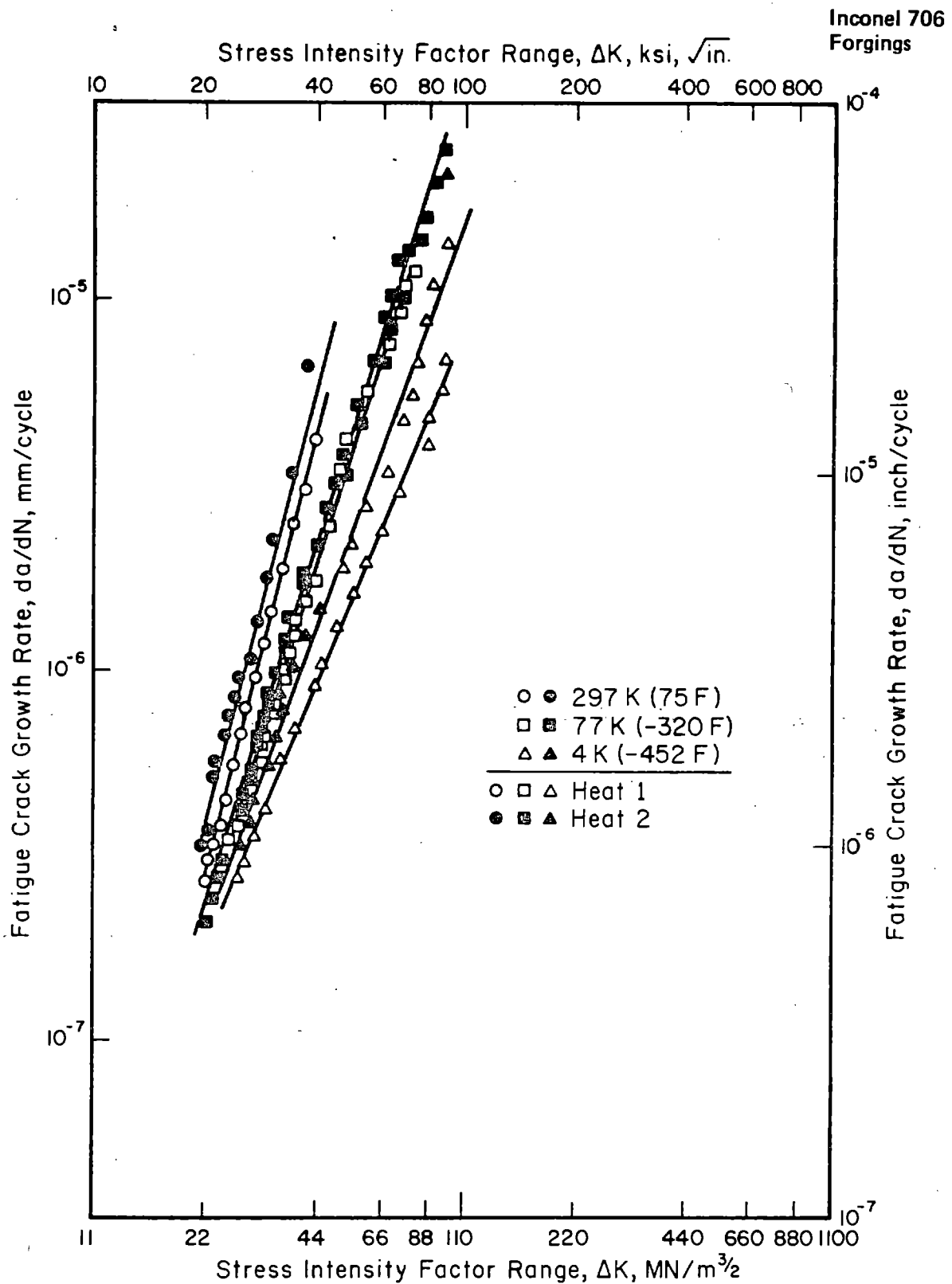


FIGURE 6.2.4-ME1. FATIGUE CRACK GROWTH RATE IN FORGINGS [OVER 5.080 cm (2.000 in.) DIAMETER] OF INCONEL 706 NICKEL-BASE ALLOY [Heat treatment: solution treated 1255 K (1800 F) 1 hr, AC, aged 1006 K (1350 F) 8 hr, FC to 895 K (1150 F) 8 hr, AC] [95168]

TABLE 6.2.4-TR1

Alloy Designation: **Inconel 706 Nickel Alloy**

Specification:

Form:

Dimension:

Condition: **Solution treated and double aged**

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.194	-0.220	-0.227	-0.228	
No. of Spec.	2	2	2	2	2	
References: 95168						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	470	245	100*	9.60	3.70	1.52
Btu lb ⁻¹ F ⁻¹	(0.112)	(5.86 x 10 ⁻²)	(2.39 x 10 ⁻²)*	(2.20 x 10 ⁻³)	(8.84 x 10 ⁻⁴)	(3.63 x 10 ⁻⁴)
No. of Spec.	2	2	0	2	2	2
References: 95168, 96888						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						
* Extrapolated.						

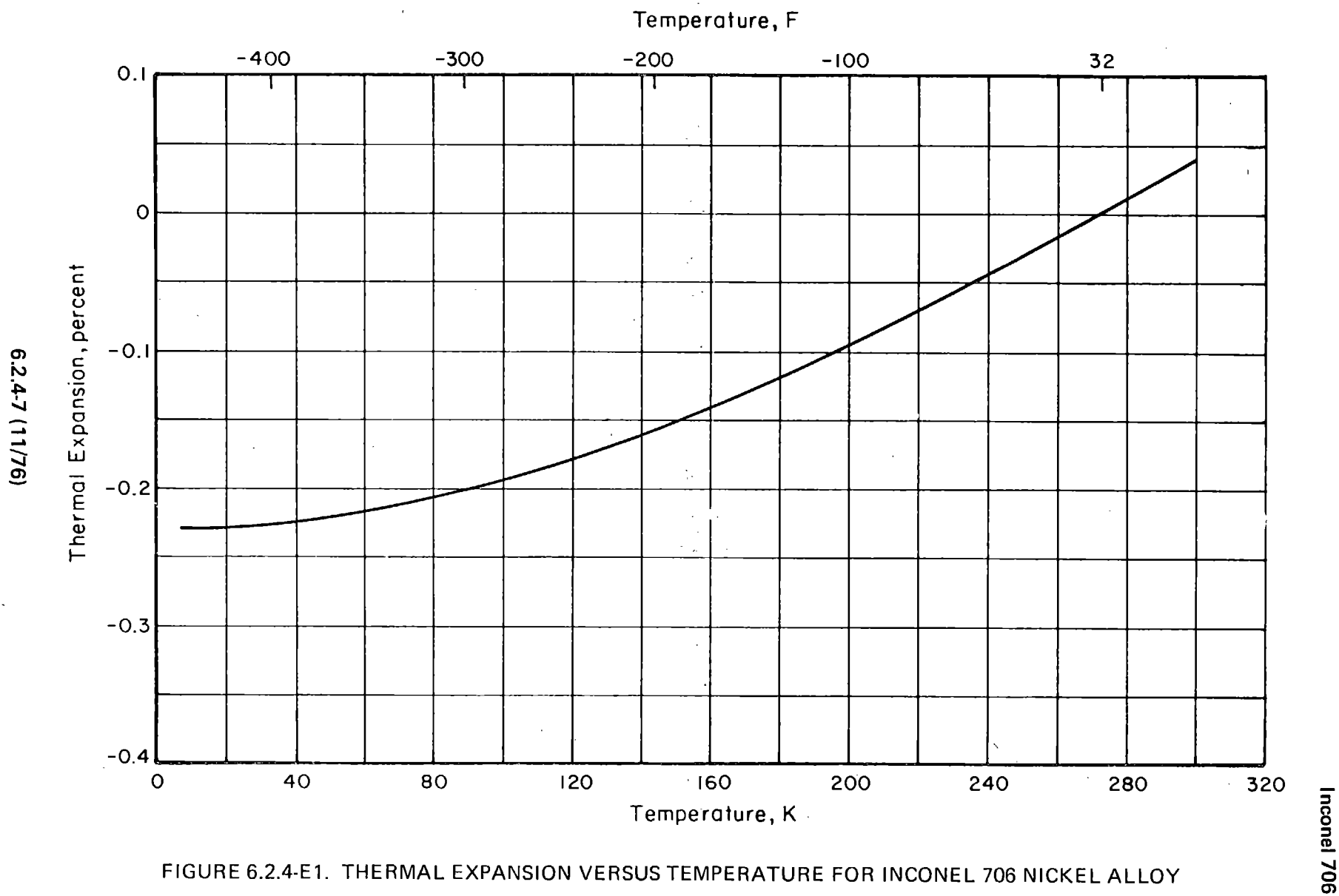


FIGURE 6.2.4-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR INCONEL 706 NICKEL ALLOY

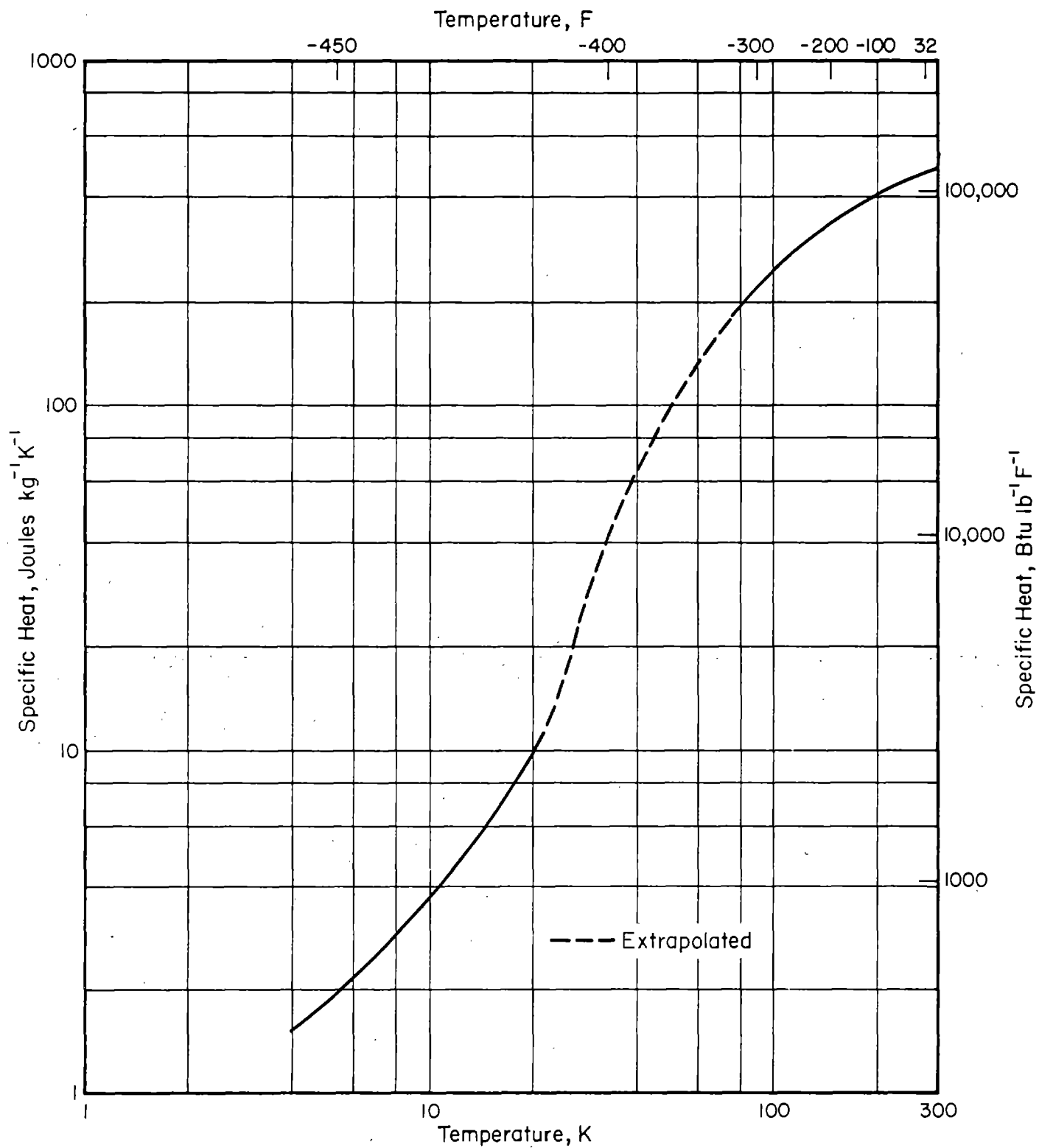


FIGURE 6.2.4-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR INCONEL 706 NICKEL ALLOY

6.2.4-8 (11/76)

TABLE 6.3.1-ME0.1

Alloy Designation: Invar 36 Controlled Expansion Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, Invar 36 filler
Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
Condition: Plate welded and tested as welded

Testing Temperature, K (F)	297 (75)	155 (-180)		77 (-320)		
Compression, Longitudinal						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	95 (70)	50 (37)		38 (28)		
Min						
No. of Spec. (No. of Heats)	1	1		1		
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K_{IE} MN/m^{3/2}(ksi√in.)						
Avg						
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 66001

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 6.3.1-ME0.2

Invar 36
Plate-Weld Metal

Alloy Designation: Invar 36 Controlled Expansion Alloy (Weld Metal)

Specification:

Form: Plate-TIG welded, Invar 36 filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate welded, weldment stress relieved 922 K (1200 F) 1½ hr, AC; tested as stress relieved

Testing Temperature, K (F)	297 (75)	155 (-108)		77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	104 (77)	56 (41)		39 (29)		
Min						
No. of Spec. (No. of Heats)	1	1		1		
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)						
(From PTSC spec.) (—)						
Avg						
Min						
No. of Spec. (No. of Heats)						

References: 66001

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 6.3.1-ME1

Alloy Designation: Invar 36 Controlled Expansion Alloy

Specification:

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Cold drawn 12-15 percent

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	649 (94.1)	789 (114)	1078 (156)	1189 (172)	1226 (178)	
	Min	643 (93.2)	772 (112)	1073 (156)	1174 (170)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	628 (91.1)	727 (105)	920 (133)	1114 (162)	1109 (161)	
	Min	620 (89.9)	720 (104)	915 (133)	1081 (157)		
Std. Deviation							
Elong, percent	Avg	20.8	28.7	26.6	23.1	19.8	
	Min	19.5	27.6	25.5	17.6		
RA, percent	Avg	61.8	59.9	61.4	57.6	51.8	
	Min	61.1	58.3	59.9	53.6		
No. of Spec. (No. of Heats)		5 (1)	7 (1)	4 (1)	4 (1)	1 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 54986

TABLE 6.3.1-ME2

Invar 36
Rod

Alloy Designation: Invar 36 Controlled Expansion Alloy

Specification:

Form: Rod
 Thickness, cm (in.): Up to 2.540 (1.000)
 Condition: Cold drawn 10 to 15 percent

Testing Temperature, K (F)		297 (75)	195 (-108)	150 (-190)	100 (-280)	77 (-320)	4 (-452)
Compression, Longitudinal							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear(a)							
SUS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Dynamic Modul:							
E, GN/m ² (10 ⁶ psi)	Avg*	143.3 (20.78)	137.9 (20.00)	135.3 (19.62)	133.4 (19.35)	132.8 (19.26)	--
		152.3 (22.09)	142.7 (20.70)	139.9 (20.29)	139.8 (20.28)	140.3 (20.30)	141.7 (20.55)
G, GN/m ² (10 ⁶ psi)	Avg*	55.8 (8.09)	53.3 (7.73)	52.1 (7.56)	51.1 (7.41)	50.8 (7.87)	--
		56.5 (8.19)	53.5 (7.76)	52.2 (7.57)	50.9 (7.38)	50.6 (7.34)	50.5 (7.32)
B, GN/m ² (10 ⁶ psi)	Avg	110.9 (16.08)	111.2 (16.13)	112.5 (16.32)	113.9 (16.52)	114.6 (16.62)	
	Min						
Poisson's Ratio	Avg	0.285	0.293	0.300	0.305	0.307	
	Min						
No. of Spec.							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness(b)							
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg						
	Min						
Orientation. —							
No. of Spec. (No. of Heats)							
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg						
(From PTSC spec.)(—)Min							
No. of Spec. (No. of Heats)							

References: 94206C

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

* The first value in each average represents pulse-echo results; the second (underneath the first) represents resonance results.

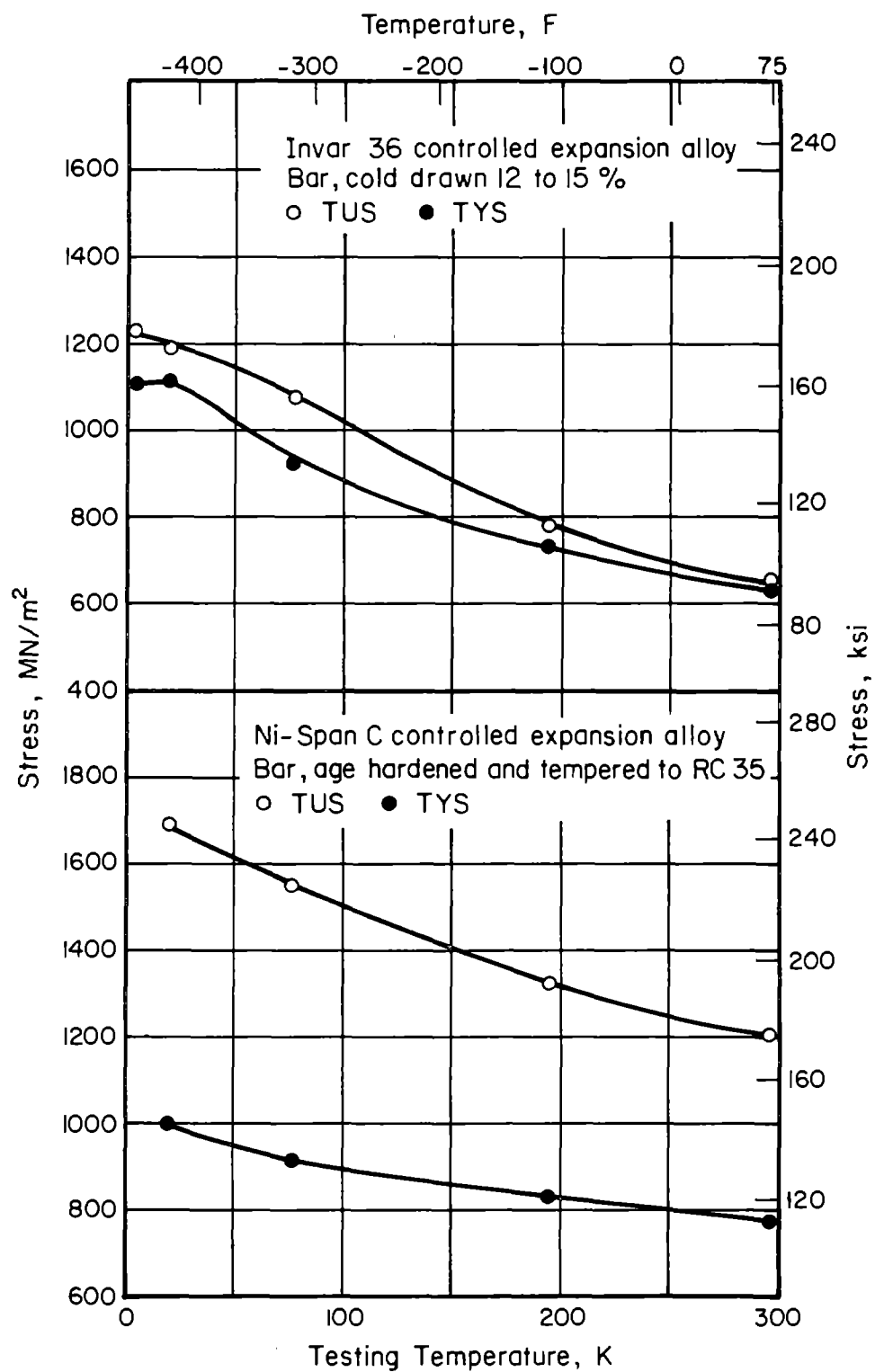


FIGURE 6.3.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF CONTROLLED EXPANSION ALLOYS

TABLE 6.3.1-TR1

Alloy Designation: Invar 36 Controlled Expansion Alloy

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal(1)						
Percent	0	-0.029	-0.034	-0.034		
No. of Spec.	3	3	2	2		
References: 74405, 90336, 70525						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity(2)						
Ohm m	79 x 10 ⁻⁸	56.5 x 10 ⁻⁸	52.0 x 10 ⁻⁸	50.5 x 10 ⁻⁸	50.0 x 10 ⁻⁸	50.0 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(475)	(340)	(313)	(304)	(301)	(301)
No. of Spec.	1	1	1	1	1	1
References: 79561						

(1) — Hot Rolled,
Cold Drawn (12-15%)

(2) — Cold Drawn (12-15%)

6.3.1-4 (11/75)

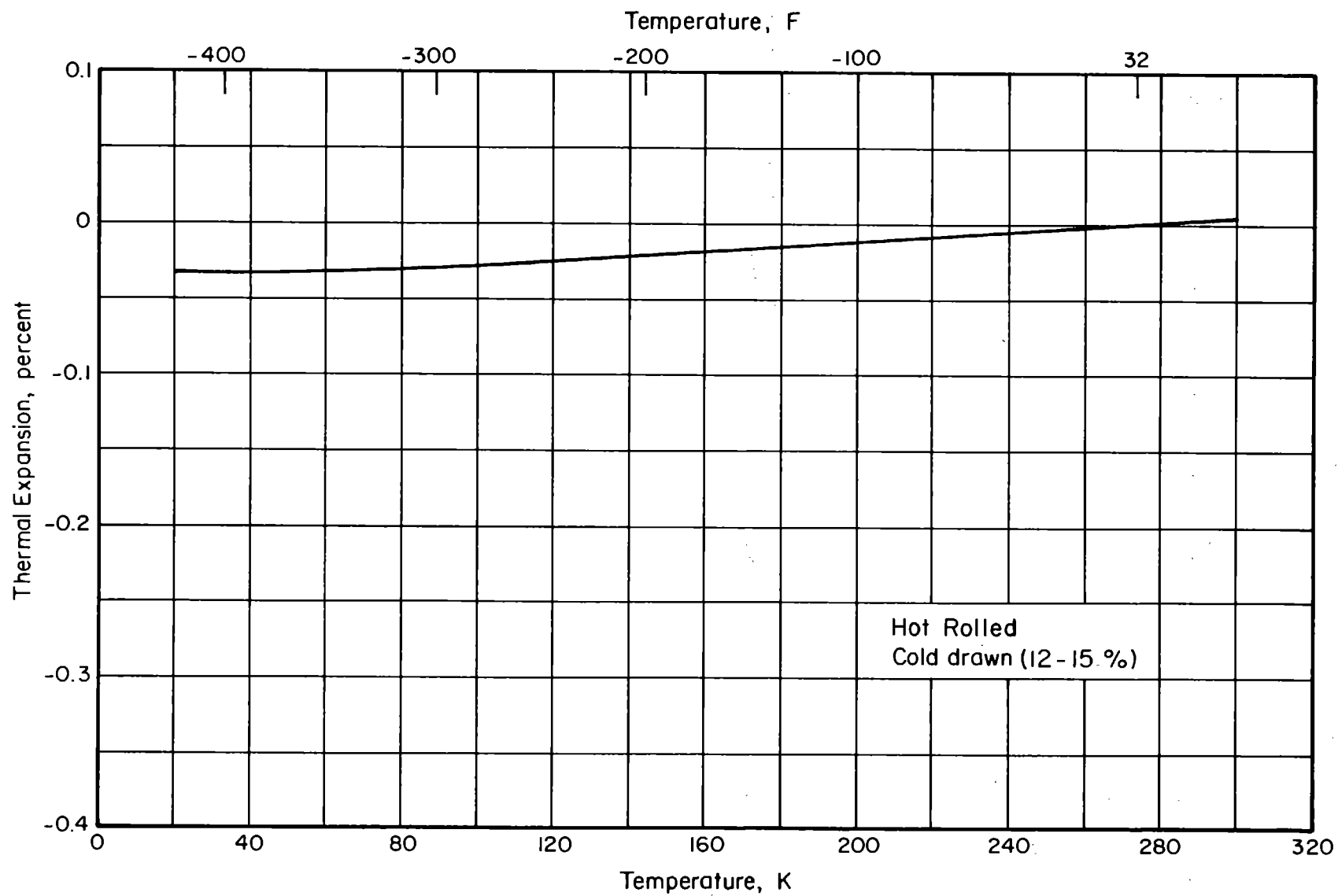


FIGURE 6.3.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR INVAR 36 CONTROLLED EXPANSION ALLOY

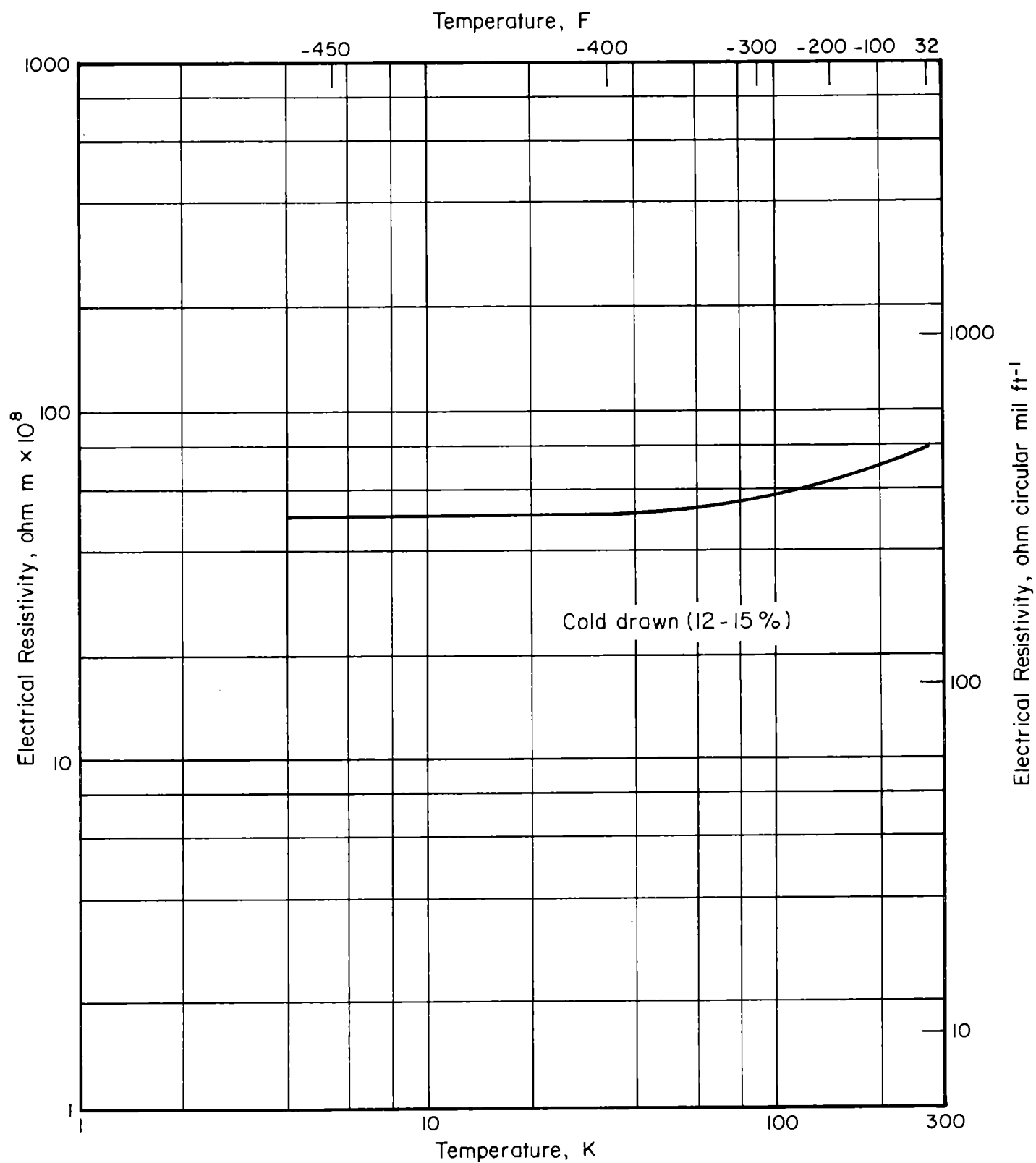


FIGURE 6.3.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR INVAR 36 CONTROLLED EXPANSION ALLOY

TABLE 6.3.2-ME1

Alloy Designation: Ni-Span C Controlled Expansion Alloy

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 to (0.039)

Condition: Cold rolled, annealed, age hardened 920 K (1200 F) 5 hr, AC

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1048 (152)			1544 (224)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	690 (100)			848 (123)		
	Min						
Std. Deviation							
Elong, percent	Avg	20.7			31.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 49048

TABLE 6.3.2-ME2

Alloy Designation: Ni-Span C Controlled Expansion Alloy

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Cold rolled, annealed, age hardened 920 K (1200 F) 5 hr, AC

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency 29-86 Hz with $R = -1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	772 (112) 1 (1)	820 (119) 1 (1)	889 (129) 1 (1)	1000 (145) 1 (1)		
Ratio S_N /TUS at 10^5 cycles	0.74			0.65		
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency 29-86 Hz with $R = -1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	565 (82) 1 (1)	690 (100) 1 (1)	690 (100) 1 (1)	841 (122) 1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.54			0.54		
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency 29-86 Hz with $R = -1$ and $K_t = 3.1$ No. of S-N Curves (No. of Heats)	483 (70) 1 (1)	538 (78) 1 (1)	552 (80) 1 (1)	758 (110) 1 (1)		
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency 29-86 Hz with $R = -1$ and $K_t = 3.1$ No. of S-N Curves (No. of Heats)	269 (39) 1 (1)	317 (46) 1 (1)	310 (45) 1 (1)	393 (57) 1 (1)		
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 49048

TABLE 6.3.2-ME3

Alloy Designation: Ni-Span C Controlled Expansion Alloy

Specification:

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Age hardened at 920 K (1200 F) for 5 hr, AC, tempered to RC35
(Grain size ASTM 8)

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal						
TUS, MN/m² (ksi)	Avg	1202 (174)	1321 (192)	1549 (225)	1686 (244)	
	Min	1200 (174)	1300 (189)	1533 (222)	1678 (243)	
Std Deviation						
TYS, MN/m² (ksi)	Avg	774 (112)	829 (120)	905 (131)	999 (145)	
	Min	773 (112)	822 (119)	887 (129)	993 (144)	
Std Deviation						
Elong, percent	Avg	24.0	27.1	31.6	30.3	
	Min	23.9	24.7	29.8	29.0	
RA, percent	Avg	50.0	48.5	47.0	43.3	
	Min	48.9	47.6	45.1	43.1	
No. of Spec. (No. of Heats)		2 (1)	3 (1)	3 (1)	2 (1)	
E, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m² (ksi)	Avg					
	Min					
K_t =						
No. of Spec. (No. of Heats)						
NTS, MN/m² (ksi)	Avg					
	Min					
K_t =						
No. of Spec. (No. of Heats)						

References: 54986

TABLE 6.3.2-TR1

Alloy Designation: Ni-Span C Controlled Expansion Alloy

Specification:

Form:

Dimension:

Condition: Age Hardened

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec. References:						
Thermal Expansion (T₂₇₃ to T) Longitudinal Percent No. of Spec. References: 48134	0 1	-0.105 1	-0.118 1	-0.120 1		
Specific Heat Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec. References:						
Electrical Resistivity Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

6.3.2-5 (11/74)

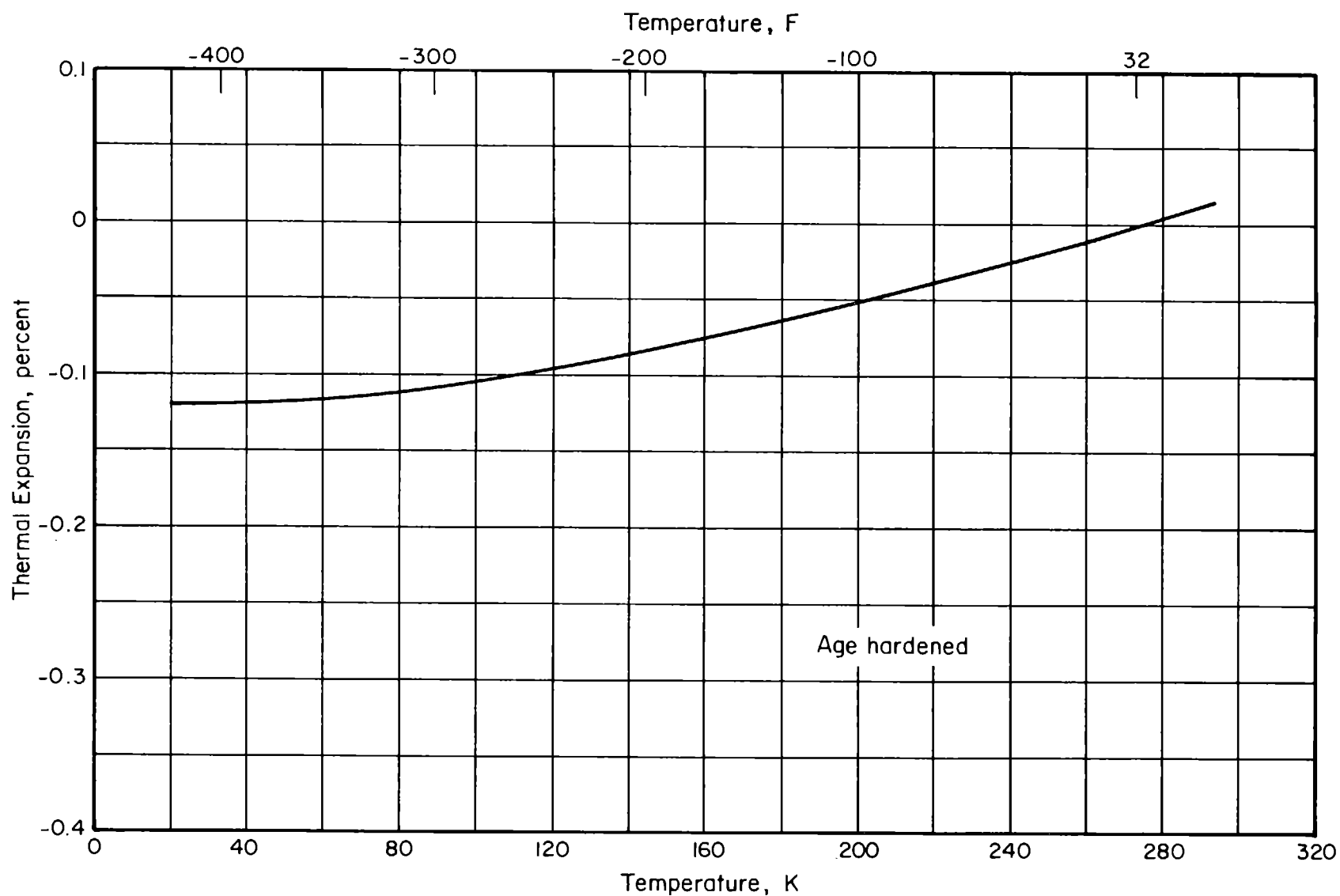


FIGURE 6.3.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR Ni-SPAN C CONTROLLED EXPANSION ALLOY

TABLE 6.3.3-ME1

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1255 K (1800 F) 0.5 hr., AC

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	669 (97)	1034 (150)				
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	372 (54)	689 (100)				
	Min						
Std. Deviation							
Elong, percent	Avg	45	38				
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 65184

TABLE 6.3.3-ME2

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1255 K (1800 F) 0.5 hr., AC + Aged 922-936 K (1200-1225 F) 8hr.

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1158 (168)	1531 (222)				
	Min	1138 (165)	1524 (221)				
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	910 (132)	1200 (174)				
	Min	889 (129)	1165 (169)				
Std. Deviation							
Elong, percent	Avg	22	12				
	Min	19	11				
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2	2				
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1117 (162)	1317 (191)				
	Min	1103 (160)	1310 (190)				
K _t = 20							
No. of Spec. (No. of Heats)		2	2				
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 65184

TABLE 6.3.3-ME3

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Sheet

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: Mill annealed

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	634 (92)	972 (141)				
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	365 (53)	641 (93)				
	Min						
Std. Deviation							
Elong, percent	Avg	43	37				
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 65184

TABLE 6.3.3-ME4

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Sheet

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: Mill annealed + Aged 922-936 K (1700-1725 F) 8 hr.

Testing Temperature, K (F)		297 (75)	77 (-320)			
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg	1207 (175)	1524 (221)			
	Min	1158 (168)	1517 (220)			
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	896 (130)	1303 (189)			
	Min	876 (127)	--			
Std. Deviation						
Elong, percent	Avg	21	22			
	Min	20	22			
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		2	2			
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg	1082 (157)	1365 (198)			
K _t = 20	Min	1076 (156)	1344 (195)			
No. of Spec. (No. of Heats)		2	2			
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 65184

TABLE 6.3.3-ME5

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	627 (91)	993 (144)				
	Min	621 (90)	972 (141)				
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	359 (57)	655 (95)				
	Min	352 (51)	655 (95)				
Std. Deviation							
Elong, percent	Avg	44	37				
	Min	43	32				
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2	2				
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	476 (69)	876 (127)				
K _t = 20	Min	448 (65)	848 (123)				
No. of Spec. (No. of Heats)		2	2				
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 65184

TABLE 6.3.3-ME6

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed

Testing Temperature, K (F)	297 (75)	77 (-320)				
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V*						
Long., Nm(ft-lb)	Avg	81.4 (60)	60.0 (44)			
	Min	77.3 (57)	--			
No. of Spec. (No. of Heats)		2	1			
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{Ic} MN/m^{3/2}(ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K_{Ic}, MN/m^{3/2}(ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 65184

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{Ic} data:

* Half-size specimens

TABLE 6.3.3-ME7

INCO LEA
Plate

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed + Aged 922-936 K (1200-1225 F) 8-16 hr.

Testing Temperature, K (F)		297 (75)	77 (-320)			
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg	1138 (165)	1558 (226)			
	Min	951 (138)	1531 (222)			
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	910 (132)	1213 (176)			
	Min	834 (121)	1165 (169)			
Std. Deviation						
Elong, percent	Avg	20	20			
	Min	16	11			
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		6	6			
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg	1138 (165)	1365 (198)			
K _t = 20	Min	1082 (157)	1310 (190)			
No. of Spec. (No. of Heats)		6	6			
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 65184

TABLE 6.3.3-ME8

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed + Aged 922-936 K (1200-1225 F) 8-16 hr.

Testing Temperature, K (F)		297 (75)	77 (-320)	20 (-423)			
Compression, Longitudinal							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear^(a)							
SUS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V*							
Long., Nm(ft-lb)	Avg	24.0 (17.7)	15.9 (11.7)	16.3 (12)			
	Min	16.3 (12)	14.9 (11)	14.9 (11)			
No. of Spec. (No. of Heats)		10	6	4			
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness^(b)							
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg						
	Min						
Orientation. —							
No. of Spec. (No. of Heats)							
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg						
(From PTSC spec.) (—)Min							
No. of Spec. (No. of Heats)							

References: 65184

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

* Half-size specimens

TABLE 6.3.3-ME9

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed 1255 K (1800 F) 0.5 hr., AC + aged 950-964 K (1250-1275 F) 4 hr.

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1062 (154)	1434 (208)				
	Min	1048 (152)	1393 (202)				
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	814 (118)	1117 (162)				
	Min	800 (116)	1103 (160)				
Std. Deviation							
Elong, percent	Avg	24	21				
	Min	22	14				
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2	2				
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1027 (149)	1282 (186)				
K _t = 20	Min	1020 (148)	1276 (185)				
No. of Spec. (No. of Heats)		2	2				
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 65184

TABLE 6.3.3-ME10

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed 1255 K (1800 F) 0.5 hr., AC + aged 950-964 K (1250-1275 F) 4hr.

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V*						
Long., Nm(ft-lb)						
Avg	28.5 (21)	20.3 (15)	20.3 (15)			
Min	27.1 (20)	19.0 (14)	20.3 (15)			
No. of Spec. (No. of Heats)	4	2	2			
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 65184

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

* Half-size specimens

TABLE 6.3.3-ME11

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F) 1 hr., AC; aged 936 K (1225 F) 8 hr., AC

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	314.4 (145.6)	1317 (191.0)	1339 (194.2)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	918.4 (133.2)	1207 (175.0)	1282 (185.9)			
	Min						
Std. Deviation							
Elong, percent	Avg	1.0	1.9	0.7			
	Min						
RA, percent	Avg	6.0	3.5	3.8			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1368 (198.4)	1641 (238.0)	1615 (234.3)			
$K_t =$	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							

References: 94208G

TABLE 6.3.3-ME11.1

INCO LEA
Plate

Alloy Designation: Inco Low Expansion Alloy (Unnamed)

Specification:

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1255 K (1800 F) 1 hr, AC; aged 936 K (1225 F) 8 hr, AC

Testing Temperature, K (F)	297 (75)					4 (-452)
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
J_{IC} MN/m (in.-lb/in.²)	Avg	0.046 (263)				0.034 (195)
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K_{IE}, MN/m^{3/2}(ksi/in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 95168

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 6.3.3-ME12

Alloy Designation: Inco Low-Expansion Alloy (unnamed)

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Annealed 1255 K (1800 F) 0.5 hr., AC; aged 936 K (1225 F) 8 hr.

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1234 (179)	1648 (239)				
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	896 (130)	1338 (194)				
	Min						
Std. Deviation							
Elong, percent	Avg	19	20				
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1	1				
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1689 (245)	2151 (312)				
K _t =	Min						
No. of Spec. (No. of Heats)		1	1				
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 65184

TABLE 6.3.3-TR1

Alloy Designation: Inco Controlled-Expansion Alloy

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	11.6	6.30	1.34	1.20	0.54	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(6.71)	(3.64)	(0.775)	(0.694)	(0.312)	
No. of Spec.	1	1	1	1	1	
References: 94206						
Thermal Expansion (T₂₇₃ to T)						
<u>Longitudinal</u>						
Percent	0	-0.068	-0.081	-0.083	-0.083	
No. of Spec.	1	1	1	1	1	
References: 94206						
Specific Heat						
Joules kg ⁻¹ K ⁻¹					2.95	1.12
Btu lb ⁻¹ F ⁻¹					(0.000705)	(0.000268)
No. of Spec.					1	1
References: 94206						
Electrical Resistivity						
Ohm m	94 x 10 ⁻⁸	76 x 10 ⁻⁸	71.5 x 10 ⁻⁸	70 x 10 ⁻⁸	70 x 10 ⁻⁸	
Ohm circular mil ft ⁻¹	(565)	(457)	(430)	(421)	(421)	
No. of Spec.	1	1	1	1	1	
References: 94206						

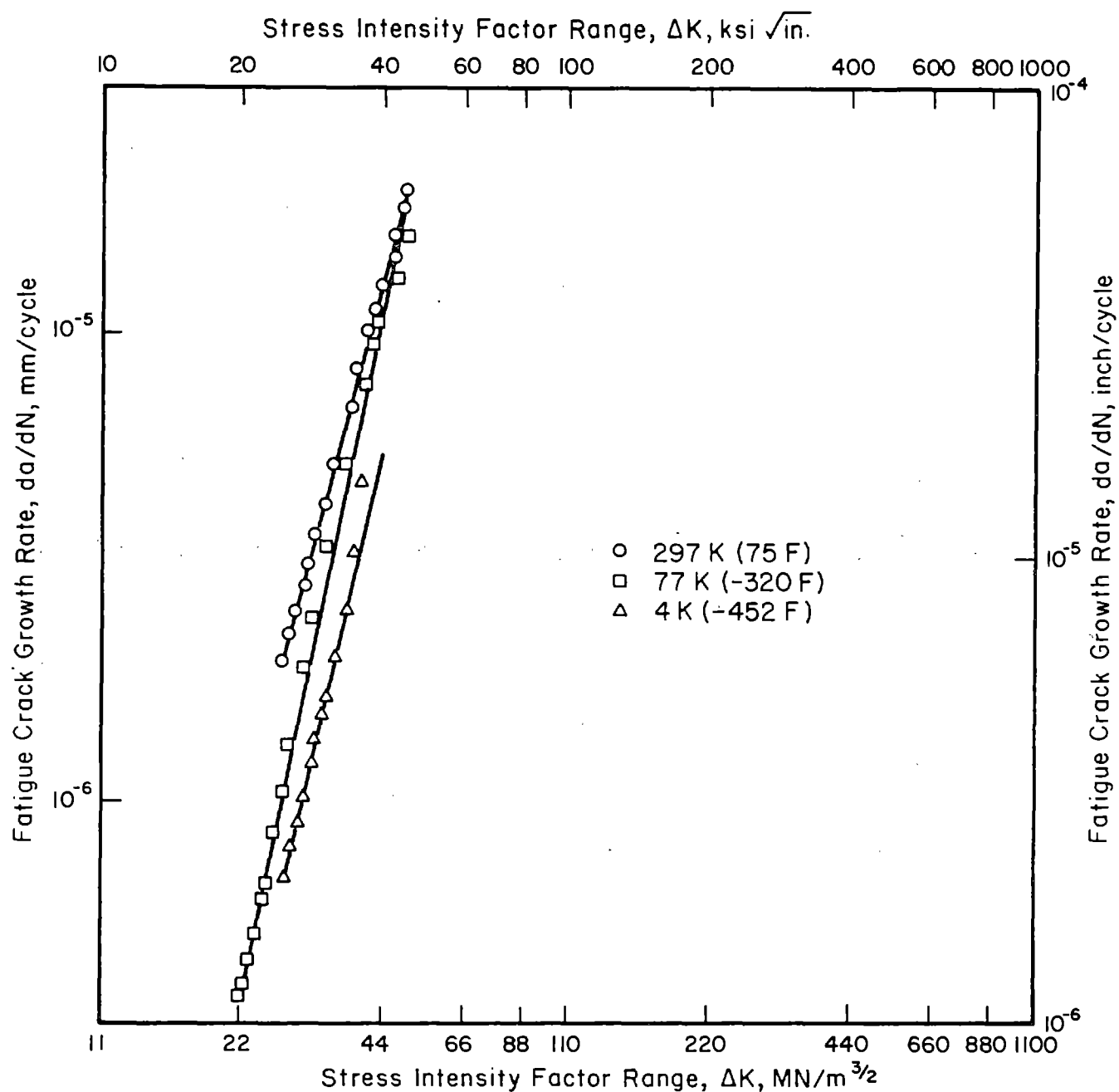


FIGURE 6.3.3-ME1. FATIGUE CRACK GROWTH RATE OF 7.6 cm (3 in.) THICK INCO LEA PLATE [Heat treatment: solution treated 1.255 K (1800 F) 1 hr, AC; aged 936 K (1225 F) 8 hr, AC]

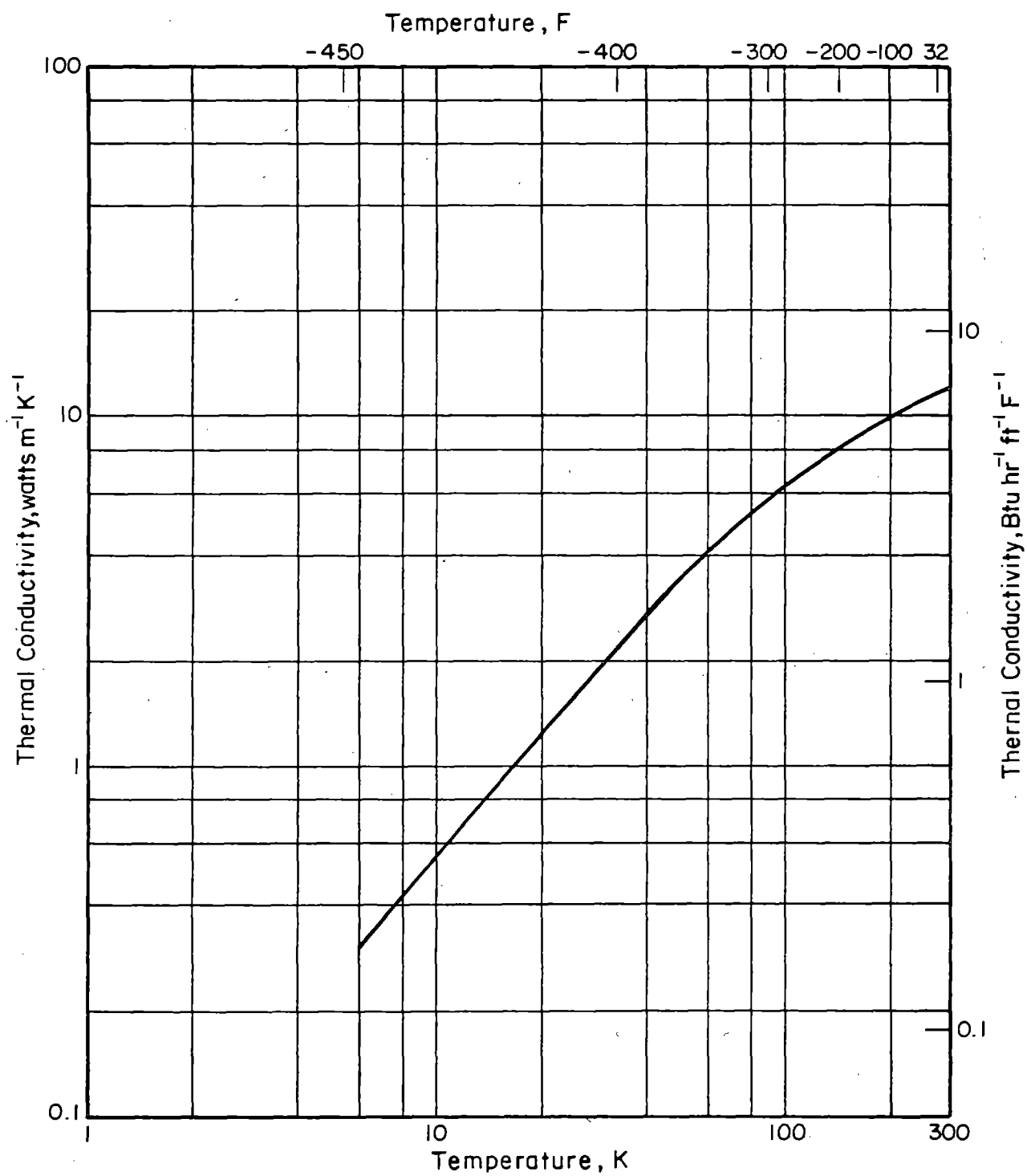


FIGURE 6.3.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR INCO CONTROLLED EXPANSION ALLOY

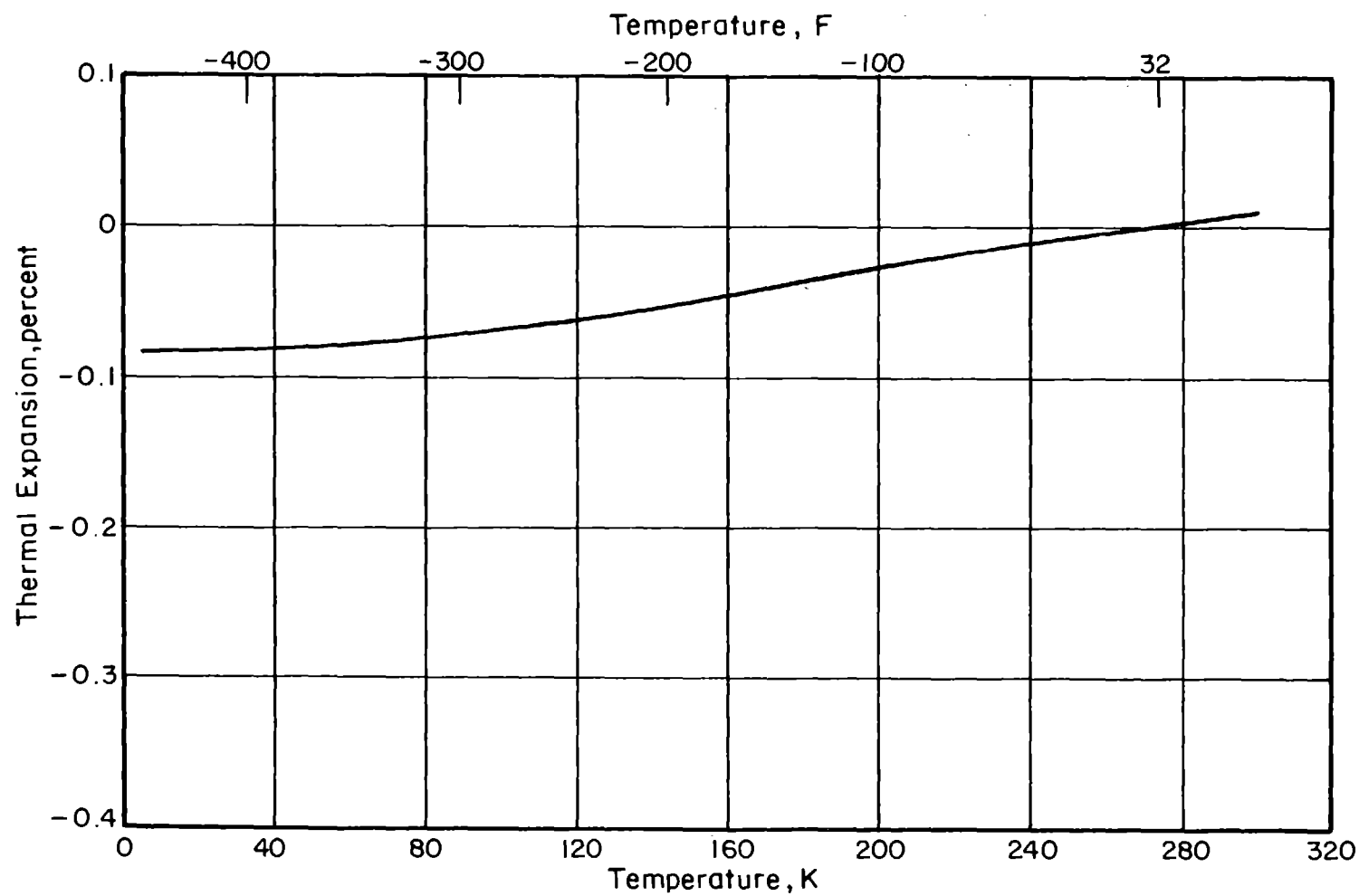


FIGURE 6.3.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR INCO CONTROLLED EXPANSION ALLOY

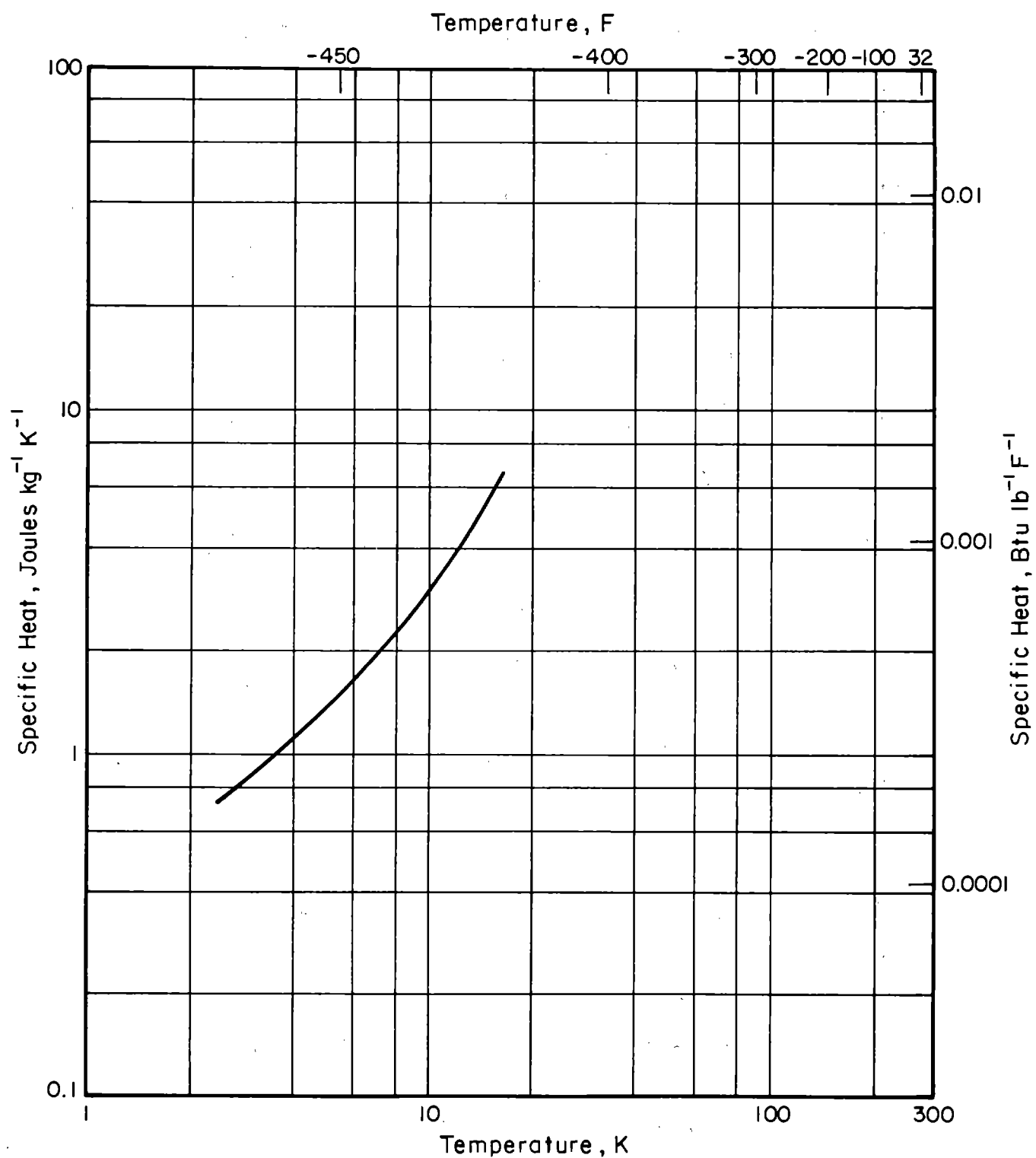


FIGURE 6.3.3-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR INCO CONTROLLED EXPANSION ALLOY

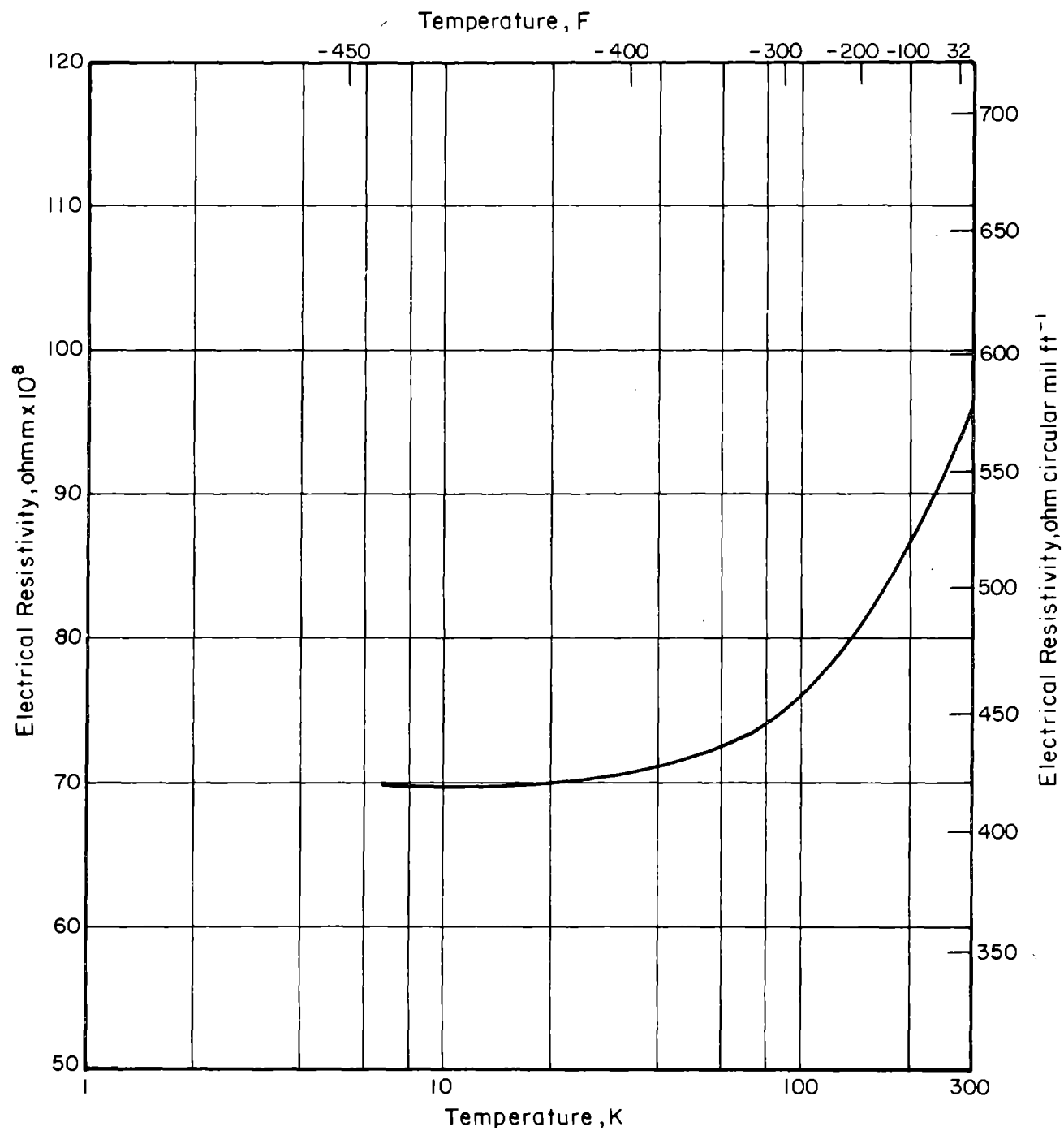


FIGURE 6.3.3-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR INCO CONTROLLED EXPANSION ALLOY

TABLE 6.4.1-ME1

Alloy Designation: Nickel-High Purity (99.99%)

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Hot-finished

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	366.1 (53.1)			492.9 (71.5)		734.3 (106)
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	173.1 (25.1)			219.3 (31.8)		225.5 (3.27)
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 or 3 (1)			2 or 3 (1)		2 or 3 (1)
E, GN/m ² (10 ⁶ psi)	Avg	206.8 (30.0)			222.7 (32.3)		224.0 (32.5)
	Min						
No. of Spec. (No. of Heats)		2 or 3 (1)			2 or 3 (1)		2 or 3 (1)
Poisson's Ratio		0.310			0.310		0.303
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 89543

TABLE 6.4.1-TR1

Alloy Designation: High Purity Nickel

Specification:

Form:

Dimensions:

Condition: Annealed

Testing Temperature, K (°F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
RRR-2500 Watts m ⁻¹ K ⁻¹	94	165	380	1650	2600	2000
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(54.4)	(95)	(220)	(954)	(1500)	(1160)
RRR-670 Watts m ⁻¹ K ⁻¹	94	165	380	1530	1670	960
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(54.4)	(95)	(220)	(885)	(966)	(555)
RRR-208 Watts m ⁻¹ K ⁻¹	94	160	340	710	610	265
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(54.4)	(92)	(197)	(410)	(353)	(153)
RRR-80 Watts m ⁻¹ K ⁻¹	94	160	335	365	217	87
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(54.4)	(92)	(194)	(211)	(126)	(50.3)
RRR-27 Watts m ⁻¹ K ⁻¹	88	140	200	185	101	44
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(50.9)	(81)	(116)	(107)	(58.4)	(25.4)
No. of Spec.	—	2	4	4	5	5
References: 26638, 90170, 90224, 90447						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.176	-0.196	-0.199	-0.199	-0.199
No. of Spec.	1	1	1	1	1	1
References: 90208						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	429	232	68.2	5.80	1.62	0.503
Btu lb ⁻¹ F ⁻¹	(0.103)	(5.54 x 10 ⁻²)	(1.63 x 10 ⁻²)	(1.39 x 10 ⁻³)	(3.87 x 10 ⁻⁴)	(1.20 x 10 ⁻⁴)
No. of Spec.	1	1	1	1	1	4
References: 42219, 90370, 96884						
Electrical Resistivity⁽¹⁾						
RRR-3000 Ohm m	6.20 x 10 ⁻⁸	1.00 x 10 ⁻⁸	1.52 x 10 ⁻⁹	1.11 x 10 ⁻¹⁰	3.60 x 10 ⁻¹¹	2.07 x 10 ⁻¹¹
Ohm circular mil ft ⁻¹	(37.3)	(6.02)	(0.914)	(6.68 x 10 ⁻²)	(2.17 x 10 ⁻²)	(1.25 x 10 ⁻²)
RRR-1000 Ohm m	6.21 x 10 ⁻⁸	1.01 x 10 ⁻⁸	1.56 x 10 ⁻⁹	1.52 x 10 ⁻¹⁰	7.20 x 10 ⁻¹¹	6.20 x 10 ⁻¹¹
Ohm circular mil ft ⁻¹	(37.4)	(6.08)	(0.938)	(9.14 x 10 ⁻²)	(4.33 x 10 ⁻²)	(3.73 x 10 ⁻²)
RRR-300 Ohm m	6.22 x 10 ⁻⁸	1.02 x 10 ⁻⁸	1.71 x 10 ⁻⁹	2.97 x 10 ⁻¹⁰	2.12 x 10 ⁻¹⁰	2.07 x 10 ⁻¹⁰
Ohm circular mil ft ⁻¹	(37.4)	(6.14)	(1.03)	(0.179)	(0.128)	(0.125)
RRR-100 Ohm m	6.26 x 10 ⁻⁸	1.06 x 10 ⁻⁸	2.13 x 10 ⁻⁹	7.16 x 10 ⁻¹⁰	6.27 x 10 ⁻¹⁰	6.26 x 10 ⁻¹⁰
Ohm circular mil ft ⁻¹	(37.7)	(6.38)	(1.28)	(0.431)	(0.377)	(0.377)
RRR-30 Ohm m	6.41 x 10 ⁻⁸	1.21 x 10 ⁻⁸	3.64 x 10 ⁻⁹	2.23 x 10 ⁻⁹	2.14 x 10 ⁻⁹	2.14 x 10 ⁻⁹
Ohm circular mil ft ⁻¹	(38.6)	(7.28)	(2.19)	(1.34)	(1.29)	(1.29)
RRR-10 Ohm m	6.89 x 10 ⁻⁸	1.69 x 10 ⁻⁸	8.39 x 10 ⁻⁹	6.98 x 10 ⁻⁹	6.89 x 10 ⁻⁹	6.89 x 10 ⁻⁹
Ohm circular mil ft ⁻¹	(41.4)	(10.2)	(5.05)	(4.20)	(4.14)	(4.14)
No. of Spec.						
References: 90217						

(1) Interpolated from original data using theoretical correlations.

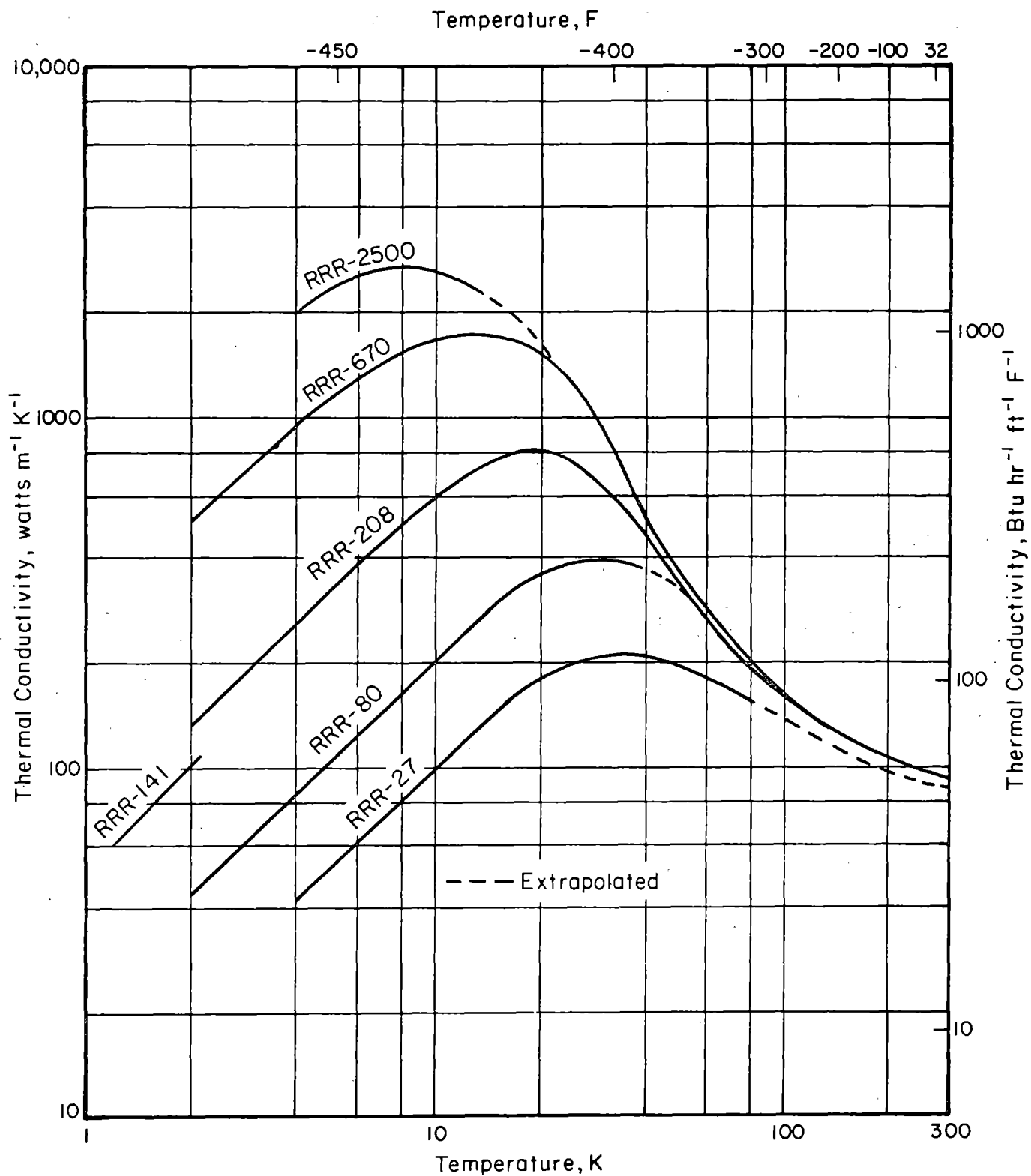


FIGURE 6.4.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR HIGH PURITY NICKEL

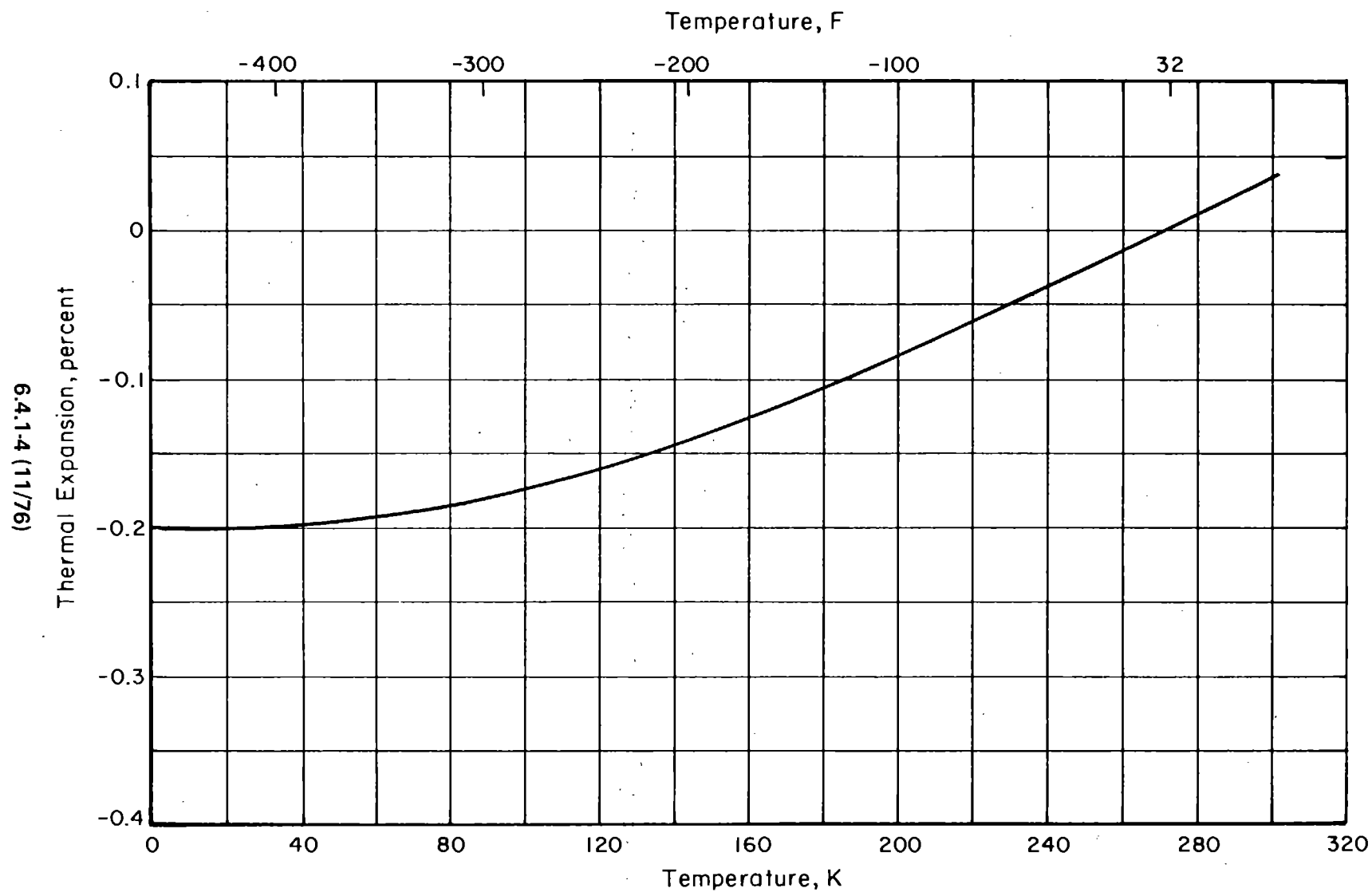


FIGURE 6.4.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR HIGH PURITY NICKEL

High Purity Nickel

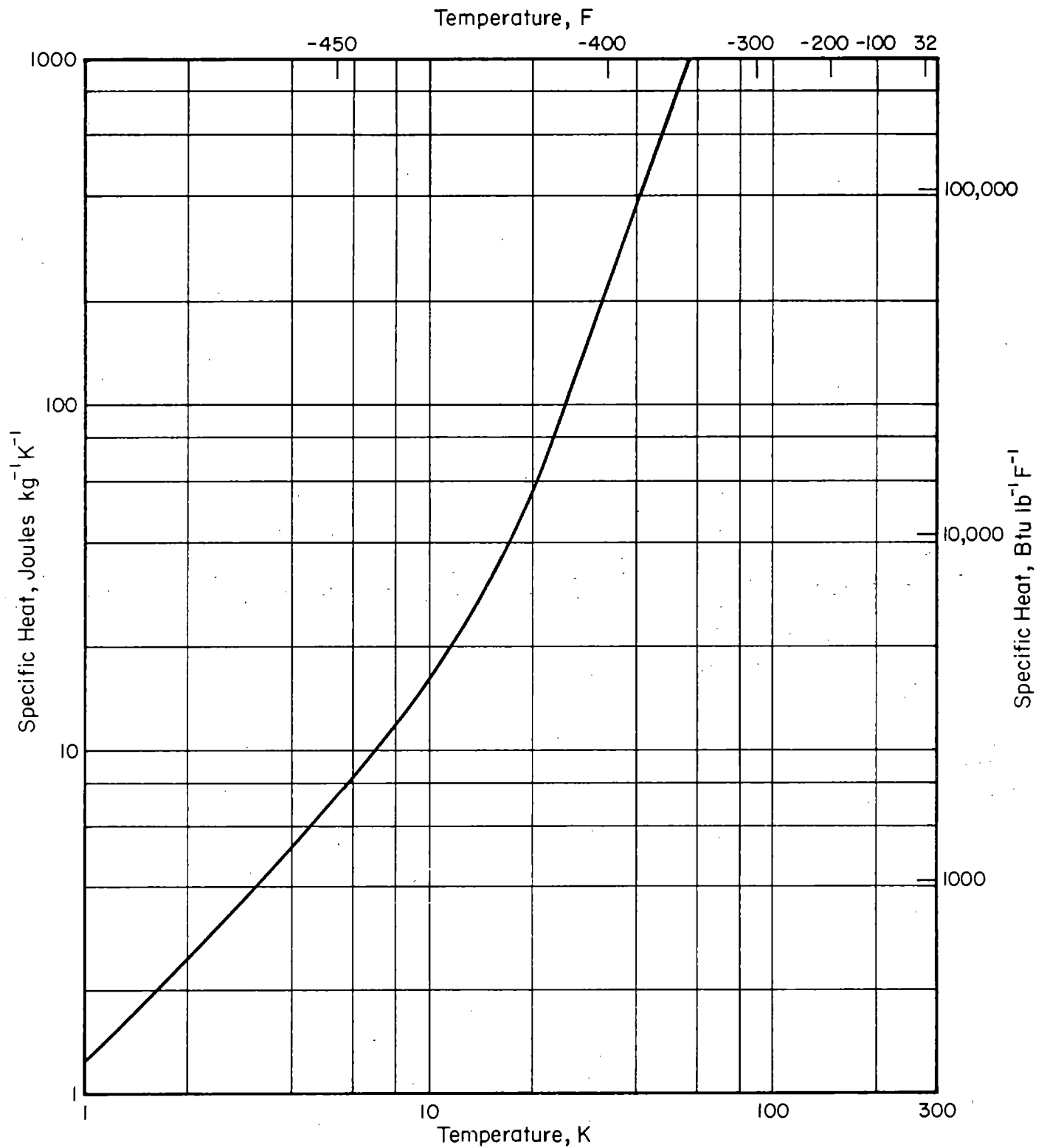


FIGURE 6.4.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR HIGH PURITY NICKEL

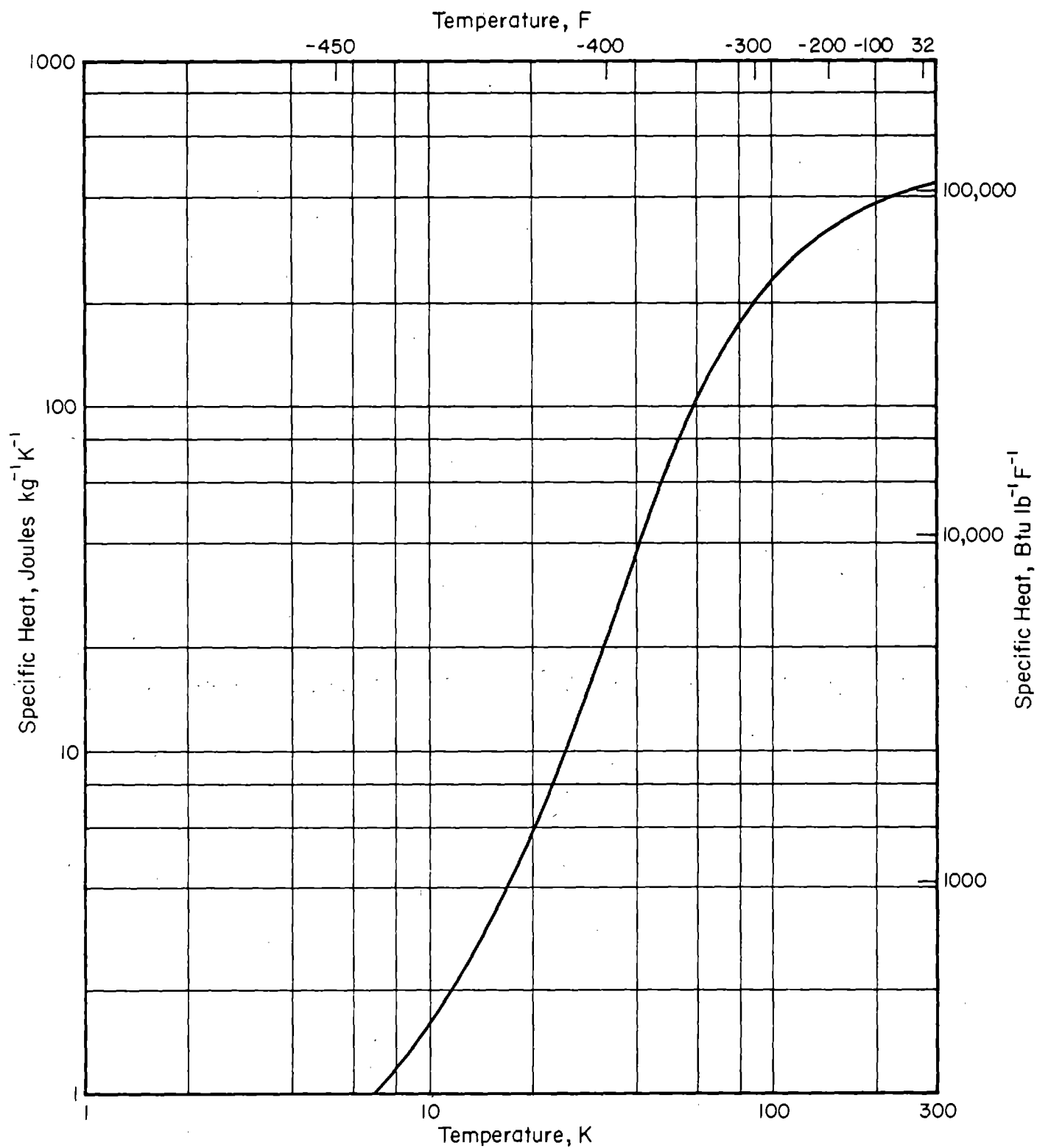


FIGURE 6.4.1-S2. SPECIFIC HEAT VERSUS TEMPERATURE FOR HIGH PURITY NICKEL

6.4.1-6 (11/76)

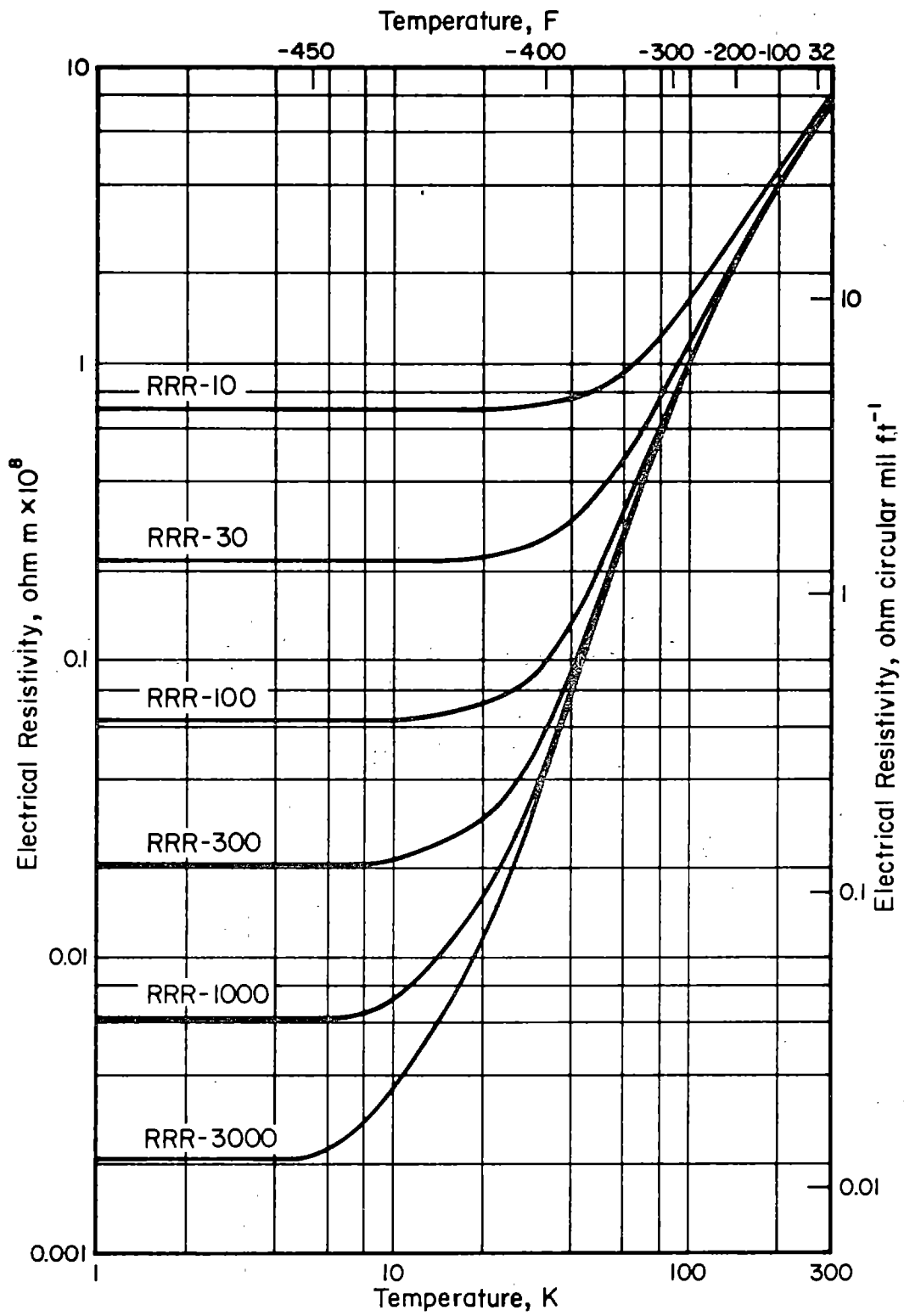


FIGURE 6.4.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR HIGH PURITY NICKEL

TABLE 6.4.2-ME1

"A" Nickel
Sheet

Alloy Designation: "A" Nickel

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed

Testing Temperature, K (F)	297 (75)				20 (-423)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 430 (62)				738 (107)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 97 (14)				230 (33)	
	Min					
Std. Deviation						
Elong, percent	Avg 43.4				36.0	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	1				1	
E, GN/m ² (10 ⁶ psi)	Avg 200 (29)				230 (33)	
	Min					
No. of Spec. (No. of Heats)	1				1	
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 49048

TABLE 6.4.2-ME2

"A" Nickel
Bar

Alloy Designation: "A" Nickel

Specification:

Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	439 (63.7)	488 (70.8)		641 (93.0)	771.5 (111.9)	
	Min	432 (62.7)	482 (69.9)		636 (92.2)	768.1 (111.4)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	144 (20.9)	152 (22.0)		197 (28.5)	265 (38.4)	
	Min	141 (20.4)	145 (21.1)		196 (28.4)	157 (37.3)	
Std. Deviation							
Elong, percent	Avg	48.4	50.3		61.2	59.2	
	Min	47.8	48.8		60.7	59.1	
RA, percent	Avg	66.2	65.6		75.2	67.8	
	Min	66.2	63.5		74.3	67.5	
No. of Spec. (No. of Heats)		3 (1)	3 (1)		3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 54986

6.4.2.3 (11/76)

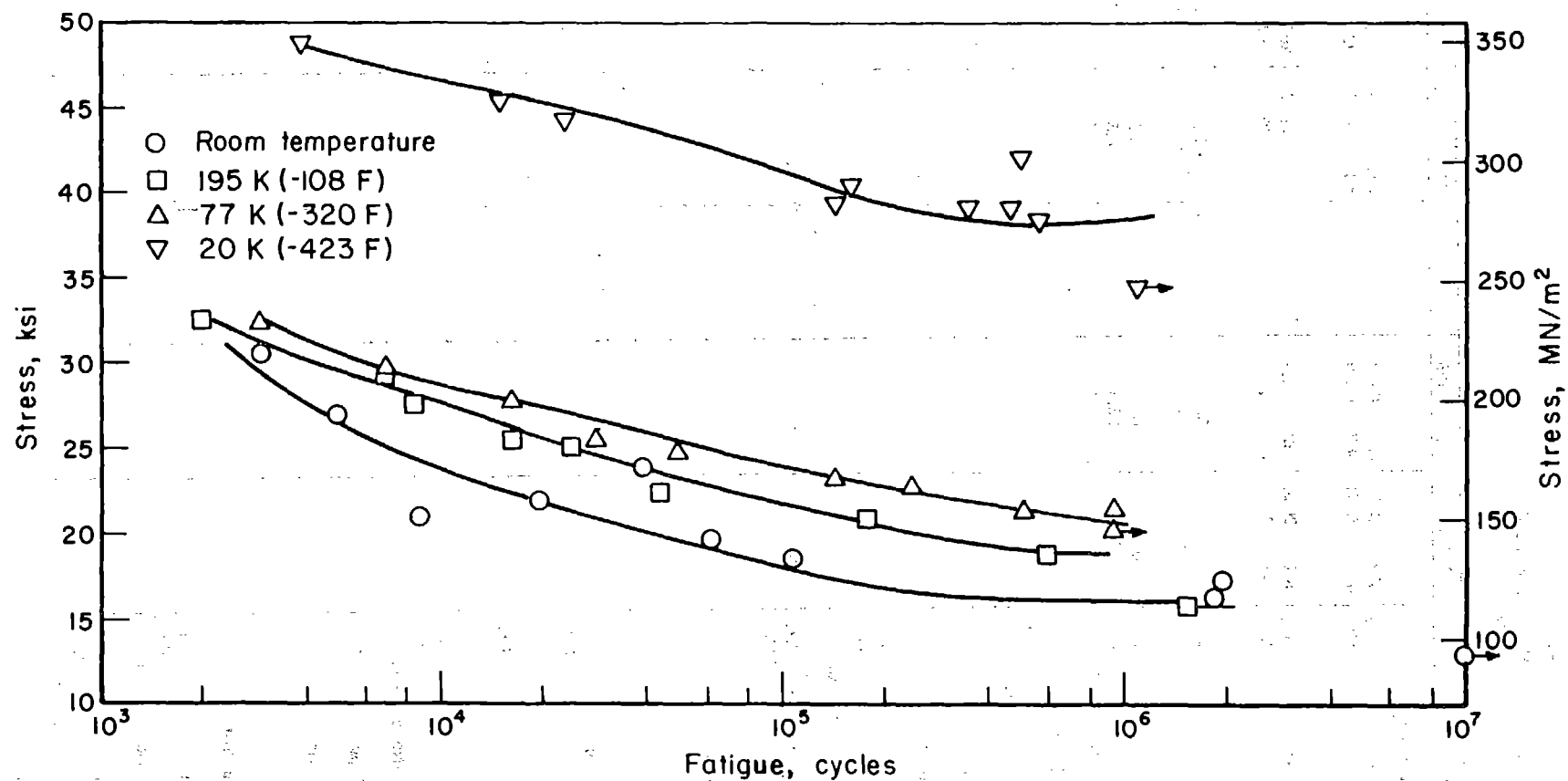


FIGURE 6.4.2ME1. FATIGUE LIFE CURVES FOR FLEXURAL LOADING ON NOTCHED ($K_T = 3.0$) AND UNNOTCHED SPECIMENS OF ANNEALED "A" NICKEL 0.053 cm (0.021 in.) THICK [49048]

"A" Nickel

TABLE 6.4.2-TR1

Alloy Designation: "A" Nickel

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹			51.0	25.0		
Btu hr ⁻¹ ft ⁻¹ F ⁻¹			(29.5)	(14.5)		
No. of Spec.			1	1		
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.178	-0.200	-0.205		
No. of Spec.	1	1	2	2		
References: 48134, 90366						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						
(1) 99.4 Ni, as forged.						

"A" Nickel

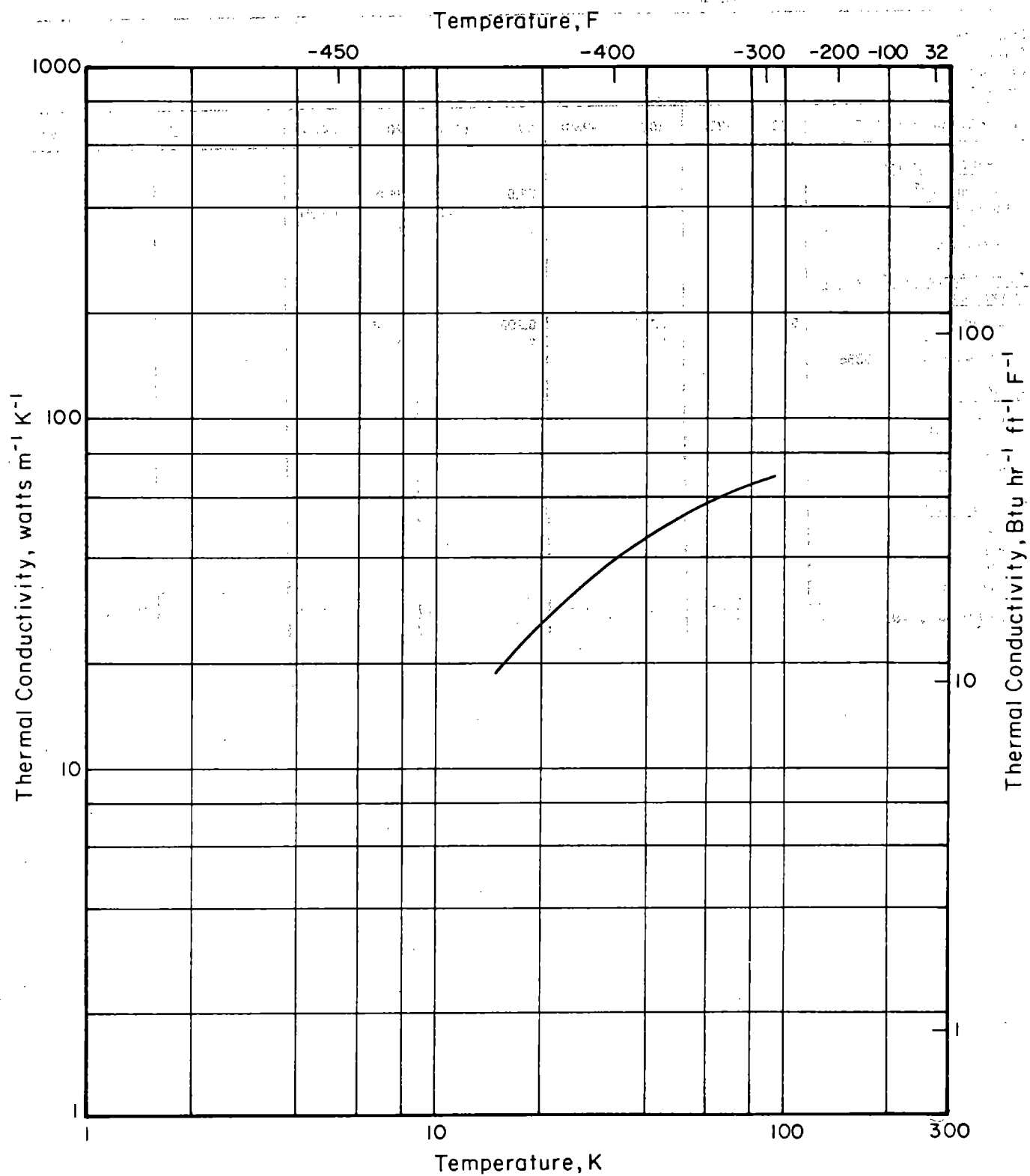


FIGURE 6.4.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR NICKEL "A"

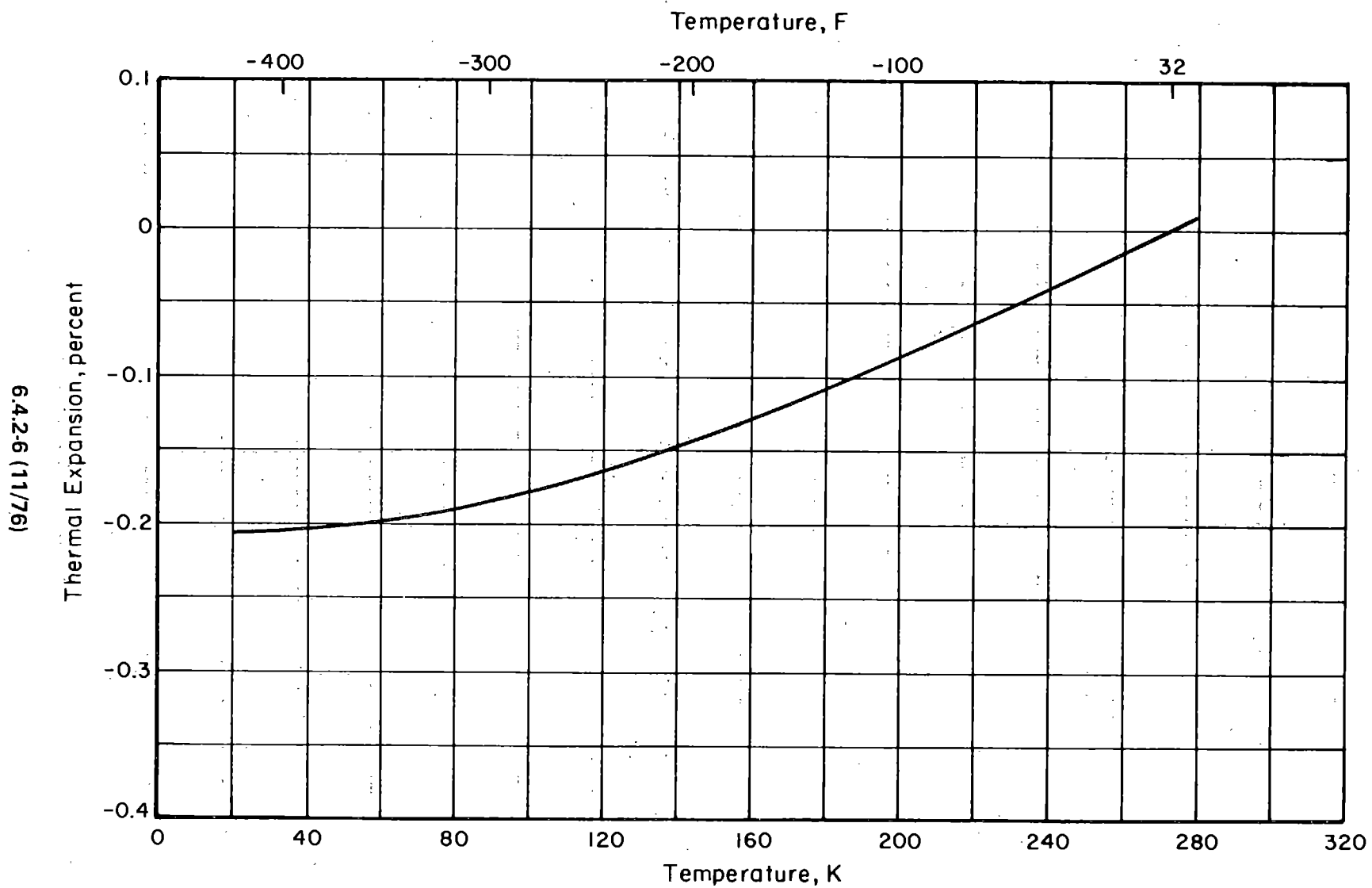


FIGURE 6.4.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR NICKEL "A"

**INDEX TO MATERIAL CODES FOR
SECTION 7.0**

ALLOY STEELS

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9Ni STEEL	7.1.1
18Ni (200) MARAGING	7.1.2
1010 STEEL	7.3.1
ARMCO IRON	7.4.1
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Fe (47-50) Ni	7.4.4

TABLE 7.1.1-ME1

9Ni Steel
Sheet

Alloy Designation: 9Ni Steel

Specification: ASTM A553-I

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 1075 K (1475 F), WQ; 840-1080 K (1050-1125 F), ac or WQ

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency Hz with $R = -1$ and $K_t = 3.1$ No. of S-N Curves (No. of Heats)	415 (60)			450 (65)		
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with $R = -1$ and $K_t = 3.1$ No. of S-N Curves (No. of Heats)	195 (28)			175 (25)		
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 92996

TABLE 7.1.1-ME2

Alloy Designation: 9Ni Steel

Specification: ASTM A553-I

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 1075 K (1475 F), WQ; 840-1080 K (1050-1125 F), AC or WQ

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	365 (53)			455 (66)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)	255 (37)			360 (52)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 92996

TABLE 7.1.1-ME3

Alloy Designation: 9Ni Steel

Specification: ASTM A353

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 882 (128)		1190 (172)	1503 (218)	1590 (231)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 558 (81.0)		1010 (146)	1096 (159)	1430 (208)	
	Min					
Std. Deviation						
Elong, percent	Avg 17.3		29.6	11.5	21.2	
	Min					
RA, percent	Avg		66.8		59.1	
	Min					
No. of Spec. (No. of Heats)	(1)		1	(1)	1	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 49048, 91494

TABLE 7.1.1-ME4

9Ni Steel
Sheet

Alloy Designation: 9Ni Steel

Specification: ASTM A353

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)	297 (75)					4 (-452)
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)	Avg					87 (73)
	Min					
Orientation: T – L						
No. of Spec. (No. of Heats)						1
K_{IE} MN/m^{3/2}(ksi√in.)	Avg					
(From PTSC spec.)(–)Min						
No. of Spec. (No. of Heats)						

References: 91494

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 7.1.1-ME5

Alloy Designation: 9Ni Steel

Specification: ASTM A353

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Double normalized at 1175 K (1650 F), and 1060 K (1450 F), and tempered at 840 K (1050 F)

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	407 (59)	448 (65)	448 (65)	400 (58)		
Loading frequency Hz						
with R = -1 and K_t = 3.1						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
S_N at 10^6 cycles, MN/m ² (ksi)	255 (37)	317 (46)	255 (37)	255 (37)		
Loading frequency Hz						
with R = -1 and K_t = 3.1						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 49048

TABLE 7.1.1-ME6

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: A553-I

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	779 (113)	1172 (170)				
	Min	765 (111)	1158 (168)				
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	731 (106)	972 (141)				
	Min	724 (105)	--				
Std. Deviation							
Elong, percent	Avg	21					
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2(2)	2(2)				
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 88112, 92996

TABLE 7.1.1-ME7

Alloy Designation: 9Ni Steel

Specification: A353

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m² (ksi)	Avg	738 (107)	1164 (169)	1594 (231)			
	Min	724 (105)	--	--			
Std. Deviation							
TYS, MN/m² (ksi)	Avg	634 (92.0)	847 (123)	1434 (208)			
	Min	617 (89.5)	--	--			
Std. Deviation							
Elong, percent	Avg	35.8	--	21.2			
	Min						
RA, percent	Avg	--	--	59.1			
	Min						
No. of Spec. (No. of Heats)		2(2)	1	1			
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m² (10⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 92996, 94197

TABLE 7.1.1-ME8

Alloy Designation: 9Ni Steel

Specification: ASTM a553-I

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)	297 (75)			77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg	115 (85.1)		52.3 (38.7)		
	Min	100 (77)		43 (32)		
No. of Spec. (No. of Heats)		9 (1)		9 (1)		
Trans., Nm(ft-lb)	Avg	89.5 (66.3)		42.9 (31.8)		
	Min	80 (59)		35 (26)		
No. of Spec. (No. of Heats)		9 (1)		9 (1)		
Fracture Toughness^(b)						
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 41531

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{Ic} data:

TABLE 7.1.1-ME9

9Ni Steel
Plate-Weld Metal

Alloy Designation: 9Ni Steel (Weld Metal)

Specification: ASTM A553-1

Form: Plate-MIG Welded, Inco Weld A covered electrode

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Plate 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ; welded; tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg			58.1 (43.0)		
	Min					
No. of Spec. (No. of Heats)				>1		
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 90537

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

* A corresponding average Charpy-V impact value of 48.6 Nm (36.0 ft-lb) was measured for stress-relieved specimens of the same type.

TABLE 7.1.1-ME10

Alloy Designation: 9Ni Steel (Weld Metal)

Specification: ASTM A553-I

Form: Plate-Pulse MIG Welded, Inconel 92 filler alloy

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Plate 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ; Welded; tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg	718.4 (104.2)		885.3 (128.4)		
	Min	699.1 (101.4)				
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		2 (1)		1		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 88112

TABLE 7.1.1-ME11

9Ni Steel
Plate-Weld Metal

Alloy Designation: 9Ni Steel (Weld Metal)

Specification: ASTM A553-I

Form: Plate-shielded MIG welded, Incoweld B filler alloy

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Plate 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ; welded; tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	718.4 (104.2)			919.1 (133.3)		
	Min	690.9 (100.2)			896.3 (130.0)		
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 88112

TABLE 7.1.1-ME12

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: ASTM A353

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)	297 (75)			77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg	109 (80.8)		45.6 (33.7)		
	Min	106 (78)		37 (27)		
No. of Spec. (No. of Heats)		6 (1)		6 (1)		
Trans., Nm(ft-lb)	Avg	91.4 (67.5)		37.6 (27.8)		
	Min	85 (63)		32 (24)		
No. of Spec. (No. of Heats)		6 (1)		6 (1)		
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 41531

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 7.1.1-ME13

9Ni Steel
Plate-Weld Metal

Alloy Designation: 9Ni Steel (Weld Metal)

Specification: ASTM A353

Form: Plate-MIG welded, Incoweld A covered electrode

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Plate, Double Normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F); welded; tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg			47.9 (35.5)*		
	Min					
No. of Spec. (No. of Heats)				>1		
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation. —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 90537

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

* A corresponding averages Charpy-V impact value of 59.4 Nm (44.0 ft-lb) was measured for stress-relieved specimens of the same type.

TABLE 7.1.1-ME14

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: A553-I

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)		173 (-150)	123 (-240)	77 (-320)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	772 (112)		917 (133)	972 (141)	1151 (167)	
	Min	710 (103)				1062 (154)	
Std. Deviation		31.5 (4.57)				57 (8.3)	
TYS, MN/m ² (ksi)	Avg	710 (103)		834 (121)	862 (125)	986 (143)	
	Min	590 (86.1)				841 (122)	
Std. Deviation		38.6 (5.60)				82.1 (11.9)	
Elong, percent	Avg	28.0		17.9	17.9	24.4	
	Min	20.0				20.4	
RA, percent	Avg	66.7		43.9	42.3	37.6	
	Min	49.0				--	
No. of Spec. (No. of Heats)		39 (7)		4 (2)	4 (2)	12 (5)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 76974, 92996

TABLE 7.1.1-ME15

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: A553-I

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)	297 (75)	77 (-320)				
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	153	(113)	71.4	(52.9)		
Min			39.3	(29)		
No. of Spec. (No. of Heats)	1		12	(5)		
Trans., Nm(ft-lb)						
Avg	107	(79)	34.3	(25.4)		
Min			30	(22)		
No. of Spec. (No. of Heats)	1		7	(2)		
Fracture Toughness^(b)						
K _{IC} , MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.) (—) Min						
No. of Spec. (No. of Heats)						

References: 41531, 92996, 96686, 96700

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 7.1.1-ME16

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: A 353

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)	297 (75)	173 (-150)	123 (-240)	77 (-320)	20 (-423)
Tension, Longitudinal					
TUS, MN/m ² (ksi)	Avg 772 (112)	906.7 (131.5)	979 (142)	1179 (171)	1390 (202)
	Min 710 (103)			1089 (158)	1330 (193)
Std Deviation	35.8 (4.90)			--	
TYS, MN/m ² (ksi)	Avg 624 (90.5)	782.6 (113.5)	834 (121)	945 (137)	1210 (175)
	Min 498 (72.2)			793 (115)	1140 (166)
Std Deviation	52.8 (7.66)			--	
Elong, percent	Avg 29.1	16.9	16.9	23.3	18.0
	Min 23.0			18.3	9
RA, percent	Avg 68.8	59.7	61.0	56.0	39.6
	Min 64.0			--	7
No. of Spec. (No. of Heats)	16 (7)	4 (2)	4 (2)	11 (4)	5 (1)
E, GN/m ² (10 ⁶ psi)	Avg				
	Min				
No. of Spec. (No. of Heats)					
Poisson's Ratio					
Work Hardening Coef					
NTS, MN/m ² (ksi)	Avg 945 (137)				1310 (190)
K _t = 6.4	Min 938 (136)				1210 (176)
No. of Spec. (No. of Heats)	5 (1)				5 (1)
NTS, MN/m ² (ksi)	Avg				
K _t =	Min				
No. of Spec. (No. of Heats)					
Tension, Transverse					
TUS, MN/m ² (ksi)	Avg				
	Min				
Std Deviation					
TYS, MN/m ² (ksi)	Avg				
	Min				
Std Deviation					
Elong, percent	Avg				
	Min				
RA, percent	Avg				
	Min				
No. of Spec. (No. of Heats)					
E, GN/m ² (10 ⁶ psi)	Avg				
	Min				
No. of Spec. (No. of Heats)					
Poisson's Ratio					
Work Hardening Coef					
NTS, MN/m ² (ksi)	Avg				
K _t =	Min				
No. of Spec. (No. of Heats)					
NTS, MN/m ² (ksi)	Avg				
K _t =	Min				
No. of Spec. (No. of Heats)					

References: 64373, 76974, 92996

TABLE 7.1.1-ME17

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: A353

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)	297 (75)		163 (-165)	77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	157 (116)		74 (55)	47.1 (34.9)		
Min				36.6 (27.0)		
No. of Spec. (No. of Heats)	1		1	8 (5)		
Trans., Nm(ft-lb)						
Avg	130 (95)			41 (30)		
Min	1			1		
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation. —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 41531, 91978, 92996

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 7.1.1-ME18

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: ASTM A553-I

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency 60. Hz	539 (78.2)			613 (88.9)		
with R = .1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N /TUS at 10^6 cycles	0.66			0.75		
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency 60. Hz	495 (71.8)					
with R = .1 and K_t = 1						
No. of S-N Curves (No. of Heats)	1					
Ratio S_N /TUS at 10^7 cycles	0.61					
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency 60. Hz	225 (32.7)			402 (58.3)		
with R = .1 and K_t = 7.1						
No. of S-N Curves (No. of Heats)	1			1		
Ratio S_N /TUS at 10^6 cycles	0.28			0.49		
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency 60. Hz	221 (32.0)					
with R = .1 and K_t = 7.1						
No. of S-N Curves (No. of Heats)	1					
Ratio S_N /TUS at 10^7 cycles	0.27					

References: 76974

TABLE 7.1.1-ME19

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: ASTM A353

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency 60. Hz with $R = .1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	578 (83.9) 1			608 (88.2) 1		
Ratio S_N/TUS at 10^6 cycles	0.70			0.74		
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency 60. Hz with $R = .1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	544 (78.9) 1					
Ratio S_N/TUS at 10^7 cycles	0.66					
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency 60. Hz with $R = .1$ and $K_t = 7.1$ No. of S-N Curves (No. of Heats)	245 (35.6) 1			466 (67.6) 1		
Ratio S_N/TUS at 10^6 cycles	0.30			0.57		
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency 60. Hz with $R = .1$ and $K_t = 7.1$ No. of S-N Curves (No. of Heats)	235 (34.1) 1					
Ratio S_N/TUS at 10^7 cycles	0.29					

References: 76974

TABLE 7.1.1-ME20

9Ni Steel
Plate-Weld Metal

Alloy Designation: 9Ni Steel (Weld Metal)

Specification: ASTM A353

Form: Plate-MIG welded, Incoweld A covered electrode

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate-Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F); welded;
tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg			89 (66)*		
	Min			81 (60)		
No. of Spec. (No. of Heats)				>1		
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _I E, MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 90537

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

* A corresponding average Charpy-V impact value of 99 Nm (73 ft-lb) was measured for stress-relieved specimens.

TABLE 7.1.1-ME21

9Ni Steel
Plate-Weld Metal

Alloy Designation: 9Ni Steel (Weld Metal)

Specification: ASTM A353
 Form: Plate-MIG welded, Inconel 92, filler
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: Plate-Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F); welded;
 tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg			134 (99)*		
	Min			130 (96)		
No. of Spec. (No. of Heats)				>1		
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 90537

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

* A corresponding average Charpy-V impact value of 130 Nm (96 ft-lb) was measured for stress-relieved specimens.

TABLE 7.1.1-ME22

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: A553-1

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)		123 (-240)	108 (-265)	77 (-320)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	765 (111)		1007 (146)	1034 (150)	1124 (163)	
	Min	710 (103)		924 (134)	965 (140)	1062 (154)	
	Std. Deviation	30.1 (4.36)				--	
TYS, MN/m ² (ksi)	Avg	710 (103)		910 (132)	924 (134)	1000 (145)	
	Min	650 (94)		820 (119)	841 (122)	940 (134)	
	Std. Deviation	40.5 (5.87)				--	
Elong, percent	Avg	25.7		--	--	26.0	
	Min	22.0		--	--	--	
RA, percent	Avg	73.5		--		--	
	Min	72.0		--		--	
	No. of Spec. (No. of Heats)	15(6)		3(3)	4(4)	5(4)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
TYS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							

References: 91978, 92996

TABLE 7.1.1-ME23

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: A553-I

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)	297 (75)		123 (-240)	108 (-265)	77 (-320)	
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	132 (97.8)		102 (75.6)	92.5 (68.5)	70.2 (52.0)	
Min	127 (94.1)		70.1 (51.9)	68.0 (50.4)	49.0 (36.3)	
No. of Spec. (No. of Heats)	2 (2)		3 (3)	4 (4)	5 (5)	
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} , MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 91978, 92996

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 7.1.1-ME24

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: A 353

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)		297 (75)		123 (-240)	108 (-265)	77 (-320)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	752 (109)		1076 (156)	1090 (158)	1160 (168)	
	Min	682 (98.9)		1091 (151)	1020 (148)	1090 (158)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	647 (93.9)		862 (125)	841 (122)	917 (133)	
	Min	498 (72.2)		834 (121)	717 (104)	793 (115)	
Std. Deviation							
Elong, percent	Avg	23.7		--	--	--	
	Min						
RA, percent	Avg			--	--	--	
	Min						
No. of Spec. (No. of Heats)		5 (4)		2 (2)	3 (3)	3 (2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 91978, 92996

TABLE 7.1.1-ME25

Alloy Designation:	9Ni Steel
Specification:	A 353
Form:	Plate
Thickness, cm (in.):	2.541 to 5.080 (1.001 to 2.000)
Condition:	Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)	297 (75)		123 (-240)	108 (-265)	77 (-320)	
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	109 (80.7)		102 (75.6)	70.7 (52.4)	53.3 (39.5)	
Min			88.0 (65.2)	52.0 (38.5)	37.0 (27.4)	
No. of Spec. (No. of Heats)	1		2 (2)	4 (4)	4 (4)	
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 91978, 92996

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 7.1.1-ME26

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: A553-I

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)		108 (-265)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	758 (110)			1165 (169)		
	Min	710 (103)			1131 (164)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	628 (91.1)		834 (121)	869 (126)		
	Min	600 (87.0)			841 (122)		
Std. Deviation							
Elong, percent	Avg	31.7			30.0		
	Min	27.0			29.0		
RA, percent	Avg	66.0			--		
	Min	5 (5)		1	6 (6)		
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 91978, 92996, 96684

TABLE 7.1.1-ME27

9Ni Steel
Plate

Alloy Designation: 9Ni Steel

Specification: A553-I

Form: Plate

Thickness, cm (in.): over 5,080 (2,000)

Condition: 1075 K (1475 F), WQ, 840 K (1050 F), AC or WQ

Testing Temperature, K (F)	297 (75)		108 (-265)	77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg		76.0 (56.3)	100 (74.4)		
	Min			66.0 (48.9)		
No. of Spec. (No. of Heats)			1	4 (4)		
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
J _{IC} KJ/m ² (in.-lb/in. ²)	Avg		430 (75.3)	111 (19.4)		
	Min		422 (73.9)	76 (13.3)		
Orientation, —			>1	>1		
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi/√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 92296, 96684

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 7.1.1-ME28

Alloy Designation: 9Ni Steel

Specification: ASTM A353

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	865 (125)	1010 (146)	1235 (179)	1509 (219)		
	Min	855 (124)	1005 (146)	1219 (177)	1501 (218)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	816 (118)	894 (130)	1101 (160)	1436 (208)		
	Min	808 (117)	880 (128)	1098 (159)	1423 (206)		
Std. Deviation							
Elong, percent	Avg	24.2	25.4	26.7	18.3		
	Min	23.8	25.1	25.7	13.5		
RA, percent	Avg	70.4	67.5	60.6	47.8		
	Min	70.3	67.3	59.6	36.9		
No. of Spec. (No. of Heats)		2 (1)	2 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 54986

TABLE 7.1.1-ME29

9Ni Steel
Forgings

Alloy Designation: 9Ni Steel

Specification: ASTM A553-1

Form: Forgings

Thickness, cm (in.): Over 5.080 (2.000)

Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)		297 (75)	123 (-240)	108 (-265)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	770 (112)	1060 (154)	1090 (158)	1210 (176)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	650 (94)	770 (112)	800 (116)	920 (133)		
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 91978

TABLE 7.1.1-ME30

9Ni Steel
Forgings

Alloy Designation: 9Ni Steel

Specification: ASTM A553-I

Form: Forgings

Thickness, cm (in.): Over 5.080 (2.000)

Condition: 1075 K (1475 F), WQ; 840 K (1050 F), AC or WQ

Testing Temperature, K (F)	297 (75)	123 (-240)	108 (-265)	77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	150 (111)	130 (96)	130 (96)	120 (89)		
Min						
No. of Spec. (No. of Heats)	1	1	1	1		
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 91978

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 7.1.1-ME31

Alloy Designation: 9Ni Steel

Specification: ASTM A353

Form: Forgings

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Double normalized at 1175 K (1650 F) and 1060 K (1450 F) and tempered at 840 K (1050 F)

Testing Temperature, K (F)	297 (75)		108 (-265)	77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg		66 (49)	73 (99)		
	Min		--	48 (65)		
No. of Spec. (No. of Heats)			1	2 (2)		
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 91978

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

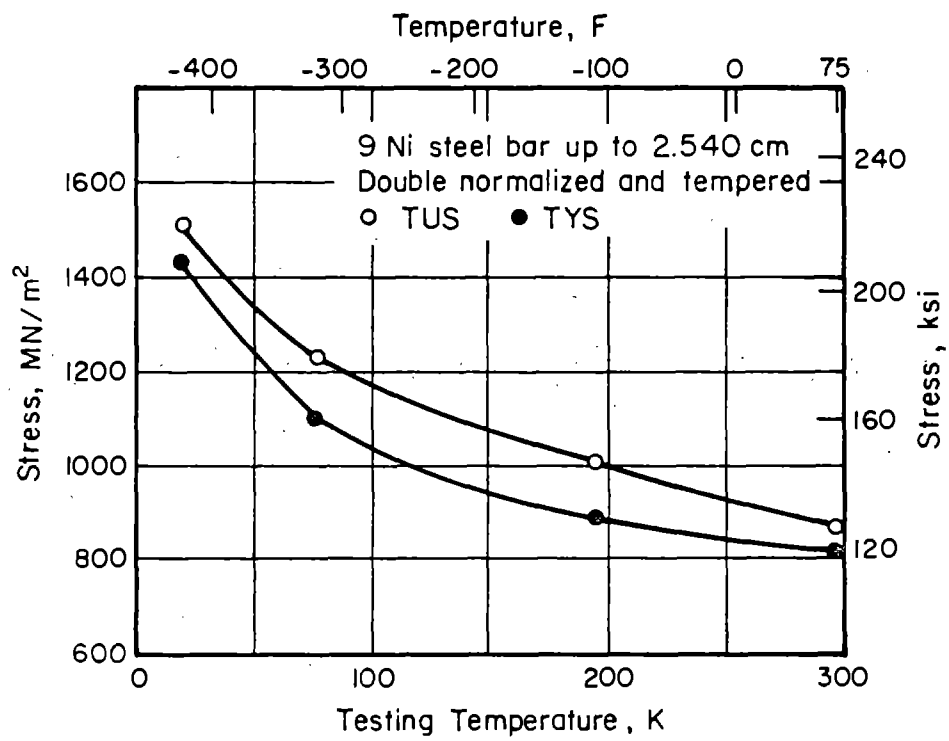


FIGURE 7.1.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 9Ni STEEL

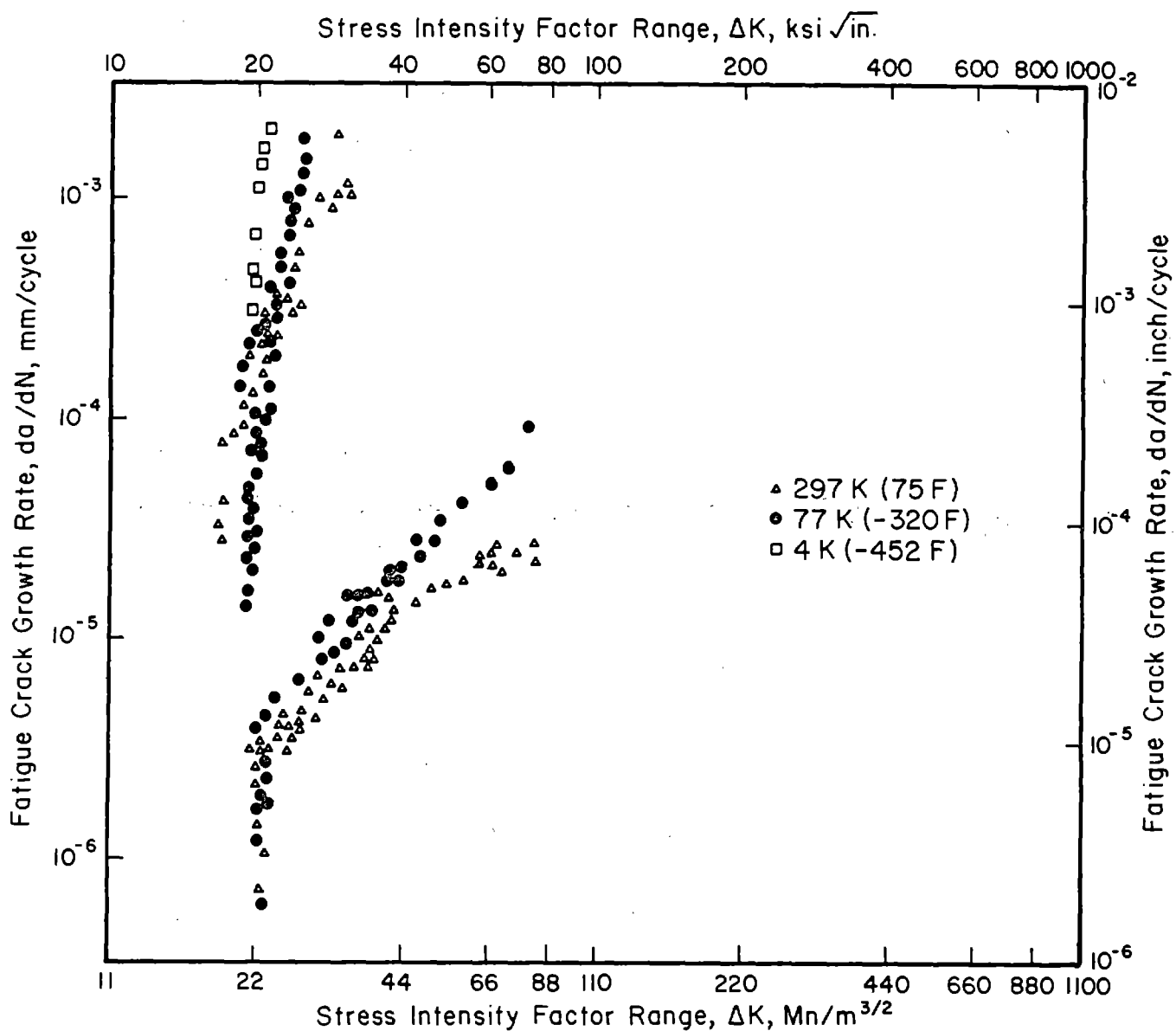


FIGURE 7.1.1-ME2. FATIGUE CRACK GROWTH RATES OF 9Ni STEEL (ASTM A553-I) AT 297, 77 AND 4 K(94208D)

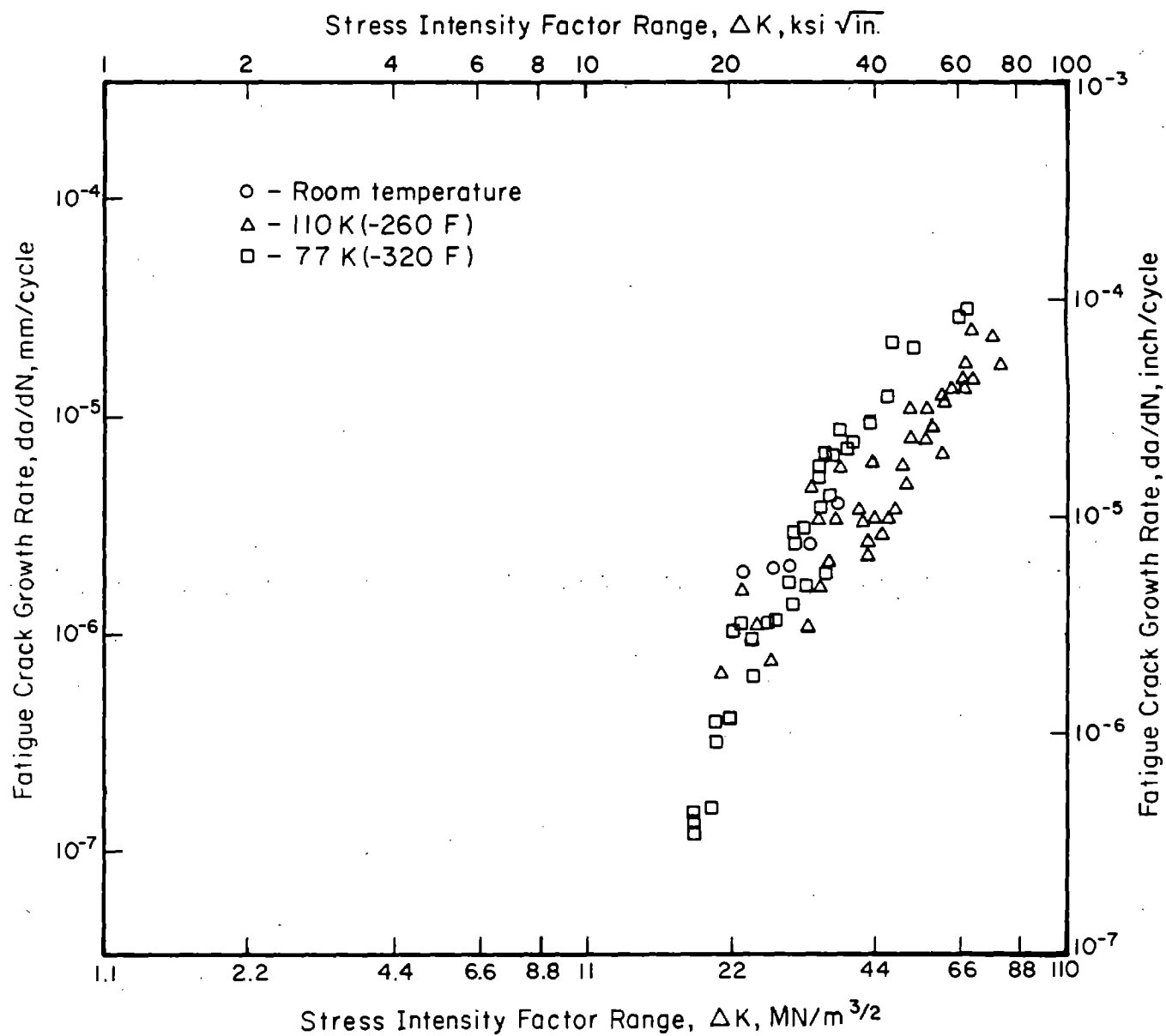


FIGURE 7.1.1-ME3. FATIGUE CRACK GROWTH RATE OF 9NI STEEL (ASTM 553-I) AT ROOM TEMPERATURE, 110 K (-261 F) and 77 K (-320 F) [96686]

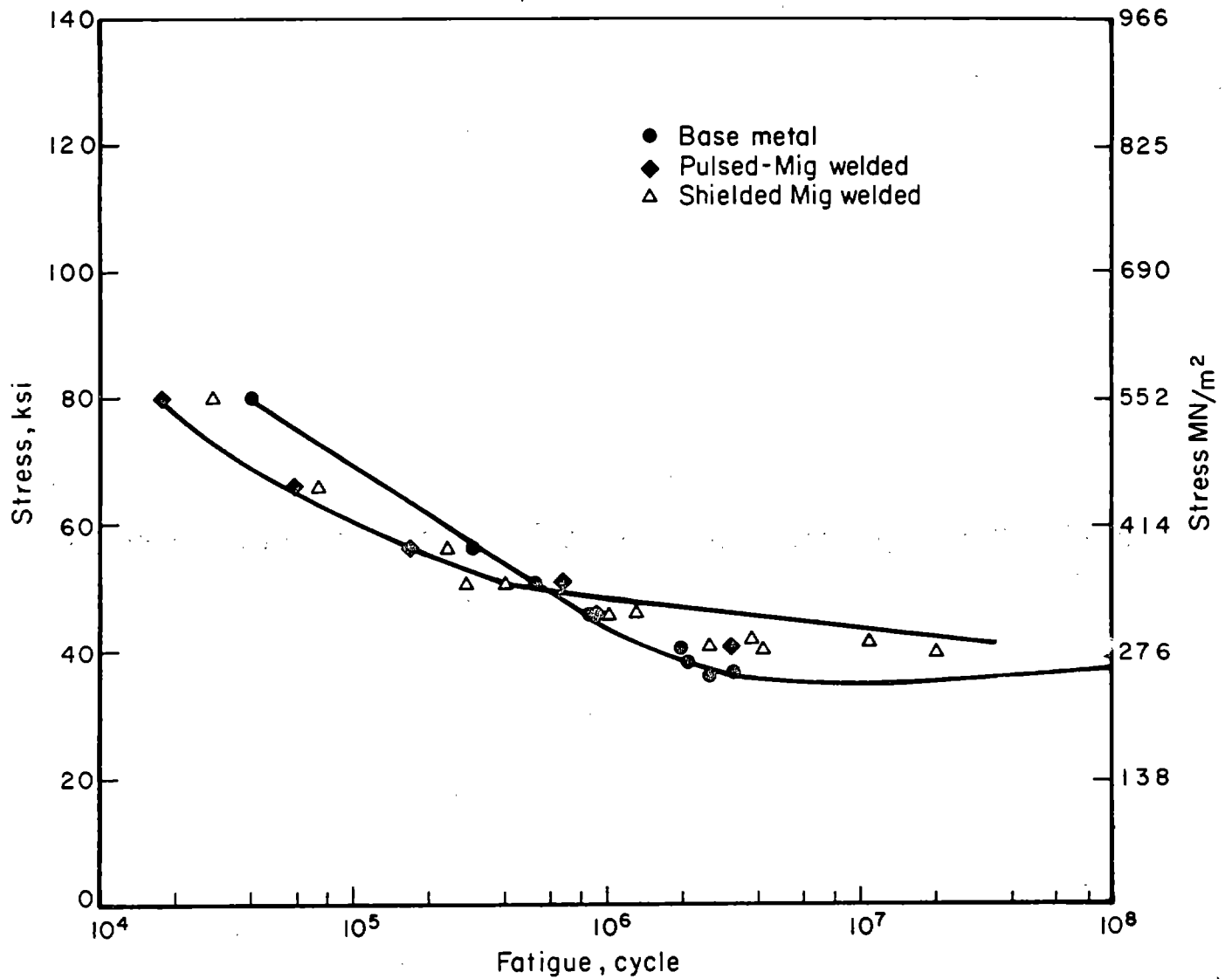


FIGURE 7.1.1-ME4. FATIGUE LIFE CURVES FOR FLEXURAL (ROTATING BEAM) LOADING ON 1.269 cm (0.25 in.)-THICK NOTCHED SPECIMENS OF WELDED AND UNWELDED 9Ni STEEL AT 77 K (-320 F) [88112]

TABLE 7.1.1-TR1

Alloy Designation: 9Ni Steel

Specification: ASTM A353

Form:

Dimension:

Condition: Double Normalized and Tempered

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
<u>Thermal Conductivity</u>						
Watts m ⁻¹ K ⁻¹	28.5	16.2				
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(16.5)	(9.37)				
No. of Spec.	1	1				
References: 90537						
<u>Thermal Expansion (T₂₇₃ to T)</u>						
<u>Longitudinal</u>						
Percent	0	-0.16				
No. of Spec.	1	1				
References: 90537						
<u>Specific Heat</u>						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
<u>Electrical Resistivity</u>						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

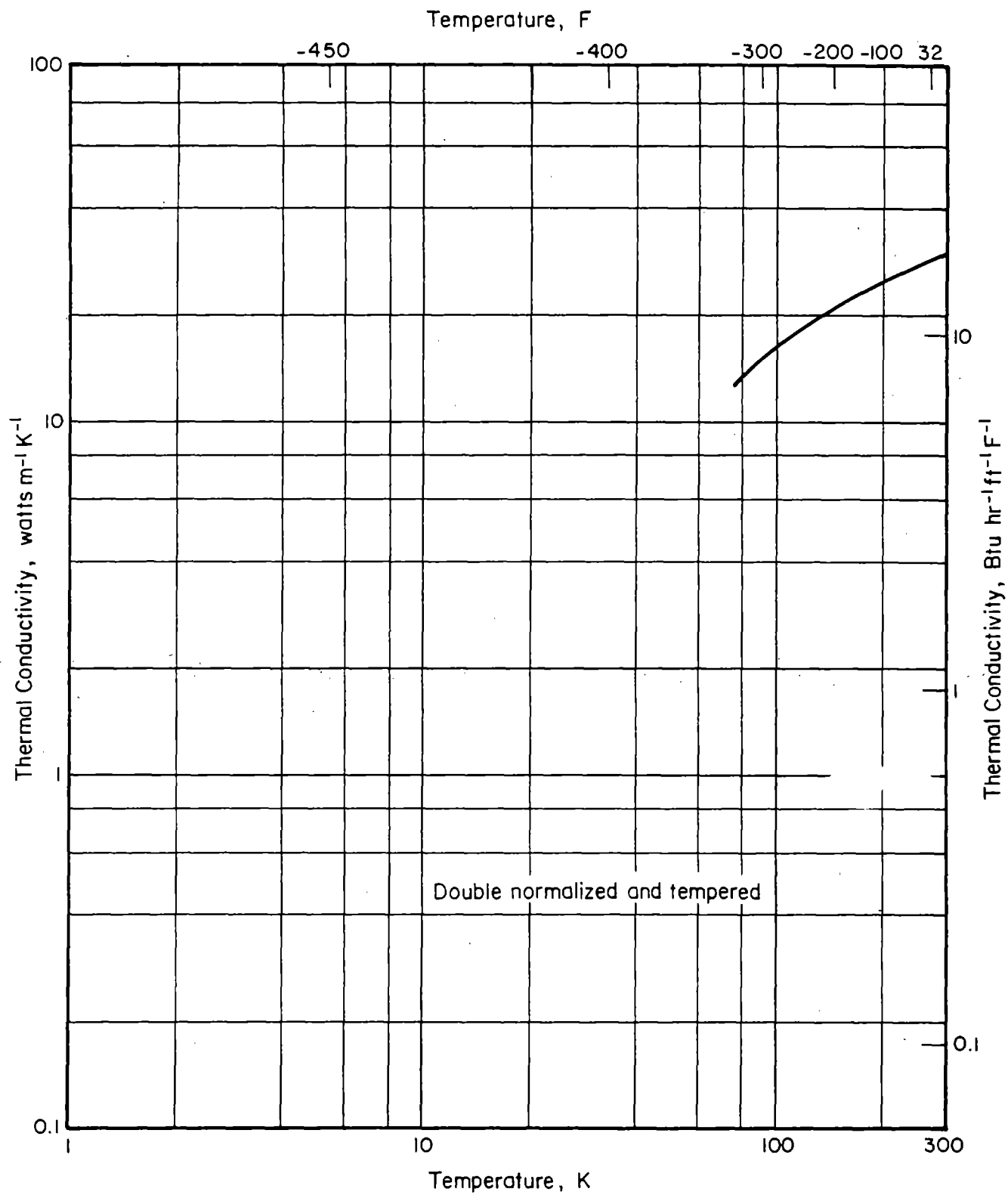


FIGURE 7.1.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR 9-Ni STEEL

7.1.1-37 (11/76)

7.1.1-38 (11/76)

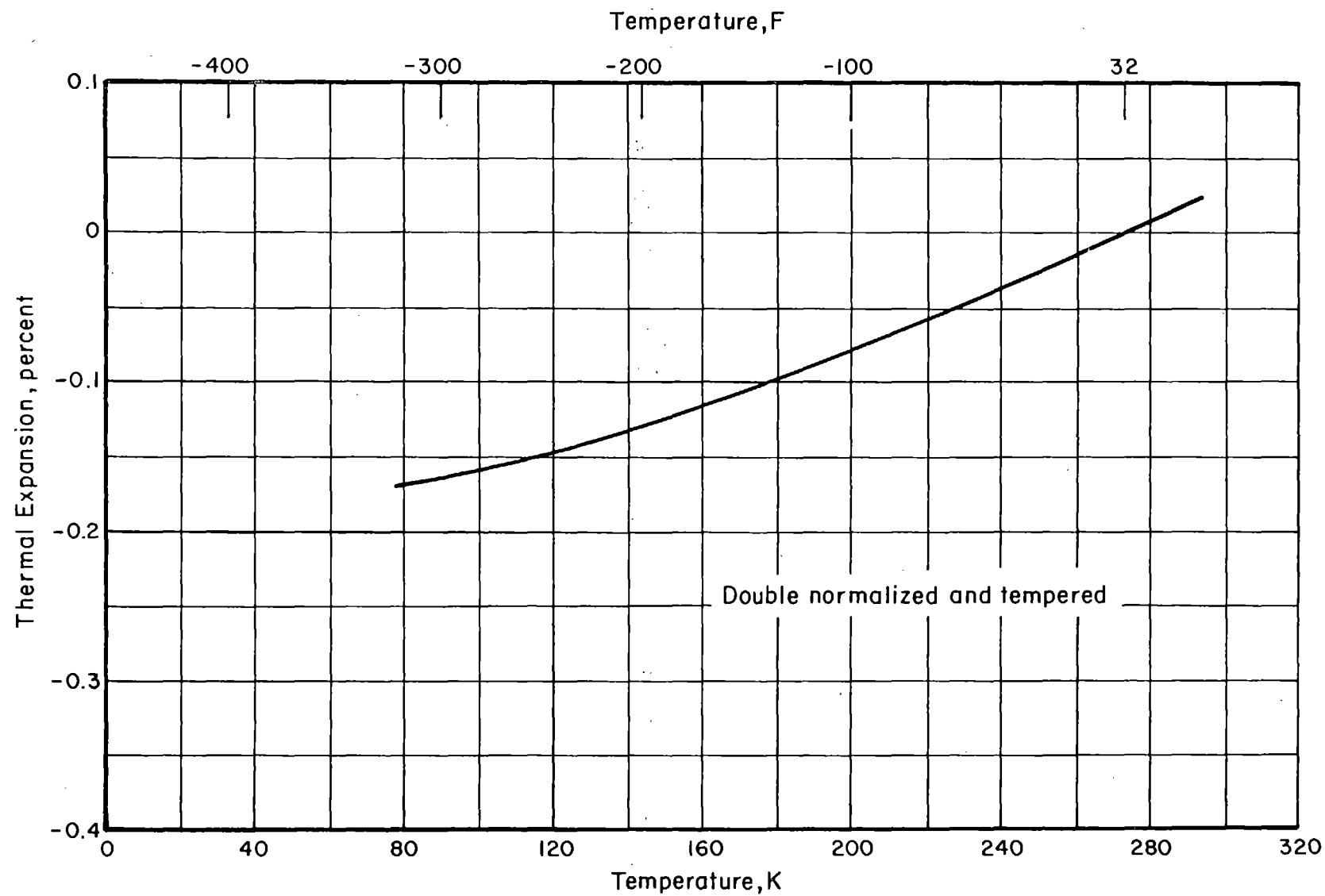


FIGURE 7.1.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE
FOR 9 Ni STEEL

TABLE 7.1.1-MA1

Alloy Designation: 9Ni Steel

Specification: ASTM A353

Form: Plate

Thickness, max; cm (in.): 5.08 (2.0)

Condition: Double normalized and tempered

Testing Temperature, K (F)	293 (68)	273 (32)	+73 (-148)	87 (-303)
<u>Magnetic Properties</u>				
Susceptibility, k	0.21	0.22	0.25	0.28
Permeability*, μ	15.21×10^{-7}	15.28×10^{-7}	15.68×10^{-7}	16.08×10^{-7}
Reference: 90537				

* B_s/H ; H = 16,700 Oe

TABLE 7.1.2-ME1

Alloy Designation: 18Ni (200) Maraging Steel

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed 1090 K (1500 F) 1 hr, AC, aged 756 K (900 F) 3 or 4 hr

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)
Tension, Longitudinal			
TUS, MN/m ² (ksi)	Avg 1486 (216)	1952 (283)	2121 (308)
	Min 1470 (213)	1930 (280)	2050 (297)
Std. Deviation			
TYS, MN/m ² (ksi)	Avg 1449 (210)	1882 (273)	2115 (307)
	Min 1380 (200)	1855 (269)	2040 (296)
Std. Deviation			
Elong, percent	Avg 9	8	5
	Min 7	6	5
RA, percent	Avg		
	Min		
No. of Spec. (No. of Heats)	5 (2)	5 (2)	3 (1)
E, GN/m ² (10 ⁶ psi)	Avg 186 (27.0)	202 (29.3)	
	Min 185 (26.9)	201 (29.1)	
No. of Spec. (No. of Heats)	2 (1)	2 (1)	
Poisson's Ratio			
Work Hardening Coef			
NTS, MN/m ² (ksi)	Avg 1850 (268)	2450 (355)	2480 (359)
K _t = 6.3	Min 1830 (265)	2310 (335)	2360 (342)
No. of Spec. (No. of Heats)	5 (1)	9 (1)	6 (1)
NTS, MN/m ² (ksi)	Avg		
K _t =	Min		
No. of Spec. (No. of Heats)			
Tension, Transverse			
TUS, MN/m ² (ksi)	Avg		
	Min		
Std. Deviation			
TYS, MN/m ² (ksi)	Avg		
	Min		
Std. Deviation			
Elong, percent	Avg		
	Min		
RA, percent	Avg		
	Min		
No. of Spec. (No. of Heats)			
E, GN/m ² (10 ⁶ psi)	Avg		
	Min		
No. of Spec. (No. of Heats)			
Poisson's Ratio			
Work Hardening Coef			
NTS, MN/m ² (ksi)	Avg		
K _t =	Min		
No. of Spec. (No. of Heats)			
NTS, MN/m ² (ksi)	Avg		
K _t =	Min		
No. of Spec. (No. of Heats)			

References: 83169, 90115

TABLE 7.1.2-ME1.1

18Ni (200)
Plate-Weld Metal

Alloy Designation: 18Ni (200) Maraging Steel (Weld Metal)

Specification:

Form: Plate-TIG welded, 18Ni Maraging steel filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Plate aged 760 K (905 F) 4 hr, AC; welded, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1490 (216)			1900 (275)		
	Min	1480 (215)			1850 (269)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1440 (209)			1750 (254)		
	Min	1430 (208)			1590 (230)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			6 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	177 (25.7)			194 (28.2)		
	Min				181 (26.2)		
No. of Spec. (No. of Heats)		1			5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90115

TABLE 7.1.2-ME2

Alloy Designation: 18Ni (200) Maraging Steel

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Solution treated and aged at 760 K (905 F) 4 hr

Testing Temperature, K (F)	297 (75)		77 (-320)			
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 1569 (228)		2019 (293)			
	Min 1530 (222)		1980 (288)			
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 1516 (220)		1951 (283)			
	Min 1470 (213)		1910 (277)			
Std. Deviation						
Elong, percent	Avg 16		13			
	Min 13		12			
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	4 (2)		4 (2)			
E, GN/m ² (10 ⁶ psi)	Avg 185 (26.8)		195 (28.2)			
	Min 183 (26.5)		192 (27.9)			
No. of Spec. (No. of Heats)	4 (2)		4 (2)			
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 90115

TABLE 7.1.2-ME2.1

Alloy Designation: 18Ni (200) Maraging Steel

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Aged at 760 K (905 F) 3 hr.

Testing Temperature, K (F)	297 (75)	77 (-320)				
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg	2274 (329.8)				
	Min	2250 (326.4)				
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	2214 (321.1)				
	Min	2198 (318.8)				
Std. Deviation						
Elong, percent	Avg	6.4				
	Min	6.0				
RA, percent	Avg	45.0				
	Min	40.7				
No. of Spec. (No. of Heats)		4 (1)				
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 90624

TABLE 7.1.2-ME3

18Ni (200)
Plate

Alloy Designation: 18Ni (200) Maraging Steel

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed and aged at 760 K (905 F) 3-4 hr.

Testing Temperature, K (F)	297 (75)		77 (-320)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg		36.8 (40.2)			
	Min		28.8 (31.6)			
Orientation: —						
No. of Spec. (No. of Heats)			10 (2)			
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg		77.4 (70.8)			
(From PTSC spec.) (—)Min			68.7 (62.9)			
No. of Spec. (No. of Heats)			6 (2)			

References: 90624

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data: Compact Tension

TABLE 7.1.2-ME3.1

18Ni (200)
Plate-Weld Metal

Alloy Designation: 18Ni (200) Maraging Steel (Weld Metal)

Specification:

Form: Plate-TIG welded, 18Ni Maraging steel filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate aged 760 K (905 F) 4 hr, AC; welded, tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1520	(221)		1980	(287)	
	Min	1517	(220)		1970	(286)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1410	(204)		1850	(269)	
	Min	1380	(200)				
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3	(1)		2	(1)	
E, GN/m ² (10 ⁶ psi)	Avg	180	(26.1)		180	(26.1)	
	Min	172	(25.0)		170	(24.6)	
No. of Spec. (No. of Heats)		3	(1)				
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90115

TABLE 7.1.2-ME4

Alloy Designation: 18Ni (200) Maraging Steel

Specification:

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Annealed 1175 K (1650 F) 2 hr, AC, annealed 1060 K (1450 F) 2 hr, AC, aged 756 K (900 F) 2 hr

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1460 (212)	1610 (234)	1930 (280)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1420 (206)	1580 (230)	1870 (271)			
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg	66	64	60			
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 80994

TABLE 7.1.2-ME5

Alloy Designation: 18Ni (200) Maraging Steel

Specification:

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Annealed 1175 K (1650 F) 2 hr, AC, annealed 1060 K (1450 F) 2 hr, AC, aged 756 K (900 F) 2 hr

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg	186 (170)	179 (164)	86.0 (78.7)		
	Min	184 (168)	173 (158)	80.3 (73.5)		
Orientation T — L						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)		
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) —)Min						
No. of Spec. (No. of Heats)						

References: 80994

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data: Precracked bend specimens.

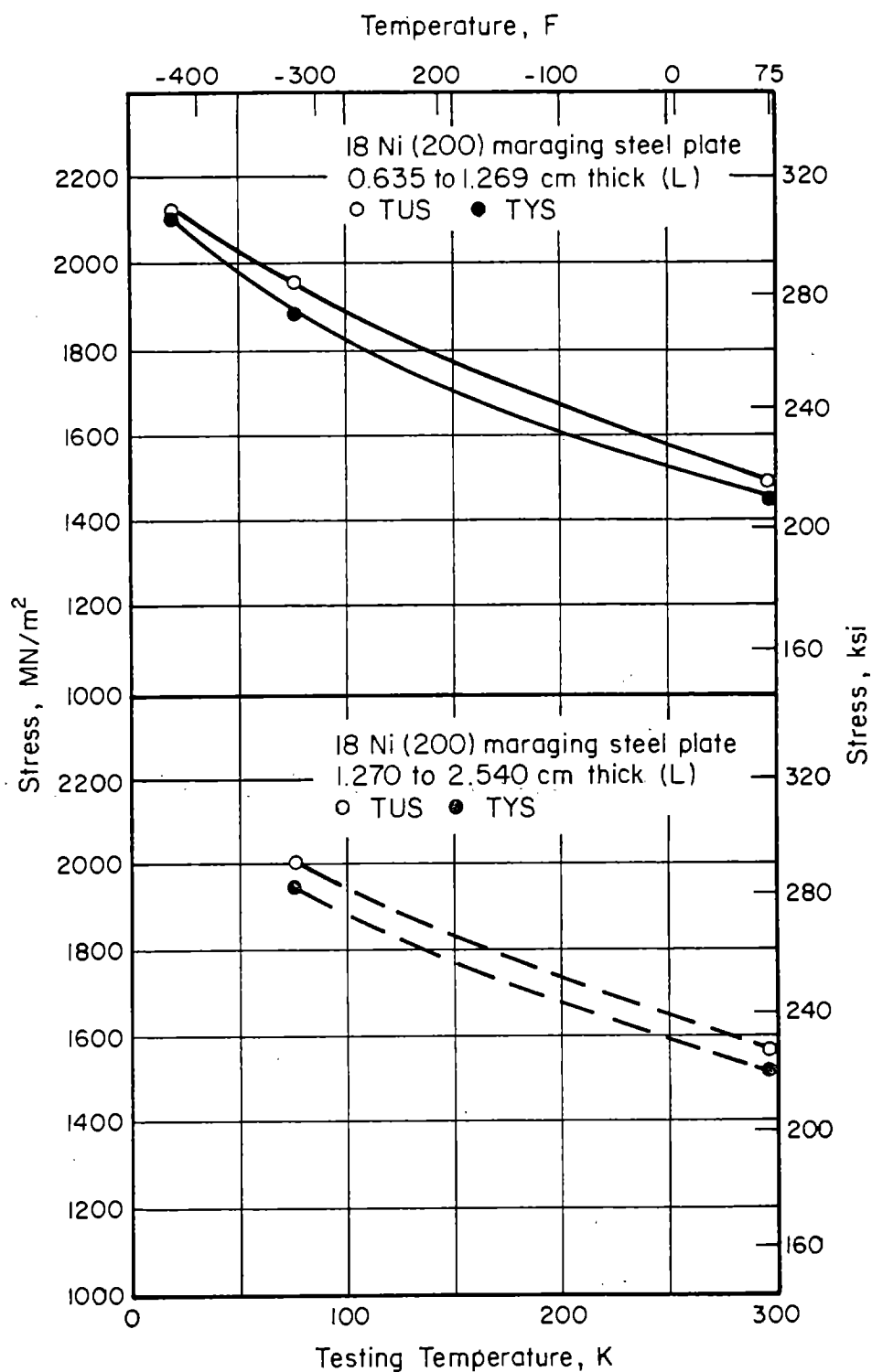


FIGURE 7.1.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF 18Ni (200) MARAGING STEEL PLATE

TABLE 7.1.2-TR1

Alloy Designation: Iron Alloy 18Ni (200) Maraging Steel

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity (1)						
Watts m ⁻¹ K ⁻¹ (2)	15.2	8.1	6.7	2.0	1.0	0.37
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(8.79)	(4.7)	(3.9)	(1.2)	(0.58)	(0.21)
Watts m ⁻¹ K ⁻¹ (3)	14.2	7.7	6.5	1.9	0.92	0.34
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(8.21)	(4.4)	(3.8)	(1.1)	(0.53)	(0.20)
No. of Spec	2	2	2	2	2	2
References: 96888						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

(1) Material measured was Iron Alloy 18Ni (300) Maraging Steel.

(2) Perpendicular to Plate.

(3) In rolling direction.

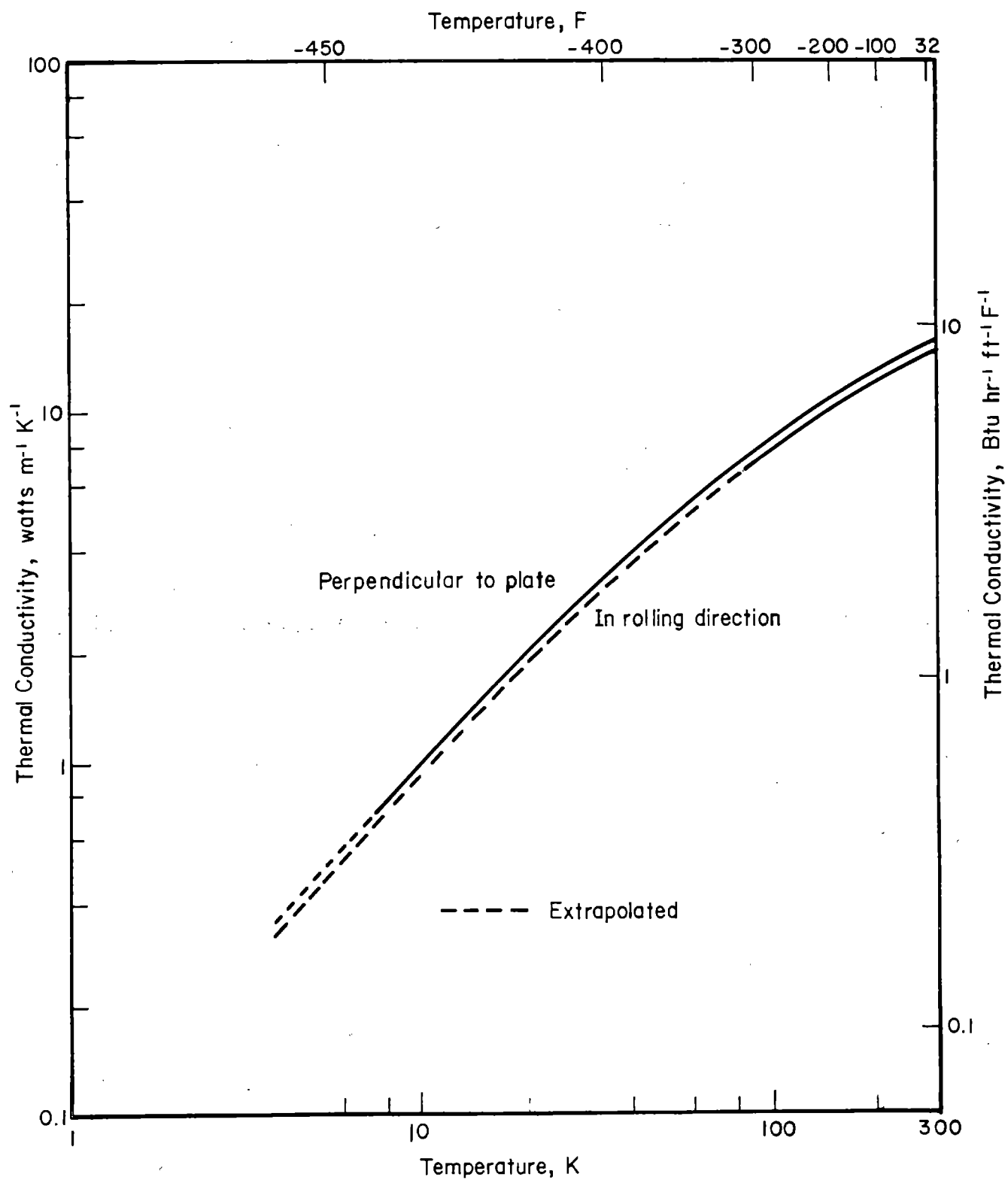


FIGURE 7.1.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR IRON ALLOY 18Ni (200) MARAGING STEEL
(Material measured was Iron Alloy 18Ni (300) Maraging Steel)

TABLE 7.3.1-TR1

Alloy Designation: 1010 Steel

G-10100

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	66.0					
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(38.2)					
No. of Spec	1					
References: 90224						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

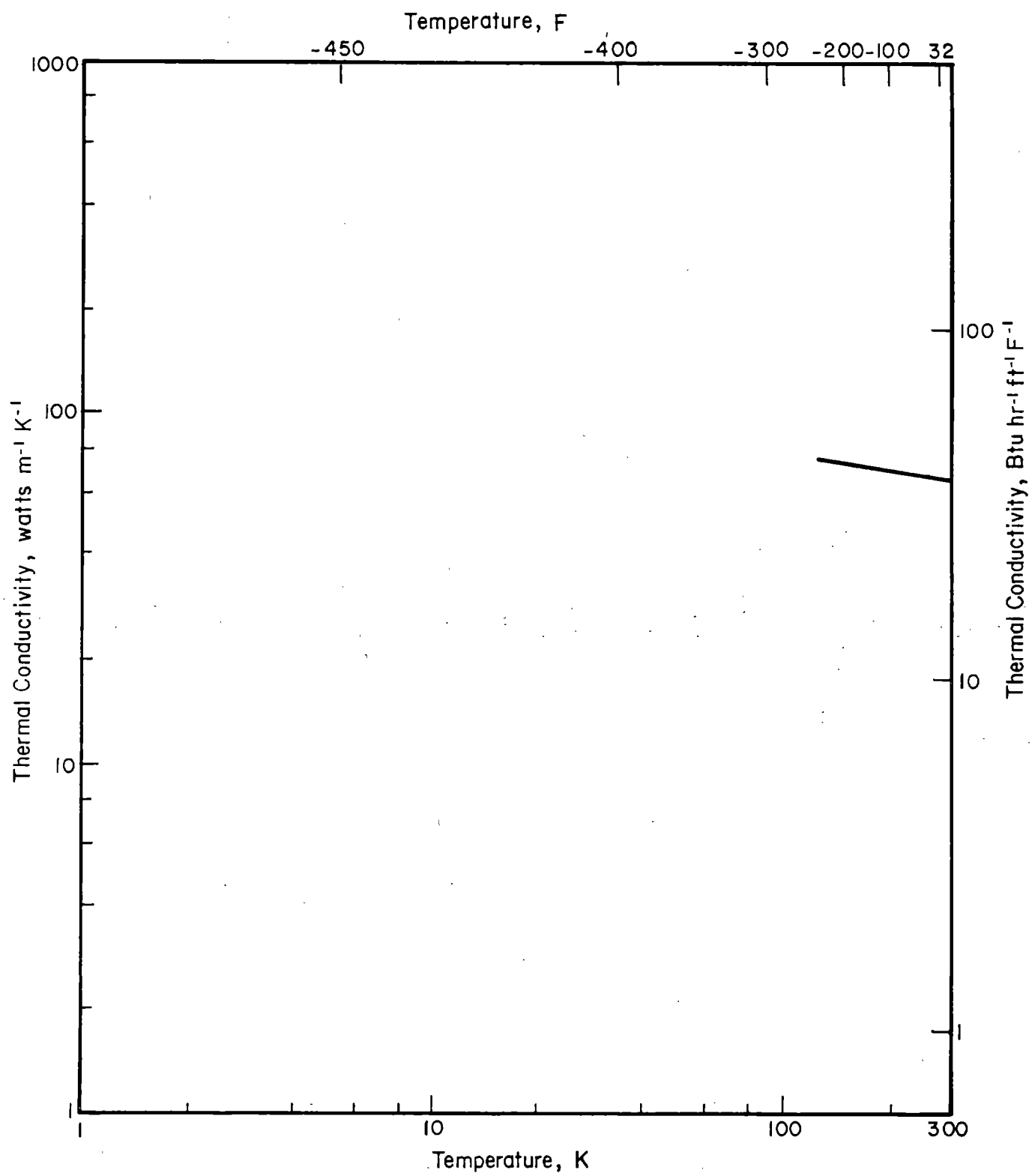


FIGURE 7.3.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR 1010 STEEL

TABLE 7.4.1-ME1

Armco Iron
Bar

Alloy Designation: Armco Iron

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Annealed and furnace cooled to 0.025 mm (10^{-5} in.) grain diam.

Testing Temperature, K (F)		297 (75)	26 (-412)	24 (-416)	17 (-429)	12 (-440)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg		879.1 (127.5)	893.6 (129.6)	809.4 (117.4)	923.2 (133.9)	935.6 (135.7)
	Min						909.4 (131.9)
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	4	(1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 96682

TABLE 7.4.1-TR1

Alloy Designation: Armco Iron

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	76.1	95.4	112	67.5	34.2	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(44.0)	(55.2)	(64.8)	(39.0)	(19.8)	
No. of Spec.	3	3	3	3	3	
References: 90230						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	9.59 x 10 ⁻⁸	2.08 x 10 ⁻⁸	9.05 x 10 ⁻⁹	7.49 x 10 ⁻⁹	7.43 x 10 ⁻⁹	7.43 x 10 ⁻⁹
Ohm circular mil ft ⁻¹	(57.7)	(12.5)	(5.44)	(4.51)	(4.47)	(4.47)
No. of Spec.	4	4	4	4	4	3
References: 90230, 96877						

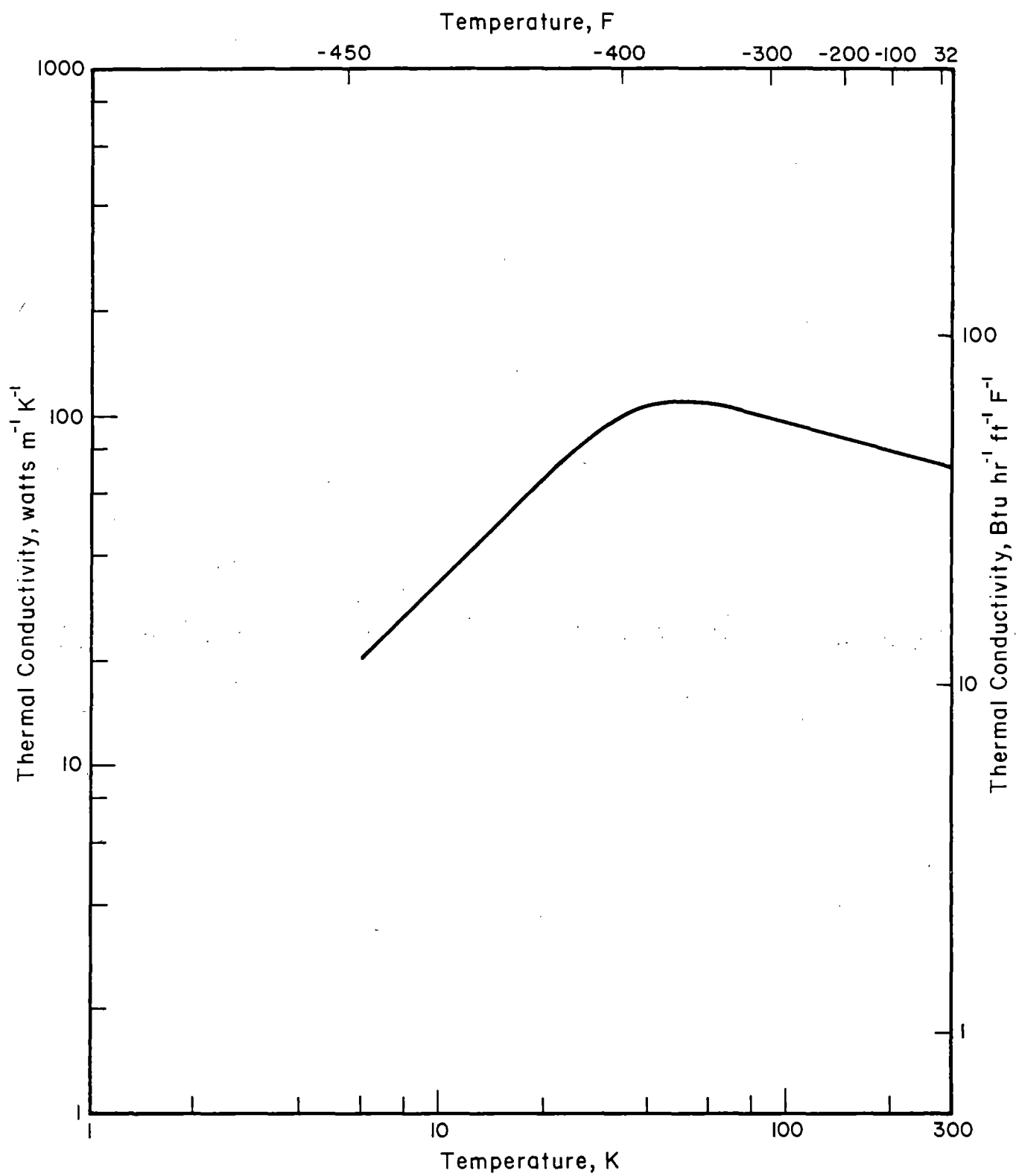


FIGURE 7.4.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR ARMCO IRON

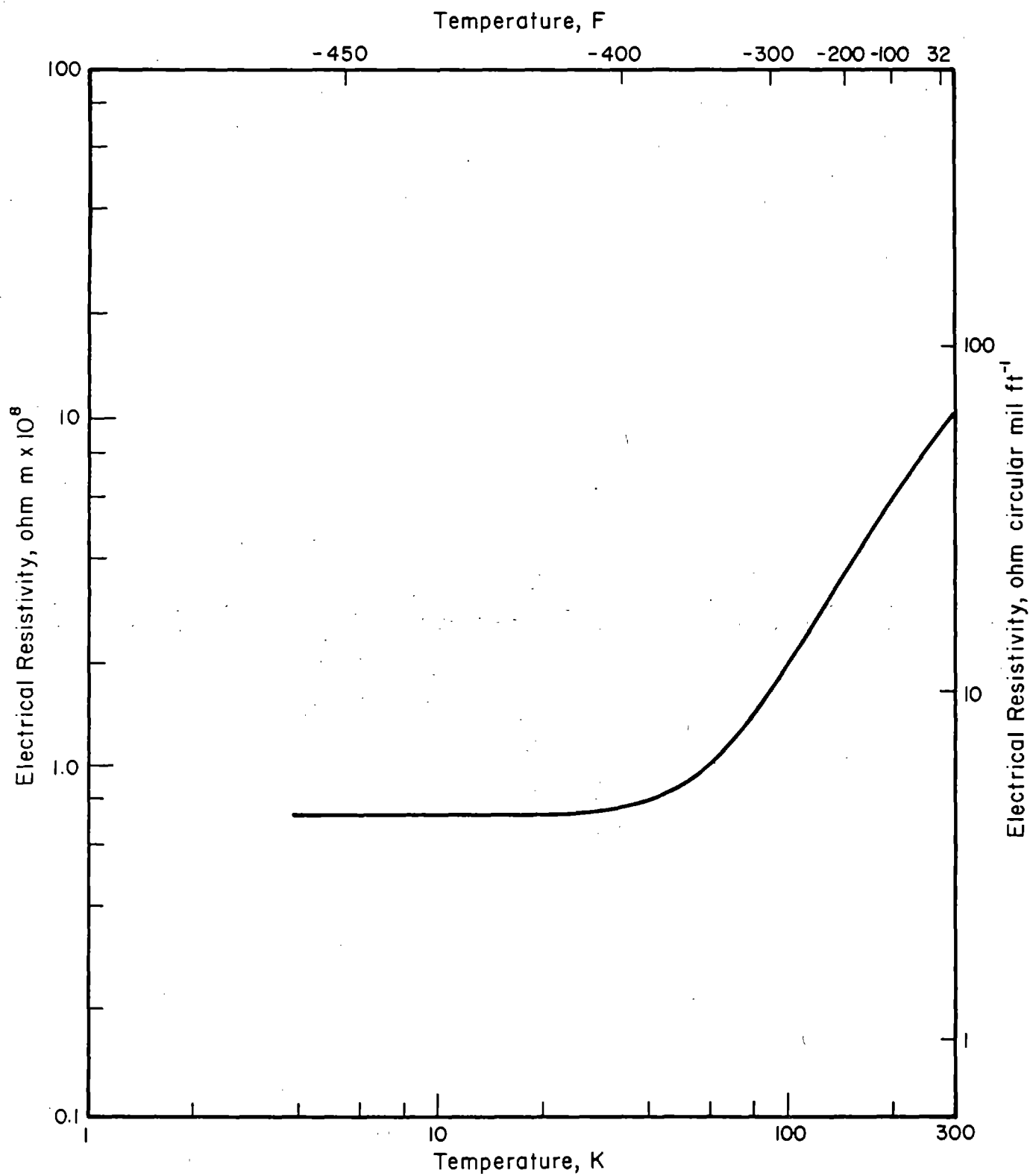


FIGURE 7.4.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR ARMCO IRON

TABLE 7.4.3-ME1

5Ni Steel
Plate

Alloy Designation: 5Ni Steel

Specification: ASTM A645

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Quenched, tempered, and reversion annealed per spec.

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)				228	(33.0)	
Loading frequency 166 Hz						
with R = -1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N /TUS at 10^7 cycles				0.21		
S_N at 10^8 cycles, MN/m ² (ksi)				200	(29)	
Loading frequency 166 Hz						
with R = -1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N /TUS at 10^8 cycles				0.18		

References: 96687

TABLE 7.4.3-ME2

5Ni Steel
Plate

Alloy Designation: 5Ni Steel

Specification: ASTM A645

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Quenched, tempered and reversion annealed per spec.

Testing Temperature, K (F)	297 (75)		105 (-270)	77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V *						
Long., Nm(ft-lb)	Avg		65.3 (49.4)	63.5 (47.0)		
	Min		58 (43)	55 (41)		
No. of Spec. (No. of Heats)			5 (1)	6 (1)		
Trans., Nm(ft-lb)	Avg		54.0 (40.0)	51.3 (38.0)		
	Min		43 (32.0)	41 (30)		
No. of Spec. (No. of Heats)			5 (1)	6 (1)		
Fracture Toughness^(b)						
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg		67.2 (384)	7.7 (44)		
	Min		57.1 (326)	6.1 (35)		
Orientation: —						
No. of Spec. (No. of Heats)			>1	>1		
K _{Ic} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 96684, 96687

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{Ic} data:

* Data are for half-size specimens; for full-size specimens, average longitudinal values are given as 81 Nm (60 ft-lb) and 112 Nm (83.0 ft-lb) for temperatures of 105 K and 77 K, respectively.

TABLE 7.4.3-ME3

5Ni Steel
Plate-Weld Metal

Alloy Designation: 5Ni Steel

Specification: ASTM A645

Form: Plate-Pulsed MIG welded, Inconel 92 filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Plate Quenched, temperized, and reversion annealed per spec.; welded, and tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
<u>Fatigue, Axial Loading</u>						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						
<u>Fatigue, Flexural Loading</u>						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)				255	(37)	
Loading frequency 166 Hz						
with R = .1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N /TUS at 10^7 cycles				0.28		
S_N at 10^8 cycles, MN/m ² (ksi)						
Loading frequency 166 Hz						
with R = .1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N /TUS at 10^8 cycles				0.27		

References: 96687

TABLE 7.4.3-ME4

5Ni Steel
Plate-Weld Metal

Alloy Designation: 5Ni Steel (Weld Metal)

Specification: ASTM A645

Form: Plate-shielded MIG welded (Incoweld Bm covered electrode)

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Quenched, tempered, and reversion annealed per spec.; welded, tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and K_t =						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)				255	(37)	
Loading frequency 166 Hz						
with R = -.1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N /TUS at 10^7 cycles				0.28		
S_N at 10^8 cycles, MN/m ² (ksi)				241	(35)	
Loading frequency 166 Hz						
with R = -.1 and K_t = 2.7						
No. of S-N Curves (No. of Heats)				1		
Ratio S_N /TUS at 10^8 cycles				0.27		

References: 96687

TABLE 7.4.3-ME5

5Ni Steel
Plate

Alloy Designation: 5Ni Steel

Specification: ASTM A645

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Quenched, tempered, and reversion annealed per spec.

Testing Temperature, K (F)		297	(75)			77	(-320)		
Tension, Longitudinal									
TUS, MN/m ² (ksi)	Avg	724	(105)			1120	(163)		
	Min	689	(100)			1110	(160)		
	Std. Deviation	21.2	(3.07)						
TYS, MN/m ² (ksi)	Avg	572	(82.9)			807	(117)		
	Min	490	(71)			745	(108)		
	Std. Deviation	45.0	(6.53)						
Elong, percent	Avg	31.2				31.0			
	Min	28				29			
RA, percent	Avg	72.8							
	Min	69							
No. of Spec. (No. of Heats)		13	(2)			5	(1)		
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
	K _t =								
	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
	K _t =								
	Min								
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
TYS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)									
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
	K _t =								
	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
	K _t =								
	Min								
No. of Spec. (No. of Heats)									

References: 92996

TABLE 7.4.3-ME6

5Ni Steel
Plate

Alloy Designation: 5Ni Steel

Specification: ASTM A645

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Quenched, tempered, and reversion annealed per spec.

Testing Temperature, K (F)	297 (75)		105 (-270)	77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg		130 (98)	119 (88.5)		
	Min			105 (78)		
No. of Spec. (No. of Heats)			1	6 (1)		
Trans., Nm(ft-lb)	Avg		110 (84)	61.7 (45.7)		
	Min		100 (76)	38 (28)		
No. of Spec. (No. of Heats)			2 (1)	6 (1)		
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 96686, 96687

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 7.4.3-ME7

Alloy Designation: 5Ni Steel

Specification: ASTM A645

Form: Plate-Pulse MIG welded, Inconel 92(1) filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Quenched, tempered, and reversion annealed per spec.; welded, and tested as welded

Testing Temperature, K (F)	297 (75)	195 (-108)	144 (-200)	77 (-320)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg	799.1 (115.9)	855.0 (124.0)	979.1 (142.0)		
	Min	797.7 (115.7)	850.8 (123.4)	978.4 (141.9)		
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 96687

TABLE 7.4.3-ME8

Alloy Designation: 5Ni Steel

Specification: ASTM A645

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: Quenched, tempered, and reversion annealed per spec.

Testing Temperature, K (F)		297 (75)	195 (-108)	110 (-270)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	708.8 (102.8)	843.9 (122.4)	930.8 (135.0)	1137 (164.9)		
	Min	687 (99.6)			1136 (164.8)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	487 (70.6)	434 (63.0)	572 (82.9)	726.0 (105.3)		
	Min	468 (67.9)		521 (75.6)	719.8 (104.4)		
Std. Deviation							
Elong, percent	Avg	32.0	30	28	29.5		
	Min	29			29		
RA, percent	Avg	70.7	70	68	62		
	Min	69					
No. of Spec. (No. of Heats)		4 (3)	1	2 (2)	3 (3)		
E, GN/m ² (10 ⁶ psi)	Avg	198 (28.7)			212 (30.7)		
	Min						
No. of Spec. (No. of Heats)		1			1		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 92996, 96684, 96687

TABLE 7.4.3-ME7

Alloy Designation: 5Ni Steel

Specification: ASTM A645

Form: Plate-Pulse MIG welded, Inconel 92(1) filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Quenched, tempered, and reversion annealed per spec.; welded, and tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg		799.1 (115.9)	855.0 (124.0)	979.1 (142.0)		
	Min		797.7 (115.7)	850.8 (123.4)	978.4 (141.9)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)			2 (1)	2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 96687

TABLE 7.4.3-ME8

Alloy Designation: 5Ni Steel

Specification: ASTM A645

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: Quenched, tempered, and reversion annealed per spec.

Testing Temperature, K (F)		297 (75)	195 (-108)	110 (-270)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	708.8 (102.8)	843.9 (122.4)	930.8 (135.0)	1137 (164.9)		
	Min	687 (99.6)			1136 (164.8)		
Std Deviation							
TYS, MN/m ² (ksi)	Avg	487 (70.6)	434 (63.0)	572 (82.9)	726.0 (105.3)		
	Min	468 (67.9)		521 (75.6)	719.8 (104.4)		
Std Deviation							
Elong, percent	Avg	32.0	30	28	29.5		
	Min	29			29		
RA, percent	Avg	70.7	70	68	62		
	Min	69					
No. of Spec (No. of Heats)		4 (3)	1	2 (2)	3 (3)		
E, GN/m ² (10 ⁶ psi)	Avg	198 (28.7)			212 (30.7)		
	Min						
No. of Spec. (No. of Heats)		1			1		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 92996, 96684, 96687

TABLE 7.4.3-ME9

5Ni Steel
Plate

Alloy Designation: 5Ni Steel

Specification: ASTM A645

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: Quenched, tempered, and reversion annealed per spec.

Testing Temperature, K (F)	297 (75)	195 (-108)	110 (-270)	77 (-320)		4 (-452)
<u>Compression, Longitudinal</u>						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN /m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Compression, Transverse</u>						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Shear^(a)</u>						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Impact, Charpy V</u>						
Long., Nm(ft-lb)	Avg		(85.7)	(58.7)		
	Min		(84)	(57)		
No. of Spec. (No. of Heats)			3 (1)	3 (1)		
Trans., Nm(ft-lb)	Avg		(89.7)	(40.0)		
	Min		(82)	(36)		
No. of Spec. (No. of Heats)			3 (1)	3 (1)		
<u>Fracture Toughness^(b)</u>						
J _{IC} KJ/m ² (in.-lb/in. ²)	Avg	(1270)	(925)	(971)	(176)	(865)
	Min		(400)	(774)	(91)	(710)
Orientation: —						
No. of Spec. (No. of Heats)	4 (1)	4 (2)	3 (1)	4 (2)		2 (1)
K _{IE} , MN/m ^{3/2} (ksi/ in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 96684, 96699

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 7.4.3-ME10

Alloy Designation: 5Ni Steel (Weld Metal)

Specification: ASTM A645

Form: Plate-Pulse MIG welded, Inconel 92 filler

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: Quenched, tempered, and reversion annealed per spec.; welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg		788.1 (114.3)	906.7 (131.5)	1010 (146.5)		
	Min			880.0 (128.8)	994.9 (144.3)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)			1	2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 96687

TABLE 7.4.3-ME11

5Ni Steel
Plate-Weld Metal

Alloy Designation: 5Ni Steel

Specification: ASTM A645

Form: Plate-Submerged arc welded, Inco 82 electrode, Incoflux 4

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: Quenched, temperized, and reversion annealed; welded, tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg			85.6 (63.4)		
	Min			50 (37)		
No. of Spec. (No. of Heats)				8 (1)		
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation. —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 96686

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

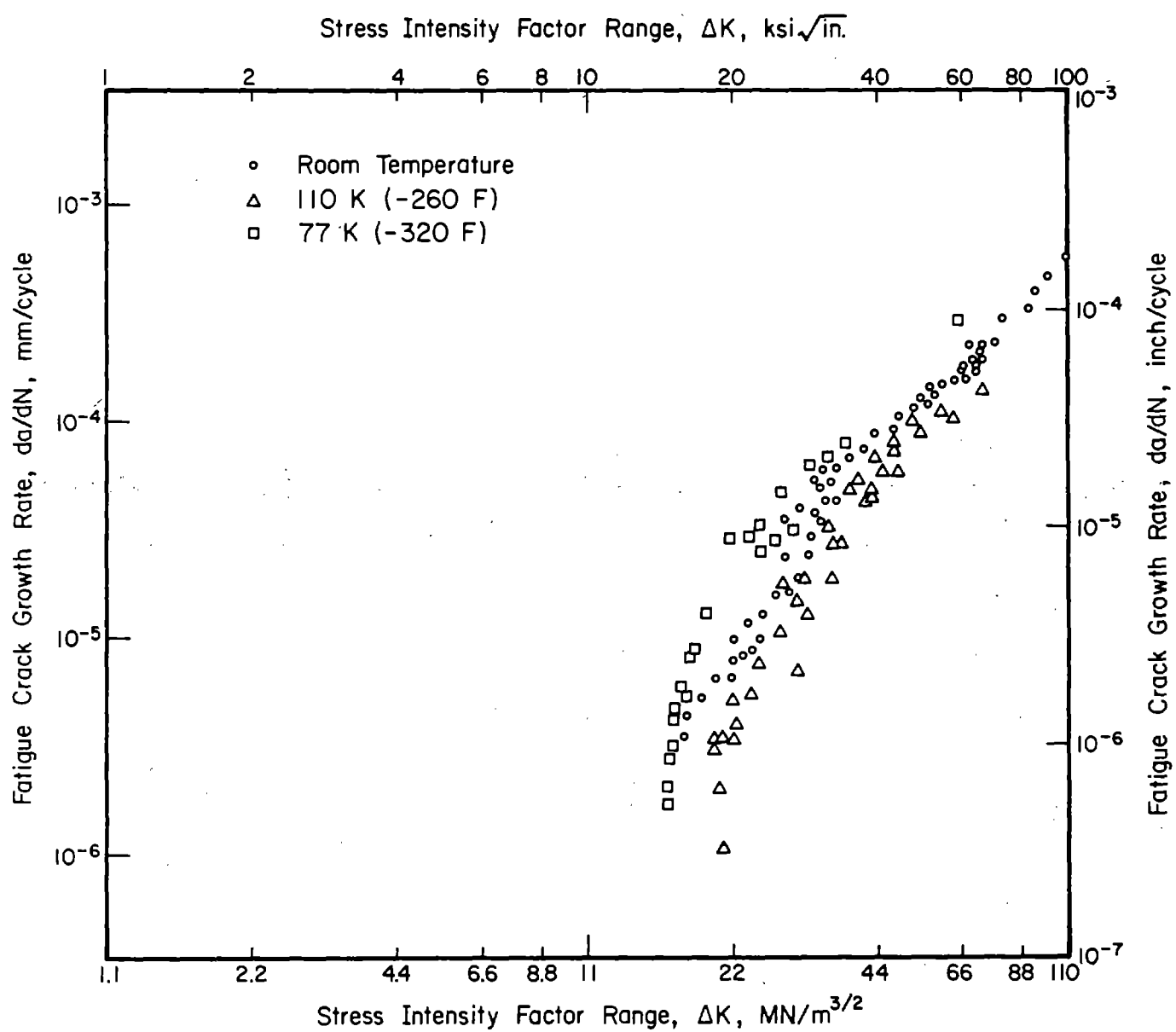


FIGURE 7.4.3-ME1. FATIGUE CRACK GROWTH RATE CURVES FOR 5Ni STEEL (ASTM A645) PLATE AT ROOM TEMPERATURE, 110 K, and 77 K [96686]
 Heat Treatment: Quenched, tempered, and reversion annealed per spec.

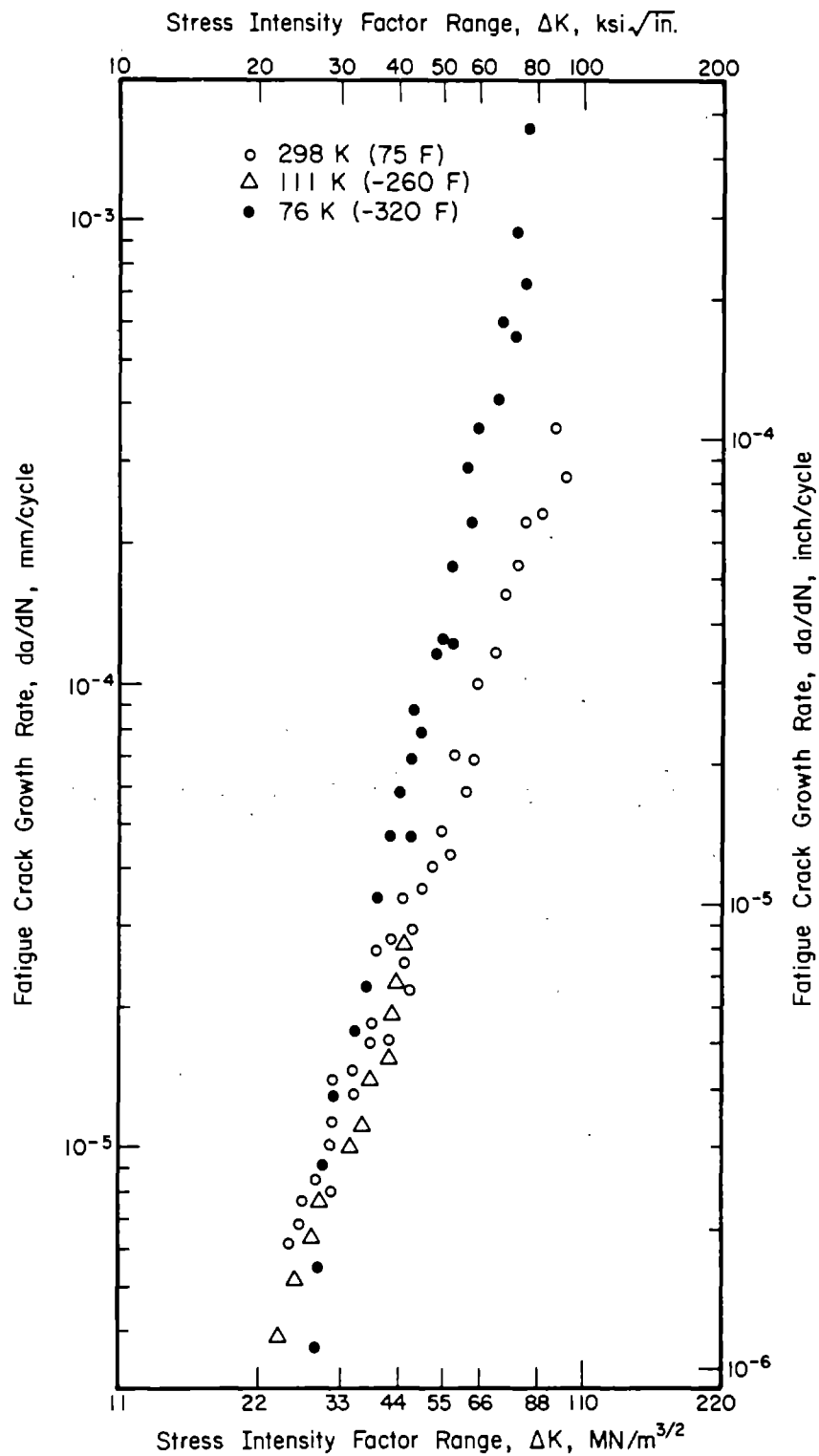


FIGURE 7.4.3-ME2. FATIGUE CRACK GROWTH RATE CURVES FOR 5NI STEEL (ASTM A645) PLATE AT ROOM TEMPERATURE, 110 K, and 77 K [96699]

TABLE 7.4.3-TR1

Alloy Designation: Iron Alloy Fe-5Ni

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	37.5	22.0	13.0	5.70	2.80	1.00
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(21.7)	(12.7)	(7.52)	(3.30)	(1.62)	(0.578)
No. of Spec.	2	2	2	2	2	2
References: 90170						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

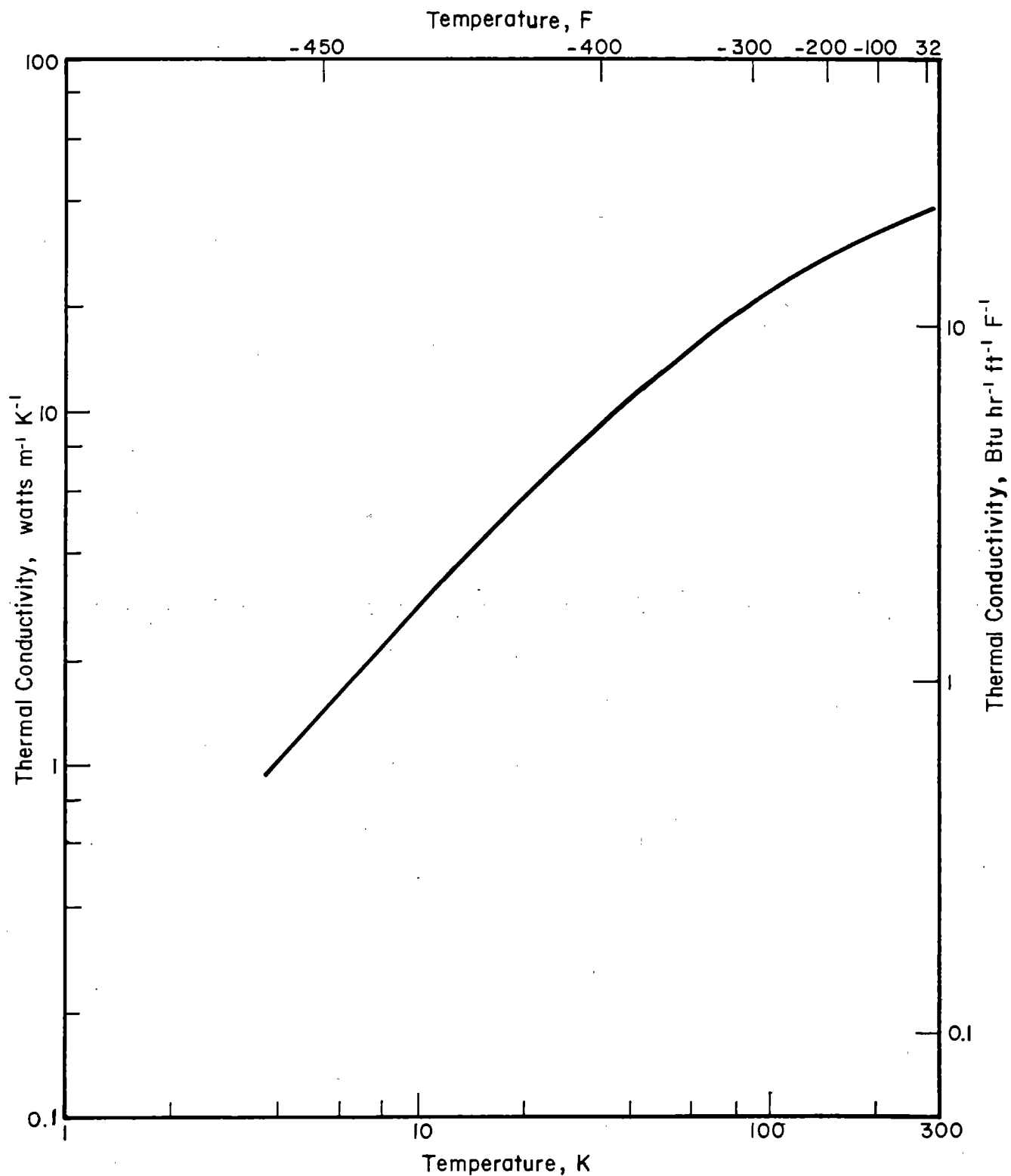


FIGURE 7.4.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR IRON ALLOY Fe-5Ni

TABLE 7.4.4-TR1

Alloy Designation: Fe(47-50)Ni Alloy

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹ (1) Btu hr ⁻¹ ft ⁻¹ F ⁻¹	20.0 (11.6)	13.9 (8.04)	8.70 (5.03)	4.00 (2.31)	2.00 (1.16)	0.72 (0.42)
Watts m ⁻¹ K ⁻¹ (2) Btu hr ⁻¹ ft ⁻¹ F ⁻¹	16.7 (9.66)	11.3 (6.53)	7.10 (4.11)	3.35 (1.94)	1.70 (0.98)	0.61 (0.35)
No. of Spec.	2	2	2	2	2	
References: 96888						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.151	-0.172	-0.175	-0.175	-0.175
No. of Spec.	1	1	1	1	1	1
References: 74405						
Specific Heat						
Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m Ohm circular mil ft ⁻¹	39.2 x 10 ⁻⁸ (236)	21.0 x 10 ⁻⁸ (126)	18.4 x 10 ⁻⁸ (111)	17.6 x 10 ⁻⁸ (106)	17.5 x 10 ⁻⁸ (105)	17.4 x 10 ⁻⁸ (105)
No. of Spec.	1	1	1	1	1	1
References: 79561						
Magnetothermal Conductivity						
	H, tesla					
W Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹	0			3.60 (2.08)	2.00 (1.16)	0.76 (0.44)
Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹	2			3.50 (2.02)	1.92 (1.11)	0.73 (0.42)
Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹	4			3.50 (2.02)	1.92 (1.11)	0.73 (0.42)
Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹	8				1.92 (1.11)	0.73 (0.42)
No. of Spec.				1	1	1
References: 96888						

(1) High Perm 49Fe-97.5Ni
(perpendicular to plate)(2) High Perm 49Fe-47.5Ni
(in rolling direction)

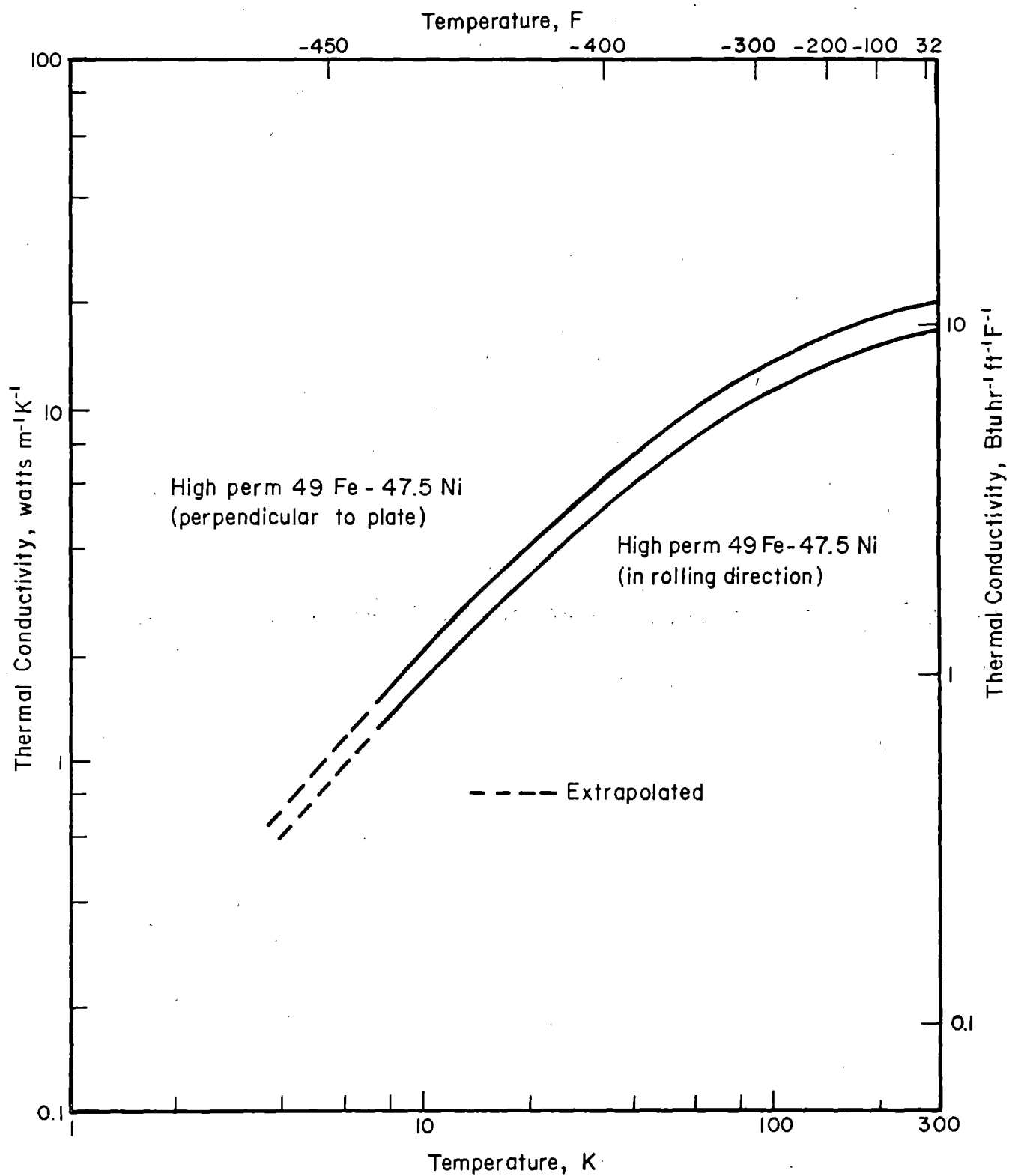


FIGURE 7.4.4-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR
IRON ALLOY Fe(47-50)Ni

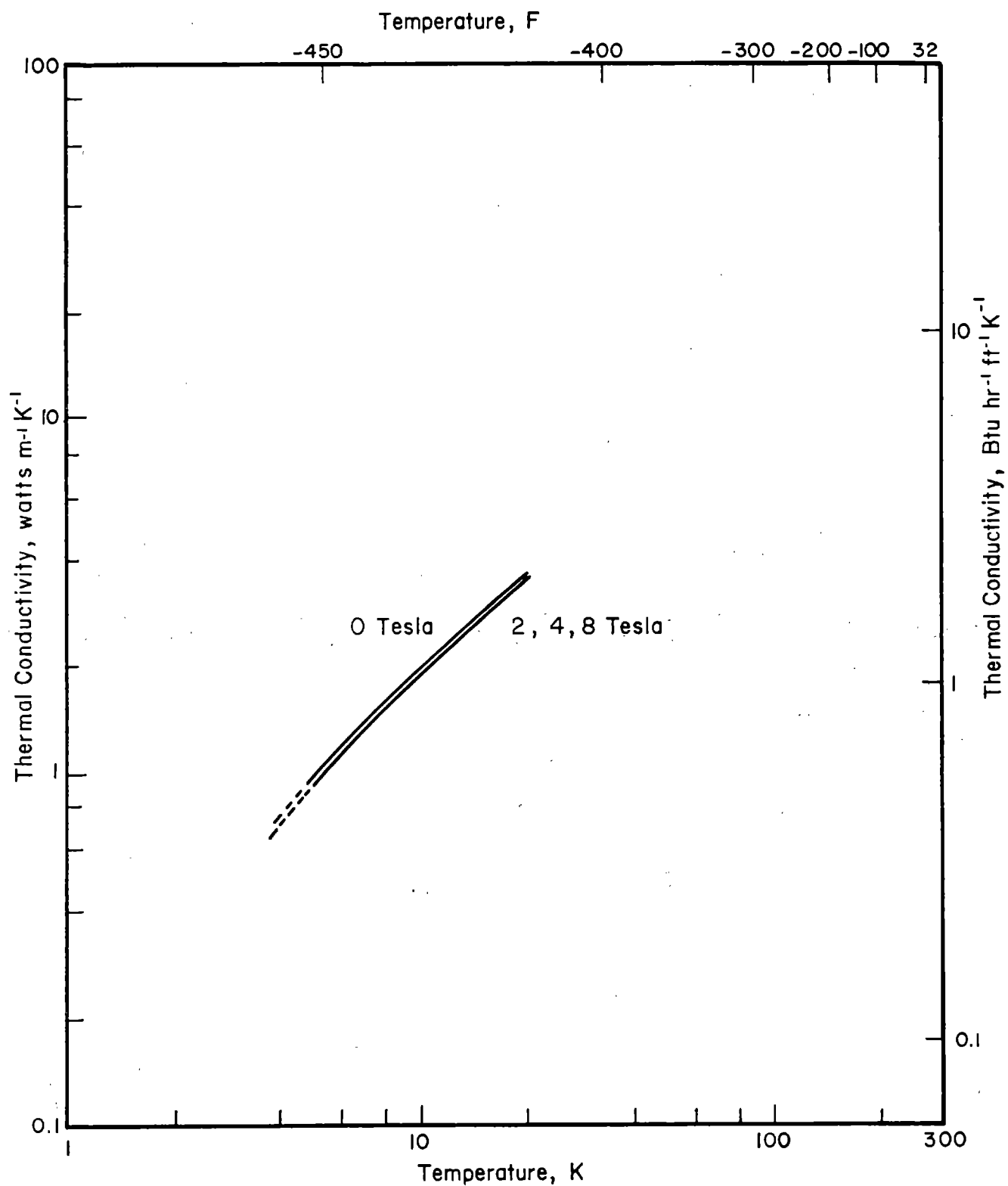


FIGURE 7.4.4-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR IRON ALLOY Fe(47-50)Ni AT SEVERAL MAGNETIC FIELDS

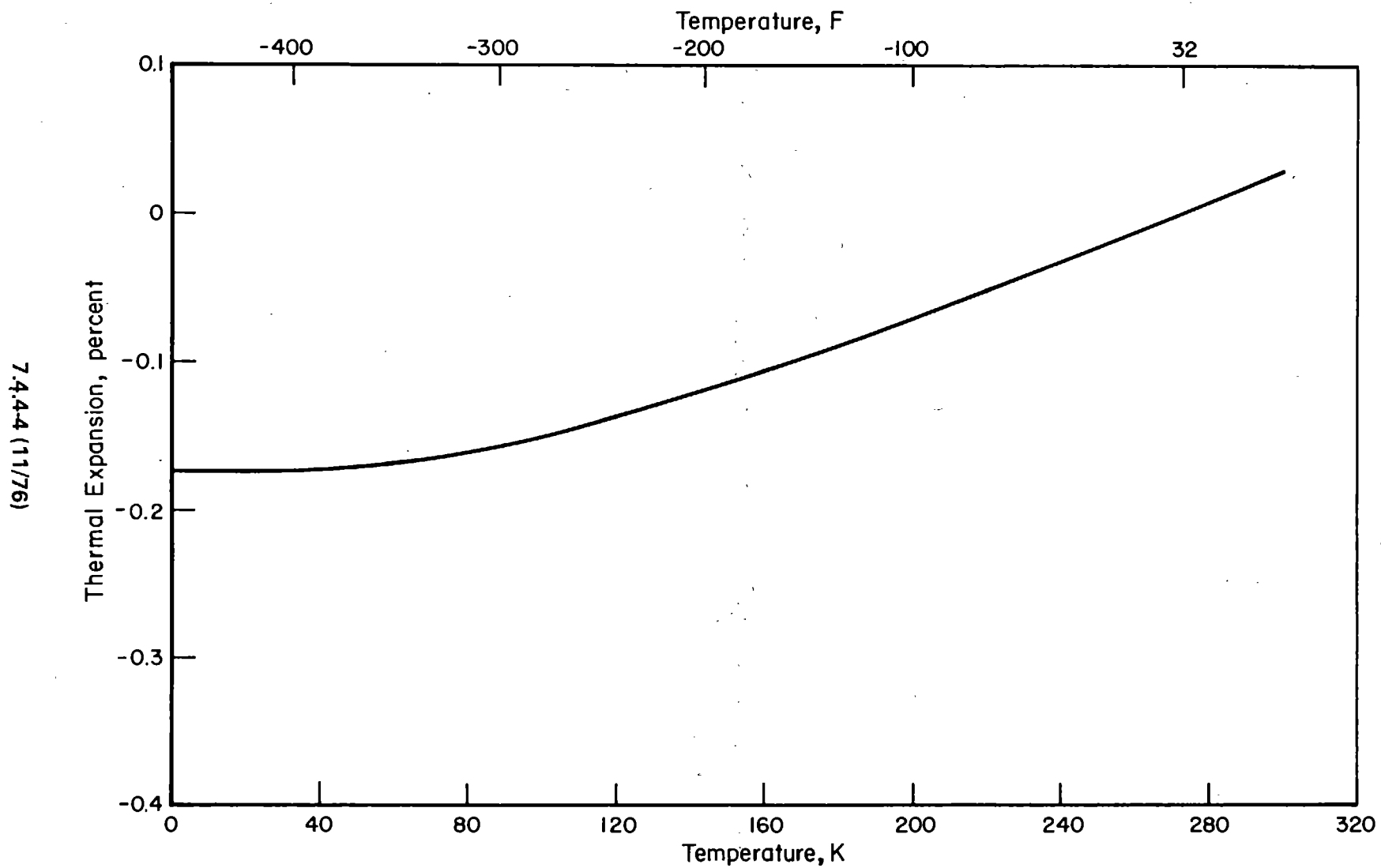


FIGURE 7.4.4-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR IRON ALLOY Fe(47-50)Ni

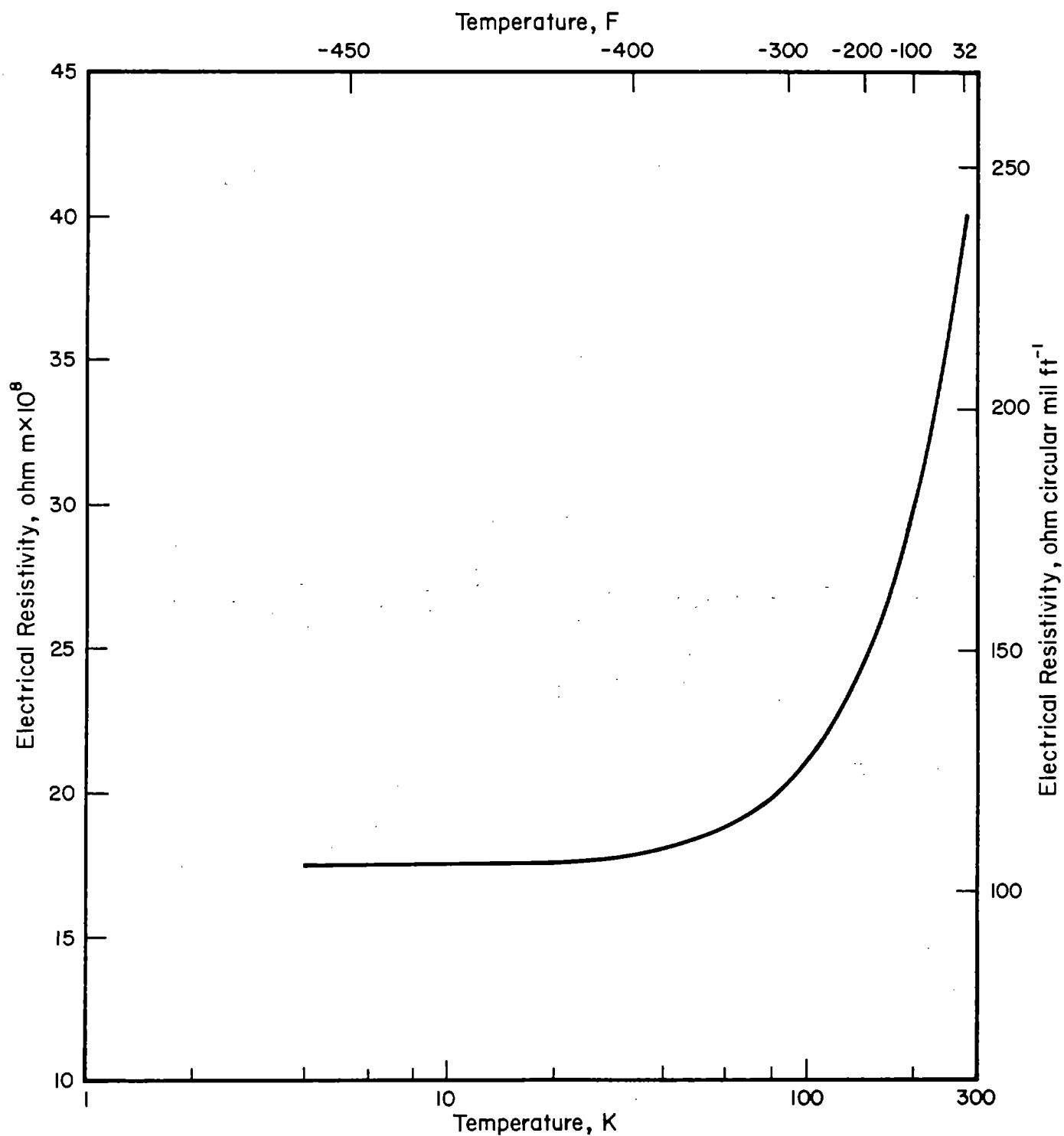


FIGURE 7.4.4-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR IRON ALLOY (47-50)Ni

**INDEX TO MATERIAL CODES FOR
SECTION 8.0**

STAINLESS STEELS

<u>MATERIALS</u>	<u>MATERIAL CODE</u>
TYPE 301	8.1.1
TYPE 303	8.1.7
TYPE 304	8.1.2
TYPE 304L	8.1.3
TYPE 310	8.1.4
TYPE 310S	8.1.8
TYPE 316	8.1.5
TYPE 321	8.1.6
TYPE 347	8.1.9
TYPE 410	8.1.10
TYPE 416	8.1.11
A-286	8.2.1
KROMARC-58	8.2.2
ARMCO 21-6-9	8.2.3
ARMCO 22-13-5	8.2.4

TABLE 8.1.1-ME1

Alloy Designation: Type 301 Stainless Steel

Specification: MIL-S-5059C

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Half hard cold rolled

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1200 (174)			2022 (293)		
	Min	1144 (166)			1689 (245)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	931 (135)			1149 (167)		
	Min	896 (130)			1069 (155)		
Std. Deviation							
Elong, percent	Avg	30.4			13.7		
	Min	26			10.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)			6 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1205 (175)			1570 (228)		
	Min	1165 (169)			1358 (197)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	818 (119)			1089 (158)		
	Min	765 (111)			1048 (152)		
Std. Deviation							
Elong, percent	Avg	27.2			9.2		
	Min	23.5			0.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (2)			6 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 59767

TABLE 8.1.1-ME2

Alloy Designation: Type 301 Stainless Steel

Specification: MIL-S-5059C

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Hard (H) cold rolled (42 to 60 percent reduction)

Testing Temperature, K (°F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1313 (190)	1557 (226)	2017 (293)	2108 (306)		
	Min	1262 (183)	1531 (222)	1965 (285)	1993 (289)		
	Std. Deviation	42.0 (6.09)		43.1 (6.26)			
TYS, MN/m ² (ksi)	Avg	1197 (174)	1133 (164)	1381 (200)	1604 (233)		
	Min	1151 (167)	1055 (153)	1289 (187)	1517 (220)		
	Std. Deviation	42.0 (6.09)		59.9 (8.69)			
Elong, percent	Avg	18.0	23.3	19.2	13.7		
	Min	15	18	15	13		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		11 (2)	6 (2)	10 (3)	5 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1384 (201)	1461 (212)	1664 (241)	1829 (265)		
	Min	1345 (195)	1407 (204)	1517 (220)	1613 (234)		
	No. of Spec. (No. of Heats)	11 (3)	7 (2)	11 (3)	6 (2)		
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1310 (190)	1558 (226)	2060 (299)	1898 (275)		
	Min	1310 (190)	1558 (226)	2048 (297)	1862 (270)		
	Std. Deviation						
TYS, MN/m ² (ksi)	Avg	1053 (153)	1069 (155)	1310 (190)	1565 (227)		
	Min	1048 (152)	1069 (155)	1269 (184)	1524 (221)		
	Std. Deviation						
Elong, percent	Avg	9.7	28.5	27.7	8.3		
	Min	9	28	27	7		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	2 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1427 (207)	1438 (208)	1673 (243)	1356 (197)		
	Min	1406 (204)	1434 (208)	1606 (233)	1303 (189)		
	No. of Spec. (No. of Heats)	3 (1)	2 (1)	3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 49088, 53354

TABLE 8.1.1-ME3

Alloy Designation: Type 301 Stainless Steel S30100

Specification: MIL-S-5059

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Extra hard (XH) cold rolled (60 percent or more reduction)

Testing Temperature, K (°F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1558 (226)	1735 (252)	2241 (325)	2234 (324)		
	Min	1393 (202)	1662 (241)	2041 (296)	1937 (281)		
	Std. Deviation	123.3 (17.88)	64.3 (9.33)	91.7 (13.30)	143.7 (20.85)		
TYS, MN/m ² (ksi)	Avg	1455 (211)	1543 (224)	1765 (256)	1951 (283)		
	Min	1241 (180)	1427 (207)	1462 (212)	1393 (202)		
	Std. Deviation	131.5 (19.08)	90.9 (13.2)	177.7 (25.77)	240.9 (34.94)		
Elong, percent	Avg	6.6	17.3	20.1	8.4		
	Min	1.0	14	16	0.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		64 (14)	11 (3)	45 (11)	74 (15)		
E, GN/m ² (10 ⁶ psi)	Avg	180 (26.15)	190 (27.5)	189.6 (28.5)	202 (29.29)		
	Min	168 (24.4)	180 (26.1)	177.8 (25.8)	179.3 (26.0)		
	No. of Spec. (No. of Heats)	23 (4)	5 (1)	23 (4)	29 (4)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1602 (232)	1720 (250)	2034 (295)	1078 (301)		
	Min	1427 (207)	1710 (248)	1868 (271)	1882 (273)		
	No. of Spec. (No. of Heats)	32 (8)	7 (2)	22 (6)	27 (8)		
NTS, MN/m ² (ksi)	Avg	1404 (203.7)	1430 (207)	1503 (218)	1342 (194.7)		
	Min	1034 (150)	1269 (184)	1255 (182)	931 (135)		
	No. of Spec. (No. of Heats)	23 (5)	5 (1)	26 (3)	23 (3)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1673 (242.71)	1835 (266)	2269.7 (328.2)	2299 (333.46)		
	Min	1496 (217)	1827 (265)	2130.5 (309)	2048 (297)		
	Std. Deviation	153.5 (22.27)	10.8 (1.57)	80.8 (11.72)	100.6 (14.59)		
TYS, MN/m ² (ksi)	Avg	1383 (200.58)	1318 (191)	1700 (246.63)	2003 (290.56)		
	Min	1165 (169)	1207 (175)	1510 (219)	1560 (232)		
	Std. Deviation	191 (27.69)	70.3 (10.2)	169.7 (24.62)	172.6 (250.4)		
Elong, percent	Avg	7.0	11.9	16.2	6.0		
	Min	5.0	11.0	12.0	1.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		38 (10)	7 (2)	27 (6)	39 (9)		
E, GN/m ² (10 ⁶ psi)	Avg	205.6 (29.82)	204 (29.5)	217 (31.52)	224 (32.48)		
	Min	180.6 (26.2)	193 (28.0)	190 (27.6)	196 (28.4)		
	No. of Spec. (No. of Heats)	17 (2)	5 (1)	17 (2)	17 (2)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1492 (216)	1541 (224)	1728 (251)	1549 (225)		
	Min	1324 (192)	1420 (206)	1462 (212)	1393 (202)		
	No. of Spec. (No. of Heats)	17 (6)	8 (2)	16 (5)	16 (4)		
NTS, MN/m ² (ksi)	Avg	1067 (154.75)	1001 (145)	948 (137.5)	896 (130)		
	Min	744.6 (108)	924 (134)	758.4 (110)	669 (97)		
	No. of Spec. (No. of Heats)	20 (2)	5 (1)	20 (2)	20 (2)		

References: 39077, 40953, 48652, 49088, 54986, 57635, 59767, 59901, 61918, 70906, 73890

TABLE 8.1.1-ME4

Alloy Designation: Type 301 Stainless Steel

Specification: MIL-S-5059

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Extra hard (XH) cold rolled (60 percent or more reduction)

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	717 (104)	724 (105)	945 (137)	738 (107)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
Ratio S_N /TUS at 10^5 cycles	0.47	0.42	0.43	0.33		
S_N at 10^6 cycles, MN/m ² (ksi)	496 (72)	448 (65)	793 (115)	669 (97)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.33	0.26	0.36	0.30		
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						
Fatigue, Flexural Loading, Notched Specimens						
S_N at 10^5 cycles, MN/m ² (ksi)	386 (56)	469 (68)	455 (66)	345 (50)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
S_N at 10^6 cycles, MN/m ² (ksi)	172 (25)	214 (31)	303 (44)			
Loading frequency Hz						
with $R = -1$ and $K_t = 3.1$						
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)	1 (1)		
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 49048

TABLE 8.1.1-ME4.1

Type 301
Sheet-Weld Metal

Alloy Designation: Type 301 Stainless Steel (Weld Metal)

S30100

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Sheet 40% cold rolled, welded, and tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	924 (134)	1470 (214)		1940 (281)	1770 (236)	
	Min	917 (133)	1450 (211)		1890 (274)	1720 (250)	
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg	21	18		14	3	
	Min	20	17		14	0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	5 (1)		4 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 39429

TABLE 8.1.1-ME4.2

Type 301
Sheet-Weld Metal

Alloy Designation: Type 301 Stainless Steel (Weld Metal)

S30100

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 60% cold rolled sheet, welded and tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1104 (160.1)	1489 (215.9)		2009 (291.4)	1536 (222.8)	
	Min	1007 (146)	1427 (207)		1944 (282)	1220 (177)	
	Std. Deviation	81.4 (11.8)	46.4 (6.73)		46.7 (6.77)	161 (23.3)	
TYS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
Elong, percent	Avg	3.9	7.2		13.8	2.7	
	Min	2.5	5.0		10.0	1.0	
	Std. Deviation						
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	15 (5)	11 (3)		15 (5)	16 (5)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1121 (162.6)	1489 (215.9)		1980 (287.2)	1461 (211.9)	
	Min	1035 (150)	1448 (210)		1944 (282)	1179 (171)	
	Std. Deviation	82.7 (12.0)			27.7 (4.02)	190 (27.6)	
TYS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
Elong, percent	Avg	2.9	3.6		7.6	1.6	
	Min	2.0	2.0		4.0	1.0	
	Std. Deviation						
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	10 (4)	7 (2)		10 (4)	10 (4)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 39429, 48652

TABLE 8.1.1-ME4.3

Type 301
Sheet-Weld Metal

Alloy Designation: Type 301 Stainless Steel (Weld Metal)

S30100

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Sheet 80% cold rolled, welded, and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	917 (133)			1940 (281)	1960 (284)	
	Min	889 (129)			1920 (278)	1840 (267)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	10			4	5	
	Min	6			2	5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			4 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 39429

TABLE 8.1.1-ME4.4

Type 301
Sheet

Alloy Designation: Type 301 Stainless Steel

S30100

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Cryostretched to 932 MN/m² (135 ksi) at 77 K (-320 F); simulated resin cure cycled 340 K (150 F) 3 hr. + 420 K (300 F) 5 hr.

Testing Temperature, K (F)		297 (75) (a)			77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1409 (204.3)			1955 (283.5)		
	Min	1372 (199.0)			1931 (280.0)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1199 (173.9)			1351 (195.9)		
	Min	1165 (169.0)			1310 (190.0)		
Std. Deviation							
Elong, percent	Avg	13.6			23.4		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	144 (20.9)			168 (24.4)		
	Min	132 (19.1)			138 (20.0)		
No. of Spec. (No. of Heats)		3 (1)			12 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 87612

(a) Specimens subjected to simulated sizing load to 1442 MN/m² (209.2 ksi) at 77 K (-320 F) prior to room temperature tests.

TABLE 8.1.1-ME5

Alloy Designation: Type 301 Stainless Steel

Specification: MIL-S-5059C

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 1/4 Hard cold rolled

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg	1055 (153)		1986 (288)	1862 (270)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	676 (98)		738 (107)	827 (120)	
	Min					
Std. Deviation						
Elong, percent	Avg	50.5		29.5	20.0	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg	889 (129)		889 (129)	889 (129)	
K _t = 19+	Min					
No. of Spec. (No. of Heats)	3 (1)		3 (1)	3 (1)		
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg	1020 (148)		1937 (281)	1730 (251)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	717 (104)		786 (114)	1041 (151)	
	Min					
Std. Deviation						
Elong, percent	Avg	42.8		31.3	17.0	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg	917 (133)		903 (131)	793 (115)	
K _t = 19+	Min					
No. of Spec. (No. of Heats)	3 (1)		3 (1)	3 (1)		

References: 40953

TABLE 8.1.1-ME6

Alloy Designation: Type 301 Stainless Steel

Specification: MIL-S-5059C

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Hard cold rolled

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1296 (188)		2082 (302)	2013 (292)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1041 (151)		1214 (176)	1351 (196)		
	Min						
Std. Deviation							
Elong, percent	Avg	25.5		26.3	17.8		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg	1324 (192)		1386 (201)	1289 (187)		
K _t = 19	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1351 (196)			2158 (313)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1048 (152)		1214 (176)	1496 (217)		
	Min						
Std. Deviation							
Elong, percent	Avg	18.5			14.0		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg	1144 (166)		1007 (146)	793 (115)		
K _t = 19	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		

References: 40953

TABLE 8.1.1-ME7

Alloy Designation: Type 301 Stainless Steel

Specification: MIL-S-5059C

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Extra hard (XH) cold rolled

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1431 (208)	1678 (243)	2210 (320)	2212 (321)	2140 (310)	
	Min	1351 (196)	1655 (240)	2041 (296)	2151 (312)	2103 (305)	
	Std. Deviation	59.9 (8.69)	16.7 (2.43)	73.1 (10.6)	42.7 (6.20)		
TYS, MN/m ² (ksi)	Avg	1267 (184)	1258 (182)	1459 (212)	1658 (240)	1934 (280)	
	Min	1138 (165)	1207 (175)	1207 (175)	1489 (216)	1882 (273)	
	Std. Deviation	75.8 (11.0)	51.7 (7.50)	147 (21.3)	132 (19.1)		
Elong, percent	Avg	11.8	27.3	23	16.8	2.3	
	Min	4	26	16	15	2	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		20 (7)	13 (5)	18 (7)	14 (5)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	172 (25.0)	172 (25.0)	166 (24.1)	178 (25.8)		
	Min	171 (24.8)	167 (24.3)	165 (23.9)	162 (23.5)		
	No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)	3 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1604 (233)	1641 (238)	1857 (269)	1700 (246)		
	Min	1510 (219)	1572 (228)	1793 (260)	1413 (205)		
	No. of Spec. (No. of Heats)	11 (4)	9 (4)	9 (4)	8 (3)		
NTS, MN/m ² (ksi)	Avg	1517 (220)		1627 (236)	1606 (233)		
	Min						
	No. of Spec. (No. of Heats)	3 (1)		3 (1)	3 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1505 (218)	1713 (248)	2125 (308)	2053 (298)		
	Min	1476 (214)	1689 (245)	1841 (267)	1717 (249)		
	Std. Deviation	29.0 (4.21)	20.8 (3.02)	146 (21.2)	166 (24.1)		
TYS, MN/m ² (ksi)	Avg	1189 (172)	1178 (171)	1416 (205)	1666 (242)		
	Min	1158 (168)	1165 (169)	1255 (182)	1489 (216)		
	Std. Deviation	28.1 (4.07)	9.4 (1.36)	153 (22.2)	145 (21.0)		
Elong, percent	Avg	9.4	23.7	20.4	4.3		
	Min	7	23	9.5	2		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		9 (4)	8 (3)	10 (4)	9 (4)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1551 (225)	1626 (236)	1644 (238)	1119 (162)		
	Min	1455 (211)	1600 (232)	1531 (222)	1069 (155)		
	No. of Spec. (No. of Heats)	6 (3)	8 (3)	6 (3)	6 (3)		
NTS, MN/m ² (ksi)	Avg	1138 (165)		1117 (162)	958 (139)		
	Min						
	No. of Spec. (No. of Heats)	3 (1)		3 (1)	3 (1)		

References: 37146, 39429, 40953, 49088, 55111, 90081

TABLE 8.1.1-ME7.1

Alloy Designation: Type 301 Stainless Steel (Weld Metal)

S30100

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Sheet 60% cold rolled, welded, and tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	957.7 (138.9)	1486 (215.5)		2006 (290.9)	1824 (264.5)	
	Min	924 (134)	1475 (214)		1965 (285)	1372 (199)	
Std. Deviation		21.9 (3.18)	6.7 (0.97)		30.2 (4.38)	216 (31.3)	
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	9.7	18.7		18.4	9.58	
	Min	8.5	16		15	3	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		13 (1)	13 (1)		13 (1)	13 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 39429

TABLE 8.1.1-ME7.2

Type 301
Sheet

Alloy Designation: Type 301 Stainless Steel

S30100

Specification:

Form: Sheet

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: Cryogenically stretched at 77 K (-320 F)

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1686 (244.5)			2138 (310.1)	1453 (355.8)	
	Min	1653 (239.8)			2123 (307.9)	2392 (346.9)	
Std Deviation							
TYS, MN/m ² (ksi)	Avg	1649 (239.1)			2113 (306.4)	2418 (350.7)	
	Min	1618 (234.6)			2085 (302.4)	2356 (341.7)	
Std Deviation							
Elong, percent	Avg	7.8			12.3	3.5	
	Min	7.0			9.0	2.8	
RA, percent	Avg	34.8			41.1	30.0	
	Min	28.9			35.9	27.4	
No. of Spec. (No. of Heats)		6 (1)			6 (1)	6 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	188 (27.2)			204 (29.6)	204 (29.6)	
	Min						
No. of Spec. (No. of Heats)		6 (1)			6 (1)	6 (1)	
Poisson's Ratio		0.32			0.28	0.37	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1662 (241.1)			2174 (315.3)	2435 (353.2)	
	Min	1624 (235.6)			2158 (313.0)	2408 (349.3)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1579 (229.0)			2077 (301.2)	2328 (337.7)	
	Min	1565 (227.0)			2051 (297.5)	2269 (329.1)	
Std. Deviation							
Elong, percent	Avg	7.1			11.6	3.3	
	Min	5.8			11.0	2.8	
RA, percent	Avg	28.1			31.1	11.0	
	Min	22.8			28.4	6.7	
No. of Spec. (No. of Heats)		6 (1)			6 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	190 (27.6)			204 (29.6)	205 (29.7)	
	Min						
No. of Spec. (No. of Heats)		6 (1)			6 (1)	5 (1)	
Poisson's Ratio		0.31			0.30	0.32	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 82916

TABLE 8.1.1-ME8

Alloy Designation: Type 301 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		166 (-160)	77 (-320)		4 (-452)
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	958 (139)		1475 (214)	1860 (270)		2030 (294)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	53		33	32		26
	Min						
RA, percent	Avg	68		61	53		47
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		(1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	662 (96.0)		1300 (188)	993 (144)		924 (134)
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		(1)		(1)	(1)		(1)
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 52856

TABLE 8.1.1-ME9

Alloy Designation: Type 301 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed

Testing Temperature, K (F)	297 (75)	133 (-220)	120 (-244)	73 (-328)	10 (-441)	
Compression, Longitudinal						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V, Testing Temp.						
Long., J(ft-lb)						
Avg	294+	(217+)	294+	(217+)	144	(106)
Min					144	(106)
No. of Spec. (No. of Heats)		(1)		(1)		(1)
Trans., J(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K_{IE} MN/m^{3/2}(ksi√in.)						
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 52856

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.1.1-ME9.1

Type 301
Plate-Weld Metal

Alloy Designation: Type 301 Stainless Steel

S30100

Specification:

Form: Plate-MIG welded, type 308 electrode

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate Welded, annealed 1366 K (2000 F) one hr, WQ, and tested as quenched

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	612 (88.7)	1082 (157.0)		1296 (188.0)		1269 (184.0)
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg	34.0	25.0		16.0		15.0
	Min						
RA, percent	Avg	58.0	41.0		21.0		19.5
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	648 (94.0)	858.4 (124.5)		941.1 (136.5)		1124 (163.0)
K _t = 6.3	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 52856

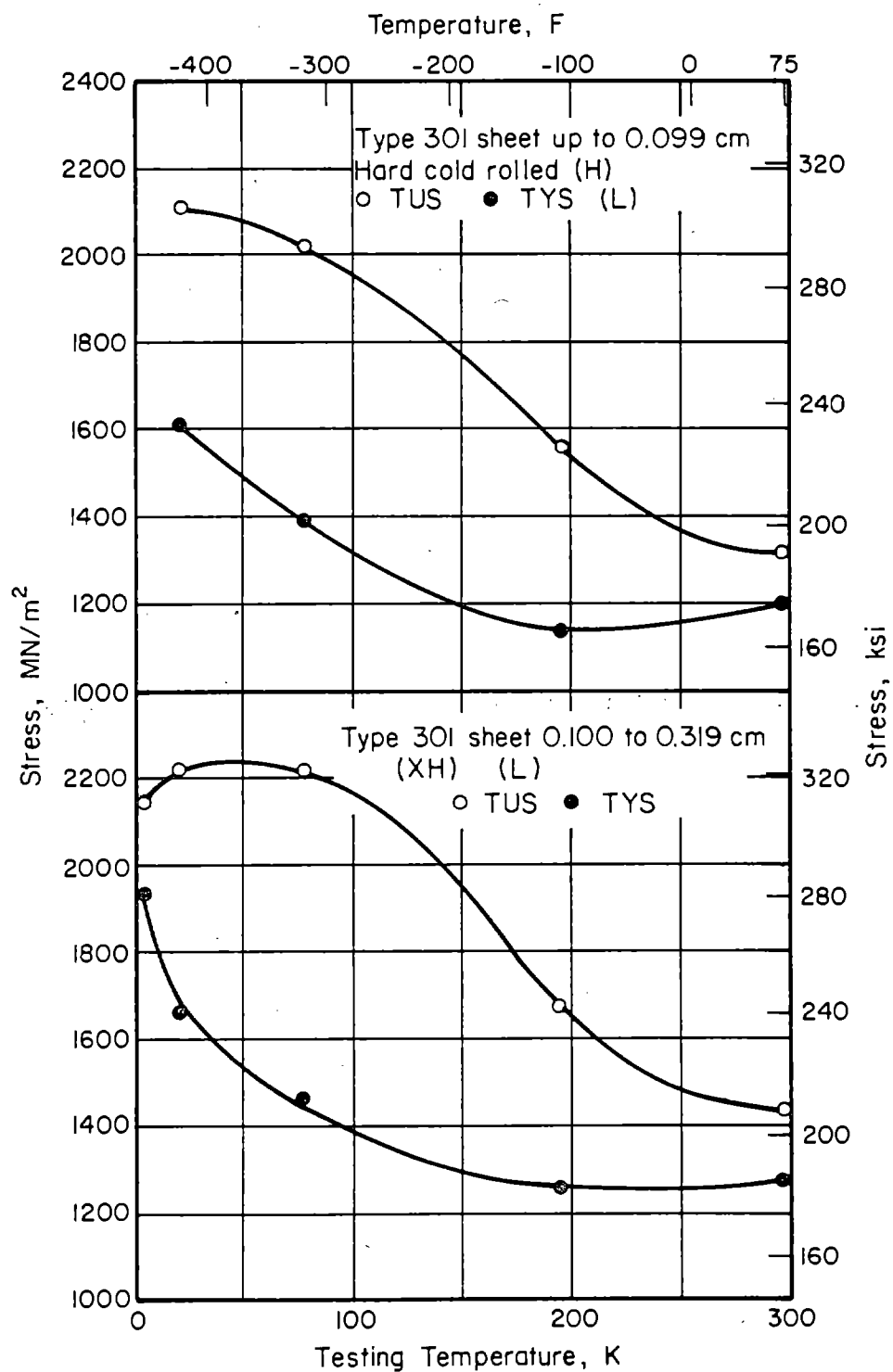


FIGURE 8.1.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 301 STAINLESS STEEL

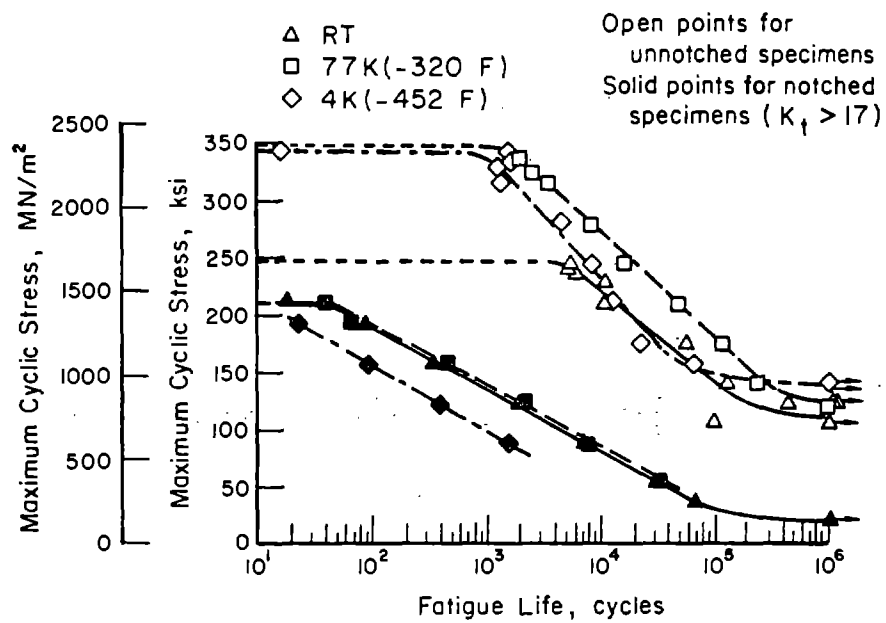


FIGURE 8.1.1-ME2. FATIGUE LIFE CURVES FOR AXIAL LOADING ON LONGITUDINAL SPECIMENS OF EXTRA HARD COLD ROLLED TYPE 301 STAINLESS STEEL SHEET 0.056 CM (0.022 IN.) THICK AT FREQUENCIES OF 3.3 AND 0.27 HERTZ AT $R = 0.14$

Reference: 70906

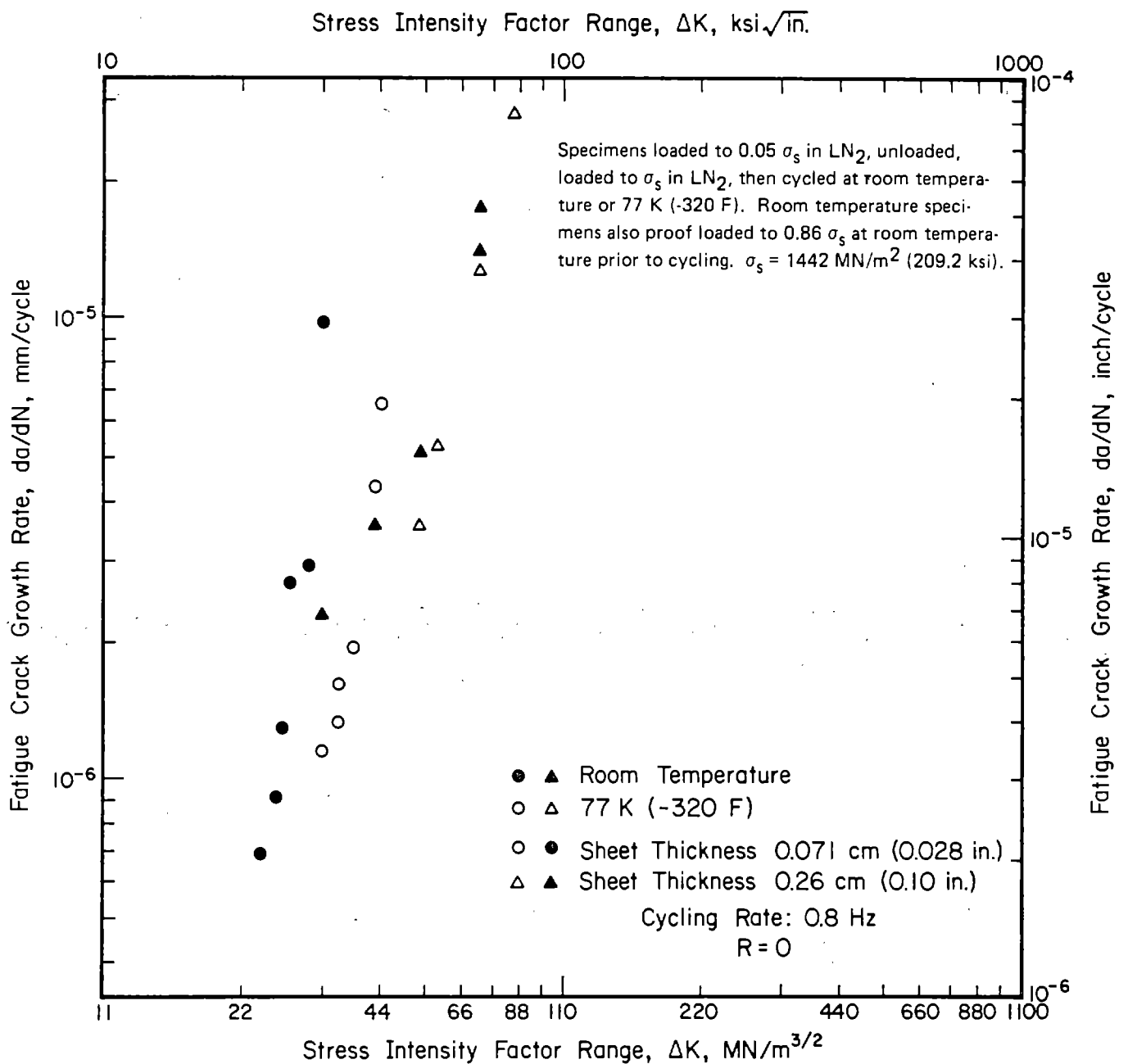


FIGURE 8.1.1-ME3. FATIGUE CRACK GROWTH RATE CURVES FOR SPECIMENS OF CRYOSTRETCHED 301 STAINLESS STEEL AT ROOM TEMPERATURE AND 77 K (-320 F) [87612]
[sheet cryostretched to 932 MN/m^2 (135 ksi) at 77 K (-320 F); simulated resin cure cycle 340 K (150 F) 3 hr + 420 K (300 F) 5 hr]

TABLE 8.1.1-TR1

Alloy Designation: Type 301 Stainless Steel

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
<u>Thermal Conductivity</u> Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec References:						
<u>Thermal Expansion (T₂₇₃ to T)</u> <u>Longitudinal</u> Percent No. of Spec. References: 48571, 90208	0 2	-0.211 2	-0.230 1	-0.232 1		
<u>Specific Heat</u> Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec References:						
<u>Electrical Resistivity</u> Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

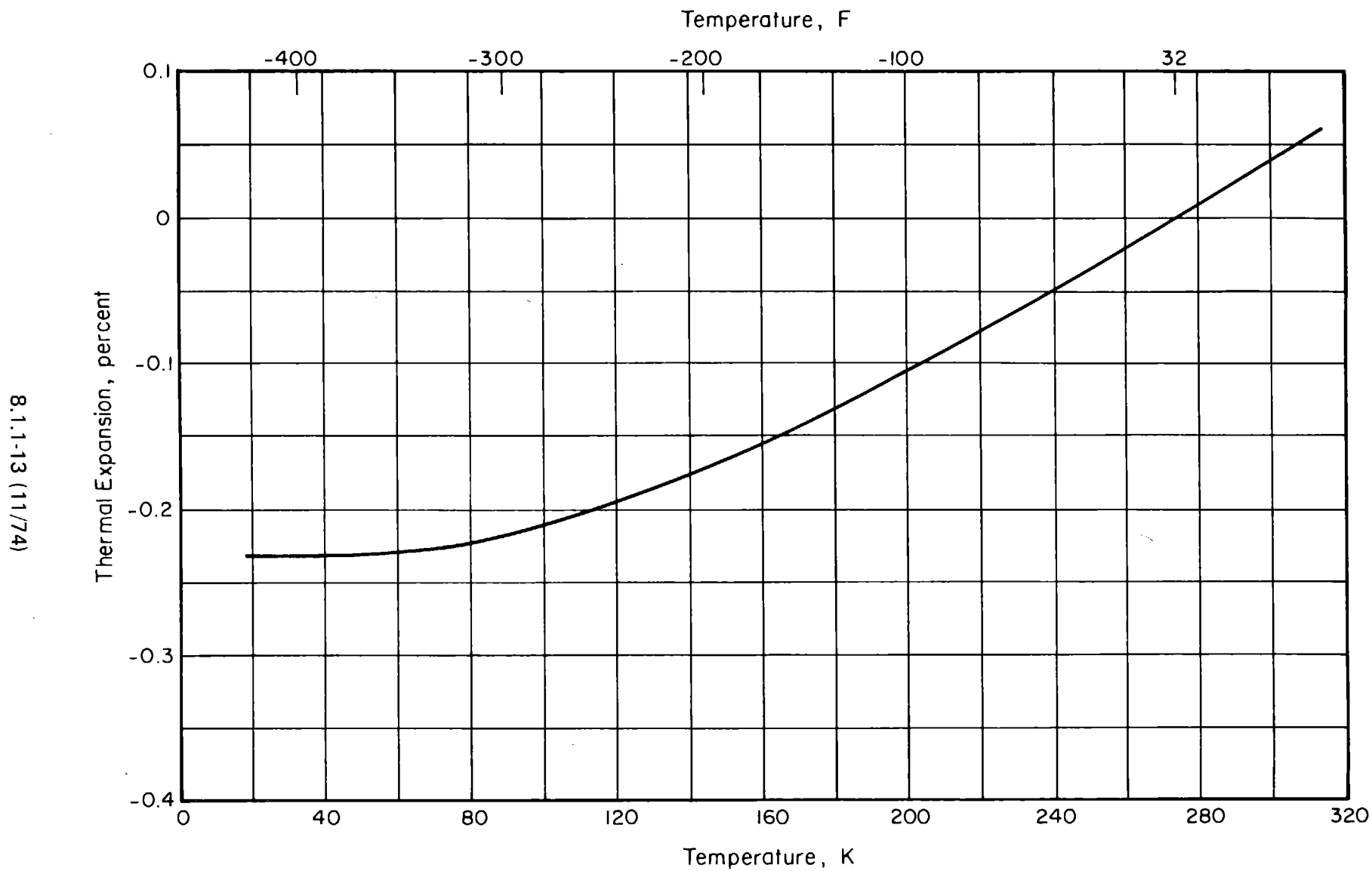


FIGURE 8.1.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR
TYPE 301 STAINLESS STEEL

TABLE 8.1.2-ME1

Alloy Designation: Type 304 Stainless Steel

Specification: AMS-5513, MIL-S-5059C

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Hard cold rolled

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1320 (191)	1469 (213)	1904 (276)	2015 (292)		
	Min	1310 (190)	1455 (211)	1882 (273)	1910 (277)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1193 (173)	1296 (188)	1434 (208)	1558 (226)		
	Min	1172 (170)	1248 (181)	1358 (197)	1462 (212)		
Std. Deviation							
Elong, percent	Avg	2.7	9.6	28.6	1.8		
	Min	2.5	8.5	28	1.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	6 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	178 (25.9)	185 (26.9)	201 (29.1)	210 (30.5)		
	Min	174 (25.3)	182 (26.4)	198 (28.8)	204 (29.6)		
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1462 (212)	1593 (231)	1910 (277)	2158 (313)		
	Min	1420 (206)	1572 (228)	1889 (274)	2117 (307)		
K _t = 6.3							
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		
NTS, MN/m ² (ksi)	Avg	1158 (168)	1303 (189)	1620 (235)	1585 (230)		
	Min	1117 (162)	1268 (184)	1565 (227)	1524 (221)		
K _t = 19+							
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1438 (209)	1601 (232)	1868 (271)	2155 (313)		
	Min	1427 (207)	1565 (227)	1848 (268)	2130 (309)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1179 (171)	1331 (193)	1476 (214)	1558 (226)		
	Min	1165 (169)	1296 (188)	1462 (212)	1517 (220)		
Std. Deviation							
Elong, percent	Avg	4.9	7.1	22.9	1.3		
	Min	4.5	6.0	21.5	1.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	193 (28.0)	199 (28.9)	207 (30.0)	214 (31.1)		
	Min	189 (27.4)	195 (28.3)	204 (29.6)	209 (30.3)		
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1200 (174)	1400 (203)	1689 (245)	1903 (276)		
	Min	1144 (166)	1338 (194)	1668 (242)	1855 (269)		
K _t = 6.3							
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		
NTS, MN/m ² (ksi)	Avg	1124 (163)	1269 (184)	1544 (224)	1572 (228)		
	Min	1062 (154)	1220 (177)	1462 (212)	1503 (218)		
K _t = 19+							
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		

References: 56261

8.1.2-1 (11/74)

TABLE 8.1.2-ME1.1

Alloy Designation: Type 304 Stainless Steel (Weld Metal)

S30400

Specification:

Form: Sheet-TIG Welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 70% cold rolled, welded, and tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	677 (98.2)	1220 (177)		1675 (243)	1827 (265)	
	Min	653 (94.7)	1200 (174)		1653 (240)	1806 (262)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.7	2.3		2.2	2.8	
	Min	1.0	2.0		1.5	2.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	703 (102)	1240 (180)		1717 (249)	2000 (290)	
	Min	684 (100)	1230 (179)		1710 (248)	1972 (286)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	2.3	2.0		2.3	2.7	
	Min	2.0	1.5		2.0	2.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (1)	5 (1)		5 (1)	5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 56261

TABLE 8.1.2-ME2

Alloy Designation: Type 304 Stainless Steel

Specification: AMS-5513, MIL-S-5059

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)		20 (-423)		4 (-452)	
Tension, Longitudinal									
TUS, MN/m ² (ksi)	Avg	658 (95.5)		1627 (236)		1800 (261)		1703 (247)	
	Min	655 (95.0)		1620 (235)					
Std. Deviation									
TYS, MN/m ² (ksi)	Avg	293 (42.5)		379 (55.0)		427 (62.0)		569 (82.5)	
	Min	283 (41.0)		372 (54.0)		421 (61.0)		552 (80.0)	
Std. Deviation									
Elong, percent	Avg	75		41.5		31		30	
	Min	70		39		30		30	
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		4 (2)		4 (2)		4 (2)		4 (2)	
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg	720 (104)		1444 (210)		1158 (168)		1227 (178)	
$K_t = 5.2$	Min	710 (103)		1406 (204)		1089 (158)		1200 (174)	
No. of Spec. (No. of Heats)		4 (2)		4 (2)		4 (2)		4 (2)	
NTS, MN/m ² (ksi)	Avg								
$K_t =$	Min								
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
TYS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)									
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
$K_t =$	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
$K_t =$	Min								
No. of Spec. (No. of Heats)									

References: 48128

TABLE 8.1.2-ME3

Type 304
Plate

Alloy Designation: Type 304 Stainless Steel

S30400

Specification: AMS-5513, MIL-S-5059

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	592.5 (85.93)		1586 (230)	1724.6 (250.13)		
	Min	587 (85.1)			1682 (244)		
	Std. Deviation	11.4 (1.65)			17 (2.47)		
TYS, MN/m ² (ksi)	Avg	328 (47.6)		377 (54.7)	410 (59.4)		
	Min						
	Std. Deviation						
Elong, percent	Avg	64		39			
	Min						
	Std. Deviation						
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	9 (2)		1 (1)	8 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	564 (81.8)		1620 (235)	1482 (215)		
	Min	605 (87.7)					
	Std. Deviation						
TYS, MN/m ² (ksi)	Avg	318 (46.1)		401 (58.1)	364 (52.8)		
	Min						
	Std. Deviation						
Elong, percent	Avg	66.5		42			
	Min	66					
	Std. Deviation						
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	2 (1)		1 (1)	1 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 56754, 87223

TABLE 8.1.2-ME3.1

Type 304
Plate

Alloy Designation: Type 304 Stainless Steel

S30400

Specification:

Form:

Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition:

Annealed

Testing Temperature, K (F)	297 (75)				20 (-423)	
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg	490	(71.1)		972.2	(141.0)
	Min					
No. of Spec. (No. of Heats)		7	(1)		7	(1)
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K_{IE}, MN/m^{3/2}(ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 56754

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.1.2-ME3.2

Type 304
Plate

Alloy Designation: Type 304 Stainless Steel S30400

Specification:

Form: Plate
 Thickness, cm (in.): Over 5.080 (2.000)
 Condition: Annealed

Testing Temperature, K (F)	297 (75)	20 (-423)				
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg	124 (91.5)				
	Min					
No. of Spec. (No. of Heats)		1				
Trans., Nm(ft-lb)	Avg	115 (85)				
	Min					
No. of Spec. (No. of Heats)		1				
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K_{IE}, MN/m^{3/2}(ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 94205

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.1.2-ME4

Type 304
Bar

Alloy Designation: Type 304 Stainless Steel

S30400

Specification: AMS-5639A, QQ-S-763

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	640 (92.8)	1151 (167)	1338 (194)	1522 (221)	1864 (270)	1721 (250)
	Min	572 (83.0)	1041 (151)		1420 (206)	1751 (254)	1668 (242)
	Std. Deviation	52.6 (7.63)	41.3 (5.99)		91.7 (13.3)	99.3 (14.4)	
TYS, MN/m ² (ksi)	Avg	234 (33.9)	298 (43.2)		282 (40.9)	418 (60.6)	402 (58.2)
	Min	179 (26.0)	276 (40.0)		200 (29.0)	358 (52.0)	379 (55.0)
	Std. Deviation	26.7 (3.87)			49.6 (7.20)	40.9 (5.93)	15.1 (2.19)
Elong, percent	Avg	75.8	50.3	46.0	45.0	26.9	30.1
	Min	50	46		41	12	26
RA, percent	Avg	81.8	75.8	73.9	66.5	53.5	55.3
	Min	76	75		55	50	49.8
	No. of Spec. (No. of Heats)	26 (7)	9 (3)	1 (1)	22 (6)	12 (4)	8 (2)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	910 (132)	1584 (230)		1993 (289)	1741 (252)	1879 (272)
	Min	903 (131)	1579 (229)		1951 (283)	1724 (250)	1813 (263)
	No. of Spec. (No. of Heats)	8 (2)	9 (2)		7 (2)	8 (2)	4 (1)
NTS, MN/m ² (ksi)	Avg	708 (103)			1053 (153)	1117 (162)	
	Min	703 (102)			1048 (152)	1089 (158)	
	No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 39871, 45464, 48128, 64373, 90190

8.1.2-4.1 (11/75)

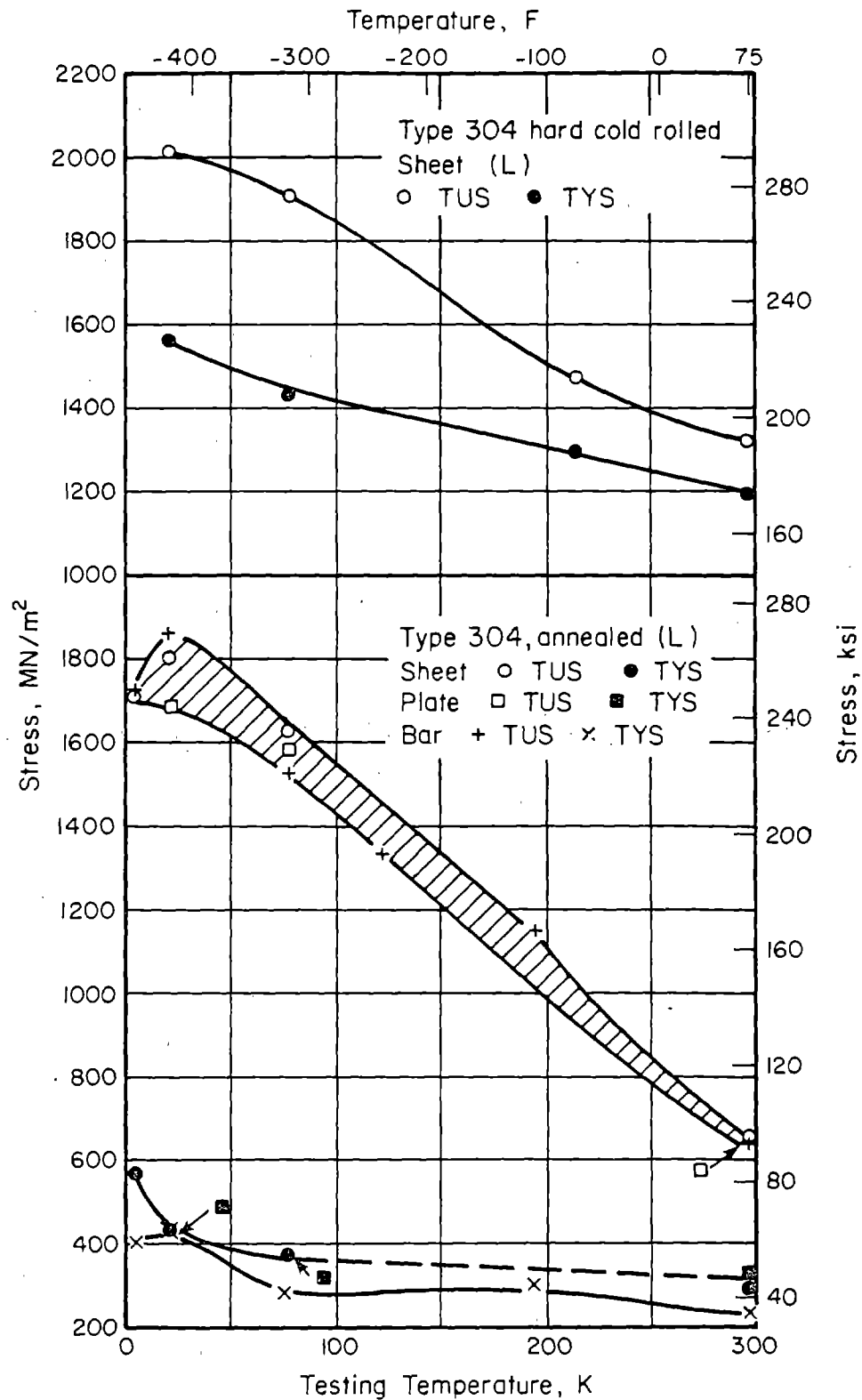


FIGURE 8.1.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 304 STAINLESS STEEL

8.1.2-5 (11/74)

TABLE 8.1.2-TR1

Type 304

Alloy Designation: Type 304 Stainless Steel

S30400

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	14.7	9.5	5.7	1.95	0.78	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(8.50)	(5.49)	(3.30)	(1.13)	(0.451)	
No. of Spec.	1	1	1	1	1	
References: 40911						
Thermal Expansion (T₂₇₃ to T)						
<u>Longitudinal</u>						
Percent	0	-0.230	-0.261	-0.264	-0.264	-0.264
No. of Spec.	2	2	2	2	2	2
References: 90208, 90336						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References: 79561						
Magnetothermal Conductivity						
	H					
	tesla,					
Watts m ⁻¹ K ⁻¹	0			2.20	0.95	0.40
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(1.27)	(0.55)	(0.23)
Watts m ⁻¹ K ⁻¹	8			2.00	0.90	0.35
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(1.16)	(0.52)	(0.20)
No. of Spec.				1	1	1
References: 95168						

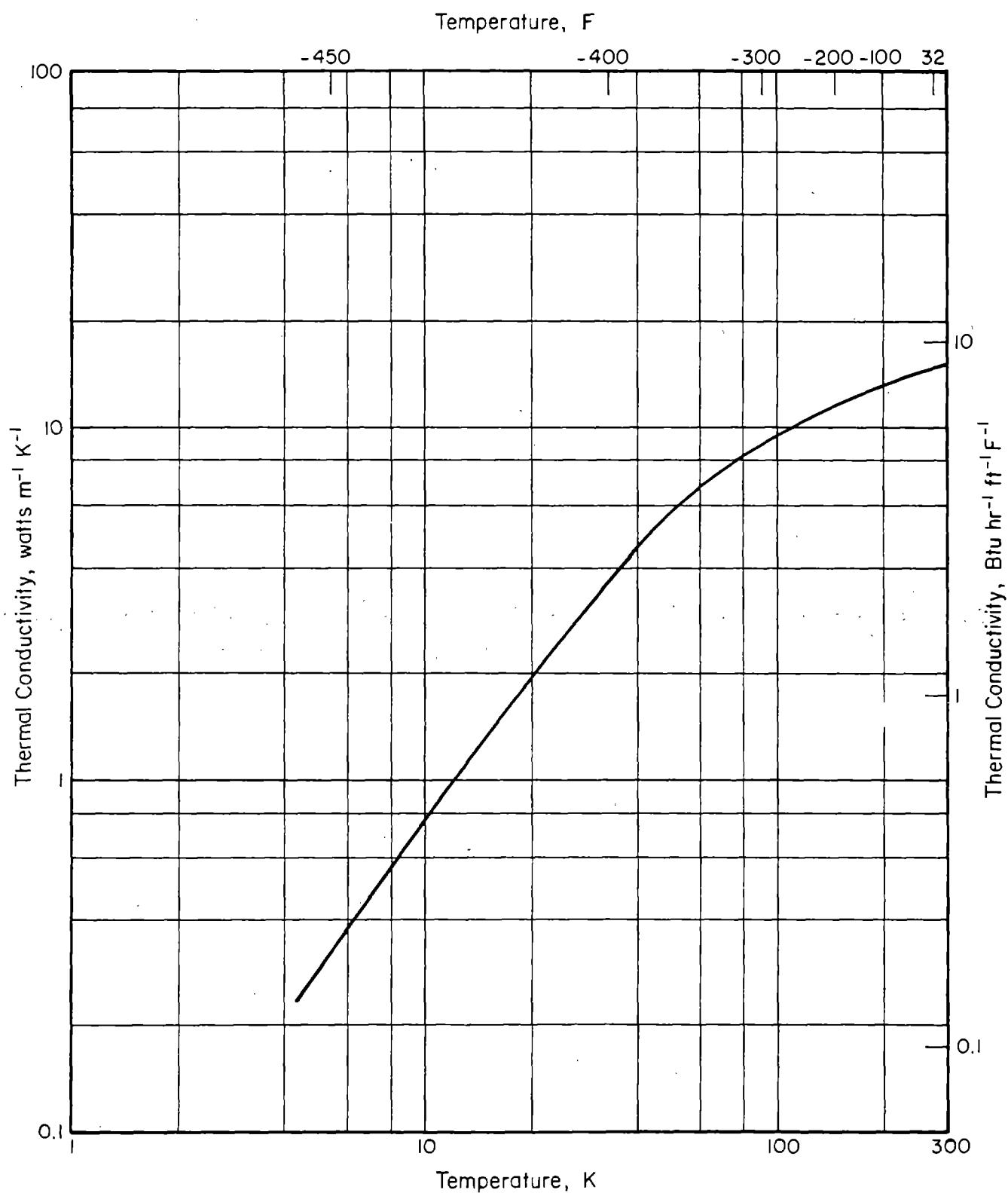


FIGURE 8.1.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE
FOR TYPE 304 STAINLESS STEEL

8.1.2-7 (11/74)

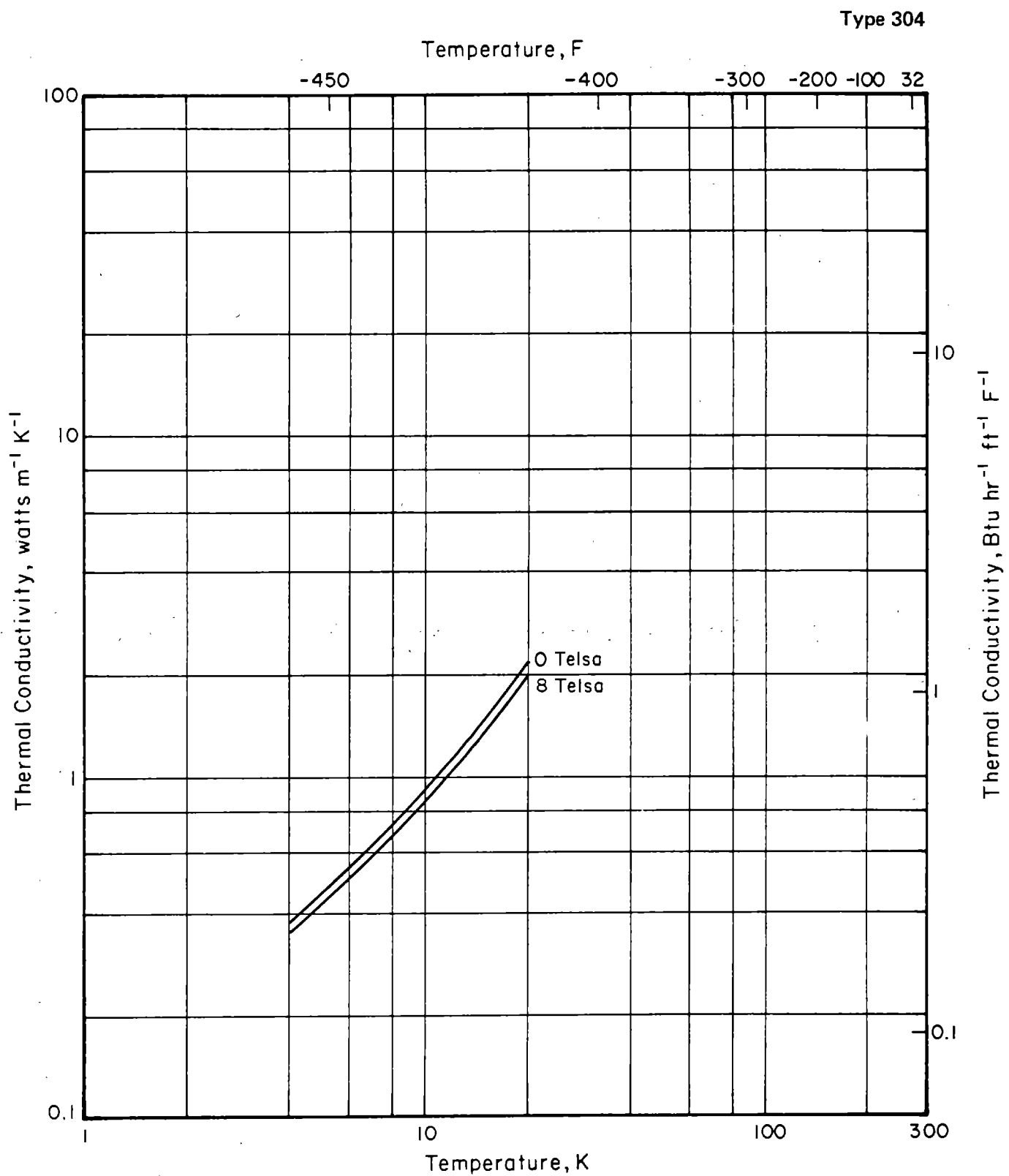


FIGURE 8.1.2-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 304 STAINLESS STEEL AT DIFFERENT MAGNETIC FIELD STRENGTHS

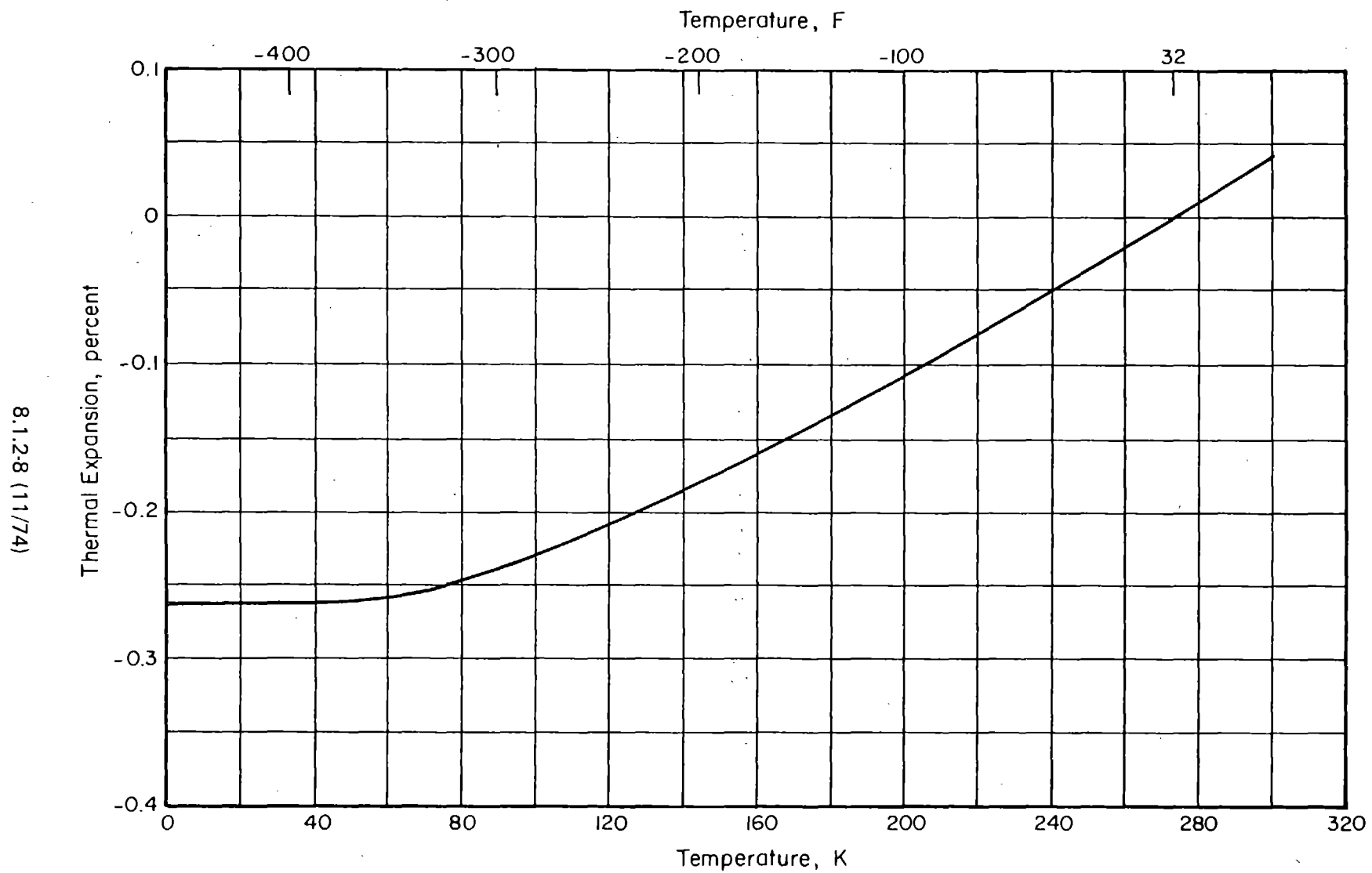


FIGURE 8.1.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR
TYPE 304 STAINLESS STEEL

TABLE 8.1.2-MA1

Type 304N
Rod

Alloy Designation: Type 304(N)* Stainless Steel

Specification:

Form: Rods

Diameter, cm (in.): 0.4 (0.157)

Condition: Annealed (heated at 1348 K (1075 C) for 0.5 hour and
water quenched)

Testing Temperature, K (F)	RT	77 (-320)	4.2 (-452)
<u>Magnetic Properties</u>			
Susceptibility, k	25.01×10^{-4}	52.17×10^{-4}	71.40×10^{-4}
Permeability, μ (H = 3 kOe)	12.60×10^{-7}	12.64×10^{-7}	12.66×10^{-7}
Permeability, μ (H = 80 kOe)	—	—	12.67×10^{-7}
References: 82534, 90087			

*High nitrogen content.

TABLE 8.1.3-ME0.1

Type 304L
Sheet

Alloy Designation: Type 304L Stainless Steel S40503

Specification:

Form: Sheet
 Thickness, cm (in.): Up to 0.099 (0.039)
 Condition: Cold rolled 50%

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg Min	1241 (180)	1379 (200)	1669 (242)	1896 (275)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg Min	1089 (158)	1234 (179)	1344 (195)	1613 (234)		
Std. Deviation							
Elong, percent	Avg Min	2.5	4.5	76.5	1.5		
RA, percent	Avg Min						
No. of Spec. (No. of Heats)		5	5	5	5		
E, GN/m ² (10 ⁶ psi)	Avg Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg Min	1372 (199)	1510 (219)	1841 (267)	2137 (310)		
K _t =							
No. of Spec. (No. of Heats)		5	5	5	5		
NTS, MN/m ² (ksi)	Avg Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg Min						
Std. Deviation							
Elong, percent	Avg Min						
RA, percent	Avg Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 94204

TABLE 8.1.3-ME0.2

Alloy Designation: Type 304L Stainless Steel (Weld Metal)

S40503

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Sheet 50% cold reduced, welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	570 (82.6)	1007 (146.0)		1502 (217.9)	1757 (254.9)	
	Min	523 (75.9)	958 (139)		1480 (215)	1710 (248)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.9	2.5		3.3	3.4	
	Min	1.5	1.5		2.0	3.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)	8 (2)		8 (2)	8 (2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	549 (79.6)	988.7 (143.4)		1487 (215.7)	1882 (272.9)	
	Min	496 (71.9)	924 (134)		1380 (200)	1800 (261)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.6	2.5		2.9	3.5	
	Min	1	2		2	2.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)	8 (2)		8 (2)	8 (2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 48652, 49088

TABLE 8.1.3-ME0.3

Type 304L
Sheet

Alloy Designation: Type 304L Stainless Steel

S40503

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 70% cold reduced

Testing Temperature, K (F)	297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg	1320 (191)		1780 (258)	2050 (298)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	1210 (176)		1630 (237)	1810 (262)	
	Min					
Std. Deviation						
Elong, percent	Avg	2.0		1.5	1.0	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	1			1	1	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg	1490 (216)		1930 (280)	2270 (329)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	1250 (182)		1700 (247)	2040 (296)	
	Min					
Std. Deviation						
Elong, percent	Avg	3.0		2.0	0.8	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	1			1	1	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 90068

TABLE 8.1.3-ME1

Alloy Designation: Type 304L Stainless Steel

S40503

Specification: AMS-5511A, MIL-S-4043

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	661 (95.9)	977 (142)	1464 (212)	1748 (254)	1589 (230)	
	Min	620 (90.0)	896 (130)	1406 (204)	1738 (252)	1538 (223)	
	Std. Deviation	27.2 (3.95)	60.4 (8.76)	34.7 (5.03)	12.2 (1.77)	43.0 (6.23)	
TYS, MN/m ² (ksi)	Avg	295 (42.8)	248 (36.0)	273 (39.6)	307 (44.5)	403 (58.5)	
	Min	262 (38.0)	200 (29.0)	200 (29.0)	200 (29.0)	317 (46.0)	
	Std. Deviation	16.6 (2.41)	43.3 (6.28)	43.6 (6.32)	65.3 (9.48)	47.1 (6.83)	
Elong, percent	Avg	55.8	42.8	36.8	33.2	29.3	
	Min	42	42	33	27	24	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		16 (4)	8 (2)	16 (4)	8 (4)	12 (4)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	734 (106)	1030 (150)	1417 (206)	1287 (187)	1460 (212)	
	Min	634 (92.0)	1027 (149)	1351 (196)	1227 (178)	1386 (201)	
	No. of Spec. (No. of Heats)	16 (4)	4 (1)	16 (4)	14 (4)	12 (3)	
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg					1536 (223)	
	Min					1400 (203)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg					410 (59.5)	
	Min					386 (56.0)	
Std. Deviation							
Elong, percent	Avg					34.8	
	Min					34	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)						5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 48128, 77930

TABLE 8.1.3-ME1.1

Type 304L
Sheet

Alloy Designation: Type 304L Stainless Steel

S40503

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 40% cold reduced

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1030	(150)		1720	(250)	1630 (236)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	793	(115)		1030	(150)	1160 (168)
	Min						
Std. Deviation							
Elong, percent	Avg	7.5			30.5		31.0
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1090	(158)		1680	(244)	1510 (219)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	924	(134)		1100	(160)	1200 (174)
	Min						
Std. Deviation							
Elong, percent	Avg	8.5			32.0		--
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90068

TABLE 8.1.3-ME2.1

Type 304L
Sheet

Alloy Designation: Type 304L Stainless Steel

S40503

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 60% reduced reduced

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1270 (184)			1790 (260)	1770 (256)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1010 (146)			1260 (183)	1520 (221)	
	Min						
Std. Deviation							
Elong, percent	Avg	5.5			28.5	5.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1300 (188)			1720 (250)	1840 (267)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1100 (160)			1390 (202)	1670 (242)	
	Min						
Std. Deviation							
Elong, percent	Avg	6.2			25.8	2.2	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
$K_t =$	Min						
No. of Spec. (No. of Heats)							

References: 90068

TABLE 8.1.3-ME1.3

Type 304L
Sheet

Alloy Designation: Type 304L Stainless Steel

S40503

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 70% cold reduced

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1330 (193)			1760 (255)	1920 (279)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	938 (136)			1430 (208)	1720 (249)	
	Min						
Std. Deviation							
Elong, percent	Avg	4.0			26.0	2.5	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1390 (202)			1850 (269)	2210 (320)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1190 (172)			1550 (225)	1840 (267)	
	Min						
Std. Deviation							
Elong, percent	Avg	4.5			23.0	1.7	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1			1	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90068

TABLE 8.1.3-ME1.4

Type 304L
Plate

Alloy Designation: Type 304L Stainless Steel S40503

Specification:

Form:

Plate

Thickness, cm (in.):

Over 5.080 (2.000)

Condition:

Annealed

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)		90.8 (67)	89.5 (66)			
Avg						
Min						
No. of Spec. (No. of Heats)		1	1			
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation. —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 94205

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.1.3-ME2

Alloy Designation: Type 304L Stainless Steel

Specification: AMS-5647B, QQ-S-763

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	659 (95.5)	1055 (153)	1509 (219)	1882 (273)	1660 (241)	
	Min	572 (83.0)	1048 (152)	1427 (207)	1882 (273)	1620 (235)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	406 (58.9)	433 (62.8)	460 (66.6)	522 (75.8)	547 (79.4)	
	Min	391 (56.7)	421 (61.1)	453 (65.7)	520 (75.4)	537 (77.9)	
Std. Deviation							
Elong, percent	Avg	78.0	69.8	42.9	42.1	33.9	
	Min	77	67.6	42.3	36.7	33.6	
RA, percent	Avg	81.2	73.9	65.9	41.2	55.6	
	Min	79	71	61	38.6	54.0	
No. of Spec. (No. of Heats)		5 (3)	4 (2)	6 (3)	4 (2)	5 (3)	
E, GN/m ² (10 ⁶ psi)	Avg	190 (27.6)		205 (29.7)		201 (29.2)	
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 48128, 54986, 89543

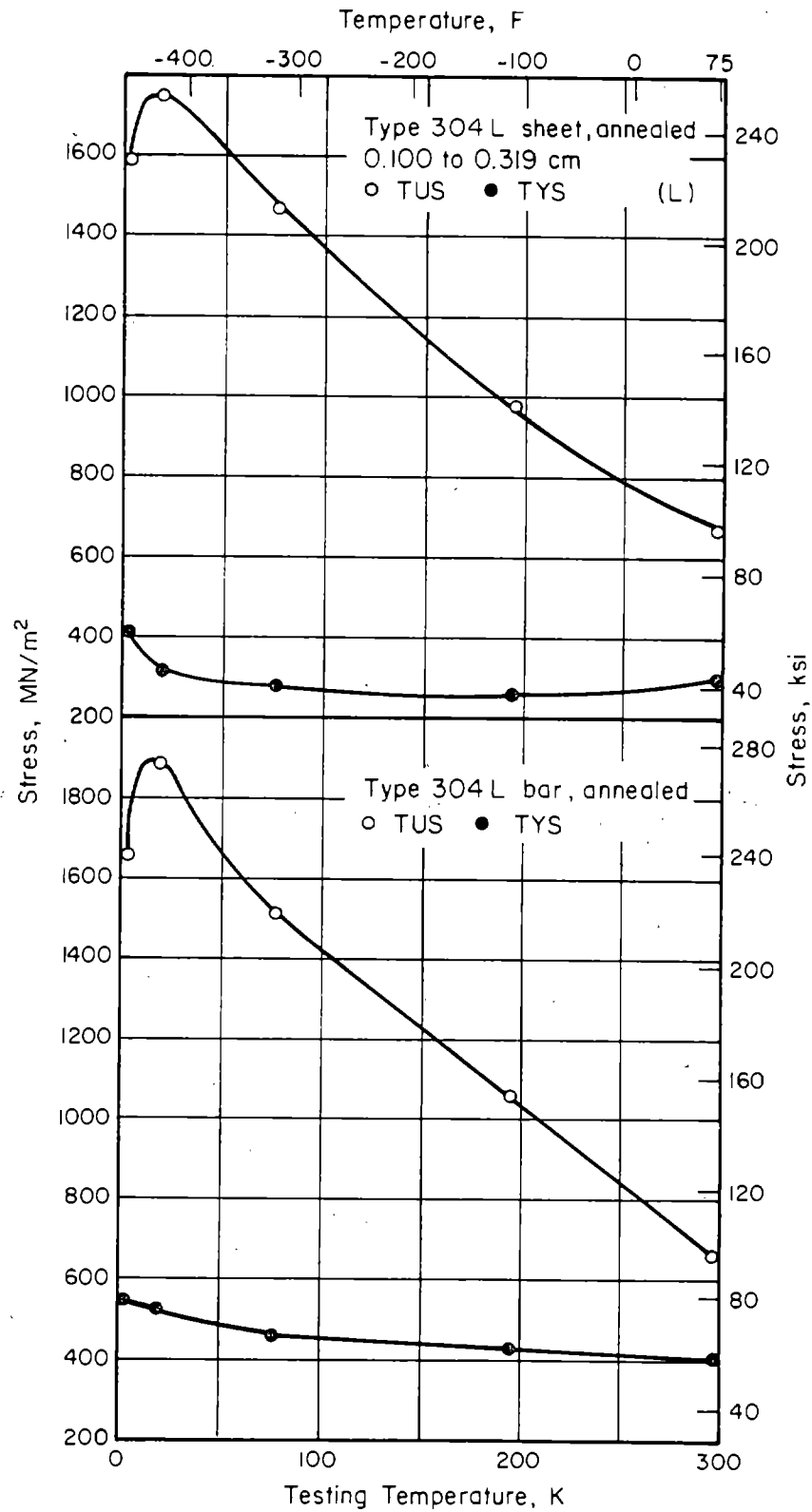


FIGURE 8.1.3-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 304L STAINLESS STEEL

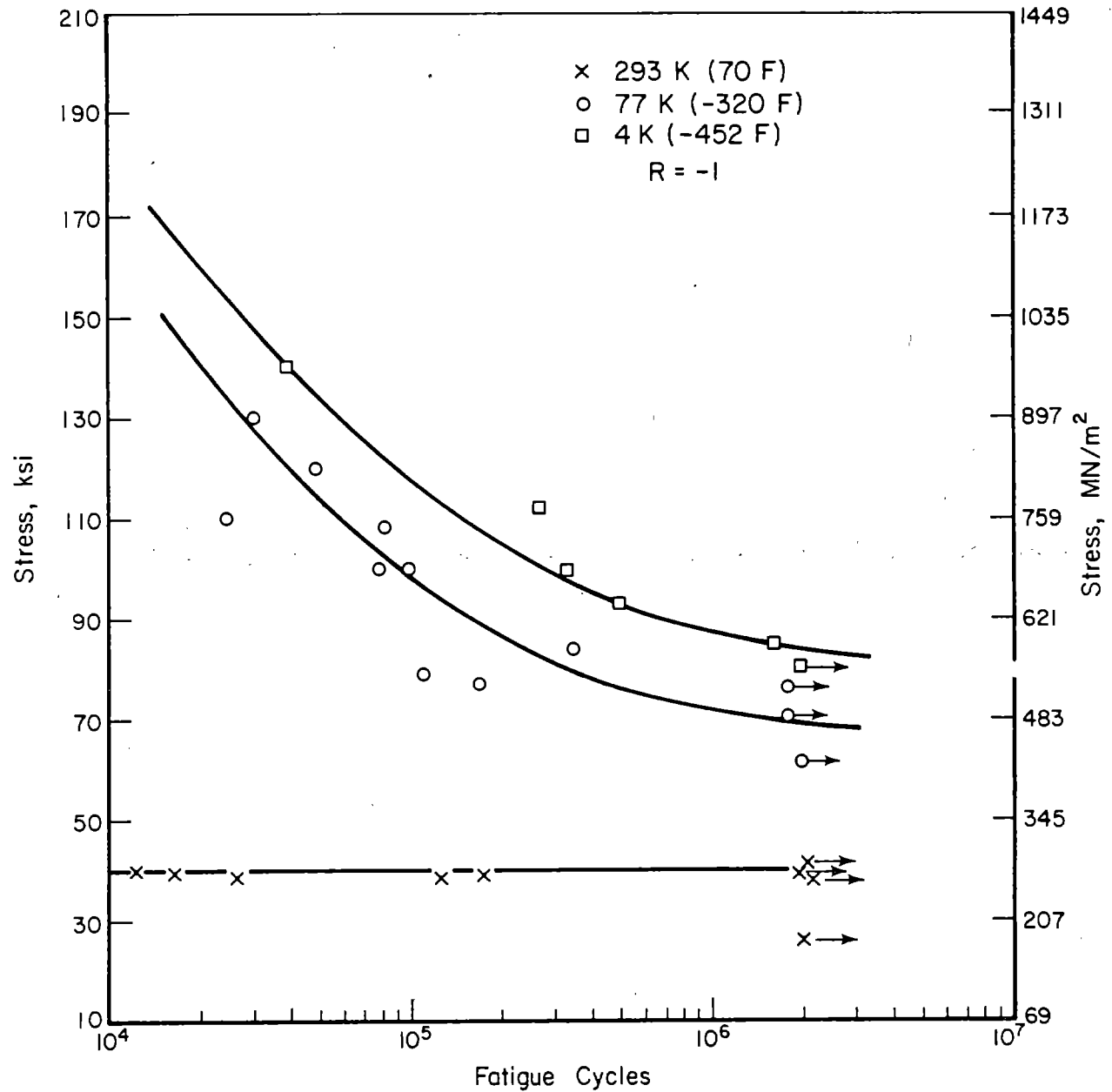


FIGURE 8.1.3-ME2. AXIAL FATIGUE LIFE CURVES FOR SMOOTH 304L STAINLESS STEEL BAR [Up to 2.540 cm (1.000 in.) diameter] [95168]

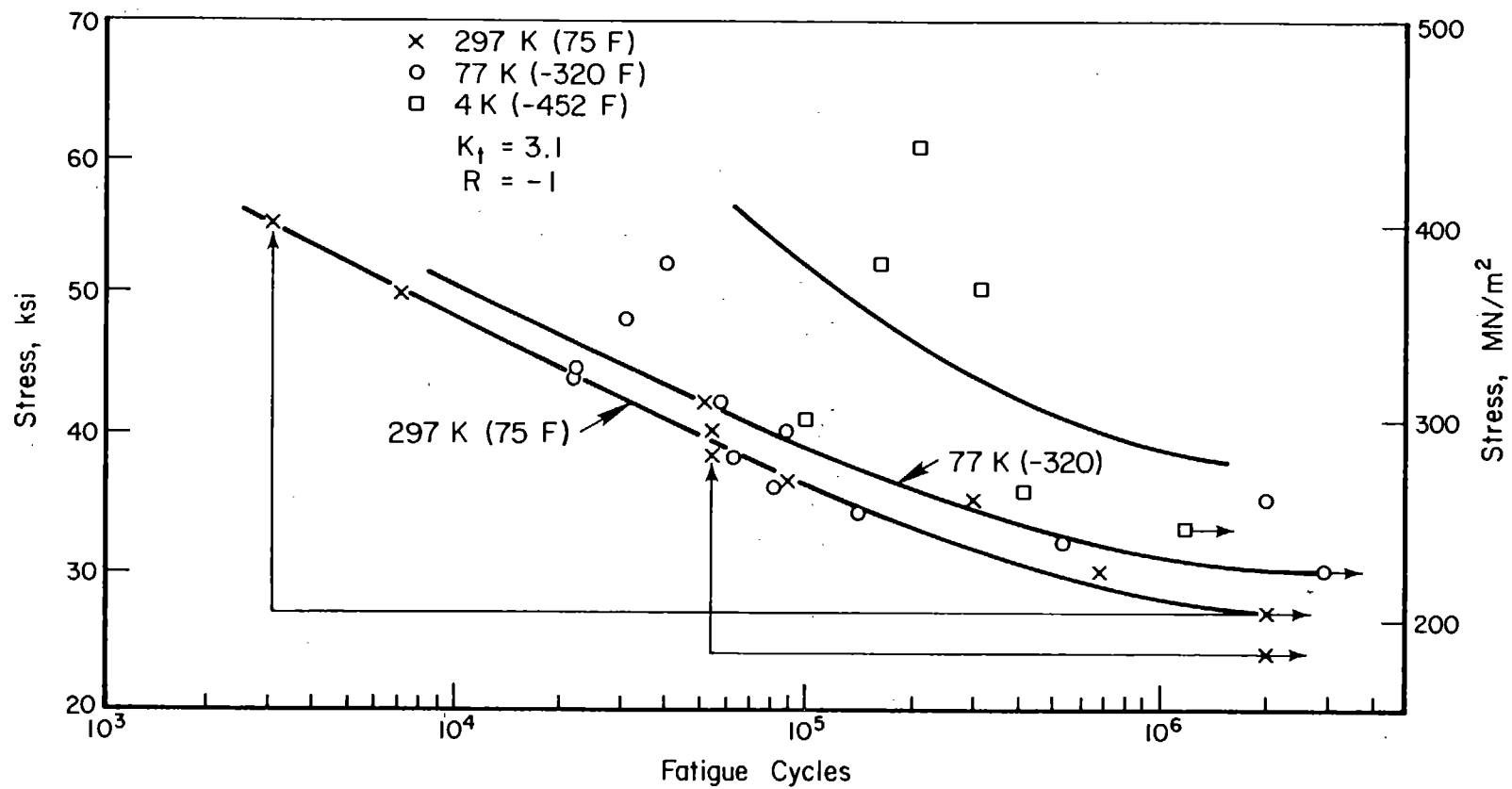


FIGURE 8.1.3-ME2.1. AXIAL FATIGUE LIFE CURVES FOR NOTCHED ANNEALED 304L STAINLESS STEEL BAR [95168]
 [Up to 2.540 cm (1.000 in.) diameter]

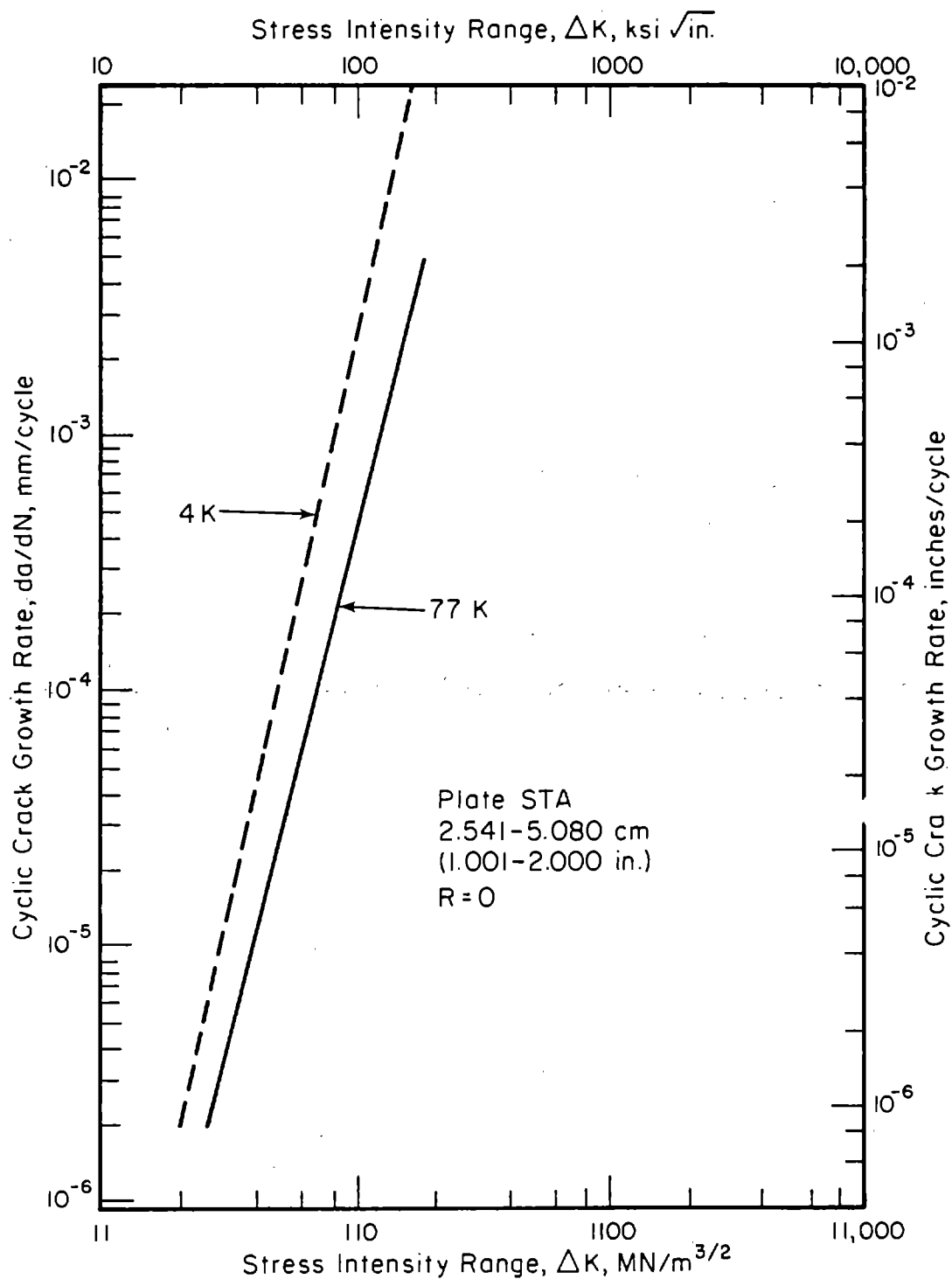


FIGURE 8.1.3-ME3. FATIGUE CRACK GROWTH RATE PROPERTIES OF 304L STAINLESS STEEL AT 77K AND 4K (-320F AND -452F)(94206A)

TABLE 8.1.3-TR1

Alloy Designation:

Type 304L Stainless Steel

S40503

Specification:

Form:

Dimension:

Condition:

Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.234	-0.268	-0.275		
No. of Spec.	1	1	1	1	1	
References: 48134						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	70.0 x 10 ⁻⁸	54.5 x 10 ⁻⁸	50.5 x 10 ⁻⁸	49.0 x 10 ⁻⁸	49.0 x 10 ⁻⁸	49.0 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(421)	(328)	(304)	(295)	(295)	(295)
No. of Spec.	1	1	1	1	1	1
References:						

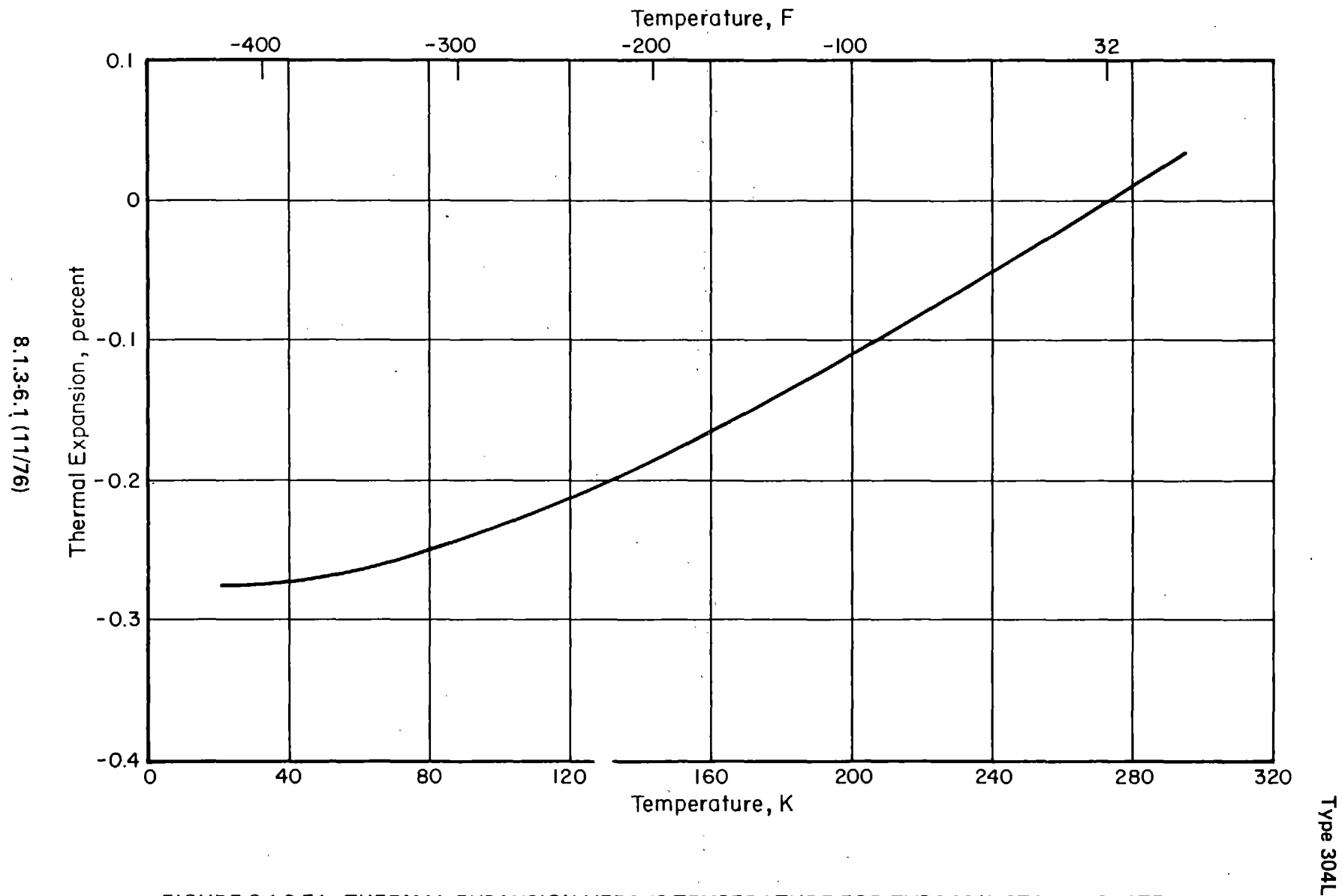


FIGURE 8.1.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 304L STAINLESS STEEL

Type 304L

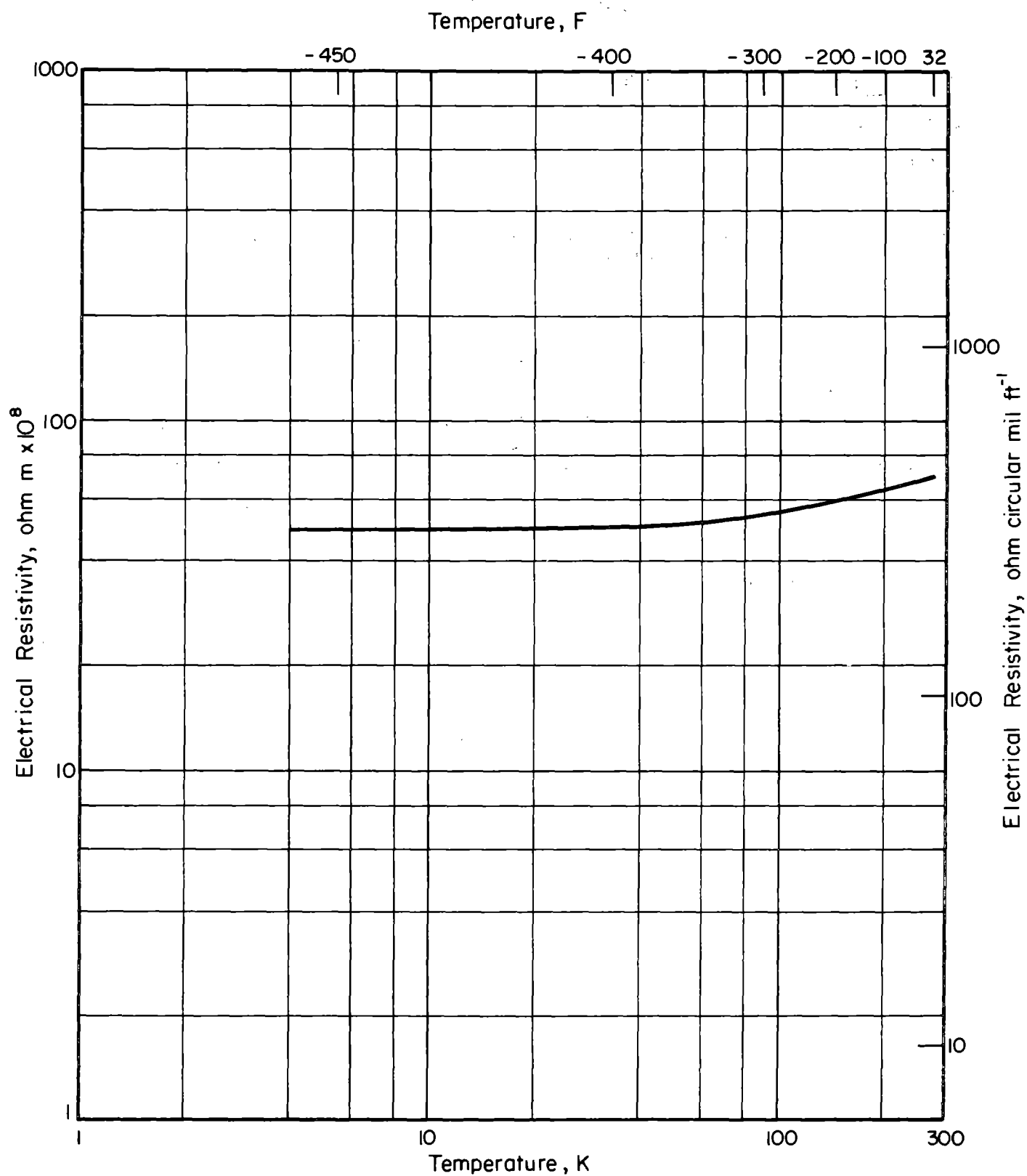


FIGURE 8.1.3-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE
FOR TYPE 304L STAINLESS STEEL

TABLE 8.1.3-MA1

Alloy Designation: Type 304L Stainless Steel S40503

Specification:

Form: Rods

Diameter, cm (in.): 0.4 (0.157)

Condition: Annealed (heated at 1348 K (1075 C) for 0.5 hour and water quenched)

Testing Temperature, K (F)	RT	77 (-320)	4.2 (-452)
<u>Magnetic Properties</u>			
Susceptibility, K	23.38×10^{-4}	61.72×10^{-4}	90.00×10^{-4}
Permeability, μ (H = 3 kOe)	12.60×10^{-7}	12.65×10^{-7}	12.68×10^{-7}
Permeability, μ (H = 80 kOe)	—	—	12.683×10^{-7}
References: 82534, 90087			

TABLE 8.1.4-ME0.1

Type 310
Sheet

Alloy Designation: Type 310 Stainless Steel

S31000

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Cold rolled 40%

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1051.5 (152.5)	1174 (170.3)	1515.5 (219.8)	1873 (271.7)		
	Min	1048 (152)	1172 (170)	1496 (217)	1806 (262)		
Std. Deviation		--	--	--	--		
TYS, MN/m ² (ksi)	Avg	949.4 (137.7)	1075.6 (156)	1248 (181)	1382 (200.5)		
	Min	944.6 (137.7)	1048 (152)	1192.8 (173)	1255 (182)		
Std. Deviation		--	--	--	--		
Elong, percent	Avg	3.5	13.3	24.0	28.5		
	Min	3.0	13.0	22.0	28.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)	4 (1)	5 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1197.6 (173.7)		1629 (236.3)	1898 (275.3)		
K _t = 6.3	Min	1151.4 (167)		1599.6 (232)	1896 (275)		
No. of Spec. (No. of Heats)		6 (1)		3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg		1237.6 (179.5)		1813.3 (263)		
	Min		1234.2 (179)		1806.4 (262)		
Std. Deviation			--		--		
TYS, MN/m ² (ksi)	Avg		1037.6 (150.5)		1503 (218)		
	Min		1027.3 (149)		(218)		
Std. Deviation			--		--		
Elong, percent	Avg		11.5		25.5		
	Min		11.0		25.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)			2 (1)		2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg				2023 (293.5)		
K _t = 6.3	Min				2006 (291)		
No. of Spec. (No. of Heats)					2 (1)		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 39429

TABLE 8.1.4-ME0.2

Alloy Designation: Type 310 Stainless Steel

S31000

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Cold rolled 60%

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1202 (174.3)		1608.5 (233.3)	1903 (276)		
	Min	1165 (169)		1606.5 (233)	1875 (272)		
Std. Deviation		--		--	--		
TYS, MN/m ² (ksi)	Avg	1055 (153)		1413 (205)	1603 (232.5)		
	Min	1048 (152)		1386 (201)	1593 (231)		
Std. Deviation							
Elong, percent	Avg	3.33		17.0	18.50		
	Min	3.00		17.00	18.00		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1243 (180.3)		1708 (247.7)	2041 (296)		
	Min	1234 (179)		1703 (247)	2034 (295)		
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg				1968 (285.5)		
	Min				1958 (284)		
Std. Deviation					--		
TYS, MN/m ² (ksi)	Avg				1562 (226.5)		
	Min				1482 (215)		
Std. Deviation					--		
Elong, percent	Avg				16.00		
	Min				16.00		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)					2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg				2123 (308)		
	Min				2103 (305)		
No. of Spec. (No. of Heats)					2 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 39429

TABLE 8.1.4-ME0.3

Type 310
Sheet

Alloy Designation: Type 310 Stainless Steel

S31000

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Cold rolled 75%

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1178.6 (170.94)	1404 (203.63)	1718.6 (249.27)	2002 (290.39)		
	Min	1220 (177)	1386 (201)	1654.7 (240)	1930.5 (280)		
	Std. Deviation	163.5 (38.22)	9.7 (1.41)	35 (5.08)	37 (5.40)		
TYS, MN/m ² (ksi)	Avg	1100.9 (159.67)	1289 (187)	1535.5 (222.7)	1786 (259)		
	Min	1048 (152)	1255 (182)	1448 (210)	1737.5 (252)		
	Std. Deviation	30.8 (4.47)	31.9 (4.63)	44.3 (6.42)	33.9 (4.92)		
Elong, percent	Avg	2.64	4.38	10.23	10.42		
	Min	2.0	2.00	8.00	1.00		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		18 (3)	8 (2)	11 (3)	18 (3)		
E, GN/m ² (10 ⁶ psi)	Avg	175 (25.4)	175.8 (25.5)	182 (26.4)	195 (28.3)		
	Min	162 (23.5)	165.5 (24.0)	175.8 (25.5)	186.8 (27.1)		
	No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)	5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1356 (196.7)	1530.6 (222)	1901 (275.7)	2230 (323.5)		
	Min	1337.6 (194)	1496 (217)	1848 (268)	2144 (311)		
	No. of Spec. (No. of Heats)	15 (3)	8 (2)	11 (2)	15 (3)		
NTS, MN/m ² (ksi)	Avg	1107 (160.6)	1270 (184.2)	1473 (213.6)	1446.5 (209.8)		
	Min	1048 (152)	1151 (167)	1317 (191)	1303 (189)		
	No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)	5 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1375 (199.36)	1544 (224.0)	1878 (272.43)	2145.6 (311.19)		
	Min	1358 (197)	1537.5 (223)	1861.6 (270)	2054.6 (298)		
	Std. Deviation	9.6 (1.39)	--	--	47.5 (6.89)		
TYS, MN/m ² (ksi)	Avg	1107 (160.6)	1291.4 (187.3)	1526 (22.13)	1796 (260.5)		
	Min	1048 (152)	1213.5 (176)	1475.5 (214)	1668.5 (242)		
	Std. Deviation	25.2 (3.64)	--	--	82.7 (11.99)		
Elong, percent	Avg	3.71	7.43	9.50	9.37		
	Min	3.00	6.50	7.50	1.00		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		14 (3)	7 (2)	7 (2)	16 (3)		
E, GN/m ² (10 ⁶ psi)	Avg	194 (28.1)	190 (27.6)	194 (28.2)	201 (29.12)		
	Min	186 (27.0)	179.3 (26.0)	187.5 (27.2)	187 (27.1)		
	No. of Spec. (No. of Heats)	4 (1)	5 (1)	5 (1)	5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1370.7 (198.8)	1639.6 (237.8)	2045 (296.6)	2196 (318.5)		
	Min	1303 (189)	1558 (226)	1993 (289)	1999.5 (290)		
	No. of Spec. (No. of Heats)	11 (3)	7 (2)	7 (2)	13 (3)		
NTS, MN/m ² (ksi)	Avg	834.3 (121)	1097.6 (159.2)	1209 (175.4)	1322 (191.8)		
	Min	799.8 (116)	1013.5 (147)	1110 (161)	1186 (172)		
	No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)	5 (1)		

References: 39429, 48652, 59901

TABLE 8.1.4-ME0.4

Alloy Designation: Type 310 Stainless Steel (Weld Metal)

S31000

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Sheet 75% cold reduced, welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	601 (87.2)	758 (110)		1120 (163)	1420 (206)	
	Min	592 (85.8)	731 (106)		1090 (158)	1380 (200)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.9	2.2		2.3	2.1	
	Min	1	2		2	1.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)	8 (2)		8 (2)	8 (2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	596 (86.5)	765 (111)		1150 (167)	1340 (195)	
	Min	571 (82.8)	752 (109)		1140 (166)	1290 (187)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	1.9	2.1		2.2	2.0	
	Min	1	2		2	1.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		8 (2)	8 (2)		8 (2)	8 (2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 48652, 49088

TABLE 8.1.4-ME0.5

Type 310
Sheet

Alloy Designation: Type 310 Stainless Steel

S31000

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 80-85% cold worked

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1310 (190)				2060 (299)	
	Min	1300 (188)				2030 (295)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1150 (167)				1740 (253)	
	Min	1140 (166)				1720 (249)	
Std. Deviation							
Elong, percent	Avg	2.3				8.1	
	Min	2.0				6.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)				6 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1370 (198)				2170 (315)	
	Min	1330 (193)				2090 (303)	
K _t = 6.3							
No. of Spec. (No. of Heats)		4 (1)				6 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 49971

TABLE 8.1.4-ME0.6

Type 310
Sheet

Alloy Designation: Type 310 Stainless Steel

S31000

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 90-92% Cold worked

Testing Temperature, K (F)		297 (75)				20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1370 (199)				2140 (310)	
	Min	1360 (198)				2120 (307)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1170 (170)				1840 (267)	
	Min	1150 (167)				1810 (262)	
Std. Deviation							
Elong, percent	Avg	1.3				4.9	
	Min	1.0				4.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (1)				7 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1360 (197)				2040 (296)	
	Min	1320 (191)				1800 (261)	
K _t = 6.3							
No. of Spec. (No. of Heats)		6 (1)				7 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 49971

TABLE 8.1.4-ME1

Alloy Designation: Type 310 Stainless Steel

Specification: QQ-S-766, AMS-5521B

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)		20 (-423)		4 (-452)	
Tension, Longitudinal									
TUS, MN/m ² (ksi)	Avg	572 (83.0)		1073 (156)		1299 (188)		1229 (178)	
	Min	552 (80.0)		1014 (147)		1262 (183)		1138 (165)	
Std Deviation									
TYS, MN/m ² (ksi)	Avg	242 (35.0)		545 (79.1)		715 (104)		770 (112)	
	Min	228 (33.0)		517 (75.0)		690 (100)		738 (107)	
Std. Deviation									
Elong, percent	Avg	49.7		68.1		56.1		58.5	
	Min	46		49		49		54	
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		7 (2)		7 (2)		7 (2)		3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg	647 (93.9)		1068 (155)		1255 (182)			
K _t = 6.3	Min								
No. of Spec. (No. of Heats)		(1)		(1)		(1)			
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m ² (ksi)	Avg	598 (86.8)		1138 (165)		1358 (197)		1282 (186)	
	Min							1262 (183)	
Std. Deviation									
TYS, MN/m ² (ksi)	Avg	240 (34.8)		619 (89.8)		807 (117)		797 (116)	
	Min							772 (112)	
Std. Deviation									
Elong, percent	Avg	46		71		44		58	
	Min							56	
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		(1)		(1)		(1)		3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg	632 (91.6)		1041 (151)		1234 (179)			
K _t = 6.3	Min								
No. of Spec. (No. of Heats)		(1)		(1)		(1)		(1)	
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									

References: 67747, 83417

TABLE 8.1.4-ME2

Alloy Designation: Type 310 Stainless Steel

Specification: QQ-S-766, AMS-5521 B

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)
Fatigue, Flexural Loading, Surface Finish 64 rms			
S_N at 10^5 cycles, MN/m ² (ksi)	193 (28)	490 (71)	641 (93)
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^5 cycles	0.35	0.46	0.51
S_N at 10^6 cycles, MN/m ² (ksi)	186 (27)	455 (66)	579 (84)
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^6 cycles	0.34	0.43	0.46
S_N at 10^7 cycles, MN/m ² (ksi)	179 (26)	441 (64)	
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^7 cycles	0.33	0.42	
Fatigue, Flexural Loading, Surface Finish 11 rms			
S_N at 10^5 cycles, MN/m ² (ksi)	228 (33)	524 (76)	696 (101)
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^5 cycles	0.40	0.48	0.54
S_N at 10^6 cycles, MN/m ² (ksi)	213 (31)	490 (71)	662 (96)
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^6 cycles	0.37	0.45	0.51
S_N at 10^7 cycles, MN/m ² (ksi)	207 (30)	455 (66)	
Loading frequency Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	
Ratio S_N/TUS at 10^7 cycles	0.36	0.42	

References: 83417

TABLE 8.1.4-ME2.1

Type 310
Sheet

Alloy Designation: Type 310 Stainless Steel

S31000

Specification: AMS 5521B

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Cold rolled 3/4 hard

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1127 (163.5)	1267 (183.8)		1619 (234.8)	1686 (244.5)	
	Min	1124 (163.0)	1258 (182.5)		1603 (232.5)	1669 (242.0)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1027 (149.0)	1140 (165.4)		1444 (209.5)	1551 (225.0)	
	Min	979.1 (142.0)	1111 (161.2)		1434 (208.0)	1517 (220.0)	
Std. Deviation							
Elong, percent	Avg	3.2	7.2		12.8	2.0	
	Min	2.5	7.0		12.5	2.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg	211 (30.6)	217 (31.5)		223 (32.4)	230 (33.4)	
	Min	211 (30.6)	216 (31.3)		219 (31.8)	230 (33.3)	
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
Poisson's Ratio		0.29	0.30		0.20	0.20	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1226 (177.8)	1356 (196.6)		1636 (237.3)	1775 (257.5)	
	Min	1214 (176.1)	1342 (194.7)		1627 (236.0)	1772 (257.0)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1000 (145.1)	1059 (153.6)		1384 (200.8)	1595 (231.3)	
	Min	987.3 (143.2)	999.7 (145.0)		1379 (200.0)	1575 (228.5)	
Std. Deviation							
Elong, percent	Avg	3.8	6.5		9.1	2.5	
	Min	2.1	4.0		6.5	2.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg	210 (30.5)	214 (31.0)		222 (32.3)	215 (31.2)	
	Min	210 (30.4)	214 (31.0)		221 (32.1)	214 (31.0)	
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)	2 (1)	
Poisson's Ratio		0.30	0.30		0.30	0.30	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 61688

TABLE 8.1.4-ME2.2

Alloy Designation: Type 310 Stainless Steel (Weld Metal)

S31000

Specification: AMS 5521B

Form: Sheet-TIG welded, 310 stainless-steel filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Cold rolled to 3/4 hard, welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	530 (76.8)	722.6 (104.8)		1026 (148.8)		
	Min	514 (74.6)	713.6 (103.5)		1017 (147.5)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	380 (55.1)	523 (75.9)		751.5 (109.0)		
	Min	362 (52.5)	517 (75.0)		751.5 (109.0)		
Std. Deviation							
Elong, percent	Avg	4.3	3.8		4.0		
	Min	4.0	3.5		4.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	181 (26.2)	187 (27.1)		199 (28.8)		
	Min	179 (26.0)	184 (26.7)		194 (28.1)		
No. of Spec. (No. of Heats)		2 (1)	2 (1)		2 (1)		
Poisson's Ratio		0.32	0.33		0.29		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 61688

TABLE 8.1.4-ME3

Alloy Designation: Type 310 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed

Testing Temperature, K (F)		297	(75)		170	(-154)	77	(-320)	20	(-423)	4	(-452)
Tension, Longitudinal												
TUS, MN/m ² (ksi)	Avg	569	(82.5)		793	(115)	1096	(159)			1303	(189)
	Min											
Std. Deviation												
TYS, MN/m ² (ksi)	Avg											
	Min											
Std. Deviation												
Elong, percent	Avg	60			79		80				63	
	Min											
RA, percent	Avg	78.5			75.5		69.5				55.0	
	Min											
No. of Spec. (No. of Heats)		(1)			(1)		(1)		(1)		(1)	
E, GN/m ² (10 ⁶ psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m ² (ksi)	Avg	752	(109)		1014	(147)	1365	(198)			1654	(240)
	Min											
K _t = 6.3												
No. of Spec. (No. of Heats)		(1)			(1)		(1)				(1)	
NTS, MN/m ² (ksi)	Avg											
	Min											
K _t =												
No. of Spec. (No. of Heats)												
Tension, Transverse												
TUS, MN/m ² (ksi)	Avg											
	Min											
Std. Deviation												
TYS, MN/m ² (ksi)	Avg											
	Min											
Std. Deviation												
Elong, percent	Avg											
	Min											
RA, percent	Avg											
	Min											
No. of Spec. (No. of Heats)												
E, GN/m ² (10 ⁶ psi)	Avg											
	Min											
No. of Spec. (No. of Heats)												
Poisson's Ratio												
Work Hardening Coef												
NTS, MN/m ² (ksi)	Avg											
	Min											
K _t =												
No. of Spec. (No. of Heats)												
NTS, MN/m ² (ksi)	Avg											
	Min											
K _t =												
No. of Spec. (No. of Heats)												

References: 52856

TABLE 8.1.4-ME3.1

Alloy Designation: Type 310 Stainless Steel (Weld Metal)

S31000

Specification:

Form: Plate-MIG welded, type 310-covered electrode

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate welded, weldment annealed 1422 K (2100 F) 1 hr, WQ, tested as quenched

Testing Temperature, K (F)		297 (75)	168 (-156)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	664 (81.8)	810.1 (117.5)		1095 (158.8)		1271 (184.4)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	62.0	66.0		61.0		50.0
	Min						
RA, percent	Avg	78.0	75.0		52.0		47.0
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	755.0 (109.5)	996.3 (144.5)		1303 (189.0)		1641 (238.0)
K _t = 6.3	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 52856

TABLE 8.1.4-ME3.2

Alloy Designation: Type 310 Stainless Steel S31000

Specification:

Form: Plate
 Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
 Condition: Annealed

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	545 (79)	1055 (153)	1179 (171)			
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg	241 (35)	545 (79)	765 (111)			
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2	2	1			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 94206B

TABLE 8.1.4-ME3.3

Type 310
Plate

Alloy Designation: Type 310 Stainless Steel S31000

Specification:

Form: Plate
 Thickness, cm (in.): Over 5.080 (2.000)
 Condition: Annealed

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg	122 (90)	117 (86.5)			
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg	118 (87)	115 (85)			
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 94205

- (a) Indicate specimen design and orientation for shear specimens:
 (b) Indicate specimen design for K_{IC} data:

TABLE 8.1.4-ME4

Type 310
Bar

Alloy Designation: Type 310 Stainless Steel

S31000

Specification:

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	585 (84.8)	738 (107)	1091 (158)	1390 (201.6)	1303 (189)	
	Min	542 (78.6)	738 (107)	1082 (157)	1248 (181)	1289 (187)	
	Std. Deviation	23 (3.35)			103.4 (15.0)		
TYS, MN/m ² (ksi)	Avg	338 (49.07)	303 (43.9)	520 (75.5)	851.5 (123.5)	717 (104)	
	Min	217 (31.5)	300 (43.5)	512 (74.3)	685 (99.3)	703 (102)	
	Std. Deviation	112.6 (16.33)			138 (20.02)		
Elong, percent	Avg	49.7	71.5	67.7	44.0	49.8	
	Min	42.0	69.8	66.6	41.9		
RA, percent	Avg	75.6	68.0	49.6	48.5	41.0	
	Min	70.2	67.7	46.2	34.1		
No. of Spec. (No. of Heats)		9 (3)	2 (1)	3 (2)	8 (2)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg			206 (29.9)		206 (29.9)	
	Min						
No. of Spec. (No. of Heats)				3 (1)		3 (1)	
Poisson's Ratio		0.287		0.303		0.296	
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	779 (113)	986 (143)	1441 (209)	1772 (257)	1786 (259)	
	Min						
	K _t = 3						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)	2 (1)	
NTS, MN/m ² (ksi)	Avg	775 (112.4)			1300 (188.6)		
	Min	758 (110.0)			1089 (158.0)		
	K _t = 6.4						
No. of Spec. (No. of Heats)		5 (1)			5 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							

References: 54986, 64373, 89543

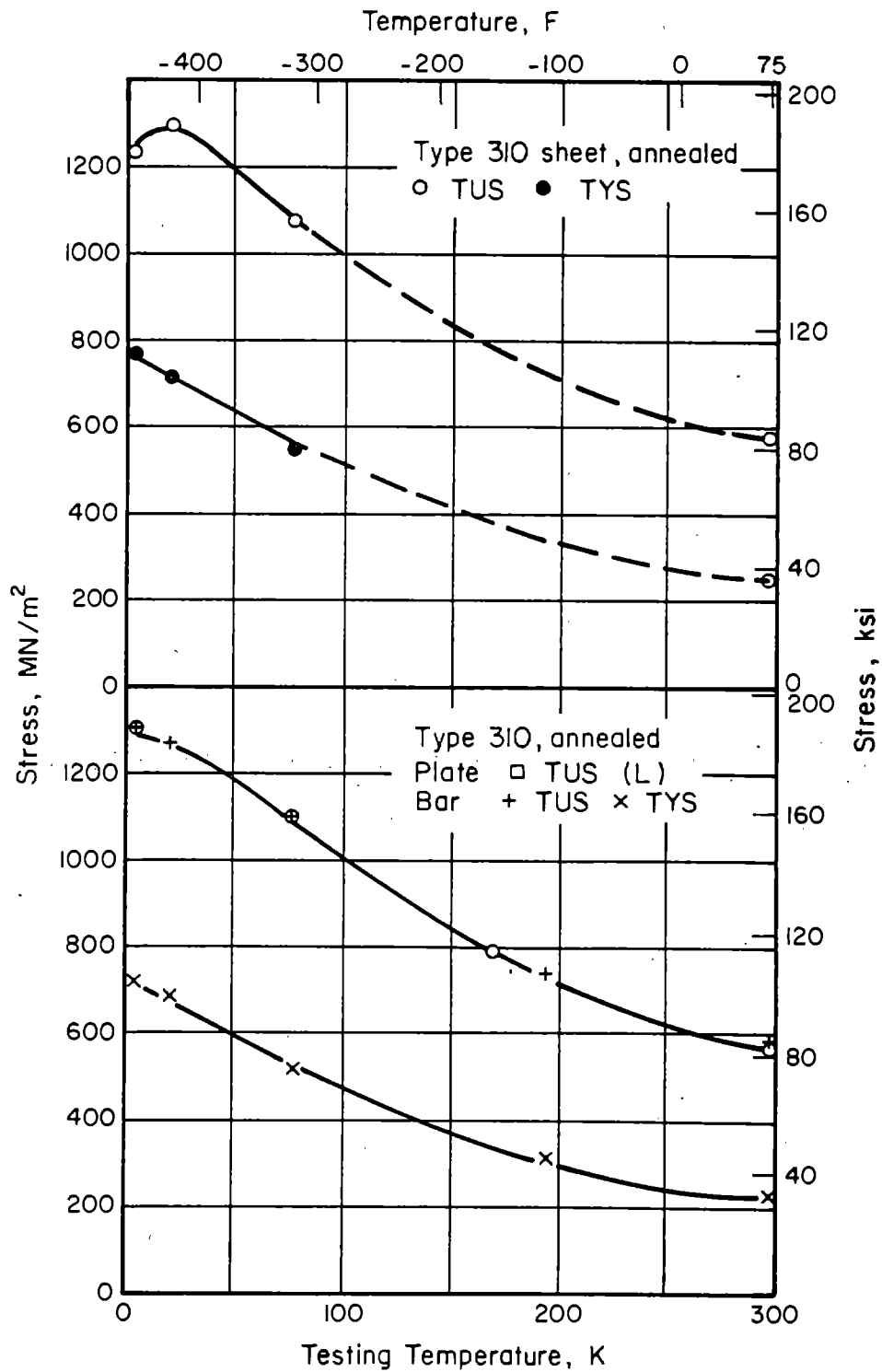


FIGURE 8.1.4-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 310 STAINLESS STEEL

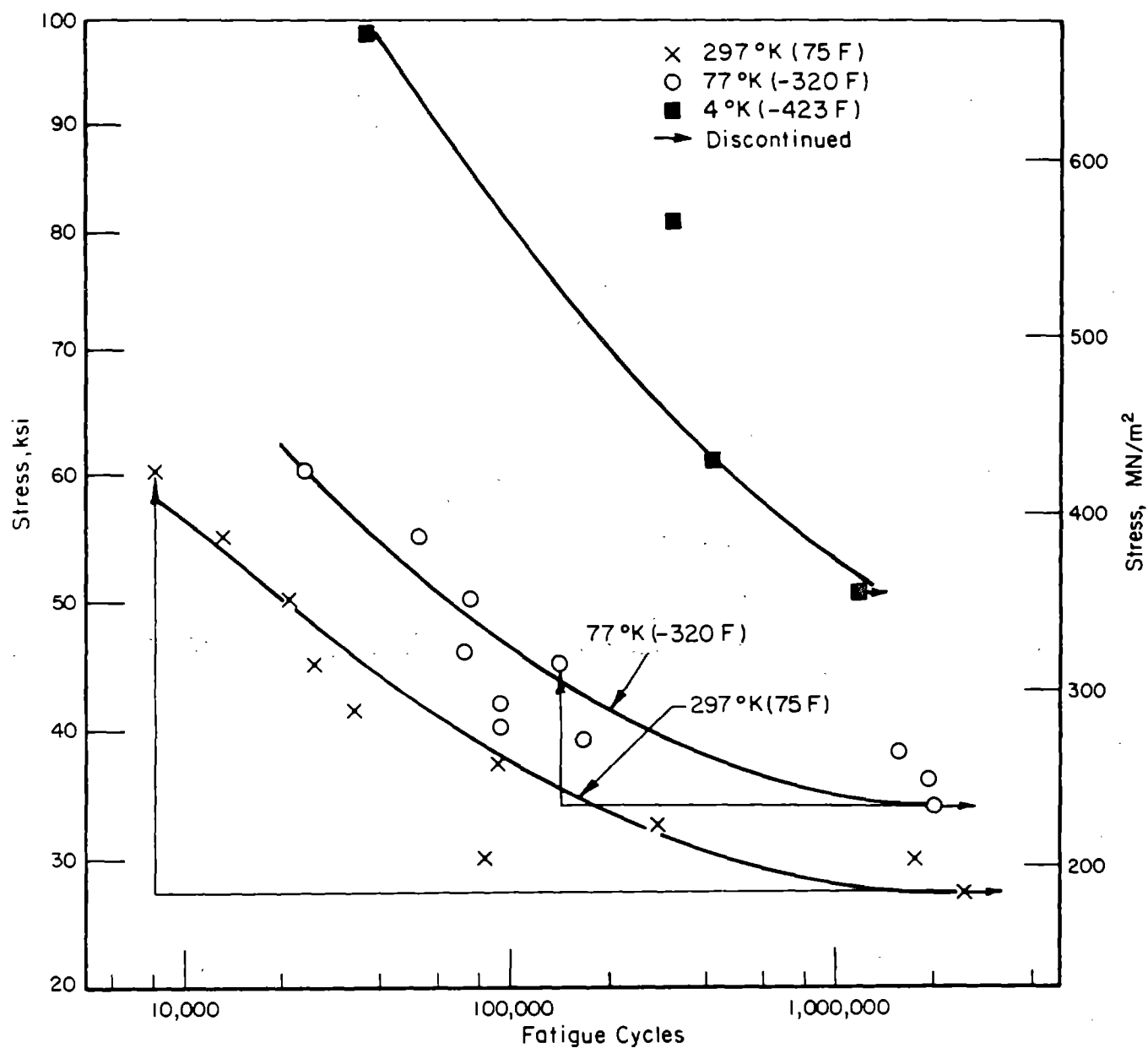
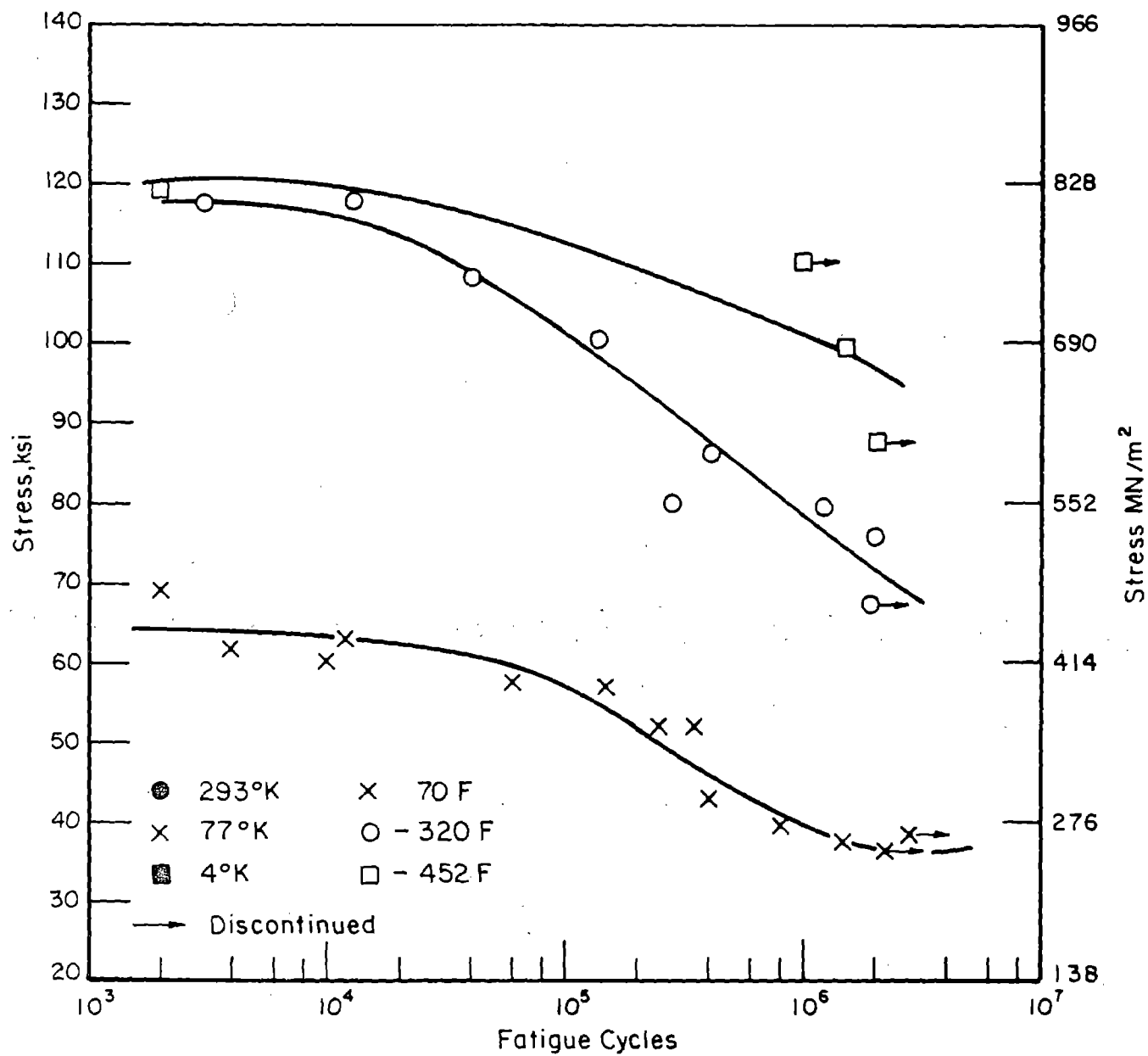


FIGURE 8.1.4-ME2. AXIAL FATIGUE LIFE CURVES FOR NOTCHED 310 STAINLESS STEEL BAR [Up to 2.540 cm (1.000 in.) diameter] [94208A, 95168]

8.1.4-6.1 (11/76)



8.1.4-6.2 (11/76)

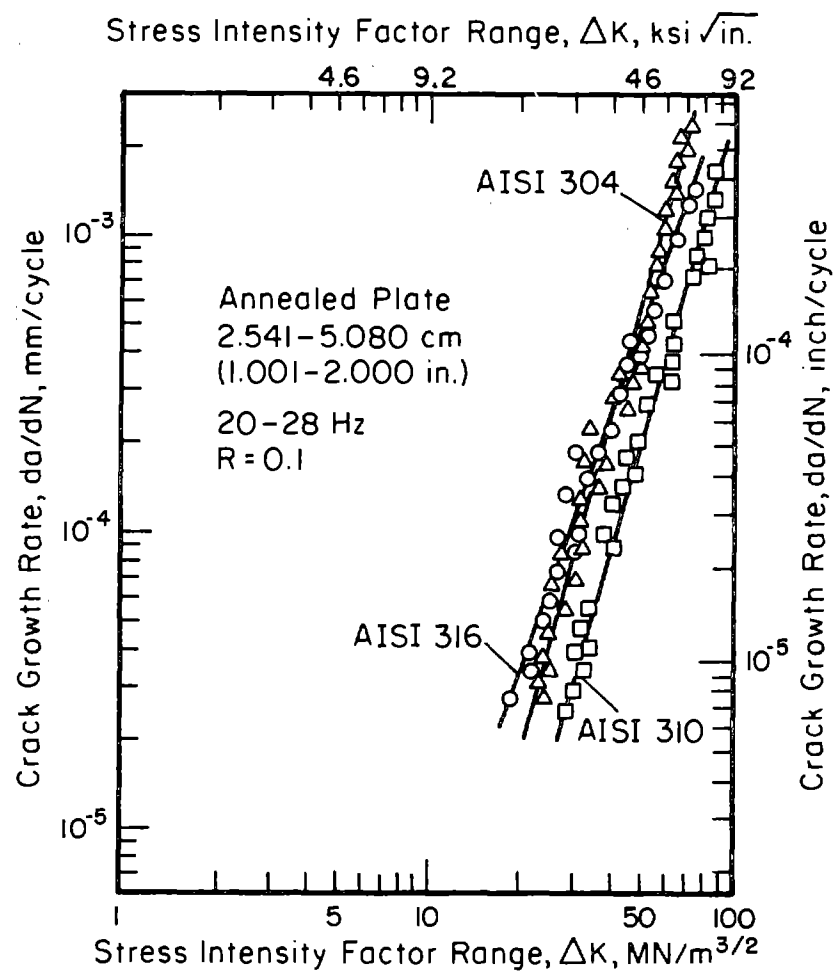


FIGURE 8.1.4-ME4. FATIGUE CRACK GROWTH RATES OF AUSTENITIC STAINLESS STEELS AT 4 K (-452 F) (94208D)

TABLE 8.1.4-TR1

Alloy Designation: Type 310 Stainless Steel

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	12.4	8.10	5.35	2.30	1.15	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(7.17)	(4.68)	(3.09)	(1.33)	(0.665)	
No. of Spec.	1	1	1	1	1	
References: 94206						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.228	-0.272	-0.282	-0.283	-0.284
No. of Spec.	3	3	2	1	1	1
References: 48134, 90202, 90208						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	88.0 x 10 ⁻⁸	74.0 x 10 ⁻⁸	70.0 x 10 ⁻⁸	68.0 x 10 ⁻⁸	67.0 x 10 ⁻⁸	67.0 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(529)	(445)	(421)	(409)	(403)	(403)
No. of Spec.	1	1	1	1	1	1
References: 79561						
Magnetothermal Conductivity						
	H Tesla					
Watts m ⁻¹ K ⁻¹	0				1.22	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹					(0.705)	
Watts m ⁻¹ K ⁻¹	8				1.25	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹					(0.723)	
No. of Spec.					1	
References: 94208						

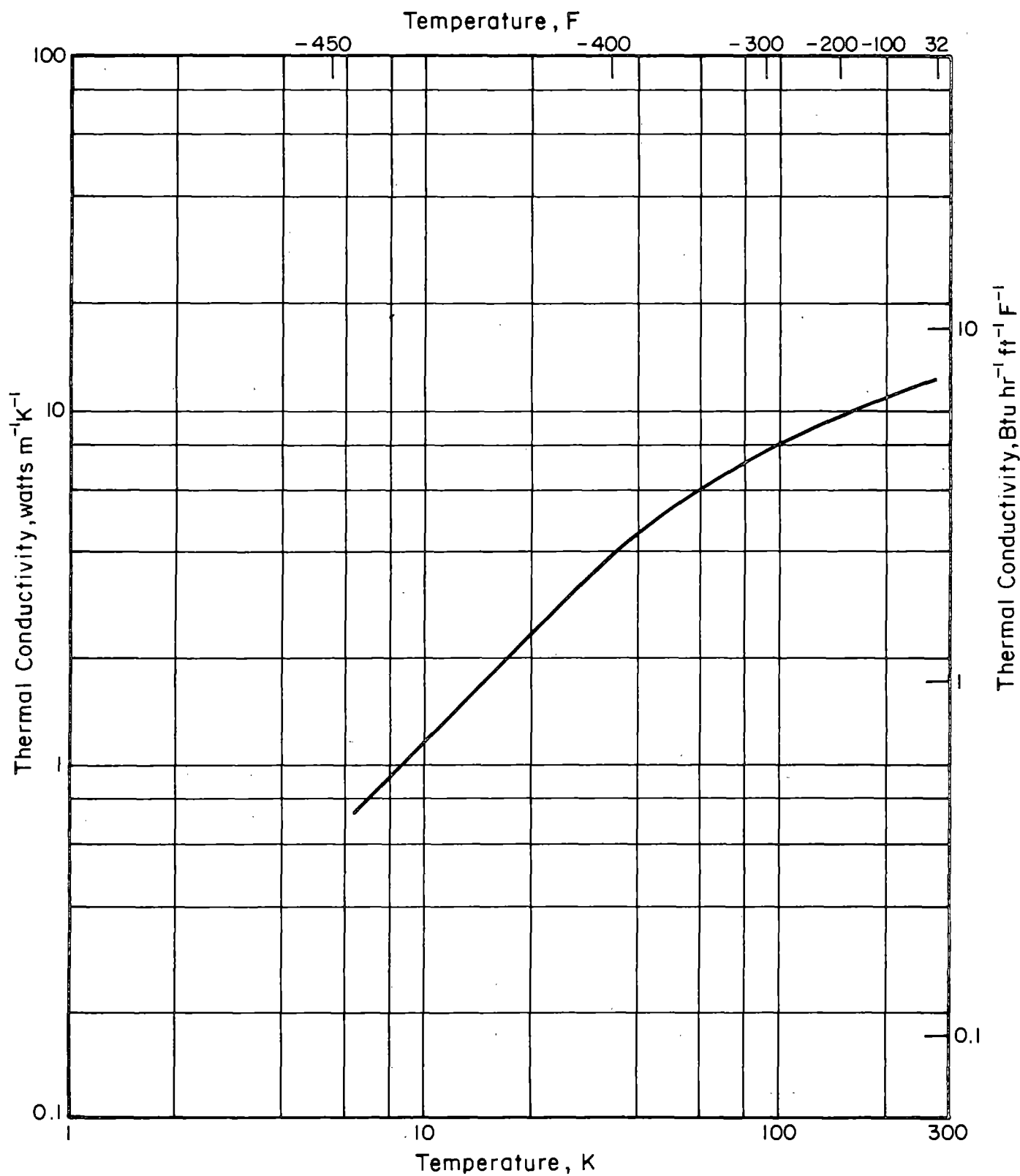


FIGURE 8.1.4-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 310 STAINLESS STEEL

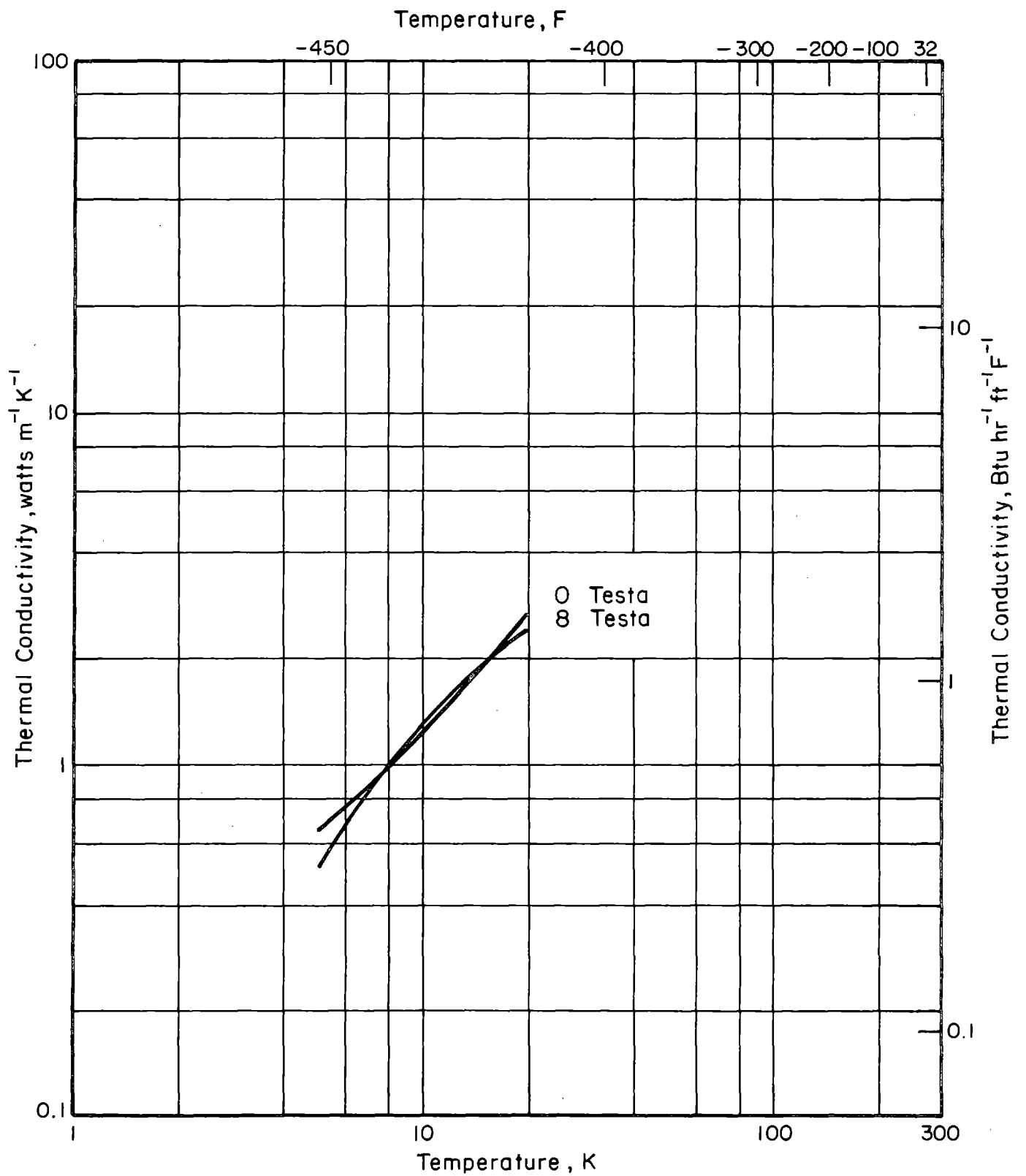


FIGURE 8.1.4-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 310 STAINLESS STEEL AT TWO MAGNETIC FIELD STRENGTHS

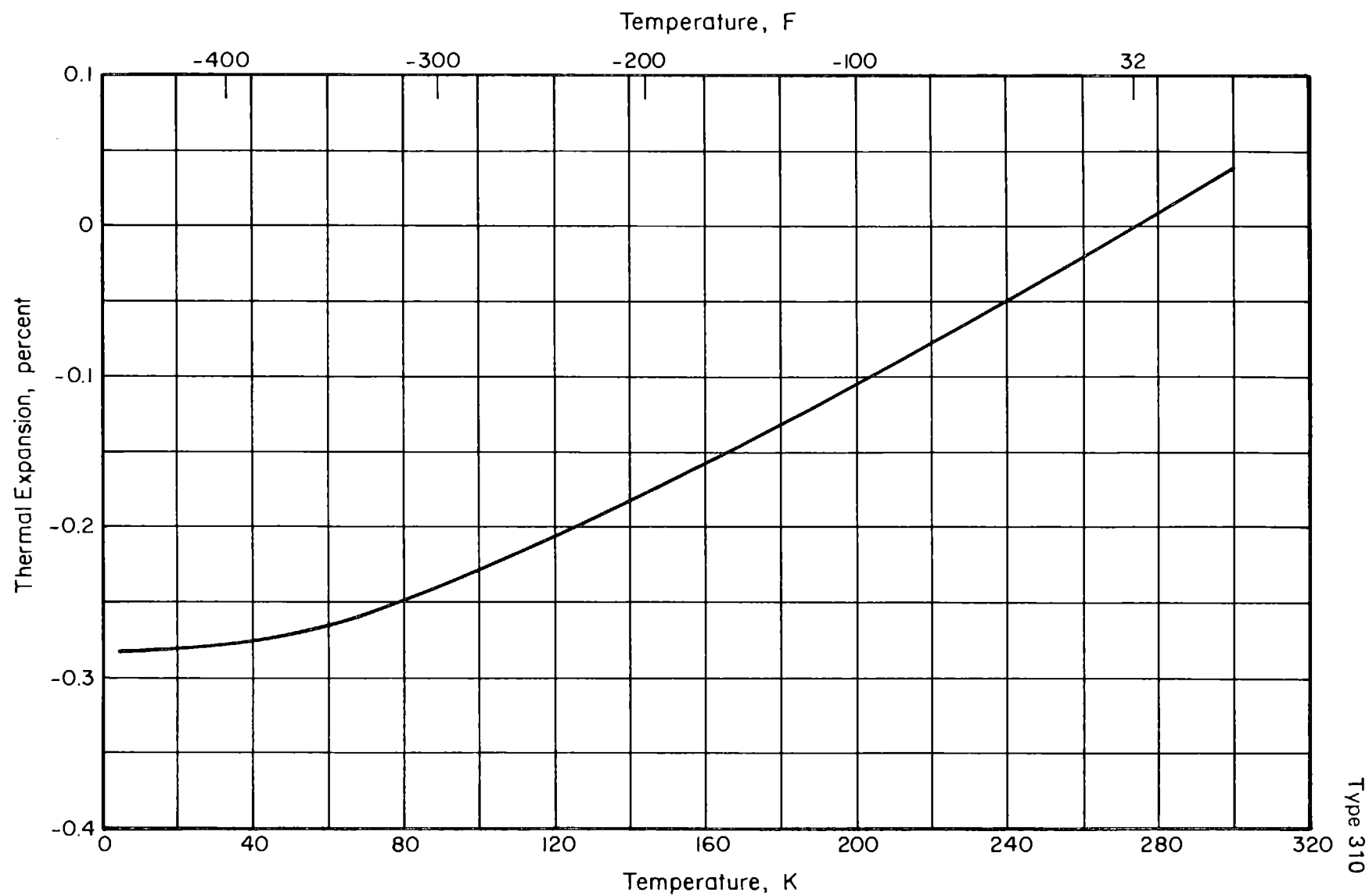


FIGURE 8.1.4-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR
TYPE 310 STAINLESS STEEL

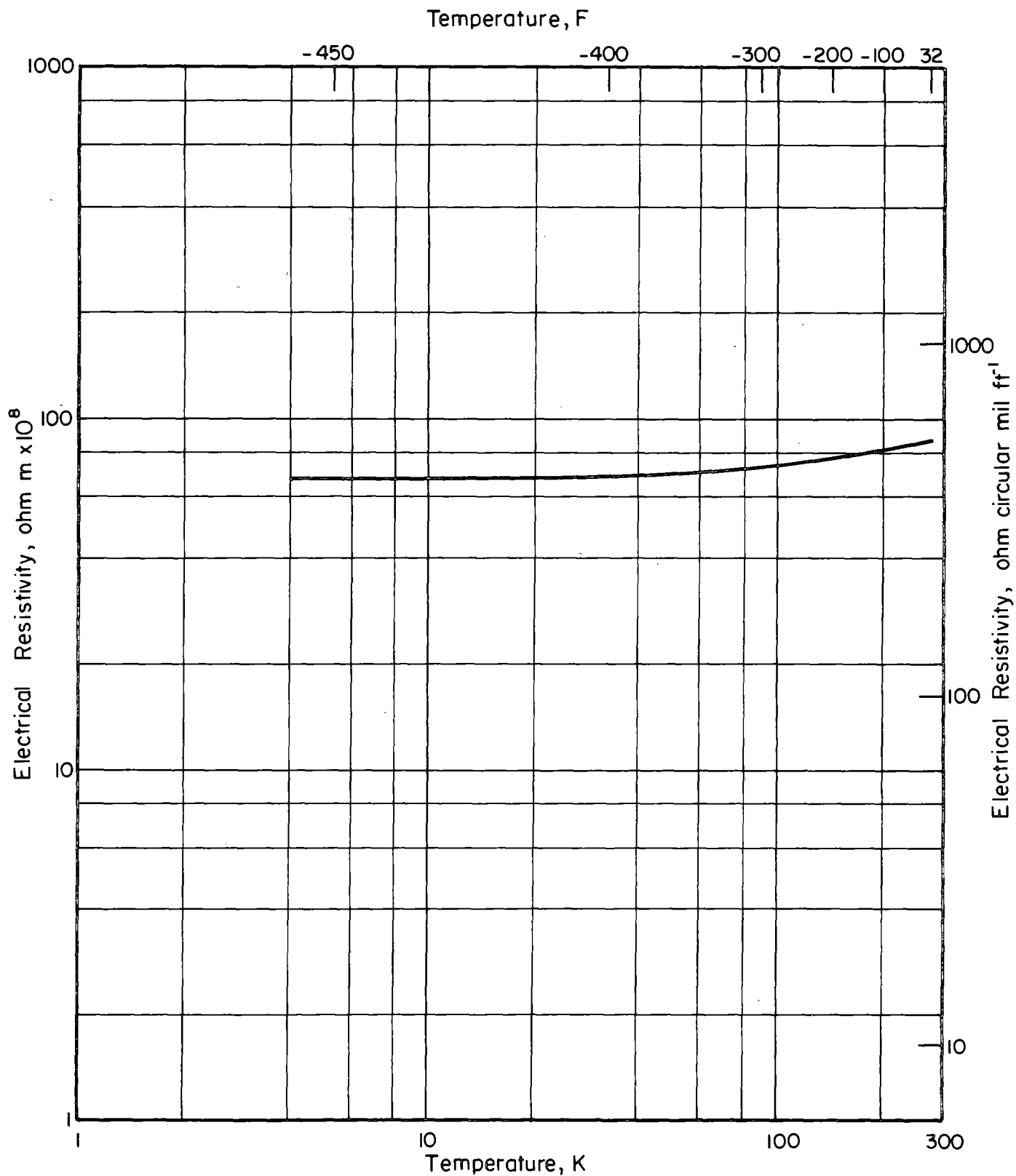


FIGURE 8.1.4-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 310 STAINLESS STEEL

8.1.4-9 (11/74)

TABLE 8.1.4-MA1

Alloy Designation: Type 310 Stainless Steel

Specification:

Form: Rods

Diameter, cm (in.) 0.4 (0.157)

Condition: Annealed (heated at 1348 K (1075 C) for 0.5 hour and water quenched)

Testing Temperature, K (F)	RT	77 (-320)	4.2 (-452)
<u>Magnetic Properties</u>			
Susceptibility, k	22.50×10^{-4}	83.34×10^{-4}	F*
Permeability, μ (H = 3 kO3)	12.60×10^{-7}	12.67×10^{-7}	—
Permeability, μ (H = 80 kOe)	—	—	12.77×10^{-7}
References: 82534, 90087			

*Ferromagnetic at this temperature.

TABLE 8.1.5-ME1

Alloy Designation: Type 316 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)		297	(75)			20	(-423)		
Tension, Longitudinal									
TUS, MN/m ² (ksi)	Avg	596	(86.4)			1576	(229)		
	Min	592	(85.9)			1510	(219)		
Std. Deviation									
TYS, MN/m ² (ksi)	Avg	275	(39.8)			666	(96.6)		
	Min	273	(39.6)			660	(95.8)		
Std. Deviation									
Elong, percent	Avg	60.5				55.3			
	Min	60				48			
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		3	(1)			3	(1)		
E _t , GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
TYS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)									
E _t , GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									

References: 33262

TABLE 8.1.5-ME1.1

Alloy Designation: Type 316 Stainless Steel (Weld Metal)

Specification:

Form: Sheet-TIG welded, Type 347 filler
 Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
 Condition: Annealed sheet welded and tested as welded

Testing Temperature, K (F)		297 (75)					20	(-423)	
Tension, Longitudinal									
TUS, MN/m ² (ksi)	Avg	554	(80.4)				1314	(190.6)	
	Min	533	(77.3)				1225	(177.7)	
Std. Deviation									
TYS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)		2	(1)				2	(1)	
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
TYS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)									
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
K _t =	Min								
No. of Spec. (No. of Heats)									

References: 33262

TABLE 8.1.5-ME2

Alloy Designation: Type 316 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		170 (-154)	77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	579 (84.0)		869 (126)	1227 (178)		1461 (212)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	76		81	64		54
	Min						
RA, percent	Avg	73.5		74.5	68.0		55.0
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(1)		(1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	696 (101)		1020 (148)	1400 (203)		1558 (226)
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 52856

TABLE 8.1.5-ME3

Alloy Designation: Type 316 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed

Testing Temperature, K (F)	297 (75)	233 (-40)	195 (-108)	153 (-184)	77 (-320)	10 (-442)
<u>Compression, Longitudinal</u>						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN /m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
<u>Compression, Transverse</u>						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
<u>Shear(a)</u>						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
<u>Impact, Charpy V, Testing Temp.</u>						
Long., J(ft-lb)	192 (142)	210 (155)	168 (124)	146 (108)	146 (108)	132 (97)
Avg						
Min						
No. of Spec. (No. of Heats)						
Trans., J(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
<u>Fracture Toughness(b)</u>						
K _{Ic} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 52856

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.1.5-ME3.1

Type 316
Plate-Weld Metal

Alloy Designation: Type 316 Stainless Steel (Weld Metal)

Specification:

Form: Plate-MIG welded, type 316 covered electrode

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate welded, annealed 1366 K (2000 F) 1 hr, WQ, tested as quenched

Testing Temperature, K (F)		297 (75)	168 (-156)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	553 (80.2)	855.0 (124.0)		1176 (170.5)		1382 (200.5)
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg	55.0	60.0		53.0		50.0
	Min						
RA, percent	Avg	60.0	51.5		54.0		43.0
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	699.8 (101.5)	868.7 (126.0)		1127 (163.5)		1351 (196.0)
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 52856

TABLE 8.1.5-ME4

Alloy Designation: Type 316 Stainless Steel

Specification:

Form: Bar
Diameter: Up to 2.540 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	647 (93.9)	910 (132)	1110 (161)	1269 (184)		1489 (216)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	47	59	60	59		52
	Min						
RA, percent	Avg	37.5	38.0	77.7	76.2		59.7
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		(1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 45464

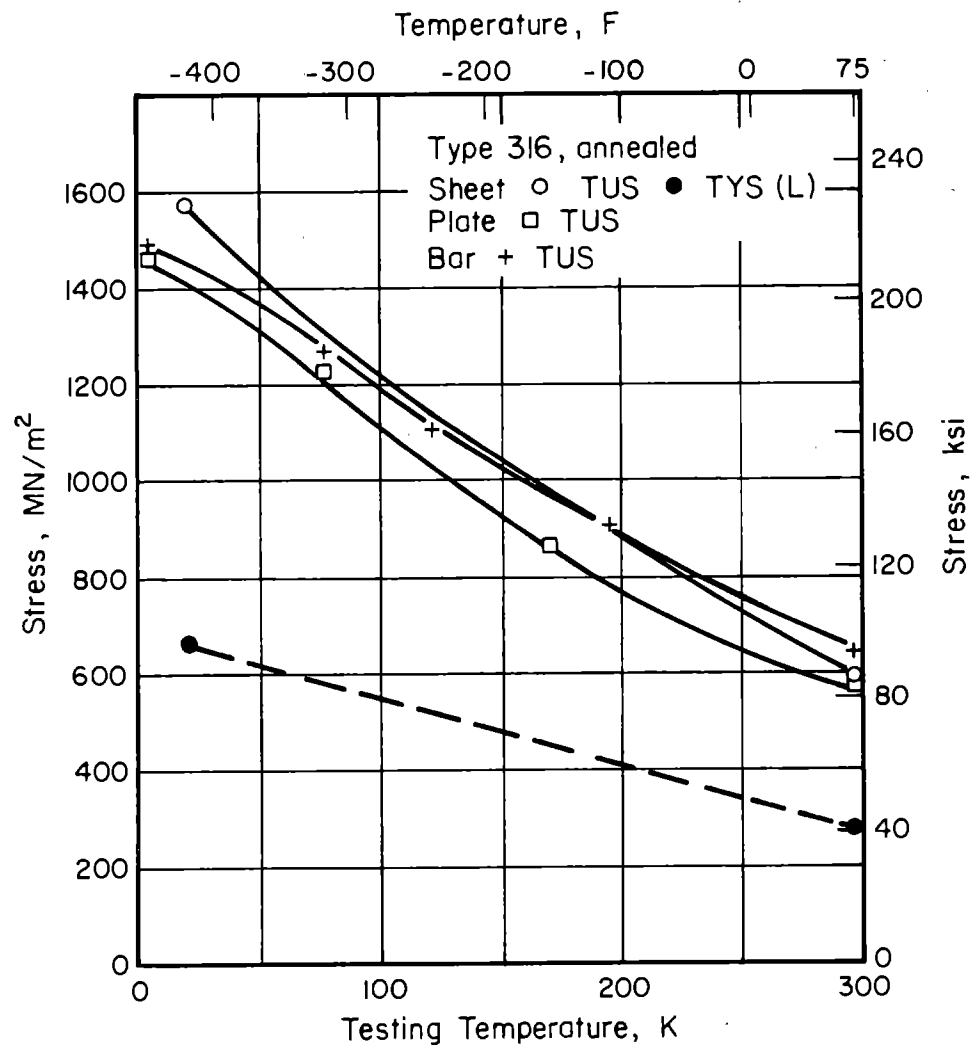


FIGURE 8.1.5-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 316 STAINLESS STEEL

TABLE 8.1.5-TR1

Alloy Designation: Type 316 Stainless Steel

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	14.7	9.4	5.6	1.90	0.78	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(8.50)	(5.44)	(3.24)	(1.10)	(0.451)	
No. of Spec.	1	1	1	1	1	
References: 40911						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.230	-0.262	-0.265	-0.265	-0.265
No. of Spec.	2	2	2	2	2	2
References: 90208, 90336						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	75.0 x 10 ⁻⁸	59.0 x 10 ⁻⁸	54.5 x 10 ⁻⁸	53.5 x 10 ⁻⁸	53.0 x 10 ⁻⁸	53.0 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(451)	(355)	(328)	(322)	(319)	(319)
No. of Spec.	2	2	2	2	2	2
References: 79561, 90164						

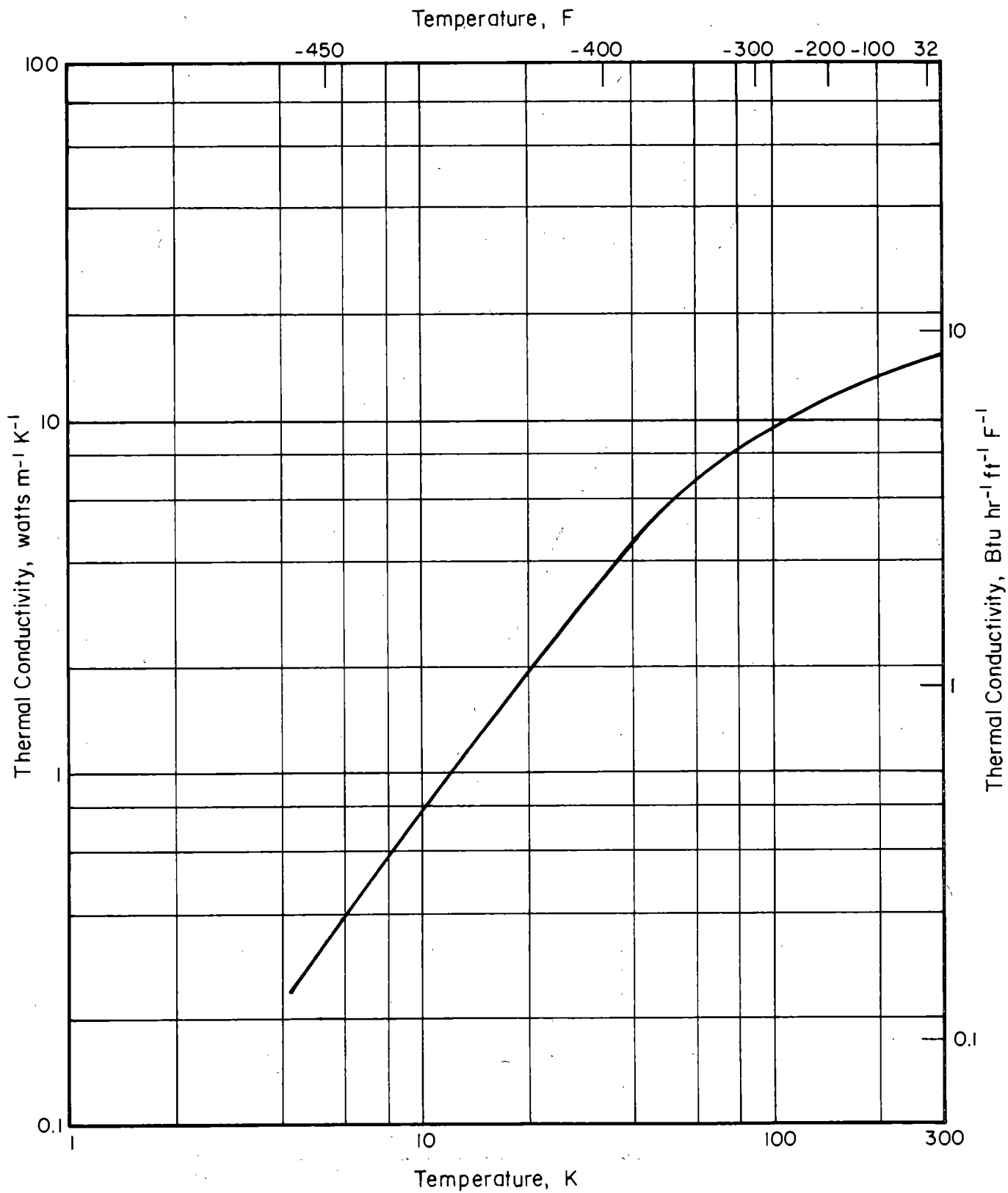


FIGURE 8.1.5-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 316 STAINLESS STEEL

8.1.5-8 (11/74)

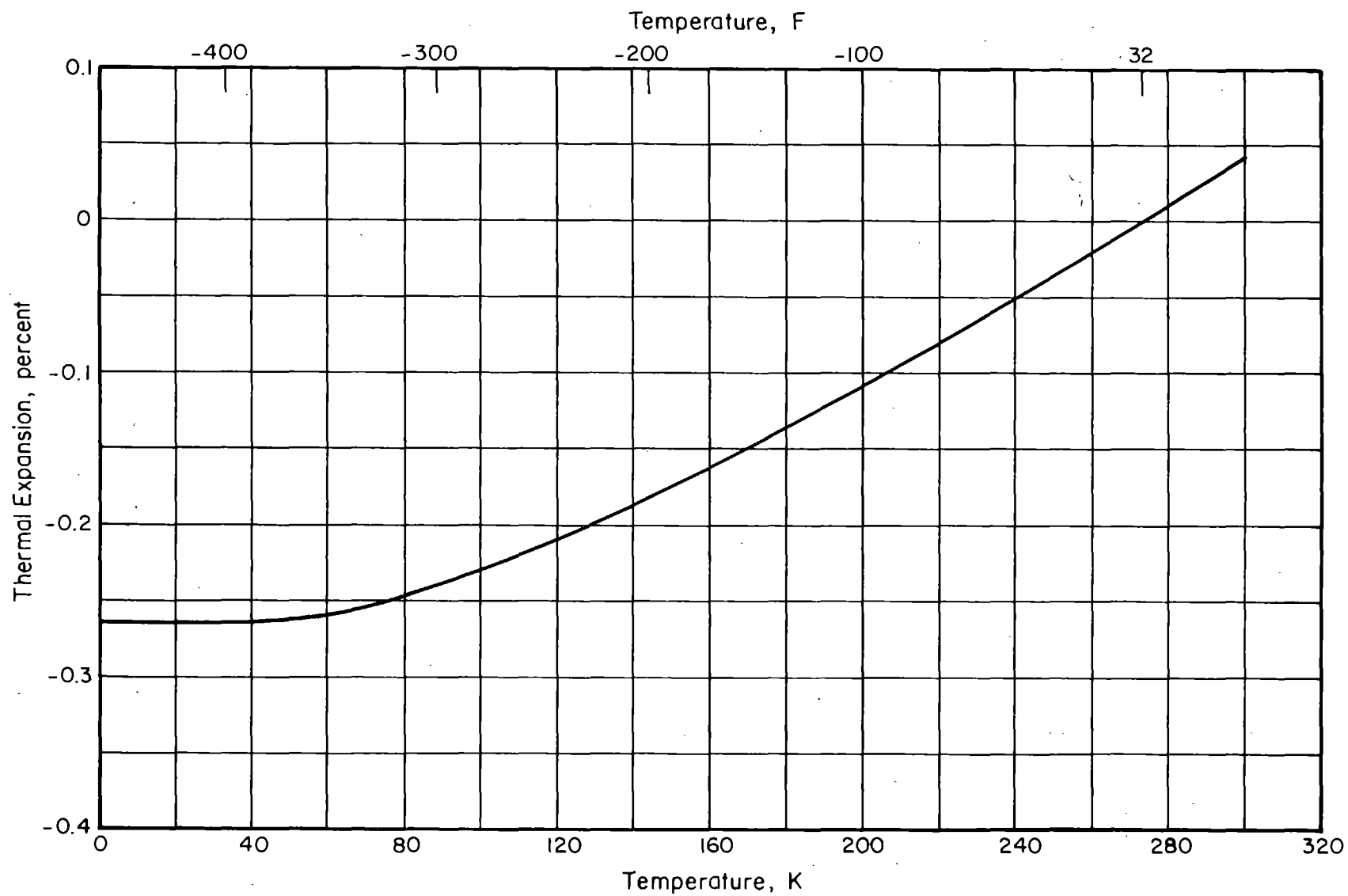


FIGURE 8.1.5-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 316 STAINLESS STEEL

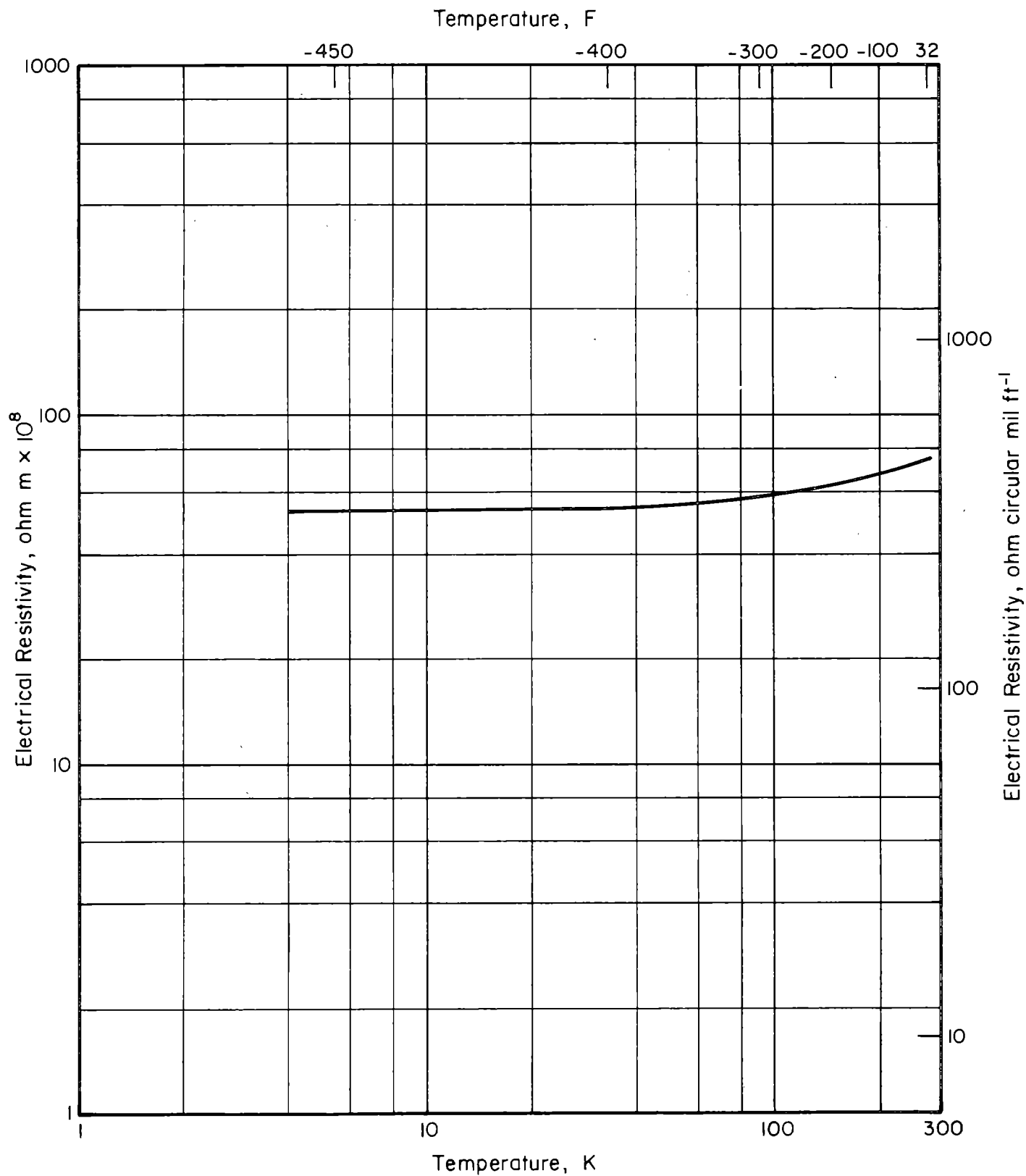


FIGURE 8.1.5-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE, FOR TYPE 316 STAINLESS STEEL

TABLE 8.1.5-MA1

Alloy Designation: Type 316 (LN)* Stainless Steel

Specification:

Form: Rods

Diameter, cm (in.): 0.4 (0.157)

Condition: Annealed (heated at 1348 K (1075 C) for 0.5 hour and water quenched)

Testing Temperature, K (F)	RT	77 (-320)	4.2 (-452)
<u>Magnetic Properties</u>			
Susceptibility, k	25.77×10^{-4}	69.14×10^{-4}	113.38×10^{-4}
Permeability, μ (H = 3 kOe)	12.60×10^{-7}	12.66×10^{-7}	12.71×10^{-7}
Permeability, μ (H = 80 kOe)	—	—	12.683×10^{-7}
References: 82534, 90087			

*Low nitrogen.

TABLE 8.1.6-ME1

Alloy Designation: Type 321 Stainless Steel

Specification: QQ-S-766

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg	618 (89.6)		1378 (200)	1649 (239)	
	Min	590 (85.5)		1338 (194)	1551 (225)	
Std. Deviation		19.8 (2.87)		34.9 (5.06)	75.1 (10.9)	
TYS, MN/m ² (ksi)	Avg	224 (32.4)		314 (45.6)	376 (54.5)	
	Min	200 (29.0)		296 (43.0)	362 (52.5)	
Std. Deviation		29.2 (4.24)		10.9 (1.59)	11.8 (1.71)	
Elong, percent	Avg	54.6		45.7	36.1	
	Min	51		43	29	
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		9 (2)		9 (2)	7 (2)	
E, GN/m ² (10 ⁶ psi)	Avg	179 (26.0)		203 (29.5)	212 (30.7)	
	Min					
No. of Spec. (No. of Heats)		(1)		(1)	(1)	
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg	623 (90.4)		1517 (220)	1462 (212)	
K _t = 3.5	Min	621 (90.1)		1497 (217)		
No. of Spec. (No. of Heats)		3 (1)		3 (1)	1 (1)	
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 61996, 83417

TABLE 8.1.6-ME2

Alloy Designation: Type 321 Stainless Steel

Specification: QQ-S-766

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^6 cycles, MN/m ² (ksi)	221 (32)		303 (44)	372 (54)		
Loading frequency Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.37		0.21	0.23		
S_N at 10^5 cycles, MN/m ² (ksi)	176 (25.5)		221 (32.0)	262 (38.0)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.5$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
S_N at 10^6 cycles, MN/m ² (ksi)	124 (18.0)		154 (22.3)	181 (26.3)		
Loading frequency Hz						
with $R = -1$ and $K_t = 3.5$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Fatigue, Flexural Loading, Surface Finish 64 rms						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency 30-40 Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)	172 (25)		303 (44)	358 (52)		
Loading frequency 30-40 Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.28		0.23	0.22		
S_N at 10^7 cycles, MN/m ² (ksi)	165 (24)		296 (43)			
Loading frequency 30-40 Hz						
with $R = -1$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N /TUS at 10^7 cycles	0.27		0.22			

References: 58024, 61996, 83417

TABLE 8.1.6-ME2.1

Type 321
Sheet-Weld Metal

Alloy Designation: Type 321 Stainless Steel (Weld Metal)

Specification:

Form: Sheet-TIG welded, filler not specified

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed sheet welded and tested as welded

Testing Temperature, K (F)		297 (75)		77 (-320)		20 (-423)	
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	598	(86.7)		1413	(205.0)	893.6 (129.6)
	Min	597	(86.6)		1367	(198.3)	792.9 (115.0)
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3	(1)		3	(1)	3 (1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 61996

TABLE 8.1.6-ME3

Alloy Designation: Type 321 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed

Testing Temperature, K (F)		297	(75)			20	(-423)		
Tension, Longitudinal									
TUS, MN/m ² (ksi)	Avg	560	(81.2)			1494	(217)		
	Min	543	(78.7)			1453	(211)		
Std. Deviation									
TYS, MN/m ² (ksi)	Avg	236	(34.3)			393	(57.0)		
	Min	205	(29.8)			386	(56.0)		
Std. Deviation									
Elong, percent	Avg	58.2				30.4			
	Min	57.5				28.2			
RA, percent	Avg	65.4				51.6			
	Min	63.8				51.3			
No. of Spec. (No. of Heats)		2	(1)			2	(1)		
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg	581	(84.3)			733	(106)		
	Min	579	(84.0)			696	(101)		
K _t = 6.3									
No. of Spec. (No. of Heats)		3	(1)			2	(1)		
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
TYS, MN/m ² (ksi)	Avg								
	Min								
Std. Deviation									
Elong, percent	Avg								
	Min								
RA, percent	Avg								
	Min								
No. of Spec. (No. of Heats)									
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
No. of Spec. (No. of Heats)									
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									
NTS, MN/m ² (ksi)	Avg								
	Min								
K _t =									
No. of Spec. (No. of Heats)									

References: 66080

TABLE 8.1.6-ME4

Alloy Designation: Type 321 Stainless Steel

Specification:

Form: Bar
Diameter: Up to 2.54 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	673 (97.6)	1054 (153)	1537 (223)	1862 (270)		
	Min	670 (97.2)	1043 (151)	1516 (220)	1844 (267)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	429 (62.2)	385 (55.9)	451 (65.4)	403 (58.5)		
	Min	425 (61.6)	371 (53.8)	445 (64.6)	402 (58.3)		
Std. Deviation							
Elong, percent	Avg	55.1	45.7	37.9	34.7		
	Min	54.5	44.6	37.1			
RA, percent	Avg	79.4	72.7	60.0	43.6		
	Min	78.4	71.8	53.3			
No. of Spec. (No. of Heats)		2 (1)	3 (1)	4 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 54986

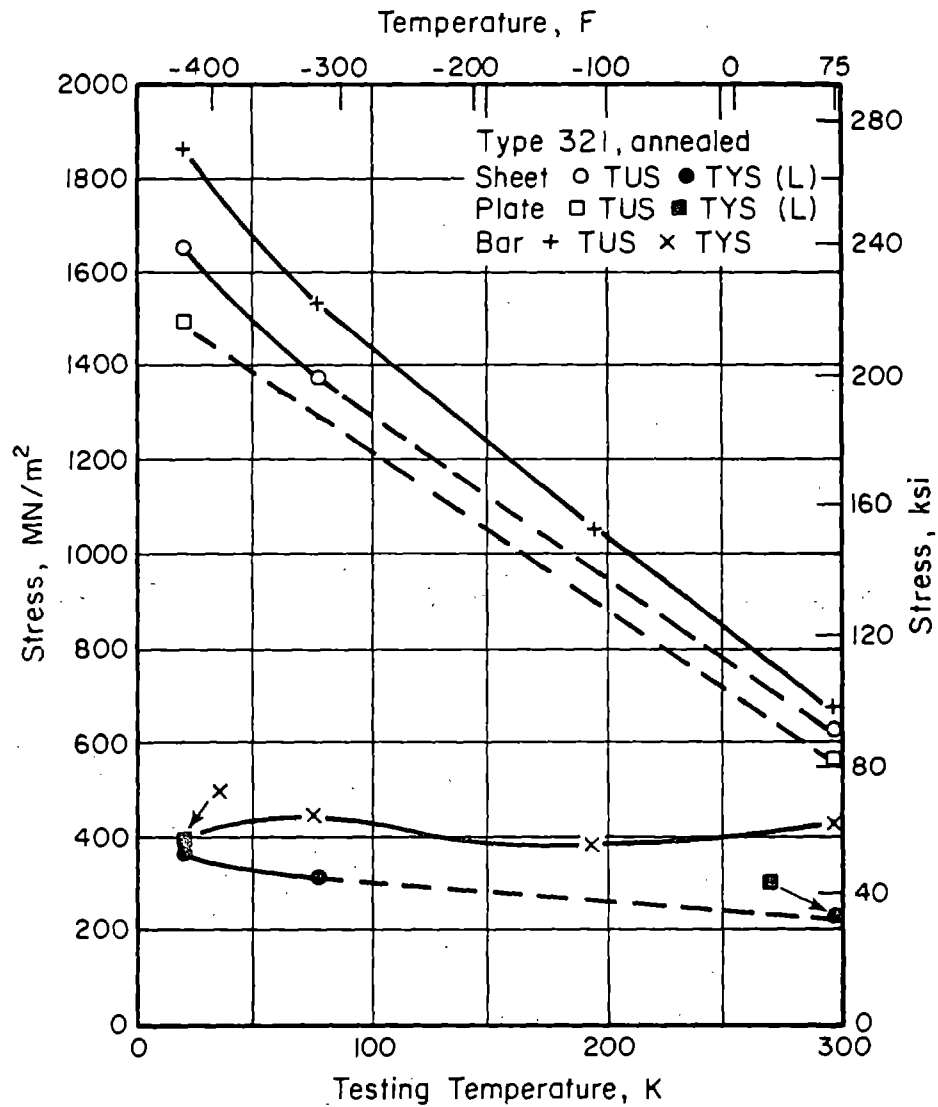


FIGURE 8.1.6-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 321 STAINLESS STEEL

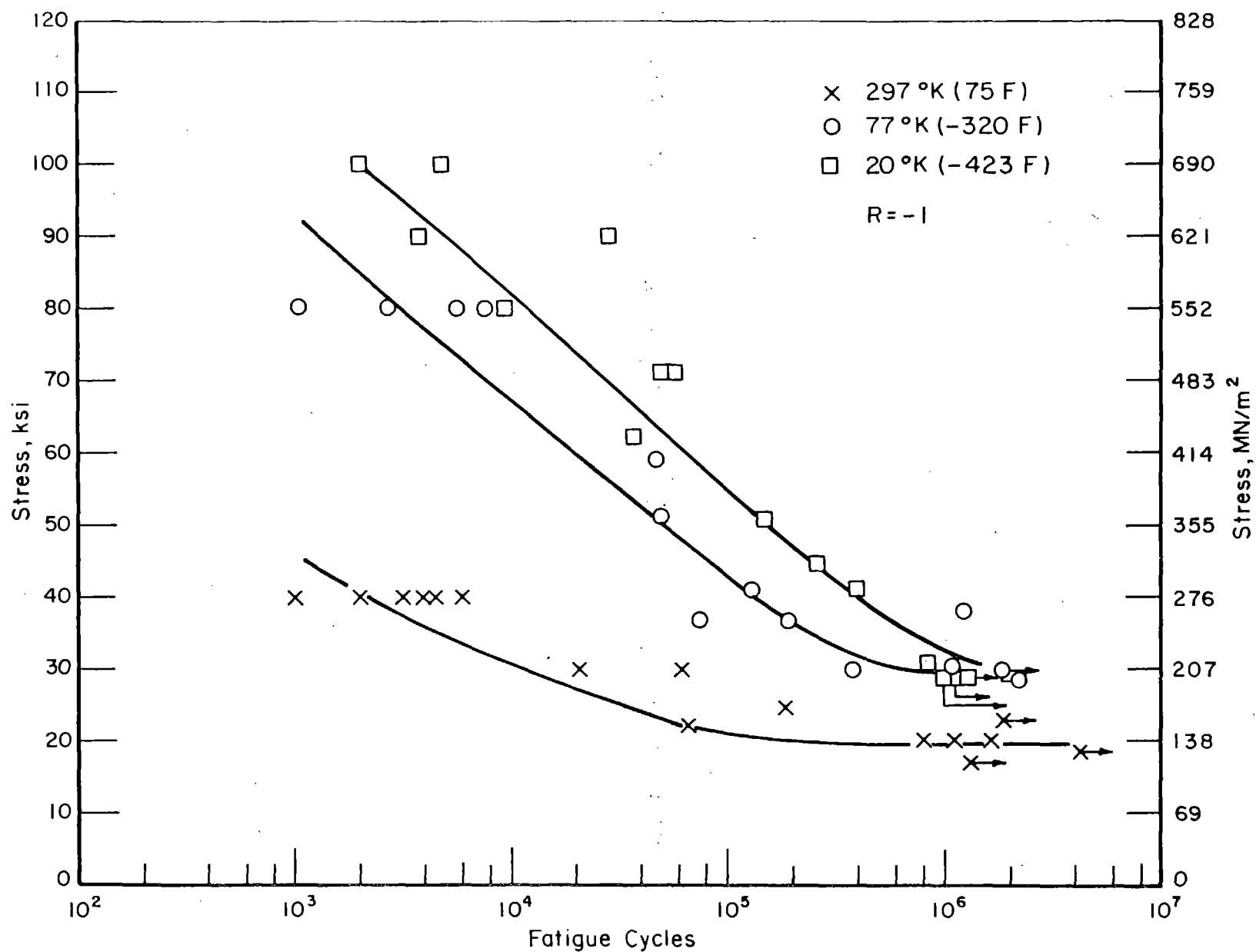


FIGURE 8.1.6-ME2. AXIAL FATIGUE LIFE CURVES FOR 321 (ANNEALED) STAINLESS STEEL ALLOY SHEET 0.230 cm (0.090 in.) THICK, AS WELDED [TIG welded; filler not specified] [61996]

TABLE B.1.6-TR1

Alloy Designation: Type 321 Stainless Steel

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.232	-0.267	-0.268	-0.269	-0.269
No. of Spec.	2	2	2	2	1	1
References: 48134, 69332						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	74.0 x 10 ⁻⁸	57.5 x 10 ⁻⁸	53.5 x 10 ⁻⁸	53.0 x 10 ⁻⁸	53.0 x 10 ⁻⁸	53.0 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(445)	(346)	(322)	(319)	(319)	(319)
No. of Spec.	1	1	1	1	1	1
References: 79561						

8.1.6-7 (11/74)

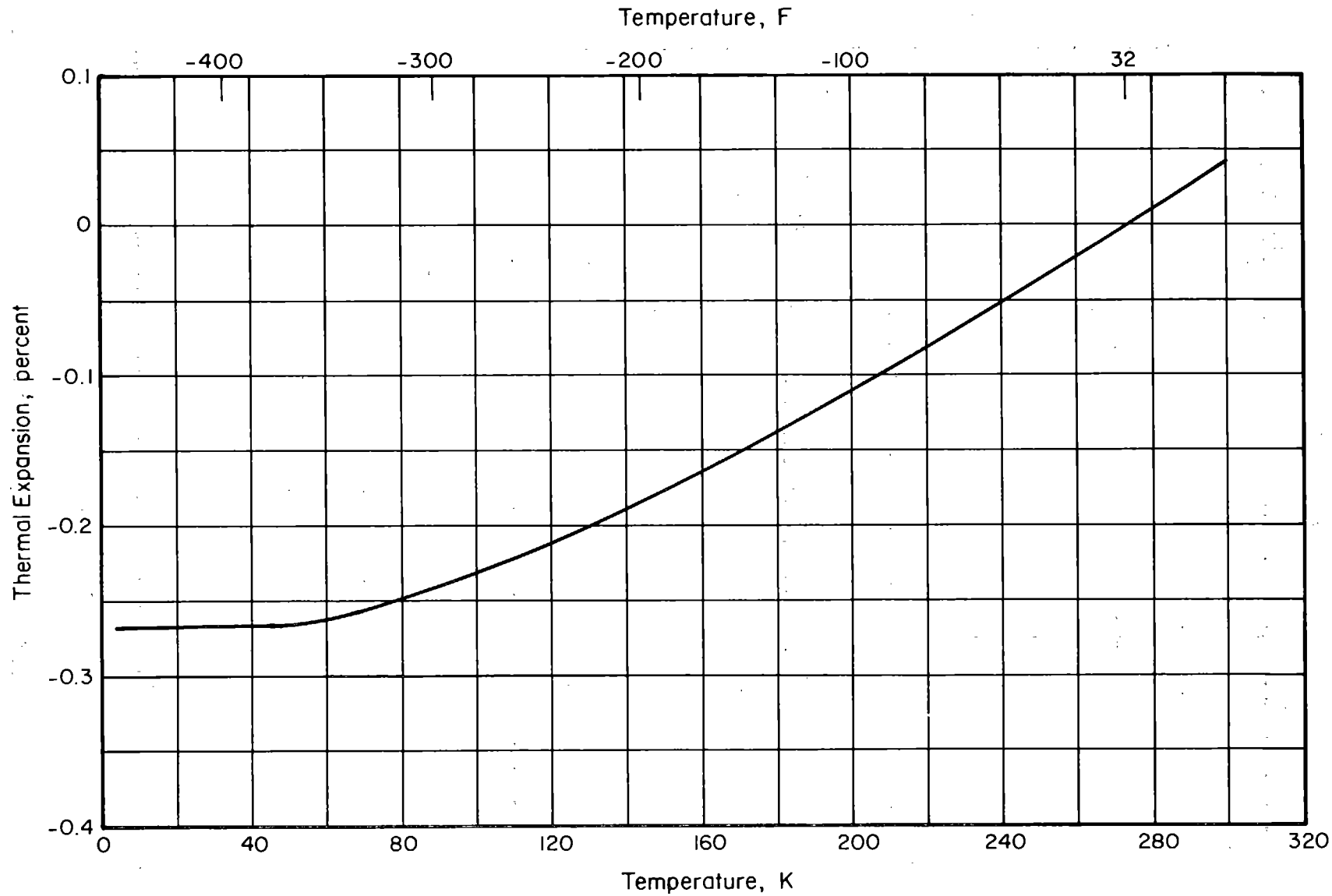


FIGURE 8.1.6-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 321 STAINLESS STEEL

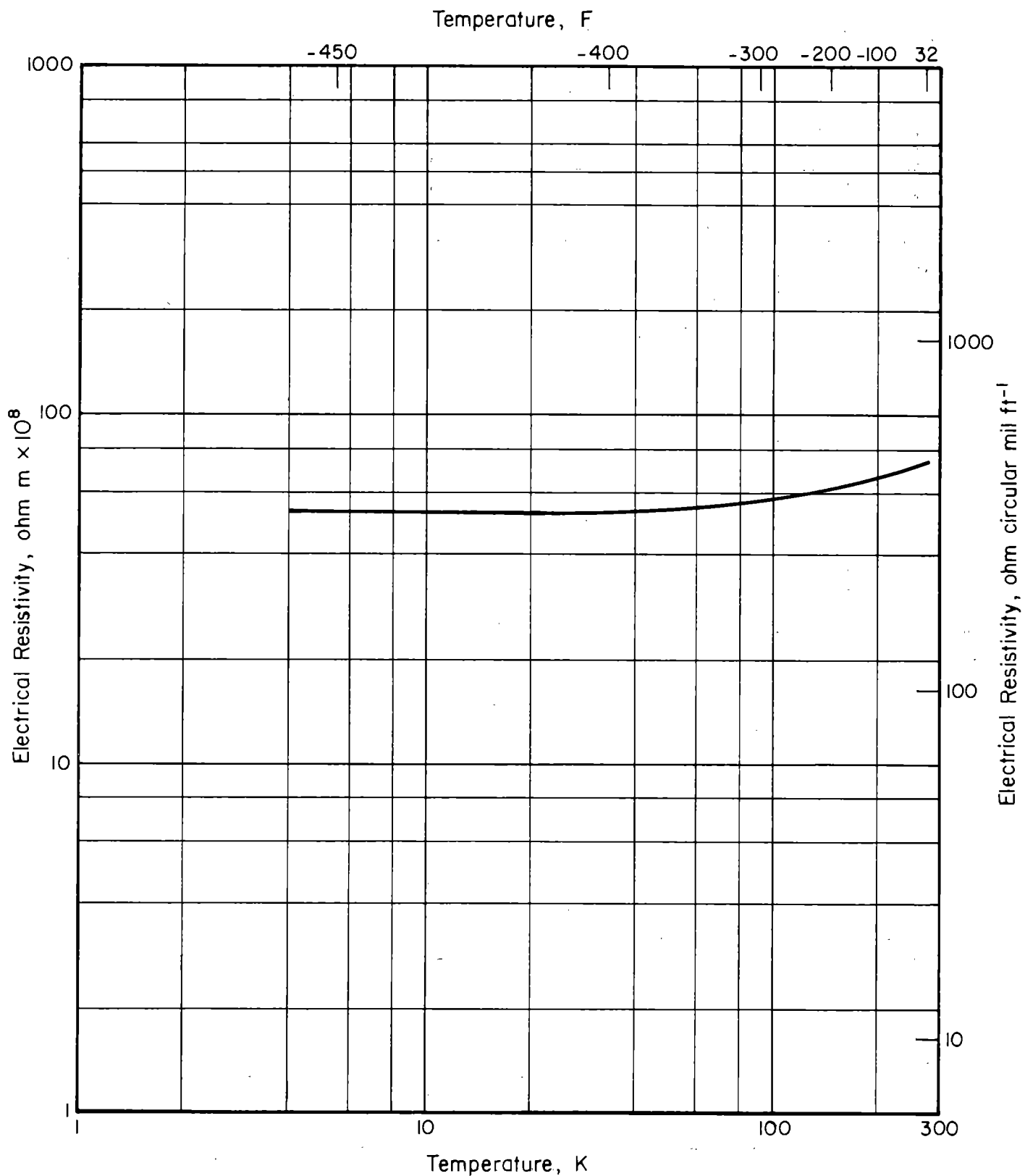


FIGURE 8.1.6-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 321 STAINLESS STEEL

8.1.6-8 (11/74)

TABLE 8.1.6-MA1

Alloy Designation: Type 321 Stainless Steel

Specification:

Form: Rods

Diameter, cm (in.): 0.4 (0.157)

Condition: Annealed (heated at 1348 K (1075 C) for 0.5 hour and water quenched)

Testing Temperature, K (F)	—	—	4.2 (-452)
<u>Magnetic Properties</u>			
Susceptibility, k	—	—	—
Permeability, μ (H = 80 kOe)	—	—	12.784×10^{-7}
Reference: 82534			

TABLE 8.1.6-MA2

Alloy Designation: Type 321 Stainless Steel (En 58B)

Specification:

Form: Bar stock

Thickness, cm (in.): See reference

Condition: Annealed

Testing Temperature, K (F)			4.2 (-452)
<u>Magnetic Properties</u>			
Susceptibility, k	—	—	0.13125
Permeability, μ	—	—	14.219×10^{-7}
Reference: 90524			

TABLE 8.1.6-MA3

Alloy Designation: Type 321 Stainless Steel

Specification:

Form: Balls

Diameter, cm (in.): 0.3 (0.118)

Condition: Annealed at 1373 K (1100 C) for 1 hour and water quenched

Testing Temperature, K (F)	240 (-27)	160 (-171)	80 (-315)	41 (-386)*
<u>Magnetic Properties**</u>				
Type 321, 10 percent nickel				
Susceptibility, k	42.74×10^{-4}	46.51×10^{-4}	72.91×10^{-4}	104.33×10^{-4}
Permeability, μ	12.62×10^{-7}	12.63×10^{-7}	12.66×10^{-7}	12.70×10^{-7}
Type 321, 9 percent nickel				
Susceptibility, k	—	—	65.36×10^{-4}	96.79×10^{-4}
Permeability, μ	—	—	12.65×10^{-7}	12.96×10^{-7}

References: 87479, 90494

* T_N (Néel point) = Below T_N , k drops in value (antiferromagnetic).

**H = 11 kOe. k (M/H) is somewhat sensitive to cryogenic temperature history (see references).

TABLE 8.1.7-ME1

Type 303
Bar

Alloy Designation: Type 303 Stainless Steel S30300

Specification:

Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	733 (106.3)	1185 (171.8)	1422 (206.8)	1655 (240.0)	2051 (297.5)	1837 (266.5)
	Min	691 (100.2)	1114 (161.5)	--	1614 (234.1)	2045 (296.6)	--
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	423 (61.4)	436 (63.3)	--	464 (67.3)	570 (82.6)	--
	Min						
Std. Deviation							
Elong, percent	Avg	67.0	43.1	37.0	36.4	33.0	29.6
	Min	59.0	42.8	--	35.0	--	--
RA, percent	Avg	70.0	59.8	53.6	54.5	--	37.3
	Min	67.4	56.8	--	51.5	--	36.8
No. of Spec. (No. of Heats)		3 (2)	3 (2)	1	3 (2)	3 (1)	3 (2)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 54986, 40004

TABLE 8.1.7-ME2

Alloy Designation: Type 303 Stainless Steel S30300

Specification:

Form: Bar
 Thickness, cm (in.): Up to 2.540 (1.000)
 Condition: Annealed

Testing Temperature, K (F)	297 (75)	195 (-108)		77 (-320)		
Compression, Longitudinal						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	46.8 (34.5)	77.3 (57.0)		120 (88.5)		
Avg						
Min						
No. of Spec. (No. of Heats)	4	6		4		
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K_{IE}, MN/m^{3/2}(ksi√in.)						
Avg						
Min						
(From PTSC spec.) (—)						
No. of Spec. (No. of Heats)						

References: 54986

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.1.7-TR1

Alloy Designation: Type 303 Stainless Steel

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
<u>Longitudinal</u>						
Percent	0	-0.233	-0.263	-0.267		
No. of Spec.	1	1	1	1		
References: 48134						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	71.2 x 10 ⁻⁸	53.7 x 10 ⁻⁸	50 x 10 ⁻⁸	50 x 10 ⁻⁸	50 x 10 ⁻⁸	50 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(428)	(323)	(301)	(301)	(301)	(301)
No. of Spec.	2	2	2	2	2	2
References: 79561, 90318						

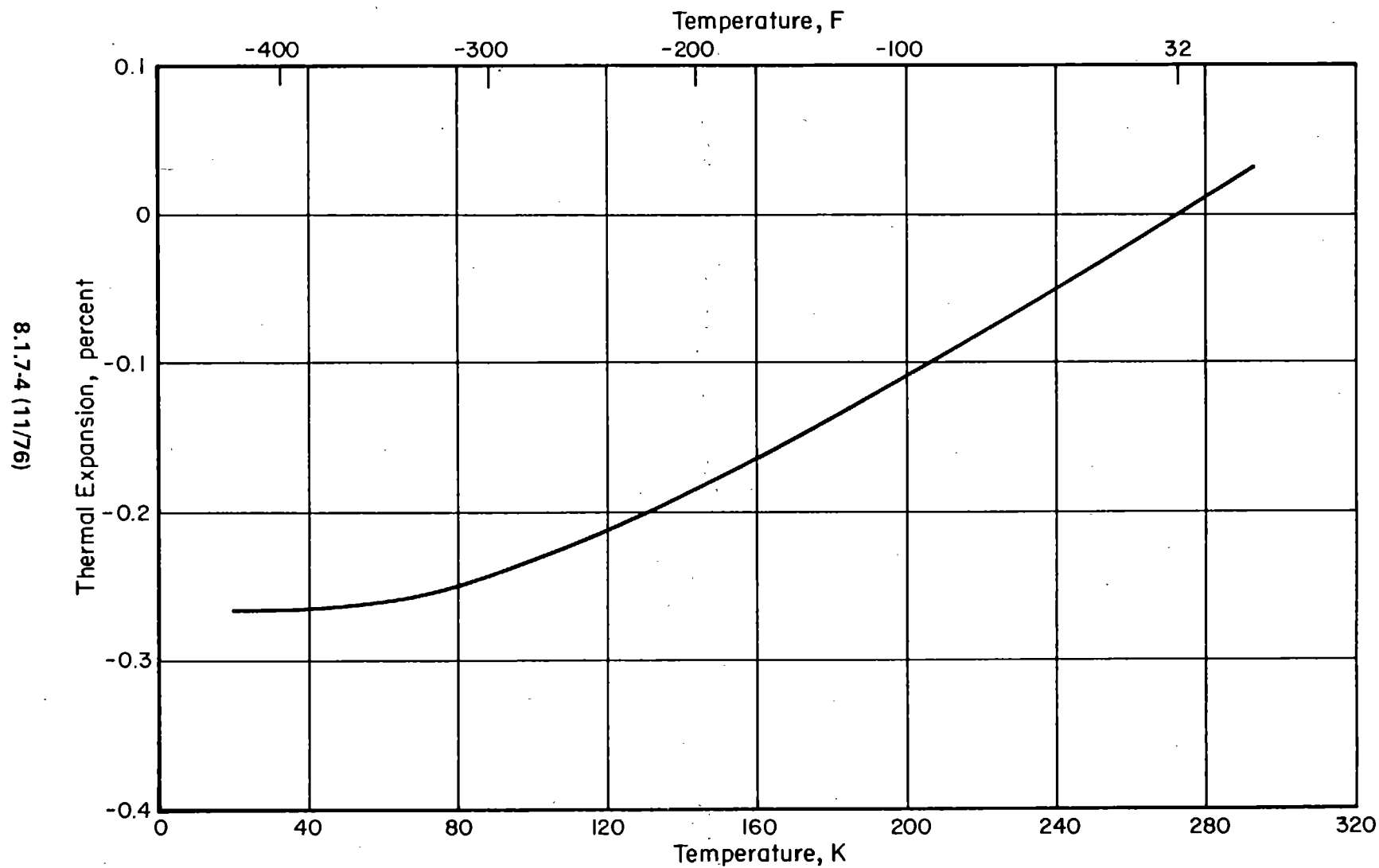


FIGURE 8.1.7-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 303 STAINLESS STEEL

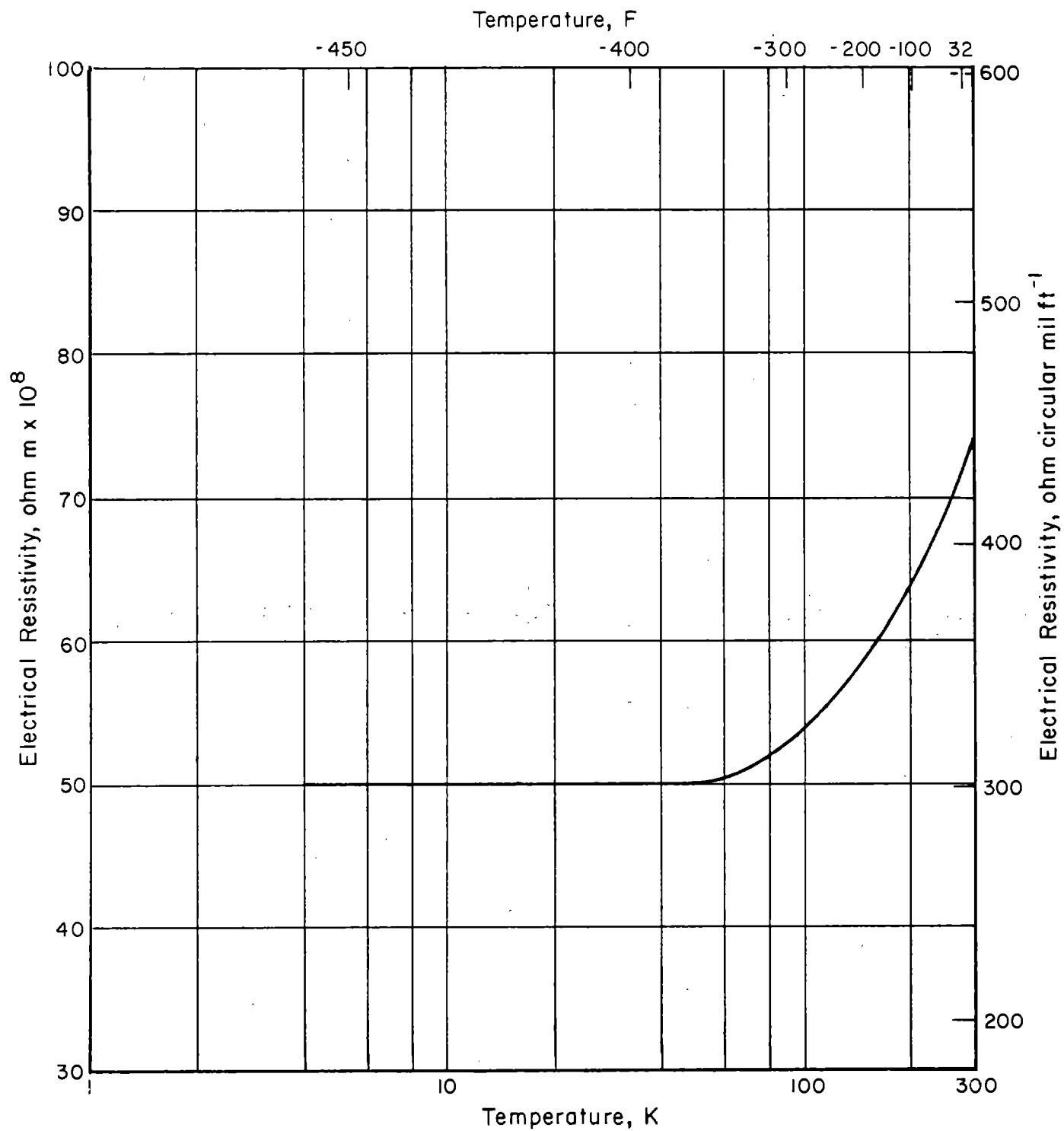


FIGURE 8.1.7-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 303 STAINLESS STEEL

TABLE 8.1.8-ME0.1

Type 310S
Sheet

Alloy Designation: Type 310S Stainless Steel

S31008

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)	297 (75)					4 (-452)
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg					1230 (178)
	Min					1140 (165)
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					772 (112)
	Min					738 (107)
Std. Deviation						
Elong, percent	Avg					59
	Min					54
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						4 (1)
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					1280 (186)
	Min					1260 (183)
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					800 (116)
	Min					772 (112)
Std. Deviation						
Elong, percent	Avg					58
	Min					56
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						3 (1)
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 77930

TABLE 8.1.8-ME1

Alloy Designation: Type 310S Stainless Steel S31008

Specification:

Form: Forging

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Solution Treated 1365 K (2000 F) 1 hr., WQ (STQ)

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	585 (84.8)	1098 (159.2)	1303 (189.0)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	261 (37.9)	604 (87.6)	817 (118.5)			
	Min						
Std. Deviation							
Elong, percent	Avg	53.8	71.8	64.3			
	Min						
RA, percent	Avg	70.7	51.6	44.6			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	798 (115.8)	1355 (196.5)	1598 (231.8)			
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 94206E
94208G

TABLE 8.1.8-ME2

Alloy Designation: Type 310S Stainless Steel S31008

Specification:

Form:

Forging

Thickness, cm (in.):

Up to 2.540 (1.000)

Condition:

Solution Treated 1365 K (2000 F) 1 hr., FC to 700 K (800 F) 30 min., AC

(STFC)

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	578 (83.8)	1034 (150.0)	1300 (188.5)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	226 (32.8)	574 (83.2)	817 (118.5)			
	Min						
Std. Deviation							
Elong, percent	Avg	57.2	48.6	61.0			
	Min						
RA, percent	Avg	62.2	31.2	43.6			
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	763 (110.6)	1198 (173.8)	1472 (213.5)			
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 94206E
94208G

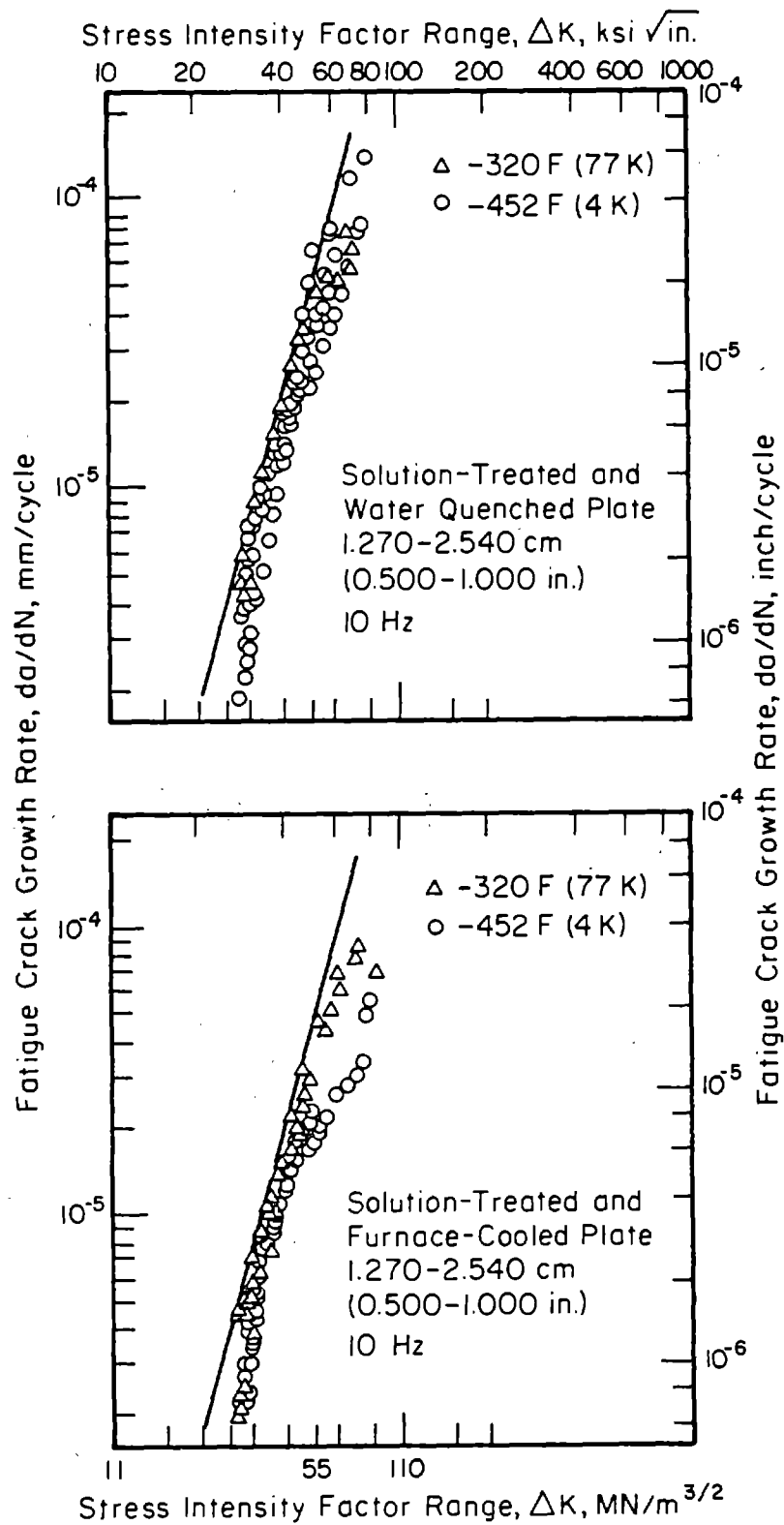


FIGURE 8.1.8-ME1. FATIGUE CARCK GROWTH RATE PROPERTIES OF AISI 310S STAINLESS STEEL AT 77K AND 4K (-320F AND -452F)(94208G)

TABLE 8.1.8-TR1

Type 310S

Alloy Designation:

Type 310S Stainless Steel

S31008

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	12.4	8.10	5.35	2.30	1.15	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(7.17)	(4.68)	(3.09)	(1.33)	(0.665)	
No. of Spec.	1	1	1	1	1	
References: 94206						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	480	255	105*	12.1	5.36	2.24
Btu lb ⁻¹ F ⁻¹	(0.115)	(6.09 x 10 ⁻²)	(2.51 x 10 ⁻²)	(2.89 x 10 ⁻³)	(1.28 x 10 ⁻³)	(5.35 x 10 ⁻⁴)
No. of Spec.	2	2	0	2	2	2
References: 90202, 94208, 95168						
Electrical Resistivity						
Ohm m	90 x 10 ⁻⁸	78 x 10 ⁻⁸	74 x 10 ⁻⁸	71 x 10 ⁻⁸	70 x 10 ⁻⁸	70 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(541)	(469)	(445)	(427)	(421)	(421)
No. of Spec.	2	2	2	2	2	2
References: 94260, 94208						
* Extrapolated						

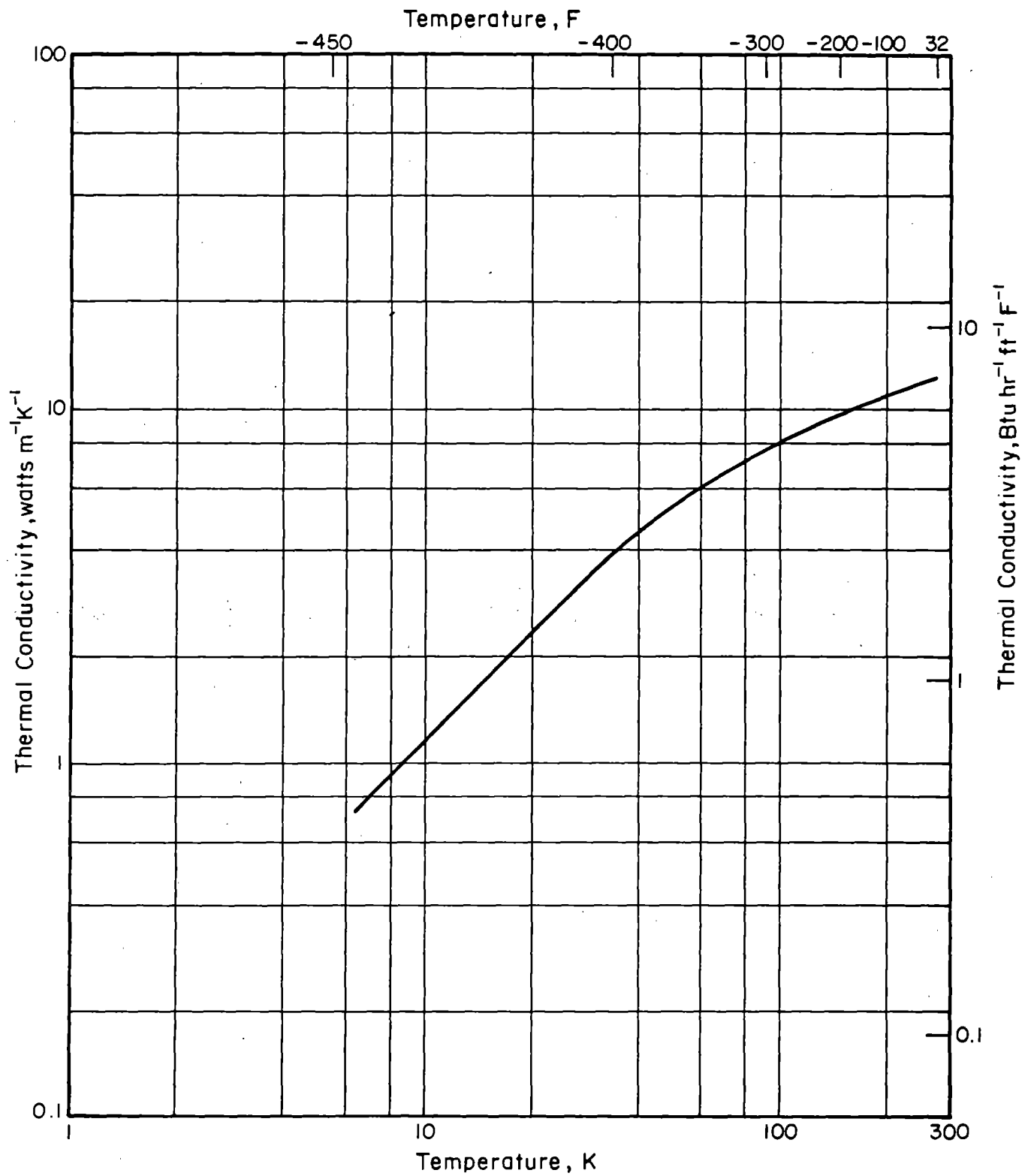


FIGURE 8.1.8-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 310 STAINLESS STEEL

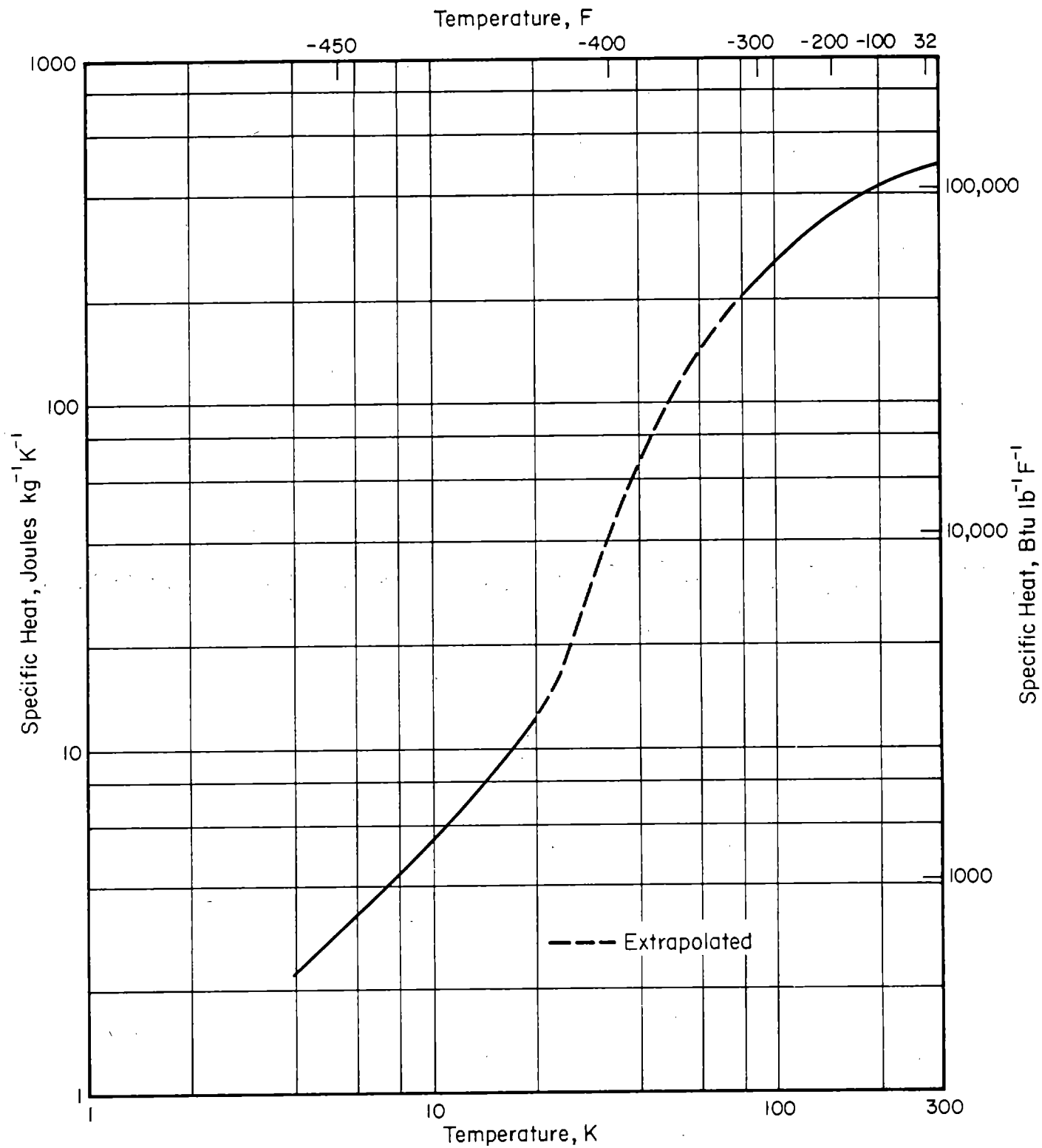


FIGURE 8.1.8-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR TYPE 310S STAINLESS STEEL

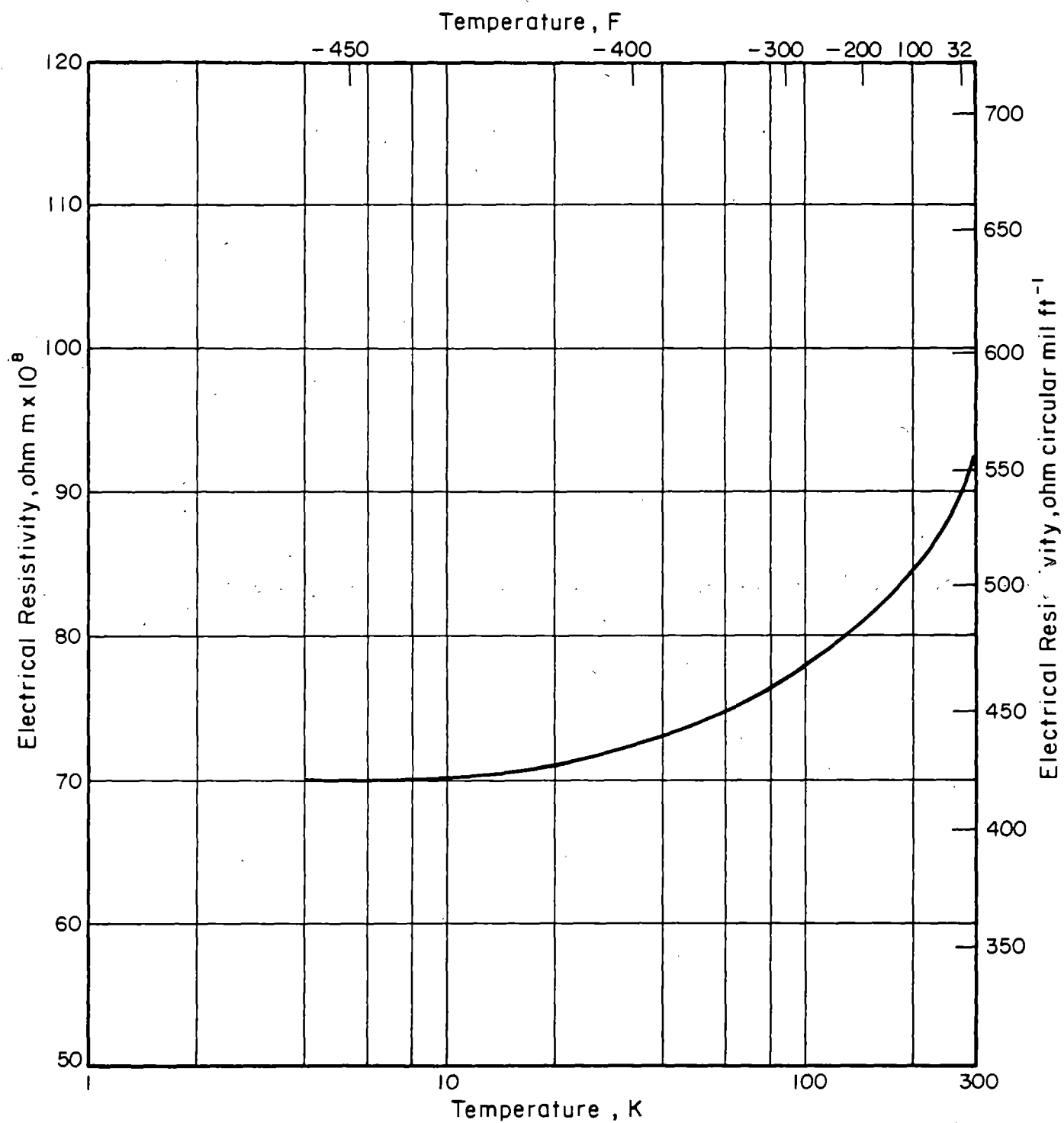
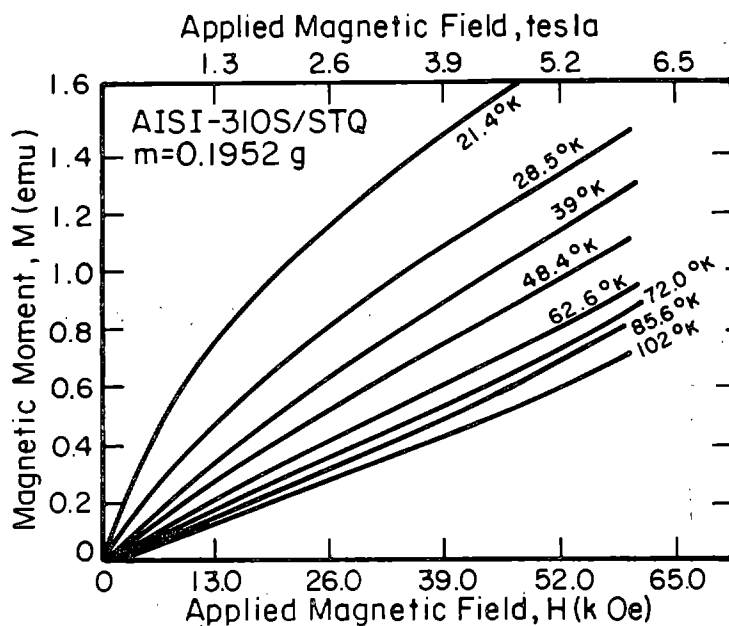


FIGURE 8.1.8-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 310S STAINLESS STEEL

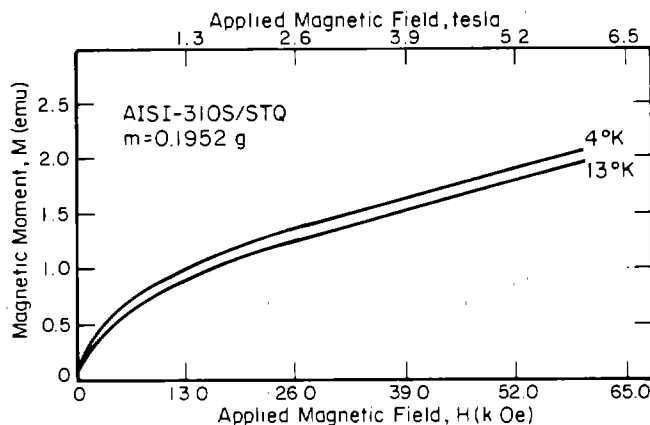
TABLE 8.1.8-MA1

Alloy Designation: Type 310S Stainless Steel
Specification: AISI 310S
Form: Rod
Dimension, cm(in.): Not given
Condition: STQ: solution treated and quenched (1800 F [1255 K] for 1 hr. and W.Q.)
Curie Temperature: Between 50 and 60 K (See Figures)
Peak induction, B_s ,
at 4.2K and 70kOe: 0.1T (tesla)



MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

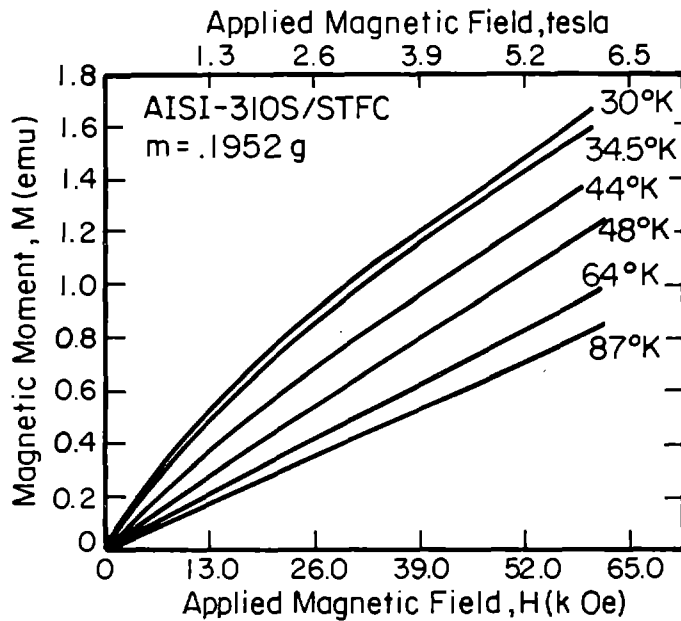
MAGNETIC MOMENT DATA AT LOW TEMPERATURES



Reference: 94206

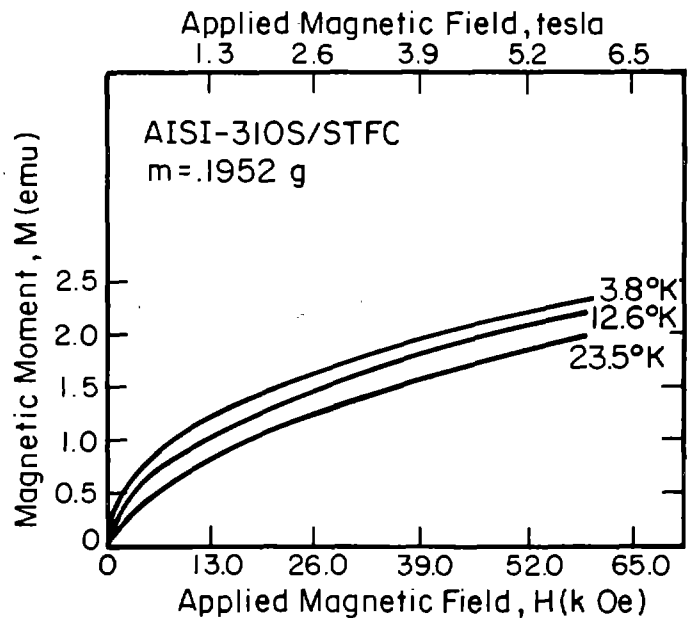
TABLE 8.1.8-MA2

Alloy Designation: Type 310S Stainless Steel
 Specification: AISI 310S
 Form: Rod
 Dimension, cm(in.): Not given
 Condition: STFC: sensitized, sample heated to 2000 F (1090 C) for 1 hr. and furnace cooled
 Curie Temperature: Between 50 and 60 K (See Figures)
 Peak induction, B_s ,
 at 4.2K and 70kOe: 1.0T (tesla)



MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

MAGNETIC MOMENT DATA AT LOW TEMPERATURES



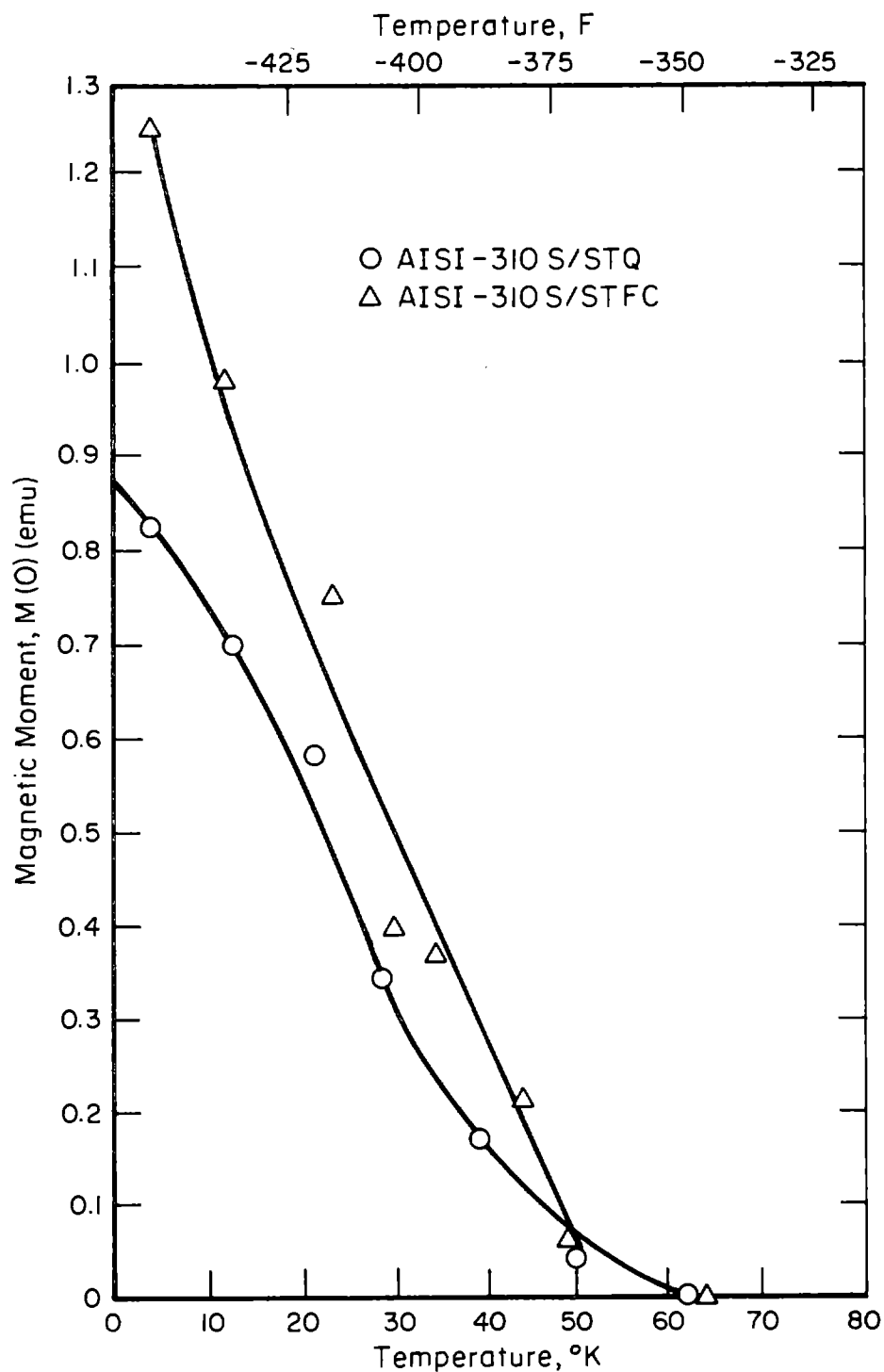


FIGURE 8.1.8-MA1. EXTRAPOLATED MAGNETIC MOMENT AT ZERO FIELD
AS A FUNCTION OF TEMPERATURE

TABLE 8.1.9-ME1

Alloy Designation: Type 347 Stainless Steel S34700

Specification:

Form: Sheet
 Thickness, cm (in.): Up to 0.099 (0.039)
 Condition: Annealed

Testing Temperature, K (F)	297 (75)			20 (-423)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 638 (92.5)			1572 (228)*		
Std. Deviation	Min					
TYS, MN/m ² (ksi)	Avg 255 (37)			662 (96)*		
Std. Deviation	Min					
Elong, percent	Avg 55.2			41		
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg 200 (29)			214 (31)		
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 49048

* Unpublished data from Battelle record book.

TABLE 8.1.9-ME2

Alloy Designation: Type 347 Stainless Steel S34700

Specification:

Form: Sheet
 Thickness, cm (in.): Up to 0.099 (0.039)
 Condition: Annealed

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency 1725 Hz* with $R = -1$ and $K_t = 3.2$ No. of S-N Curves (No. of Heats)	248 (36)	400 (52)	448 (65)	565 (82)		
Ratio S_N/TUS at 10^5 cycles	0.39	--	--	0.36		
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency 1725 Hz* with $R = -1$ and $K_t = 3.2$ No. of S-N Curves (No. of Heats)	179 (26)	324 (47)	345 (50)	462 (67)		
Ratio S_N/TUS at 10^6 cycles	0.28	--	--	0.29		
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency 1725 Hz* with $R = -1$ and $K_t = 6.4$ No. of S-N Curves (No. of Heats)	269 (39)	400 (58)	524 (76)	510 (74)		
Ratio S_N/TUS at 10^5 cycles	0.42	--	--	0.32		
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency 1725 Hz* with $R = -1$ and $K_t = 6.4$ No. of S-N Curves (No. of Heats)	179 (26)	317 (46)	400 (58)	331 (48)		
Ratio S_N/TUS at 10^6 cycles	0.28	--	--	0.21		
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with $R =$ and $K_t =$ No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 49048

* 3450 Hz at 20 K.

TABLE 8.1.9-ME3

Type 347
Sheet

Alloy Designation: Type 347 Stainless Steel S34700

Specification: QQ-S-766

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1340 K (1950 F) ASTM Grain Size 7½

Testing Temperature, K (F)		297 (75)	77 (-320)	20 (-423)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	648 (94)	1365 (198)	1613 (234)			
	Min	641 (93)	1351 (196)	1503 (218)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	255 (37)	421 (61)	434 (63)			
	Min	248 (36)	400 (58)	400 (58)			
Std. Deviation							
Elong, percent	Avg	52	47	35			
	Min	50	46	30			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)	6 (2)	6 (2)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 83417

TABLE 8.1.9-ME4

Alloy Designation:	Type 347 Stainless Steel	S34700
Specification:	QQ-S-766	
Form:	Sheet	
Thickness, cm (in.):	0.100 to 0.319 (0.040 to 0.125)	
Condition:	Annealed 1340 K (1950 F)	ASTM Grain Size 7½

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)		
Fatigue, Flexural Loading, Surface Finish 11 rms					
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency Hz with $R = -1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	248 (36)	503 (73)	531 (77)		
Ratio S_N/TUS at 10^5 cycles	0.39	0.37	0.31		
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency Hz with $R = -1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	241 (35)	469 (68)	510 (74)		
Ratio S_N/TUS at 10^6 cycles	0.38	0.34	0.30		
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with $R = -1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	241 (35)	455 (66)	--		
Ratio S_N/TUS at 10^7 cycles	0.37	0.33	--		
Fatigue, Flexural Loading, Surface Finish 64 rms					
S_N at 10^5 cycles, MN/m ² (ksi) Loading frequency Hz with $R = -1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	234 (34)	441 (64)	441 (64)		
Ratio S_N/TUS at 10^5 cycles	0.37	0.33	0.29		
S_N at 10^6 cycles, MN/m ² (ksi) Loading frequency Hz with $R = -1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	221 (32)	421 (61)	386 (56)		
Ratio S_N/TUS at 10^6 cycles	0.34	0.31	0.25		
S_N at 10^7 cycles, MN/m ² (ksi) Loading frequency Hz with $R = -1$ and $K_t = 1$ No. of S-N Curves (No. of Heats)	214 (31)	421 (61)	--		
Ratio S_N/TUS at 10^7 cycles	0.33	0.31	--		

References: 83417

TABLE 8.1.9-ME5

Alloy Designation:

Type 347 Stainless Steel

S34700

Specification:

Form:

Plate

Thickness, cm (in.):

0.635 to 1.269 (0.250 to 0.499)

Condition:

Hot rolled, annealed and pickled

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	629 (91.2)	945 (137.0)	1427 (207.0)	1792 (259.9)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg	4 min.	4 min.	4 min.	4 min.		
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

TABLE 8.1.9-ME6

Alloy Designation: Type 347 Stainless Steel S34700

Specification:

Form: Plate
 Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)
 Condition: Hot rolled, annealed and pickled

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg	531 (77.0)	779 (113.0)	1000 (145.0)	1048 (152.0)	
	Min					
No. of Spec. (No. of Heats)	4 min.	4 min.	4 min.	4 min.		
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 65182

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.1.9-ME7

Type 347
Plate

Alloy Designation: Type 347 Stainless Steel S34700

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed 2000 F 1 hr., WQ Average grain diameter 0.013mm

Testing Temperature, K (F)		297 (75)	168 (-76)	77 (-320)	4 (-452)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	594 (86.2)	982 (142.5)	1322 (191.7)	1560 (232.0)		
	Min	554 (80.4)	962 (139.6)	1296 (188.0)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg		465 (67.4)	493 (71.6)			
	Min						
Std. Deviation							
Elong, percent	Avg	58.5	50.0	43.0	41.0		
	Min	57.0	47.0	38.0			
RA, percent	Avg	68.4	61.9	46.8	49.0		
	Min	66.3	58.8	34.6			
No. of Spec. (No. of Heats)		2 (2)	2 (2)	2 (2)	1 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	724 (105.0)	1114 (161.5)	1200 (174.0)	1351 (196.0)		
K _t = 6.3	Min						
No. of Spec. (No. of Heats)		1	1	1	1		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 52856, 96683

TABLE 8.1.9-ME7.1

Type 347
Plate

Alloy Designation: Type 347 Stainless Steel

S34700

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Commercially treated, softened, descaled

Testing Temperature, K (F)		297 (75)	223 (-58)	173 (-148)	148 (-193)	123 (-240)	77 (-320)
Compression, Longitudinal							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Compression, Transverse							
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Shear^(a)							
SUS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Impact, Charpy V							
Long., Nm(ft-lb)	Avg	120 (87)	140 (105)	140 (105)	120 (92)	120 (91)	110 (83)
	Min	110 (83)	130 (99)				110 (80)
No. of Spec. (No. of Heats)		2 (1)	2 (1)	1	1	1	3 (1)
Trans., Nm(ft-lb)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Fracture Toughness^(b)							
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg						
	Min						
Orientation: —							
No. of Spec. (No. of Heats)							
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg						
(From PTSC spec.) (—)Min							
No. of Spec. (No. of Heats)							

References: 96683

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.1.9-ME7.2

Alloy Designation: Type 347 Stainless Steel (Weld Metal) S34700

Specification:

Form: Plate-MIG welded, type 347 covered electrode

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate welded, annealed 1366 K (2000 F) 1 hr, WQ, tested as quenched

Testing Temperature, K (F)		297 (75)	168 (-156)		77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	634 (92.0)	1034 (150.0)		1358 (197.0)		1505(227.0)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	59.0	62.0		48.0		41.0
	Min						
RA, percent	Avg	68.5	66.5		60.5		41.0
	Min						
No. of Spec. (No. of Heats)		1	1		1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	761.9 (110.5)	899.7 (130.5)		1045 (151.5)		1200(174.0)
K _t = 6.3	Min						
No. of Spec. (No. of Heats)		1	1		1		1
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 52856

TABLE 8.1.9-ME8

Alloy Designation: Type 347 Stainless Steel S34700

Specification:

Form: Plate
 Thickness, cm (in.): over 5.080 (2.000)
 Condition: Annealed

Testing Temperature, K (F)	297 (75)	90 (-300)	20 (-423)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)		104 (77)	80.0 (59)			
Avg						
Min						
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)		78.6 (58)	71.9 (53)			
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 94205

- (a) Indicate specimen design and orientation for shear specimens:
 (b) Indicate specimen design for K_{IC} data:

TABLE 8.1.9-ME9

Type 347
Bar

Alloy Designation: Type 347 Stainless Steel

S34700

Specification:

Form:

Bar

Thickness, cm (in.):

Up to 2.540 (1.000)

Condition:

Annealed

ASTM grain size 9-10

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	17 (-430)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	672 (97.4)	996 (144.5)	1472 (213.5)	1849 (268.1)	1687 (237.4)	1630 (236.4)
	Min	647 (93.9)	742 (136.6)	1389 (201.4)	1837 (266.4)	1606 (233.0)	--
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	340 (49.3)	474 (68.8)	429 (62.2)	527 (76.4)	358 (51.9)	--
	Min	294 (42.7)	463 (67.2)	414 (60.1)	497 (72.1)	328 (47.5)	--
Std. Deviation							
Elong, percent	Avg	57.4	50.9	42.6	38.0	41.3	38.0
	Min	50.0	49.9	41.1	37.6	36	--
RA, percent	Avg	75.9	70.8	59.8	45.3	43.8	54.7
	Min	73.0	69.3	56.3	42.3	28	--
No. of Spec. (No. of Heats)		8 (3)	4 (2)	4 (2)	3 (1)	4 (1)	1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	785 (113.8)				1477 (214.2)	
	Min	745 (108.0)				1124 (163.0)	
K _t = 6.4							
No. of Spec. (No. of Heats)		5 (1)				5 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 54986, 45464, 64373

TABLE 8.1.9-ME10

Alloy Designation: Type 347 Stainless Steel S34700

Specification:
 Form: Bar
 Thickness, cm (in.): Up to 2.540 (1.000)
 Condition: Annealed

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg	71.9 (53.5)	79.3 (58.5)	73.9 (54.5)	60.3 (44.5)		
Min	66.4 (49.0)	75.9 (56.0)	71.9 (53.0)	60.3 (44.5)		
No. of Spec. (No. of Heats)	4	3	3	2		
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 54986

- (a) Indicate specimen design and orientation for shear specimens:
 (b) Indicate specimen design for K_{IC} data:

8.1.9-11 (11/75)

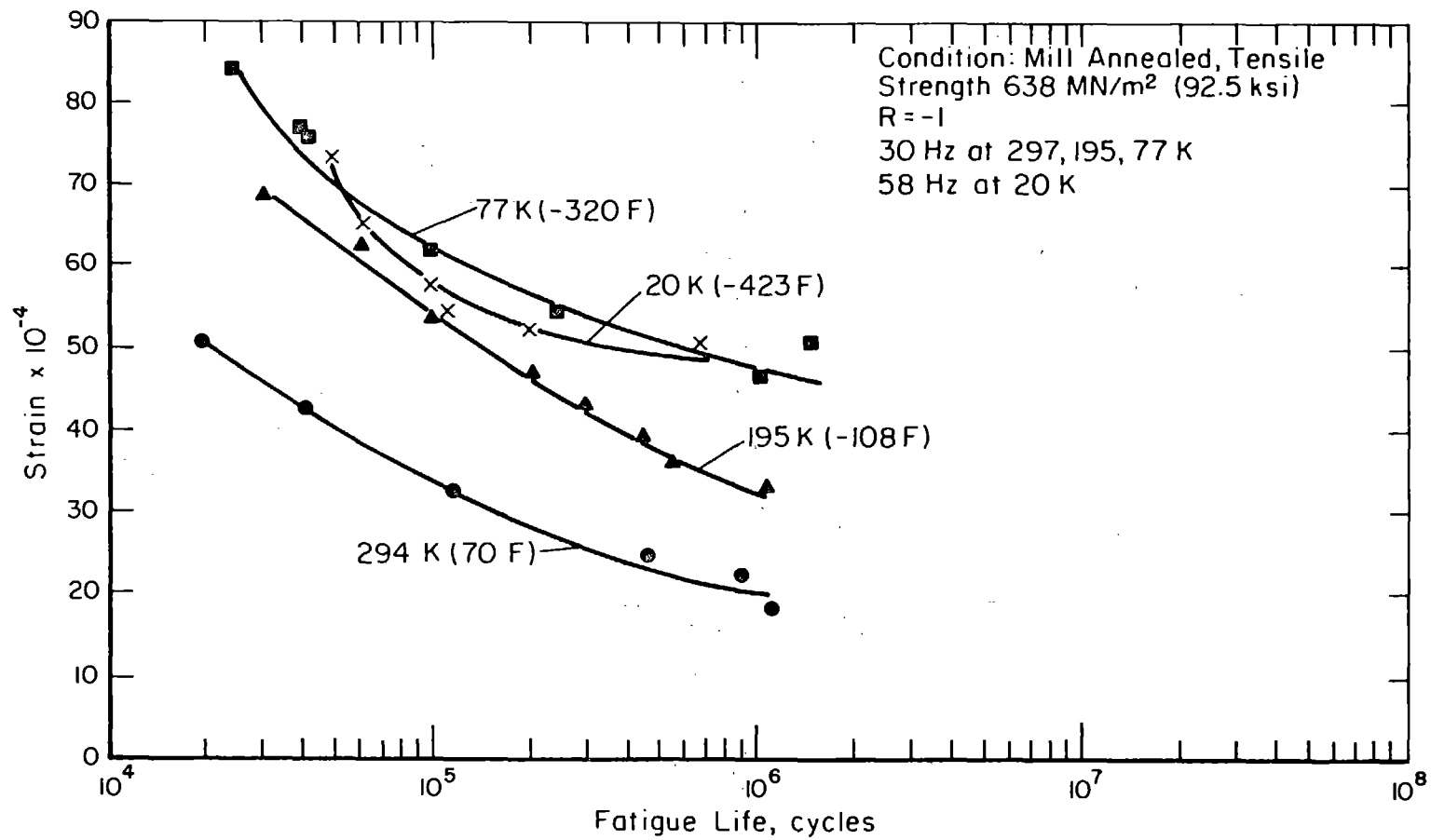


FIGURE 8.1.9-ME1. UNNOTCHED ($K_T = 1$) FLEXURE FATIGUE BEHAVIOR OF ANNEALED 347 STAINLESS STEEL SHEET (U_p to 0.099cm [0.039 in.])⁴⁹⁰⁴⁸

TABLE 8.1.9-TR1

Alloy Designation:

Type 347 Stainless Steel

S34700

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹ (1)	13.6	9.04	5.65	2.18	0.926	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(7.86)	(5.23)	(3.27)	(1.26)	(0.535)	
No. of Spec.	1	1	1	1	1	
References: 90193						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.234	-0.266	-0.267	-0.267	-0.267
No. of Spec.	1	1	1	1	1	1
References: 69332						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m(1)	74.4 x 10 ⁻⁸	58.6 x 10 ⁻⁸	54.7 x 10 ⁻⁸	54.4 x 10 ⁻⁸	54.4 x 10 ⁻⁸	
Ohm circular mil ft ⁻¹	(448)	(352)	(329)	(327)	(327)	
Ohm m(2)	70.8 x 10 ⁻⁸	54.0 x 10 ⁻⁸	50.2 x 10 ⁻⁸	50.0 x 10 ⁻⁸	50.1 x 10 ⁻⁸	50.1 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(426)	(325)	(302)	(301)	(301)	(301)
No. of Spec.	2	2	2	2	2	2
References: 79561, 90193						

(1) Triple brazed condition.

(2) Annealed.

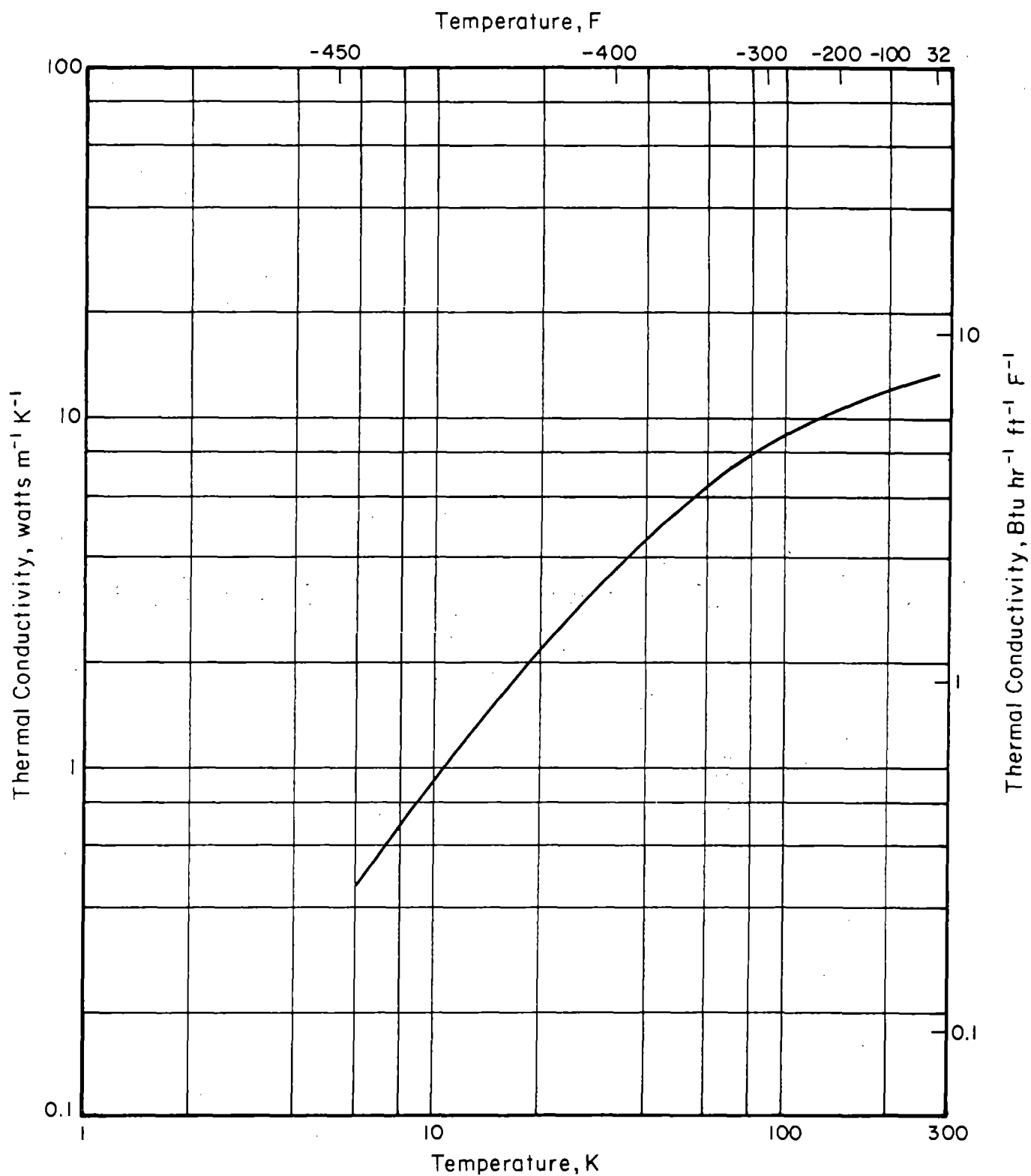


FIGURE 8.1.9-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 347 STAINLESS STEEL (Triple Braze Condition)

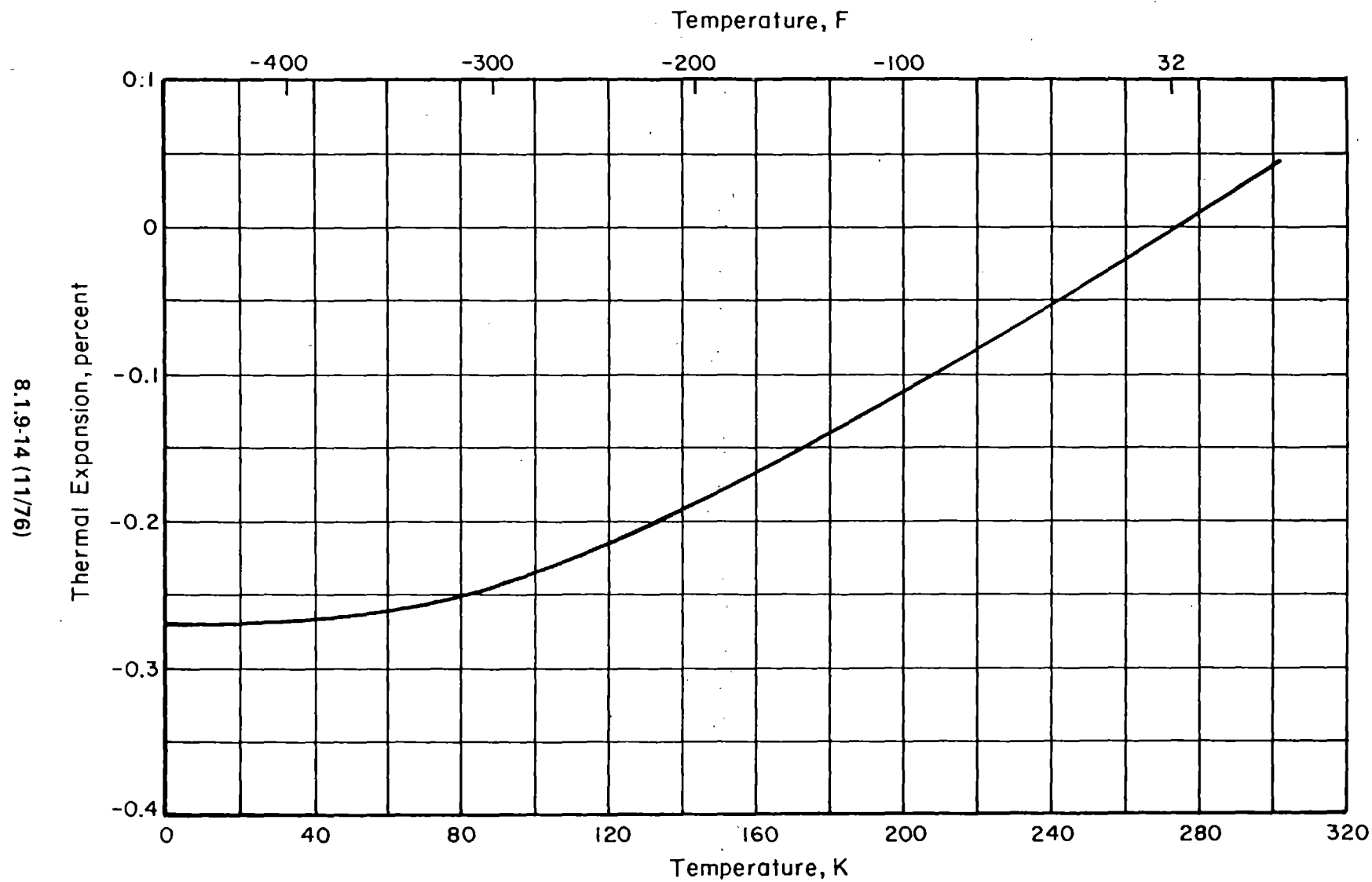


FIGURE 8.1.9-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 347 STAINLESS STEEL

Type 347

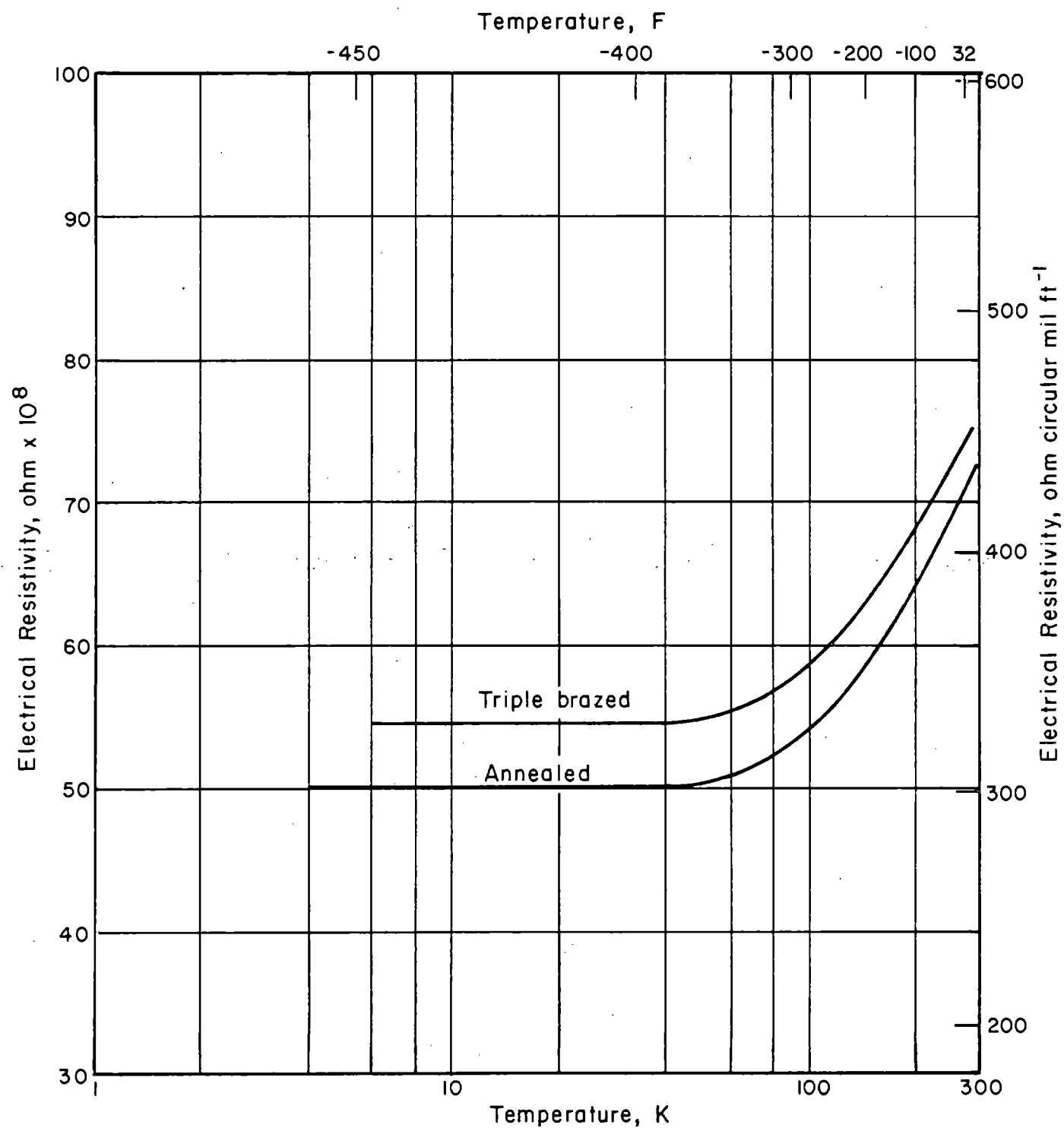


FIGURE 8.1.9-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 347 STAINLESS STEEL

TABLE 8.1.10-ME1

Alloy Designation: Type 410 Stainless Steel

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Heat treated 1255 K (1800 F) 1 hr, OQ, tempered 644 K (700 F) 4 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1383 (200.6)	1463 (212.2)		1821 (264.1)	2219 (321.8)	
	Min	1342 (194.7)	1419 (205.8)		1785 (258.9)	2178 (315.9)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1383 (200.6)	1463 (212.2)		1821 (264.1)		
	Min	1342 (194.7)	1419 (205.8)		1785 (258.9)		
Std. Deviation							
Elong, percent	Avg	14.3	15.1		5.8	0.8	
	Min	13.9	13.8		5.4	0.7	
RA, percent	Avg	67.2	64.4		20.6	5.6	
	Min	66.2	63.2		20.6	5.2	
No. of Spec. (No. of Heats)		3 (1)	3 (1)		2 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 54986

TABLE 8.1.10-ME2

Type 410
Bar

Alloy Designation: Type 410 Stainless Steel

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Heat treated 1255 K (1800 F) 1 hr, OQ, tempered 644 K (700 F) 4 hr, AC

Testing Temperature, K (F)	297 (75)	195 (-108)		77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg	30.4 (22.5)	12.8 (9.5)	3.4 (2.5)		
	Min	22.3 (16.5)	8.1 (6.0)	2.7 (2.0)		
No. of Spec. (No. of Heats)		7 (1)	8 (1)	5 (1)		
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 54986

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.1.10-TR1

Alloy Designation: Type 410 Stainless Steel

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
<u>Thermal Conductivity</u>						
Watts m ⁻¹ K ⁻¹	27.2	21.1	13.1			
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(15.7)	(12.3)	(7.57)			
No. of Spec.	1	1	1			
References: 90224						
<u>Thermal Expansion (T₂₇₃ to T)</u>						
<u>Longitudinal</u>						
Percent	0	-0.144	-0.155	-0.156	-0.156	-0.156
No. of Spec.	2	2	2	2	2	2
References: 48571, 90226						
<u>Specific Heat</u>						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
<u>Electrical Resistivity⁽¹⁾</u>						
Ohm m	5.50 x 10 ⁻⁷	4.12 x 10 ⁻⁷	3.86 x 10 ⁻⁷	3.82 x 10 ⁻⁷	3.82 x 10 ⁻⁷	3.82 x 10 ⁻⁷
Ohm circular mil ft ⁻¹	(336)	(248)	(232)	(230)	(230)	(230)
No. of Spec.	1	1	1	1	1	1
References: 79561						
1) Hardened.						

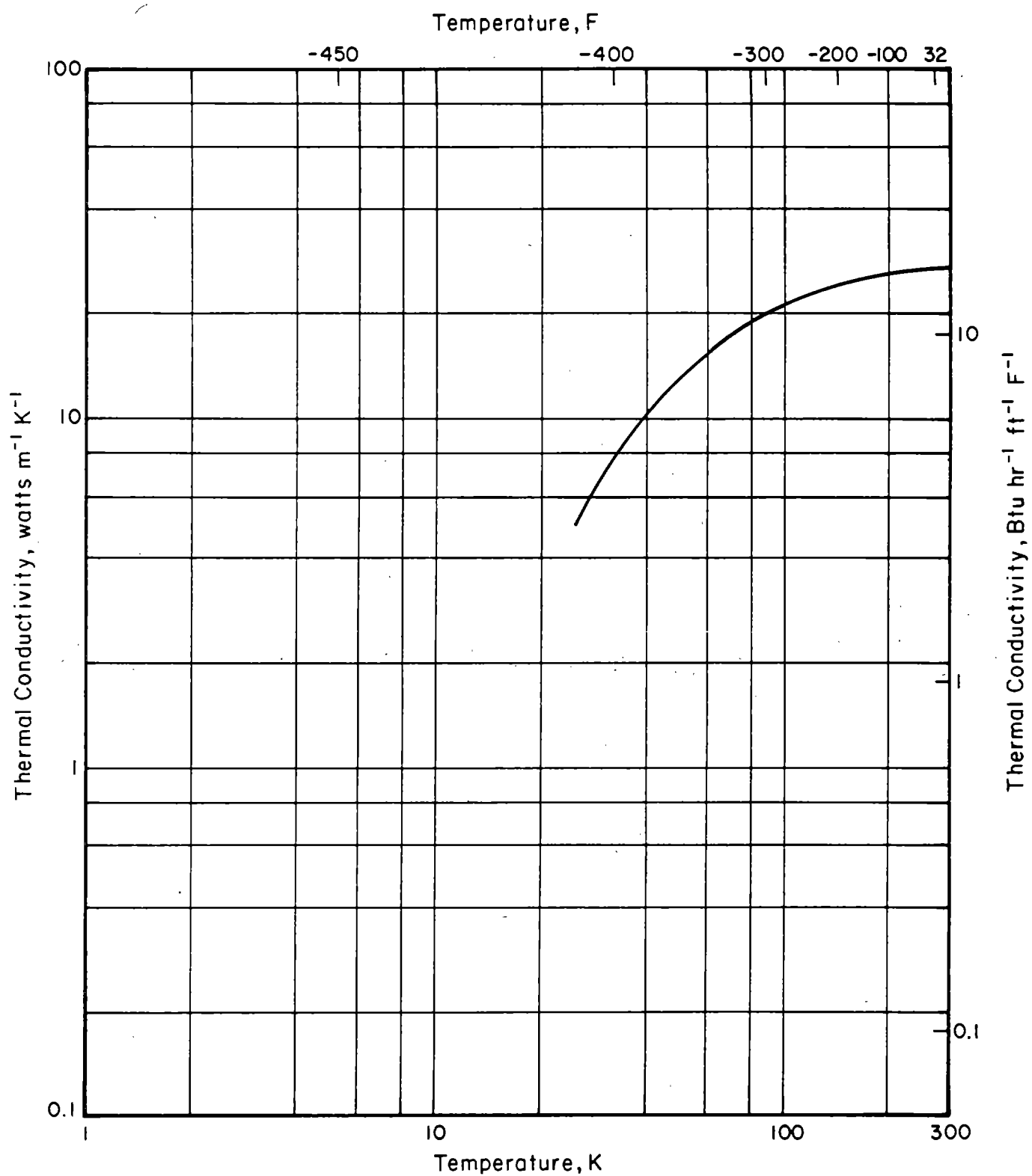


FIGURE 8.1.10-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TYPE 410 STAINLESS STEEL

8.1.10-4 (11/76)

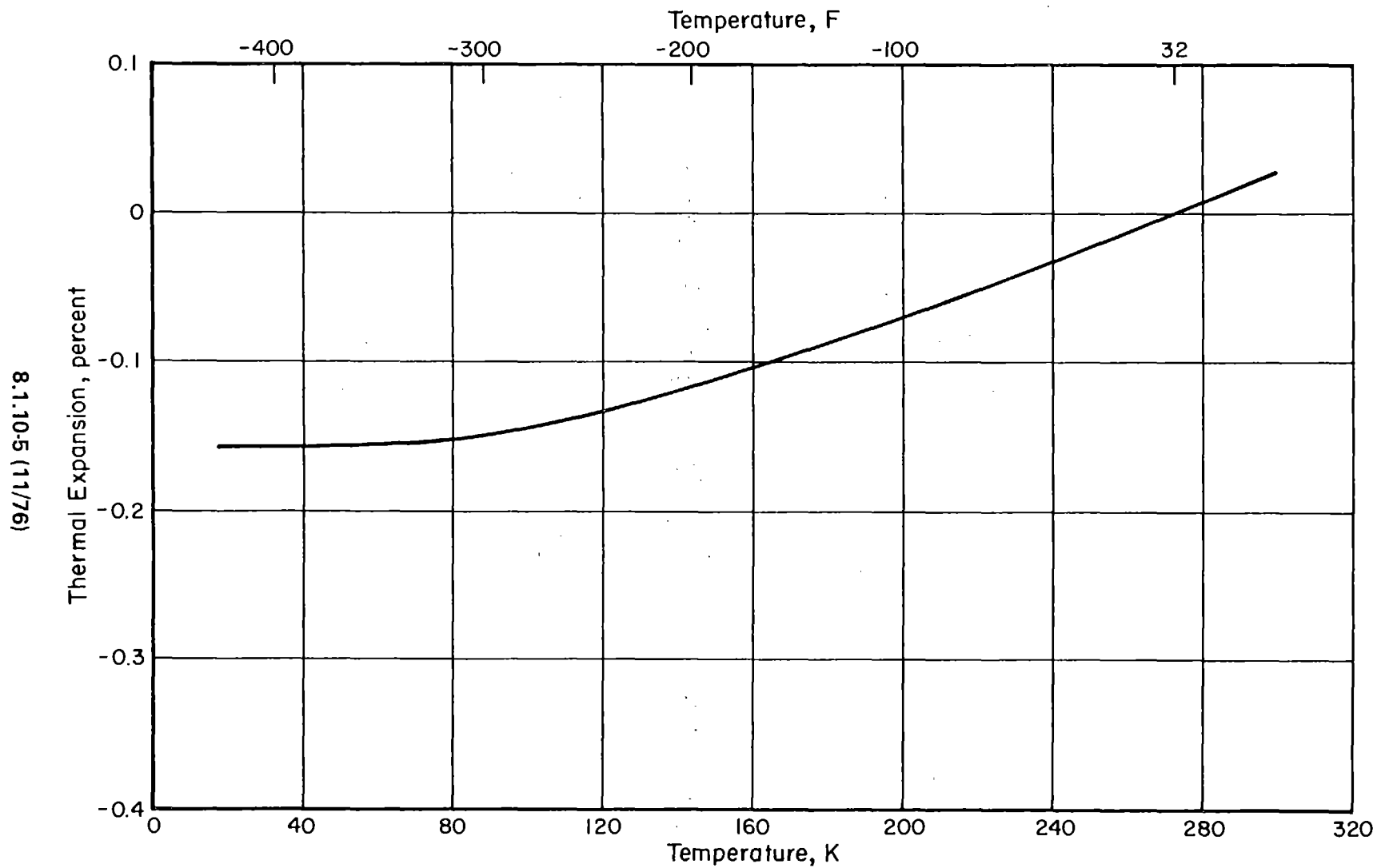


FIGURE 8.1.10-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 410 STAINLESS STEEL

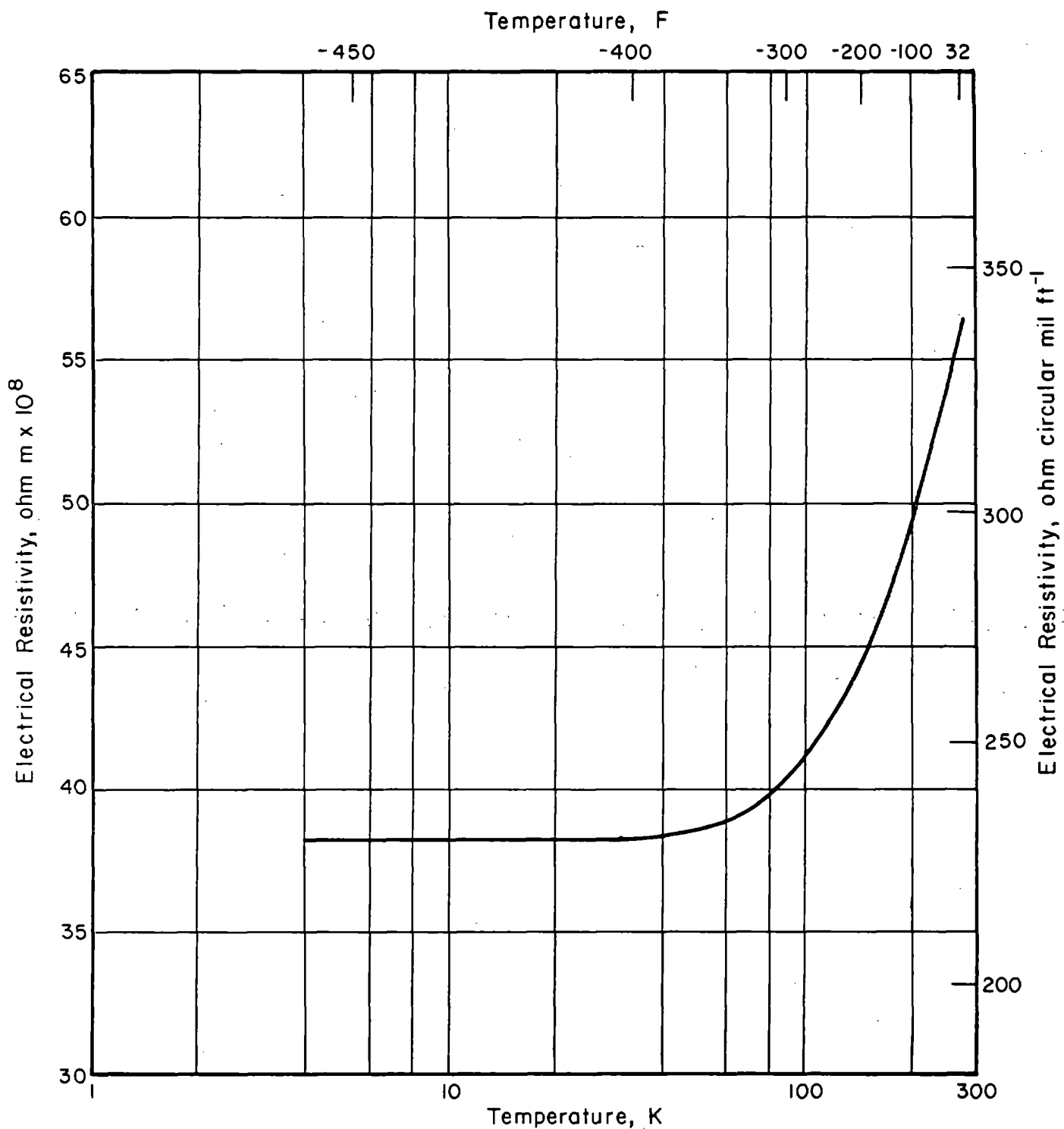


FIGURE 8.1.10-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 410 STAINLESS STEEL

8.1.10-6 (11/76)

TABLE 8.1.11-ME1

Type 416
Bar

Alloy Designation: Type 416 Stainless Steel

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Heat treated 1255 K (1800 F) 1 hr, OQ, tempered 644 K (700 F) 4 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1400 (203.1)	1504 (218.1)		1800 (261.1)	2017 (292.6)	
	Min	1388 (201.3)	1498 (217.3)		1781 (258.3)	2000 (290.1)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1200 (174.1)	1259 (182.6)		1598 (231.8)	2017 (292.6)	
	Min	1142 (165.6)	1257 (182.3)		1587 (230.2)	2000 (290.1)	
Std. Deviation							
Elong, percent	Avg	15.1	15.4		9.2	0.4	
	Min	14.9	15.3		8.2		
RA, percent	Avg	53.3	52.0		23.5	2.3	
	Min	52.2	51.6		18.2	2.1	
No. of Spec. (No. of Heats)		3 (1)	2 (1)		4 (1)	2 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 54986

TABLE B.1.11-ME2

Type 416
Bar

Alloy Designation: Type 416 Stainless Steel

Specification:

Form:

Thickness, cm (in.):

Condition:

Testing Temperature, K (F)	297 (75)	195 (-108)		77 (-320)		
<u>Compression, Longitudinal</u>						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN /m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Compression, Transverse</u>						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Shear^(a)</u>						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Impact, Charpy V</u>						
Long., Nm(ft-lb)	Avg	45.4 (33.6)	13.5 (10.0)	3.4 (2.5)		
	Min	45.2 (33.5)	12.8 (9.5)	2.7 (2.0)		
No. of Spec. (No. of Heats)		3 (1)	3 (1)	5 (1)		
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Fracture Toughness^(b)</u>						
K _{Ic} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{Ic} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 54986

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.1.11-TR1

Alloy Designation: Type 416 Stainless Steel

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)⁽¹⁾						
Longitudinal						
Percent	0	-0.148	-0.164	-0.167		
No. of Spec.	1	1	1	1		
References: 48134						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity ⁽²⁾						
Ohm m	6.62 x 10 ⁻⁷	5.46 x 10 ⁻⁷	5.27 x 10 ⁻⁷	5.23 x 10 ⁻⁷	5.23 x 10 ⁻⁷	5.23 x 10 ⁻⁷
Ohm circular mil. ft ⁻¹	(398)	(328)	(317)	(315)	(315)	(315)
No. of Spec.	1	1	1	1	1	1
References: 79561						

(1) Hot-rolled.

(2) Hardened.

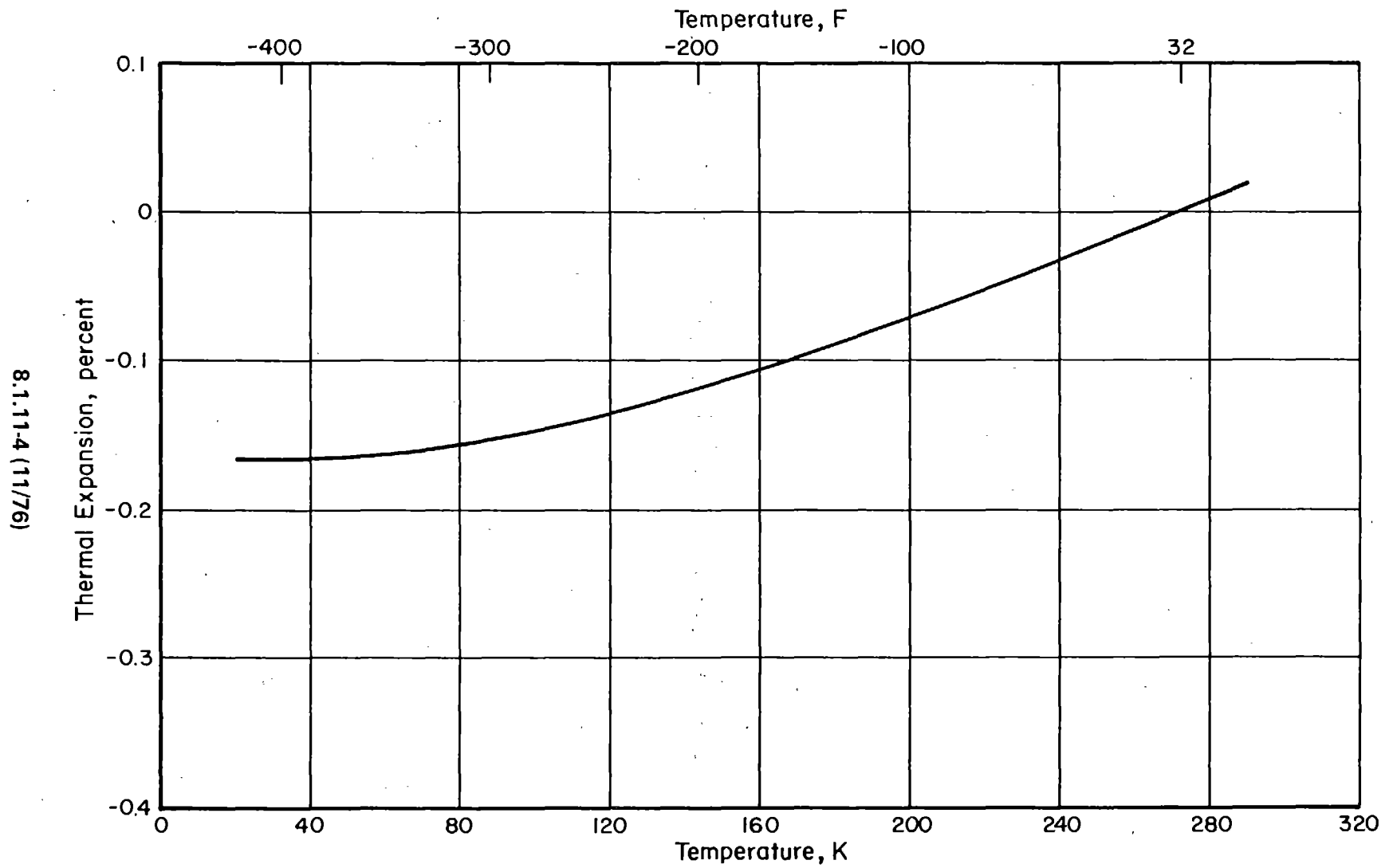


FIGURE 8.1.11-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TYPE 416 STAINLESS STEEL (Hot-rolled)

Type 416

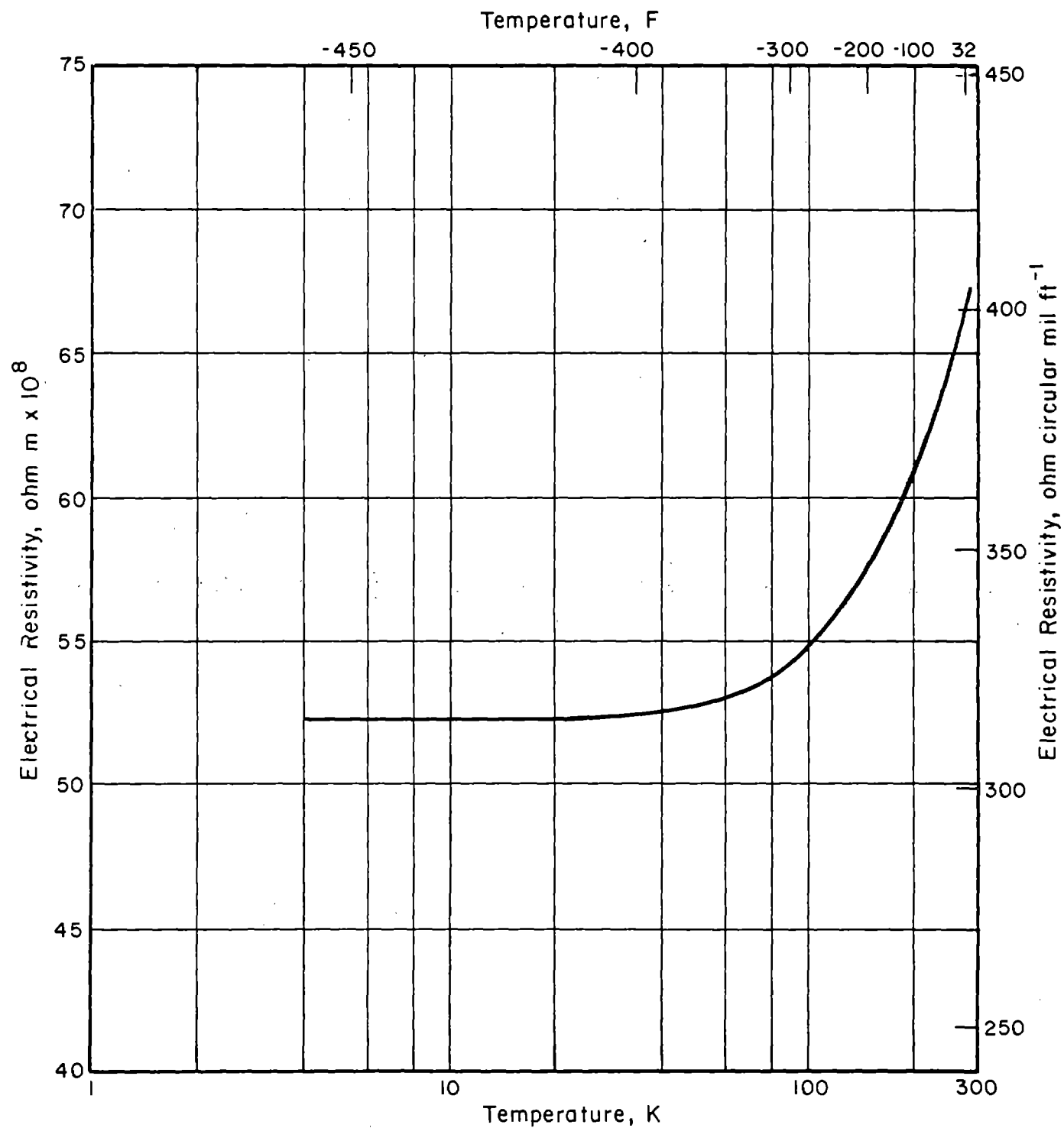


FIGURE 8.1.11-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR TYPE 416 STAINLESS STEEL (Hardened)

TABLE 8.2.1-ME1

Alloy Designation: A-286 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed 1255 K (1800 F) 30 min, WQ, aged 865 K (1100 F) 16 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1109 (161)		1486 (216)	1714 (249)		
	Min	1098 (159)		1475 (214)	1711 (248)		
Std Deviation							
TYS, MN/m ² (ksi)	Avg	632 (91.7)		796 (115)	915 (133)		
	Min	618 (89.7)		780 (113)	910 (132)		
Std Deviation							
Elong, percent	Avg	17.7		15.3	24.7		
	Min	17.0		15.0	22.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1062 (154)		1271 (184)	1528 (222)		
	Min	1044 (151)		1239 (180)	1517 (220)		
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg	1022 (148)		1212 (176)	1377 (200)		
	Min	1011 (147)		1191 (173)	1359 (197)		
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1102 (160)		1468 (213)			
	Min	1098 (159)		1468 (213)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	659 (95.6)		868 (126)			
	Min	649 (94.1)		838 (122)			
Std. Deviation							
Elong, percent	Avg	22.0		29.8			
	Min	22.0		27.0			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1111 (161)		1338 (194)			
	Min						
No. of Spec. (No. of Heats)		1 (1)		1 (1)			
NTS, MN/m ² (ksi)	Avg	1080 (157)		1282 (186)			
	Min						
No. of Spec. (No. of Heats)		1 (1)		1 (1)			

References: 39414

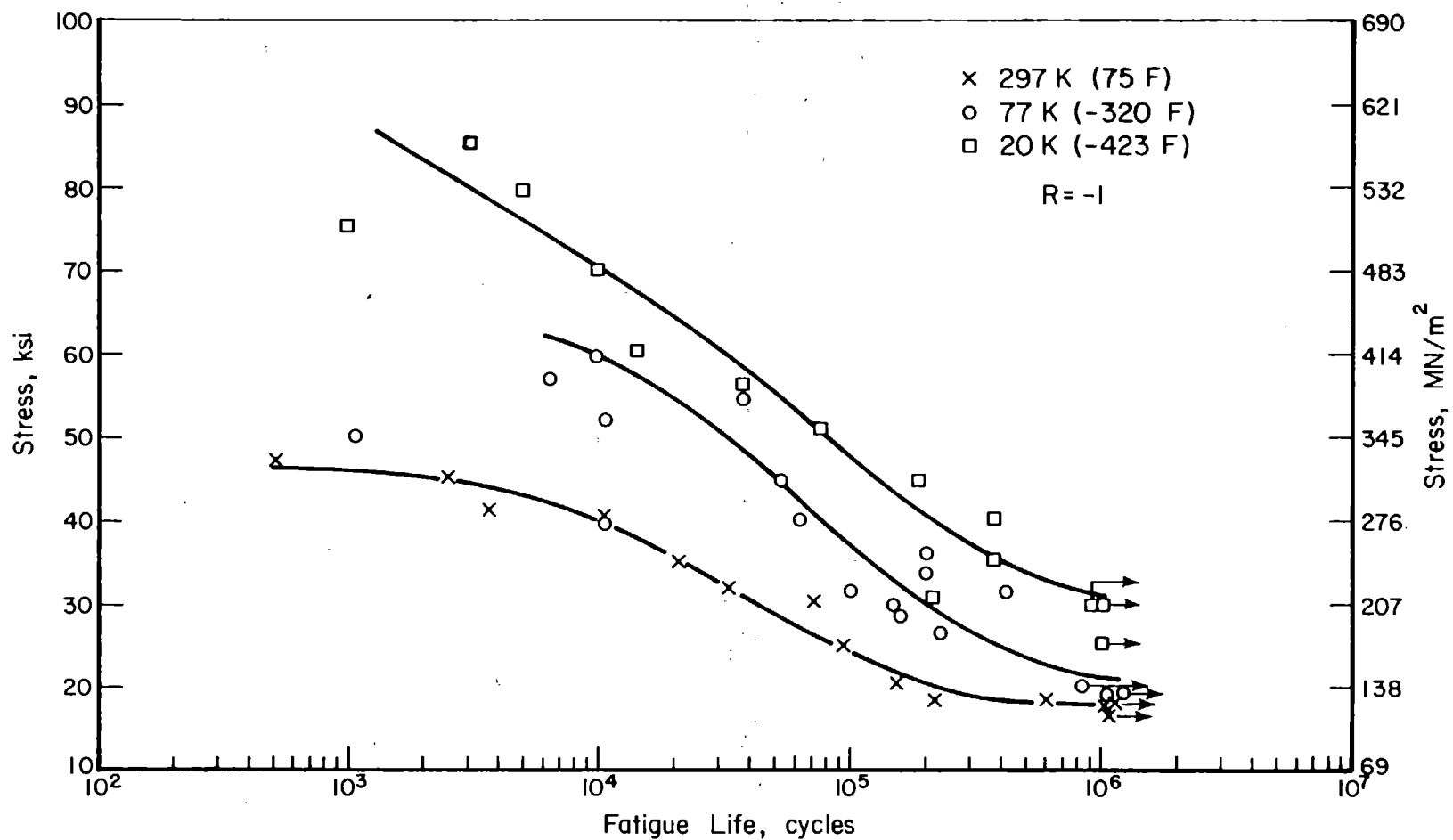


FIGURE 8.2.1-ME1.1. AXIAL FATIGUE PROPERTIES OF WELDED A-286 STAINLESS STEEL SHEET 0.319 cm (0.125 in.) THICK (STA Sheet TIG Welded, Hastelloy W filler, Tested as Welded) [61996]

TABLE 8.2.1-ME2

Alloy Designation: A-286 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed 1255 K (1800 F) 30 min, WQ, aged 990 K (1325 F) 16 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1034 (150)		1400 (203)	1603 (232)		
	Min	1028 (149)		1397 (203)	1586 (230)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	668 (96.9)		839 (122)	956 (139)		
	Min	658 (95.5)		793 (115)	945 (137)		
Std. Deviation							
Elong, percent	Avg	14.5		22.3	17.7		
	Min	13.5		21.0	17.0		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1050 (152)		1241 (180)			
	Min	1047 (152)		1197 (174)			
K _t = 3.2							
No. of Spec. (No. of Heats)		3 (1)		3 (1)			
NTS, MN/m ² (ksi)	Avg	1015 (147)		1228 (178)	1401 (203)		
	Min	1014 (147)		1211 (176)	1393 (202)		
K _t = 6.3							
No. of Spec. (No. of Heats)		2 (1)		3 (1)	3 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1042 (151)		1382 (200)			
	Min	1036 (150)		1362 (198)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	729 (106)		889 (129)			
	Min	720 (105)		878 (127)			
Std. Deviation							
Elong, percent	Avg	19.3		27.0			
	Min	19.0		26.0			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1081 (157)		1919 (191)			
	Min						
K _t = 3.2							
No. of Spec. (No. of Heats)		1 (1)		1 (1)			
NTS, MN/m ² (ksi)	Avg	1093 (158)		1296 (188)			
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		1 (1)		1 (1)			

References: 39414

TABLE 8.2.1-ME3

Alloy Designation: A-286 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1255 K (1800 F) 30 min, WQ, aged 867 K (1100 F) 16 hr, AC

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	860 (125)		1234 (179)	1460 (212)		
	Min	832 (121)		1200 (174)	1296 (188)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	413 (59.9)		616 (89.4)	743 (108)		
	Min	387 (56.1)		535 (77.6)	717 (104)		
Std. Deviation							
Elong, percent	Avg	36.4		43.8	34.2		
	Min	30		35	24		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)		5 (2)	6 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	884 (128)		1214 (176)	1365 (198)		
K _t = 3.2	Min	869 (126)		1182 (172)	1339 (194)		
No. of Spec. (No. of Heats)		6 (2)		6 (2)	6 (2)		
NTS, MN/m ² (ksi)	Avg	857 (124)		1198 (174)	1363 (198)		
K _t = 6.3	Min	807 (117)		1089 (158)	1248 (181)		
No. of Spec. (No. of Heats)		6 (2)		6 (2)	6 (2)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	842 (122)		1213 (176)	1449 (210)		
	Min	821 (119)		1191 (173)	1395 (202)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	406 (58.9)		603 (87.4)	739 (107)		
	Min	391 (56.7)		581 (84.3)	699 (101)		
Std. Deviation							
Elong, percent	Avg	40.2		46.5	41.5		
	Min	38.5		44	30		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		6 (2)		5 (2)	6 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	886 (128)		1214 (176)	1382 (200)		
K _t = 3.2	Min	866 (126)		1196 (173)	1362 (198)		
No. of Spec. (No. of Heats)		6 (2)		6 (2)	6 (2)		
NTS, MN/m ² (ksi)	Avg	854 (124)		1158 (168)	1333 (193)		
K _t = 6.3	Min	791 (115)		1096 (159)	1241 (180)		
No. of Spec. (No. of Heats)		6 (2)		5 (2)	6 (2)		

References: 39414

TABLE 8.2.1-ME4

Alloy Designation: A-286 Stainless Steel

Specification: AMS-5525

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1255 K (1800 F) 30 min, WQ or AQ, aged 990 K (1325 F) 16 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1038 (151)	1054 (153)	1116 (162)	1361 (197)	1513 (219)	
	Min	969 (140)			1318 (191)	1452 (211)	
	Std. Deviation	44.3 (6.43)			41.4 (6.01)	38.3 (5.55)	
TYS, MN/m ² (ksi)	Avg	688 (99.8)	696 (101)	760 (110)	822 (119)	918 (133)	
	Min	645 (93.6)			780 (113)	862 (125)	
	Std. Deviation	33.4 (4.84)			26.2 (3.80)	37.5 (5.44)	
Elong, percent	Avg	21.1	25.7	28.2	32.9	26.4	
	Min	17			20	14	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		17 (5)	3 (1)	3 (1)	15 (4)	17 (5)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1111 (161)			1344 (195)	1469 (213)	
	Min	1110 (160)			1315 (191)	1455 (211)	
	No. of Spec. (No. of Heats)	6 (2)			6 (2)	6 (2)	
NTS, MN/m ² (ksi)	Avg	1103 (160)			1379 (200)	1473 (214)	
	Min	1038 (151)			1358 (197)	1276 (185)	
	No. of Spec. (No. of Heats)	10 (3)			6 (2)	8 (3)	
NTS, MN/m ² (ksi)	Avg	910 (132)	967 (140)	1005 (146)	1080 (157)	1245 (181)	
	Min						
	No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1044 (152)	1122 (163)	1185 (172)	1350 (196)	1526 (221)	
	Min	1022 (148)			1327 (192)	1520 (220)	
	Std. Deviation	23.8 (3.46)			15.7 (2.28)	9.5 (1.38)	
TYS, MN/m ² (ksi)	Avg	723 (105)	783 (114)	839 (122)	842 (122)	932 (135)	
	Min	676 (98.1)			760 (110)	848 (123)	
	Std. Deviation	34.5 (5.01)			52.5 (7.61)	58.9 (8.54)	
Elong, percent	Avg	23.3	27.3	27.3	32.9	34.8	
	Min	21.5			20	31.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		9 (3)	3 (1)	3 (1)	9 (3)	6 (2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1134 (164)			1356 (197)	1444 (209)	
	Min	1090 (158)			1325 (192)	1431 (208)	
	No. of Spec. (No. of Heats)	6 (2)			6 (2)	3 (1)	
NTS, MN/m ² (ksi)	Avg	1134 (164)			1367 (198)	1446 (210)	
	Min	1085 (157)			1318 (191)	1441 (209)	
	No. of Spec. (No. of Heats)	6 (2)			6 (2)	3 (1)	

References: 39414, 53548, 58060, 66080, 83417

TABLE 8.2.1-ME5

Alloy Designation: A-286 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1255 K (1800 F) 30 min, WQ or AQ, aged 990 K (1325 F) 16 hr, AC

Testing Temperature, K (F)	297 (75)	77 (-320)	20 (-423)
Fatigue, Flexural Loading, Surface Finish 72 rms			
S_N at 10^5 cycles, MN/m ² (ksi)	538 (78)	703 (102)	772 (112)
Loading frequency 30-40 Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^5 cycles	0.52	0.52	0.52
S_N at 10^6 cycles, MN/m ² (ksi)	427 (62)	579 (84)	586 (85)
Loading frequency 30-40 Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^6 cycles	0.42	0.43	0.40
S_N at 10^7 cycles, MN/m ² (ksi)	400 (58)	517 (75)	
Loading frequency 30-40 Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	
Ratio S_N/TUS at 10^7 cycles	0.39	0.38	
Fatigue, Flexural Loading, Surface Finish 10 rms			
S_N at 10^5 cycles, MN/m ² (ksi)	593 (86)	758 (110)	869 (126)
Loading frequency 30-40 Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^5 cycles	0.56	0.55	0.55
S_N at 10^6 cycles, MN/m ² (ksi)	496 (72)	703 (102)	779 (113)
Loading frequency 30-40 Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	1 (1)
Ratio S_N/TUS at 10^6 cycles	0.47	0.51	0.50
S_N at 10^7 cycles, MN/m ² (ksi)	434 (63)	676 (98)	
Loading frequency 30-40 Hz			
with $R = -1$ and $K_t = 1$			
No. of S-N Curves (No. of Heats)	1 (1)	1 (1)	
Ratio S_N/TUS at 10^7 cycles	0.41	0.49	

References: 83417

TABLE 8.2.1-ME5.1

Alloy Designation: A-286 Stainless Steel (Weld Metal)

K66286

Specification:

Form: Sheet-TIG welded, A-286 filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed sheet welded, tested as welded

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	4 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	641 (93.0)	727.4 (105.5)	801.2 (116.2)	981.8 (142.4)	1068 (154.9)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	301 (43.7)	354 (51.4)	412 (59.8)	507 (73.6)	613 (88.9)	
	Min						
Std. Deviation							
Elong, percent	Avg	34.0	33.0	42.2	47.0	32.0	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 53548

TABLE 8.2.1-ME5.2

A-286
Sheet-Weld Metal

Alloy Designation: A-286 Stainless Steel (Weld Metal)

K66286

Specification:

Form: Sheet-TIG welded, A-286 filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed sheet welded, age hardened, and tested as aged

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg	861.2 (124.9)	930.8 (135.0)	1007 (146.0)	1145 (166.1)	1286 (186.5)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	601 (87.2)	610 (88.9)	669 (97.0)	743.9 (107.9)	866.0 (125.6)	
	Min						
Std. Deviation							
Elong, percent	Avg	11.0	13.2	12.8	15.8	15.3	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 53548

TABLE 8.2.1-ME5.3

A-286
Sheet-Weld Metal

Alloy Designation: A-286 Stainless Steel (Weld Metal)

K66286

Specification:

Form: Sheet-TIG welded, A-286 filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Age hardened sheet welded, and tested as welded

Testing Temperature, K (F)		297 (75)	915 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	685 (99.3)	780.5 (113.2)	877.7 (127.3)	948.0 (137.5)	1069 (155.1)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	386 (56.0)	472 (68.4)	543 (78.8)	601 (87.2)	717.1 (104.0)	
	Min						
Std. Deviation							
Elong, percent	Avg	8.8	8.0	11.0	9.0	7.8	
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1	1	1	1	1	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 53548

TABLE 8.2.1-ME5.4

A-286
Sheet-Weld Metal

Alloy Designation: A-286 Stainless Steel (Weld Metal)

Specification:

Form: Sheet-TIG welded, Hastelloy W filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: STA sheet welded and tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 608 (88.2)			886.7 (128.6)	1005 (145.8)	
	Min 605 (87.8)			835.6 (121.2)	1004 (145.6)	
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (1)			3 (1)	3 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 61996

TABLE 8.2.1-ME6

Alloy Designation: A-286 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed 1255 K (1800 F) 1.5 hr, AC, aged 1006 K (1350 F) 16 hr, AC

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	696 (101)	593 (86.0)	731 (106)	1158 (168)		
Avg						
Min						
No. of Spec. (No. of Heats)	(1)	(1)	(1)	(1)		
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 65182

(a) Indicate specimen design and orientation for shear specimens: 0.394 cm (0.155 in.) diameter

(b) Indicate specimen design for K_{IC} data:

TABLE 8.2.1-ME7

Alloy Designation: A-286 Stainless Steel

Specification: AMS-5737

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed 1175 K (1650 F) 2 hr, WQ or OQ, aged 992 K (1325 F) 16 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	17 (-430)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1146 (166)	1226 (178)	1261 (183)	1431 (208)	1627 (236)	1698 (246)
	Min	1099 (159)					1668 (242)
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	852 (124)	802 (116)	845 (122)	965 (140)	1041 (151)	1114 (162)
	Min	762 (111)					1082 (157)
Std. Deviation							
Elong, percent	Avg	26.9	34	33.5	45	44	31.8
	Min	23					31
RA, percent	Avg	50.0	48.8	48.8	50.4	44.7	42.2
	Min	47.6					33
No. of Spec. (No. of Heats)		9 (2)	4 (1)	4 (1)	4 (1)	4 (1)	4 (1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1353 (196)					1758 (255)
K _t = 6.4	Min	1262 (183)					1731 (251)
No. of Spec. (No. of Heats)		5 (1)					5 (1)
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 64373, 83948

TABLE 8.2.1-ME8

Alloy Designation: A-286 Stainless Steel

Specification: AMS-5735

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed 1255 K (1800 F) 1.5 hr, AC, aged 992 to 1006 K (1325 to 1350 F) 16 hr, AC

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	17 (-430)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1082 (157)	1174 (170)	1240 (180)	1406 (204)	1613 (234)	1620 (235)
	Min	1009 (146)	1114 (162)		1308 (190)	1609 (233)	1586 (230)
	Std. Deviation	38.0 (5.51)	43.2 (6.27)		71.7 (10.4)	7.5 (1.09)	
TYS, MN/m ² (ksi)	Avg	756 (110)	778 (113)	803 (116)	863 (125)	1030 (149)	1031 (150)
	Min	674 (97.8)	690 (100)		753 (109)	127 (149)	1020 (148)
	Std. Deviation	33.1 (4.80)	62.4 (9.05)		77.2 (11.2)		
Elong, percent	Avg	28.1	32.3	36	39.9	41.3	34.5
	Min	25	29		35.3	35.5	32
RA, percent	Avg	48.5	48.3	51.5	48.3	45.9	46.5
	Min	39.6	39.8		44.1	41.8	42
	No. of Spec. (No. of Heats)	13 (4)	9 (3)	4 (1)	9 (3)	6 (2)	5 (1)
E, GN/m ² (10 ⁶ psi)	Avg	182 (26.4)	227 (33.0)		196 (28.4)		
	Min	179 (26.0)	226 (32.8)		192 (27.9)		
	No. of Spec. (No. of Heats)	2 (1)	3 (1)		3 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1248 (181)					1492 (216)
	Min	1234 (179)					1400 (203)
	No. of Spec. (No. of Heats)	5 (1)					5 (1)
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
TYS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 47735, 54986, 64373, 83948

TABLE 8.2.1-ME9

Alloy Designation: A-286 Stainless Steel

Specification: AMS-5735

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed 1255 K (1800 F) 1.5 hr, AC, aged 992 to 1006 K (1325 to 1350 F) 16 hr, AC

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb)	Avg	75.2 (55.5)	77.3 (57.0)	70.8 (52.2)		
	Min	74.6 (55.0)	74.6 (55.0)	70.5 (52.0)		
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)		
Trans., J(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 54986

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.2.1-ME9.1

A-286
Bar

Alloy Designation: A-286 Stainless Steel

K66286

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Cold worked 40% (min.) and aged

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1382 (200.5)	1500 (217.5)	1570 (227.6)	1761 (255.9)	1938 (281.1)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1288 (186.8)	1372 (199.0)	1420 (206.0)	1531 (222.1)	1681 (243.8)	
	Min						
Std. Deviation							
Elong, percent	Avg	13.1	16.0	16.2	19.5	19.3	
	Min						
RA, percent	Avg	41.9	42.4	42.0	40.1	33.9	
	Min						
No. of Spec. (No. of Heats)		12 (4)	10 (3)	11 (3)	14 (4)	17 (4)	
E, GN/m ² (10 ⁶ psi)	Avg	207 (30.0)	210 (30.4)	213 (30.9)	226 (32.8)	224 (32.5)	
	Min						
No. of Spec. (No. of Heats)		7 (2)	5 (1)	5 (1)	2 (1)	3 (1)	
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	2164 (313.8)			2266 (328.7)	2388 (346.3)	
	Min						
K _t = 10							
No. of Spec. (No. of Heats)		2 (1)			2 (1)	3 (1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 80755

TABLE 8.2.1-ME9.2

A-286
Bar

Alloy Designation: A-286 Stainless Steel

K66286

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: Cold worked 40% (min.) and aged

Testing Temperature, K (F)	297 (75)			77 (-320)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear (a)						
SUS, MN/m ² (ksi)	Avg	763.9 (110.8)		1042 (151.1)		
	Min					
No. of Spec. (No. of Heats)		4 (1)		3 (1)		
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg	27.7 (20.5)		26.6 (19.7)		
	Min					
No. of Spec. (No. of Heats)		11 (3)		11 (3)		
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness (b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 80755

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 8.2.1-ME10

Alloy Designation:

A-286 Stainless Steel

K66286

Specification:

Form:

Square Bar

Thickness, cm (in.):

Over 5.080 (2.000)

Condition:

Solution treated 1170 K (1650 F) 2 hr., OQ + aged 1005 K (1350 F) 16hr., AC

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
<u>Tension, Longitudinal</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg	607 (88)	745 (108)	889 (129)			
	Min	572 (83)	734 (106.5)	887 (128.7)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 94206B

TABLE 8.2.1-ME11

A-286
Bar

Alloy Designation: A-296 Stainless Steel

K66286

Specification:

Form: Square Bar

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Solution treated 1170 K (1650 F) 2 hr., OQ + aged 1005 K (1350 F) 16 hr., AC

Testing Temperature, K (F)	297 (75)	77 (-320)	4 (-452)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
J _{IC} , kJ/m ² (in.-lb/in ²)	Avg	74.5 (426)	67.2 (385)	61.2 (350)		
	Min	70.0 (401)	64.8 (370)	57.8 (330)		
		4	4	3		

References: 94208E

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for J_{IC} data: Compact Specimens

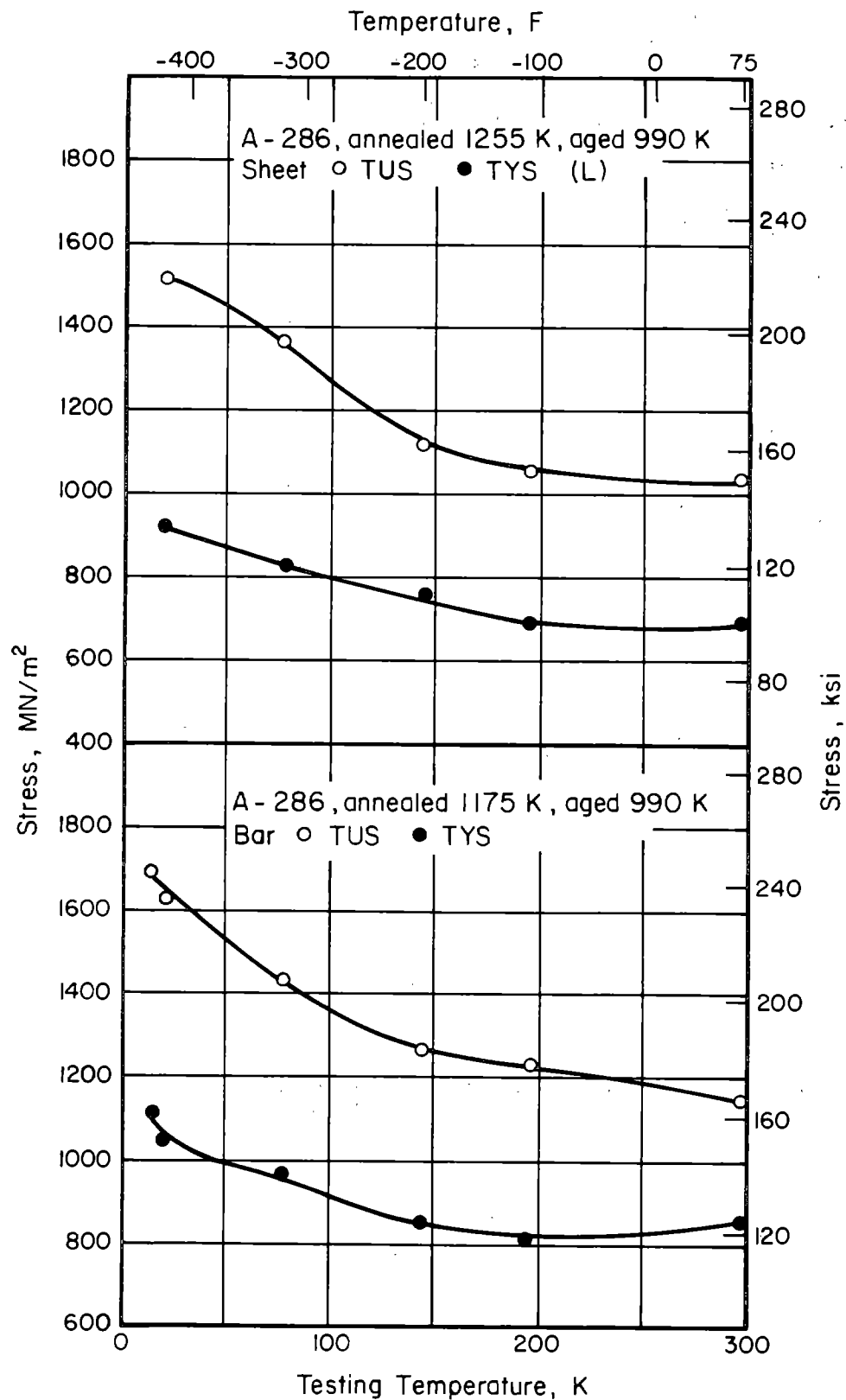


FIGURE 8.2.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF A-286 STAINLESS STEEL

8.2.1-10.2 (11/75)

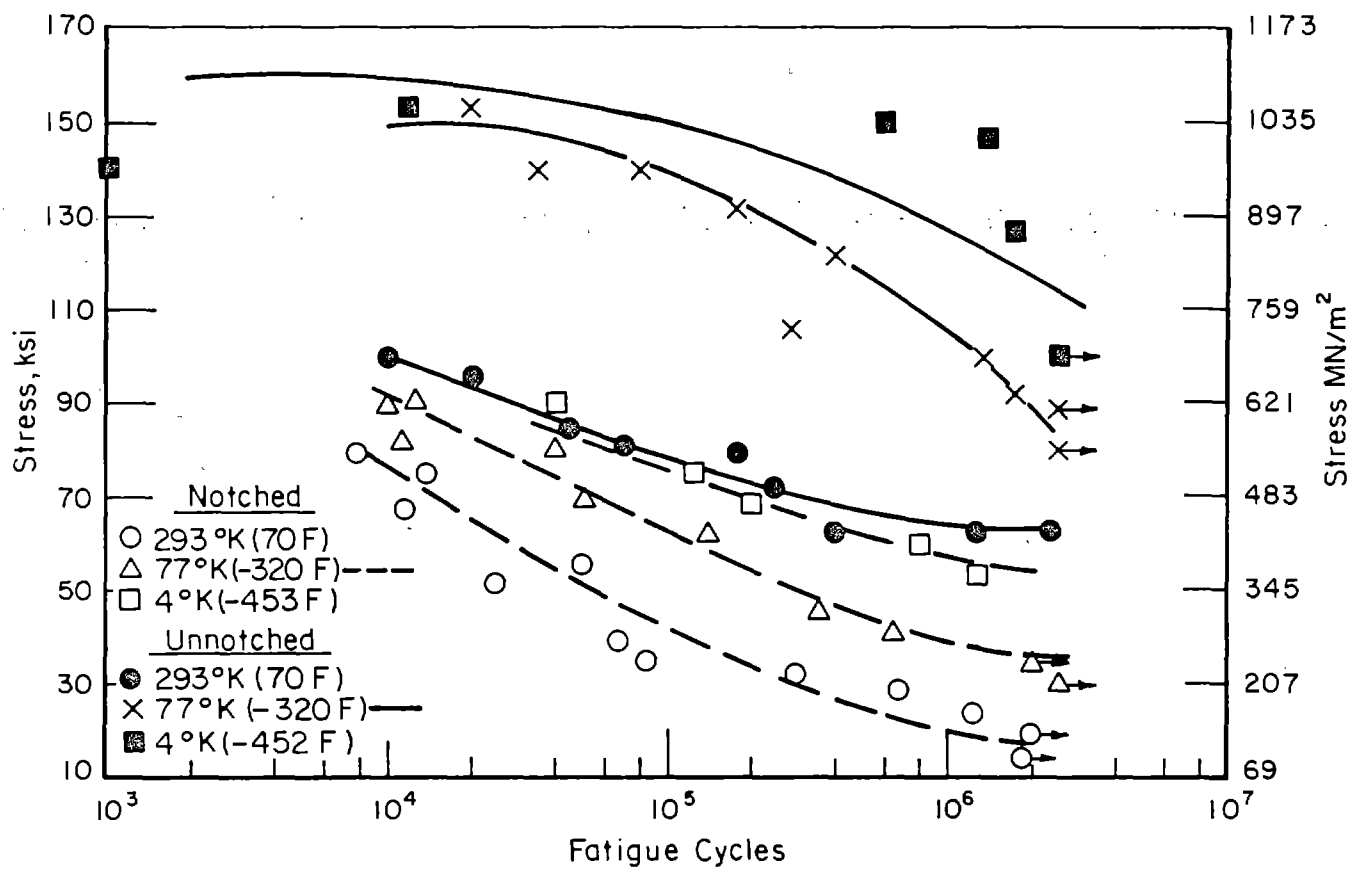


FIGURE 8.2.1-ME2.1. AXIAL FATIGUE LIFE CURVES FOR 1.27 cm (0.50 in.) DIAMETER BAR OF SOLUTION TREATED AND AGED A-286 STAINLESS STEEL [95168]

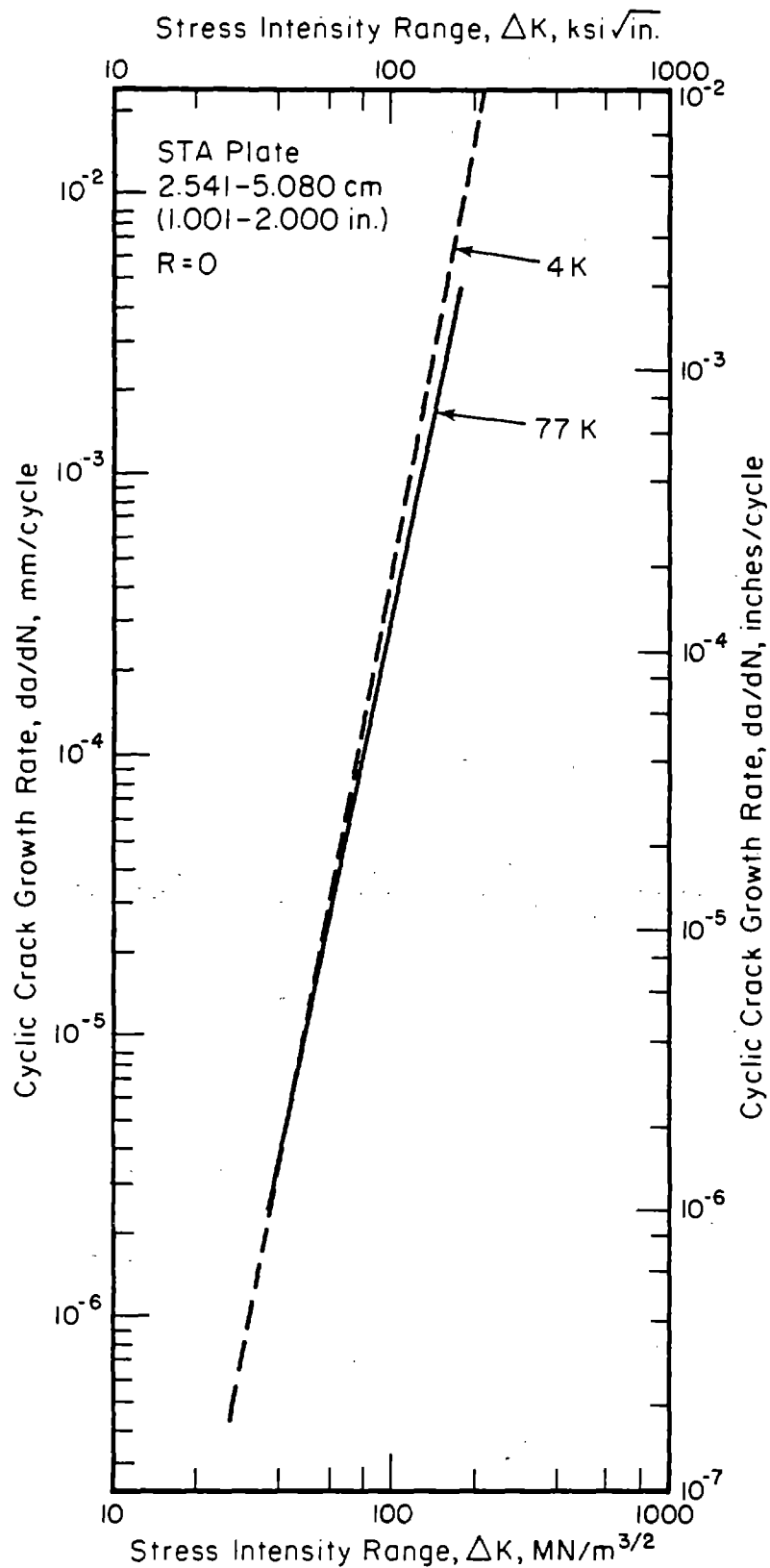


FIGURE 8.2.1-ME2. FATIGUE CRACK GROWTH RATE PROPERTIES OF A-286 STAINLESS STEEL AT 77K AND 4K (-320F AND -452F)(94206A)

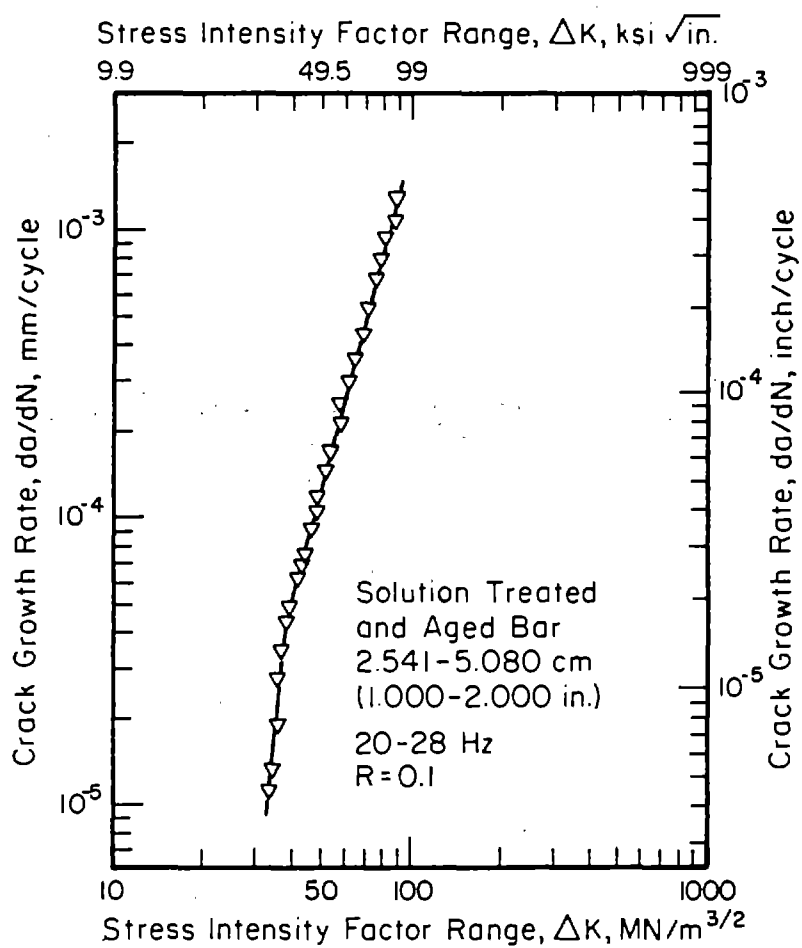


FIGURE 8.2.1-ME3. FATIGUE CRACK GROWTH RATES OF A-286 ALLOY (ASTM A453) AT 4K (-452F)(94208D)

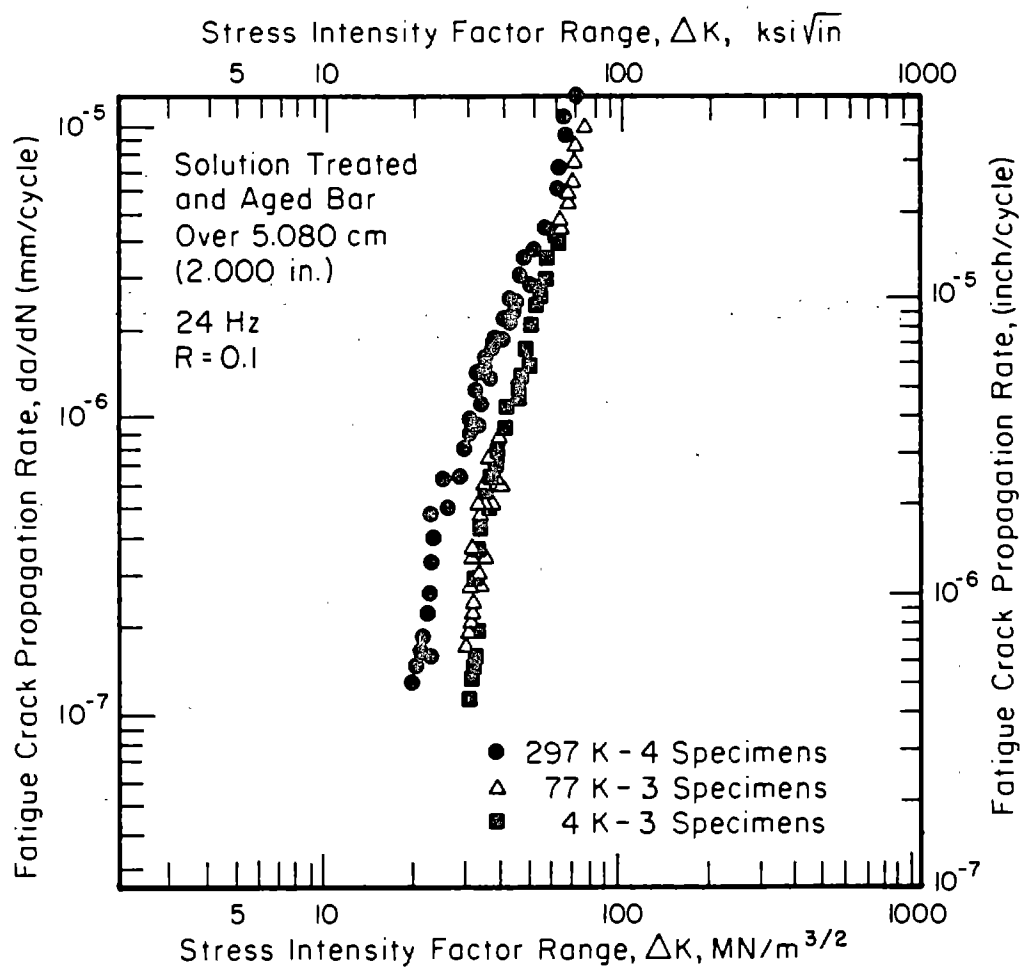


FIGURE 8.2.1-ME4. FATIGUE CRACK GROWTH RATES FOR A-286 AT 297K, 77K, AND 4K (75F, -320F, AND -452F) (94208E)

TABLE 8.2.1-TR1

Alloy Designation: A-286 Stainless Steel

Specification:

Form:

Dimension:

Condition: Annealed except as noted below.

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	11.2	7.6	5.0	2.20	1.01	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(6.48)	(4.39)	(2.89)	(1.27)	(0.584)	
No. of Spec.	1	1	1	1	1	
References: 90194						
Thermal Expansion (T₂₇₃ to T) Longitudinal(1)						
Percent	0	-0.225	-0.253	-0.255		
No. of Spec.	2	2	2	2		
References: 48134, 48571						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	93.0 x 10 ⁻⁸	80.0 x 10 ⁻⁸	79.0 x 10 ⁻⁸	78.0 x 10 ⁻⁸	77.5 x 10 ⁻⁸	77.0 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(559)	(481)	(475)	(469)	(466)	(463)
No. of Spec.	3	3	3	3	3	1
References: 90164, 90194						

(1) Age Hardened

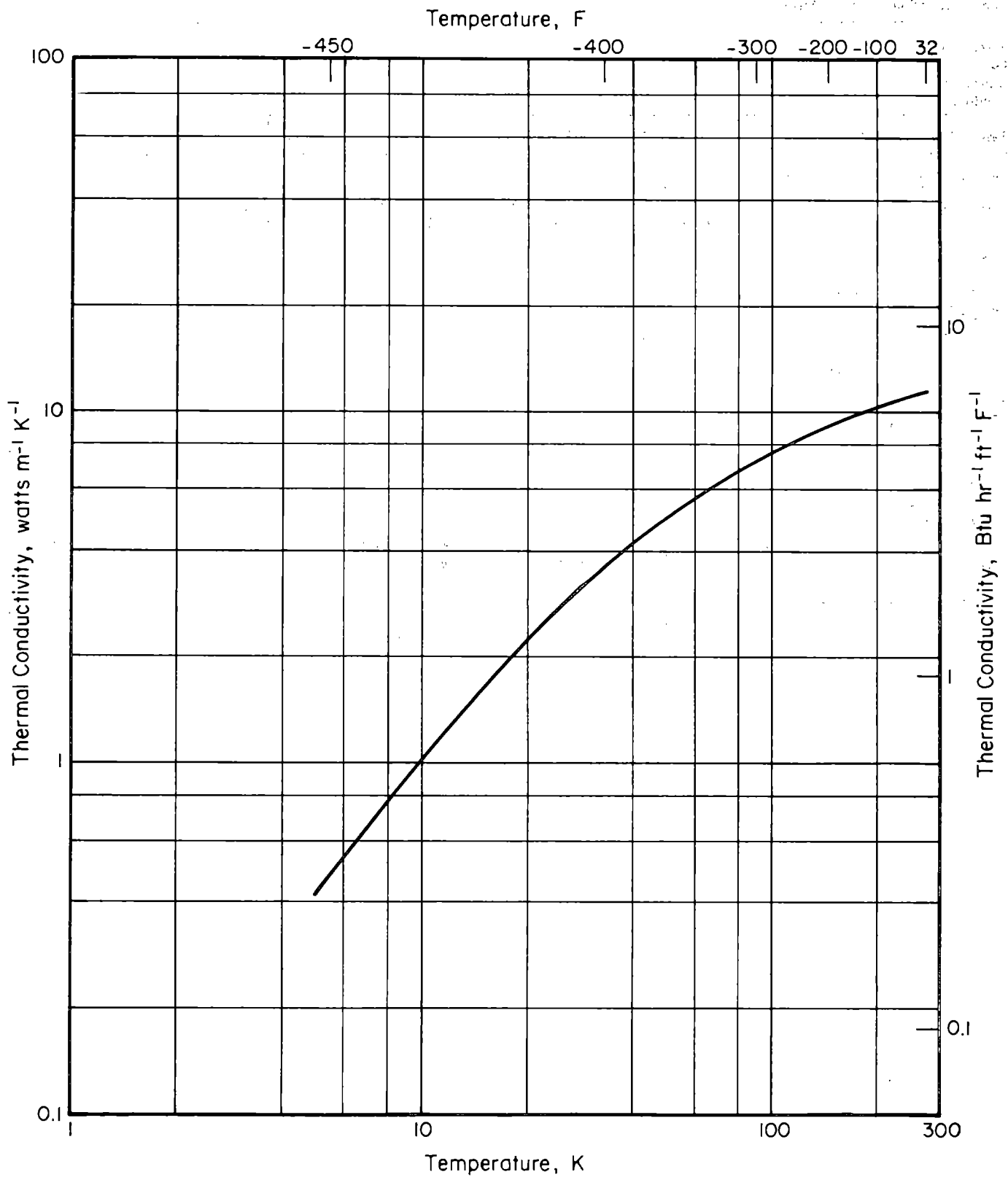


FIGURE 8.2.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE
FOR A-286 STAINLESS STEEL

8.2.1-12 (11/74)

8.2.1-13 (11/74)

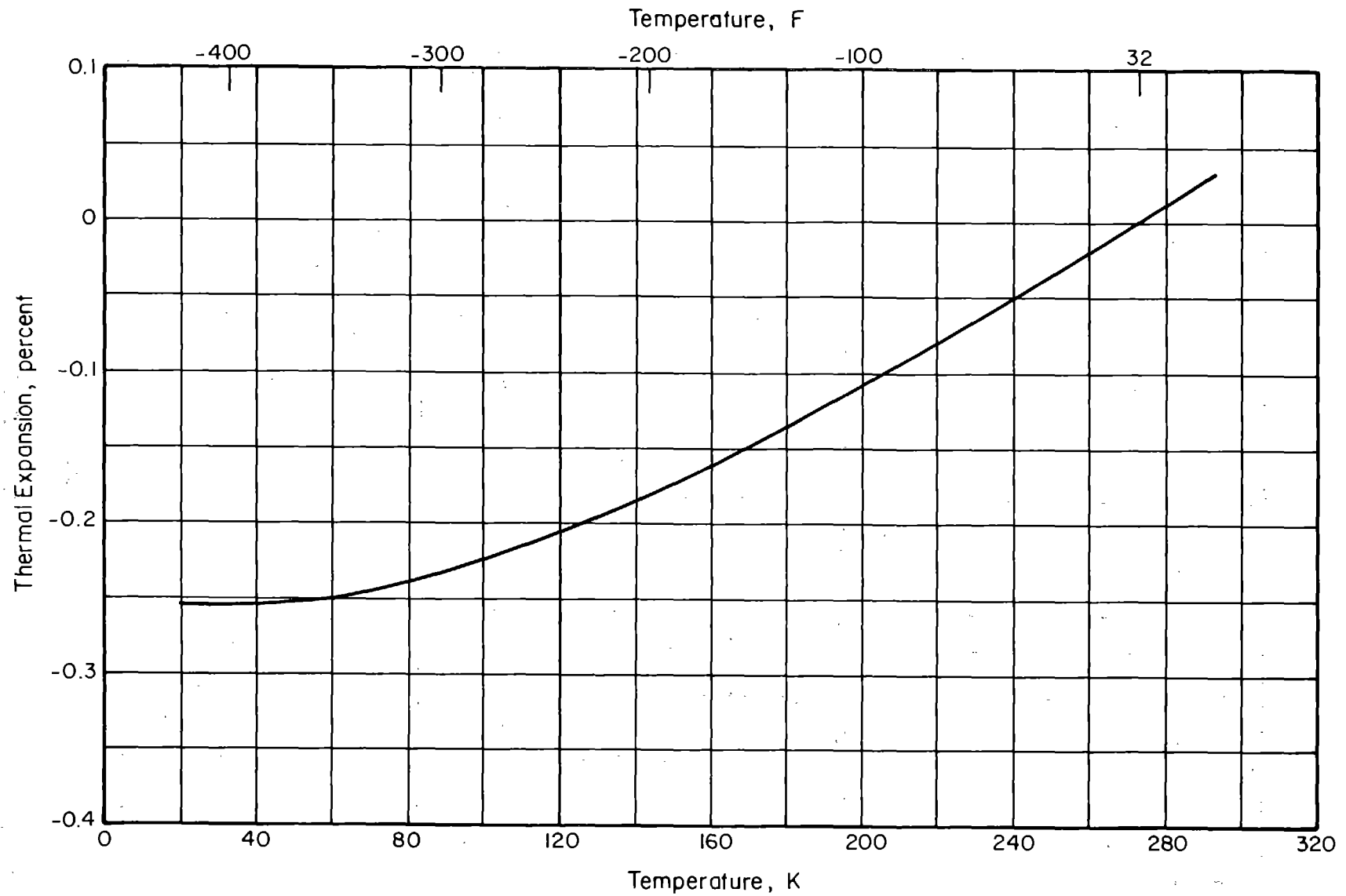


FIGURE 8.2.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR A-286 STAINLESS STEEL AGE HARDENED

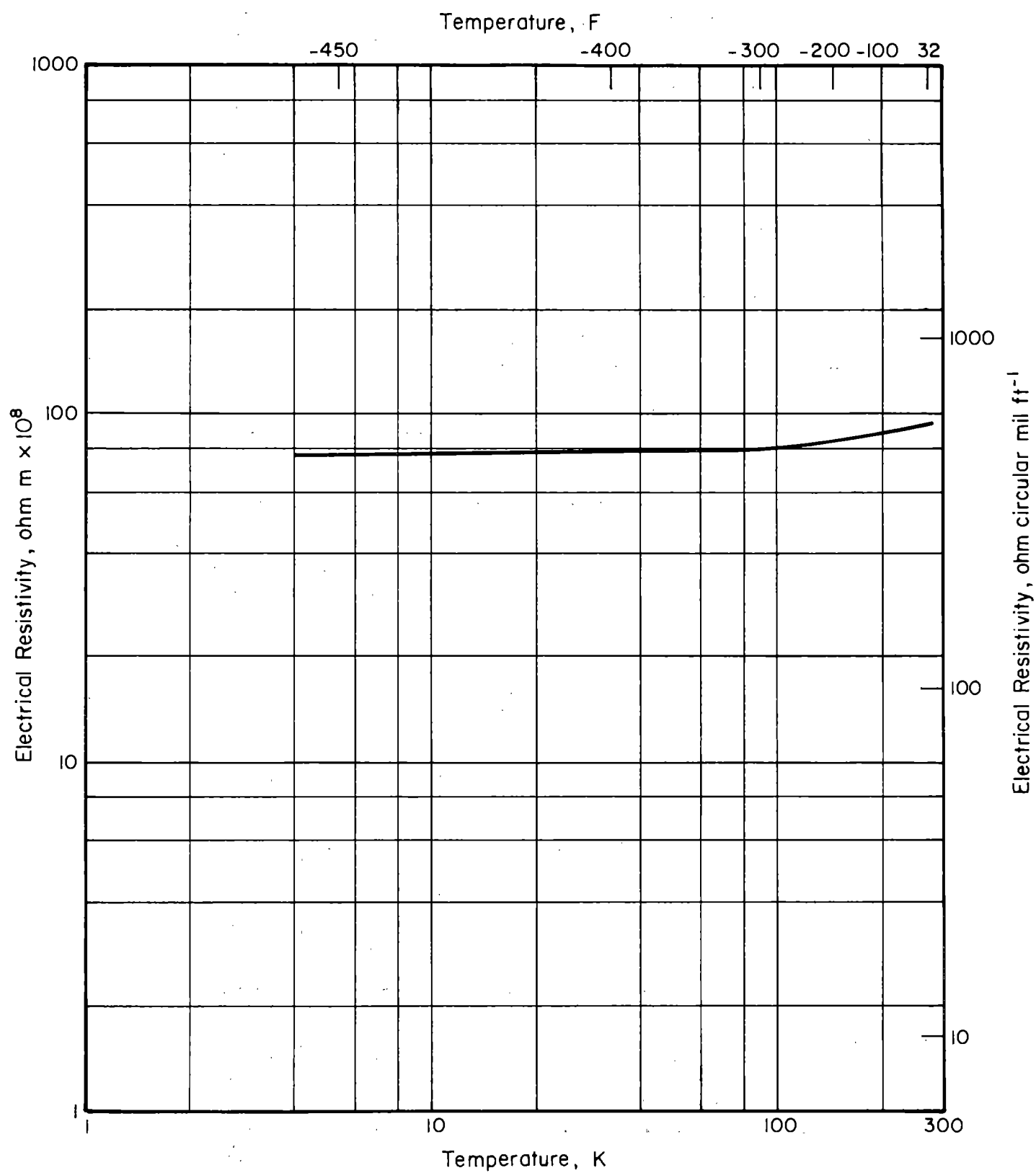


FIGURE 8.2.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE
FOR A-286 STAINLESS STEEL

8.2.1-14 (11/74)

A286
Rod

Alloy Designation: A-286 Stainless Steel K66286

Specification:

Form: Rod

Diameter, cm (in.): 0.37 (0.145)

Condition: Solution annealed

Test Temperature: 4.2 K (−452 F)

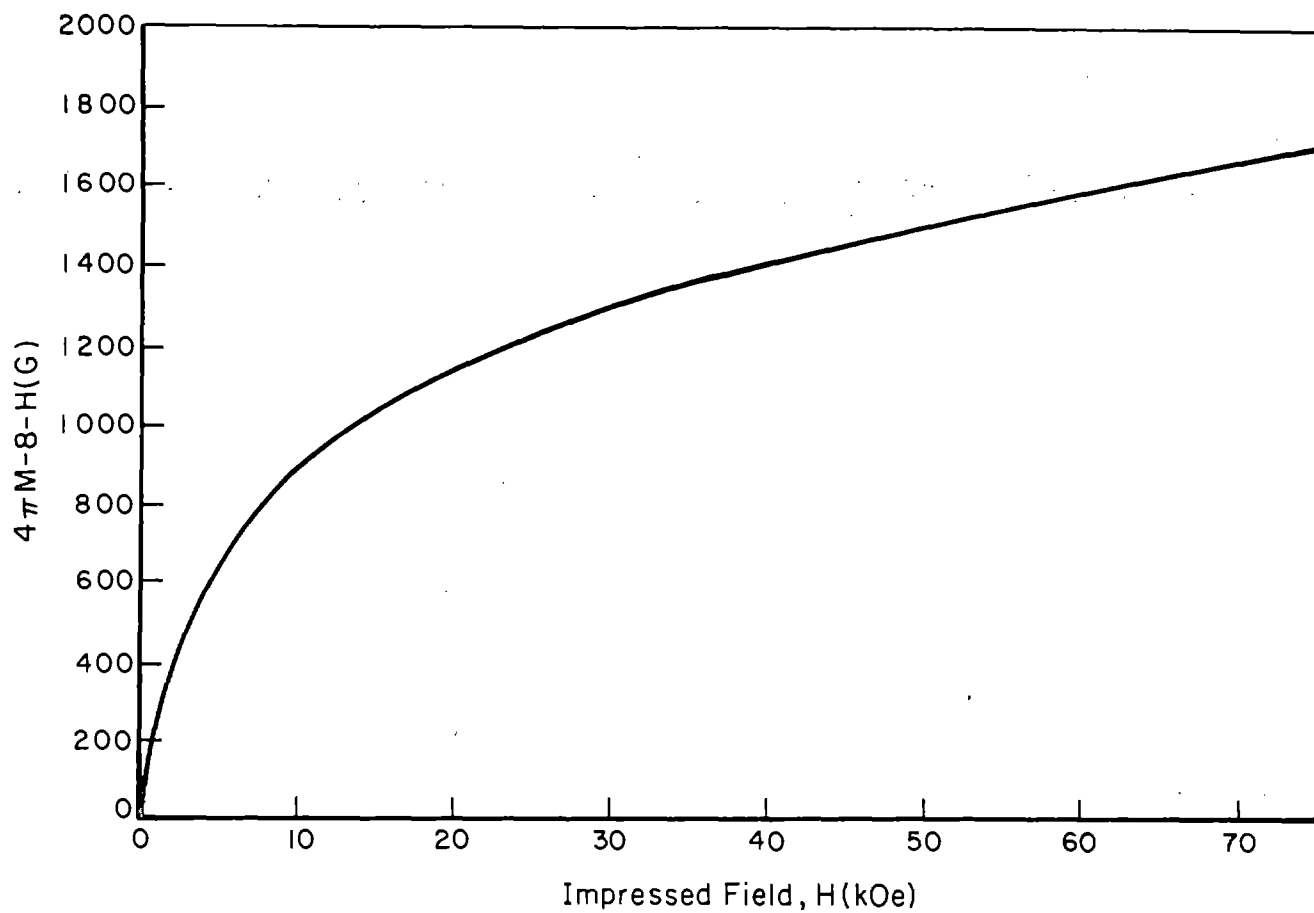


FIGURE 8.2.1-MA1. MAGNETIZATION VERSUS APPLIED MAGNETIC FIELD FOR A-286 STAINLESS STEEL [96871]

TABLE 8.2.2-ME1

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1157 K (1625 F) 1 hr

Testing Temperature, K (F)	297	75		77	(-320)			
Tension, Longitudinal								
TUS, MN/m ² (ksi)	Avg	793	(115)		1420	(206)		
	Min							
Std. Deviation								
TYS, MN/m ² (ksi)	Avg	486	(70.5)		910	(132)		
	Min							
Std. Deviation								
Elong, percent	Avg	43.2			53.6			
	Min							
RA, percent	Avg	63.3			49.4			
	Min							
No. of Spec. (No. of Heats)		(1)			(1)			
E, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Poisson's Ratio								
Work Hardening Coef								
NTS, MN/m ² (ksi)	Avg							
K _t =	Min							
No. of Spec. (No. of Heats)								
NTS, MN/m ² (ksi)	Avg							
K _t =	Min							
No. of Spec. (No. of Heats)								

TABLE 8.2.2-ME2

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1157 K (1625 F) 1 hr, cold rolled 30 percent

Testing Temperature, K (F)	297	(75)		77	(-320)			
Tension, Longitudinal								
TUS, MN/m ² (ksi)	Avg	1100	(160)		1710	(248)		
	Min							
Std. Deviation								
TYS, MN/m ² (ksi)	Avg	1050	(152)		1540	(224)		
	Min							
Std. Deviation								
Elong, percent	Avg	9.8			30.2			
	Min							
RA, percent	Avg	38.2			42.5			
	Min							
No. of Spec. (No. of Heats)		(1)			(1)			
E, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Poisson's Ratio								
Work Hardening Coef								
NTS, MN/m ² (ksi)	Avg							
K _t =	Min							
No. of Spec. (No. of Heats)								
NTS, MN/m ² (ksi)	Avg							
K _t =	Min							
No. of Spec. (No. of Heats)								

References: 90123

TABLE 8.2.2-ME3

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1157 K (1625 F) 1 hr, cold rolled 60 percent

Testing Temperature, K (F)		297 (75)		77 (-320)	(-320)		
<u>Tension, Longitudinal</u>					(a)		
TUS, MN/m ² (ksi)	Avg	1290 (187)		1850 (268)	1890 (274)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1230 (178)		1740 (252)	1770 (257)		
	Min						
Std. Deviation							
Elong, percent	Avg	6.6		13.6	14		
	Min						
RA, percent	Avg	40.8		37.7	33.5		
	Min						
No. of Spec. (No. of Heats)		(1)		(1)	(2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
<u>Tension, Transverse</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90123

(a) Annealed 1150 K (1625 F) 1 hr, cold rolled 60 percent, aged 810 K (1000 F) 4 hr

8.2.2-2 (11/74)

TABLE 8.2.2-ME4

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1340 K (1950 F) 1 hr

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	696 (101)	827 (120)	1280 (185)	1450 (210)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	286 (41.5)	400 (57.6)	696 (101)	882 (128)		
	Min						
Std. Deviation							
Elong, percent	Avg	62.5	58.8	81.5	56.0		
	Min						
RA, percent	Avg	59.0	56.1	54.0	40.0		
	Min						
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg			(160)			
K _t = 6.3	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

TABLE 8.2.2-ME5

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1340 K (1950 F) 1 hr, cold rolled 30 percent

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	993 (144)		1620 (235)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	938 (136)		1410 (205)			
	Min						
Std. Deviation							
Elong, percent	Avg	13.0		37.6			
	Min						
RA, percent	Avg	49.9		43.5			
	Min						
No. of Spec. (No. of Heats)		(1)		(1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg			1810 (262)			
K _t = 6.3	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 90123

TABLE 8.2.2-ME6

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1340 K (1950 F), cold rolled 60 percent

Testing Temperature, K (F)	297 (75)		77 (-320)	77 (-320)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 1200 (174)		1780 (259)	1820 (264)	(a)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 1140 (165)		1670 (242)	1670 (242)		
	Min					
Std. Deviation						
Elong, percent	Avg 6.6		19.2	17		
	Min					
RA, percent	Avg 42.5		37.7	36		
	Min					
No. of Spec. (No. of Heats)	(1)		(1)	(2)		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg		2040 (296)			
	Min					
K _t = 6.3						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

TABLE 8.2.2-ME7

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed 1340 K (1950 F), cold rolled 80 percent

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	20 (-423)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 1282 (186)	1510 (219)	1875 (272)	2100 (304)	2150 (312)	(a)
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 1210 (175)	1430 (207)	1740 (252)	1990 (288)	1980 (287)	
	Min					
Std. Deviation						
Elong, percent	Avg 6.3	7.4	8.8	1.2	2.5	
	Min					
RA, percent	Avg 41.7	38.0	35.1	17.5	27.1	
	Min					
No. of Spec. (No. of Heats)	(1)	(1)	(1)	(1)	(1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 1365 (198)	1640 (238)	2000 (290)	2170 (315)	2290 (332)	
	Min					
K _t = 6.3						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 90123

(a) Annealed 1340 K (1950 F), cold rolled, and aged 810 K (1000 F) 4 hr
8.2.2-4 (11/74)

TABLE 8.2.2-ME8

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Solution treated 1255 K (1800 F) 1 hr., WQ

ASTM drain size 5.5

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	701 (101.7)	1297 (188.1)	1325 (192.2)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	371 (53.8)	788 (114.3)	1094 (158.7)			
	Min						
Std. Deviation							
Elong, percent	Avg	45.8	49.8	42.0			
	Min						
RA, percent	Avg	66.8	58.2	55.0			
	Min						
No. of Spec. (No. of Heats)		1	1	1			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	928 (134.6)	1578 (228.9)	1877 (272.3)			
	Min						
K _t = 10							
No. of Spec. (No. of Heats)		1	1	1			
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 94206E
94208G

TABLE 8.2.2-ME9

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Cold worked to 30% reduction in thickness

ASTM grain size 9.5

Testing Temperature, K (F)		297 (75)	77 (-320)	4 (-452)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	980 (142.2)	1520 (220.4)	1325 (192.2)			
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	947 (137.3)	1288 (186.8)	1094 (158.7)			
	Min						
Std. Deviation							
Elong, percent	Avg	13.9	37.0	42.0			
	Min						
RA, percent	Avg	50.4	49.7	55.0			
	Min						
No. of Spec. (No. of Heats)		1	1	1			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1541 (223.5)	2126 (308.4)	1877 (272.3)			
K _t = 10	Min						
No. of Spec. (No. of Heats)		1	1	1			
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 94206E
94208G

TABLE 8.2.2-ME10

Alloy Designation: Kromarc 58 Stainless Steel (Weld Metal)

Specification:

Form: Plate-TIG welded, Kromarc 58 filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate heated 1255 K (1800 F) 1 hr, WQ, welded, and tested as welded

Testing Temperature, K (F)		297 (75) *			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	915.6 (132.8)			1321 (191.6)		1438 (208.6)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	498 (72.3)			852.2 (123.6)		1060 (153.8)
	Min						
Std. Deviation							
Elong, percent	Avg	35.9			45.6		33.4
	Min						
RA, percent	Avg	60.8			41.4		40.6
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1153 (167.3)			1908 (276.8)		2173 (315.2)
	Min						
K _t = 10							
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 94208

* Room-temperature specimens fractures in base metal.

TABLE 8.2.2-ME11

Alloy Designation: Kromarc 58 Stainless Steel (Weld Metal)

Specification:

Form: Plate-TIG welded, Kromarc 58 filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate-cold worked 30%, welded, and tested as welded

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	957.0 (138.8)			1303 (189.0)		1415 (205.3)
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	828.1 (120.1)			1111 (161.2)		1269 (184.1)
	Min						
Std. Deviation							
Elong, percent	Avg	12.9			12.6		11.4
	Min						
RA, percent	Avg	57.6			45.7		42.7
	Min						
No. of Spec. (No. of Heats)		1			1		1
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1108 (160.7)			1919 (278.3)		2149 (311.7)
K _t = 10	Min						
No. of Spec. (No. of Heats)		1			1		1
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 94208

TABLE 8.2.2-ME12

Alloy Designation: Kromarc 58 Stainless Steel (Weld Metal)

Specification:

Form: Plate-TIG welded, Kromarc 58 filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Plate-cold worked 30%, welded, and tested as welded

Testing Temperature, K (F)	297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 1223 (177.4)			1474 (213.8)		1571 (227.9)
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 1138 (165.0)			1260 (182.8)		1389 (201.4)
	Min					
Std. Deviation						
Elong, percent	Avg 8.0			17.5		13.4
	Min					
RA, percent	Avg 43.6			37.6		33.9
	Min					
No. of Spec. (No. of Heats)	1			1		1
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 1547 (224.4)			2216 (321.4)		2366 (343.2)
	Min					
K _t = 10						
No. of Spec. (No. of Heats)	1			1		1
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 94208

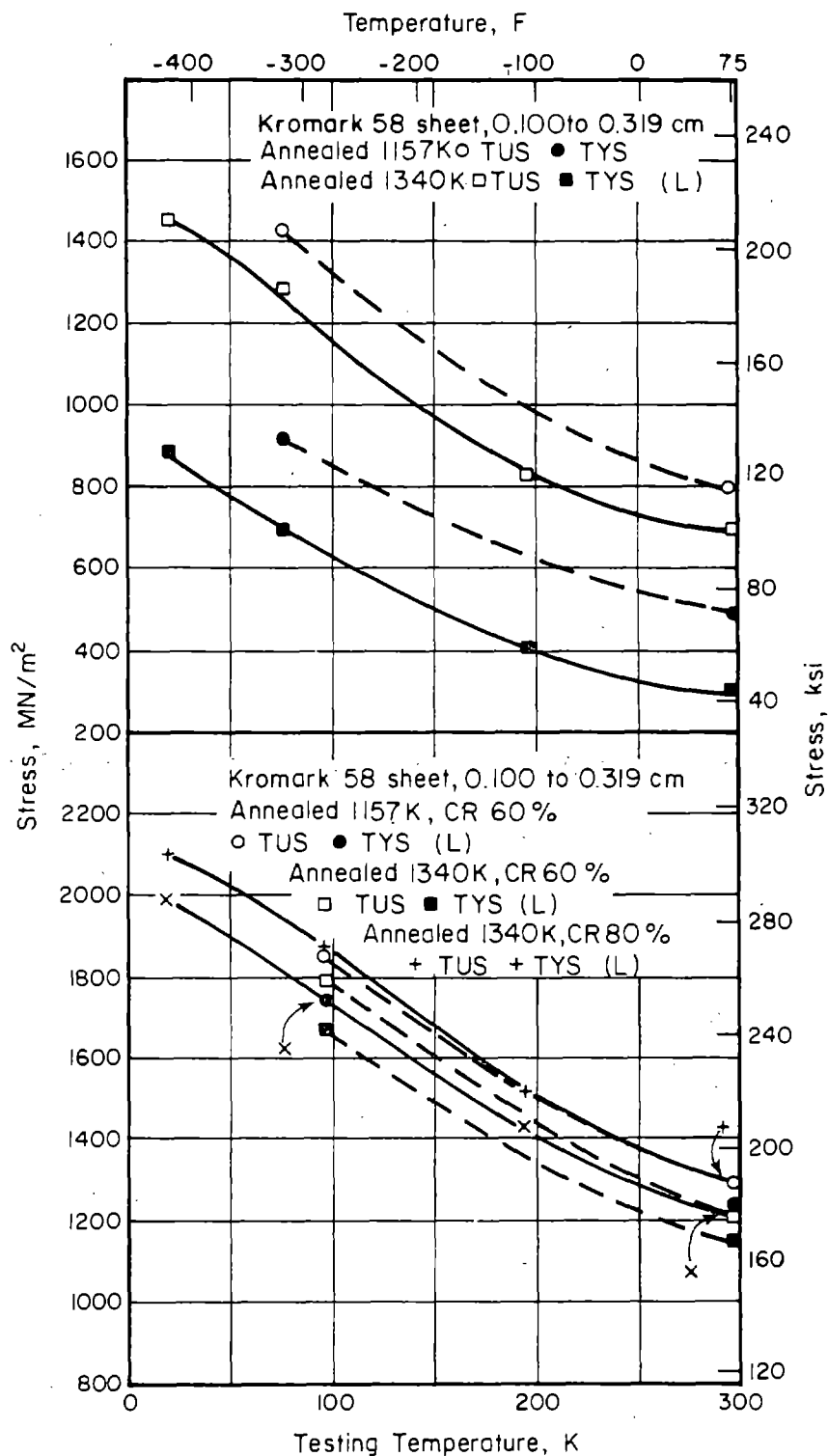


FIGURE 8.2.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF KROMARC 58 STAINLESS STEEL SHEET

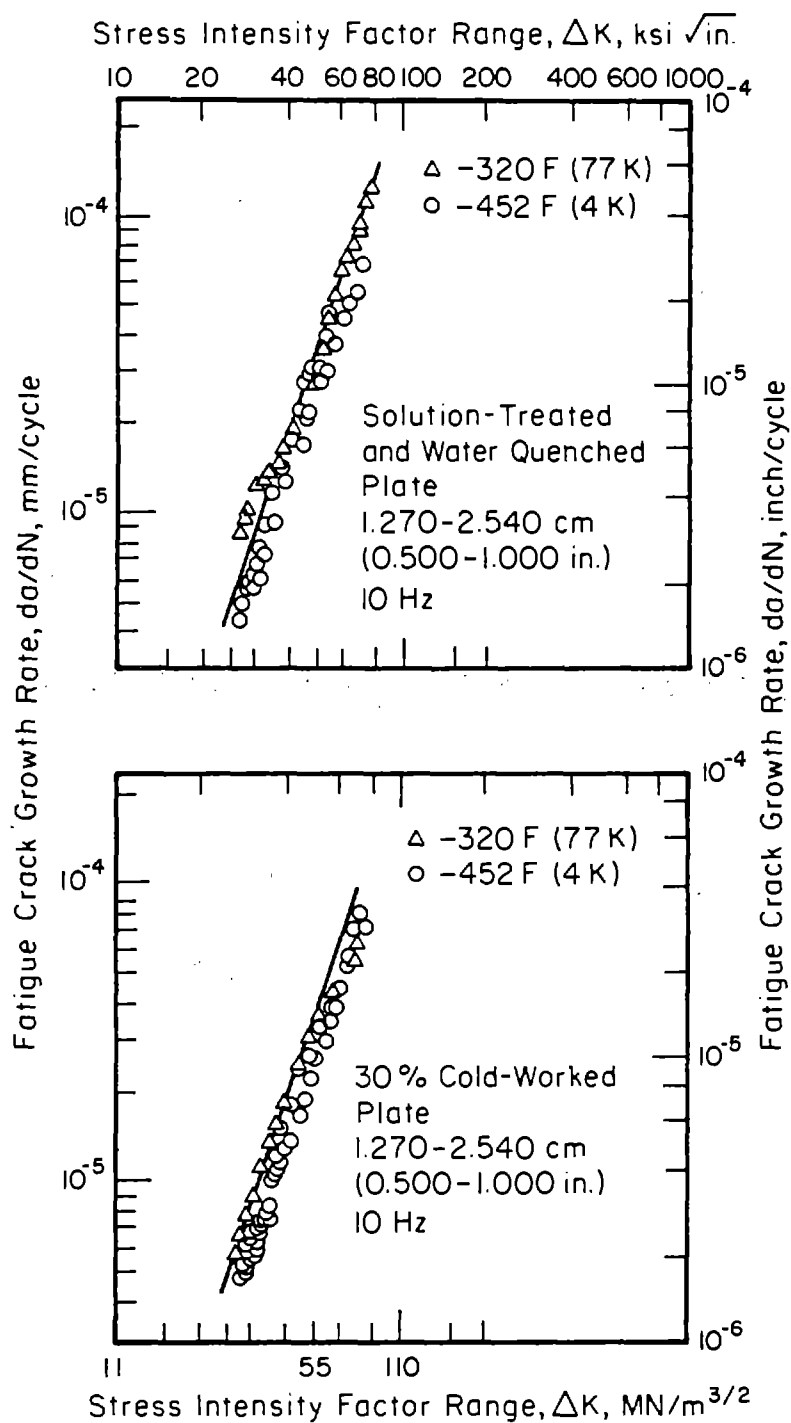


FIGURE 8.2.2-ME2. FATIGUE CRACK GROWTH RATE PROPERTIES OF KROMARC 58 STAINLESS STEEL AT 77K AND 4K (-320F AND -452F)(94208G)

TABLE 8.2.2-TR1

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form:

Dimension:

Condition: Solution Treated and Quenched

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	11.5	6.8	4.2	1.55	0.72	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(6.65)	(3.93)	(2.43)	(0.896)	(0.416)	
No. of Spec.	1	1	1	1	1	
References: 94206						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.238	-0.270	-0.274	-0.275	-0.275
No. of Spec.	2	2	1	1	1	1
References: 47125, 90202						
Specific Heat						
Joules kg ⁻¹ K ⁻¹					4.25	1.62
Btu lb ⁻¹ F ⁻¹					(0.00102)	(0.000387)
No. of Spec.					2	2
References: 90202, 94206						
Electrical Resistivity						
Ohm m	96 x 10 ⁻⁸	84 x 10 ⁻⁸	82 x 10 ⁻⁸	82 x 10 ⁻⁸	82 x 10 ⁻⁸	82 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(577)	(505)	(493)	(493)	(493)	(493)
No. of Spec.	1	1	1	1	1	1
References: 94206						

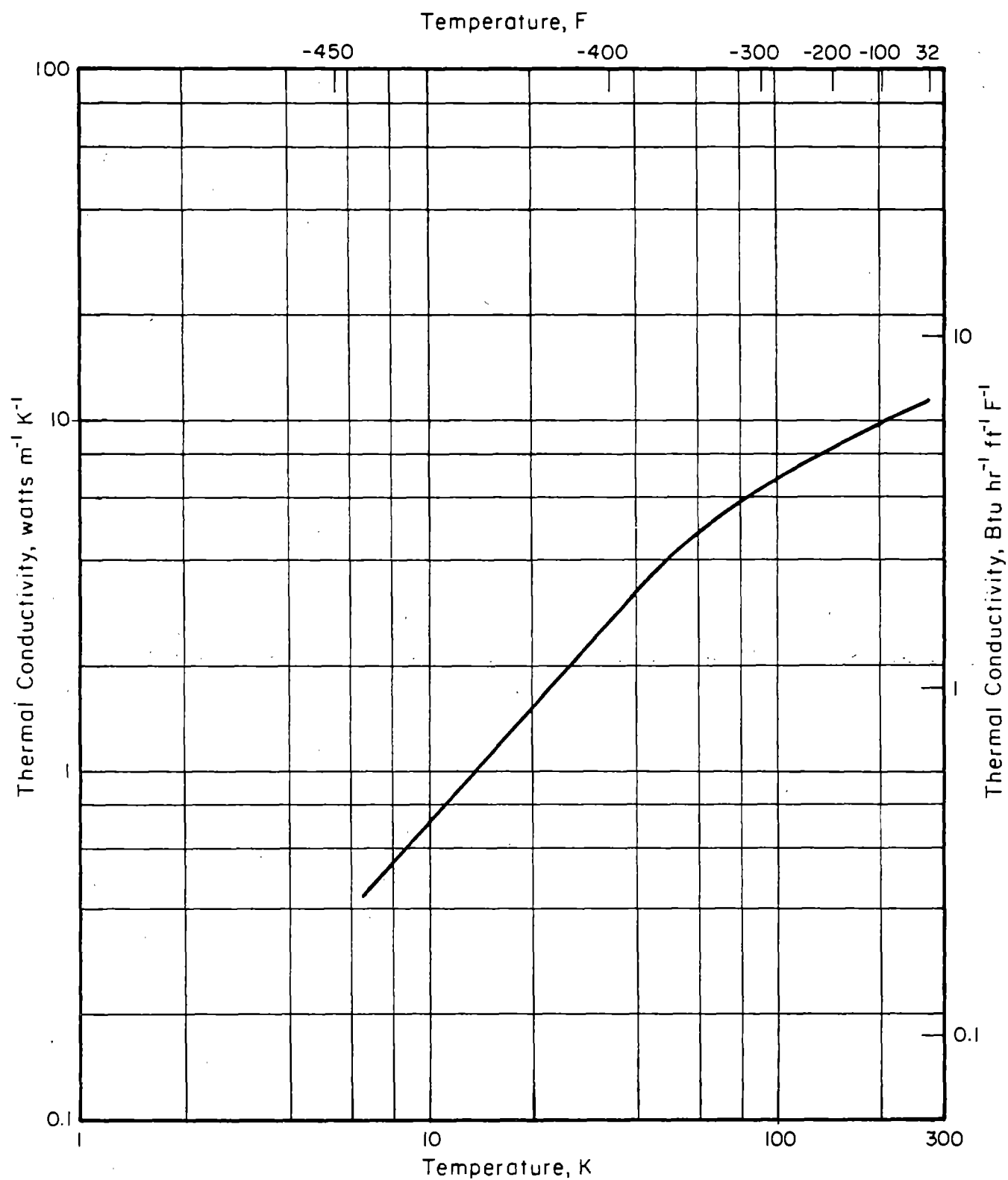


FIGURE 8.2.2-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR KROMARC 58 STAINLESS STEEL

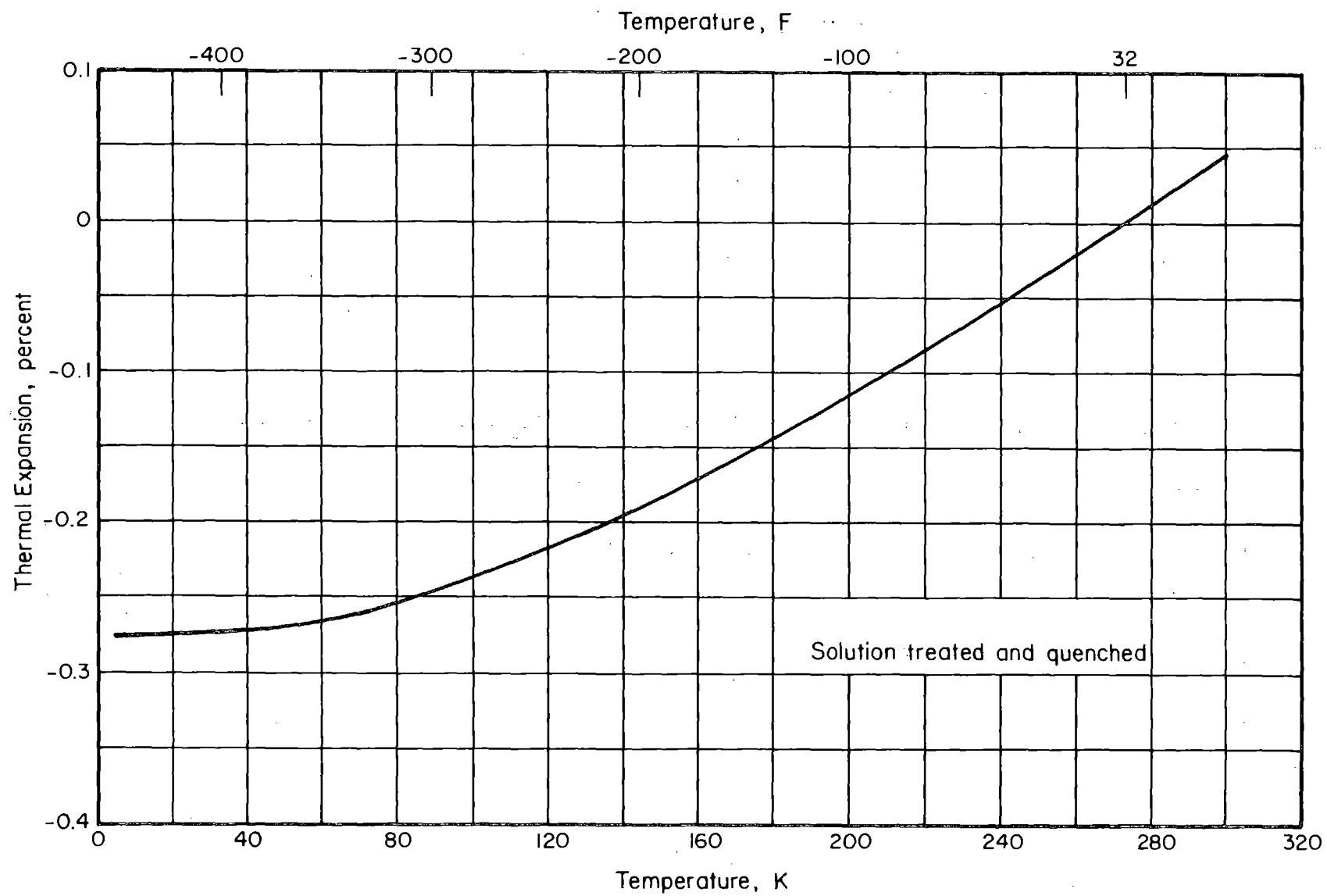


FIGURE 8.2.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR KROMARC 58 STAINLESS STEEL

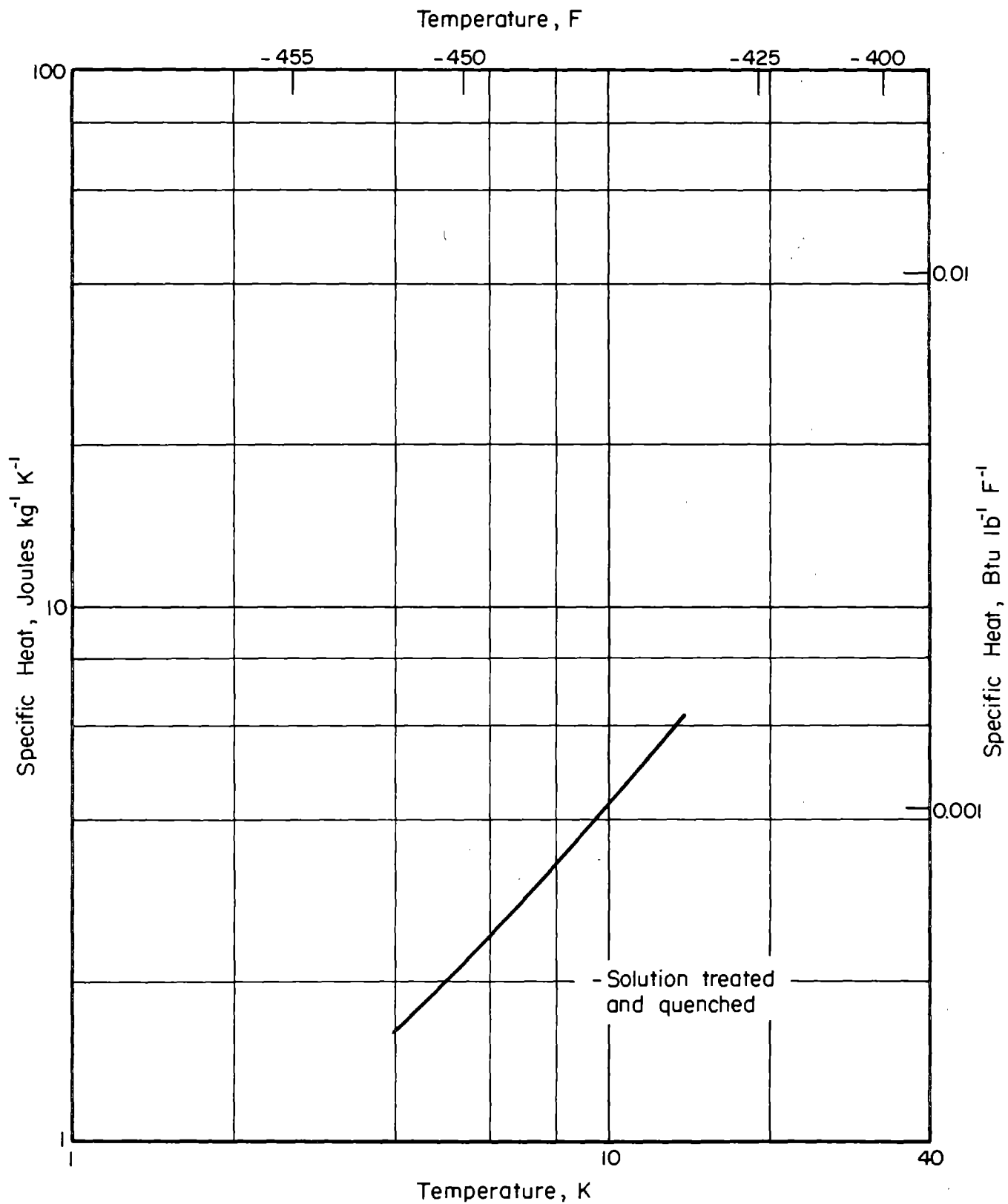


FIGURE 8.2.2-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR KROMARC 58 STAINLESS STEEL

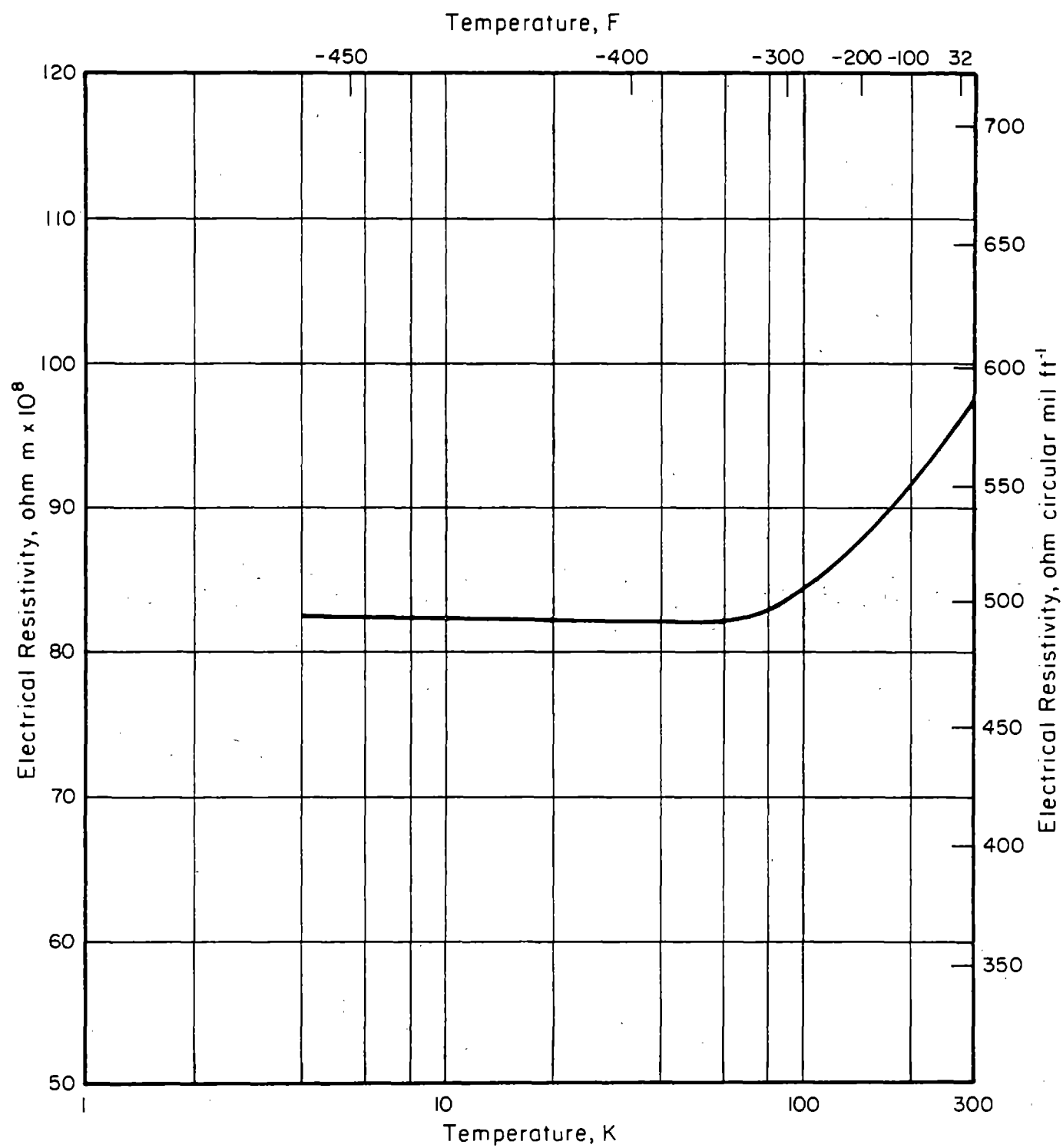


FIGURE 8.2.2-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR KROMARC 58 STAINLESS STEEL

TABLE 8.2.2-MA1

Alloy Designation: Kromarc 58 Stainless Steel

Specification:

Form: Rod

Dimension, cm(in.): Not given

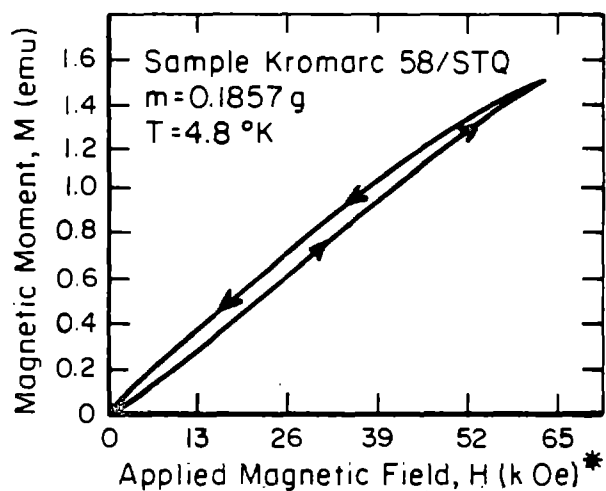
Condition: STQ: solution treated and quenched (1800 F [1255 K]
1 hr. and water quenched)

FIGURE 8.2.2-MA1.1. MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

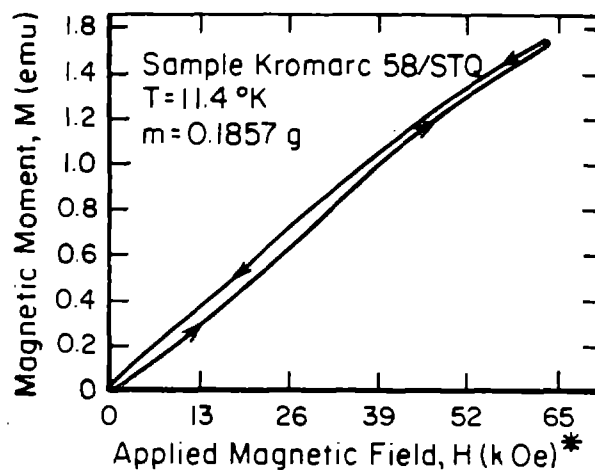


FIGURE 8.2.2-MA1.2. MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

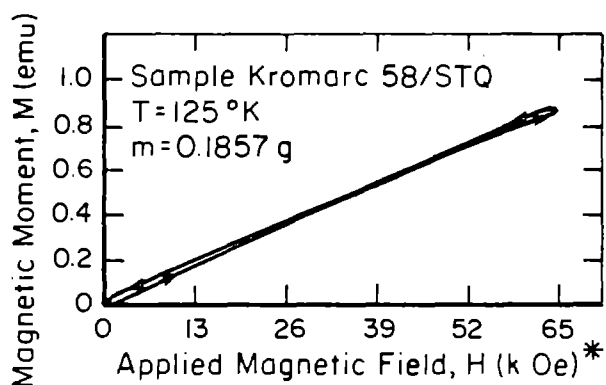


FIGURE 8.2.2-MA1.3. MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

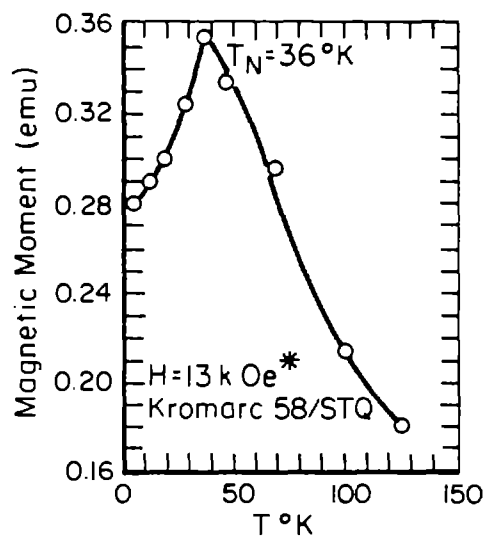


FIGURE 8.2.2-MA1.4. MAGNETIC MOMENT AT 13 k Oe AS A FUNCTION OF THE TEMPERATURE

* 1 tesla = 10kOe
Reference 94206

TABLE 8.2.2-MA2

Alloy Designation: Kromarc 58 Stainless Steel

Form: Rod

Dimension, cm (in.): Not given

Condition: CW: cold worked to about 30 percent reduction in thickness

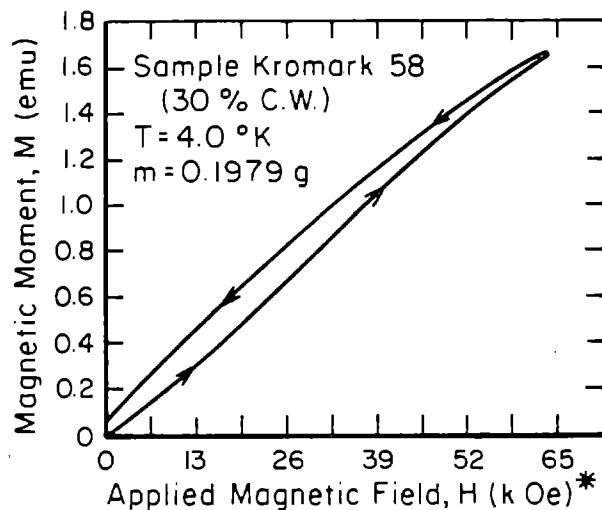


FIGURE 8.2.2-MA2.1. MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

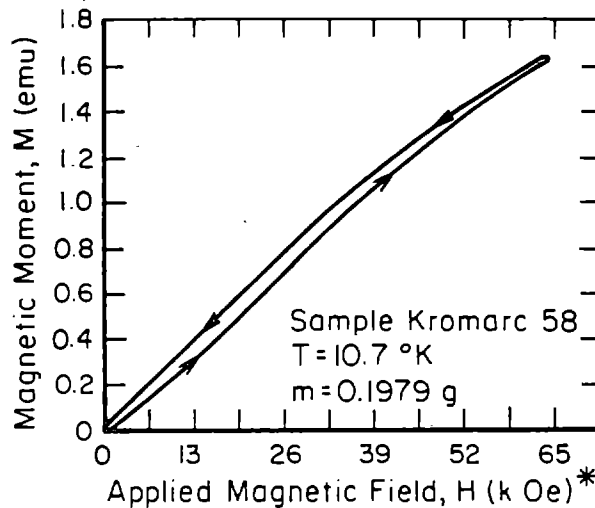


FIGURE 8.2.2-MA2.2. MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD

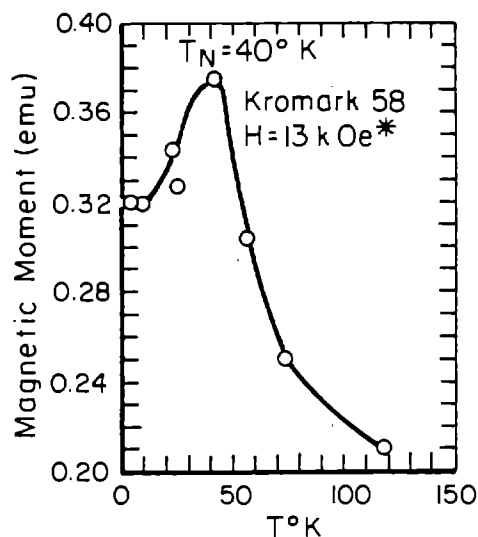
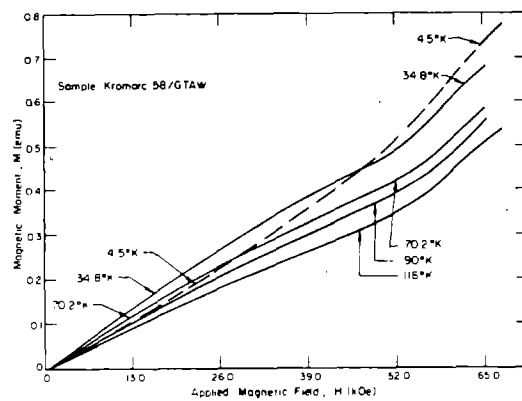
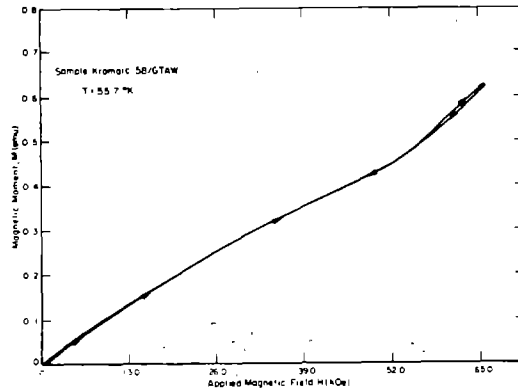
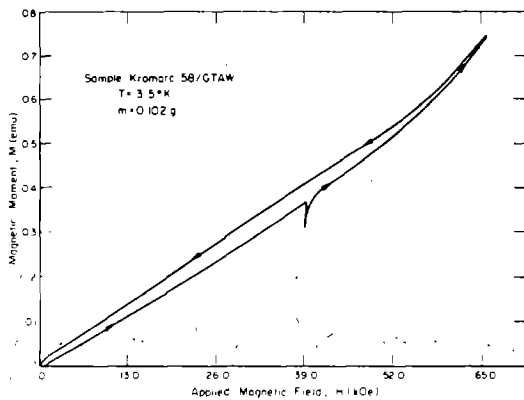


FIGURE 8.2.2-MA2.3. MAGNETIC MOMENT AT 13 k Oe AS A FUNCTION OF THE TEMPERATURE

* 1 tesla = 10kOe
Reference 94206

TABLE 8.2.2-MA3

Alloy Designation: Kromarc 58 Stainless Steel
Specification: Kromarc 58 GTAW
Form: Rod
Dimension, cm (in.): 0.305 (0.12)
Condition: Gas tungsten arc welded (GTAW)

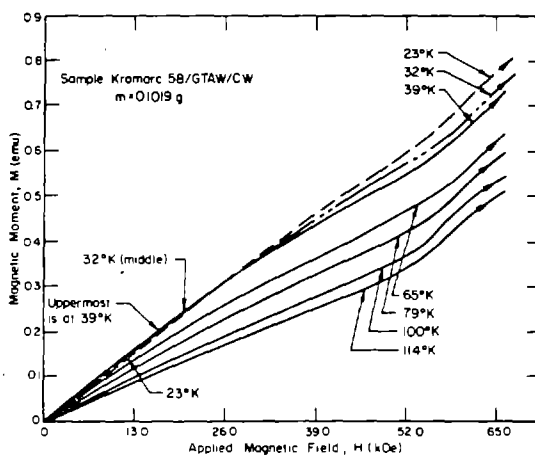
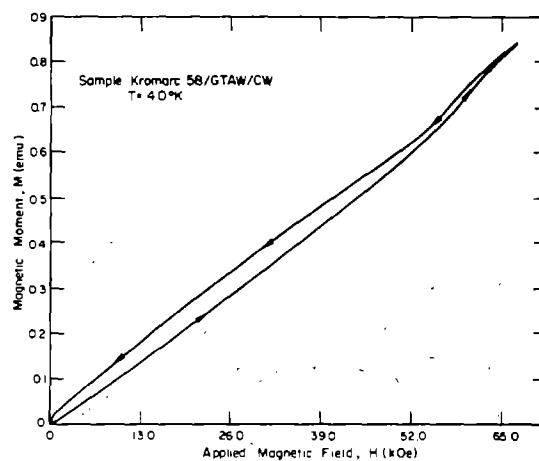
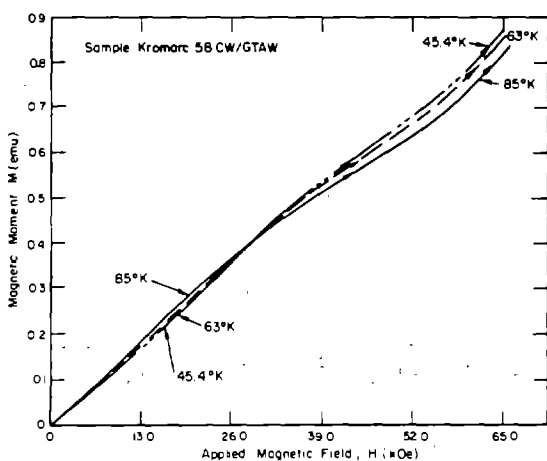


MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD [94206]

8.2.2-12 (11/76)

TABLE 8.2.2-MA4

Alloy Designation: Kromarc 58 Stainless Steel
Specification: 58 GTAW/CW
Form: Rod
Dimension, cm (in.): 0.305 (0.12)
Condition: GTAW/CW: Gas tungsten arc welded and cold worked to about 30% reduction in thickness



MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD [94206]

TABLE 8.2.2-MA5

Alloy Designation: Kromarc 58 Stainless Steel

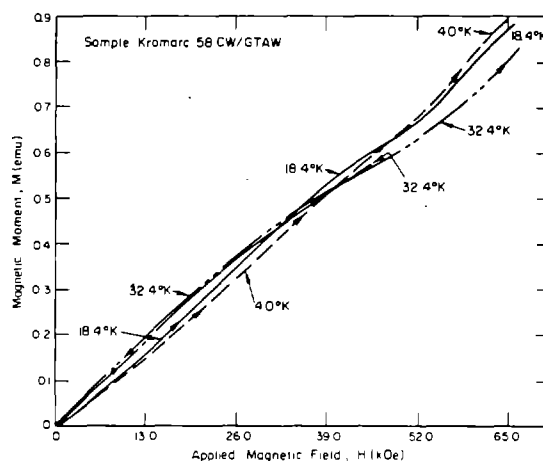
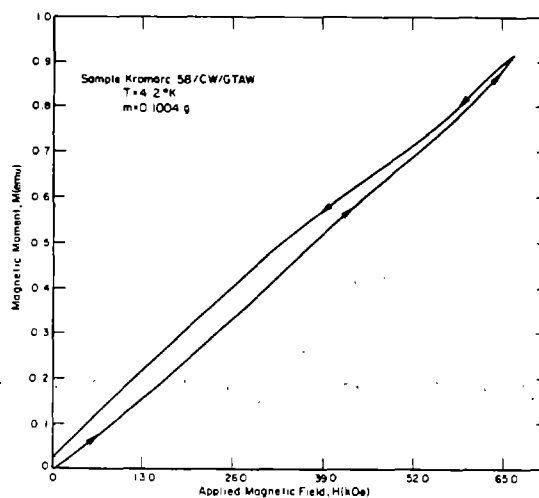
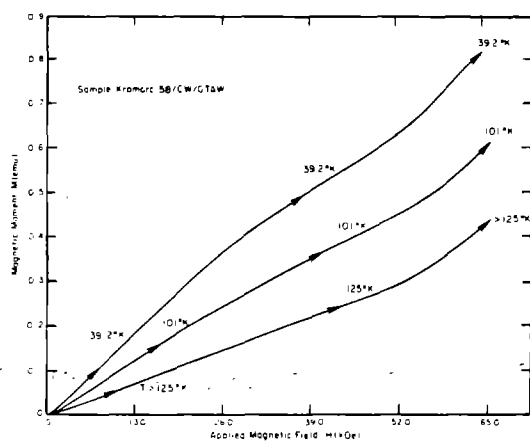
Specification: Kromarc 58 CW/GTAW

Form: Rod

Dimension, cm (in.): 0.305 (0.12)

Condition: CW/GTAW: Cold worked to about 30% reduction in thickness and gas tungsten arc welded

Neel Temperature: ~40 K (-387 F)



MAGNETIC MOMENT AS A FUNCTION OF THE EXTERNAL FIELD [94206]

TABLE 8.2.3-ME0.1

21-6-9
Plate

Alloy Designation: Armco 21-6-9 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.000 to 2.000)

Condition: Annealed 1283 K (1850 F) 1½ hr, AC; annealed 1366 K (2000 F) 1½ hr, WQ

Testing Temperature, K (F)		297 (75)			77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	701 (102)			1474 (213.8)		1634 (237.0)
	Min	696 (101)			1462 (212.1)		1633 (236.9)
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	358 (51.2)			899 (130)		1241 (180.0)
	Min	350 (50.8)			886 (129)		1224 (177.5)
Std. Deviation							
Elong, percent	Avg	61			43		16
	Min	61			42		
RA, percent	Avg	78			37		40
	Min	78			32		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		2 (1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 95168

TABLE 8.2.3-ME1

21-6-9
Plate

Alloy Designation: Armco 21-6-9 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Annealed 1340 K (1950 F) 1 hr., WQ

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	702 (101.8)	899 (130.4)	1510 (219.0)	1662 (241.0)		
	Min	688 (99.8)	889 (129.0)	1503 (218.0)	1579 (229.0)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	385 (55.9)	589 (85.4)	971 (140.9)	1219 (176.8)		
	Min	374 (54.2)	565 (82.0)	899 (130.4)	1108 (160.7)		
Std. Deviation							
Elong, percent	Avg	54.5	60.0	41.0	16.0*		
	Min	54.0	60.0	37.0	--		
RA, percent	Avg	79.6	74.8	32.8	46.0		
	Min	78.4	73.5	32.0	22.0		
No. of Spec. (No. of Heats)		4 (1)	2 (1)	2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	704 (102.1)	917 (133.0)	1444 (209.5)	1682 (244.0)		
	Min	698 (101.2)	907 (131.5)	1400 (203.0)	1675 (243.0)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	392 (56.9)	581 (84.3)	962 (139.5)	1248 (181.0)		
	Min	374 (54.2)	502 (81.5)	889 (129.0)	1148 (166.5)		
Std. Deviation							
Elong, percent	Avg	51.0	58.0	34.0*	16.0		
	Min	47.0	57.0	--	15.0		
RA, percent	Avg	71.8	70.3	27.8	24.3		
	Min	65.0	69.5	24.0	20.5		
No. of Spec. (No. of Heats)		4 (1)	2 (1)	2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 83166

* One specimen only

TABLE 8.2.3-ME2

Alloy Designation: Armco 21-6-9 Stainless Steel

Specification:
 Form: Plate
 Thickness, cm (in.): Over 5.080 (2.000)
 Condition: Annealed 1340 K (1950 F) 1 hr., WQ

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	2 (-423)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg	325 ⁺ (240 ⁺)	289 (213)	129 (95)	98 (72)	
	Min	325 ⁺ (240 ⁺)	286 (211)	122 (90)	—	
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	1	
Trans., Nm(ft-lb)	Avg	278 (205.3)	198 (146)	78 (57.5)	64 (47.0)	
	Min	260 (192.0)	198 (146)	68 (50)	56 (41.0)	
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)	
Fracture Toughness(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 83166

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

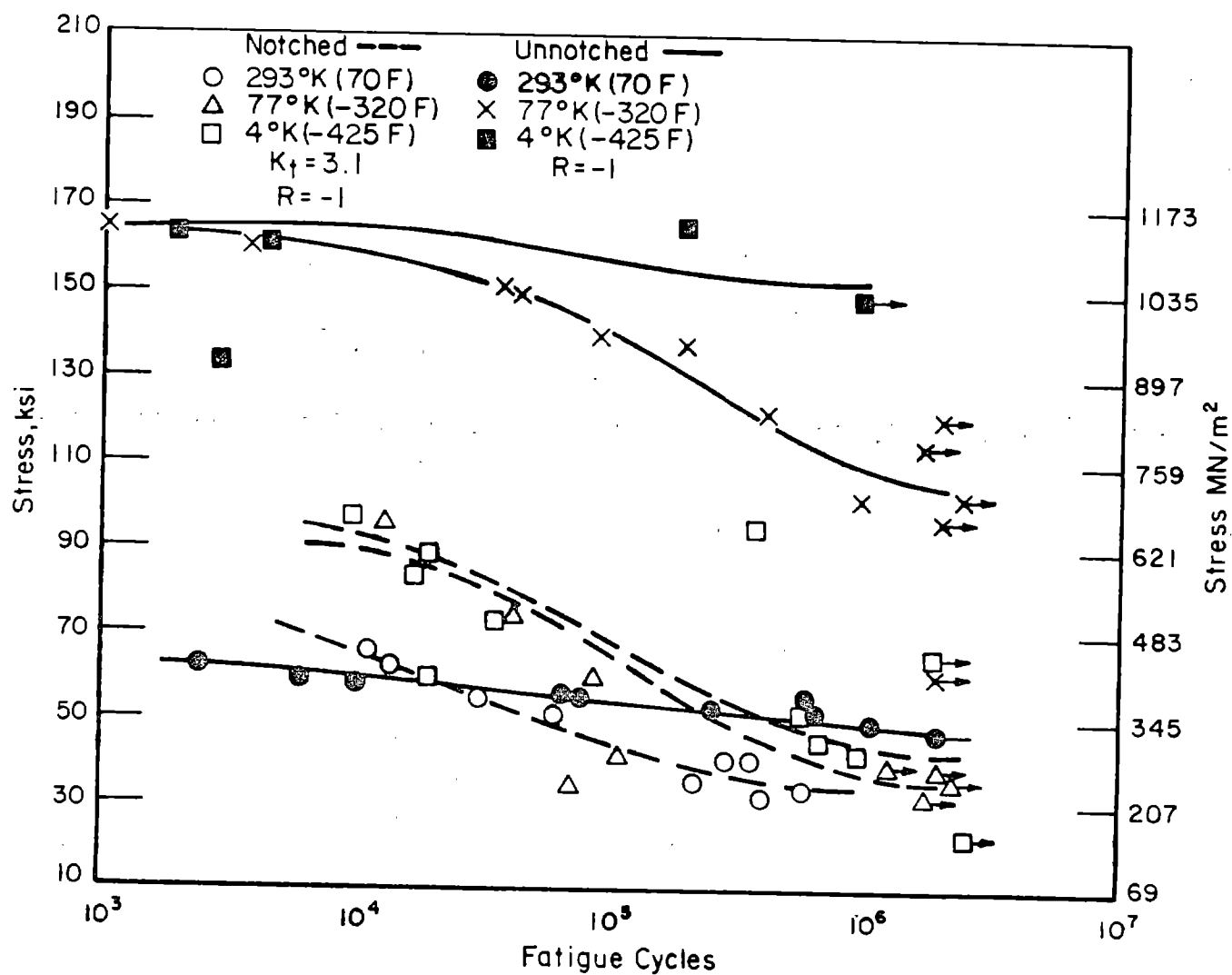


FIGURE 8.2.3-ME1. AXIAL FATIGUE-LIFE CURVES FOR 1.270 cm (0.500 in.) DIAMETER NOTCHED AND UNNOTCHED BAR SPECIMENS OF ANNEALED 21-6-9 STAINLESS STEEL [95168]

TABLE 8.2.3-MA1

Alloy Designation:	Armco 21-6-9 Stainless Steel
Specification:	19.00Cr–5.5Ni–8.00Mn–1.00Si–0.15N–0.08C–0.06P–0.03S–Bal Fe
Form:	Sheet and rod
Dimensions:	Not given
Condition:	As indicated in table below

Magnetic Permeability at Room Temperature

Condition	Field Strength (tesla)		
	5×10^{-3}	10×10^{-3}	20×10^{-3}
Hot rolled and pickled	12.67×10^{-7}	12.66×10^{-7}	12.65×10^{-7}
Hot rolled and pickled	12.63×10^{-7}	12.62×10^{-7}	12.62×10^{-7}
Cold drawn, 15 percent	12.62×10^{-7}	12.62×10^{-7}	12.61×10^{-7}
Cold drawn, 35 percent	12.63×10^{-7}	12.63×10^{-7}	12.63×10^{-7}
Cold drawn, 60 percent	12.70×10^{-7}	12.70×10^{-7}	12.72×10^{-7}
Annealed	--	--	12.60×10^{-7}

Reference: 64335

TABLE 8.2.4-ME1

Alloy Designation: Armco 22-13-5 Stainless Steel

Specification:

Form: Plate
 Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)
 Condition: Simulated braze cycle

Testing Temperature, K (F)		297 (75)	77 (-320)			
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg		1491 (216.2)			
	Min		1458 (211.5)			
Std. Deviation						
TYS, MN/m ² (ksi)	Avg		1078 (156.4)			
	Min		1062 (154.1)			
Std. Deviation						
Elong, percent	Avg		20.8			
	Min		17.3			
RA, percent	Avg		17.9			
	Min		17.0			
No. of Spec. (No. of Heats)			3 (1)			
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

References: 90624

TABLE 8.2.4-ME2

Alloy Designation: Armco 22-13-5 Stainless Steel

Specification:

Form: Plate

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: Simulated braze cycle

Testing Temperature, K (F)	297 (75)	77 (-320)				
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)	Avg	78.2 (85.9)				
	Min	75.1 (82.5)				
Orientation: —		5 (1)				
No. of Spec. (No. of Heats)						
K_{IE} MN/m^{3/2}(ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 90624

- (a) Indicate specimen design and orientation for shear specimens:
- (b) Indicate specimen design for K_{IC} data: Compact Tension

TABLE 8.2.4-TR1

Alloy Designation: Fe-22Cr-13Ni-5Mn

Specification:

Form:

Dimension:

Condition: Furnace brazed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	12.6	8.00	5.12	2.17	0.991	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(7.29)	(4.63)	(2.96)	(1.25)	(0.573)	
No. of Spec.	1	1	1	1	1	
References: 90196						
Thermal Expansion (T₂₇₃ to T)						
<u>Longitudinal</u>						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	80.0 x 10 ⁻⁸	65.8 x 10 ⁻⁸	62.4 x 10 ⁻⁸	62.1 x 10 ⁻⁸	62.1 x 10 ⁻⁸	62.2 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(481)	(396)	(375)	(374)	(374)	(374)
No. of Spec.	1	1	1	1	1	1
References: 90196						

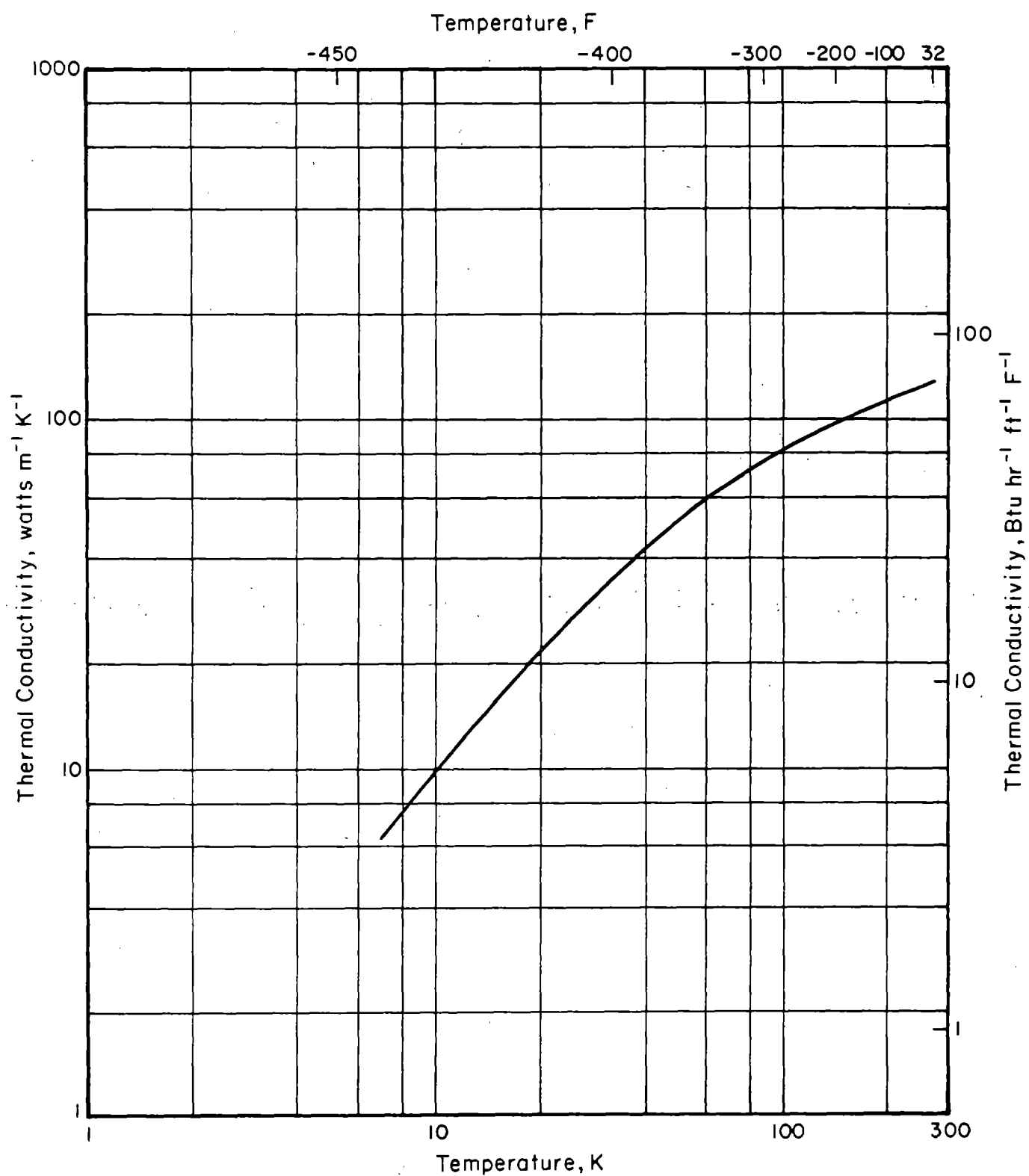


FIGURE 8.2.4-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR
FE-22CR-13NI-5MN ALLOY (Furnace Brazed Condition)

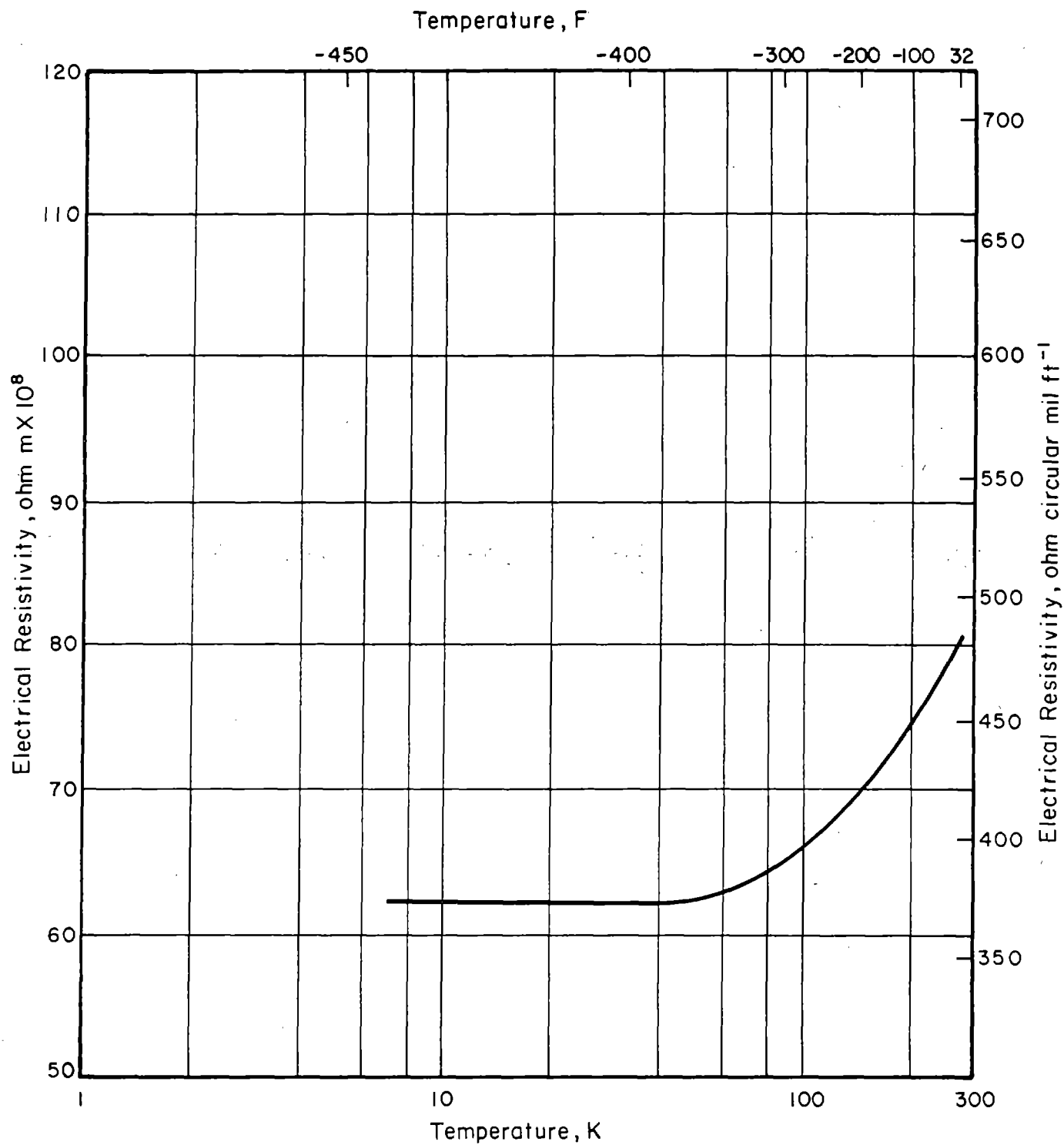


FIGURE 8.2.4-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR
FE-22CR-13NI-5MN ALLOY (Furnace Brazed Condition)

INDEX TO MATERIAL CODES FOR
SECTION 9.0

TITANIUM AND TITANIUM ALLOYS

<u>MATERIALS</u>	<u>MATERIAL CODE</u>
Ti-65A	9.1.1
Ti-75A	9.1.2
Ti-5Al-2.5Sn (NORMAL INTERSTITIAL CONTENT)	9.2.1
Ti-5Al-2.5Sn (ELI)	9.2.2
Ti-6Al-4V (ELI)	9.3.1
Ti-6Al-4V (NORMAL INTERSTITIAL CONTENT)	9.3.2

TABLE 9.1.1-ME1

Alloy Designation: Ti-65A Unalloyed Titanium

Specification: MIL-T-7993 A

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed

Testing Temperature, K (F)	297 (75)				17 (-430)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 462 (67.0)				1207 (175)	
	Min 449 (65.1)				1151 (167)	
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 369 (53.5)				861 (125)	
	Min 328 (47.5)				814 (118)	
Std. Deviation						
Elong, percent	Avg 30.0				32.2	
	Min 25				30	
RA, percent	Avg 62.3				49.7	
	Min 59				44	
No. of Spec. (No. of Heats)	5 (1)				8 (1)	
E, GN/m ² (10 ⁶ psi)	Avg				129 (18.7)	
	Min				124 (18.0)	
No. of Spec. (No. of Heats)					3 (1)	
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 581 (84.3)				1151 (167)	
K _t = 6.4	Min 565 (81.9)				1089 (158)	
No. of Spec. (No. of Heats)	5 (1)				5 (1)	
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 64373, 78652

TABLE 9.1.1-ME2

Alloy Designation: Ti-65A Unalloyed Titanium

Specification: MIL-T-7993 A

Form: Bar

Thickness, cm (in.): 2.541 to 5.080 (1.001 to 2.000)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	470 (68.1)	592 (85.8)	762 (110)	962 (140)		1214 (176)
	Min	444 (64.4)	567 (82.2)	717 (104)	949 (138)		
	Std Deviation	14.0 (2.03)	14.4 (2.09)	22.6 (3.28)	11.6 (1.69)		
TYS, MN/m ² (ksi)	Avg						
	Min						
	Std Deviation						
Elong, percent	Avg	29.5	41.8	57.1	50.6		37.0
	Min	27.9	35.0	51.0	49.3		
RA, percent	Avg	50.9	61.8	70.6	63.2		55.8
	Min	49.0	59.2	65.4	51.4		
	No. of Spec. (No. of Heats)	9 (2)	10 (2)	12 (2)	12 (2)		(1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
TYS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 36821, 45464, 56105

TABLE 9.1.2-ME1

Alloy Designation: Ti-75A Unalloyed Titanium

Specification: AMS-4901 D
 Form: Sheet
 Thickness, cm (in.): Up to 0.099 (0.039)
 Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	581 (84.3)	754 (109)	1048 (152)	1282 (186)		
	Min	574 (83.2)	752 (109)	1048 (152)	1262 (183)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	466 (67.6)	615 (89.2)	938 (136)	1193 (173)		
	Min	445 (64.5)	605 (87.8)	924 (134)	1172 (170)		
Std. Deviation							
Elong, percent	Avg	25.0	25.0	18	8		
	Min	24.5	24.5	16.5	6.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	786 (114)		1096 (159)	876 (127)		
	Min	779 (113)		1041 (151)	807 (117)		
K _t = 6.3							
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	587 (85.1)	758 (110)	1055 (153)	1338 (194)		
	Min	585 (84.8)	758 (110)	1055 (153)	1310 (190)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	476 (69.0)	644 (93.4)	965 (140)	1255 (182)		
	Min	474 (68.7)	639 (92.7)	965 (140)	1227 (178)		
Std. Deviation							
Elong, percent	Avg	25.2	20.2	13.8	6.8		
	Min	25.0	20.0	13.5	6.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	800 (116)	903 (131)	1124 (163)	882 (128)		
	Min	793 (115)	889 (129)	1096 (159)	855 (124)		
K _t = 6.3							
No. of Spec. (No. of Heats)		2 (1)	2 (1)	2 (1)	2 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 44291

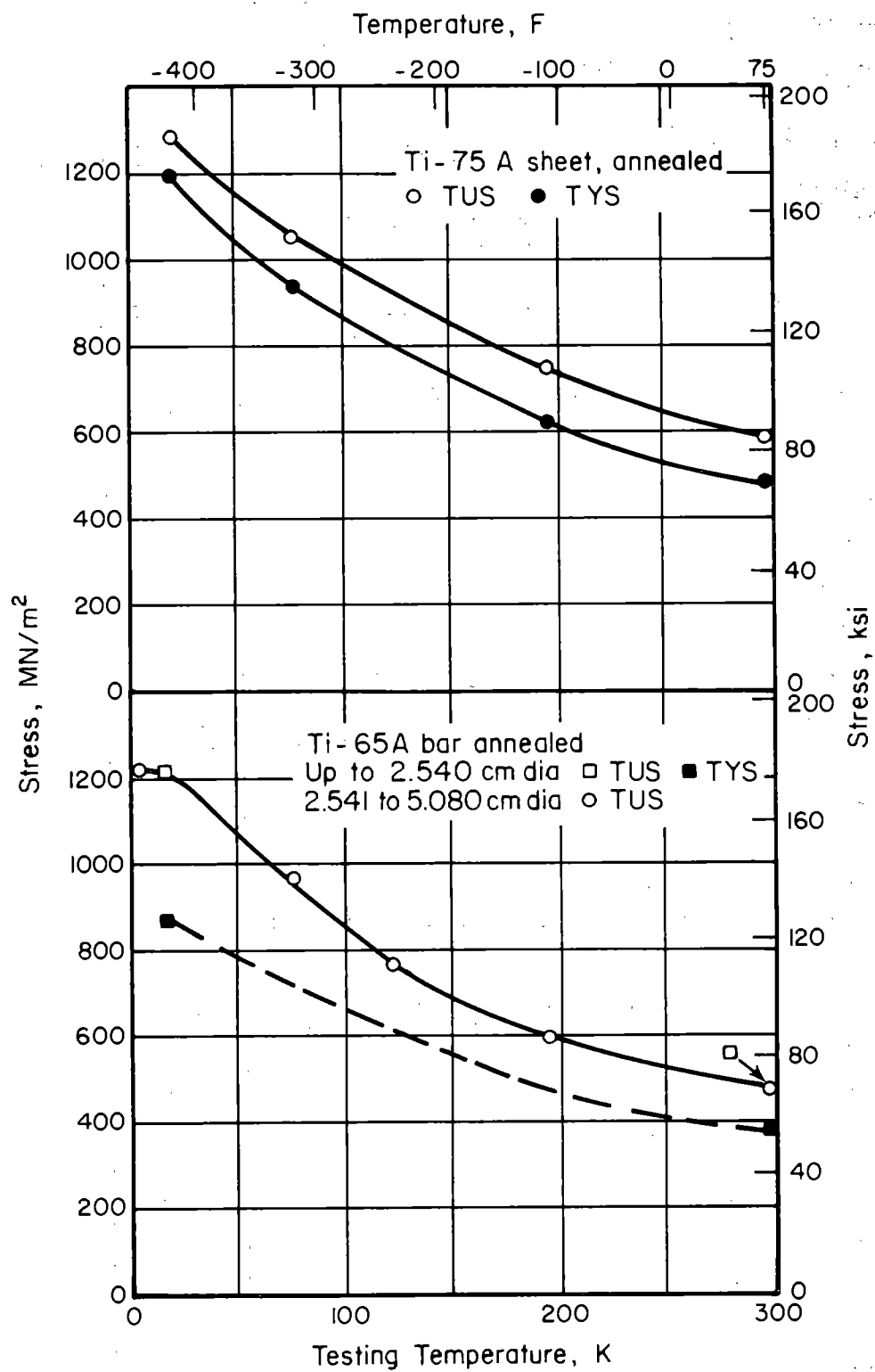


FIGURE 9.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF UNALLOYED TITANIUM

TABLE 9.1.1-TR1

Alloy Designation: Titanium

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹		30.0	34.5	26.3	13.3	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹		(17.3)	(19.9)	(15.2)	(7.69)	
No. of Spec.		4	4	4	4	
References: 90170, 90224						
Thermal Expansion (T₂₇₃ to T)						
<u>Longitudinal</u>						
Percent	0	-0.118	-0.133	-0.134	-0.134	-0.134
No. of Spec.	1	1	1	1	1	1
References: 90208						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	510	295	100	7.0	1.25	0.31
Btu lb ⁻¹ F ⁻¹	(0.122)	(0.0705)	(0.0239)	(0.00167)	(0.000299)	(0.0000740)
No. of Spec.	3	3	3	3	4	4
References: 40911, 42219, 90223						
Electrical Resistivity						
Ohm m	43.0 x 10 ⁻⁸	9.75 x 10 ⁻⁸	3.85 x 10 ⁻⁸	2.20 x 10 ⁻⁸	2.10 x 10 ⁻⁸	2.02 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(259)	(58.6)	(23.2)	(13.2)	(12.6)	(12.2)
No. of Spec.	6	2	2	2	1	1
References: 90206						

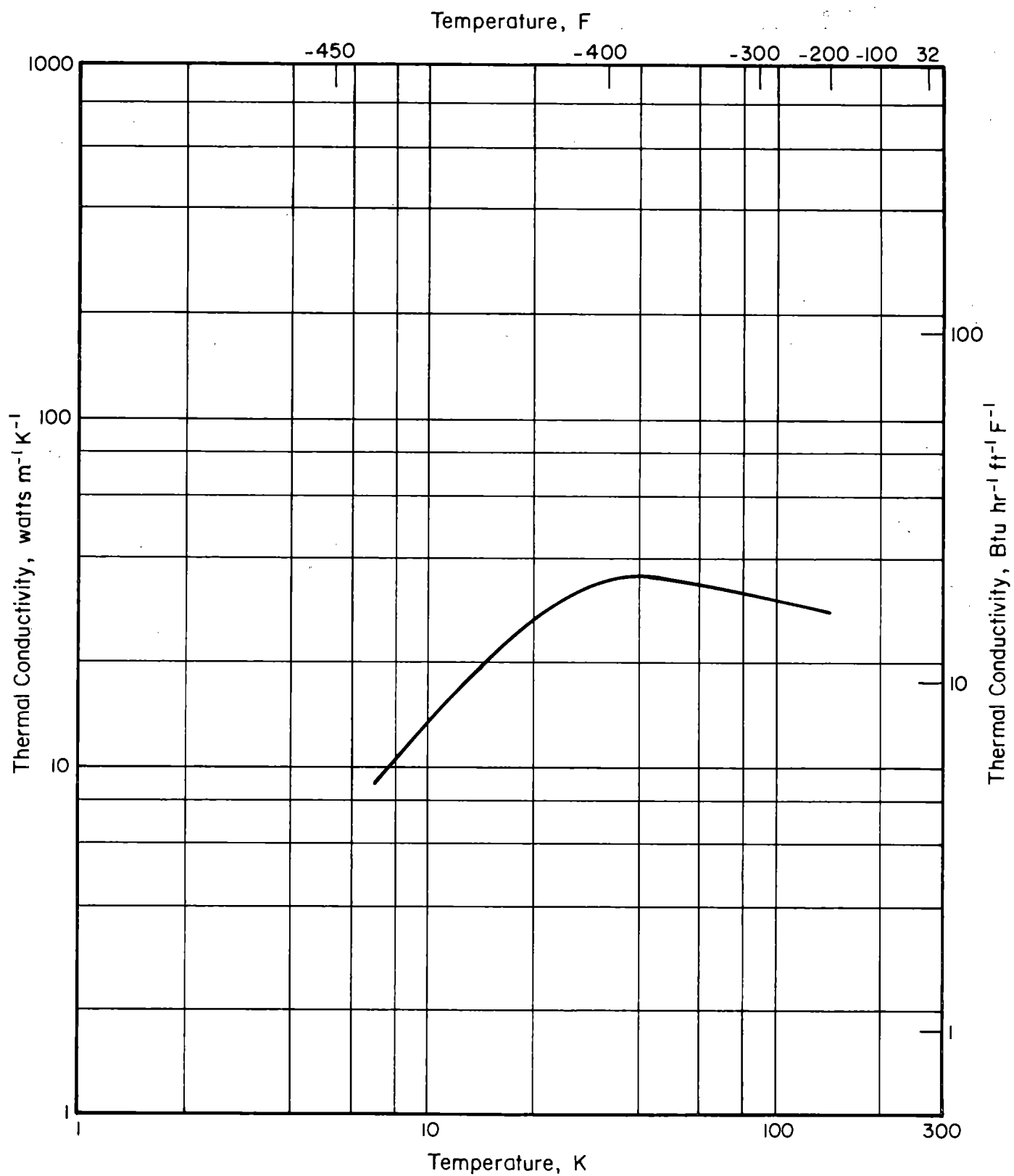


FIGURE 9.1.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR TITANIUM

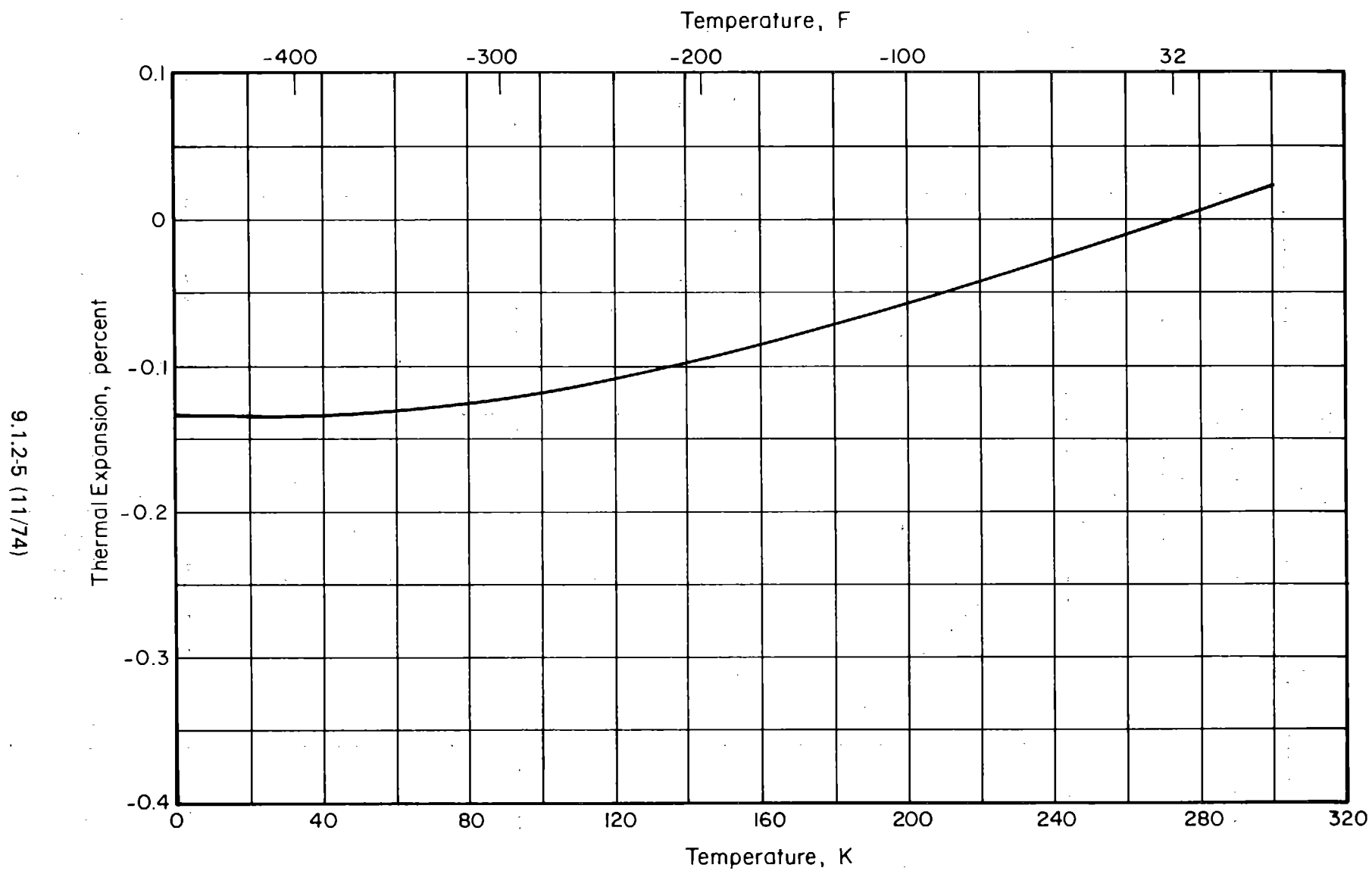


FIGURE 9.1.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR TITANIUM

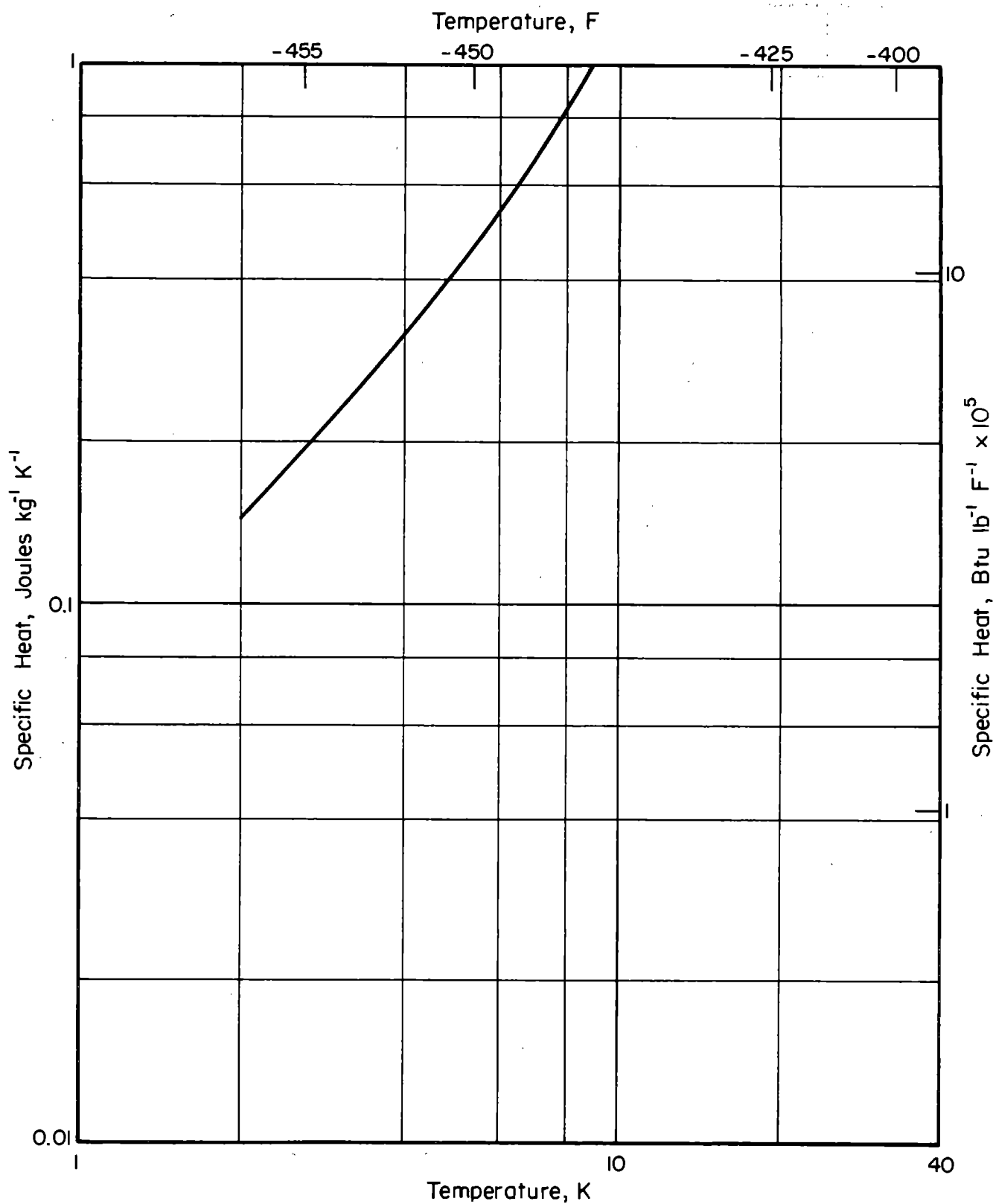


FIGURE 9.1.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE
FOR TITANIUM

9.1.2-6 (11/74)

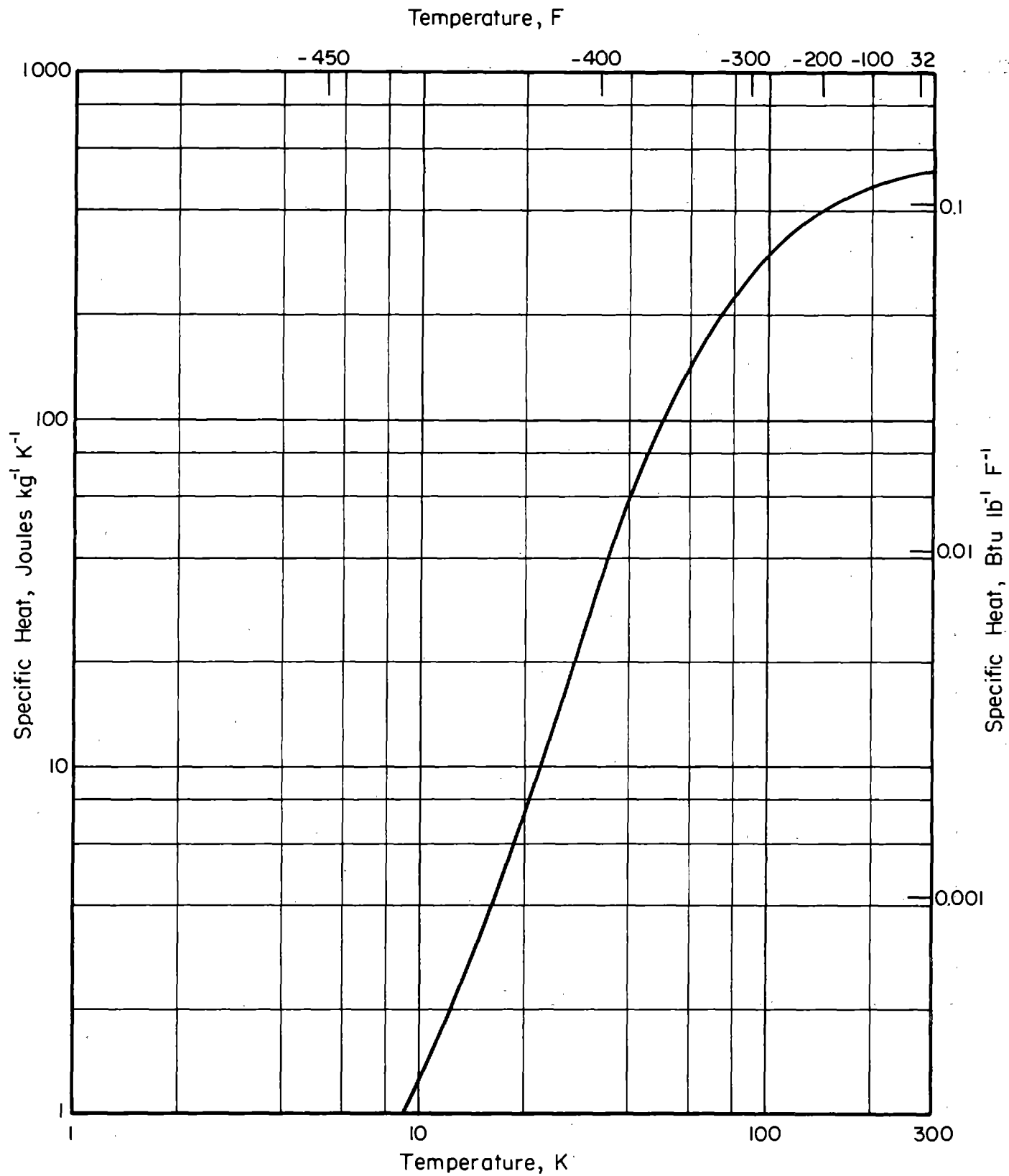


FIGURE 9.1.1-S2. SPECIFIC HEAT VERSUS TEMPERATURE
FOR TITANIUM

9.1.2-7 (11/74)

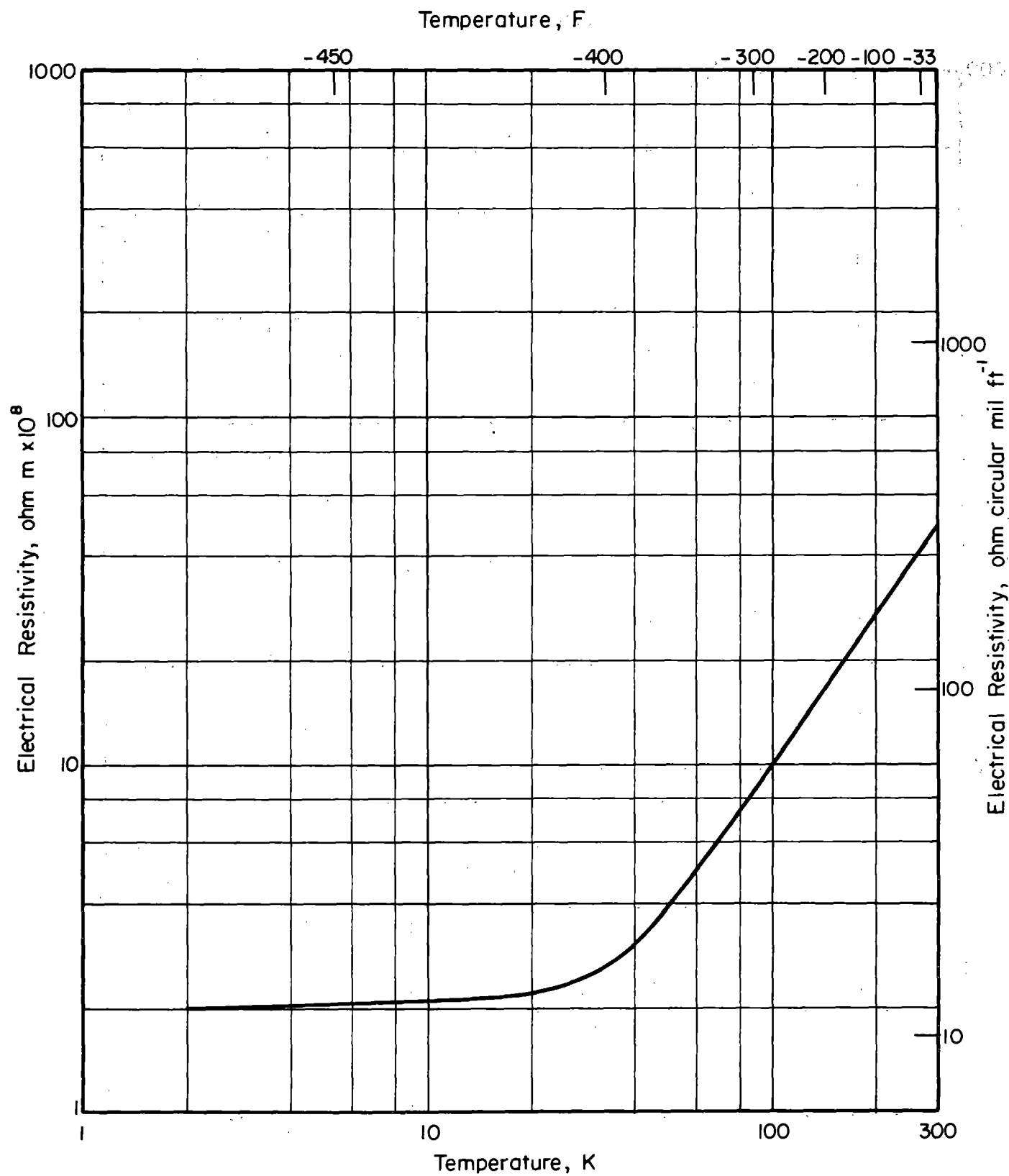


FIGURE 9.1.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE
FOR TITANIUM

9.1.2-8 (11/74)

TABLE 9.2.1-ME1

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content)

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	844 (122)	1037 (150)	1347 (195)	1686 (245)		
	Min	745 (108)	993 (144)	1234 (179)	1517 (220)		
Std. Deviation		62.8 (9.11)	55.2 (8.00)	78.6 (11.4)	88.9 (12.9)		
TYS, MN/m ² (ksi)	Avg	785 (114)	957 (139)	1275 (185)	1576 (228)		
	Min	703 (102)	889 (129)	1186 (172)	1427 (207)		
Std. Deviation		49.8 (7.23)	50.2 (7.28)	52.1 (7.56)	87.6 (12.7)		
Elong, percent	Avg	15.2	13.6	13.6	6.3		
	Min	12	12.5	11	3		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		21 (9)	8 (2)	12 (3)	23 (9)		
E, GN/m ² (10 ⁶ psi)	Avg	106 (15.4)	114 (16.6)	122 (17.7)	127 (18.5)		
	Min	93 (13.5)	109 (15.8)	117 (17.0)	116 (16.9)		
No. of Spec. (No. of Heats)		10 (2)	5 (1)	9 (2)	8 (2)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1121 (163)	1233 (179)	1644 (238)	1480 (215)		
	Min	1014 (147)	1131 (164)	1600 (232)	1338 (194)		
K _t = 6.3							
No. of Spec. (No. of Heats)		12 (7)	6 (2)	6 (2)	13 (7)		
NTS, MN/m ² (ksi)	Avg	947 (137)	976 (142)	956 (139)	831 (120)		
	Min	848 (123)	869 (126)	862 (125)	758 (110)		
K _t = 19+							
No. of Spec. (No. of Heats)		7 (2)	5 (1)	5 (1)	8 (2)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	872 (126)	1016 (147)	1398 (203)	1695 (246)		
	Min	807 (117)	979 (142)	1344 (195)	1579 (229)		
Std. Deviation		40.8 (5.92)	43.4 (6.29)	55.9 (8.11)	63.3 (9.18)		
TYS, MN/m ² (ksi)	Avg	819 (119)	966 (140)	1317 (191)	1589 (230)		
	Min	765 (111)	938 (136)	1262 (183)	1510 (219)		
Std. Deviation		33.6 (4.87)	33.4 (4.84)	49.6 (7.19)	40.7 (5.90)		
Elong, percent	Avg	14.3	11.7	10.0	4.7		
	Min	11	7.5	9	1		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		12 (7)	7 (2)	7 (2)	12 (6)		
E, GN/m ² (10 ⁶ psi)	Avg	104 (15.1)	122 (17.7)	126 (18.3)	134 (19.4)		
	Min	101 (14.7)	112 (16.2)	118 (17.2)	128 (18.5)		
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1144 (166)	1248 (181)	1626 (236)	1448 (210)		
	Min	1041 (151)	1200 (174)	1606 (233)	1255 (182)		
K _t = 6.3							
No. of Spec. (No. of Heats)		11 (6)	7 (2)	8 (2)	12 (5)		
NTS, MN/m ² (ksi)	Avg	952 (138)	1138 (165)	872 (126)	767 (111)		
	Min	876 (127)	945 (137)	827 (120)	683 (99)		
K _t = 19+							
No. of Spec. (No. of Heats)		7 (2)	5 (1)	5 (1)	8 (2)		

References: 40128, 48652, 50498, 59159, 70906

TABLE 9.2.1-ME1.1

Alloy Designation: Ti-5Al-2.5Sn (Nominal Interstitial Content)

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 20% cold rolled

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	827 (120)			1634 (237)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	710 (103)			1365 (198)		
	Min						
Std. Deviation							
Elong, percent	Avg	8			6		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1014 (147)			1634 (237)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	827 (120)			1600 (232)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	674 (97.8)			1393 (202)		
	Min						
Std. Deviation							
Elong, percent	Avg	9			6		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1082 (157)			1820 (264)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90171

TABLE 9.2.1-ME1.2

Alloy Designation: Ti-5Al-2.5Sn (Nominal Interstitial Content)

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: 40% cold rolled

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	889 (127)			1641 (238)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	745 (108)			1427 (207)		
	Min						
Std. Deviation							
Elong, percent	Avg	7			4		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	924 (134)			1131 (164)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	889 (129)			1627 (236)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	8			9		
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1117 (162)			1717 (249)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		1 (1)			1 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90171

TABLE 9.2.1-ME1.3

Alloy Designation: Ti-5Al-2.5Sn (Nominal Interstitial Content)

Specification:

Form: Sheet
 Thickness, cm (in.): Up to 0.099 (0.039)
 Condition: 50% cold rolled

Testing Temperature, K (F)		297 (75)				20 (-423)		
Tension, Longitudinal								
TUS, MN/m ² (ksi)	Avg	876	(127)			1679	(229)	
	Min							
Std. Deviation								
TYS, MN/m ² (ksi)	Avg	738	(107)			1400	(203)	
	Min							
Std. Deviation								
Elong, percent	Avg	5				1		
	Min							
RA, percent	Avg							
	Min							
No. of Spec. (No. of Heats)		1	(1)			1	(1)	
E, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Poisson's Ratio								
Work Hardening Coef								
NTS, MN/m ² (ksi)	Avg	814	(118)			986	(143)	
K _t = 6.3	Min							
No. of Spec. (No. of Heats)		1	(1)			1	(1)	
NTS, MN/m ² (ksi)	Avg							
K _t =	Min							
No. of Spec. (No. of Heats)								
Tension, Transverse								
TUS, MN/m ² (ksi)	Avg	869	(126)			1613	(234)	
	Min							
Std. Deviation								
TYS, MN/m ² (ksi)	Avg	738	(107)			1462	(212)	
	Min							
Std. Deviation								
Elong, percent	Avg	8				9		
	Min							
RA, percent	Avg							
	Min							
No. of Spec. (No. of Heats)		1	(1)			1	(1)	
E, GN/m ² (10 ⁶ psi)	Avg							
	Min							
No. of Spec. (No. of Heats)								
Poisson's Ratio								
Work Hardening Coef								
NTS, MN/m ² (ksi)	Avg	1096	(159)			1538	(223)	
K _t = 6.3	Min							
No. of Spec. (No. of Heats)		1	(1)			1	(1)	
NTS, MN/m ² (ksi)	Avg							
K _t =	Min							
No. of Spec. (No. of Heats)								

References: 90171

TABLE 9.2.1-ME1.4

Alloy Designation: Ti-5Al-2.5Sn (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		195 (-108)		77 (-320)		20 (-423)	
Tension, Longitudinal									
TUS, MN/m ² (ksi)	Avg	816	(118.4)	1004	(145.6)	1320	(191.4)	1657.5	(240.4)
	Min	765	(111.0)	1000	(145.0)	1241	(180.0)	1482.4	(215.0)
	Std. Deviation	33.8	(4.91)			66	(9.57)	139	(20.17)
TYS, MN/m ² (ksi)	Avg								
	Min								
	Std. Deviation								
Elong, percent	Avg	8.3		14.4		6.6		2.8	
	Min	1.0		12.5		1.5		1.0	
RA, percent	Avg								
	Min								
	No. of Spec. (No. of Heats)	15	(3)	5	(1)	10	(1)	15	(3)
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
	No. of Spec. (No. of Heats)								
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
	K _t =								
	Min								
NTS, MN/m ² (ksi)	Avg								
	K _t =								
	Min								
No. of Spec. (No. of Heats)									
Tension, Transverse									
TUS, MN/m ² (ksi)	Avg	818	(118.6)	978	(141.8)	1292	(187.4)	1573	(228.2)
	Min	779	(113.0)	965	(140.0)	1186	(172.0)	1331	(193.0)
	Std. Deviation	18.75	(2.72)			83.1	(12.05)	143	(20.75)
TYS, MN/m ² (ksi)	Avg								
	Min								
	Std. Deviation								
Elong, percent	Avg	7.5		12.1		6.2		3.0	
	Min	1.0		11.0		0.5		1.0	
RA, percent	Avg								
	Min								
	No. of Spec. (No. of Heats)	10	(1)	5	(1)	10	(1)	10	(1)
E, GN/m ² (10 ⁶ psi)	Avg								
	Min								
	No. of Spec. (No. of Heats)								
Poisson's Ratio									
Work Hardening Coef									
NTS, MN/m ² (ksi)	Avg								
	K _t =								
	Min								
NTS, MN/m ² (ksi)	Avg								
	K _t =								
	Min								
No. of Spec. (No. of Heats)									

References: 40128, 48652, 59159

TABLE 9.2.1-ME2

Alloy Designation: Ti-5Al-2.5Sn (Nominal Interstitial Content)

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	144 (-200)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	858 (124.4)	1118 (162)	1186 (172)	1400 (203)	1708 (247.8)	1620 (235)
	Min	793 (115)	1055 (153)		1276 (185)	1586 (230)	
	Std. Deviation	56.3			106 (15.4)	95.5 (13.85)	
TYS, MN/m ² (ksi)	Avg	804 (116.6)	1074 (156)	1165 (169)	1327 (192)	(23.54)	
	Min	710 (103)	1007 (146)		1186 (172)	1468 (213)	
	Std. Deviation	68.7 (9.96)			126 (18.3)	(15.36)	
Elong, percent	Avg	16.28	11.7	9.3	13.6	7.82	1.3
	Min	10.80	7.3		4.6	2.00	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		25 (7)	7 (3)	3 (1)	21 (8)	31 (7)	3 (1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1138 (165)	1386 (201)		1622 (235)	1382 (200)	
	Min	1076 (156)	1379 (200)		1586 (230)	1110 (161)	
	No. of Spec. (No. of Heats)	15 (6)	2 (1)		15 (6)	21 (9)	
NTS, MN/m ² (ksi)	Avg	1110 (161)	1193 (173)	1303 (189)	1186 (172)	1062 (154)	1007 (146)
	Min						
	No. of Spec. (No. of Heats)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)	3 (1)
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	924 (134)	1089 (158)	1207 (175)	1469 (213)	1638 (238)	1593 (231)
	Min					1600 (232)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	903 (131)	1069 (155)	1200 (174)	1434 (208)	1635 (237)	
	Min						
Std. Deviation							
Elong, percent	Avg	14.3	11.5	10.7	13.2	6.3	1.5
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)	4 (2)	3 (1)
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1206 (175)				1131 (164)	
	Min						
	No. of Spec. (No. of Heats)	(1)				(1)	
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

TABLE 9.2.1-ME2.1

Alloy Designation: Ti-5Al-2.5Sn (Nominal Interstitial Content)

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: 20% cold rolled

Testing Temperature, K (F)	297 (75)			20 (-423)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg	1000 (145)			1889 (274)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	862 (125)			1682 (244)	
	Min					
Std. Deviation						
Elong, percent	Avg	9			4	
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	1	(1)			1	(1)
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg	1303 (189)			1586 (230)	
K _t = 6.3	Min					
No. of Spec. (No. of Heats)	1	(1)			1	(1)
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 90171

TABLE 9.2.1-ME2.2

Alloy Designation: Ti-5Al-2.5Sn (Nominal Interstitial Content) (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler
 Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)
 Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	834 (121)	976 (141.5)		1326 (192.3)	1644 (238.4)	
	Min	827 (120)	972 (141.0)		1310 (190.0)	1551 (225.0)	
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	12.3	11.0		8.0	3.7	
	Min	11.0	10.0		2.0	0.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	2 (1)		3 (1)	5 (2)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 40128, 59159

TABLE 9.2.1-ME2.3

Ti-5Al-2.5Sn
Plate

Alloy Designation: Ti-5Al-2.5Sn (Nominal Interstitial Content)

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	917 (133)		1438 (208.6)	1578 (228.8)		
	Min	914 (132.6)		1429 (207.3)	1577 (228.7)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	876 (127)		1358 (197)	1502 (217.8)		
	Min	875 (126.9)		1341 (194.5)	1485 (215.4)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg	38.0		32.0	16.6		
	Min	32.8		31.7	12.4		
No. of Spec. (No. of Heats)		2 (1)		2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg				133 (19.3)		
	Min				132 (19.2)		
No. of Spec. (No. of Heats)					2 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 91793

TABLE 9.2.1-ME3

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content)

Specification:

Form: Bar

Diameter: Up to 2.54 cm (1.000 in.)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	17 (-430)	4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	910 (132)	1088 (158)	1410 (204.5)	1774 (257)	1551 (225)	1475 (214)
	Min	862 (125)	1062 (154)	1344 (195)	1731 (251)	1469 (213)	1475 (214)
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	862 (125)	1032 (150)	1293 (187.5)	1721 (250)	1413 (205)	1413 (205)
	Min	827 (120)	1020 (148)	1096 (159)	1668 (242)	1379 (200)	1413 (205)
Std. Deviation							
Elong, percent	Avg	15.8	13.2	12.0	8.7	13.7	
	Min	12	12	10	3	12.0	
RA, percent	Avg	35.8	33	28.2	15	30	
	Min	25	27	22	17	21	
No. of Spec. (No. of Heats)		6 (3)	4 (2)	6 (3)	3 (2)	4 (1)	2 (1)
E, GN/m ² (10 ⁶ psi)	Avg	119 (17.3)		126 (18.3)			129 (18.7)
	Min	119 (17.3)		126 (18.3)			129 (18.7)
No. of Spec. (No. of Heats)		2 (1)		2 (1)			2 (1)
Poisson's Ratio		0.289		0.287			0.287
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 78652, 89543

TABLE 9.2.1-ME4

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content)

Specification:

Form: Bar
 Diameter: Up to 2.540 cm (1.000 in.)
 Condition: Annealed

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)			
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb)	Avg	23.9 (17.6)	19.4 (14.3)	15.2 (11.2)		
	Min	23.7 (17.5)	18.3 (13.5)	14.2 (10.5)		
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)		
Trans., J(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) —)Min						
No. of Spec. (No. of Heats)						

References: 54986

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 9.2.1-ME5

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content)

Specification:

Form: Bar
Diameter: Over 2.540 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	871 (126)	1087 (158)	1297 (188)	1440 (209)		
	Min	841 (122)	1051 (152)	1265 (184)	1406 (204)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	17.8	13.6	12.9	11.1		
	Min	15.0			9.3		
RA, percent	Avg	32.9	24.4	25.2	18.4		
	Min	29.8	20.6	23.6	15		
No. of Spec. (No. of Heats)		7 (1)	6 (1)	6 (1)	6 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 36821

TABLE 9.2.1-ME 5.1

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content)

Specification:

Form: Bar

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Commercial annealed

Testing Temperature, K (F)	297 (75)	77 (-320)	4 (-452)			
Compression, Longitudinal						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC}, MN/m^{3/2}(ksi√in.)						
Avg	63.8 (70.3)	34.9 (38.3)	34.9 (38.3)			
Min	62.7 (68.9)	--	33.8 (37.1)			
Orientation: —						
No. of Spec. (No. of Heats)	2(1)	1	2(1)			
K_{IE}, MN/m^{3/2}(ksi√in.)						
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 94206B

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data: Compact Tension

TABLE 9.2.1-ME5.2

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content)

Specification:

Form: Forging

Thickness, cm (in.): Over 5.080 (2.000)

Condition: Vacuum Annealed 1035 K (1400 F)

Testing Temperature, K (F)	297 (75)	77 (-320)				
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg	1306 (189.4)				
	Min	1265 (183.5)				
Std. Deviation		36.5 (5.3)				
TYS, MN/m ² (ksi)	Avg	1231 (178.5)				
	Min	1198 (173.7)				
Std. Deviation		37.2 (5.4)				
Elong, percent	Avg	13.4				
	Min	7.7				
RA, percent	Avg	27.6				
	Min	16.1				
No. of Spec. (No. of Heats)		9(1)				
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 90624

TABLE 9.2.1-ME6

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content)

Specification:

Form: Large Forgings

Thickness, cm (in.):

Condition: As forged

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	777 (113)	917 (133)	1266 (184)	1409 (204)		
	Min	765 (111)	910 (132)	1248 (181)	1344 (195)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	761 (110)	899 (130)	1174 (170)	1276 (185)		
	Min	752 (109)	889 (129)	1138 (165)	1207 (175)		
Std. Deviation							
Elong, percent	Avg	10	8	8	6		
	Min	9	7	8	3		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1214 (176)	1400 (203)	1682 (244)	1441 (209)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	772 (112)	931 (135)	1273 (185)	1406 (204)		
	Min	758 (110)	917 (133)	1261 (183)	1393 (202)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	740 (107)	910 (132)	1149 (167)	1257 (182)		
	Min	724 (105)	903 (131)	1131 (164)	1193 (173)		
Std. Deviation							
Elong, percent	Avg	8	9.5	7.3	6.6		
	Min	8	9	6	6		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1317 (191)	1406 (204)	1448 (210)	1358 (197)		
	Min						
K _t = 6.3							
No. of Spec. (No. of Heats)		(1)	(1)	(1)	(1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 71237

TABLE 9.2.1-ME7

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content)

Specification:

Form: Large Forgings

Thickness, cm (in.):

Condition: As forged

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Short Transverse							
TUS, MN/m ² (ksi)	Avg	756 (110)	915 (133)	1264 (183)	1390 (202)		
	Min	745 (108)	869 (126)	1207 (175)	1317 (191)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	717 (104)	882 (128)	1163 (169)	1279 (186)		
	Min	703 (102)	841 (122)	1117 (162)	1276 (185)		
Std. Deviation							
Elong, percent	Avg	10.3	6.6	8.5	6		
	Min	7	6	8	3		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1303 (189)	1476 (214)	1489 (216)	1406 (204)		
	Min	(1)	(1)	(1)	(1)		
K _t = 6.3							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
References: 71237							

TABLE 9.2.1-ME8

Alloy Designation: Ti-5Al-2.5Sn (Normal Interstitial Content)

Specification:

Form: Large Forgings

Thickness, cm (in.):

Condition: Annealed

Testing Temperature, K (F)	297 (75)			20 (-423)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg			1427 (207)		
	Min			1344 (195)		
Std. Deviation				54.3 (7.88)		
TYS, MN/m ² (ksi)	Avg			1303 (189)		
	Min			1220 (177)		
Std. Deviation				52.7 (7.64)		
Elong, percent	Avg			13.6		
	Min			6		
RA, percent	Avg			23.3		
	Min			11		
No. of Spec. (No. of Heats)				25		
E, GN/m ² (10 ⁶ psi)	Avg			135 (19.6)		
	Min			121 (17.6)		
No. of Spec. (No. of Heats)				25		
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg			1655 (240)		
K _t = 5.5 - 7.8	Min			1524 (221)		
No. of Spec. (No. of Heats)				25		
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 56510

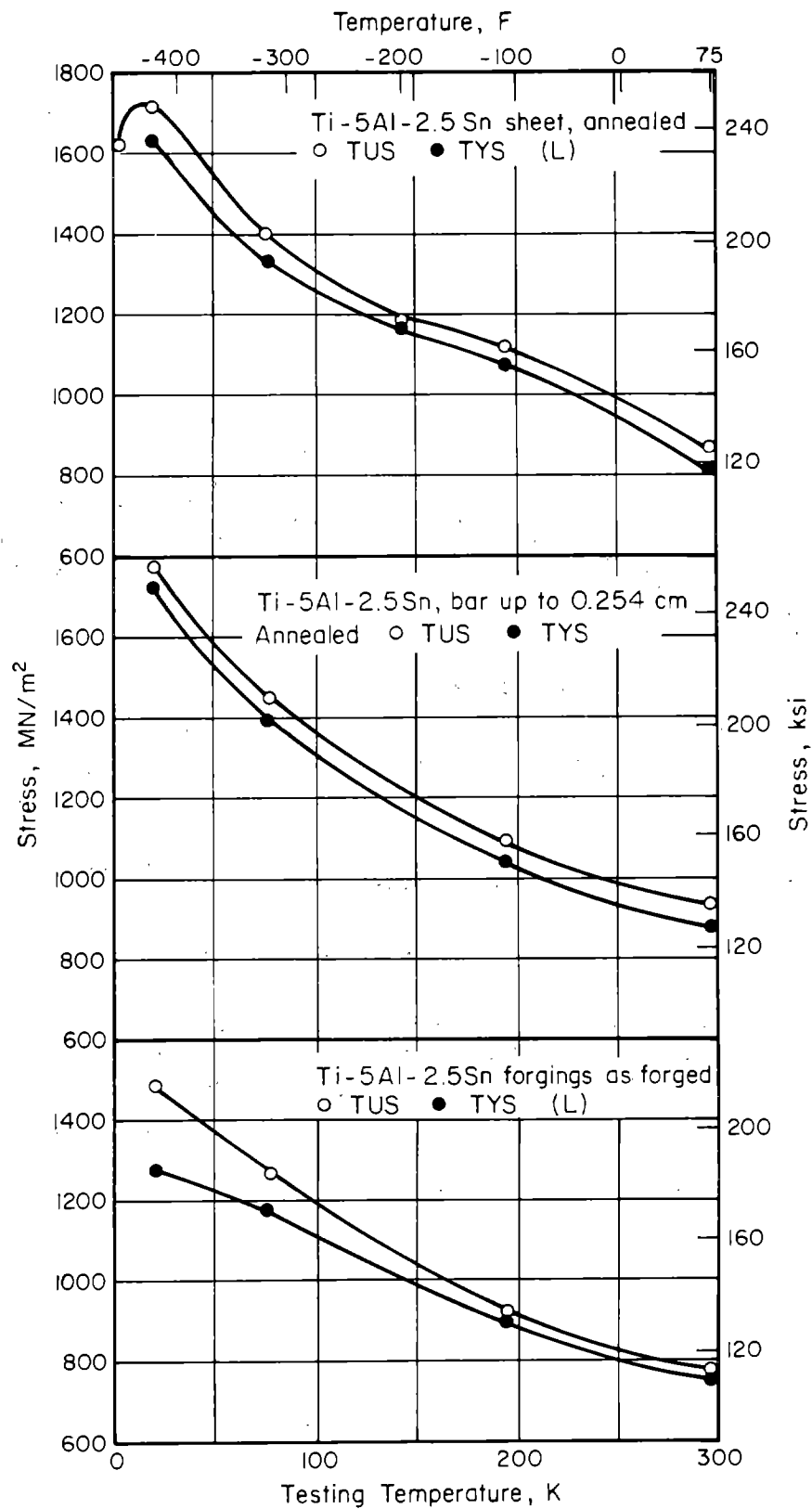


FIGURE 9.2.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF Ti-5Al-2.5Sn ALLOY

9.2.1-9 (11/74)

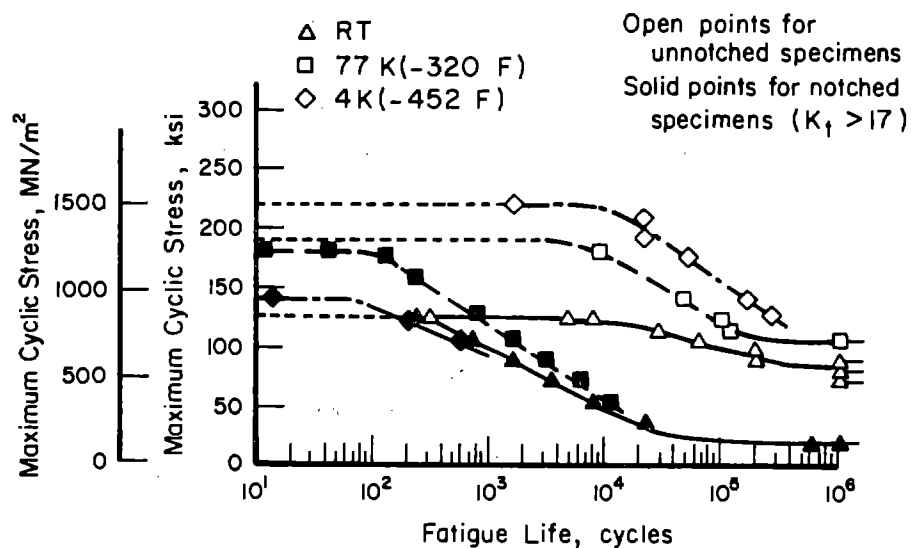


FIGURE 9.2.1-ME2. FATIGUE LIFE CURVES FOR AXIAL LOADING ON LONGITUDINAL SPECIMENS OF Ti-5Al-2.5Sn SHEET 0.050 CM (0.020 IN.) THICK AT FREQUENCIES OF 3.3 AND 0.27 HERTZ AT $R = 0.14$

Reference: 70906

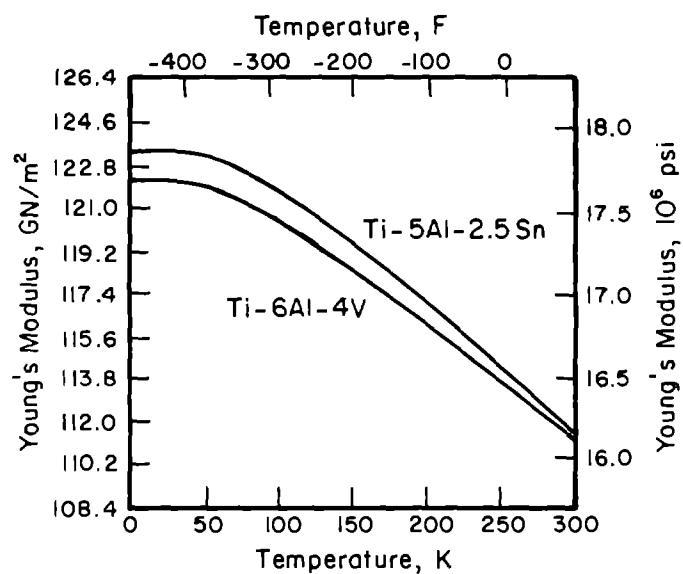


FIGURE 9.2.1-ME3. YOUNG'S MODULUS OF TWO TITANIUM ALLOYS (ANNEALED BARS) DETERMINED BY MEASURING THE ULTRASONIC WAVE VELOCITIES AT LOW TEMPERATURES (89525)

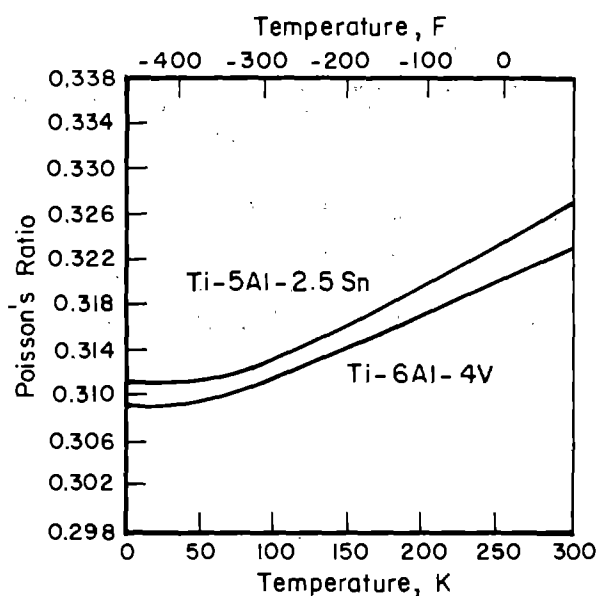


FIGURE 9.2.1-ME4. POISSON'S RATIO OF TWO TITANIUM ALLOYS (ANNEALED BARS) DETERMINED BY MEASURING THE ULTRASONIC WAVE VELOCITIES AT LOW TEMPERATURES (89525)

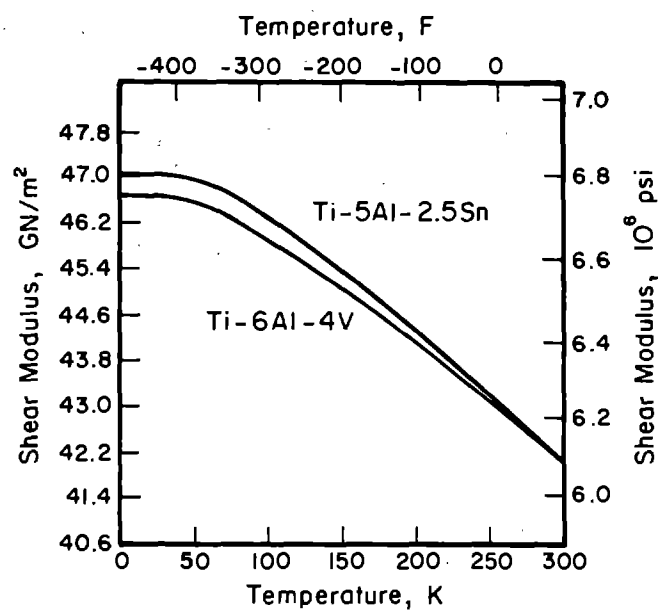


FIGURE 9.2.1-ME5. SHEAR MODULUS OF TWO TITANIUM ALLOYS (ANNEALED BARS) DETERMINED BY MEASURING THE ULTRASONIC WAVE VELOCITIES AT LOW TEMPERATURES (89525)

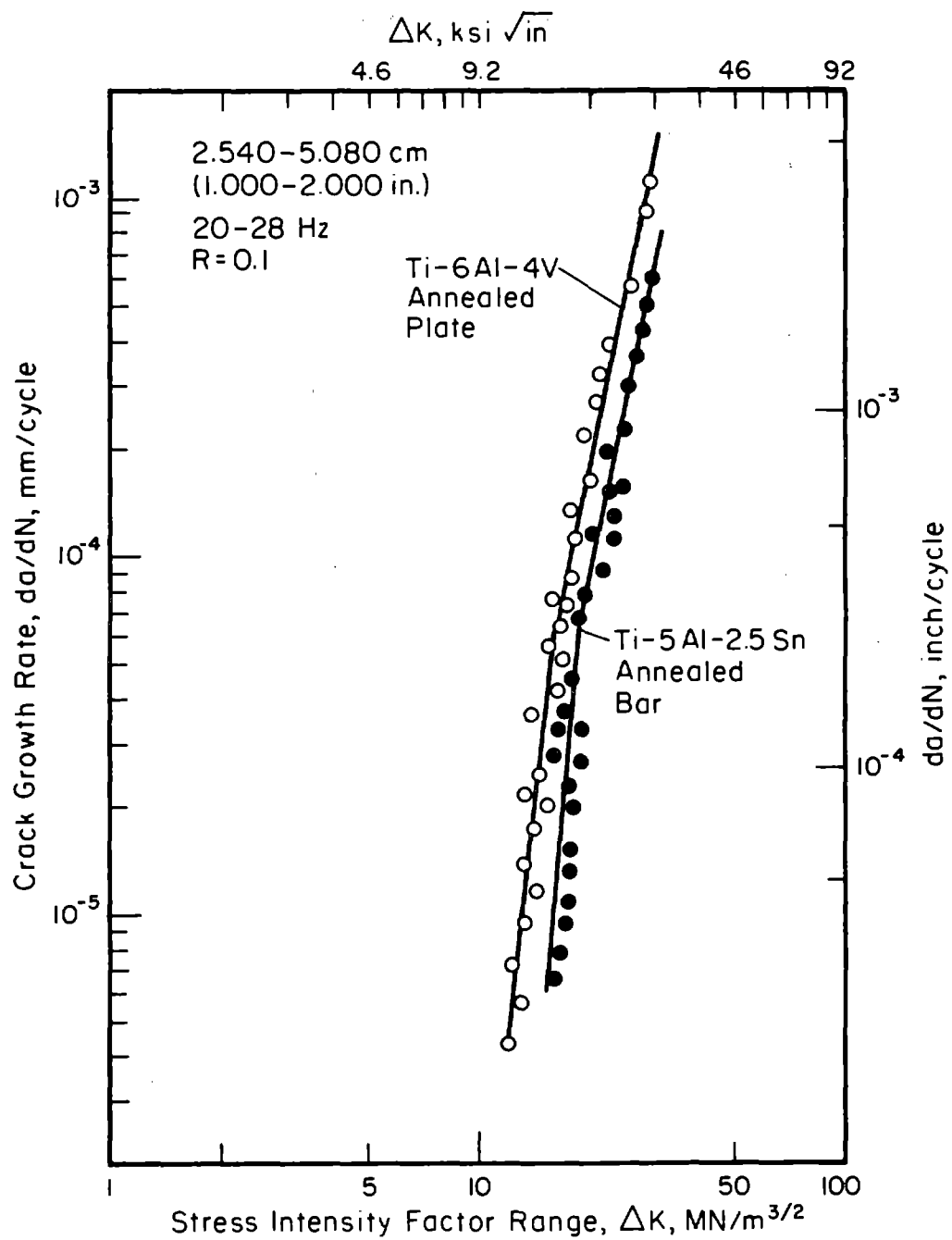


FIGURE 9.2.1-ME6. FATIGUE CRACK GROWTH RATES FOR TITANIUM ALLOYS AT 4 K (-452 F) (94208D)

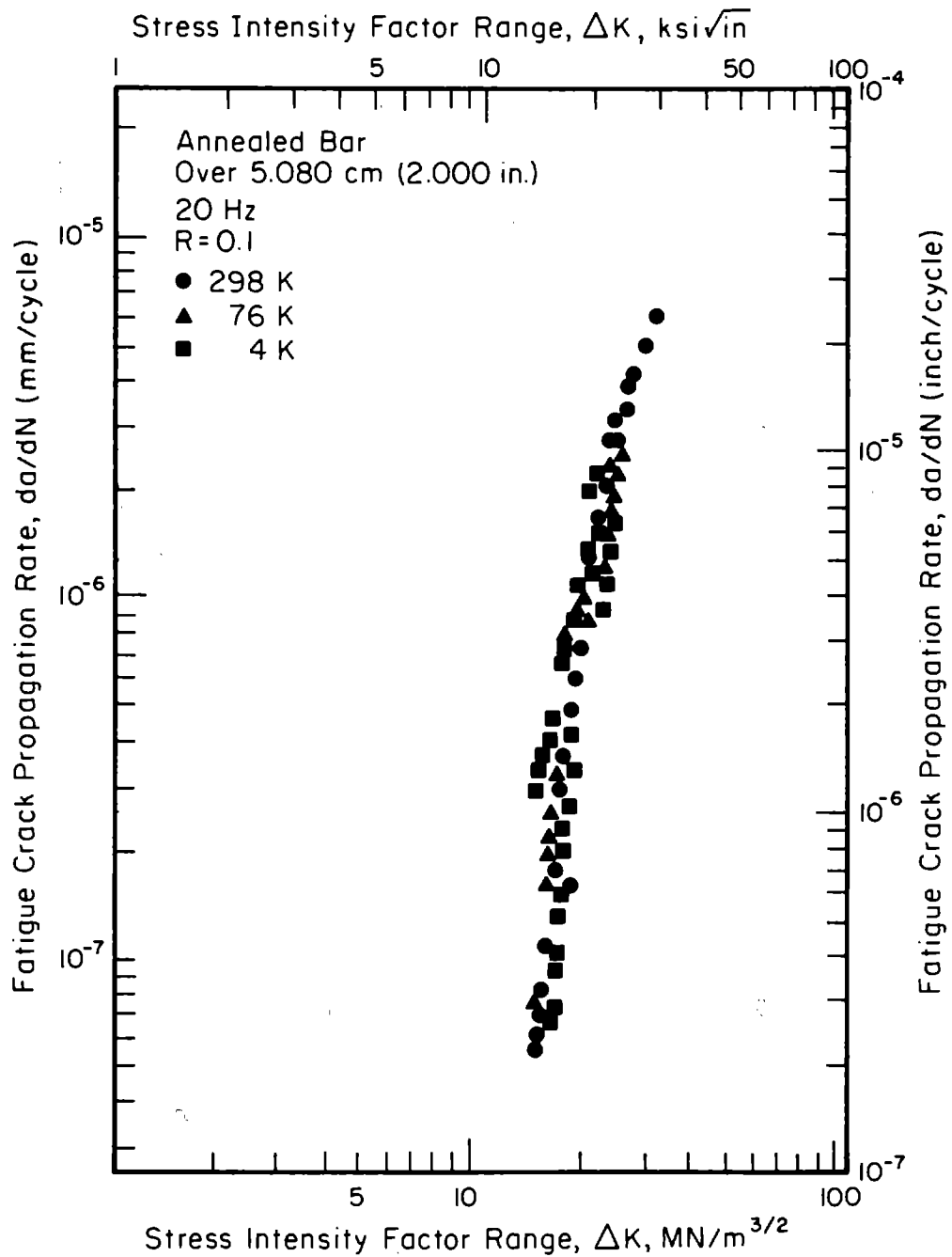


FIGURE 9.2.1-ME7. FATIGUE CRACK GROWTH RATES FOR Ti-5Al-2.5Sn AT 4K, 76K, AND 298K (-452F, -321F, AND 76F)(94206B)

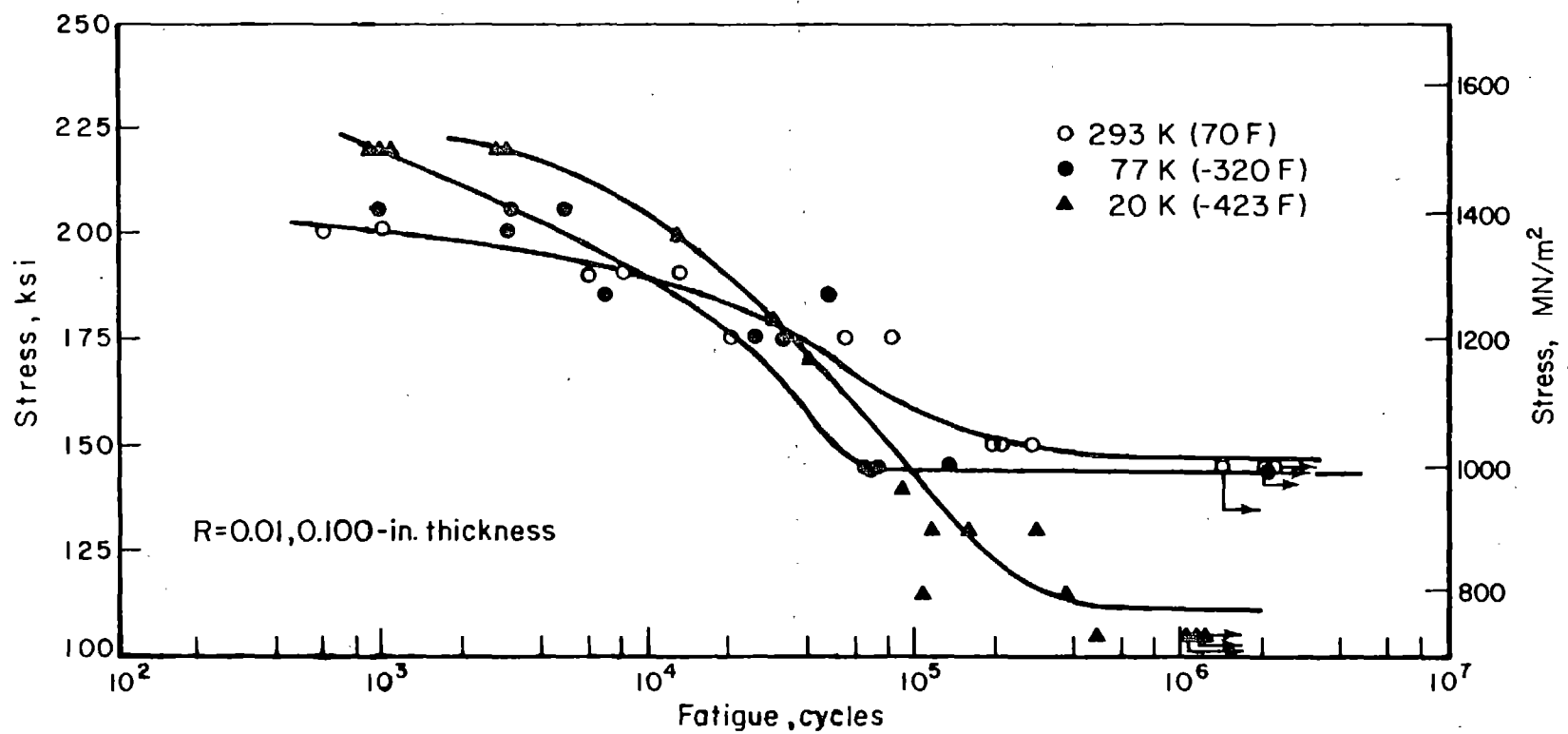


FIGURE 9.2.1-ME8. AXIAL FATIGUE LIFE CURVES FOR UNNOTCHED 5Al-2.5Sn (ANNEALED) TITANIUM ALLOY [58024]

9.2.1-12.4 (11/76)

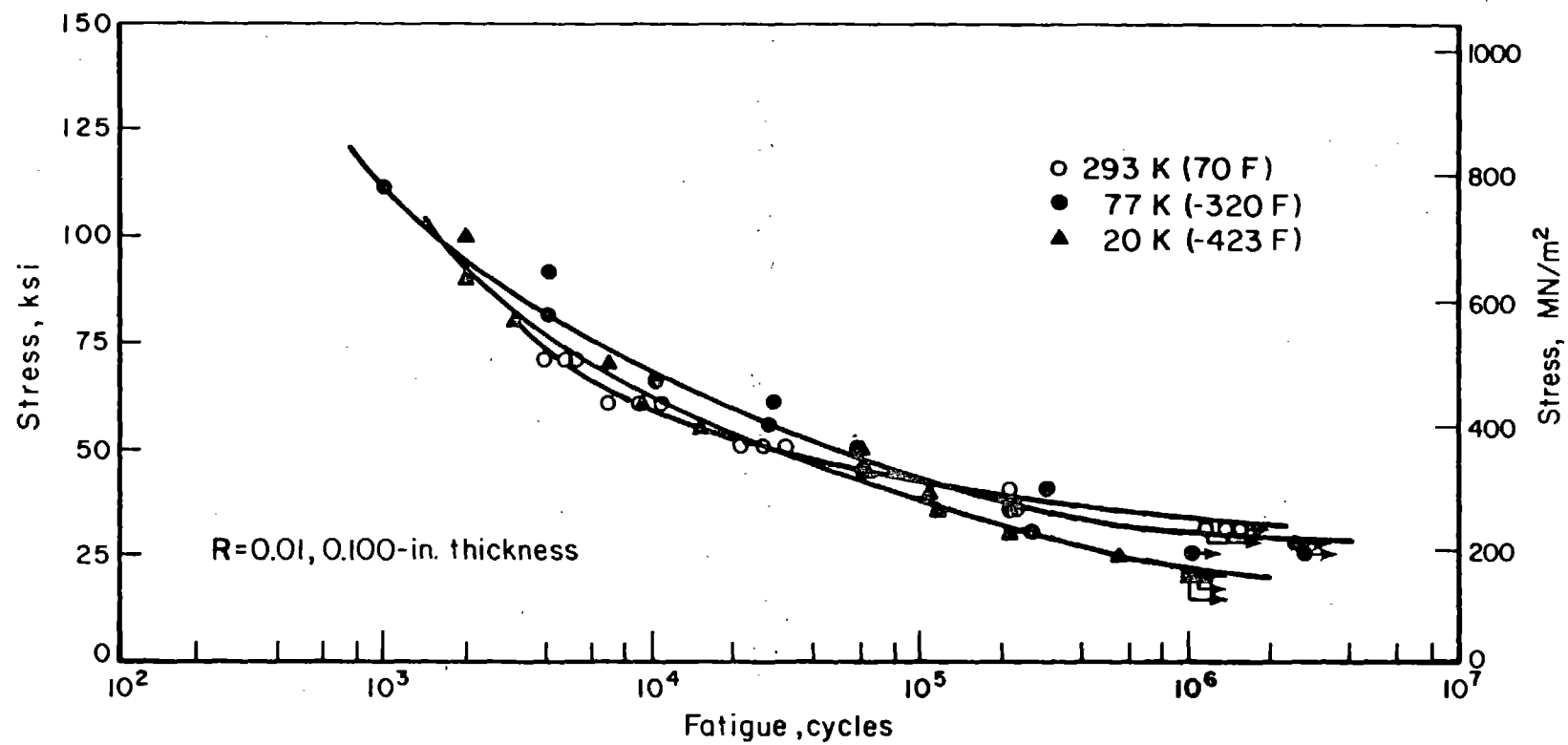


FIGURE 9.2.1-ME9. AXIAL FATIGUE LIFE CURVES FOR NOTCHED 5Al-2.5Sn (ANNEALED) TITANIUM ALLOY [58024]

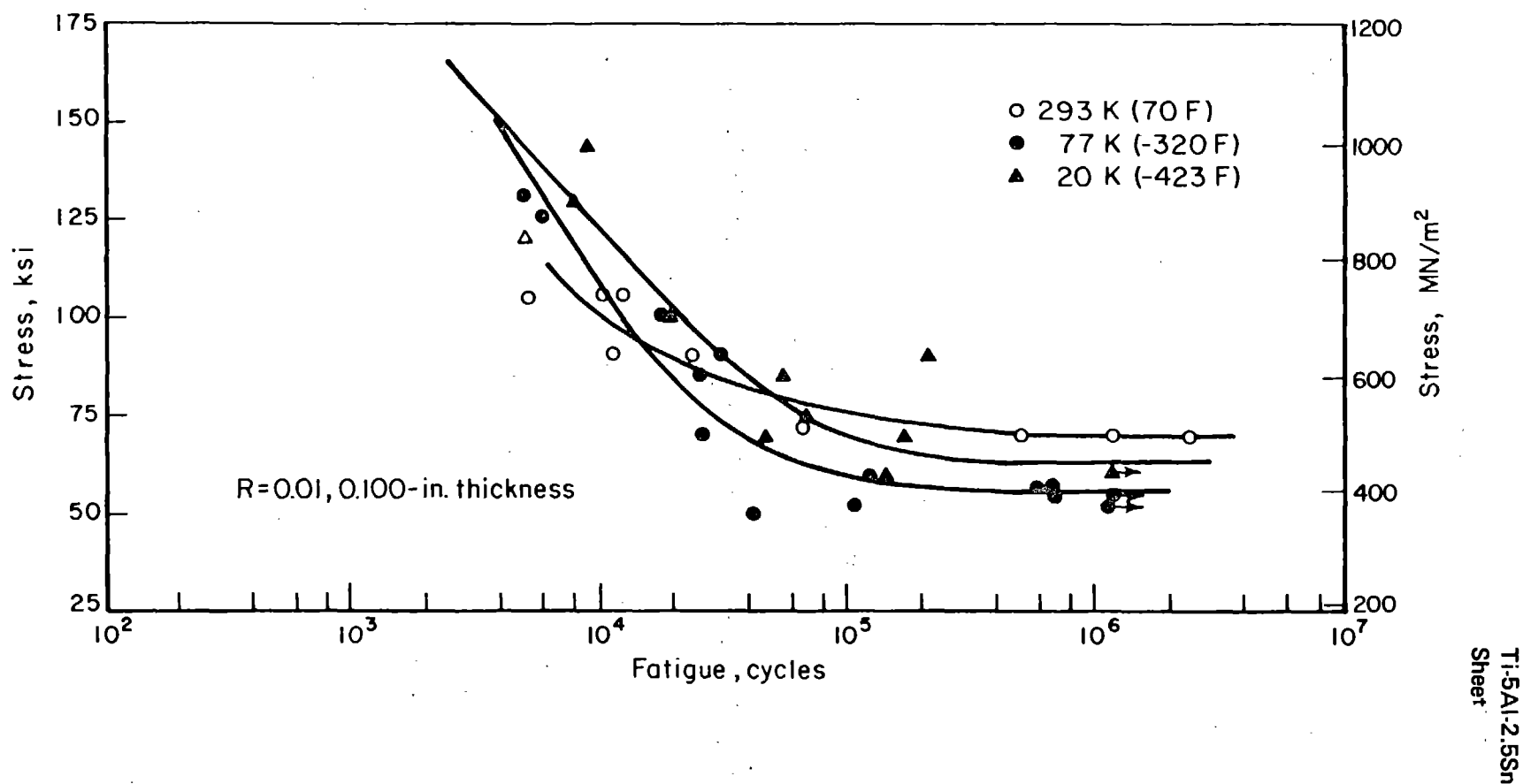


FIGURE 9.2.1-ME10. AXIAL FATIGUE LIFE CURVES FOR 5Al-2.5Sn (ANNEALED) TITANIUM ALLOY SHEET AS WELDED [TIG welded; parent metal filler] [58024]

TABLE 9.2.1-TR1

Alloy Designation: Ti-5Al-2.5Sn Alloy

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	7.79	4.83	3.59	1.95	0.996	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(4.50)	(2.79)	(2.08)	(1.13)	(0.576)	
No. of Spec.	1	1	1	1	1	
References: 96885						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.128	-0.147	-0.152	-0.152	-0.153
No. of Spec.	3	3	3	2	1	1
References: 94206						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	161 x 10 ⁻⁸	142 x 10 ⁻⁸	137 x 10 ⁻⁸	136 x 10 ⁻⁸	136 x 10 ⁻⁸	136 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(968)	(854)	(824)	(818)	(818)	(818)
No. of Spec.	2	2	2	2	2	2
References: 96885						

Ti-5Al-2.5Sn

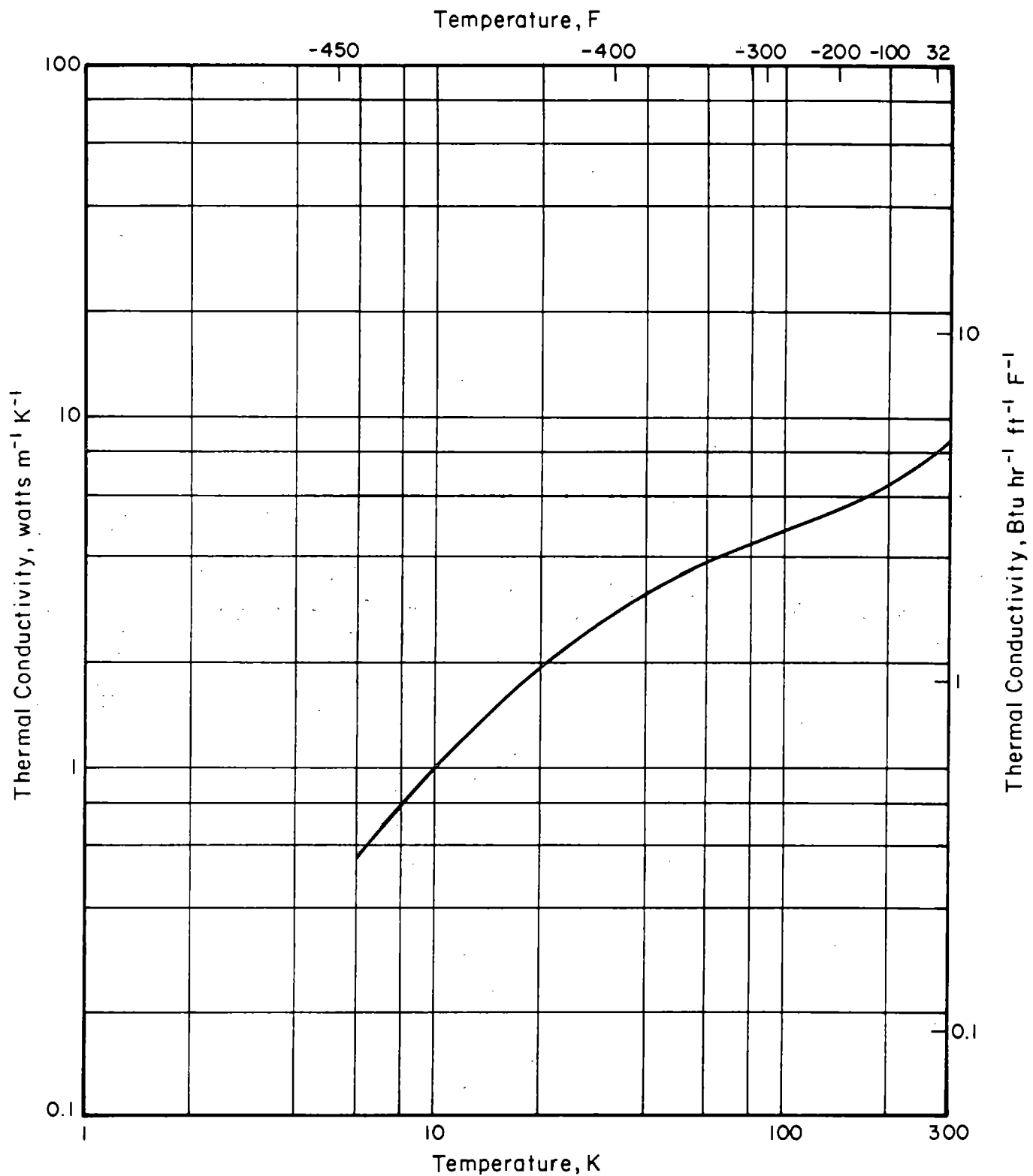


FIGURE 9.2.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Ti-5Al-2.5Sn ALLOY

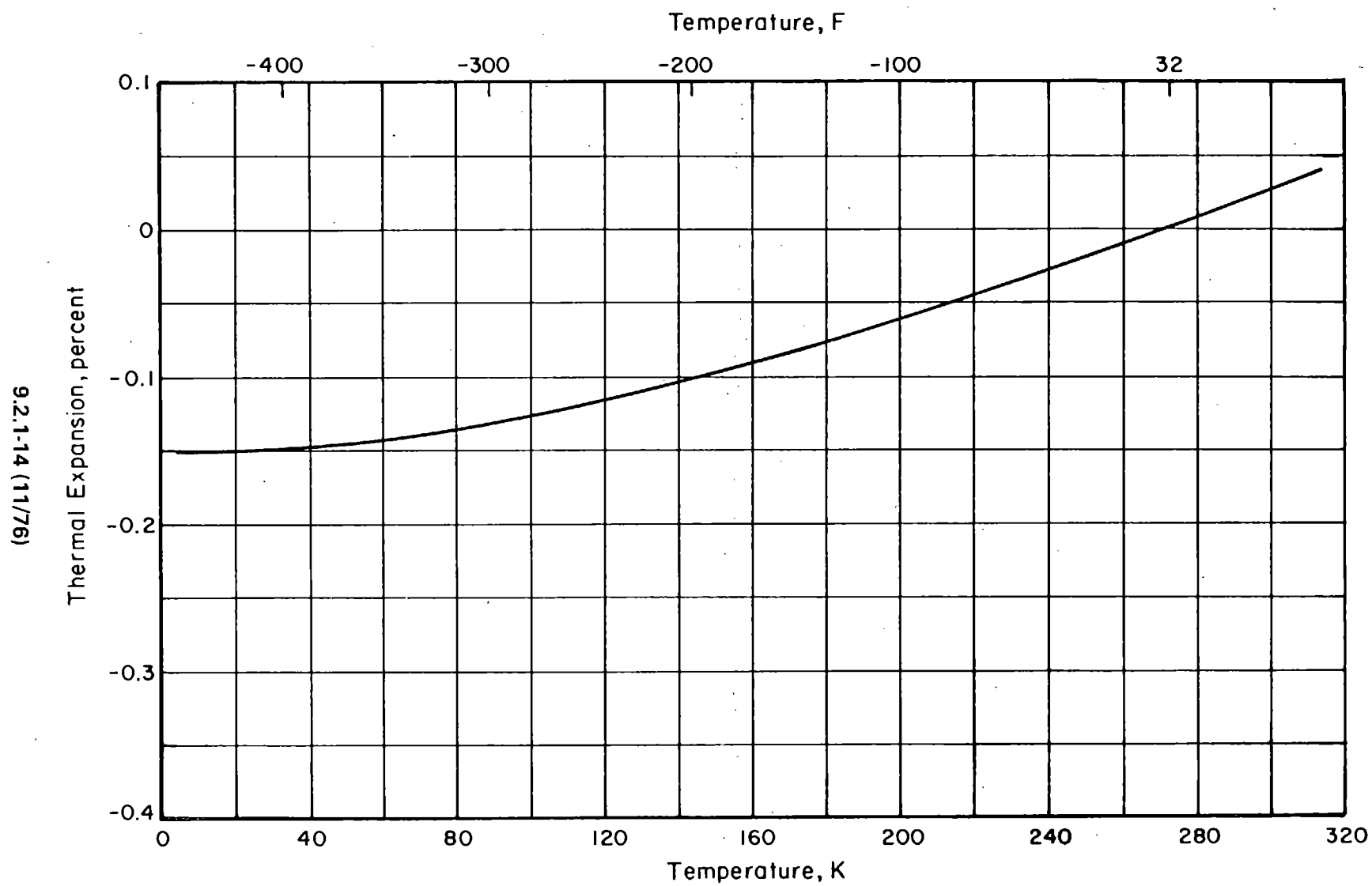


FIGURE 9.2.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR Ti-5Al-2.5Sn ALLOY

Ti-5Al-2.5Sn

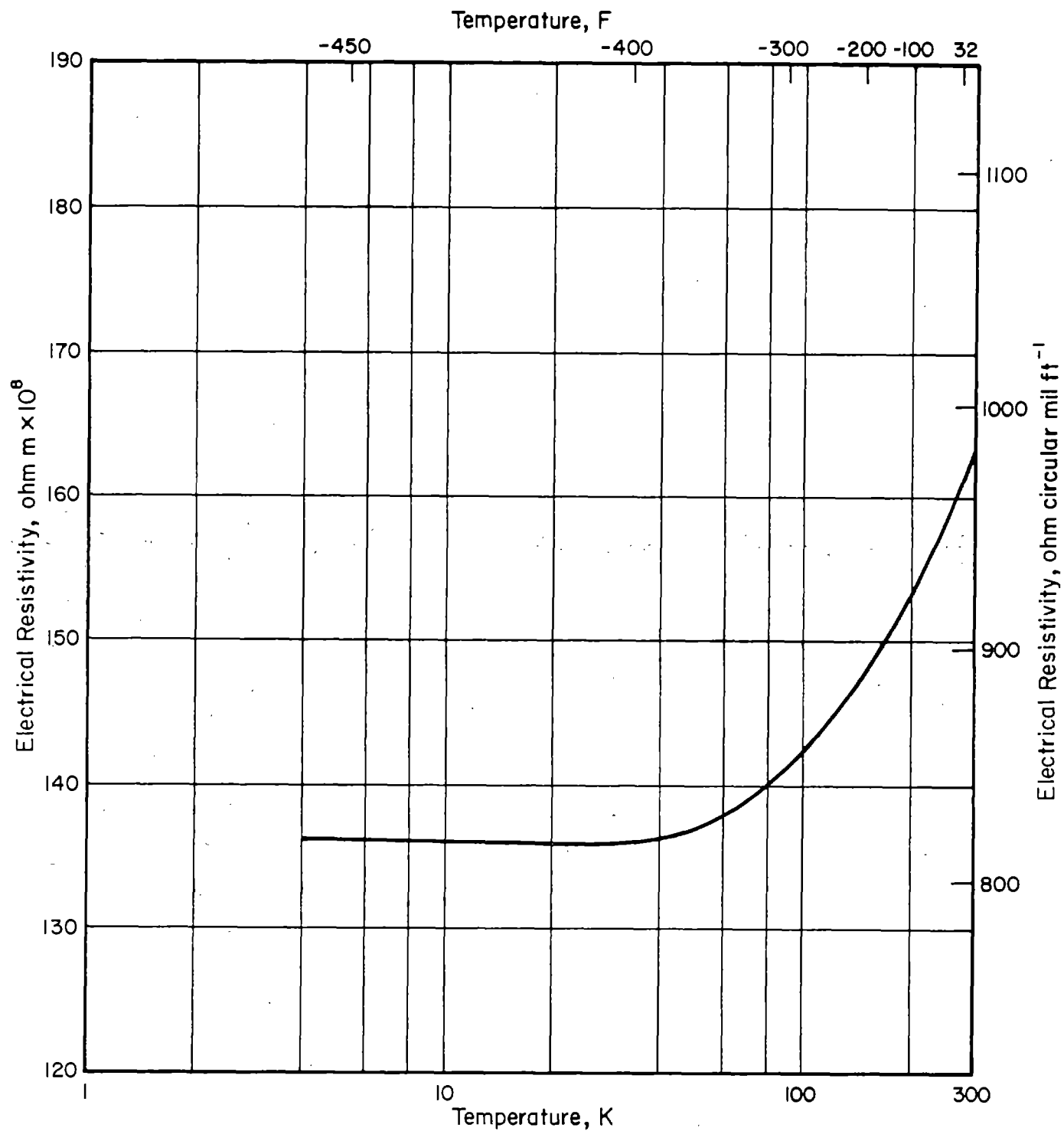


FIGURE 9.2.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR Ti-5Al-2.5Sn ALLOY

TABLE 9.2.2-ME1

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	779 (113)	933 (135)	1276 (185)	1537 (223)		
	Min	654 (94.9)	889 (129)	1227 (178)	1363 (198)		
	Std. Deviation	55.8 (8.10)		31.8 (4.62)	80.6 (11.7)		
TYS, MN/m ² (ksi)	Avg	721 (105)	855 (124)	1186 (172)	1429 (207)		
	Min	652 (94.6)	807 (117)	1117 (162)	1317 (191)		
	Std. Deviation	53.6 (7.78)		30.1 (4.37)	76.2 (11.1)		
Elong, percent	Avg	16.6	14.3	15.8	10.6		
	Min	12	11	10	nil		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		41 (16)	3 (3)	21 (7)	46 (16)		
E, GN/m ² (10 ⁶ psi)	Avg	111 (16.1)		127 (18.5)	131 (19.0)		
	Min	108 (15.7)		123 (17.8)	118 (17.1)		
	No. of Spec. (No. of Heats)	7 (2)		10 (2)	11 (2)		
Poisson's Ratio		0.416		0.364	0.328		
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1031 (150)	1156 (168)	1549 (225)	1691 (245)		
	Min	869 (126)	1096 (159)	1441 (209)	1413 (205)		
	No. of Spec. (No. of Heats)	26 (11)	3 (3)	7 (5)	26 (11)		
NTS, MN/m ² (ksi) K _t = 19	Avg	820 (119)			900 (131)		
	Min						
	No. of Spec. (No. of Heats)	1 (1)			3 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	799 (116)	926 (134)	1288 (187)	1566 (227)		
	Min	654 (94.9)	896 (130)	1220 (177)	1441 (209)		
	Std. Deviation	60.4 (8.76)		37.5 (5.44)	60.2 (8.73)		
TYS, MN/m ² (ksi)	Avg	749 (109)	857 (124)	1226 (178)	1471 (213)		
	Min	637 (92.4)	827 (120)	1138 (165)	1310 (190)		
	Std. Deviation	64.3 (9.33)		46.8 (6.79)	75.8 (11.0)		
Elong, percent	Avg	15.3	14.7	16.8	9.4		
	Min	13.5	12	16	2		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		18 (10)	3 (3)	8 (4)	19 (10)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1090 (158)	1220 (177)	1620 (235)	1627 (236)		
	Min	876 (127)	1179 (171)	1538 (223)	1434 (208)		
	No. of Spec. (No. of Heats)	11 (7)	3 (3)	5 (4)	11 (7)		
NTS, MN/m ² (ksi) K _t = 19	Avg	810 (118)			869 (126)		
	Min	807 (117)			800 (116)		
	No. of Spec. (No. of Heats)	2 (1)			3 (1)		

References: 45136, 48652, 50498, 53354, 59159, 66103, 66886, 68968, 69759

9.2.2-1 (11/74)

TABLE 9.2.2-ME1.1

Ti-5Al-2.5Sn(ELI)
Sheet-Weld Metal

Alloy Designation: Ti-5Al-2.5Sn(ELI) (Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed

Testing Temperature, K (F)		297 (75)			77 (-320)	20 (-423)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	733.6 (106.4)			1262 (183)	1528 (221.6)	
	Min	643.3 (93.3)			1262 (183)	1386 (201.0)	
	Std. Deviation	46.3 (6.71)				26.7 (11.13)	
TYS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
Elong, percent	Avg	13.4			2.0	2.65	
	Min	1.7			2.0	0.00	
	Std. Deviation						
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	11 (3)			1 (1)	35 (3)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	807 (117)			1234 (179)	1475.5 (214)	
	Min	807 (117)			1234 (179)	1475.5 (214)	
	Std. Deviation						
TYS, MN/m ² (ksi)	Avg						
	Min						
	Std. Deviation						
Elong, percent	Avg	1.6			1.6	1.0	
	Min	1.6			1.6	1.0	
	Std. Deviation						
RA, percent	Avg						
	Min						
	No. of Spec. (No. of Heats)	1 (1)			1 (1)	1 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 53354, 59159, 60578

TABLE 9.2.2-ME2

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	812 (118)	985 (143)	1313 (190)	1599 (232)		
	Min	758 (110)	910 (132)	1234 (179)	1429 (207)		
Std. Deviation		41.6 (6.03)	69.6 (10.1)	53.2 (7.72)	91.7 (13.3)		
TYS, MN/m ² (ksi)	Avg	752 (109)	905 (131)	1230 (178)	1475 (214)		
	Min	696 (101)	814 (118)	1158 (168)	1331 (193)		
Std. Deviation		37.9 (5.50)	56.8 (8.24)	55.9 (8.11)	91.7 (13.3)		
Elong, percent	Avg	15.5	14.8	15.4	9.5		
	Min	6.5	5.5	3.0	1.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		24 (10)	7 (4)	25 (11)	29 (11)		
E, GN/m ² (10 ⁶ psi)	Avg	114 (16.6)	124 (18.0)	129 (18.8)	134 (19.4)		
	Min	108 (15.7)	124 (18.0)	120 (17.4)	131 (19.0)		
No. of Spec. (No. of Heats)		10 (5)	2 (1)	10 (4)	5 (2)		
Poisson's Ratio		0.32	0.285	0.31	0.34		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1089 (158)		1613 (234)	1769 (257)		
	Min	1089 (158)		1551 (225)	1565 (227)		
K _t = 3.5							
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg	1076 (156)	1227 (178)	1567 (227)	1640 (238)		
	Min	1048 (152)	1200 (174)	1531 (222)	1372 (199)		
K _t = 6.3							
No. of Spec. (No. of Heats)		11 (5)	5 (3)	11 (5)	14 (6)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	817 (118)	986 (143)	1308 (190)	1576 (228)		
	Min	758 (110)	910 (132)	1326 (179)	1402 (203)		
Std. Deviation		52.3 (7.59)		64.2 (9.31)	133 (19.4)		
TYS, MN/m ² (ksi)	Avg	776 (112)	936 (136)	1244 (180)	1473 (214)		
	Min	703 (102)	896 (130)	1189 (172)	1386 (201)		
Std. Deviation		44.4 (6.44)		52.2 (7.57)	82.7 (12.0)		
Elong, percent	Avg	12.2	9.1	12.2	8.1		
	Min	6.5	5.5	1.5	1.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		9 (6)	6 (4)	9 (6)	10 (5)		
E, GN/m ² (10 ⁶ psi)	Avg	110 (16.0)	127 (18.4)	125 (18.1)	138 (20.1)		
	Min	107 (15.5)	127 (18.4)	117 (17.0)	135 (19.6)		
No. of Spec. (No. of Heats)		4 (2)	2 (1)	4 (2)	2 (1)		
Poisson's Ratio		0.305	0.305	0.275	0.315		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1105 (160)	1300 (188)	1529 (222)	1439 (209)		
	Min	1089 (158)	1289 (187)	1462 (212)	1220 (177)		
K _t = 6.3							
No. of Spec. (No. of Heats)		3 (1)	2 (2)	4 (3)	4 (3)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 40128, 45136, 46356, 50498, 58024, 61688, 80104, 81726, 84318, 87195

9.2.2-2 (11/74)

TABLE 9.2.2-ME3

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading						
S_N at 10^5 cycles, MN/m ² (ksi)	586 (85)		827 (120)	965 (140)		
Loading frequency Hz						
with R = 0.01 and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^5 cycles	0.73		0.65	0.60		
S_N at 10^6 cycles, MN/m ² (ksi)	483 (70)		827 (120)	882 (128)		
Loading frequency Hz						
with R = 0.01 and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.60		0.65	0.55		
S_N at 10^6 cycles, MN/m ² (ksi)	496 (72)		814 (118)	758 (110)		
Loading frequency Hz						
with R = 0.01 and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N /TUS at 10^6 cycles	0.62		0.62	0.48		
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with R = and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N /TUS at 10^7 cycles						

References: 53308, 56753, 58024

TABLE 9.2.2-ME3.1

Alloy Designation: Ti-5Al-2.5Sn (ELI) (Weld Metal)

Specification:

Form: Sheet-TIG welded, Ti-5Al-2.5Sn filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	820 (119.0)	1086 (157.5)	1314 (190.6)	1595 (231.3)	1627 (236.0)	
	Min	770 (111.7)	1086 (157.5)	1252 (181.6)	1495 (216.9)	1627 (236.0)	
Std Deviation							
TYS, MN/m ² (ksi)	Avg	905 (131.2)	1047 (151.9)	1444 (209.5)	1649 (239.2)		
	Min	905 (131.2)	1047 (151.9)	1444 (209.5)	1649 (239.2)		
Std Deviation							
Elong, percent	Avg	11.0	10.0	10.0	6.2	1.5	
	Min	11.0	10.0	10.0	6.2	1.5	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (2)	1 (1)	4 (2)	4 (2)	1 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	789 (114.5)		1262 (183.0)	1377 (199.7)		
	Min	776 (112.5)		1247 (180.9)	1338 (194.1)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	736 (106.8)		1187 (172.2)			
	Min	722 (104.8)		1178 (170.9)			
Std. Deviation							
Elong, percent	Avg	7.0		9.0			
	Min	6.0		8.0			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)		3 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	112.4 (16.3)		123.4 (17.9)			
	Min	111.0 (16.1)		117.9 (17.1)			
No. of Spec. (No. of Heats)		2 (1)		3 (1)			
Poisson's Ratio		0.350		0.340	0.340		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 58024, 58060, 84318

TABLE 9.2.2-ME3.2

Ti-5Al-2.5Sn(ELI)
Sheet-Weld Metal

Alloy Designation: Ti-5Al-2.5Sn (ELI)(Weld Metal)

Specification:

Form: Sheet-TIG welded, no filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	852 (123.6)		1338 (194.1)	1612 (233.8)		
	Min	805 (116.8)		1305 (189.3)	1593 (231.0)		
	Std. Deviation	37.3 (5.41)		25.2 (3.66)			
TYS, MN/m ² (ksi)	Avg	767 (111.2)		1241 (180)	1457 (211.3)		
	Min	731 (106.0)		1227 (178)	1420 (206.0)		
	Std. Deviation	22.5 (3.27)		12.4 (1.80)			
Elong, percent	Avg	16.1		5.2			
	Min	16.1		5.2			
RA, percent	Avg	44.0		13.0			
	Min	44.0		13.0			
No. of Spec. (No. of Heats)		9 (2)		9 (2)	6 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	896 (130)		1372 (199)			
	Min	896 (130)		1372 (199)			
	K _t = 6						
No. of Spec. (No. of Heats)		3 (1)		3 (1)			
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
	K _t =						
No. of Spec. (No. of Heats)							

References: 77998, 81726

TABLE 9.2.2-ME4

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Sheet

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	807 (117)		1317 (191)	1519 (220)		
	Min	786 (114)		1289 (187)	1434 (208)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	764 (111)		1241 (180)	1459 (212)		
	Min	758 (110)		1227 (178)	1420 (206)		
Std. Deviation							
Elong, percent	Avg	16.5		15.6	5.7		
	Min	15		12	4		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		5 (2)		7 (4)	8 (4)		
E, GN/m ² (10 ⁶ psi)	Avg	110 (16.0)		121 (17.6)			
	Min	110 (16.0)		120 (17.4)			
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
Poisson's Ratio		0.33		0.36	0.42		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	798 (116)		1280 (186)	1419 (206)		
	Min	793 (115)		1280 (186)	1400 (203)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	779 (113)		1227 (178)	1391 (202)		
	Min	779 (113)		1227 (178)	1377 (200)		
Std. Deviation							
Elong., percent	Avg	17		15			
	Min	17		15			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)		2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	108 (15.7)		128 (18.6)			
	Min	108 (15.7)		126 (18.3)			
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 66218, 84318, 84320, 86296

TABLE 9.2.2-ME5

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Sheet

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: Annealed

Testing Temperature, K (F)	297 (75)			20 (-423)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
	Min					
Orientation. —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg			56.9 (52.1)		
(From PTSC spec.)(L — S)Min				51.8 (47.4)		
No. of Spec. (No. of Heats)				3 (1)		

References: 84320

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 9.2.2-ME5.1

Alloy Designation: Ti-5Al-2.5Sn(ELI) (Weld Metal)

Specification:

Form: Sheet-TIG welded, Ti-5Al-2.5Sn filler

Thickness, cm (in.): 0.320 to 0.634 (0.126 to 0.249)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	807 (117.1)		1277 (185.2)	1414 (205.1)		
	Min	804 (116.6)		1277 (185.2)	1393 (202.1)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	764 (110.8)		1215 (176.3)			
	Min	764 (110.8)		1215 (176.3)			
Std. Deviation							
Elong, percent	Avg	11.5		11.0			
	Min	11.0		10.0			
RA, percent	Avg	39		22	21		
	Min	37		20	21		
No. of Spec. (No. of Heats)		2 (1)		2 (1)	2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg	126 (18.3)		130 (18.8)			
	Min	123 (17.9)		128 (18.6)			
No. of Spec. (No. of Heats)		2 (1)		2 (1)			
Poisson's Ratio		0.270		0.260	0.250		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 84318

TABLE 9.2.2-ME6

Ti-5Al-2.5Sn(ELI)
Plate

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	820 (118.9)	910 (132)	1280 (185.6)	1506 (218.4)		
	Min	789 (114.5)		1220 (177)	1441 (209)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	754 (109.4)	869 (126)	1199 (174)	1375 (199.4)		
	Min	689 (100)		1175 (170.5)	1344 (195)		
Std. Deviation		--		31.8 (4.62)	41.9 (6.08)		
Elong, percent	Avg	18.7	24	12.4	8.1		
	Min	14		8	5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (4)	(1)	7 (4)	7 (4)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef		0.076	0.058				
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	809 (117)	912 (132)	1261 (183)	1473 (214)		
	Min	786 (114)	903 (131)	1251 (181)	1400 (203)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	740 (107)	884 (128)	1203 (174)	1310 (190)		
	Min	706 (102)	869 (126)		1248 (181)		
Std. Deviation							
Elong, percent	Avg	21.3	21.8	23.4	21.4		
	Min	15.5	21.3	22.7	17.1		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		3 (2)	2 (1)	8 (2)	6 (3)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef		0.063	0.037				
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 56755, 64969, 79816, 80996, 84321, 96685

9.2.2-6 (11/76)

TABLE 9.2.2-ME7

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification: MIL-T-9046 C, Class 3

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Shear(a)						
SUS, MN/m ² (ksi)						
Avg	594	(86.1)	758	(110)	979	(142)
Min						
No. of Spec. (No. of Heats)	4	(1)	4	(1)	4	(1)
G, GN/m ² (10 ⁶ psi)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)						
Avg						
Min						
No. of Spec. (No. of Heats)						
Fracture Toughness(b)						
K _{IC} , MN/m ^{3/2} (ksi√in.)						
Avg						
Min						
Orientation —						
No. of Spec. (No. of Heats)						
K _{IE} , MN/m ^{3/2} (ksi√in.)						
Avg						
(From PTSC spec.) (—) Min						
No. of Spec. (No. of Heats)						

References: 65182

- (a) Indicate specimen design and orientation for shear specimens: 0.394 cm (0.155 in.) diameter
(b) Indicate specimen design for K_{IC} data:

TABLE 9.2.2-ME7.1

Ti-5Al-2.5Sn(ELI)
Plate-Weld Metal

Alloy Designation: Ti-5Al-2.5Sn(ELI)(Weld Metal)

Specification:

Form: Plate-TIG welded, no filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	869 (126)		1324 (192)	1551 (225.0)		
	Min	869 (126)		1324 (192)	1529 (221.8)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	807 (117)		1269 (184)	1406 (204)		
	Min	807 (117)		1269 (184)	1406 (204)		
Std. Deviation							
Elong, percent	Avg	11.0		9.0	7.4		
	Min	11.0		9.0	6.2		
RA, percent	Avg				24.6		
	Min				21.1		
No. of Spec. (No. of Heats)		1 (1)		1 (1)	3 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 76455, 84321

TABLE 9.2.2-ME8

Ti-5Al-2.5Sn(ELI)
Plate

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Plate

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	765 (111)	905 (131)	1247 (180.8)	1438 (208.5)		
	Min	745 (108)	889 (129)	1213 (176)	1386 (201)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	702 (101.8)	859 (124)	1204 (174.7)	1389 (201.5)		
	Min	683 (99)	854 (124)	1176 (170.6)	1289 (187)		
Std. Deviation				12 (1.76)	46 (6.68)		
Elong, percent	Avg	32.8	22.4	26.0	17.0		
	Min	14.0	22.2	8.0	3.0		
RA, percent	Avg	43.2	40.4	35.8	31.6		
	Min	42.6	38.7	34.8	31.2		
No. of Spec. (No. of Heats)		5 (3)	2 (1)	5 (3)	5 (3)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef		0.067	0.049	0.060			
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	776 (112)	906 (131)	1234 (179)	1542 (224)		
	Min	776 (112)	887 (129)	1230 (178)	1513 (219)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	696 (101)	855 (124)	1203 (174.5)	1420 (206)		
	Min	696 (101)		1165 (169)	1400 (203)		
Std. Deviation				13.4 (1.95)	21.5 (3.12)		
Elong, percent	Avg	24.6	20.6	21.4	17.8		
	Min	23.1	20	20			
RA, percent	Avg	42.8	39.6	36.8	31.5		
	Min	41.9	38.7	36.5	31.2		
No. of Spec. (No. of Heats)		2 (1)	2 (1)	13 (2)	15 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef		0.062	0.054				
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 64969, 84321, 91793, 96685

TABLE 9.2.2-ME8.1

Ti-5Al-2.5Sn(ELI)
Plate-Weld Metal

Alloy Designation: Ti-5Al-2.5Sn(ELI)(Weld Metal)

Specification:

Form: Plate-TIG welded, no filler

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: Tested as welded

Testing Temperature, K (°F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	809 (117.3)		1158 (168.0)	1481 (214.8)		
	Min	809 (117.3)		1149 (166.7)	1481 (214.8)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	717 (104)		1027 (149)			
	Min	717 (104)		993 (144)			
Std. Deviation							
Elong, percent	Avg	15.8		12.1	8.0		
	Min	15.8		12.0	8.0		
RA, percent	Avg	16.3		17.4	32.4		
	Min	16.3		17.4	32.4		
No. of Spec. (No. of Heats)		1 (1)		2 (1)	1 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 76455

TABLE 9.2.2-ME9

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Bar
Diameter: Up to 2.54 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)	17 (-430)	4 (-452)
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 878 (127)		1376 (200)	1531 (222)	1575 (228.4)	1476 (214)
	Min 814 (118)		1317 (191)	1503 (218)	1538 (223)	
Std. Deviation	30.1 (4.36)		57.7 (8.37)		33.6 (4.88)	
TYS, MN/m ² (ksi)	Avg 814 (118)		1260 (183)	1455 (211)	1477 (214.2)	1413 (205)
	Min 717 (104)		1096 (159)	1427 (207)	1400 (203)	
Std. Deviation	37.1 (5.38)		128 (18.6)		51.7 (7.5)	
Elong, percent	Avg 15.8		12.2	5.7	9.7	
	Min 12		8	3	8.0	
RA, percent	Avg 42.2				32.3	
	Min 39				32	
No. of Spec. (No. of Heats)	14 (4)		9 (3)	3 (1)	10 (2)	3 (1)
E, GN/m ² (10 ⁶ psi)	Avg 119 (17.3)		126 (18.3)			129 (18.7)
	Min					
No. of Spec. (No. of Heats)	3 (1)		3 (1)			3 (1)
Poisson's Ratio	0.289		0.287			0.287
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 1058 (153)				1842 (267)	
K _t = 6.4	Min 1000 (145)				1800 (261)	
No. of Spec. (No. of Heats)	5 (1)				5 (1)	
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

TABLE 9.2.2-ME10

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Bar

Thickness, cm (in.): Up to 2.54 cm (1.000 in.)

Condition: Annealed

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Fatigue, Axial Loading, Surface Finish 32 rms						
S_N at 10^5 cycles, MN/m ² (ksi)	807 (117)		1207 (175)	1076 (156)		
Loading frequency 28 Hz						
with $R = 0$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^5 cycles	0.92		0.91	0.70		
S_N at 10^6 cycles, MN/m ² (ksi)	758 (110)		986 (143)	924 (134)		
Loading frequency 28 Hz						
with $R = 0$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)	1 (1)		
Ratio S_N/TUS at 10^6 cycles	0.87		0.74	0.60		
S_N at 10^7 cycles, MN/m ² (ksi)	717 (104)		882 (128)			
Loading frequency 28 Hz						
with $R = 0$ and $K_t = 1$						
No. of S-N Curves (No. of Heats)	1 (1)		1 (1)			
Ratio S_N/TUS at 10^7 cycles	0.82		0.66			
Fatigue, Flexural Loading						
S_N at 10^5 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^5 cycles						
S_N at 10^6 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^6 cycles						
S_N at 10^7 cycles, MN/m ² (ksi)						
Loading frequency Hz						
with $R =$ and $K_t =$						
No. of S-N Curves (No. of Heats)						
Ratio S_N/TUS at 10^7 cycles						

References: 83417

TABLE 9.2.2-ME11

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Forged plates and other shapes

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: As forged

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	872 (126)		1372 (199)	1526 (221)		
	Min	858 (124)		1368 (198)	1503 (218)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	834 (121)		1324 (192)	1503 (218)		
	Min	810 (118)		1316 (191)	1476 (214)		
Std. Deviation							
Elong, percent	Avg	19.3		14.5	7.5		
	Min	18		13.5	6		
RA, percent	Avg	47.3		33.2	24.0		
	Min	46.4		29.6	20		
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1250 (181)		1712 (248)	1620 (235)		
	Min	1158 (168)		1668 (242)	1572 (228)		
K _t = 5 - 7							
No. of Spec. (No. of Heats)		3 (1)		3 (1)	2 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	857 (124)		1330 (193)	1478 (214)		
	Min	847 (123)		1329 (193)	1462 (212)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	797 (116)		1258 (182)	1403 (204)		
	Min	789 (114)		1251 (181)	1393 (202)		
Std. Deviation							
Elong, percent	Avg	17.0		13.7	9.7		
	Min	16		11	8		
RA, percent	Avg	38.2		35.1	16		
	Min	34.5			14		
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1170 (170)		1593 (231)	1560 (226)		
	Min	1138 (165)		1482 (215)	1482 (215)		
K _t = 5 - 7							
No. of Spec. (No. of Heats)		3 (1)		3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 66080

TABLE 9.2.2-ME12

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Forgings

Thickness, cm (in.): Up to 2.540 (1.000)

Condition: As forged

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Tangential							
TUS, MN/m ² (ksi)	Avg	832 (121)	978 (142)	1258 (182)	1418 (206)		
	Min	806 (117)	957 (139)	1234 (179)	1317 (191)		
	Std. Deviation	19.6 (2.84)	16.3 (2.37)		70.3 (10.2)		
TYS, MN/m ² (ksi)	Avg	761 (110)	900 (131)	1096 (159)	1252 (182)		
	Min	737 (107)	879 (128)	1023 (148)	1220 (177)		
	Std. Deviation				31.8 (4.62)		
Elong, percent	Avg	14.8	12.1	15.0	12.7		
	Min	13	10	10	6		
RA, percent	Avg	36.4	31.3	29.9	21.6		
	Min	32.2	26.7	24.4	16		
	No. of Spec. (No. of Heats)	8 (2)	8 (2)	7 (2)	10 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1122 (163)	1282 (186)	1611 (234)	1618 (235)		
	Min	1062 (154)	1220 (177)	1572 (228)	1523 (221)		
	No. of Spec. (No. of Heats)	8 (2)	8 (2)	10 (2)	10 (2)		
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 66080

TABLE 9.2.2-ME13

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Large Forgings

Thickness, cm (in.):

Condition: As forged

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Tangential							
TUS, MN/m ² (ksi)	Avg	724 (105)			1434 (208)		
	Min	714 (104)			1351 (196)		
	Std. Deviation				41.1 (5.96)		
TYS, MN/m ² (ksi)	Avg	674 (97.8)			1291 (187)		
	Min	671 (97.3)			1182 (172)		
	Std. Deviation				48.9 (7.09)		
Elong, percent	Avg	11.8			15.2		
	Min	11			6		
RA, percent	Avg	28.8			20.3		
	Min	28.4			14.1		
	No. of Spec. (No. of Heats)	2 (1)			18		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1016 (147)			1600 (232)		
	Min	1013 (147)			1544 (224)		
	No. of Spec. (No. of Heats)	2 (1)			2 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Radial							
TUS, MN/m ² (ksi)	Avg	760 (110)			1372 (199)		
	Min	754 (109)			1365 (198)		
	Std. Deviation						
TYS, MN/m ² (ksi)	Avg	716 (104)			1206 (175)		
	Min	704 (102)			1198 (174)		
	Std. Deviation						
Elong, percent	Avg	12.2			9		
	Min	11.5			8		
RA, percent	Avg	19.8			15.2		
	Min	17.6			14.5		
	No. of Spec. (No. of Heats)	2 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1034 (150)			1638 (238)		
	Min	1024 (148)			1624 (236)		
	No. of Spec. (No. of Heats)	2 (1)			2 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 70525, 88439

TABLE 9.2.2-ME14

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Large Forgings

Thickness, cm (in.):

Condition: As forged

Testing Temperature, K (F)	297 (75)			20 (-423)		
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg			79.0 (72.3)		
	Min			66.8 (61.1)		
Orientation: R — L, R — C						
No. of Spec. (No. of Heats)				32		
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 88439

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data: Compact specimens

TABLE 9.2.2-ME15

Alloy Designation: Ti-5Al-2.5Sn (ELI)

Specification:

Form: Extruded Shapes

Thickness, cm (in.):

Condition: As extruded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	826 (120)	960 (139)	1292 (187)	1456 (211)		
	Min	814 (118)	945 (137)	1287 (187)	1406 (204)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	741 (108)	854 (124)	1152 (167)	1369 (199)		
	Min	717 (104)	832 (121)	1130 (164)	1365 (198)		
Std. Deviation							
Elong, percent	Avg	15.0	12.0	15.4	15.6		
	Min	14	10	14	14		
RA, percent	Avg	43.8	34.8	36.5	22.6		
	Min	42.8	27.5	30.7	17		
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1139 (165)	1287 (187)	1652 (240)	1747 (253)		
	Min	1124 (163)	1269 (184)	1634 (237)	1696 (246)		
K _t = 8 - 10							
No. of Spec. (No. of Heats)		5 (1)	5 (1)	5 (1)	5 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Tangential							
TUS, MN/m ² (ksi)	Avg	832 (121)	966 (140)	1264 (183)	1423 (206)		
	Min	792 (115)	932 (135)	1244 (180)	1351 (196)		
Std. Deviation		27.1 (3.93)	21.4 (3.10)	14.7 (2.14)	36.3 (5.27)		
TYS, MN/m ² (ksi)	Avg	767 (111)	887 (129)	1172 (170)	1318 (191)		
	Min	724 (105)	836 (121)	1092 (158)	1262 (183)		
Std. Deviation		26.3 (3.81)	30.3 (4.40)	36.2 (5.25)	25.0 (3.62)		
Elong, percent	Avg	15.0	13.1	17.1	13.5		
	Min	13	11	10	9		
RA, percent	Avg	43.3	36.1	35.6	23.3		
	Min	35.1	31.3	29	11		
No. of Spec. (No. of Heats)		15 (3)	15 (3)	15 (3)	15 (3)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1128 (164)	1313 (190)	1637 (238)	1639 (238)		
	Min	1041 (151)	1269 (184)	1586 (230)	1531 (222)		
K _t = 6 - 9							
No. of Spec. (No. of Heats)		15 (3)	14 (3)	15 (3)	15 (3)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 66080

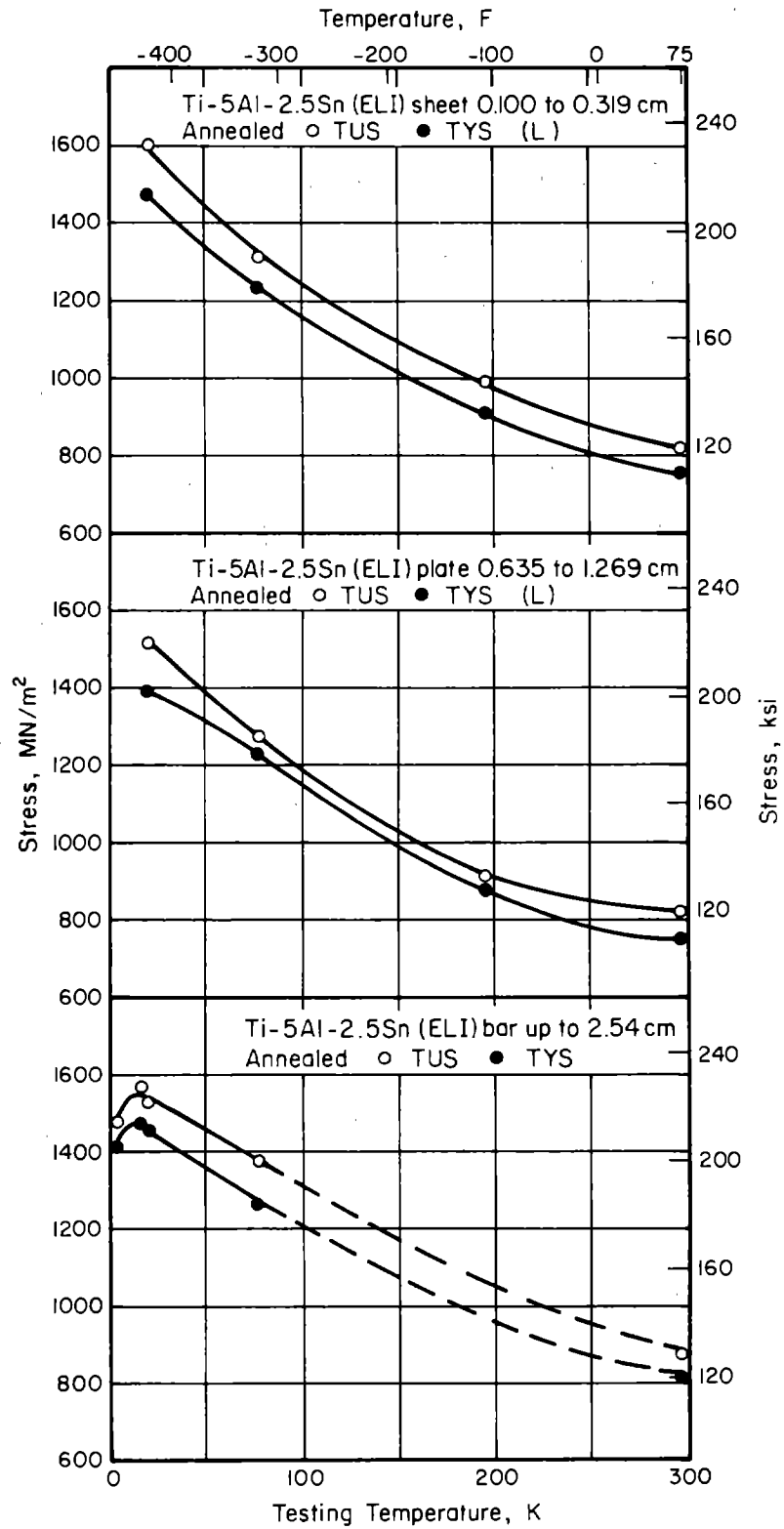


FIGURE 9.2.2-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF Ti-5Al-2.5Sn (ELI) ALLOY

TABLE 9.3.1-ME1

Alloy Designation: Ti-6Al-4V (ELI)

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	958 (139)	1165 (169)	1489 (216)	1744 (253)		
	Min	855 (124)	1131 (164)	1351 (196)	1531 (222)		
	Std. Deviation	54 (7.85)		67 (9.73)	91 (13.2)		
TYS, MN/m ² (ksi)	Avg	889 (129)	1118 (162)	1393 (202)	1682 (244)		
	Min	827 (120)	1117 (162)	1207 (175)	1462 (212)		
	Std. Deviation	49 (7.07)		114 (16.47)	79 (11.40)		
Elong, percent	Avg	12.14	10.5	10.75	6.20		
	Min	10	7	5	1		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		11 (3)	5 (1)	13 (3)	14 (4)		
E, GN/m ² (10 ⁶ psi)	Avg	110 (16.0)	115 (16.7)	119 (17.3)	132 (19.1)		
	Min	109 (15.8)	111 (16.1)	114 (16.5)	128 (18.6)		
	No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)	5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1131 (164)	1291 (187)	1517 (220)	1689 (245)		
	Min	1020 (148)	1248 (181)	1462 (212)	1386 (201)		
	No. of Spec. (No. of Heats)	7 (2)	5 (1)	7 (2)	7 (2)		
NTS, MN/m ² (ksi) K _t = 19	Avg	945 (137)	814 (118)	889 (129)	855 (124)		
	Min	869 (126)	724 (105)	807 (117)	807 (117)		
	No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)	5 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	912 (132)	1129 (164)	1472 (214)	1763 (256)		
	Min	814 (118)	1123 (163)	1379 (200)	1627 (236)		
	Std. Deviation				100 (14.5)		
TYS, MN/m ² (ksi)	Avg	857 (124)	1064 (154)	1428 (207)	1715 (249)		
	Min	800 (116)	1054 (153)	1331 (193)	1613 (234)		
	Std. Deviation						
Elong, percent	Avg	13.1	13.7	12.6	6.1		
	Min	12.5	12.5	7.5	2		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		7 (2)	5 (1)	7 (2)	9 (2)		
E, GN/m ² (10 ⁶ psi)	Avg	108 (15.7)	111 (16.1)	118 (17.2)	131 (19.1)		
	Min	105 (15.3)	109 (15.8)	114 (16.5)	126 (18.3)		
	No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)	5 (1)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1094 (159)	1247 (181)	1488 (216)	1845 (268)		
	Min	1082 (157)	1241 (180)	1393 (202)	1813 (263)		
	No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)	5 (1)		
NTS, MN/m ² (ksi) K _t = 19	Avg	841 (122)	809 (117)	1000 (145)	793 (115)		
	Min	786 (114)	807 (117)	979 (142)	745 (108)		
	No. of Spec. (No. of Heats)	5 (1)	5 (1)	5 (1)	5 (1)		

References: 47125, 51527, 90185

TABLE 9.3.1-ME2

Ti-6Al-4V(ELI)
Sheet

Alloy Designation: Ti-6Al-4V (ELI)

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)	20 (-423)
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg	958 (138.9)	1144 (165.9)	1324 (192)	1506 (218.5)	1779 (258)
	Min	896 (130)	1107 (160.5)		1482 (215)	1717 (249)
	Std. Deviation	40.7 (5.9)	--		12 (1.72)	34.4 (4.99)
TYS, MN/m ² (ksi)	Avg	889 (128.9)	1082 (157)		1448 (210)	1717 (249)
	Min	841 (122)	1053 (152.8)		1393 (202)	1648 (239)
	Std. Deviation	35 (5.09)	--		34 (4.97)	41.4 (6.0)
Elong, percent	Avg	11.28	8.17	8	9.50	2.98
	Min	7	2.5		2	1.7
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		9 (5)	6 (4)	(1)	10 (5)	9 (4)
E, GN/m ² (10 ⁶ psi)	Avg	112.4 (16.3)	113 (16.4)		122 (17.7)	124 (18.0)
	Min	108.9 (15.8)	112.4 (16.3)		119 (17.3)	118.6 (17.2)
	No. of Spec. (No. of Heats)	2 (1)	2 (1)		3 (1)	3 (1)
Poisson's Ratio		0.21	0.24		0.20	0.18
Work Hardening Coef						
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1105 (160.3)	1151 (167)		1400 (203)	1303 (189)
	Min	1082 (157)	1131 (164)		1248 (181)	1117 (162)
	No. of Spec. (No. of Heats)	6 (3)	3 (2)		6 (3)	6 (3)
NTS, MN/m ² (ksi) K _t = 10 - 11.2	Avg	1048 (152)	1138 (165)	1202 (177)	1193 (173)	
	Min					
	No. of Spec. (No. of Heats)	(1)	(1)	(1)	(1)	
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg	1004 (145.6)	1198 (173.7)		1522 (220.7)	1735 (251.6)
	Min	938 (136)	1158 (168)		1475 (214)	1599 (232)
Std. Deviation						
TYS, MN/m ² (ksi)	Avg	944 (137)	1149 (166.6)		1491 (216.3)	1682 (244)
	Min	882 (128)	1103 (160)		1448 (210)	1586 (230)
Std. Deviation						
Elong, percent	Avg	12.2	10.9		10	1.94
	Min	10	10		5	1
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)		5 (2)	5 (3)		7 (3)	7 (3)
E, GN/m ² (10 ⁶ psi)	Avg	112 (16.3)	116 (16.8)		133 (19.3)	134 (19.4)
	Min	109.6 (15.9)	113 (16.4)		120 (17.4)	127 (18.4)
	No. of Spec. (No. of Heats)	2 (1)	3 (1)		3 (1)	3 (1)
Poisson's Ratio		0.27	0.25		0.24	0.20
Work Hardening Coef						
NTS, MN/m ² (ksi) K _t = 6.3	Avg	1165 (169)	1273 (184.7)		1389 (201.5)	1255 (182)
	Min	1158 (168)	1248 (181)		1255 (182)	1158 (168)
	No. of Spec. (No. of Heats)	4 (2)	3 (2)		4 (2)	4 (2)
NTS, MN/m ² (ksi) K _t =	Avg					
	Min					
	No. of Spec. (No. of Heats)					

References: 40128, 47334, 49225, 69800, 90185

TABLE 9.3.1-ME2.1

Alloy Designation: Ti-6Al-4V(ELI) (Weld Metal)

Specification:

Form: Sheet-TIG welded, Ti-6Al-4V filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Solution treated and aged (1660 F/5 min, WQ; 1000 F/4 hours, AC)

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 1027 (149)		1615 (234.3)	1898 (275.3)		
	Min 1020 (148)		1598 (231.8)	1850 (268.3)		
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)	3 (2)		4 (2)	4 (2)		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 56753, 58024

TABLE 9.3.1-ME3

Alloy Designation: Ti-6Al-4V (ELI)

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	892 (129.4)		1418 (205.7)	1640 (237.8)		
	Min	858 (124.5)		1362 (197.6)	1626 (235.8)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	841 (122)		1331 (193)	1601 (232.2)		
	Min				1599 (232.0)		
Std. Deviation							
Elong, percent	Avg	14.7		7.7			
	Min	14		6			
RA, percent	Avg	37		17	8.5		
	Min	34		13	6		
No. of Spec. (No. of Heats)		4 (2)		4 (2)	3 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	867 (125.8)		1363 (197.7)	1617 (234.6)		
	Min	862 (125.0)		1362 (197.5)	1597 (231.6)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	841 (122)		1331 (193)	1575 (228.5)		
	Min				1553 (225.3)		
Std. Deviation							
Elong, percent	Avg	15.5		6			
	Min	15		6			
RA, percent	Avg	44		19	9		
	Min				8		
No. of Spec. (No. of Heats)		2 (2)		2 (2)	2 (2)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 75531, 79816, 87195

TABLE 9.3.1-ME4

Alloy Designation: Ti-6Al-4V (ELI)

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Compression, Longitudinal						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m² (10⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K_{IC} MN/m^{3/2}(ksi√in.)	Avg					
	Min					
Orientation: —						
No. of Spec. (No. of Heats)						
K_{IE}, MN/m^{3/2}(ksi√in.)	Avg	85.2 (78)	77.3 (70.7)	57.2 (52.3)		
(From PTSC spec.)(L — S)Min			71.0 (65.0)	54.6 (50.0)		
No. of Spec. (No. of Heats)		(1)	3 (1)	3 (1)		

References: 79816

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 9.3.1-ME4.1

Ti-6Al-4V(ELI)
Plate-Weld Metal

Alloy Designation: Ti-6Al-4V(ELI) (Weld Metal)

Specification:

Form: Plate-TIG welded, Ti-6Al-4V(ELI) filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed, tested as welded

Testing Temperature, K (F)	297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 994 (114.2)		1524 (221.0)	1674 (242.8)		
	Min 993 (144.0)		1521 (220.6)	1642 (238.2)		
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 916 (132.9)		1480 (214.6)			
	Min 909 (131.8)		1473 (213.7)			
Std. Deviation						
Elong, percent	Avg 6.7		4.3			
	Min 6.0		4.0			
RA, percent	Avg 14.7		13.7	13.3		
	Min 14		11	11		
No. of Spec. (No. of Heats)	3 (1)		3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
Tension, Transverse						
TUS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg					
	Min					
Std. Deviation						
Elong, percent	Avg					
	Min					
RA, percent	Avg					
	Min					
No. of Spec. (No. of Heats)						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg					
K _t =	Min					
No. of Spec. (No. of Heats)						

References: 75531

TABLE 9.3.1-ME5

Alloy Designation: Ti-6Al-4V (ELI)

Specification:

Form: Bar
Diameter: Up to 2.540 cm (1.000 in.)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	122 (-240)	77 (-320)		4 (-452)
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1001 (145)	1179 (171)	1365 (198)	1560 (226)		1824 (264)
	Min	986 (143)			1524 (221)		1710 (248)
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	943 (137)	1117 (162)	1303 (189)	1506 (218)		1753 (254)
	Min	917 (133)			1476 (214)		1655 (240)
Std. Deviation							
Elong, percent	Avg	14	12	12	11		4
	Min						
RA, percent	Avg	52	43	45	43		32
	Min						
No. of Spec. (No. of Heats)		4 (2)	(1)	(1)	4 (2)		4 (2)
E, GN/m ² (10 ⁶ psi)	Avg	109 (15.8)			118 (17.1)		119 (17.3)
	Min						
No. of Spec. (No. of Heats)		3 (1)			3 (1)		3 (1)
Poisson's Ratio		0.333			0.327		0.311
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	K _t =						
	Min						
No. of Spec. (No. of Heats)							

References: 47334, 89543

TABLE 9.3.1-ME6

Alloy Designation: Ti-6Al-4V (ELI)

Specification:

Form: Bar

Diameter: Up to 2.540 cm (1.000 in.)

Condition: Annealed

Testing Temperature, K (F)	297 (75)	233 (-40)	122 (-240)	77 (-320)		10 (-441)
Compression, Longitudinal						
CYS, MN/m ² (ksi)	Avg					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
No. of Spec. (No. of Heats)						
Compression, Transverse						
CYS, MN/m ² (ksi)	Avg					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
No. of Spec. (No. of Heats)						
Shear^(a)						
SUS, MN/m ² (ksi)	Avg					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
No. of Spec. (No. of Heats)						
Impact, Charpy V						
Long., J(ft-lb)	Avg	32.0 (23.6)	25.8 (19)	19.5 (14.4)		18.7 (13.8)
No. of Spec. (No. of Heats)						
Trans., J(ft-lb)	Avg					
No. of Spec. (No. of Heats)						
Fracture Toughness^(b)						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg					
Orientation: —						
No. of Spec. (No. of Heats)						
K _{IE} MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.) (—)Min						
No. of Spec. (No. of Heats)						

References: 47334

(a) Indicate specimen design and orientation for shear specimens:

(b) Indicate specimen design for K_{IC} data:

TABLE 9.3.1-ME6.1

Alloy Designation: Ti-6Al-4V (ELI)

Specification: AMS 4930
Form: Forged Ring
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Commercial anneal 977 K (1300 F) 2 hr, AC

Testing Temperature, K (F)	297 (75)	125 (-235)	110 (-260)	77 (-320)	4 (-452)	
<u>Compression, Longitudinal</u>						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Compression, Transverse</u>						
CYS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Ec, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Shear(a)</u>						
SUS, MN/m ² (ksi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Impact, Charpy V</u>						
Long., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Trans., Nm(ft-lb)	Avg					
	Min					
No. of Spec. (No. of Heats)						
<u>Fracture Toughness(b)</u>						
K _{IC} MN/m ^{3/2} (ksi√in.)	Avg	91.2 (100.2)	71.0 (78.0)	55.6 (61.1)	49.2 (54.1)	
	Min			54.5 (59.9)	48.9 (53.7)	
Orientation: —						
No. of Spec. (No. of Heats)		1	1	4(1)	3(1)	
K _{IE} , MN/m ^{3/2} (ksi√in.)	Avg					
(From PTSC spec.)(—)Min						
No. of Spec. (No. of Heats)						

References: 94208C

- (a) Indicate specimen design and orientation for shear specimens:
(b) Indicate specimen design for K_{IC} data: Compact Tension

TABLE 9.3.1-ME7

Alloy Designation: Ti-6Al-4V (ELI)

Specification:

Form: Forged Plates

Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)

Condition: As forged

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	970 (141)	1158 (168)	1565 (227)	1650 (239)		
	Min	965 (140)	1144 (166)	1517 (220)	1586 (230)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	917 (133)	1126 (163)	1478 (214)	1565 (227)		
	Min	910 (132)	1103 (160)	1455 (211)	1538 (223)		
Std. Deviation							
Elong, percent	Avg	14	13	10.7	11		
	Min	14	13	10	10		
RA, percent	Avg	39.6	30.8	31.3	24.2		
	Min	39.1	28.7	27.6	23		
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1333 (193)	1558 (226)	1903 (276)	1820 (264)		
	Min	1317 (191)	1551 (225)	1862 (270)	1806 (262)		
K _t = 5 - 8							
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	954 (138)	1126 (163)	1496 (217)	1604 (233)		
	Min	952 (138)	1117 (162)	1489 (216)	1593 (231)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	919 (133)	1087 (158)	1427 (207)	1593 (231)		
	Min	910 (132)	1062 (154)	1420 (206)			
Std. Deviation							
Elong, percent	Avg	14	13.3	11	6		
	Min	13	13	10	6		
RA, percent	Avg	43.7	35.4	30.2	22.3		
	Min	42.6	34	28.7	20.1		
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1303 (189)	1480 (215)	1784 (259)	1547 (224)		
	Min	1296 (188)	1455 (211)	1738 (252)	1517 (220)		
K _t = 5 - 8							
No. of Spec. (No. of Heats)		3 (1)	3 (1)	3 (1)	3 (1)		
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 66080

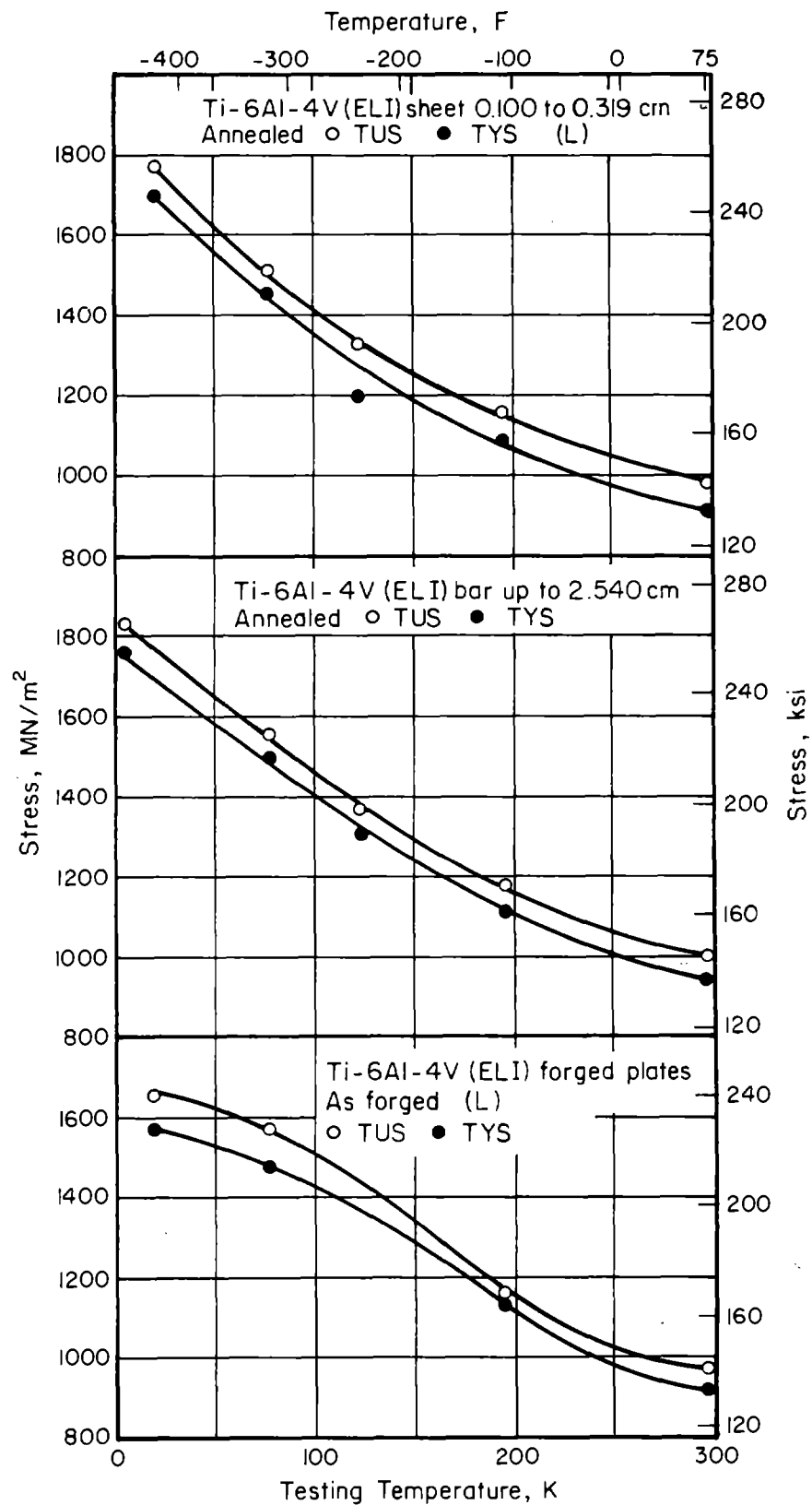


FIGURE 9.3.1-ME1. EFFECT OF TEMPERATURE ON THE STRENGTH OF Ti-6Al-4V (ELI) ALLOY

9.3.1-8 (11/74)

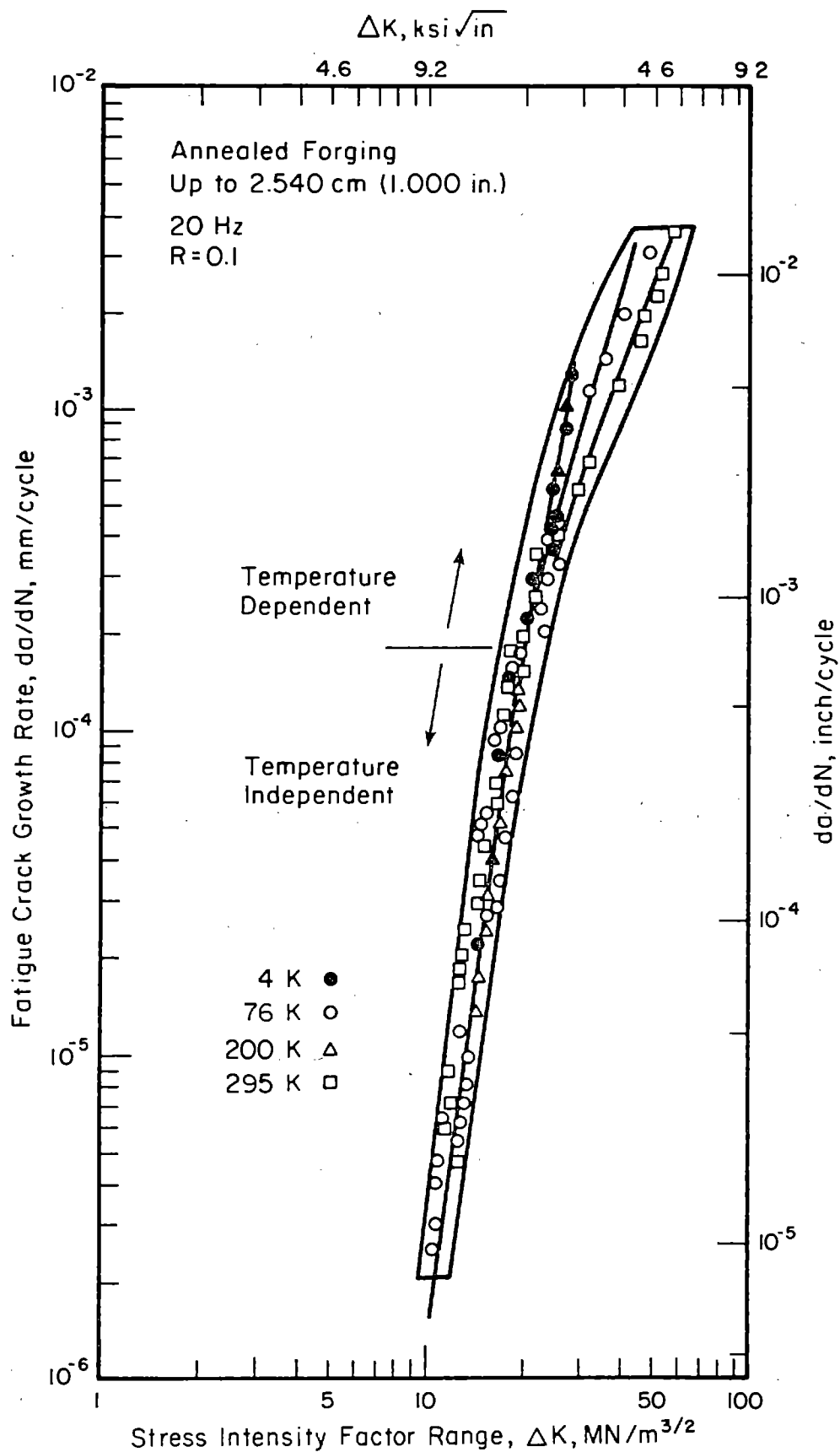


FIGURE 9.3.1-ME2. FATIGUE CRACK GROWTH RATES FOR Ti-6Al-4V (ELI) ALLOY AT 4K, 76K, 200K AND 295K (-452F, -321F, -103F AND 73F)(94208C)

TABLE 9.3.1-TR1

Alloy Designation: Ti-6Al-4V(ELI) Alloy

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹				1.58	0.90	0.43
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(0.91)	(0.52)	(0.25)
No. of Spec.				1	1	1
References: 96888						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	156 x 10 ⁻⁸	139 x 10 ⁻⁸	135 x 10 ⁻⁸	133 x 10 ⁻⁸		
Ohm circular mil ft ⁻¹	(938)	(836)	(812)	(800)		
No. of Spec.	1	1	1	1		
References: 79561						
Magnetothermal						
Conductivity						
	H					
	tesla					
Watts m ⁻¹ K ⁻¹	0			1.58	0.90	0.43
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(0.91)	(0.52)	(0.25)
Watts m ⁻¹ K ⁻¹	1			1.57	0.89	0.39
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(0.91)	(0.51)	(0.23)
Watts m ⁻¹ K ⁻¹	4			1.56	0.87	0.38
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(0.90)	(0.50)	(0.22)
Watts m ⁻¹ K ⁻¹	8			1.56	0.86	0.35
Btu hr ⁻¹ ft ⁻¹ F ⁻¹				(0.90)	(0.50)	(0.20)
No. of Spec.				1	1	1
References: 96888						

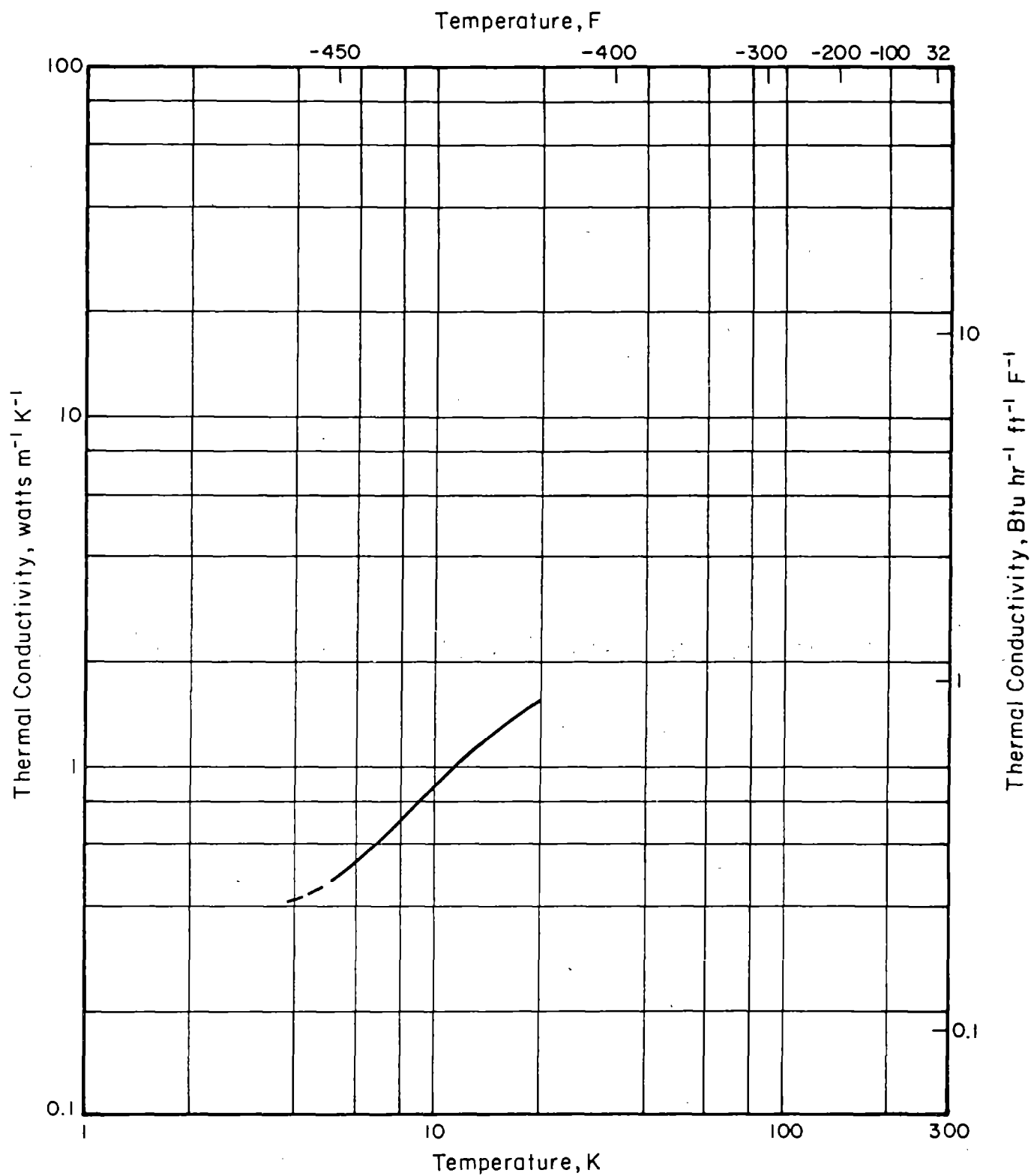


FIGURE 9.3.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Ti-6Al-4V(ELI) ALLOY

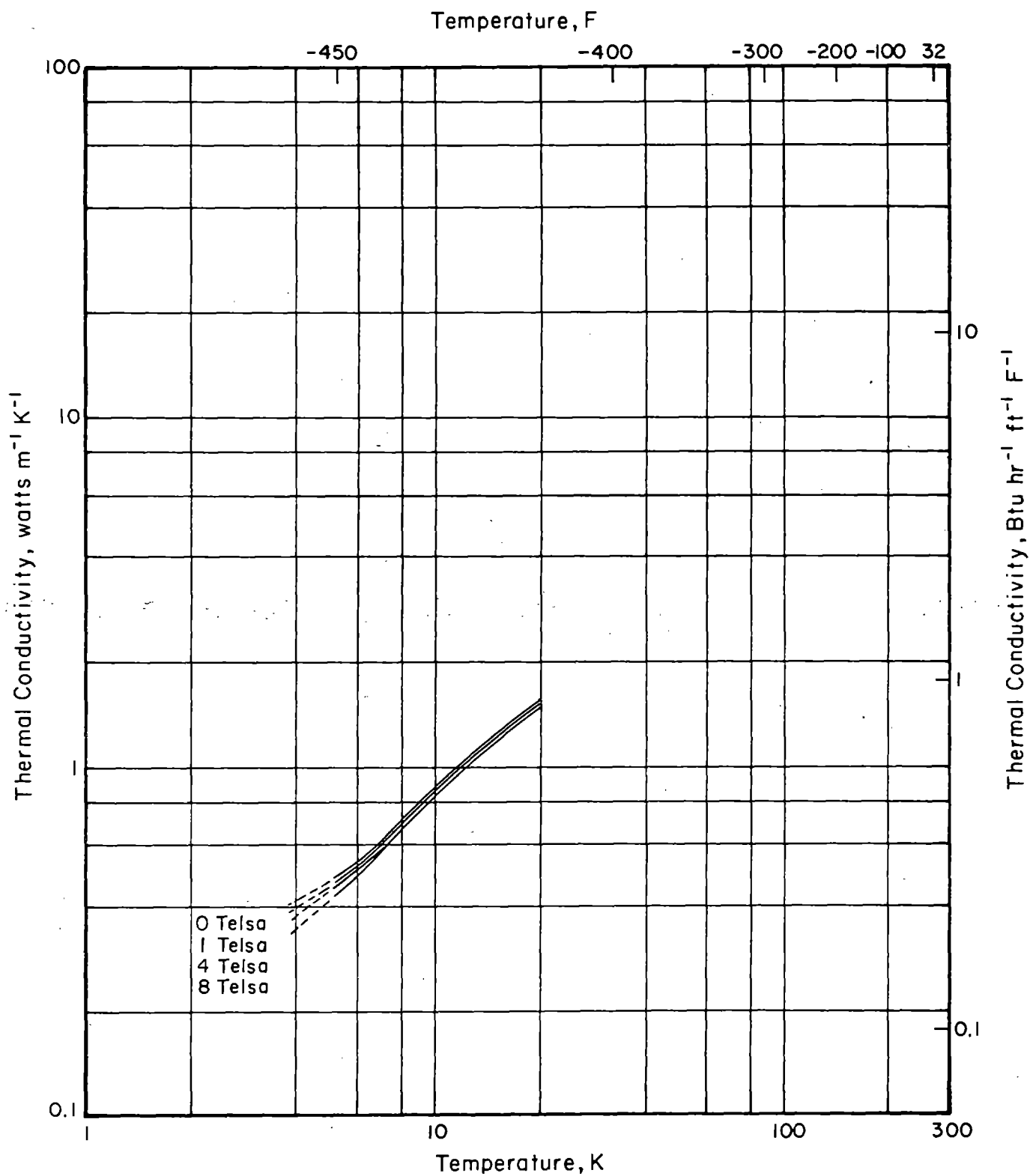


FIGURE 9.3.1-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Ti-6Al-4V(ELI) ALLOY AT SEVERAL MAGNETIC FIELDS

Ti-6Al-4V(ELI)

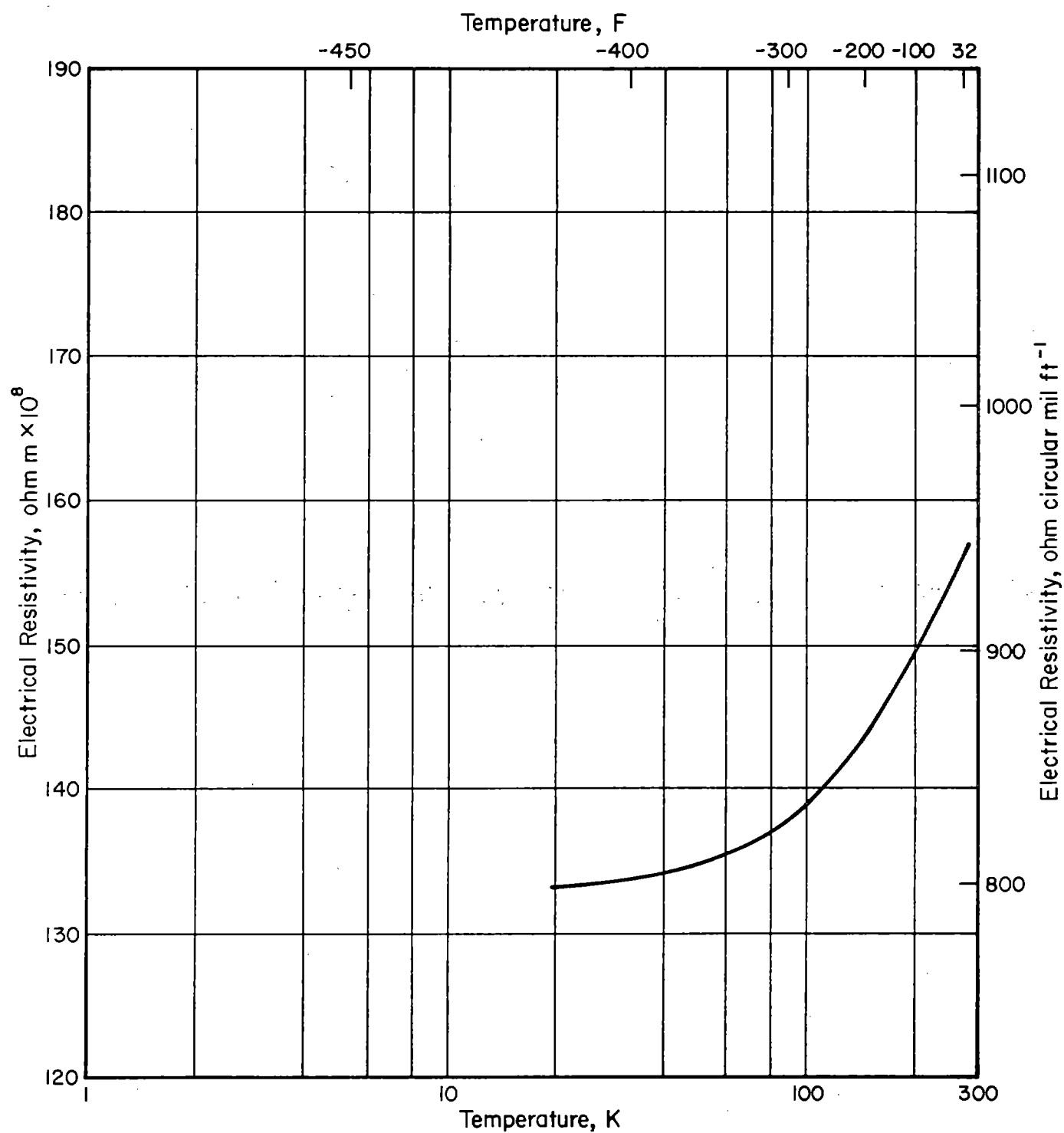


FIGURE 9.3.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR Ti-6Al-4V(ELI) ALLOY

TABLE 9.3.2-ME1

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content)

Specification:

Form: Sheet

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: STA

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1151 (167)	1344.5 (195)	1737.5 (252)	1950.5 (282.9)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1052 (152.6)	1253 (181.7)	1648 (239)	1900 (275.6)		
	Min						
Std. Deviation							
Elong, percent	Avg	7.9	5.0	5.9	2.7		
	Min						
RA, percent	Avg	32.3		21.0	15.8		
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg	114 (16.6)	116 (16.8)	125 (18.2)	123 (17.9)		
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio		0.300		0.290	0.280		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1169 (169.5)	1404 (203.7)	1696 (246)	1929 (279.8)		
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1082 (157)	1303 (189)	1619 (234.8)	1855 (269)		
	Min						
Std. Deviation							
Elong, percent	Avg	6.9	4.6	4.5	2.5		
	Min						
RA, percent	Avg	29.9		21.4	16.9		
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg	123 (17.9)	121 (17.5)	127 (18.4)	132 (19.1)		
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio		0.310		0.300	0.270		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 64353, 89716, 89983

TABLE 9.3.2-ME2

Ti-6Al-4V
Sheet-Weld Metal

Alloy Designation: Ti-6Al-4V (Weld Metal)

Specification:

Form: Sheet-TIG welded, Ti-6Al-4V filler

Thickness, cm (in.): Up to 0.099 (0.039)

Condition: Post weld treatment, stress relieved in vacuum furnace at 811 K (1000 F) for 4 hours

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1099 (159.4)			1910 (277)		
	Min	1083 (157.1)			1870 (271.2)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1078 (156.3)			1910 (277)		
	Min	1054 (152.8)			1870 (271.2)		
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg	0.4			0.75		
	Min	0.3			0.50		
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 89983

TABLE 9.3.2-ME3

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content)

Specification:

Form: Sheet

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: STA

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1112 (161.3)	1330 (192.9)	1679 (243.6)	1826 (264.9)		
	Min	938 (136.0)	1112 (161.3)	1504 (218.1)	1468 (213.0)		
	Std. Deviation	107 (15.53)	139 (20.21)	129 (18.71)	220 (31.94)		
TYS, MN/m ² (ksi)	Avg	1030 (149.4)	1200 (174.0)	1584 (229.8)	1693 (245.6)		
	Min	876 (127.0)	834 (121.0)	1172 (170.0)	1296 (188.0)		
	Std. Deviation	101 (14.69)	184 (26.65)	177 (25.72)	255 (37.0)		
Elong, percent	Avg	11.6	6.7	7.7	4.9		
	Min	5.8	2.5	3.8	1.0		
RA, percent	Avg	31.1	23.5	17.5	25.0		
	Min	24.5	16.1	10.8	15.0		
No. of Spec. (No. of Heats)		17 (9)	9 (5)	14 (7)	18 (8)		
E, GN/m ² (10 ⁶ psi)	Avg	112 (16.2)	117 (16.9)	122 (17.7)	126 (18.3)		
	Min	104 (15.1)	114 (16.6)	121 (17.5)	113 (16.4)		
	No. of Spec. (No. of Heats)	9 (5)	5 (2)	7 (3)	10 (4)		
Poisson's Ratio		0.333			0.368		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1333 (193.4)	1517 (220)	1932 (280.2)	2077 (301.3)		
	Min	1296 (188.0)	1489 (216)	1682 (244.0)	1773 (257.1)		
	No. of Spec. (No. of Heats)	6 (2)	3 (1)	5 (2)	6 (2)		
NTS, MN/m ² (ksi)	Avg	1172 (170)		1444 (209.5)	1262 (275.6)		
	Min	1172 (170)		1351 (196.0)	1193 (173)		
	No. of Spec. (No. of Heats)	2 (1)		2 (1)	2 (1)		
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1174 (170.3)	1328 (192.3)	1679 (243.5)	1900 (275.6)		
	Min	1034 (150.0)	1175 (170.4)	1489 (216.0)	1668 (241.9)		
	Std. Deviation	65 (9.44)					
TYS, MN/m ² (ksi)	Avg	1076 (156.0)	1202 (174.4)	1586 (230)	1801 (261.2)		
	Min	876 (127.0)	979 (142.0)	1337 (194)	1656 (240.2)		
	Std. Deviation	81.4 (11.81)					
Elong, percent	Avg	10.5	6.4	7.6	3.0		
	Min	6.0	5.0	4.0	2.0		
RA, percent	Avg	31.7					
	Min	22.3					
No. of Spec. (No. of Heats)		10 (5)	5 (3)	5 (3)	3 (2)		
E, GN/m ² (10 ⁶ psi)	Avg	112 (16.3)	114 (16.6)	119 (17.3)	125 (18.1)		
	Min	104 (15.1)	113 (16.4)	116 (16.9)			
	No. of Spec. (No. of Heats)	7 (3)	3 (1)	3 (1)	1 (1)		
Poisson's Ratio		0.309			0.372		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						
NTS, MN/m ² (ksi)	Avg						
	Min						
	No. of Spec. (No. of Heats)						

References: 37146, 47311, 49048, 49088, 58024, 58060, 78652, 89983, 90172, 90185

TABLE 9.3.2-ME4

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content) (Weld Metal)

Specification:

Form: Sheet-TIG welded, Ti-6Al-4V filler

Thickness, cm (in.): 0.100 to 0.319 (0.040 to 0.125)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	967 (140.3)	1130 (163.9)	1521 (220.6)	1740 (252.4)	1663 (241.2)	
	Min	956 (138.6)	1102 (159.8)	1519 (220.3)	1584 (229.7)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	916 (132.9)	1071 (155.4)	1495 (216.8)	1562 (226.6)		
	Min						
Std. Deviation							
Elong, percent	Avg	8.7	8.0	8.6	3.0	1.0	
	Min	7.5	6.0	7.3	2.0	1.0	
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (2)	2 (2)	2 (2)	2 (2)	1 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 58060, 90185

TABLE 9.3.2-ME5

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content) (Weld Metal)

Specification:

Form:

Sheet-TIG welded, Ti-6Al-4V filler

Thickness, cm (in.):

0.100 to 0.319 (0.040 to 0.125)

Condition:

STA, post weld treated, stress relieved in a vacuum furnace at 811 K (1000 F) for 4 hours

Testing Temperature, K (F)		297 (75)			20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1119 (162.3)			1952 (283.1)		
	Min	1113 (161.5)			1927 (279.5)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1093 (158.5)			1952 (283.1)		
	Min	1082 (157.0)			1927 (279.5)		
Std. Deviation							
Elong, percent	Avg	1.0			1.5		
	Min	0.6			1.5		
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		2 (1)			2 (1)		
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 89983

TABLE 9.3.2-ME6

Alloy Designation: Ti-6Al-4V Alloy

Specification: MIL-T-9046 F, Type III, Composition C

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Annealed

Testing Temperature, K (F)		297 (75)	77 (-320)				
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	917 (133.0)	1485 (215.4)				
	Min	905 (131.2)	1482 (214.9)				
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	838 (121.6)	1378 (199.8)				
	Min	828 (120.1)	1360 (197.3)				
Std. Deviation							
Elong, percent	Avg	18.5	20.1				
	Min	18.1	17.3				
RA, percent	Avg	14.2	12.3				
	Min	13.4	9.9				
No. of Spec. (No. of Heats)		3(1)	3(1)				
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 90624

TABLE 9.3.2-ME7

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content)

Specification:

Form: Plate

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: STA

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1158 (168.0)		1734 (251.5)	1758 (255.0)		
	Min	1120 (162.4)		1703 (247.0)	1398 (202.8)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1062 (154)		1620 (235)	1937 (281)		
	Min	1022 (148.2)		1544 (224)	1855 (269)		
Std. Deviation							
Elong, percent	Avg	6.2		8.0	3.0		
	Min	3.0		3.0	3.0		
RA, percent	Avg	17.4		14.6	17.3		
	Min	4.0		4.0	15.9		
No. of Spec. (No. of Heats)		5 (3)		3 (2)	5 (3)		
E, GN/m ² (10 ⁶ psi)	Avg	114 (16.6)		133 (19.25)	123 (17.89)		
	Min	108 (15.6)		132 (19.20)	120 (17.40)		
No. of Spec. (No. of Heats)		3 (2)		2 (1)	3 (2)		
Poisson's Ratio		0.300		0.290	0.270		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1172 (170.0)		1710 (248)	1779 (258)		
	Min	1129 (163.8)		1689 (245)	1531 (222)		
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1082 (157.0)		1620 (235)	1855 (269)		
	Min	1055 (153.1)		1558 (226)	1800 (261)		
Std. Deviation							
Elong, percent	Avg	6.0		4.8	2.7		
	Min						
RA, percent	Avg	16.7		16.2	16.3		
	Min	2.0		4.0	14.6		
No. of Spec. (No. of Heats)		5 (3)		3 (2)	5 (3)		
E, GN/m ² (10 ⁶ psi)	Avg	122 (17.67)		134 (19.4)	132 (19.1)		
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio		0.310		0.300	0.270		
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 89716, 89983, 91696

TABLE 9.3.2-ME8

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content) (Weld Metal)

Specification:

Form: Plate-TIG welded, Ti-6Al-4V filler

Thickness, cm (in.): 0.635 to 1.269 (0.250 to 0.499)

Condition: Stress relieved, 1300 F, 1 hour at Temp., air cooled after welding

Testing Temperature, K (F)		297 (75)		77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	967 (140.3)		1516 (219.9)			
	Min	961 (139.4)		1500 (217.6)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg	12.0		14.3			
	Min	11.0		11.5			
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)		4 (1)		3 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
No. of Spec. (No. of Heats)							

References: 49088

TABLE 9.3.2-ME9

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content)

Specification:

Form: Plate
 Thickness, cm (in.): 1.270 to 2.540 (0.500 to 1.000)
 Condition: STA

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)			
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1096 (159)		1544 (224)			
	Min						
Std. Deviation				1542 (223.7)			
TYS, MN/m ² (ksi)	Avg	1027 (149)	1228 (178.1)	1486 (215.5)			
	Min						
Std. Deviation			1228 (178.1)	1453 (210.7)			
				44.3 (6.42)			
Elong, percent	Avg	8.0		8.0			
	Min						
		8.0		7.5			
RA, percent	Avg	9.0		19.7			
	Min						
		9.0		17.9			
No. of Spec. (No. of Heats)		4 (2)	3 (1)	14 (3)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1117 (162)					
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	1007 (146)					
	Min						
Std. Deviation							
Elong, percent	Avg	8.0					
	Min						
		8.0					
RA, percent	Avg	9.0					
	Min						
		9.0					
No. of Spec. (No. of Heats)		1 (1)					
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 55916, 76411, 80994, 91696

TABLE 9.3.2-ME10

Ti-6Al-4V
Bar

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content)

Specification:

Form: Bar
Thickness, cm (in.): Up to 2.540 (1.000)
Condition: Annealed

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1077 (156.2)	1308 (189.7)	1709 (247.9)	1854 (268.9)	1708 (248)	
	Min	923 (133.8)	1153 (167.2)	1524 (221.0)	1717 (249.0)	1708 (248)	
Std. Deviation		214 (31.01)			73.4 (10.65)		
TYS, MN/m ² (ksi)	Avg	935 (135.6)	1124 (163.0)	1551 (225)	1751 (25.4)	1655 (240)	
	Min	883 (128.0)	1112 (161.3)	1475 (214)	1572 (228)	1655 (240)	
Std. Deviation		29.5 (4.28)			129 (18.67)		
Elong, percent	Avg	14.5	13.2	11.1	6.6	4.0	
	Min	12.0	12.0	9.0	1.9	4.0	
RA, percent	Avg	46.4	40.8	38.7	27.1	32.0	
	Min	42.0	38.5	32.5	2.7	32.0	
No. of Spec. (No. of Heats)		12 (4)	7 (3)	7 (3)	18 (4)	1 (1)	
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg	1271 (184.4)			1942 (281.6)		
K _t = 6.4	Min	1262 (183.0)			1875 (272.0)		
No. of Spec. (No. of Heats)		5 (1)			5 (1)		
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							

References: 35611, 47311, 49349, 54986, 64373

TABLE 9.3.2-ME11

Alloy Designation: Ti-6Al-4V (Nominal Interstitial Content)

Specification:

Form: Forgings

Thickness, cm (in.):

Condition: Annealed

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	1166 (169.1)		1703 (247)	1780 (258.1)		
	Min	1014 (147.0)		1606 (233)	1686 (244.5)		
Std. Deviation					37.2 (5.4)		
TYS, MN/m ² (ksi)	Avg	1034 (150)		1620 (235)	1655 (240)		
	Min	896 (130)		1565 (227)	1420 (206)		
Std. Deviation					56 (8.1)		
Elong, percent	Avg	16.0		8.2			
	Min	10.0		3.8			
RA, percent	Avg	35.1		23.4	26.8		
	Min	15.0		7.4	18.8		
No. of Spec. (No. of Heats)		3 (2)		3 (2)	82 (7)		
E, GN/m ² (10 ⁶ psi)	Avg				(21.6)		
	Min				(18.5)		
No. of Spec. (No. of Heats)					82 (7)		
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg			1689 (245)			
	Min			1631 (236.5)			
K _t = 6.3				2 (1)			
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
Tension, Transverse							
TUS, MN/m ² (ksi)	Avg	1069 (155)		1689 (245)			
	Min	1069 (155)		1689 (245)			
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	917 (133)		1627 (236)			
	Min	917 (133)		1627 (236)			
Std. Deviation							
Elong, percent	Avg	26.0		12.0			
	Min	26.0		12.0			
RA, percent	Avg	36.0		23.0			
	Min	36.0		23.0			
No. of Spec. (No. of Heats)		1 (1)		1 (1)			
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Spec. (No. of Heats)							

References: 49088, 90117, 90185

9.3.2-11.1 (11/76)

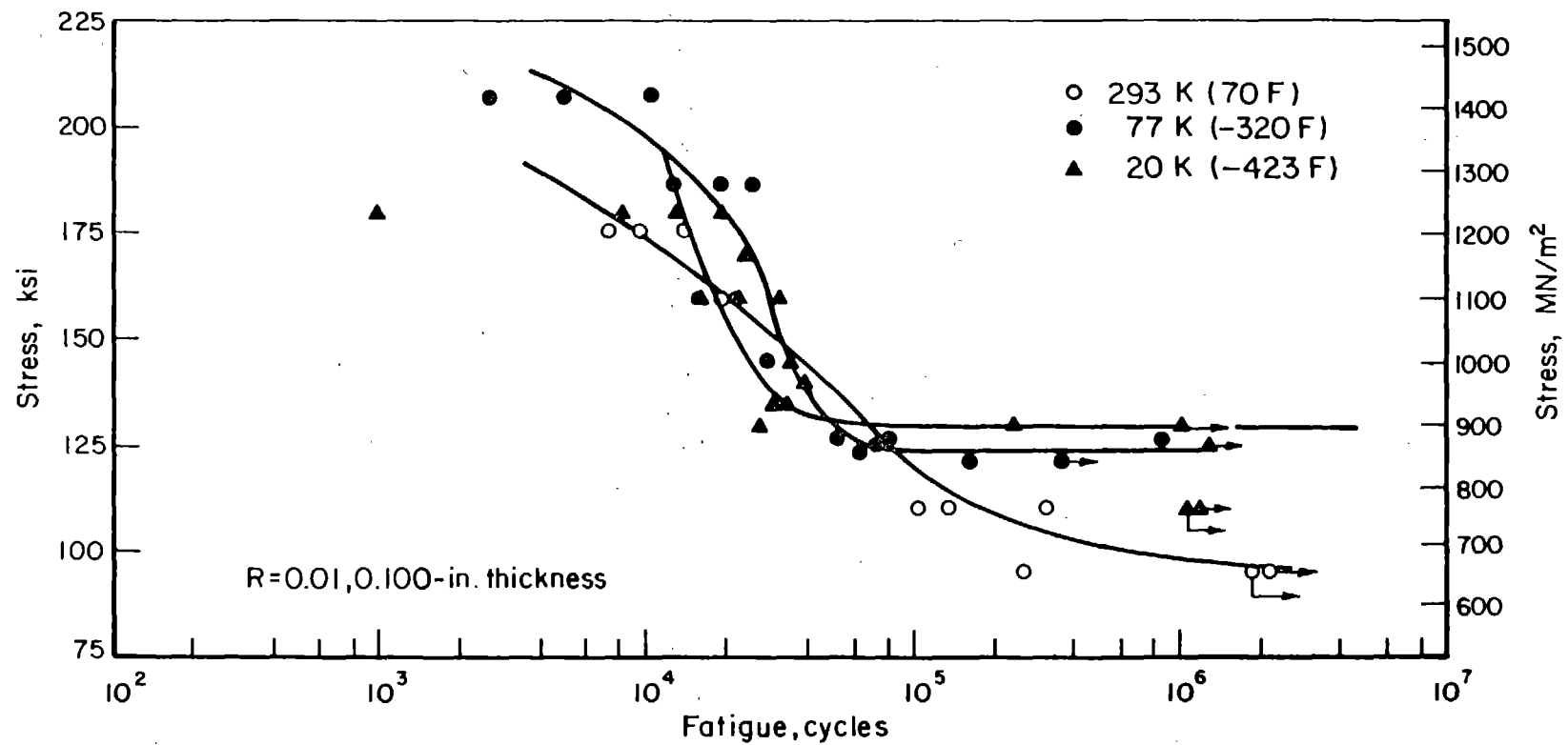


FIGURE 9.3.2-ME1. AXIAL FATIGUE LIFE CURVES FOR UNNOTCHED 6Al-4V (SOLUTION TREATED AND AGED) TITANIUM ALLOY [58024]

9.3.2-11.2 (11/76)

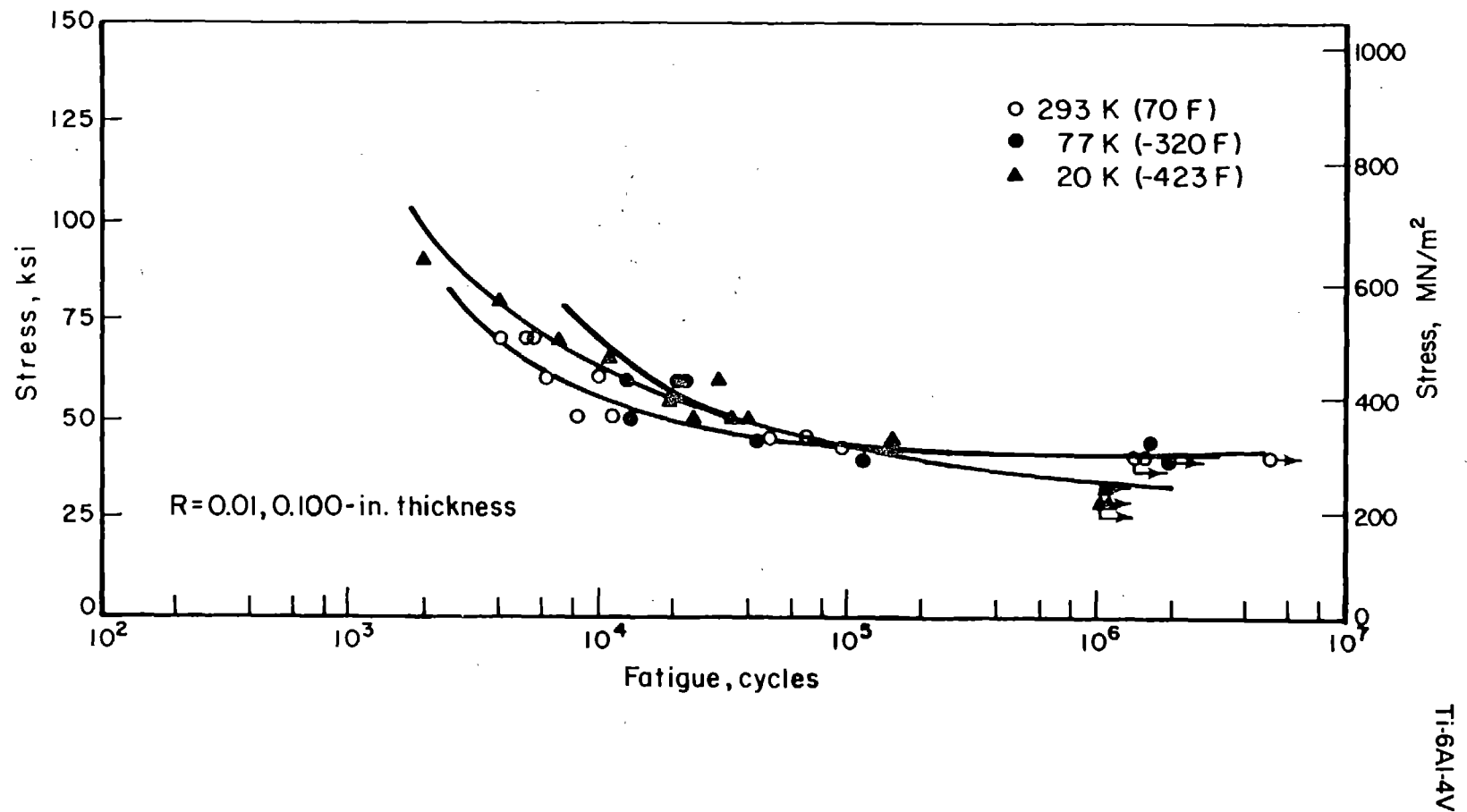


FIGURE 9.3.2-ME2. AXIAL FATIGUE LIFE CURVES FOR NOTCHED 6Al-4V (SOLUTION TREATED AND AGED) TITANIUM ALLOY [58024]

9.3.2-11.3 (11/76)

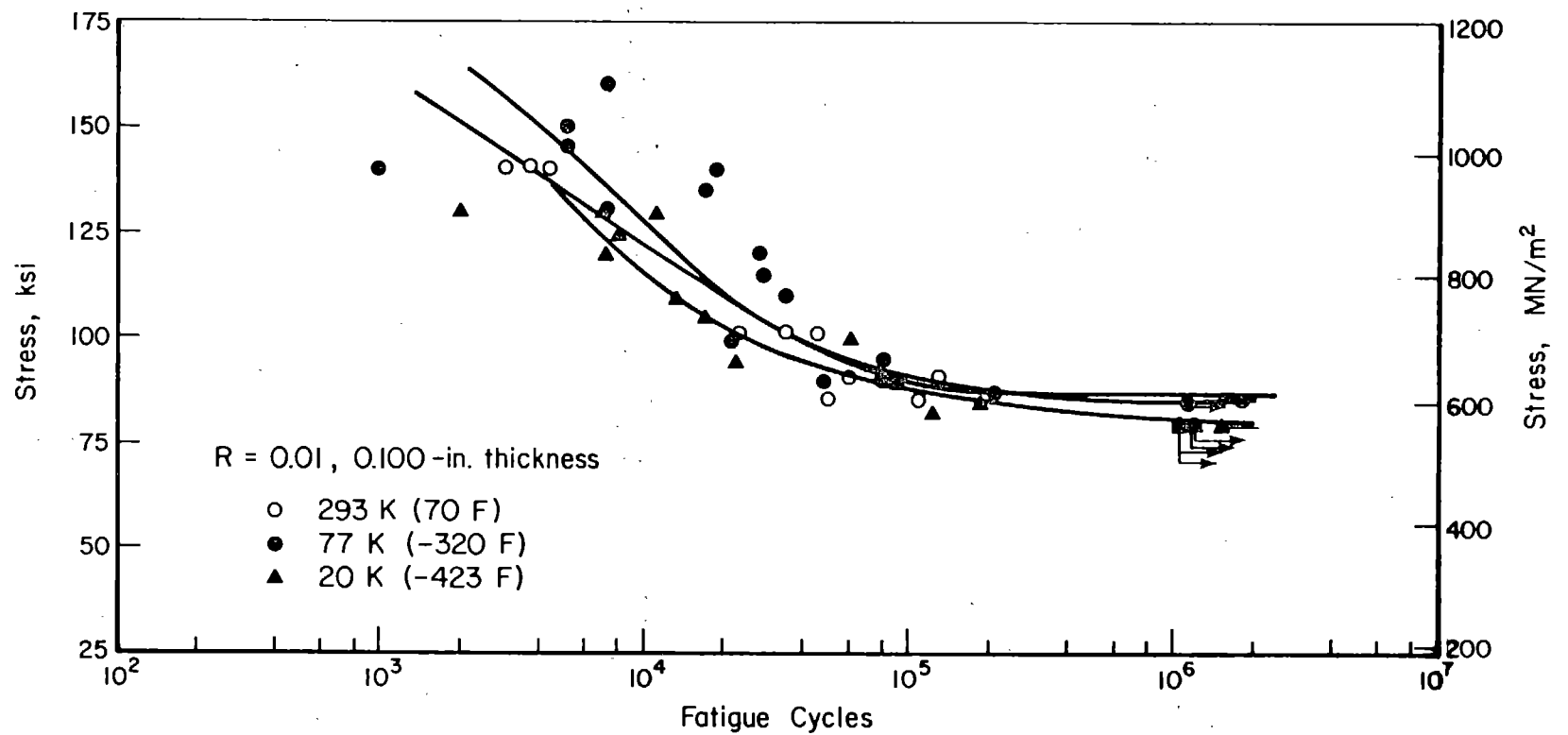
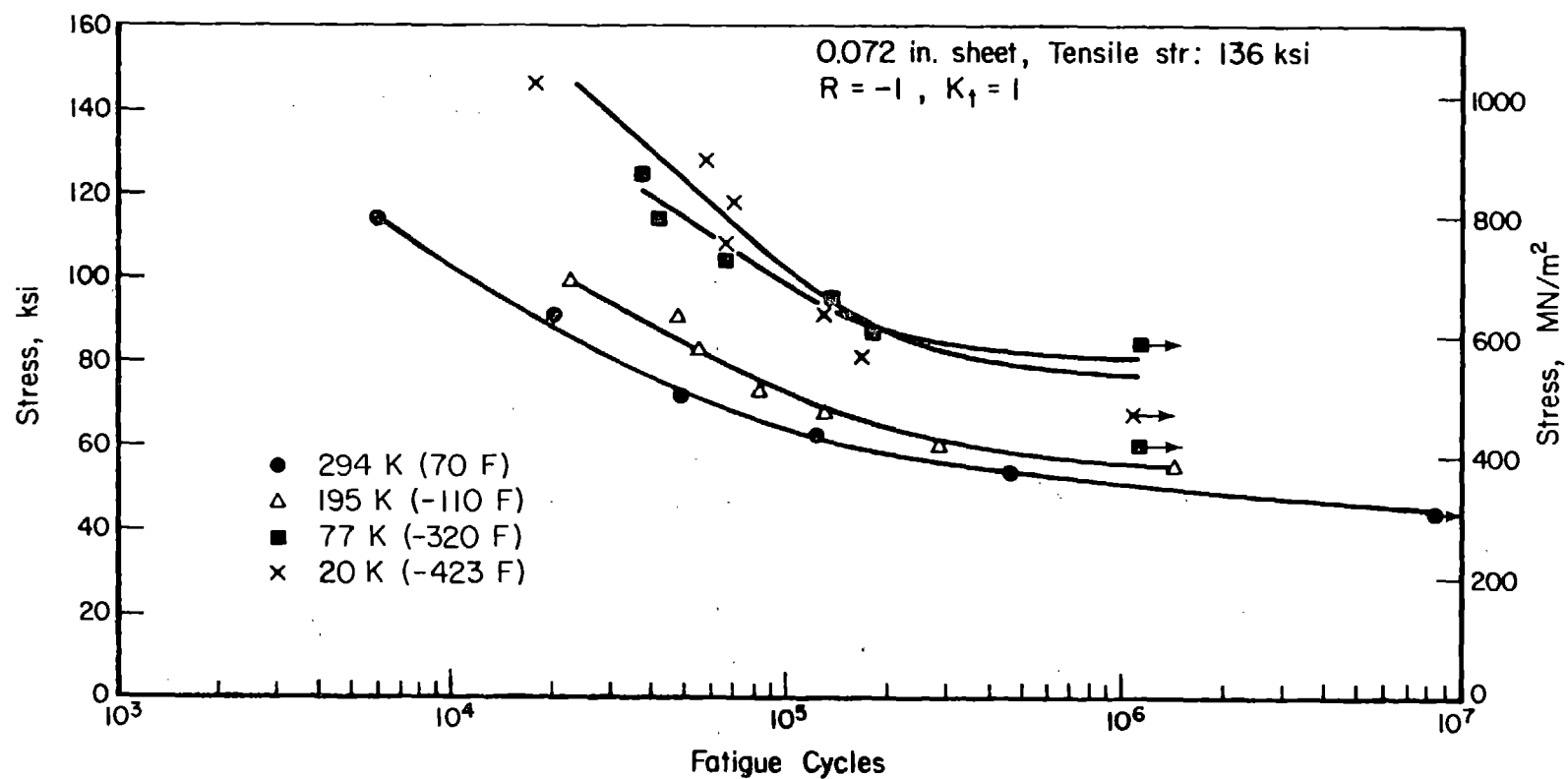


FIGURE 9.3.2-ME3. AXIAL FATIGUE LIFE CURVES FOR WELDED 6Al-4V (SOLUTION TREATED AND AGED) TITANIUM ALLOY [TIG welded; parent metal filler] [58024]

9.3.2-11.4 (11/76)



Ti-6Al-4V

FIGURE 9.3.2-ME4. FLEXURAL FATIGUE LIFE CURVES FOR ANNEALED 6Al-4V TITANIUM [49048]

9.3.2-11.5 (11/76)

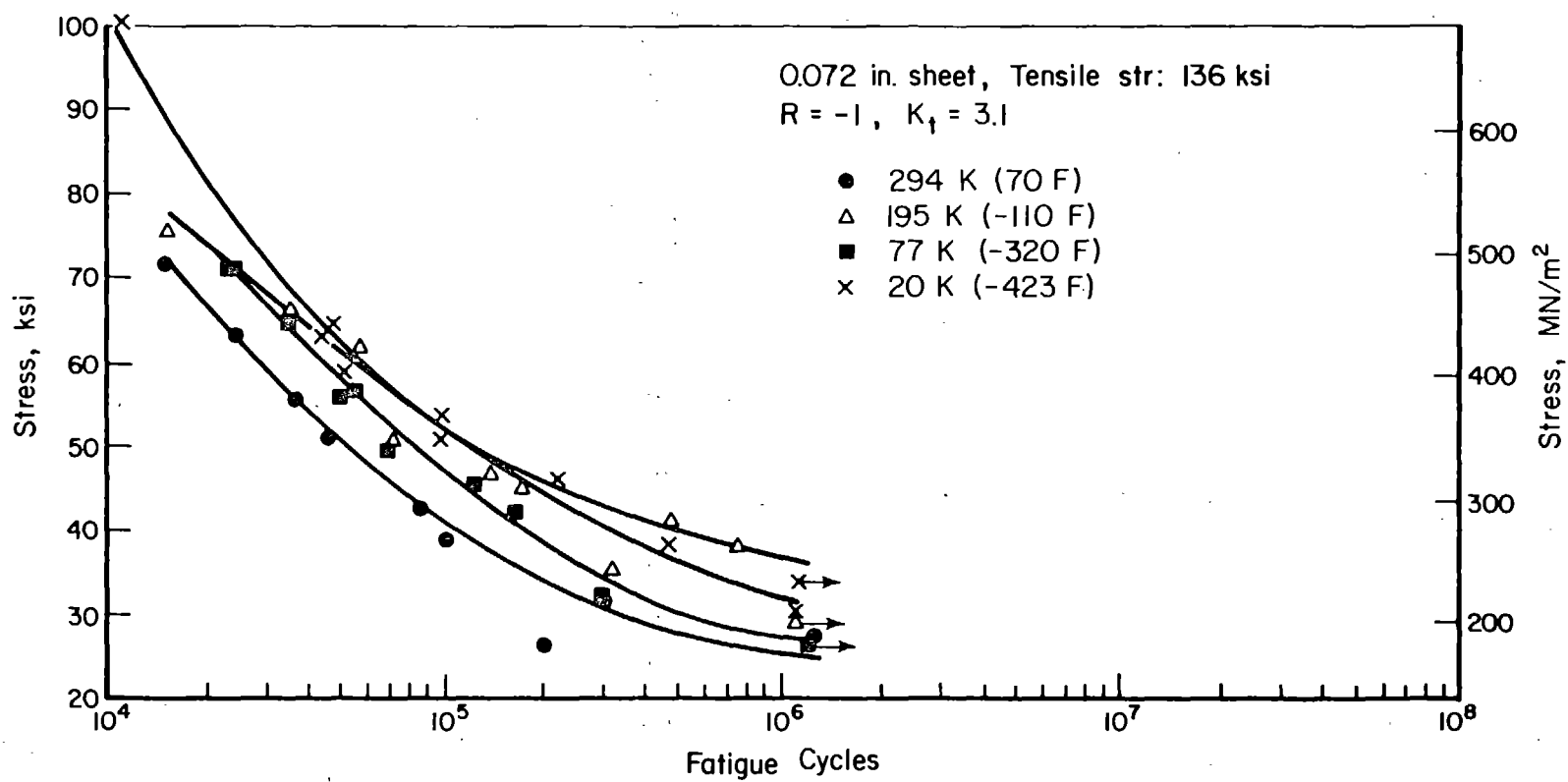


FIGURE 9.3.2-ME5. FLEXURAL FATIGUE LIFE CURVES FOR ANNEALED NOTCHED 6Al-4V TITANIUM [49048]

9.3.2-11.6 (11/76)

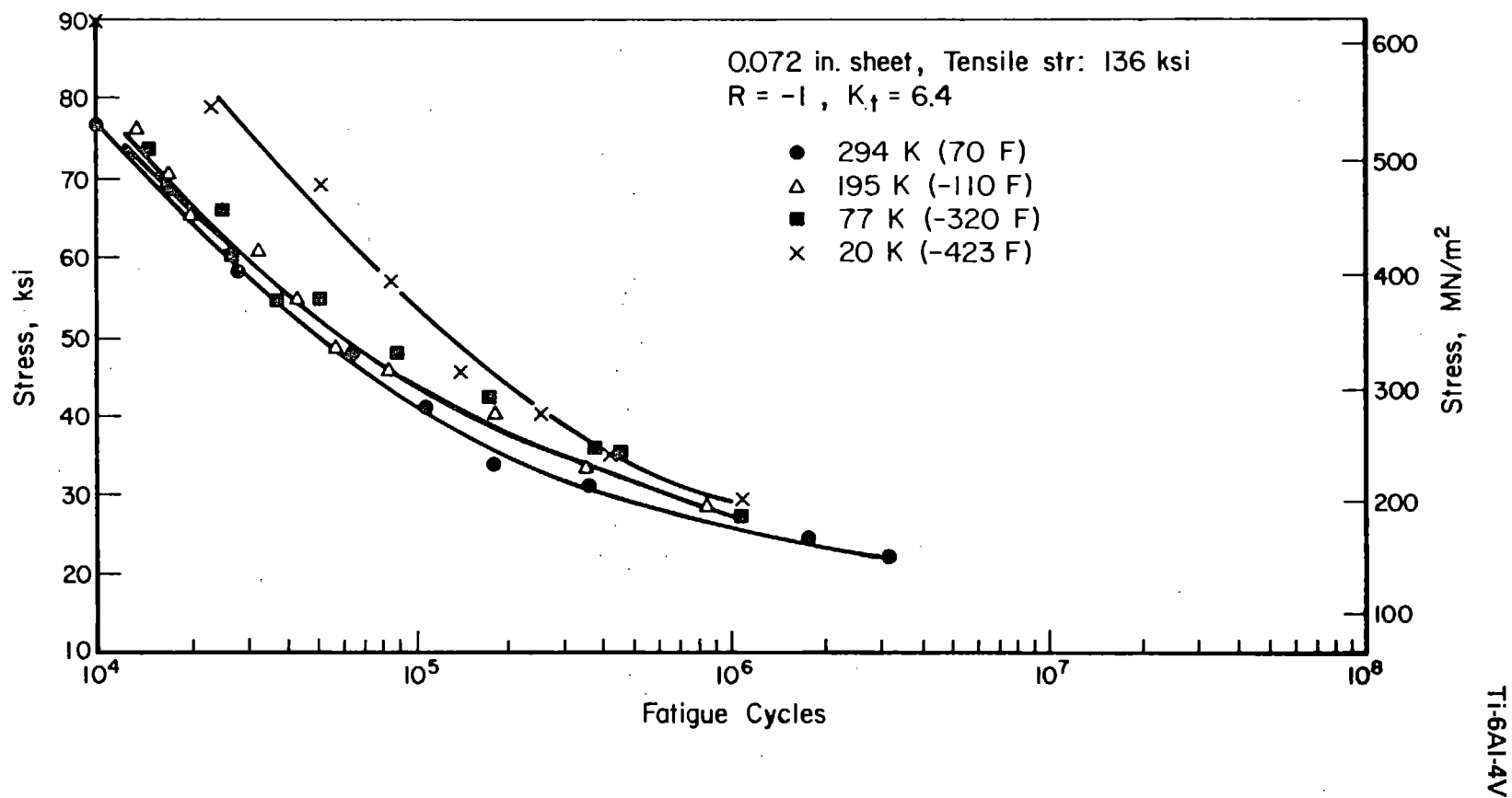


FIGURE 9.3.2-ME6. FLEXURAL FATIGUE LIFE CURVES FOR ANNEALED 6Al-4V TITANIUM [49048]

TABLE 9.3.1-TR1

Alloy Designation: Ti-6Al-4V Alloy

Specification:

Form:

Dimension:

Condition: Annealed

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.132	-0.150	-0.152		
No. of Spec.	3	3	3	1		
References: 48570, 90223						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m	160 x 10 ⁻⁸	145 x 10 ⁻⁸	140 x 10 ⁻⁸	138 x 10 ⁻⁸		
Ohm circular mil ft ⁻¹	(962)	(872)	(842)	(830)		
No. of Spec.	2	2	2	2		
References: 79561						

9.3.2-13 (11/76)

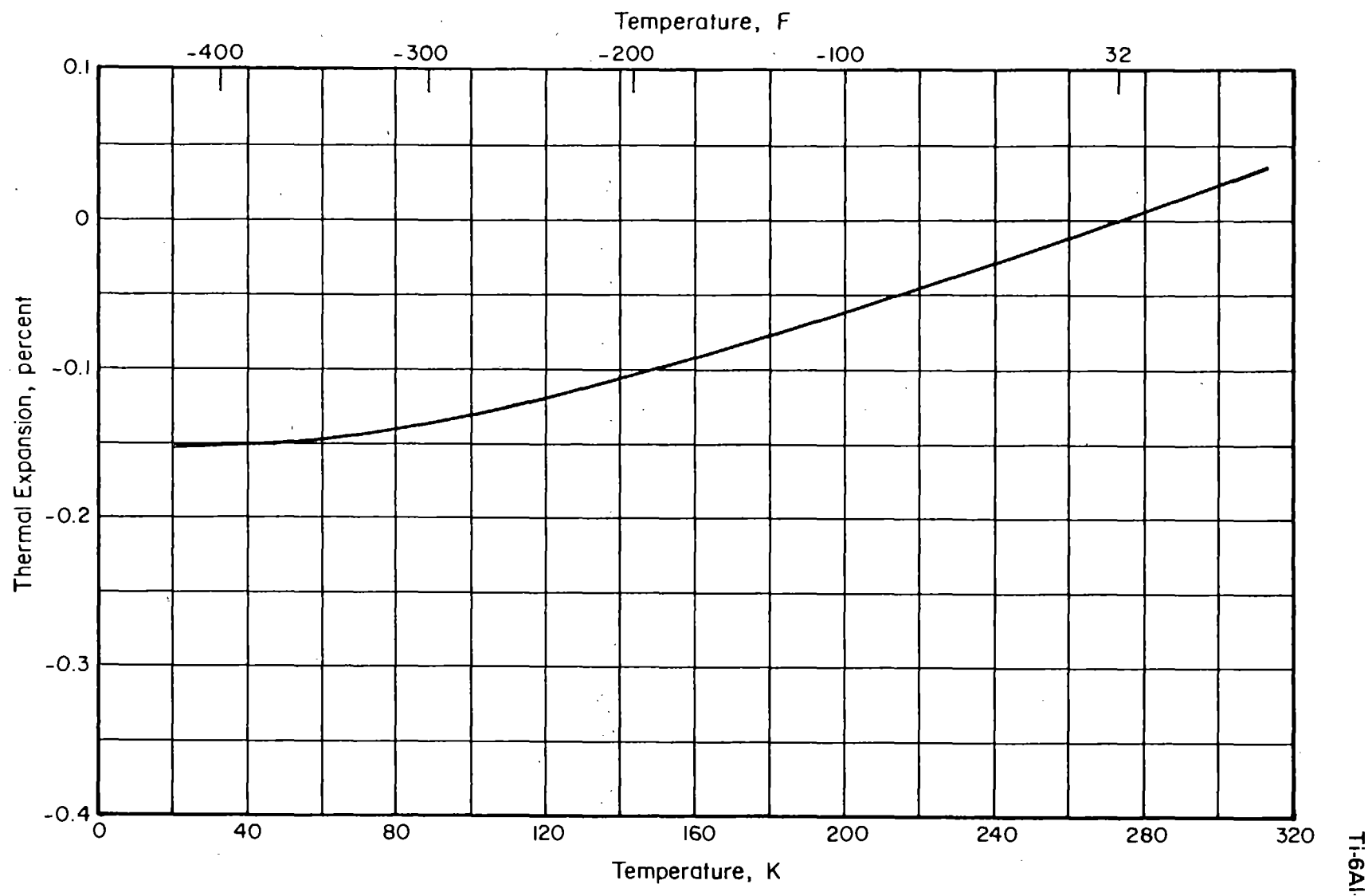


FIGURE 9.3.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR Ti-6 Al-4 V ALLOY

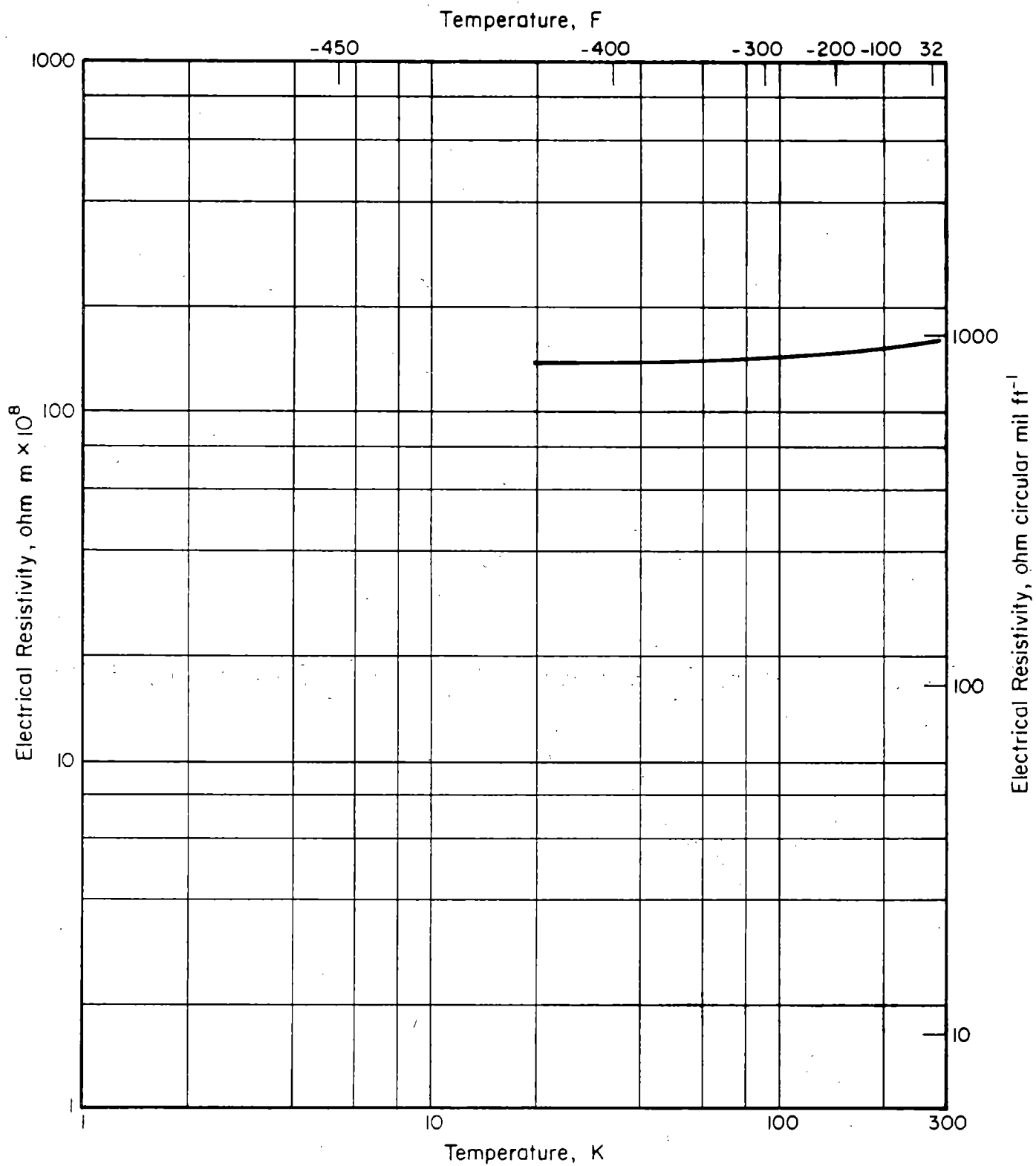


FIGURE 9.3.2-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE
FOR Ti-6 Al-4 V ALLOY

9.3.2-14 (11/76)

**INDEX TO MATERIAL CODES FOR
SECTION 10.0**

SPECIAL METALS

<u>MATERIALS</u>	<u>MATERIAL CODE</u>
NIOBIUM	10.1.1
Nb ₃ Sn	10.1.2
NIOBIUM-ZIRCONIUM ALLOYS	10.1.3
TITANIUM-NIOBIUM ALLOYS	10.1.4
V ₃ Ga	10.2.1
MAGNESIUM ALLOYS-AZ31B	10.3.1

TABLE 10.1.1-TR1

Alloy Designation: Niobium

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹			45.5	31.5	16.0	3.10(n) 2.85(s)
Btu hr ⁻¹ ft ⁻¹ F ⁻¹			(26.3)	(18.2)	(9.25)	(1.79(n)) (1.65(s))
No. of Spec			3	3	3	8
References: 90170, 90224						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.106	-0.124	-0.128	-0.129	-0.129
No. of Spec.	1	1	1	1	1	1
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	262	200	97	12.0(n)(a) 12.5(s)(b)	2.15(n) 2.15(s)	0.405(n) 0.275(s)
Btu lb ⁻¹ F ⁻¹	(0.0626)	(0.0478)	(0.0232)	(0.00288(n)) (0.00299(s))	(0.000154(n)) (0.000154(s))	(0.0000968(n)) (0.0000657(s))
No. of Spec.	7	7	7	7(n) 6(s)	7(n) 6(s)	7(n) 6(s)
References: 40911, 42219, 90223, 90347						
Electrical Resistivity						
Ohm m	14	4.3	1.45	0.51		
Ohm circular mil ft ⁻¹	(84.2)	(25.9)	(8.72)	(3.07)		
No. of Spec.	2	2	2	2		
References: 90178						

(a) n Normal state

(b) s Superconducting state

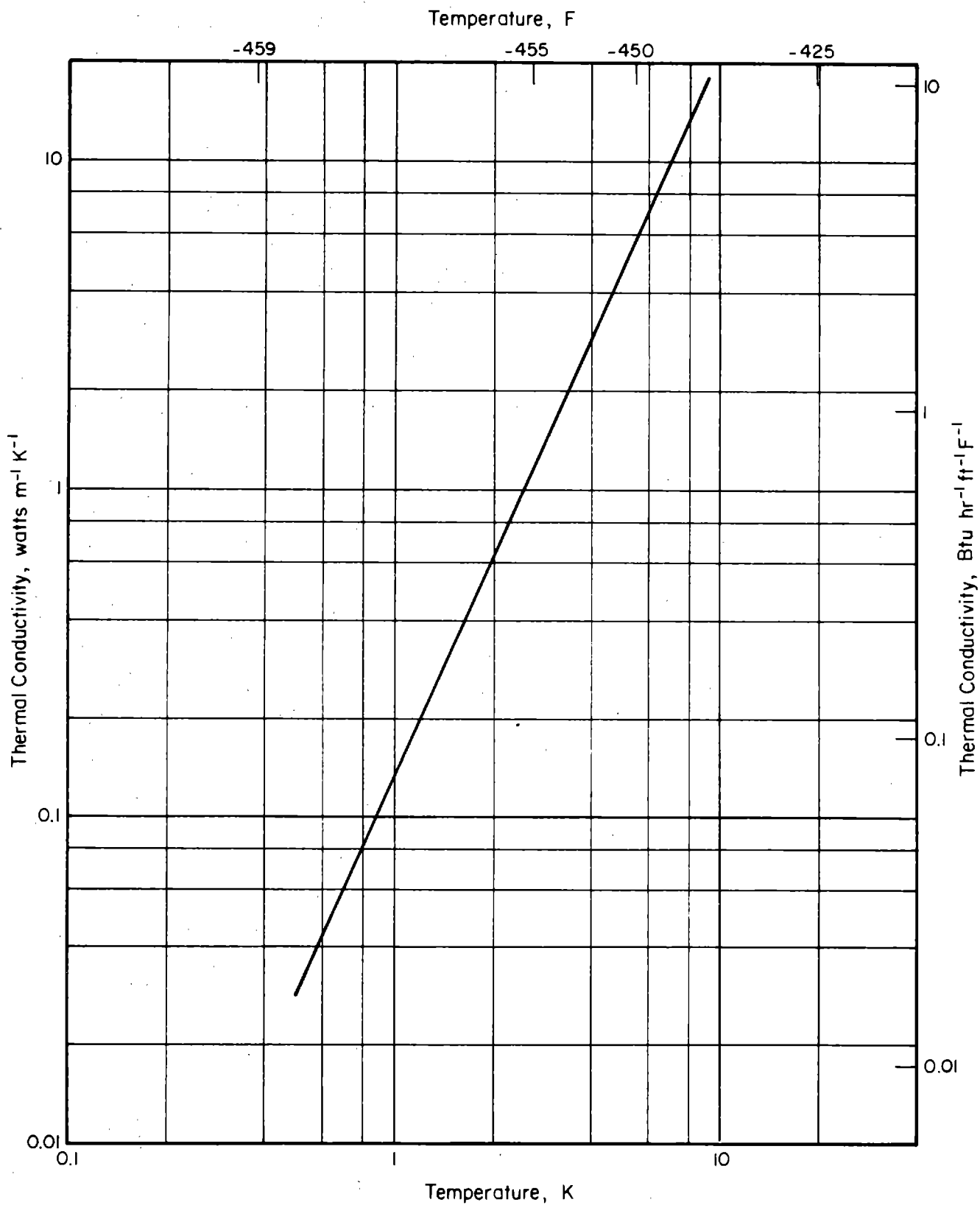


FIGURE 10.1.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR NIOBIUM - SUPERCONDUCTING STATE

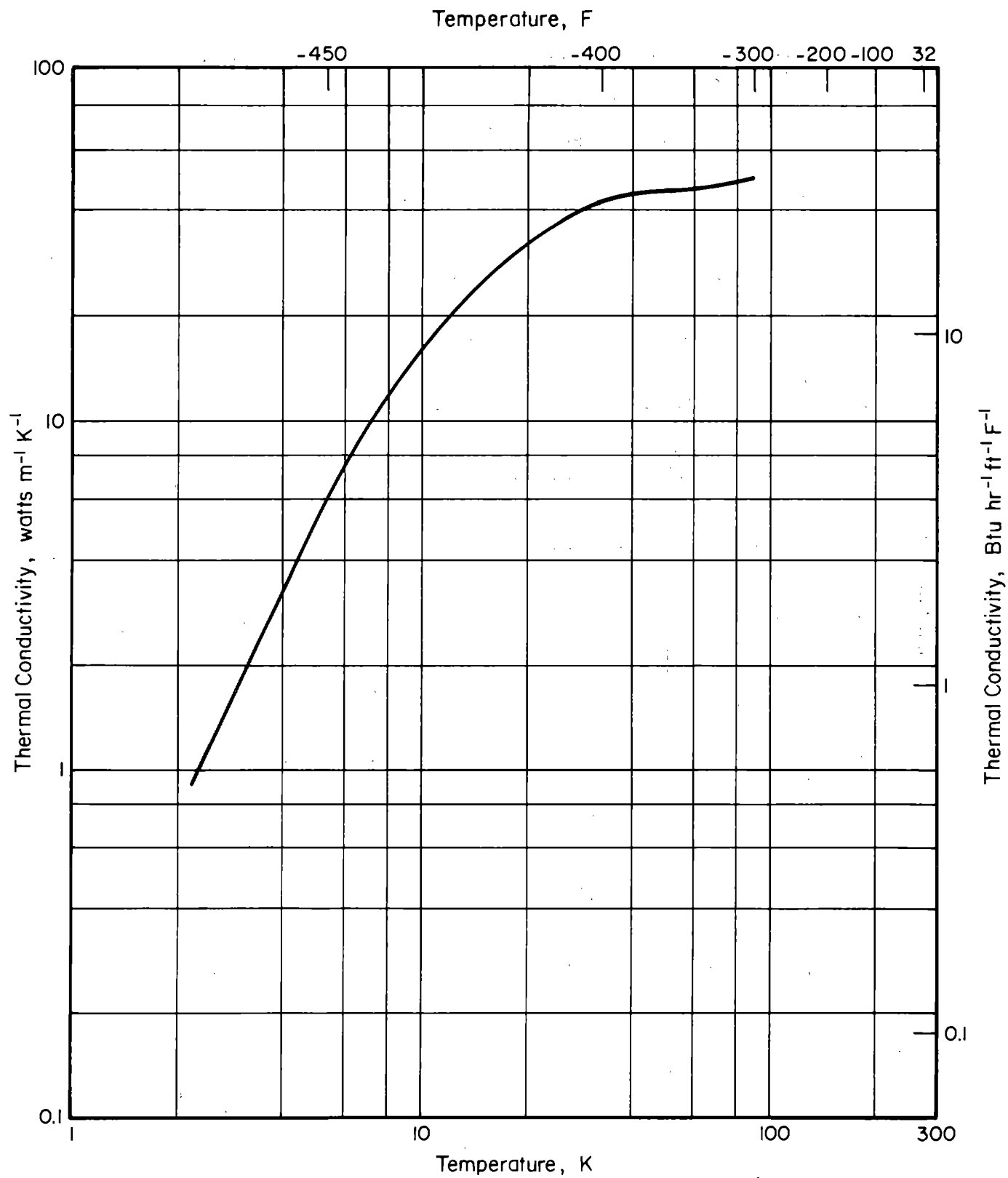


FIGURE 10.1.1-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR NIOBIUM – NORMAL STATE

10.1.1-4 (11/74)

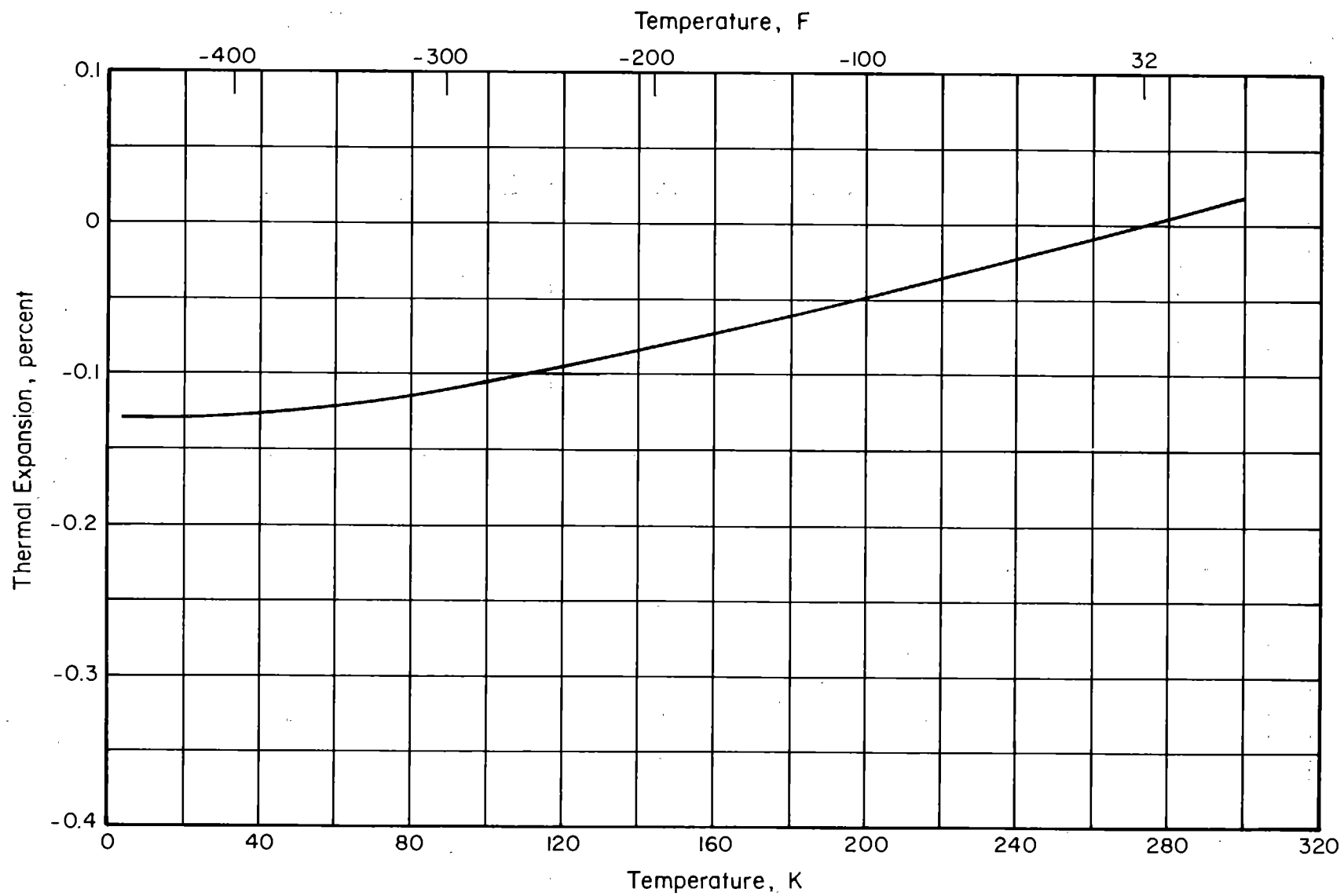


FIGURE 10.1.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR NIOBIUM

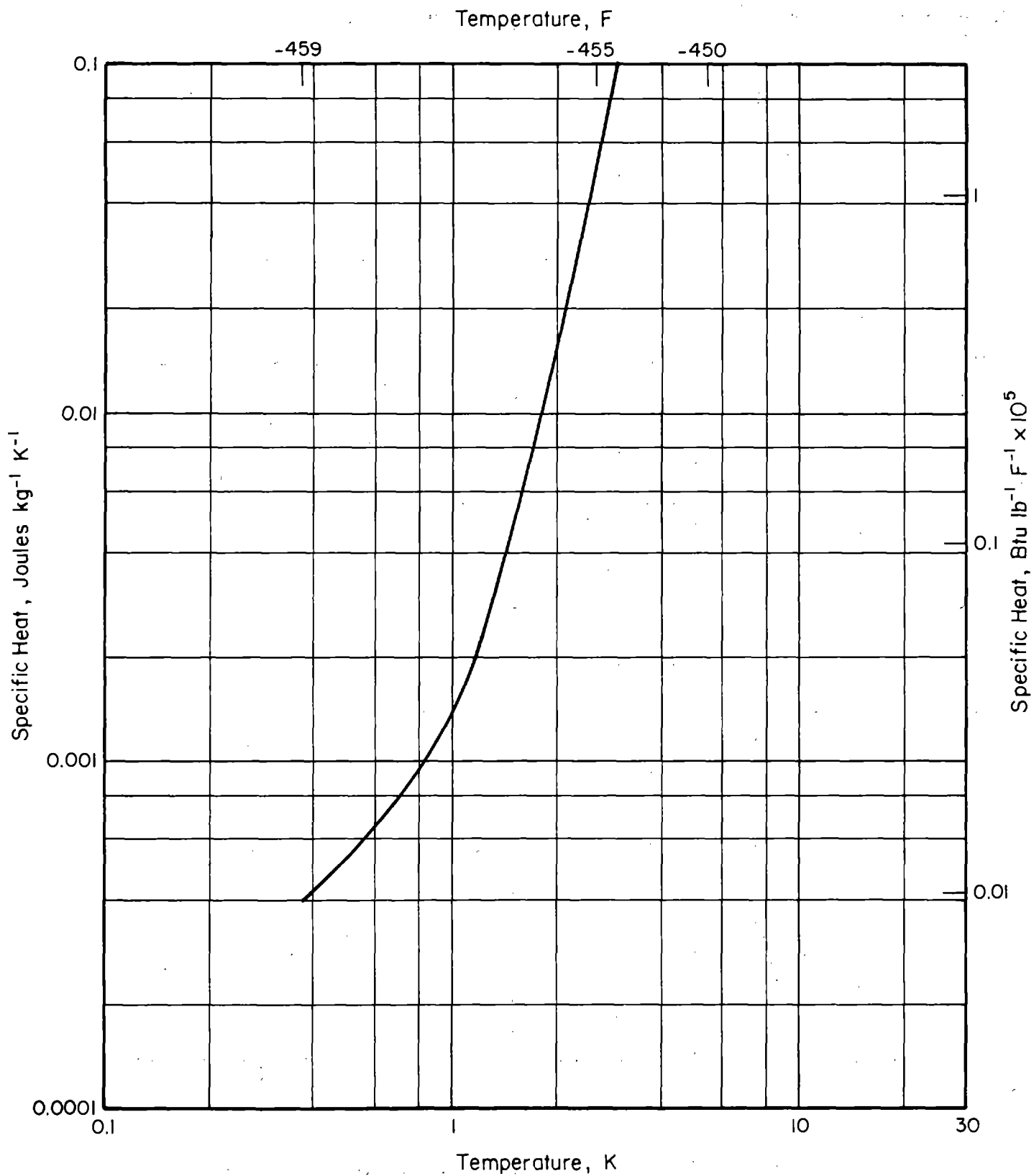


FIGURE 10.1.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE
FOR NIOBIUM - SUPERCONDUCTING
STATE

10.1.1-5 (11/74)

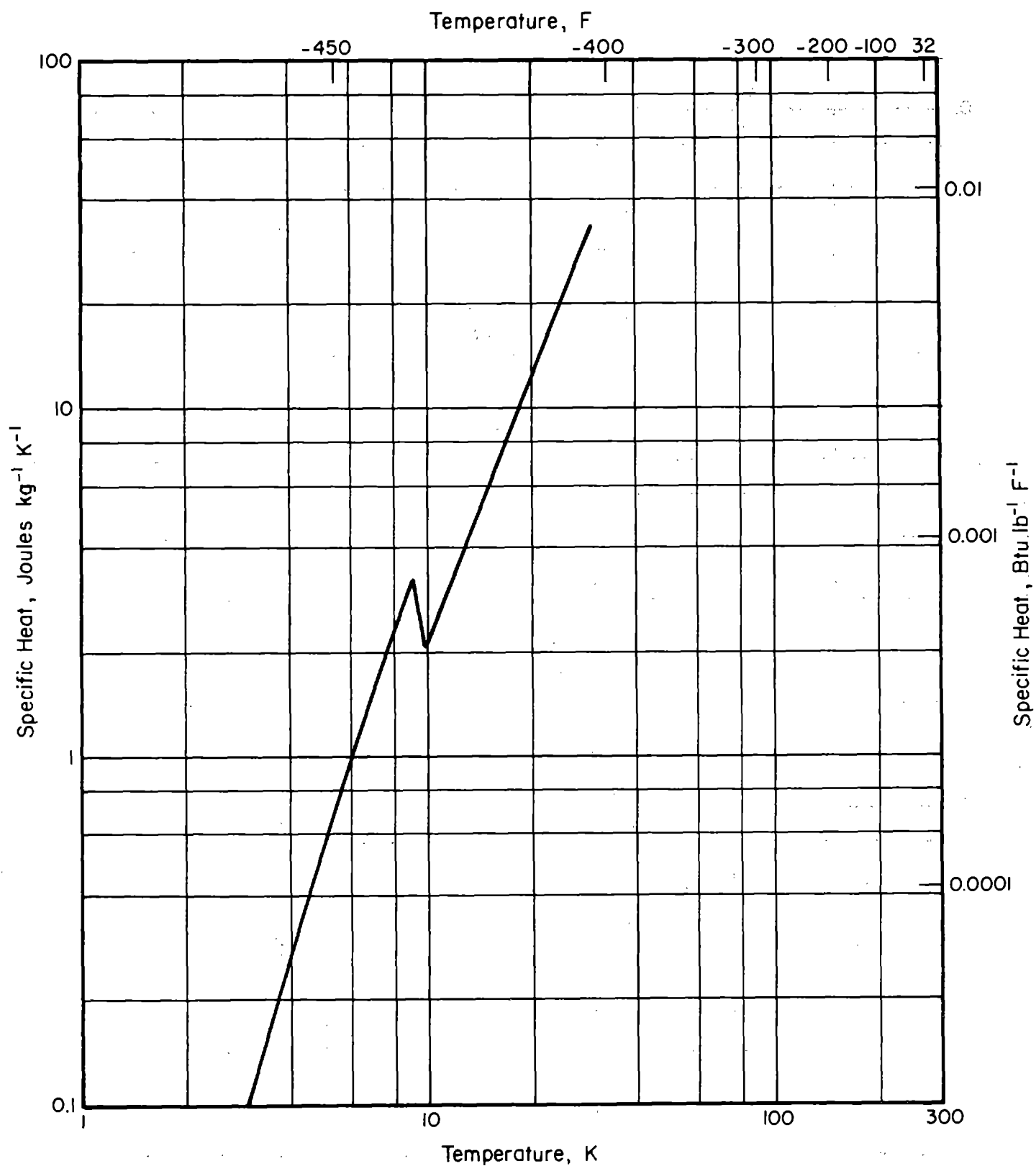


FIGURE 10.1.1-S2. SPECIFIC HEAT VERSUS TEMPERATURE FOR NIOBIUM - SUPERCONDUCTING STATE

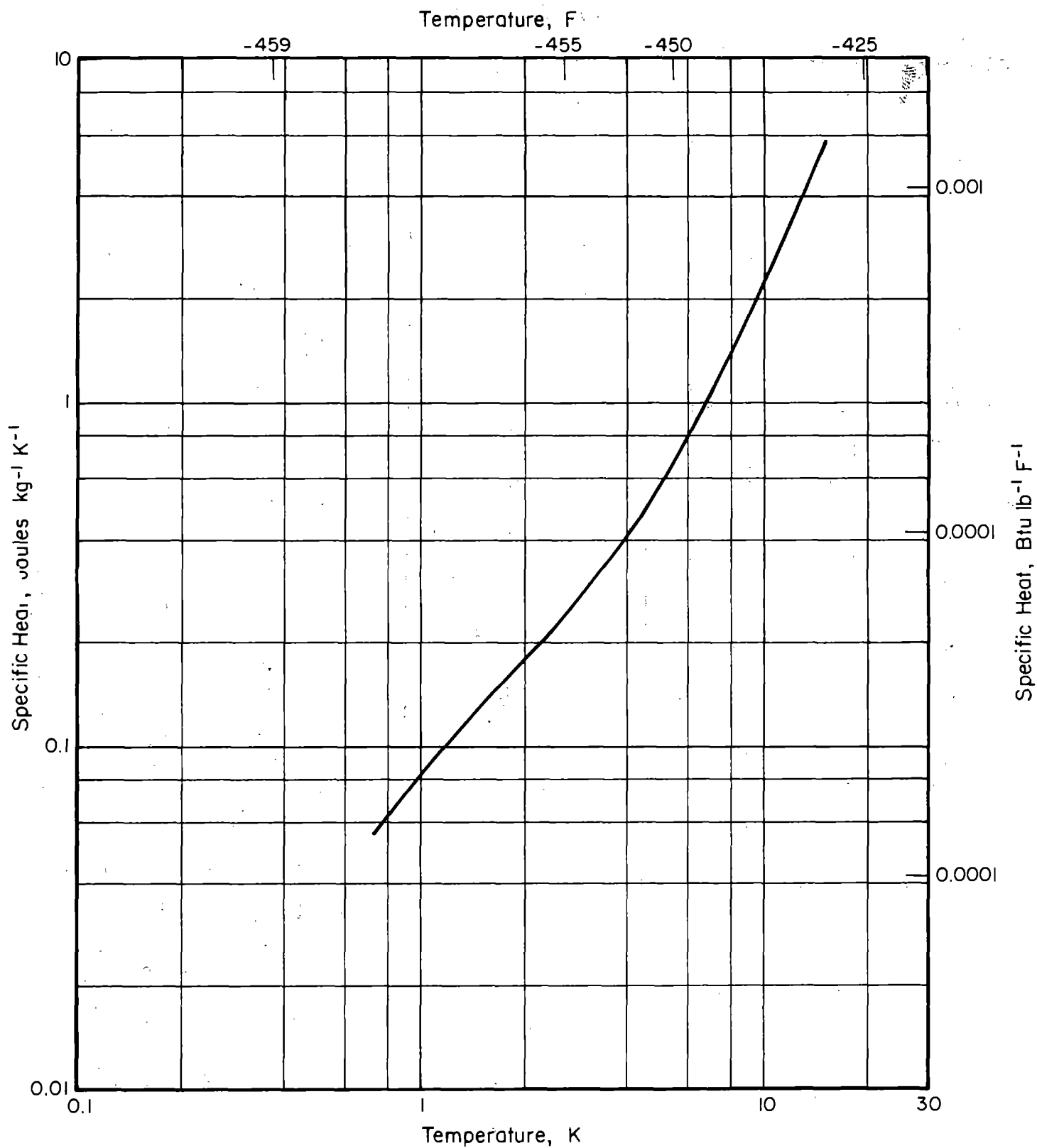


FIGURE 10.1.1-S3. SPECIFIC HEAT VERSUS TEMPERATURE
FOR NIOBIUM - NORMAL STATE

10.1.1-7 (11/74)

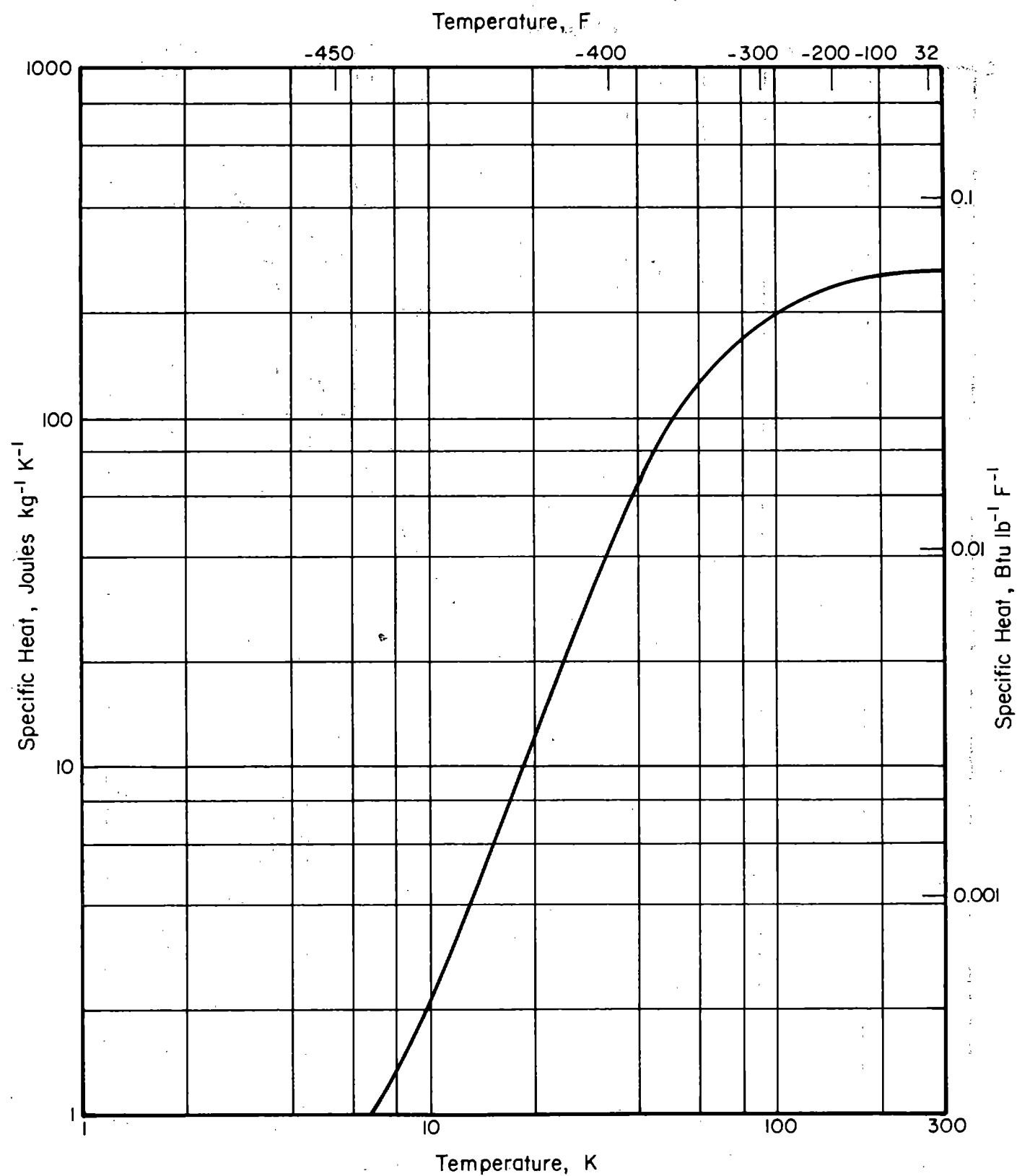


FIGURE 10.1.1-S4. SPECIFIC HEAT VERSUS TEMPERATURE
FOR NIOBIUM - NORMAL STATE

10.1.1-8 (11/74)

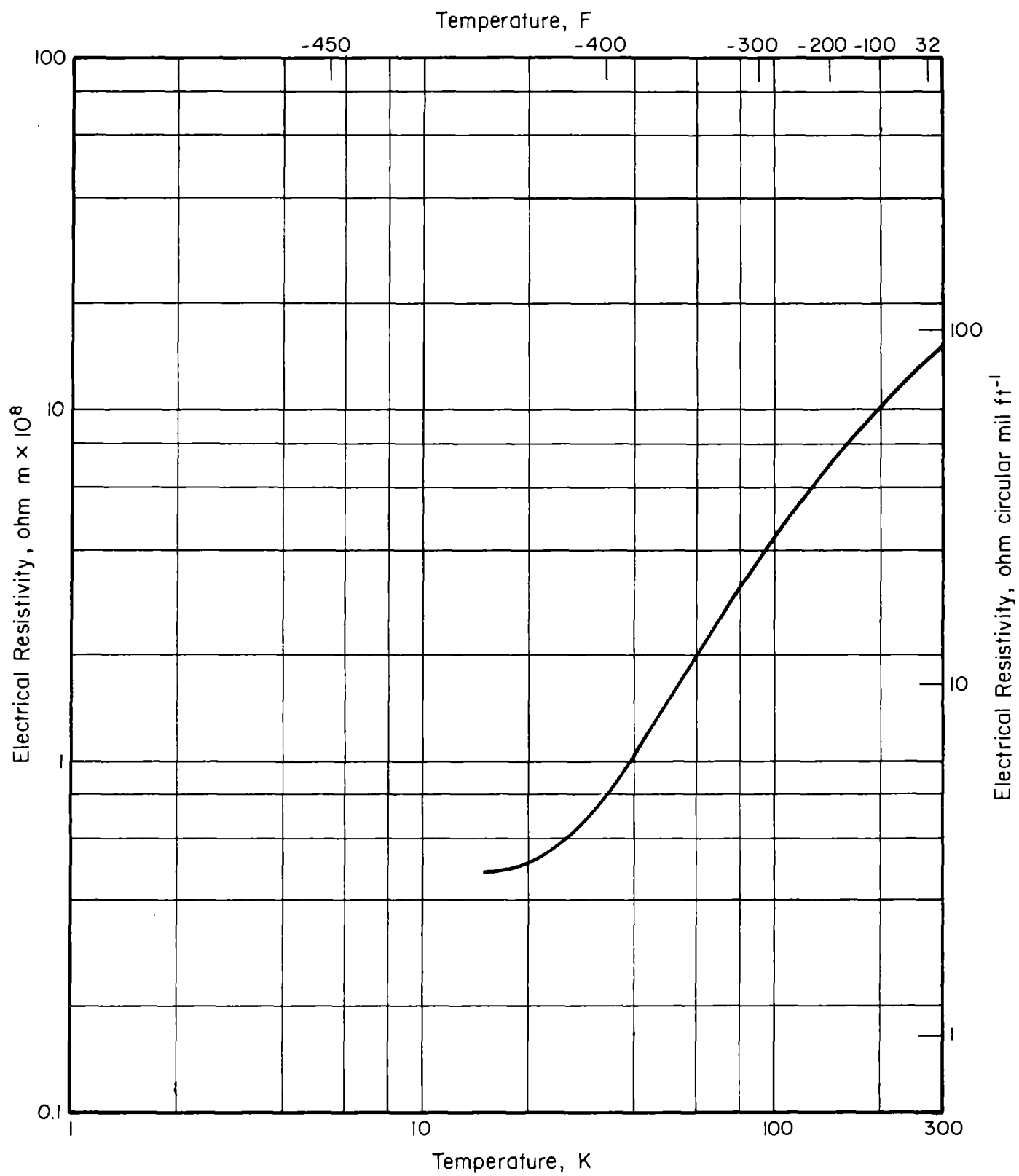


FIGURE 10.1.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR NIOBIUM - NORMAL STATE

TABLE 10.1.2-TR1

Alloy Designation: Nb₃Sn

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹			26.8	25.3	0.55(s) ^(a)	0.038(s)
Btu hr ⁻¹ ft ⁻¹ F ⁻¹			(15.5)	(14.6)	(0.318(s))	(0.022(s))
No. of Spec.			1	1	1	1
References: 90170						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

(a) s Superconducting state

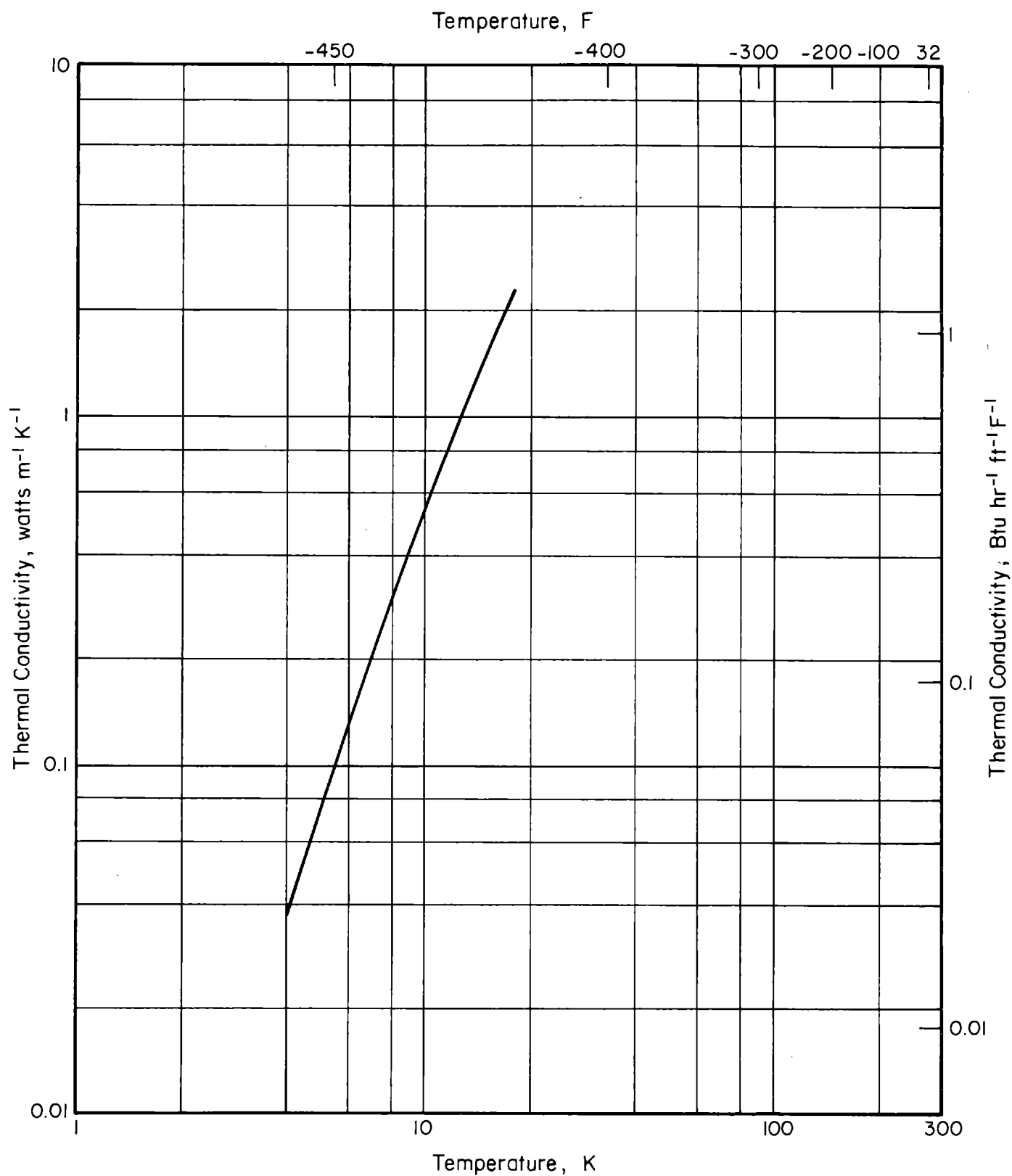


FIGURE 10.1.2-C1, THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Nb_3Sn - SUPERCONDUCTING STATE

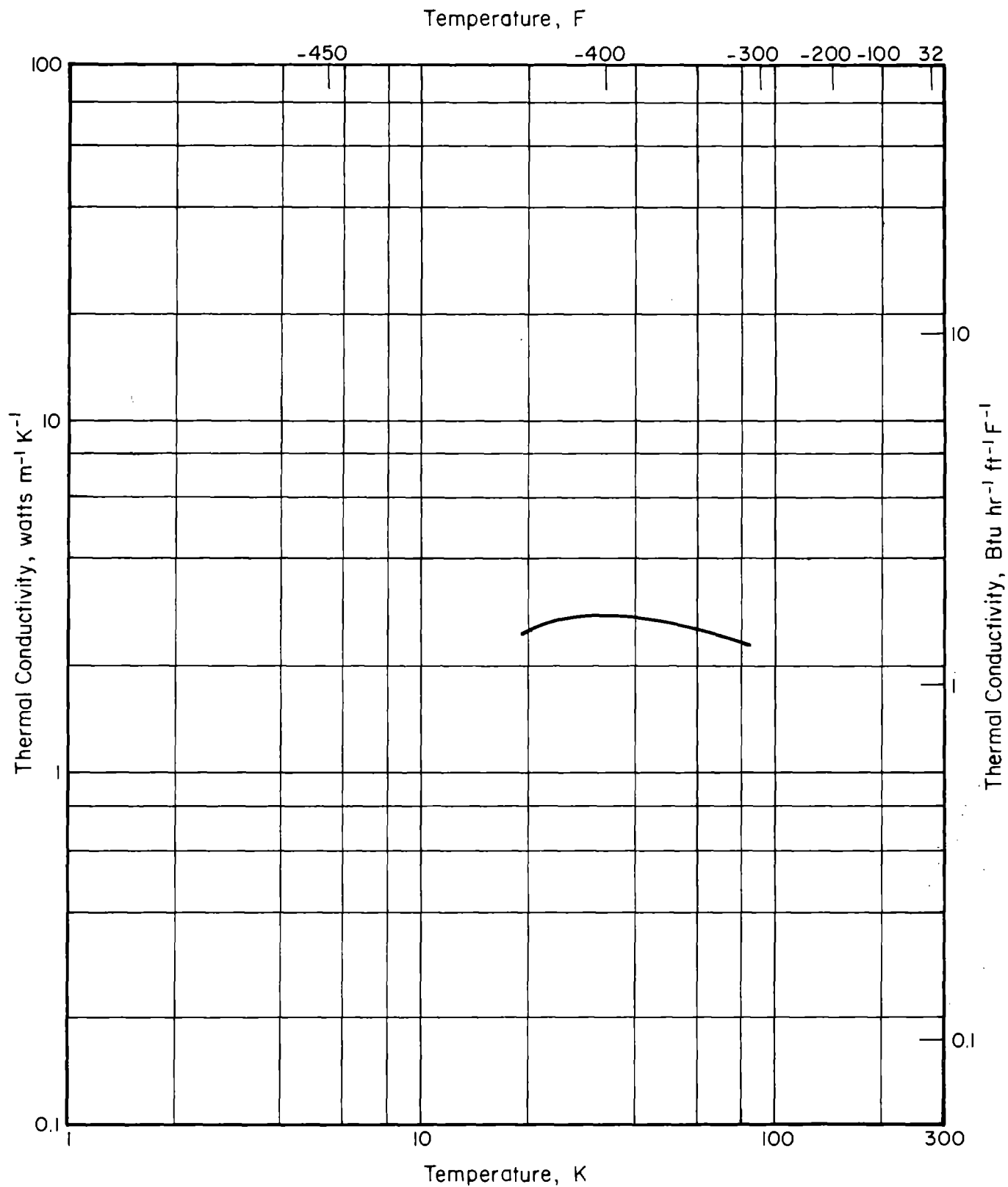
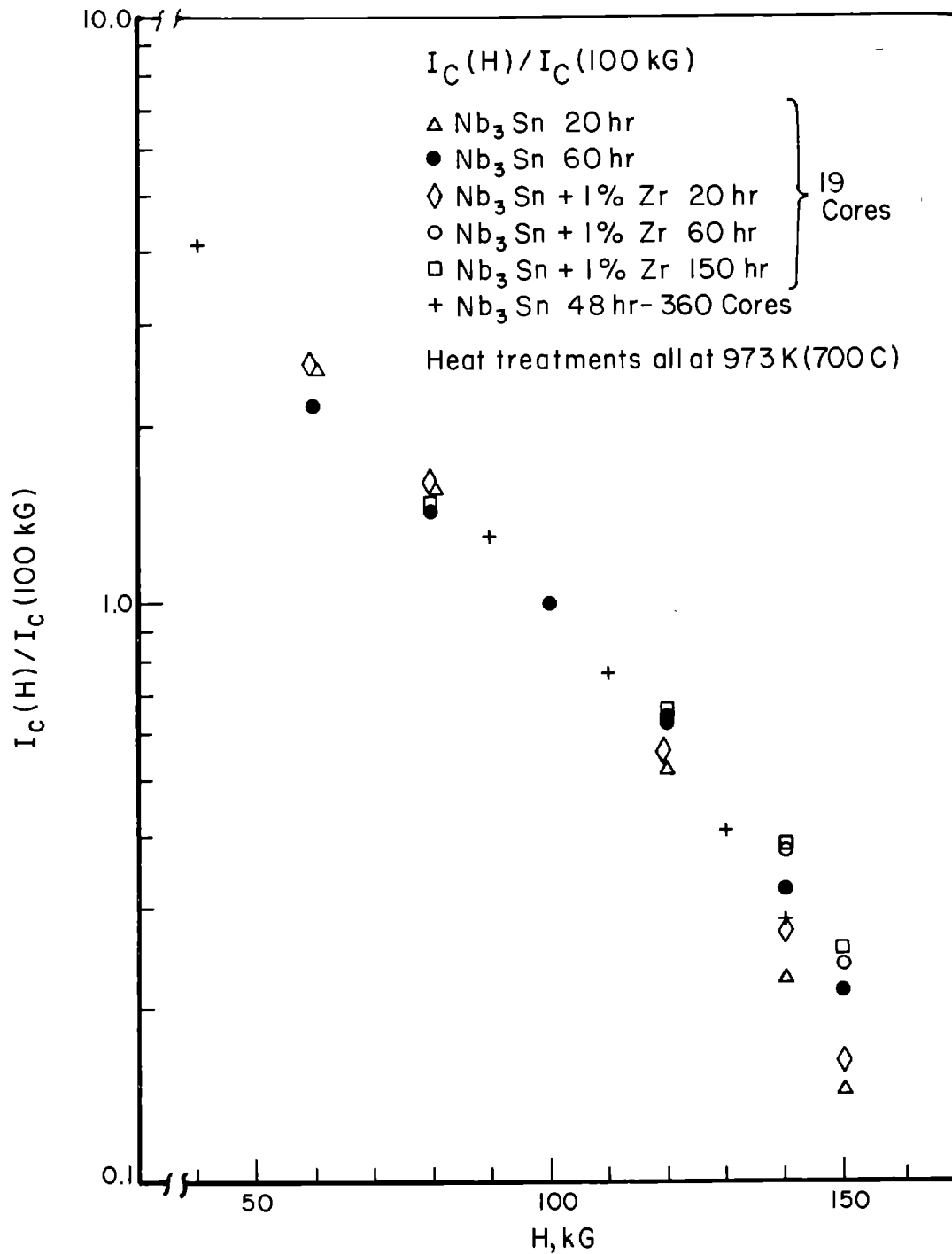


FIGURE 10.1.2-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Nb_3Sn - NORMAL STATE

TABLE 10.1.2-MA1 (Continued)



Critical current versus applied field at 4.2 K, normalized to the current at 100 kG for Nb₃Sn heat treated for various times (90512).

TABLE 10.1.3-TR1

Alloy Designation: Nb-0.2Zr Alloy

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
<u>Thermal Conductivity</u> Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec. References: 90341						18.0(n)(a) 4.2(s)(b) (10.4(n)) (2.43(s)) 1
<u>Thermal Expansion (T₂₇₃ to T)</u> <u>Longitudinal</u> Percent No. of Spec. References:						
<u>Specific Heat</u> Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec. References:						
<u>Electrical Resistivity</u> Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

(a) n Normal state

(b) s Superconducting state

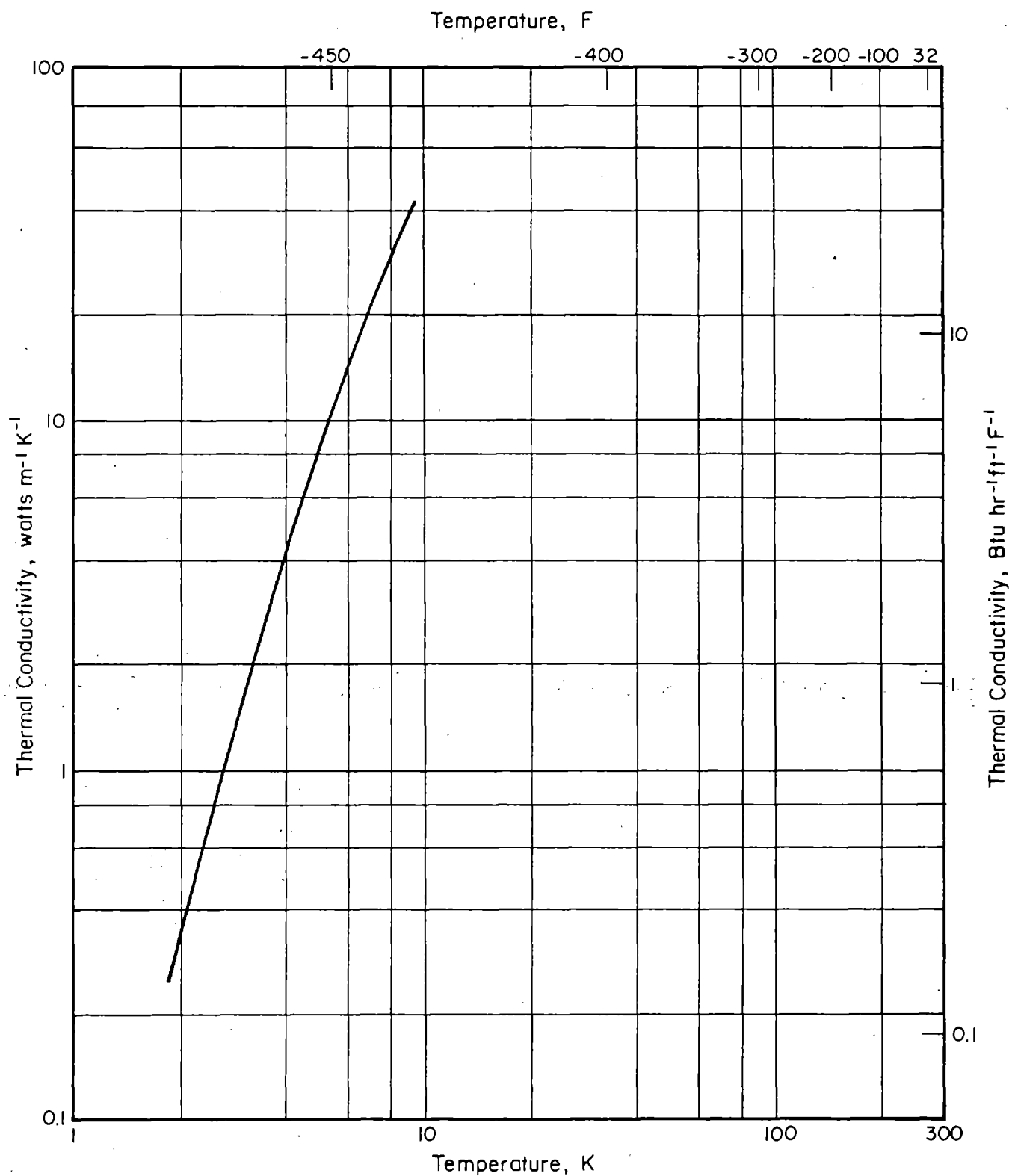


FIGURE 10.1.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Nb-0.2 Zr ALLOY - SUPERCONDUCTING STATE

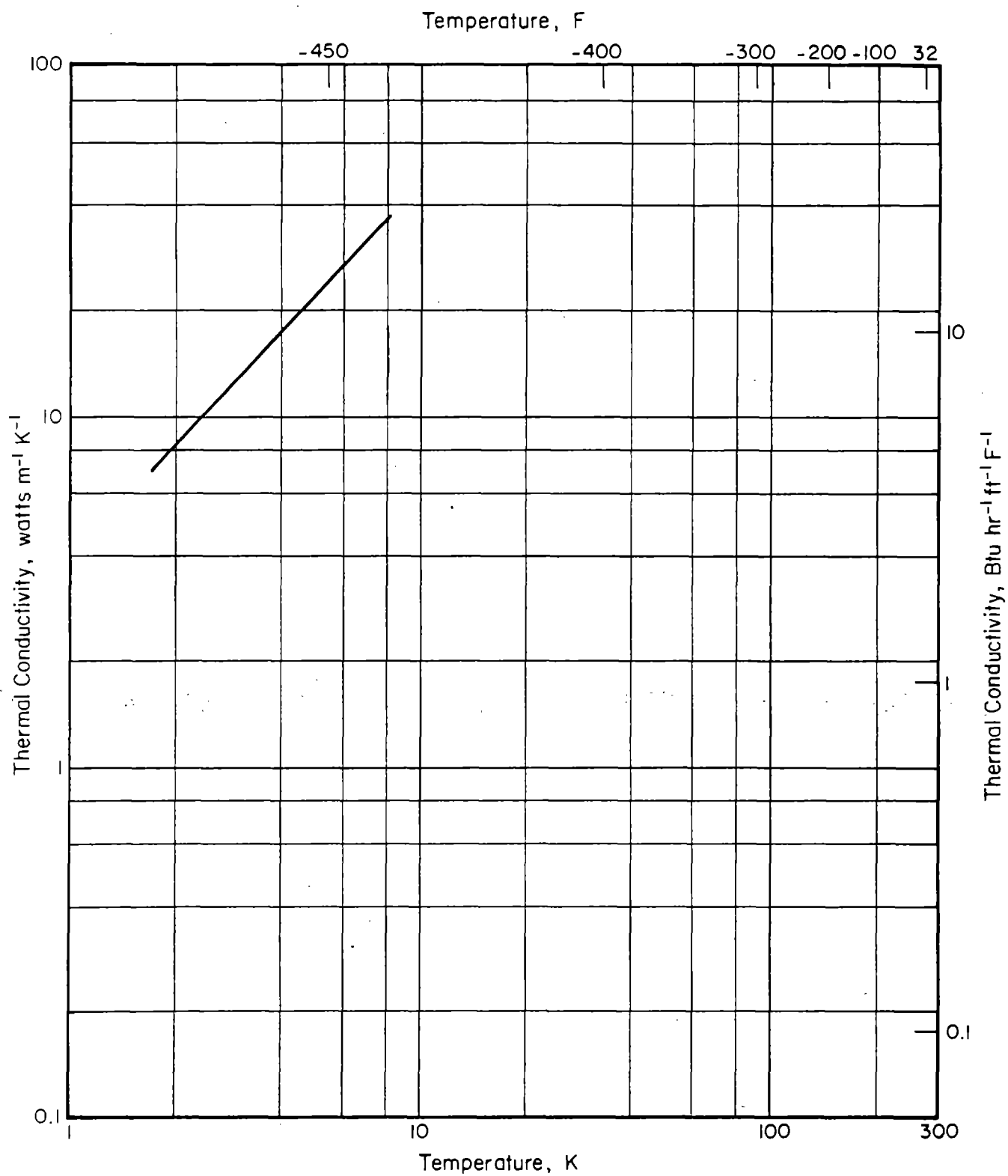


FIGURE 10.1.3-C2. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Nb-0.2 Zr ALLOY - NORMAL STATE

10.1.3-3 (11/76)

TABLE 10.1.3-TR2

Alloy Designation: Nb-2Zr Alloy

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						17.0(n)(a)
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						4.05(s)(b)
No. of Spec.						(9.83(n))
References: 90341						(2.34(s))
						1
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec.						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil-ft ⁻¹						
No. of Spec.						
References:						

(a) n Normal state

(b) s Superconducting state

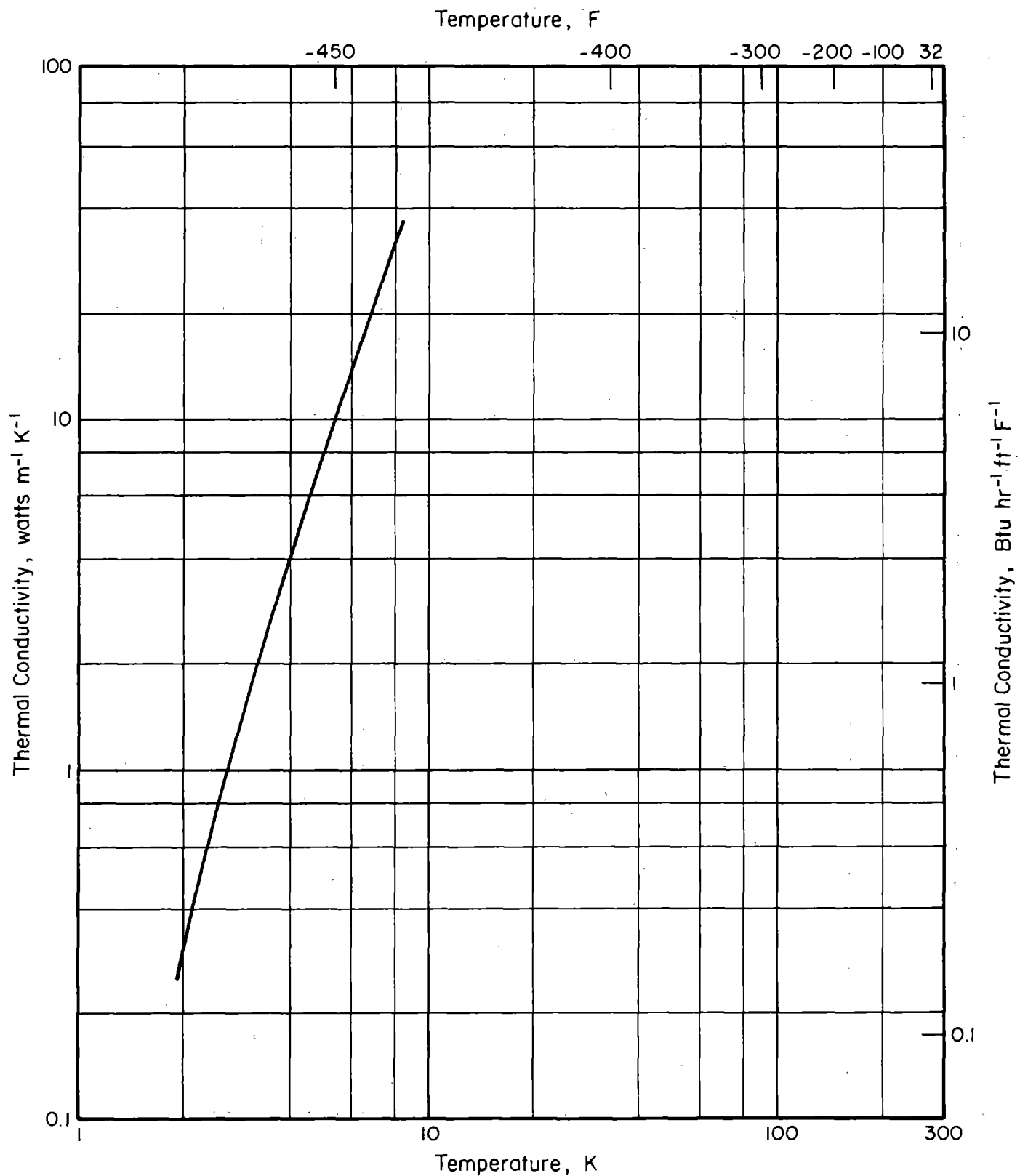


FIGURE 10.1.3-C3. THERMAL CONDUCTIVITY VERSUS TEMPERATURE
FOR Nb-2 Zr ALLOY - SUPERCONDUCTING STATE
10.1.3-5 (11/74)

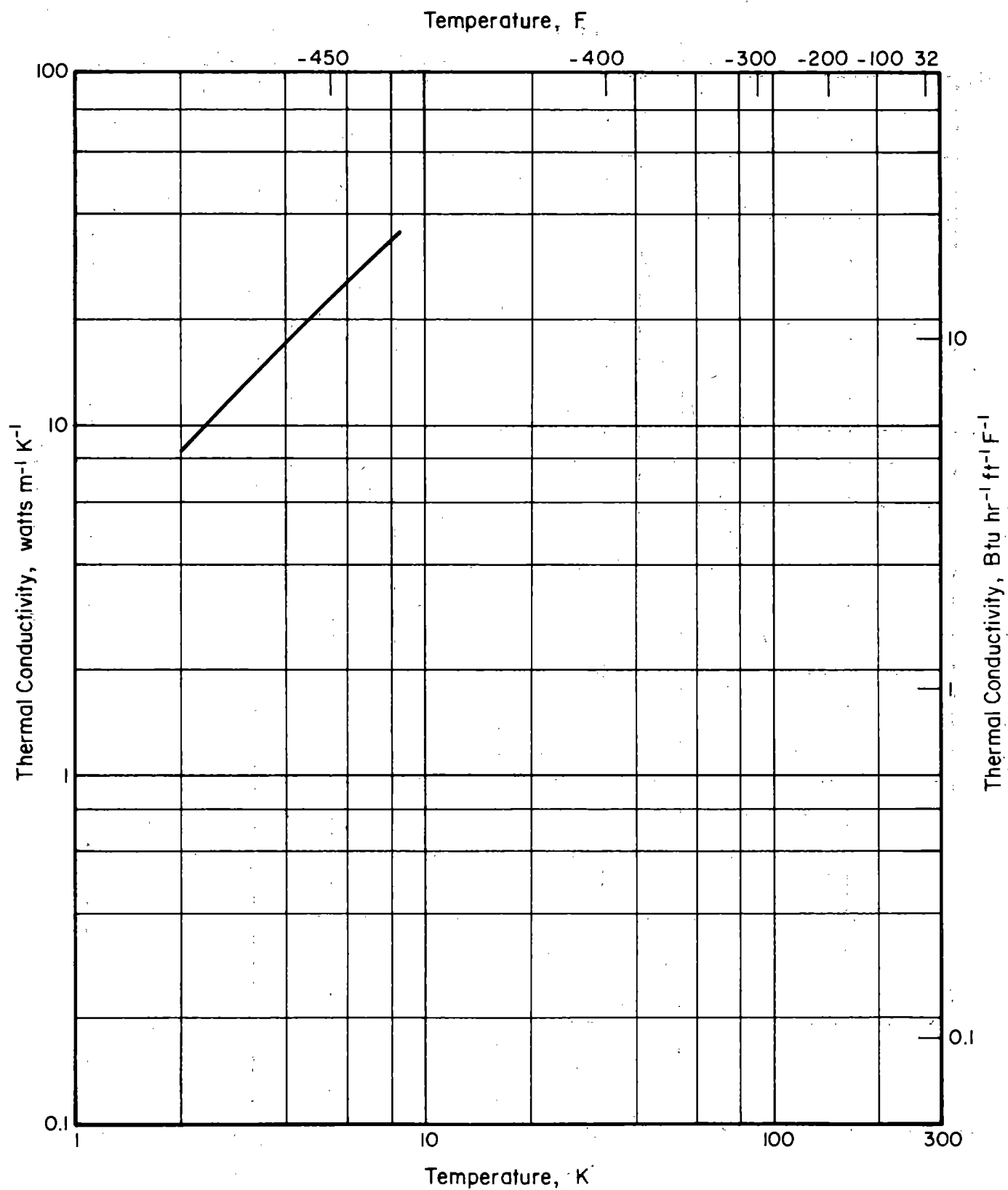


FIGURE 10.1.3-C4. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR Nb-2 Zr ALLOY - NORMAL STATE

10.1.3-6 (11/74)

TABLE 10.1.4-ME1

Alloy Designation: Ti-7Nb Alloy

Specification:

Form: Forged Bar

Size: 1.4 x 1.4 cm (0.55 x 0.55 in.)

Condition: Annealed 875 to 975 K (1110 to 1290 F)

Testing Temperature, K (F)	297 (75)		77 (-320)		4 (-452)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 586 (85)		1040 (151)		1230 (178)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 510 (74)		930 (135)		1100 (159)	
	Min					
Std. Deviation						
Elong, percent	Avg 18		16		6	
	Min					
RA, percent	Avg 72		72		46	
	Min					
No. of Spec. (No. of Heats)	5 (1)		5 (1)		5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 1230 (178)		1960 (284)		2210 (320)	
	Min					
K _t = 5.3						
No. of Spec. (No. of Heats)	5 (1)		5 (1)		5 (1)	
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						

TABLE 10.1.4-ME2

Alloy Designation: Ti-11Nb Alloy

Specification:

Form: Forged Bar

Size: 1.4 x 1.4 cm (0.55 x 0.55 in.)

Condition: Annealed 875 to 975 K (1110 to 1290 F)

Testing Temperature, K (F)	297 (75)		77 (-320)		4 (-452)	
Tension, Longitudinal						
TUS, MN/m ² (ksi)	Avg 690 (100)		1300 (188)		1430 (207)	
	Min					
Std. Deviation						
TYS, MN/m ² (ksi)	Avg 630 (91)		1230 (178)		1370 (199)	
	Min					
Std. Deviation						
Elong, percent	Avg 14		6		6	
	Min					
RA, percent	Avg 42		50		36	
	Min					
No. of Spec. (No. of Heats)	5 (1)		5 (1)		5 (1)	
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
No. of Spec. (No. of Heats)						
Poisson's Ratio						
Work Hardening Coef						
NTS, MN/m ² (ksi)	Avg 1300 (188)		2140 (310)		2020 (293)	
	Min					
K _t = 5.3						
No. of Spec. (No. of Heats)	5 (1)		5 (1)		5 (1)	
NTS, MN/m ² (ksi)	Avg					
	Min					
K _t =						
No. of Spec. (No. of Heats)						
References: 90133						

TABLE 10.1.4-ME3

Alloy Designation: Nb-Ti-Zr Alloys (Ti:Zr Ratio 9:1)

Specification:

Form:

Thickness, cm (in.):

Condition:

Composition:		50 wt.% Nb				44 wt.% Nb				27 wt.% Nb			
Testing Temperature, K (F)		297	(75)	77	(-320)	297	(75)	77	(-320)	297	(75)	77	(-320)
Tension, Longitudinal													
TUS, MN/m ² (ksi)	Avg	930	(135)	1880	(273)	834	(121)	1760	(256)	807	(117)	1510	(219)
	Min												
Std Deviation													
TYS, MN/m ² (ksi)	Avg			1880	(273)			1760	(256)			1280	(185)
	Min												
Std Deviation													
Elong, percent	Avg	12		0		15		1		21		2.5	
	Min												
RA, percent	Avg	36		—		48		4		55		9	
	Min												
No. of Spec. (No. of Heats)		(1)		(1)		(1)		(1)		(1)		(1)	
E, GN/m ² (10 ⁶ psi)	Avg												
	Min												
No. of Spec. (No. of Heats)													
Poisson's Ratio													
Work Hardening Coef													
NTS, MN/m ² (ksi)	Avg												
K _t =	Min												
No. of Spec. (No. of Heats)													
NTS, MN/m ² (ksi)	Avg												
K _t =	Min												
No. of Spec. (No. of Heats)													

TABLE 10.1.4-ME4

Composition		15 wt.% Nb				8 wt.% Nb					
Testing Temperature, K (F)		297	(75)	77	(-320)	297	(75)	77	(-320)		
Tension, Longitudinal											
TUS, MN/m ² (ksi)	Avg	882	(128)	1470	(213)	910	(132)	1450	(210)		
	Min										
Std. Deviation											
TYS, MN/m ² (ksi)	Avg			1370	(199)			1350	(196)		
	Min										
Std. Deviation											
Elong, percent	Avg	17		4		15		5.5			
	Min										
RA, percent	Avg	40		10		50		18			
	Min										
No. of Spec. (No. of Heats)		(1)		(1)		(1)		(1)			
E, GN/m ² (10 ⁶ psi)	Avg										
	Min										
No. of Spec. (No. of Heats)											
Poisson's Ratio											
Work Hardening Coef											
NTS, MN/m ² (ksi)	Avg										
K _t =	Min										
No. of Spec. (No. of Heats)											
NTS, MN/m ² (ksi)	Avg										
K _t =	Min										
No. of Spec. (No. of Heats)											

References: 90306

TABLE 10.1.4-ME5

Alloy Designation: Nb-35Ti (+Zr) Wire (65BT)

Specification:

Form: Wire

Thickness, cm (in.):

Condition:

Testing Temperature, K (F)		297 (75)		77 (-320)	20 (-423)		
Tension, Longitudinal							
TUS, MN/m ² (ksi)	Avg	793 (115)		1370 (199)	1880 (273)		
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
Elong, percent	Avg						
	Min						
RA, percent	Avg						
	Min						
No. of Spec. (No. of Heats)							
E, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec. (No. of Heats)							
Poisson's Ratio							
Work Hardening Coef							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Spec. (No. of Heats)							
References: 90310							

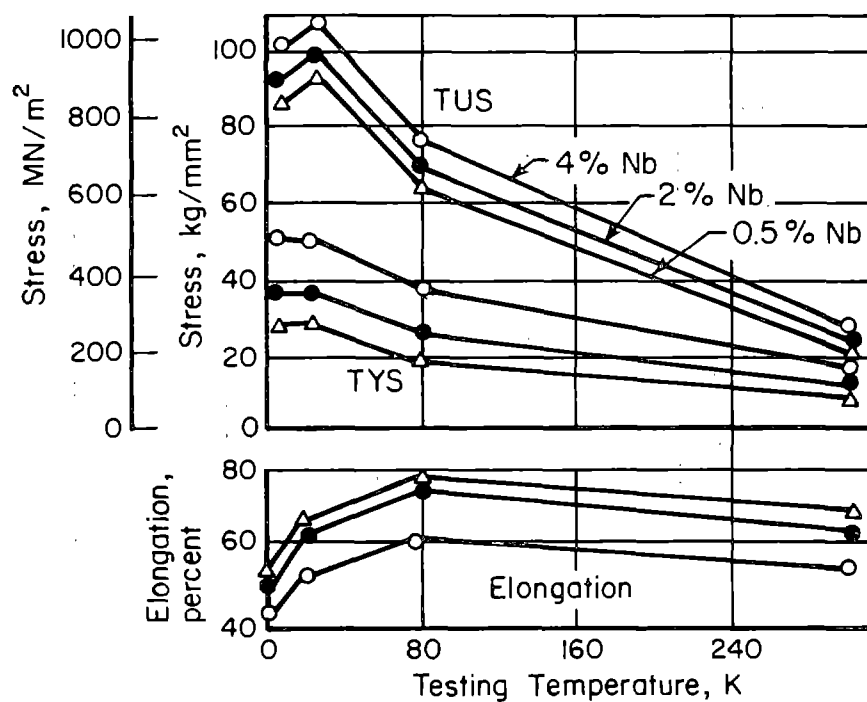


FIGURE 10.1.4-ME1. TENSILE PROPERTIES OF Ti-Nb ALLOYS UP TO 4 PERCENT Nb IN THE RANGE 293 TO 4 K (79385)

TABLE 10.1.4-TR1

Alloy Designation: Ti-9Nb

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.122	-0.146	-0.154	-0.155	
No. of Spec.	1	1	1	1	1	
References: '90202						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

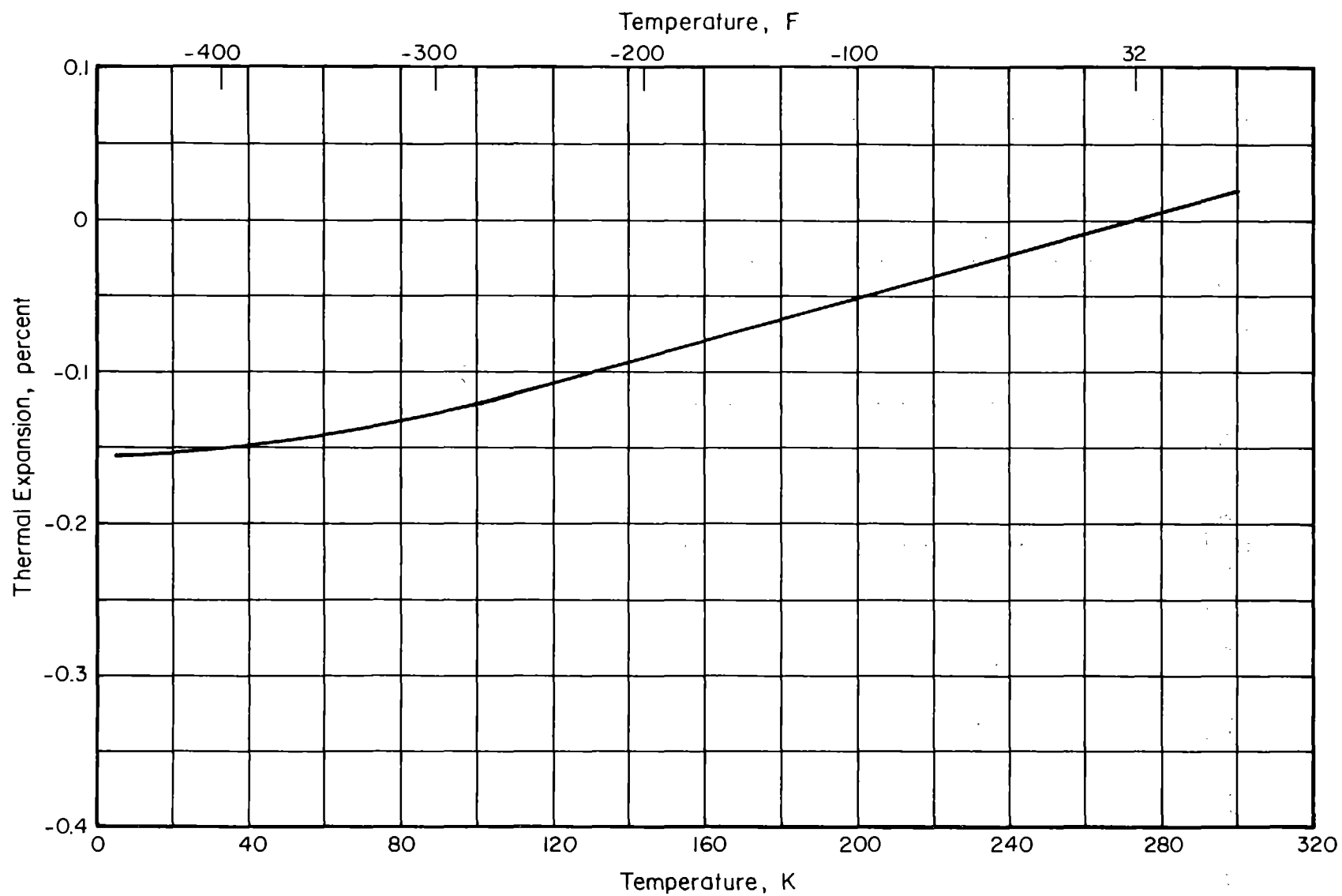


FIGURE 10.1.4-E1. THERMAL EXPANSION VERSUS TEMPERATURE
FOR Ti-9Nb ALLOY

TABLE 10.1.4-TR2

Alloy Designation: Ti-18Nb

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec. References:						
Thermal Expansion (T₂₇₃ to T) <u>Longitudinal</u> Percent No. of Spec. References: 90202	0 1	-0.113 1	-0.134 1	-0.141 1	-0.142 1	
Specific Heat Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec. References:						
Electrical Resistivity Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

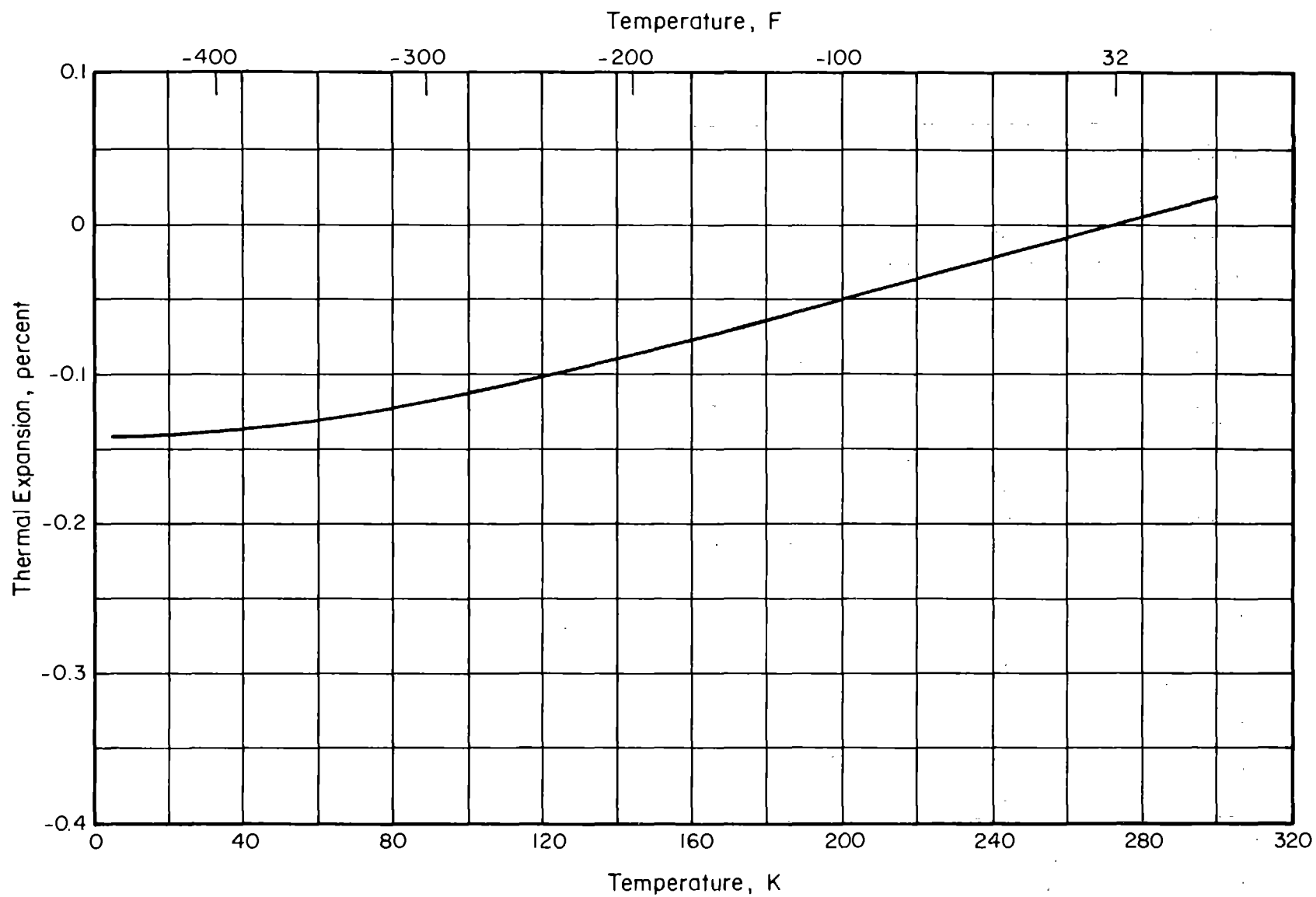


FIGURE 10.1.4-E2. THERMAL EXPANSION VERSUS TEMPERATURE
FOR Ti-18Nb ALLOY

TABLE 10.1.4-TR3

Alloy Designation: Ti-26Nb

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec. References:						
Thermal Expansion (T₂₇₃ to T) Longitudinal Percent No. of Spec. References: 90202	0 1	-0.105 1	-0.128 1	-0.134 1	-0.134 1	
Specific Heat Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec. References:						
Electrical Resistivity Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

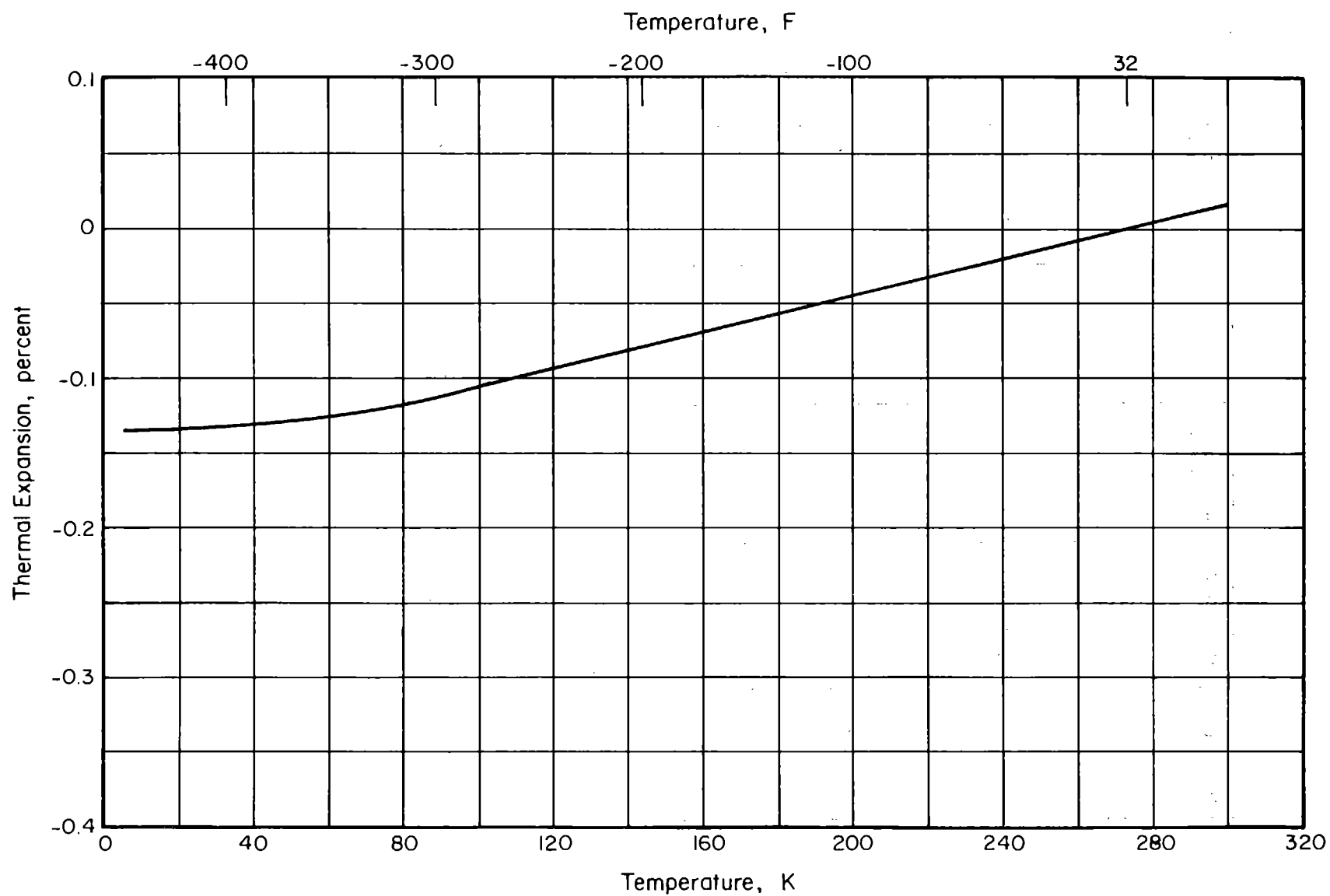


FIGURE 10.1.4-E3. THERMAL EXPANSION VERSUS TEMPERATURE
FOR Ti-26Nb ALLOY

TABLE 10.1.4-TR4

Alloy Designation: Ti-33Nb

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.093	-0.113	-0.118	-0.119	
No. of Spec.	1	1	1	1	1	
References: 90202						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

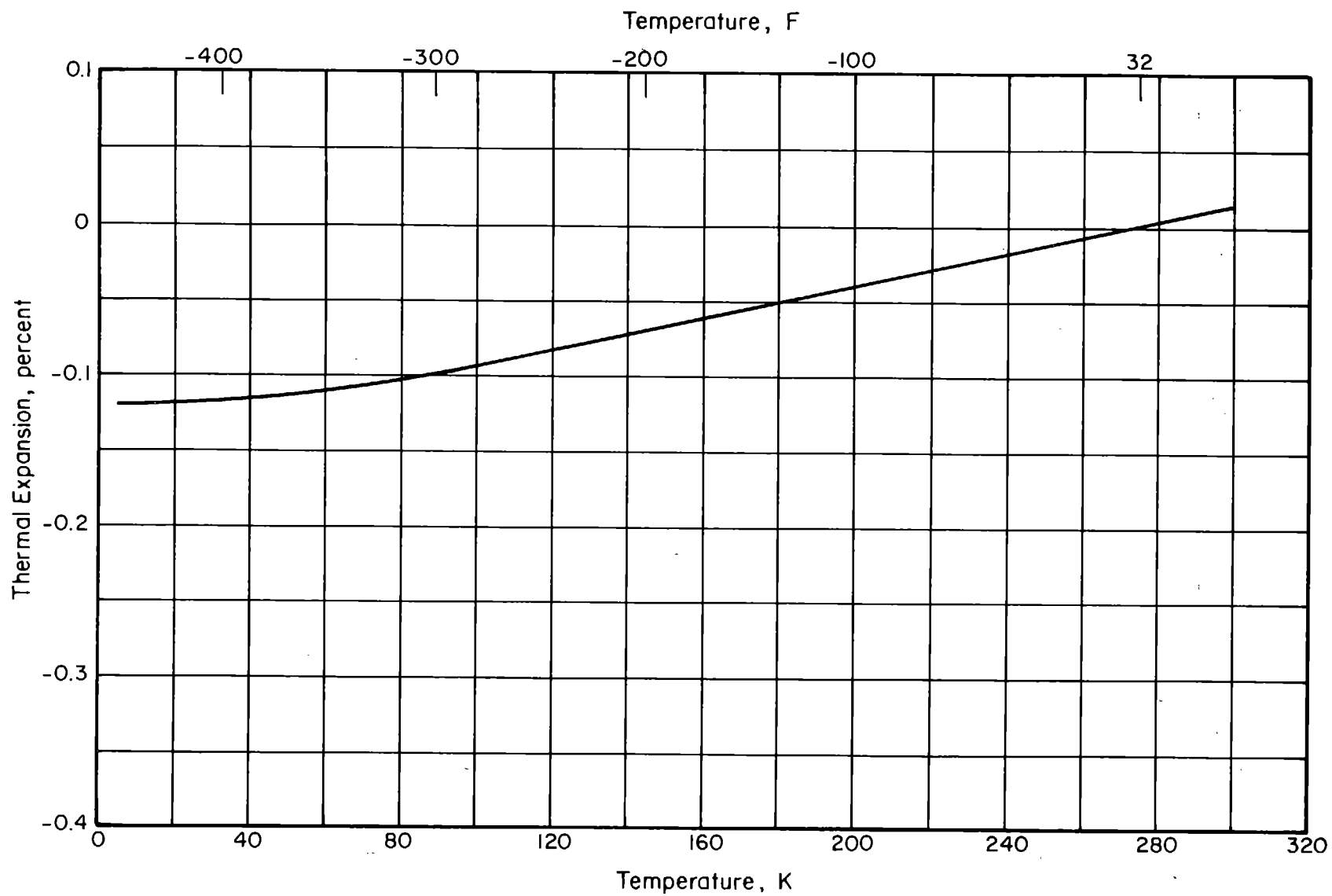


FIGURE 10.1.4-E4. THERMAL EXPANSION VERSUS TEMPERATURE
FOR Ti-33Nb ALLOY

TABLE 10.1.4-TR5

Alloy Designation: Nb-45Ti

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec						
References:						
Thermal Expansion (T₂₇₃ to T)						
<u>Longitudinal</u>						
Percent	0	-0.137	-0.163	-0.168	-0.169	-0.169
No. of Spec.	1	1	1	1	1	1
References: 95168						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec						
References:						

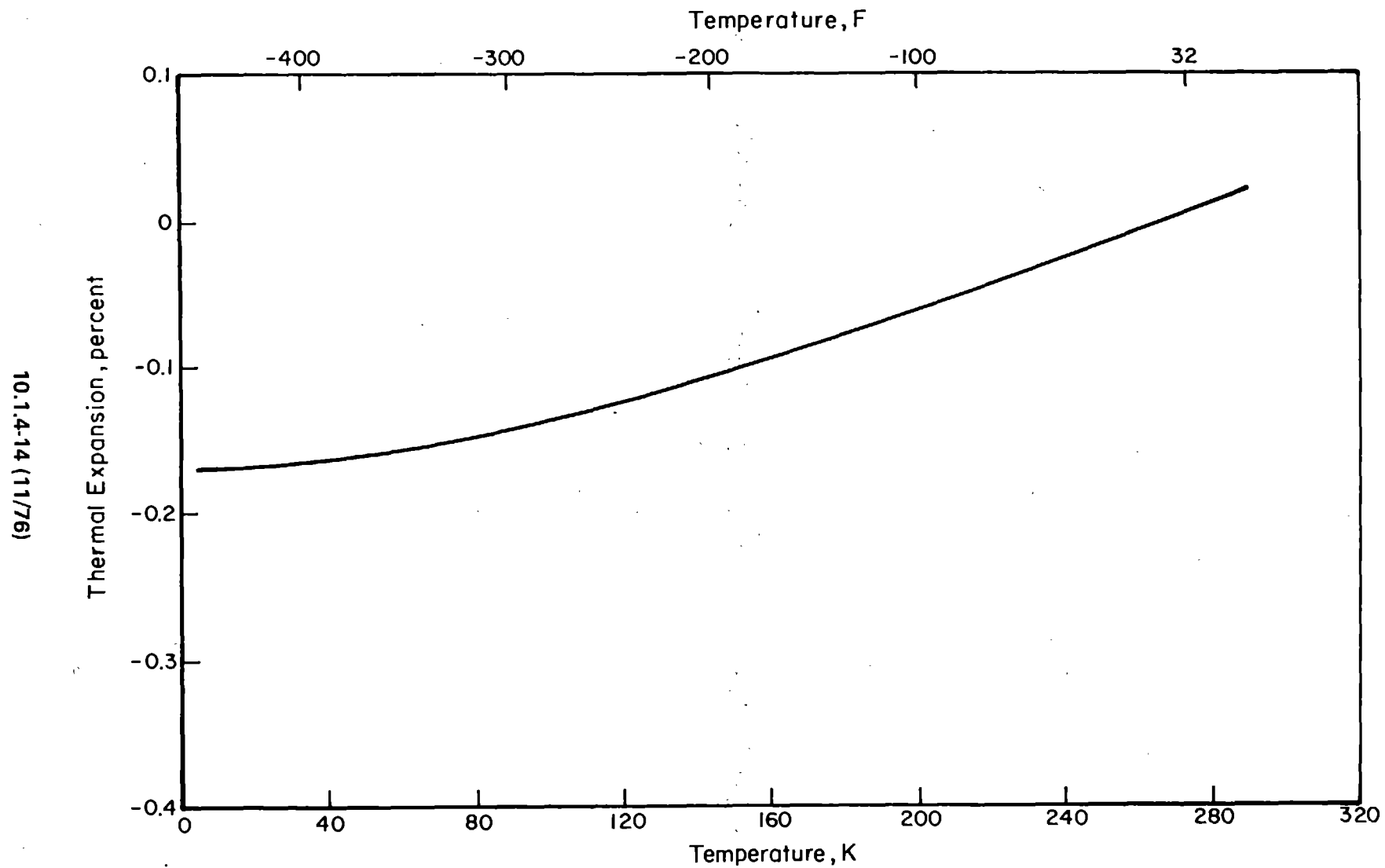


FIGURE 10.1.4-E5. THERMAL EXPANSION VERSUS TEMPERATURE FOR Nb-45Ti ALLOY

TABLE 10.1.4-TR6

Alloy Designation: Nb-48Ti.

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.140	-0.163	-0.171	-0.172	-0.174
No. of Spec	1	1	1	1	1	1
References: 95168						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec						
References:						

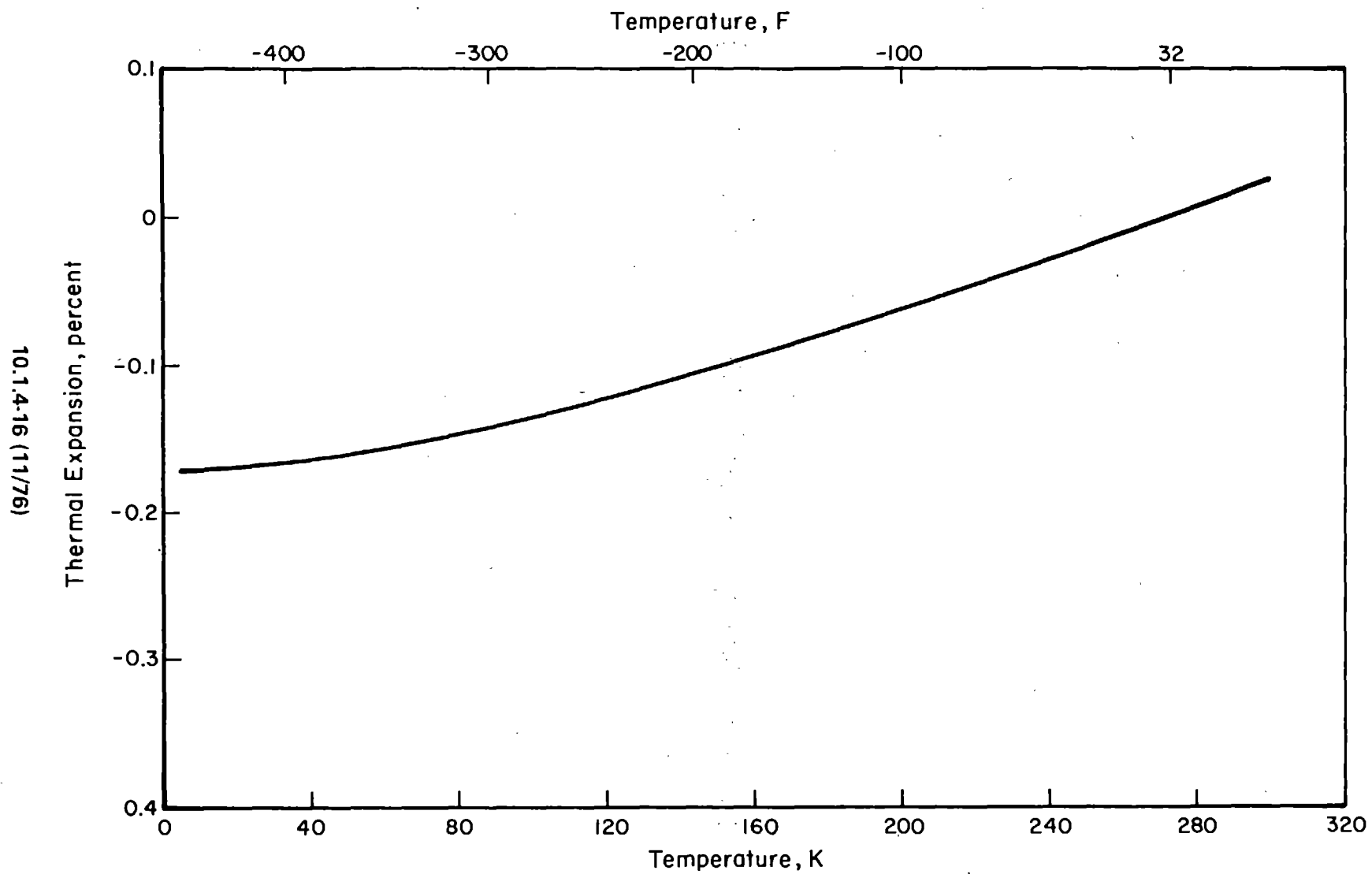


FIGURE 10.1.4-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR Nb-48Ti ALLOY

TABLE 10.1.4-MA5

Alloy Designation: Nb-64 at. % Ti

Specification:

Form: Copper-clad wire

Diameter, cm (in.): See graph captions (various)

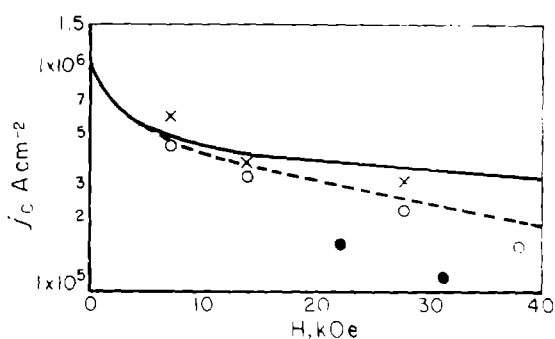
Condition: Cold drawn; some samples were annealed as indicated

Testing Temperature: 4.2 K

Comparison of the critical current densities j_c determined by different methods (samples with different heat treatment) (90517)

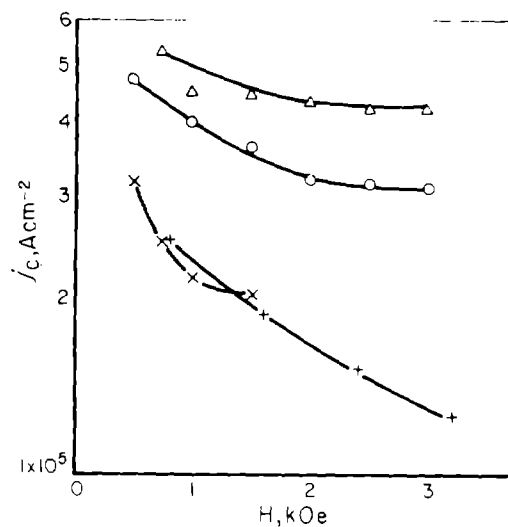
Sample	$j_c, 10^5 \text{ A cm}^{-2}$											
	H = 13.76 kOe				H = 27.6 kOe				H = 36.0 kOe			
	I	II	III	IV	I	II	III	IV	I	II	III	IV
1	4.88	4.88	7.42	—	3.46	3.38	3.28	—	2.91	2.96	—	1.40
2	4.75	4.80	—	—	3.39	3.25	—	1.54	2.83	2.43	—	1.16
3	4.52	3.84	—	—	3.20	2.52	—	1.57	2.72	1.69	—	1.11
4	4.50	4.03	—	—	3.19	3.13	—	1.58	2.67	2.90	—	1.20
5	3.68	3.33	3.83	—	2.61	2.35	3.20	1.34	2.19	1.57	—	1.05
6	1.37	1.57	1.20	—	0.97	1.33	0.96	0.26	0.81	1.13	—	0.24

- I $j_{c,c}$ from relations (1) and (2)
 II $j_{c,c}$ from magnetization according to relation (3)
 III $j_{c,c}$ from differential magnetization loops
 IV transport current density $j_{c,a}$



Comparison of critical current densities determined by different methods [Sample 5 of above tabulation, without intermediate annealing, final annealing 1 h - 673 K (400 C) diameter 0.11 mm] (90517)

- $j_{c,c}$ { — full line according to relation (1)
 - - - dashed line according to relations (1) and (2)
 ○ from magnetization according to relation (3)
 × from differential magnetization loops
 $j_{c,a}$ ● measured transport current density



Comparison of critical current densities determined by different methods (sample without heat treatment, diameter 0.19 mm) (90517)

- $j_{c,c}$ { Δ from the losses in a longitudinal magnetic field
 ○ calculated according to relation (1)
 × from the losses in a transversal magnetic field
 $j_{c,a}$ { + measured transport current density

TABLE 10.1.4-MA5 (Continued)

Relations (1), (2), and (3)

$$(1) \quad j_c = \frac{10}{4\pi} \frac{\alpha}{2H^1 - \gamma}$$

(j_c in A cm⁻², H in G)

$$(2) \quad \left(1 - \frac{1}{H_{C2}}\right) \text{ used as a factor in Relation (1)}$$

$$(3) \quad j_{c,c} = \frac{10}{4\pi} \frac{3}{R} (-4\pi \overline{M}_{irr}) + \frac{1}{4} R \frac{dj_{c,c}}{dr} - \dots$$

($\overline{M}_{irr}$, irreversible portion of magnetization in G)

TABLE 10.1.4-MA6

Alloy Designation: Ti-30 at. % Nb

Specification:

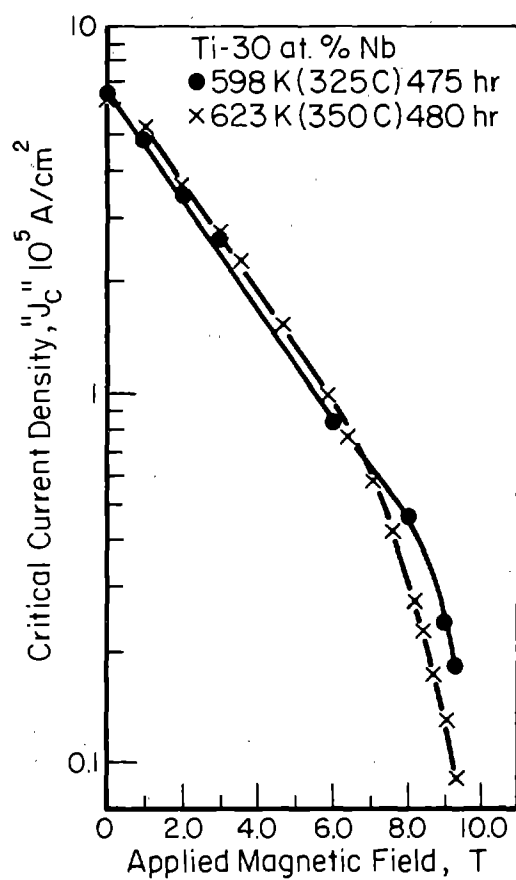
Form: Copper coated wire

Diameter, cm (in.): 0.038 (0.015)

Condition: Cold drawn and heat treated in vacuum as indicated

Testing temperature: 4.2 K

Critical temperature: 7.2 K



Plot of J_c versus H_a for a very ductile and easily fabricated higher temperature alloy of this series (90525).

TABLE 10.1.4-MA7

Alloy Designation: Ti-25.5 at. % Nb

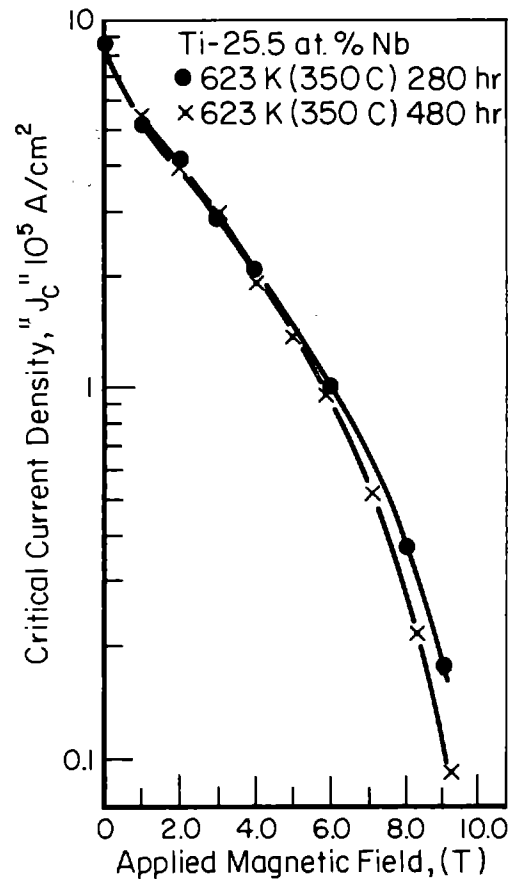
Specification:

Form: Copper coated wire

Diameter, cm (in.): 0.038 (0.015)

Condition: Cold drawn and heat treated in vacuum as indicated

Testing temperature: 4.2 K



Plot of J_c versus H_a shows that low-field data are not always indicative of high field performance even though the same alloy and PHT temperature (90525).

TABLE 10.1.4-MA8

Alloy Designation: Ti-25.2 at. % Nb

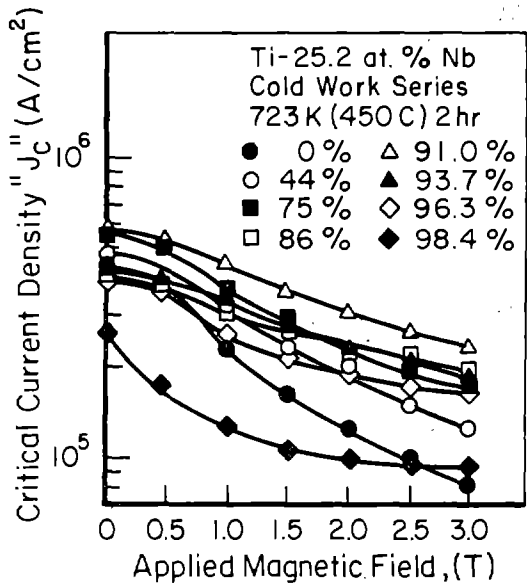
Specification:

Form: Copper coated wire

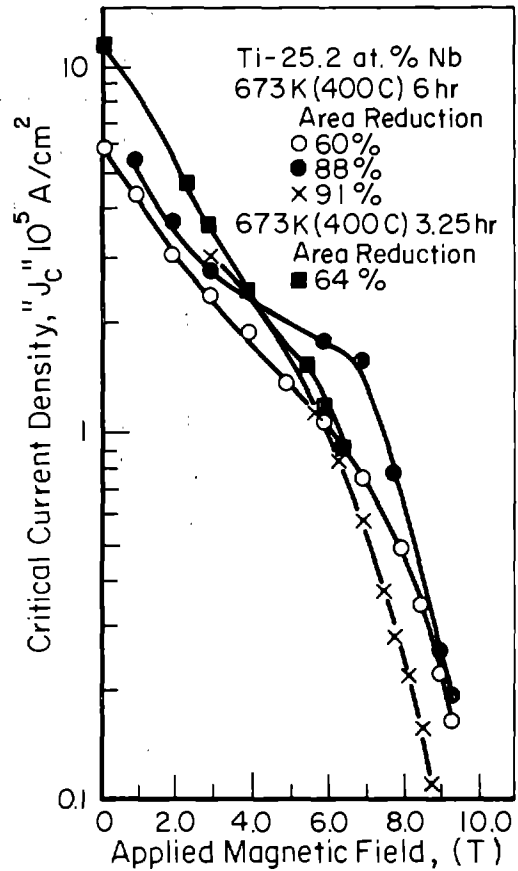
Diameter, cm (in.): 0.038 (0.015)

Condition: Cold drawn and heat treated in vacuum as indicated

Testing temperature: 4.2 K



Plot of critical current versus applied magnetic field for Ti-25.2 at. % Nb given a PHT of 723 K (450 C) for 2h and then drawn to 0.38 mm in diameter and then measured. Each curve represents a different percent of cold area reduction (90525).



Graph of J_c versus H_a shows some of the highest values obtained in this study and the region that they apply (90525).

TABLE 10.1.4-MA9

Alloy Designation: Ti-22.5 at. % Nb

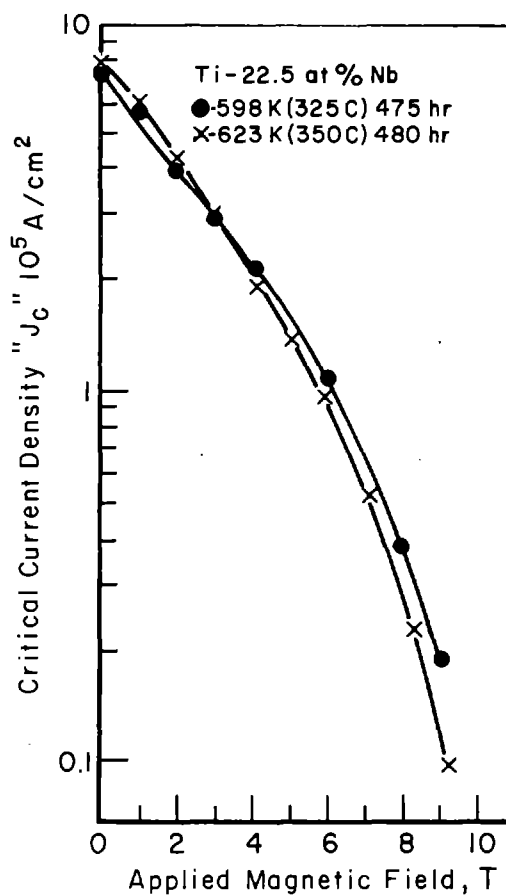
Specification:

Form: Copper coated wire

Diameter, cm (in.): 0.038 (0.015)

Condition: Cold drawn and heat treated in vacuum as indicated

Testing temperature: 4.2 K



Plot of J_c versus H_a shows that low-field data are not always indicative of high field performance even in a particular alloy (90525).

*T = tesla (1 tesla = 10 kilooersteds).

TABLE 10.2.1-TR1

Alloy Designation: **V₃Ga**

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-0.140	-0.162	-0.168	-0.169	-0.169
No. of Spec.	1	1	1	1	1	1
References: 96878						
Specific Heat						
Joules kg ⁻¹ K ⁻¹					5.813(n)	1.914(n)
Btu lb ⁻¹ F ⁻¹				18.96	7.22 (s)	0.196(s)
No. of Spec.				(4.529 x 10 ⁻³)	[1.389 x 10 ⁻³ (n)]	[4.57 x 10 ⁻⁴ (n)]
References: 96876				1	[1.73 x 10 ⁻³ (s)]	[4.68 x 10 ⁻⁵ (s)]
					1	1
Electrical Resistivity						
Ohm m	185 x 10 ⁻⁸	149 x 10 ⁻⁸	139 x 10 ⁻⁸	132 x 10 ⁻⁸	129 x 10 ⁻⁸	127 x 10 ⁻⁸
Ohm circular mil ft ⁻¹	(1110)	(896)	(836)	(794)	(776)	(764)
No. of Spec.	1	1	1	1	1	1
References: 96879						
(n) Normal State						
(s) Superconducting State						

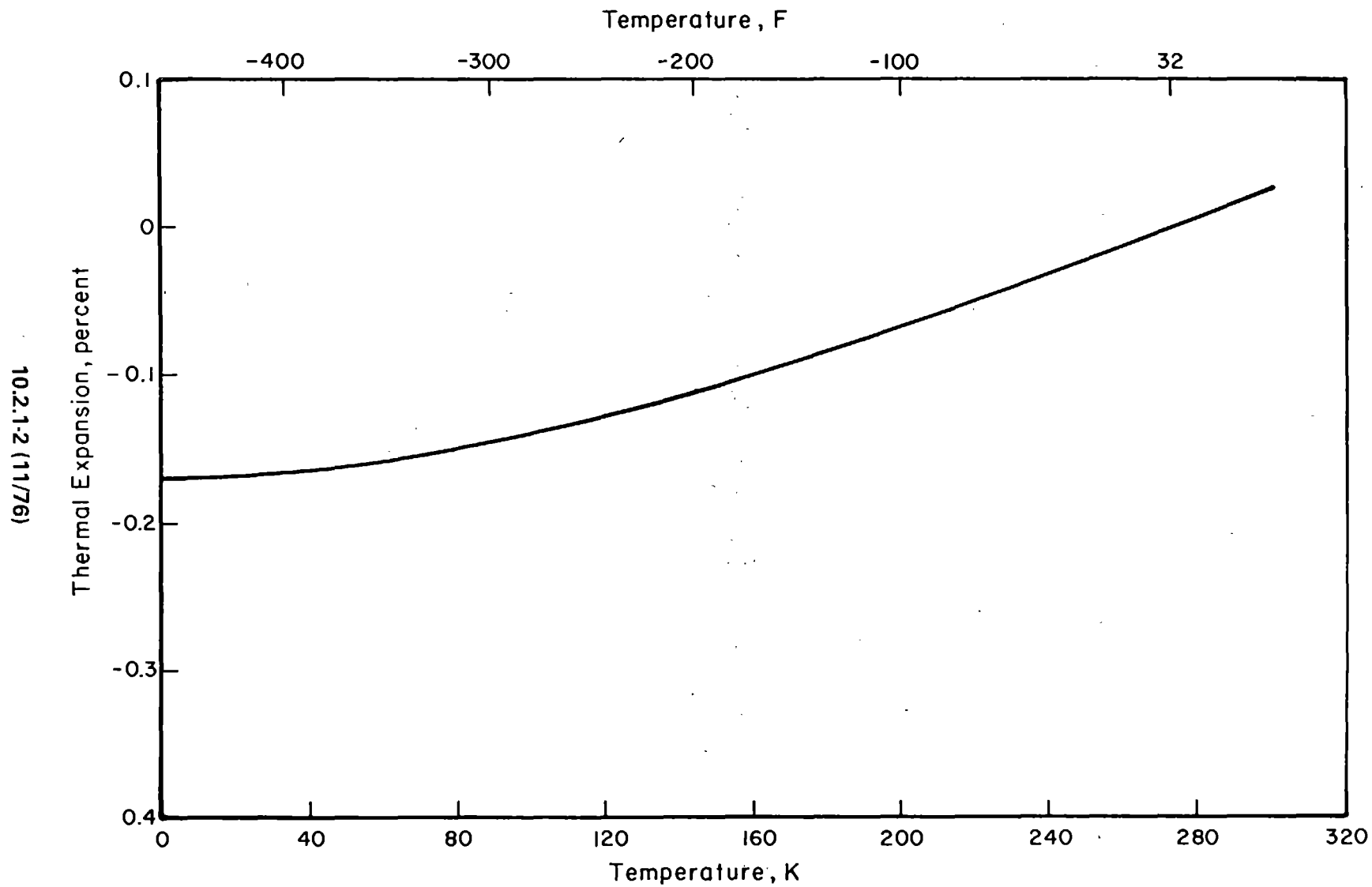


FIGURE 10.2.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR V_3Ga

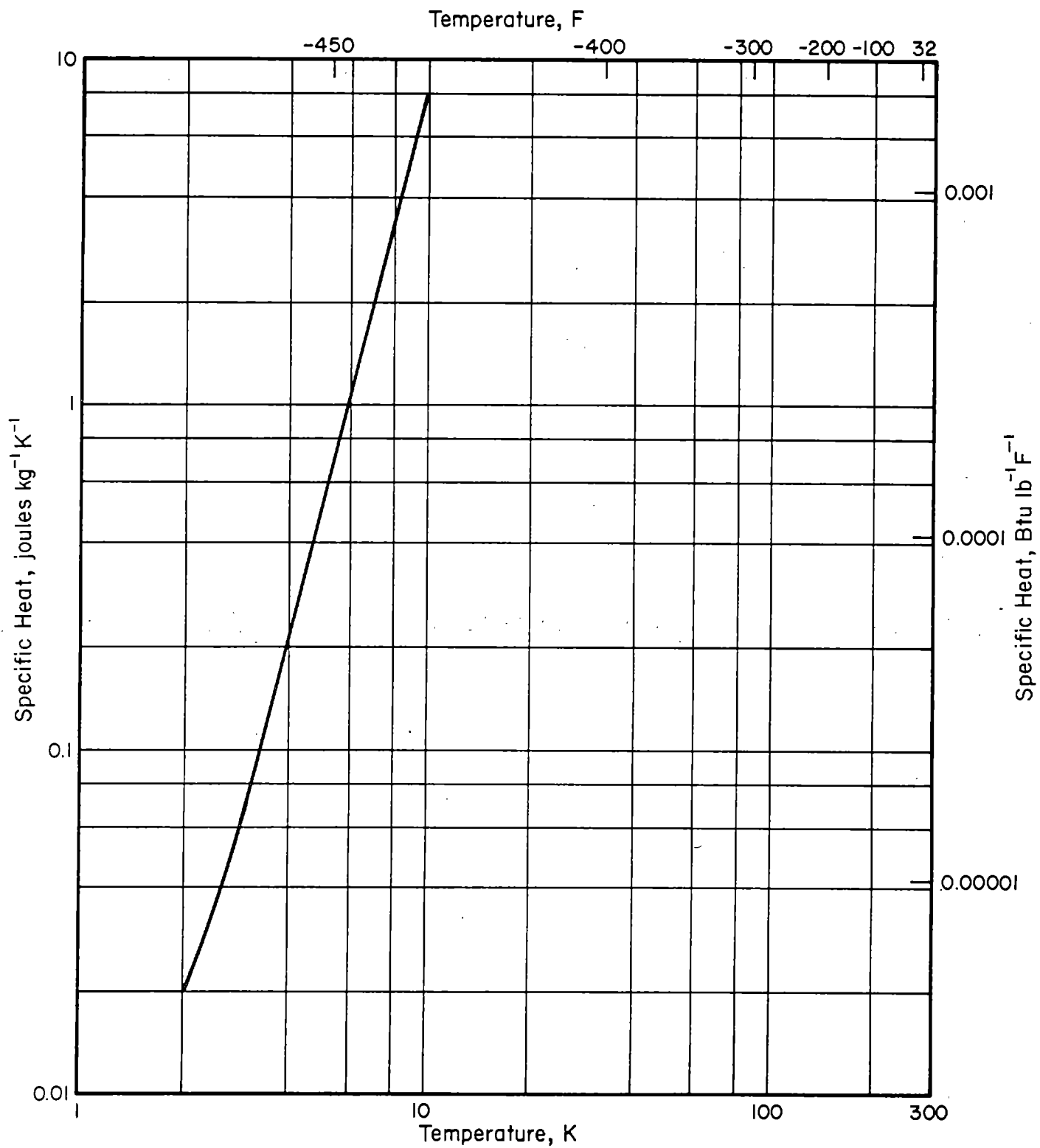


FIGURE 10.2.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR V_3Ga -- SUPERCONDUCTING STATE

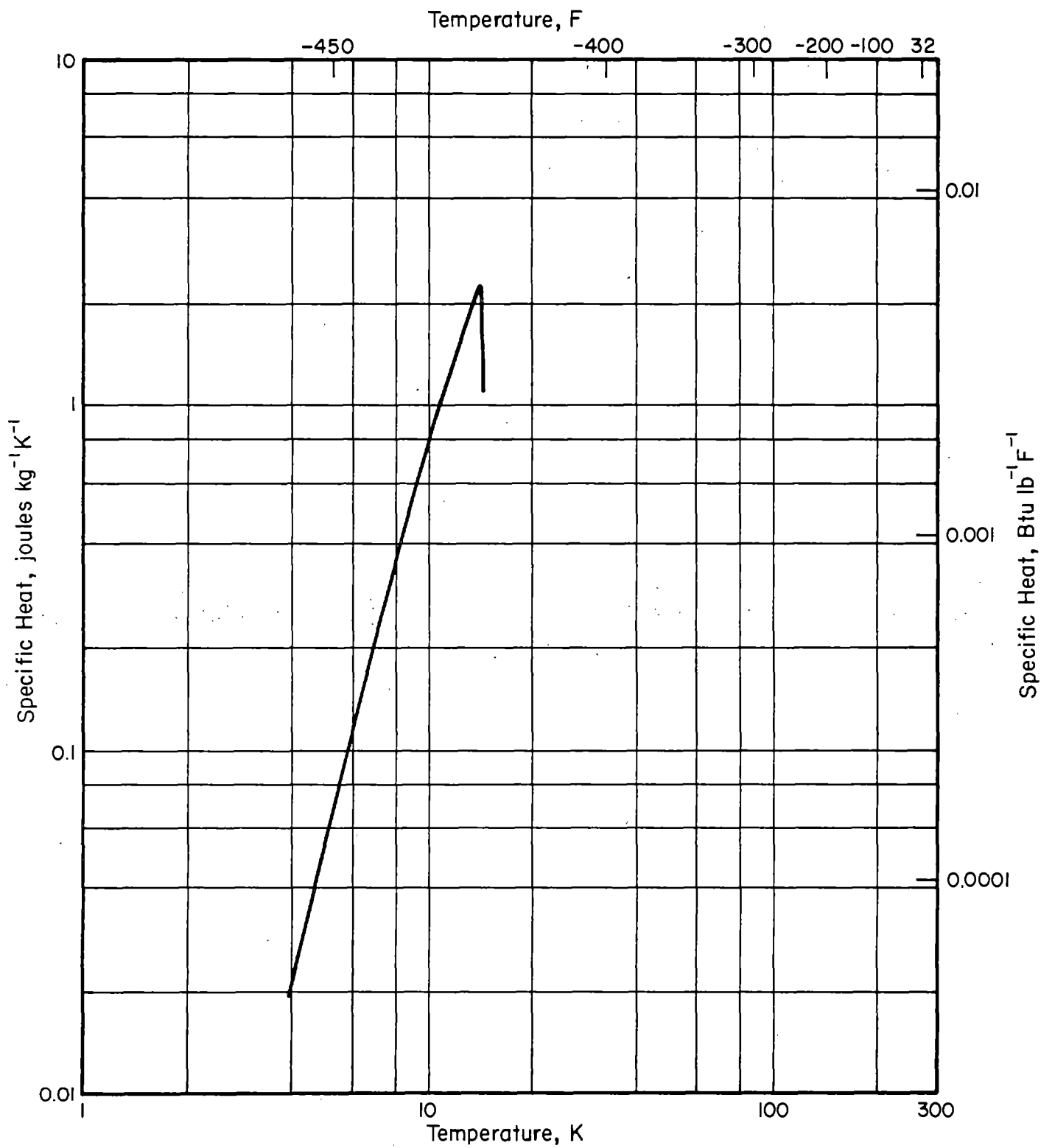


FIGURE 10.2.1-S2. SPECIFIC HEAT VERSUS TEMPERATURE FOR V_3Ga -- SUPERCONDUCTING STATE

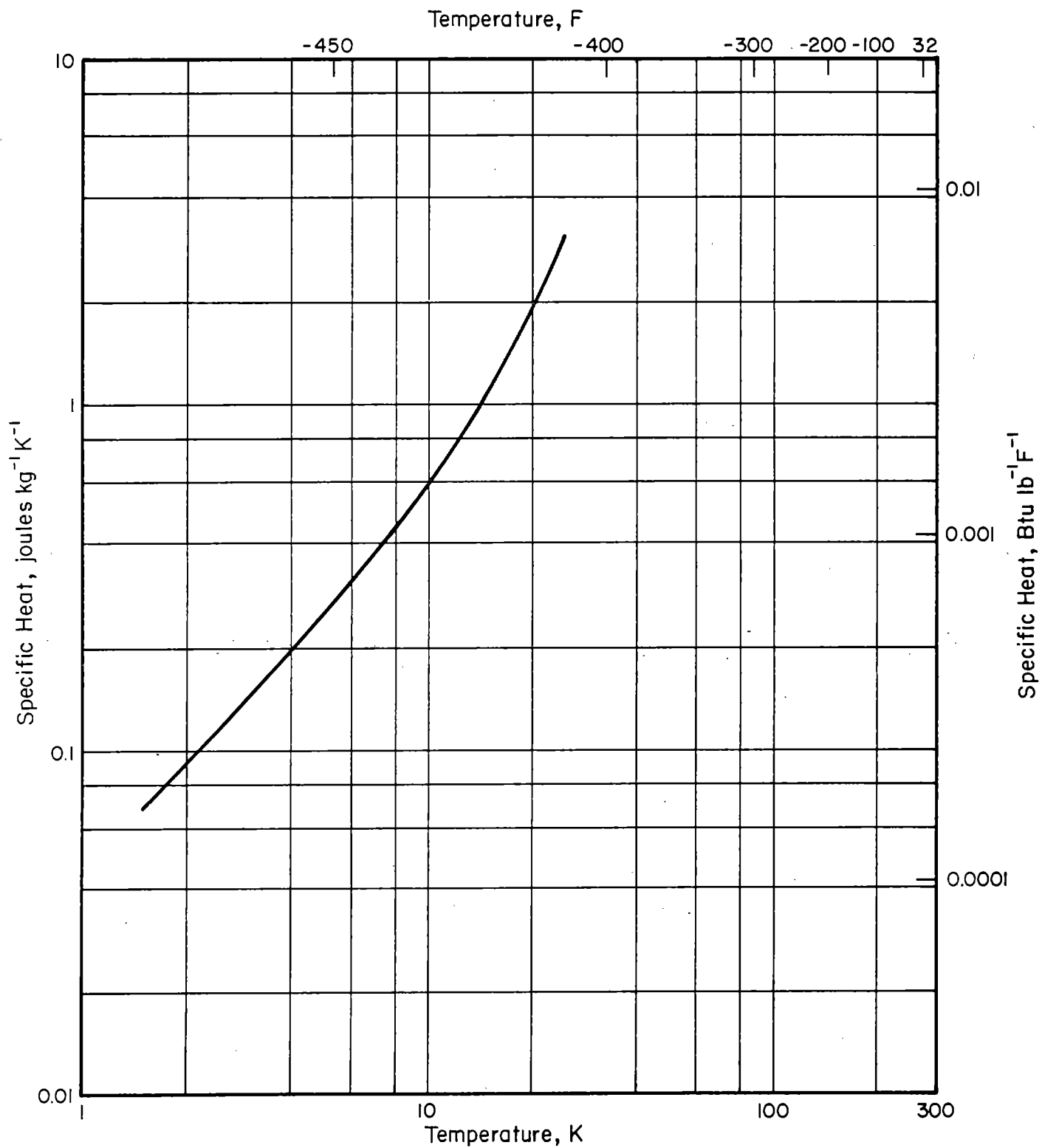


FIGURE 10.2.1-S3. SPECIFIC HEAT VERSUS TEMPERATURE FOR V_3Ga -- NORMAL STATE

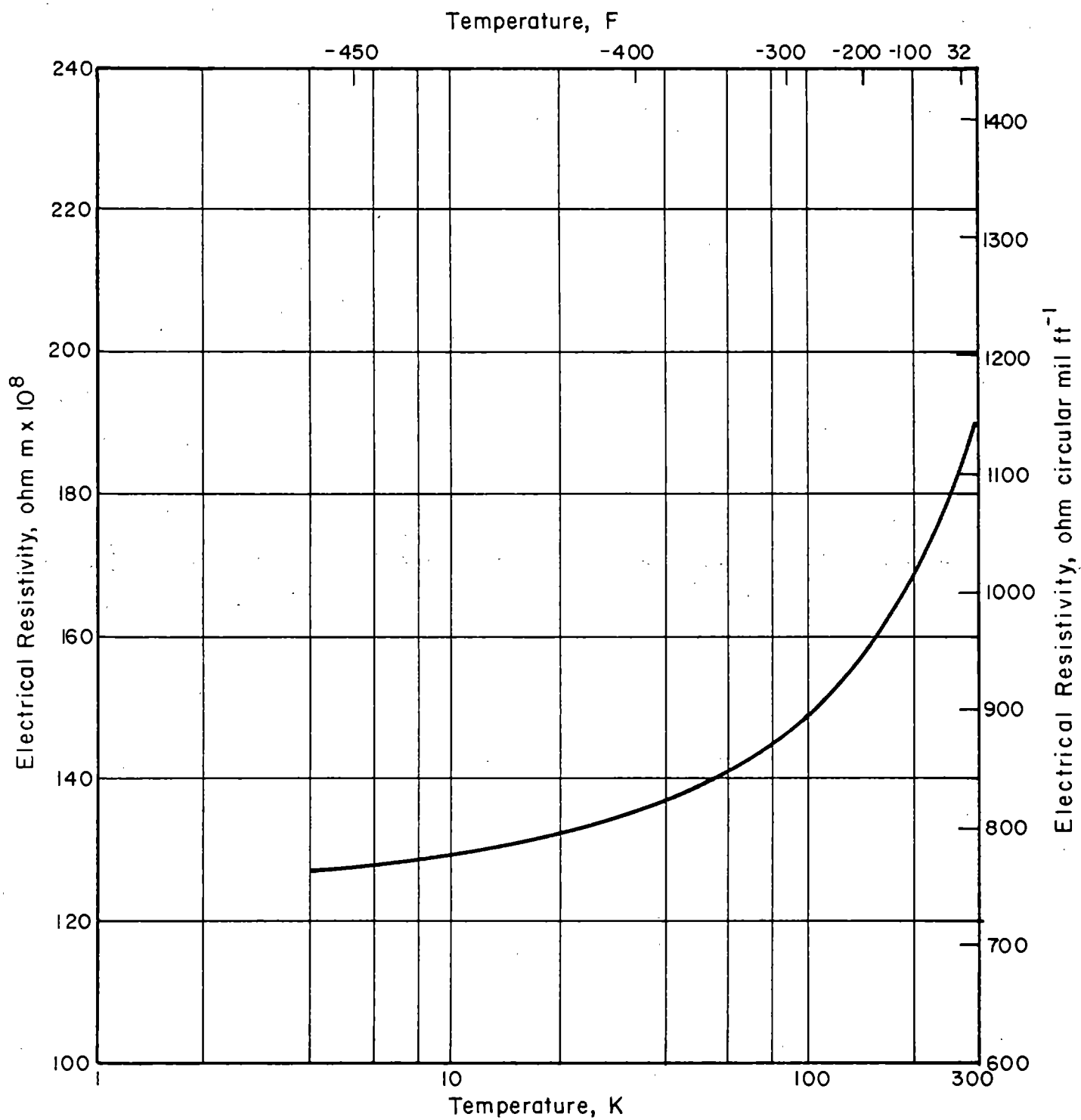


FIGURE 10.2.1-R1. ELECTRICAL RESISTIVITY VERSUS TEMPERATURE FOR V₃Ga -- NORMAL STATE

TABLE 10.3.1-TR1

Alloy Designation: Magnesium Alloy AZ 31-B

Specification:

Form:

Dimension:

Condition:

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹ (1)	72.0					
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(4.16)					
No. of Spec	1					
References: 90224						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent						
No. of Spec						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
No. of Spec						
References:						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec						
References:						
(1) AN-M-29(approximately same composition as AZ 31-B						

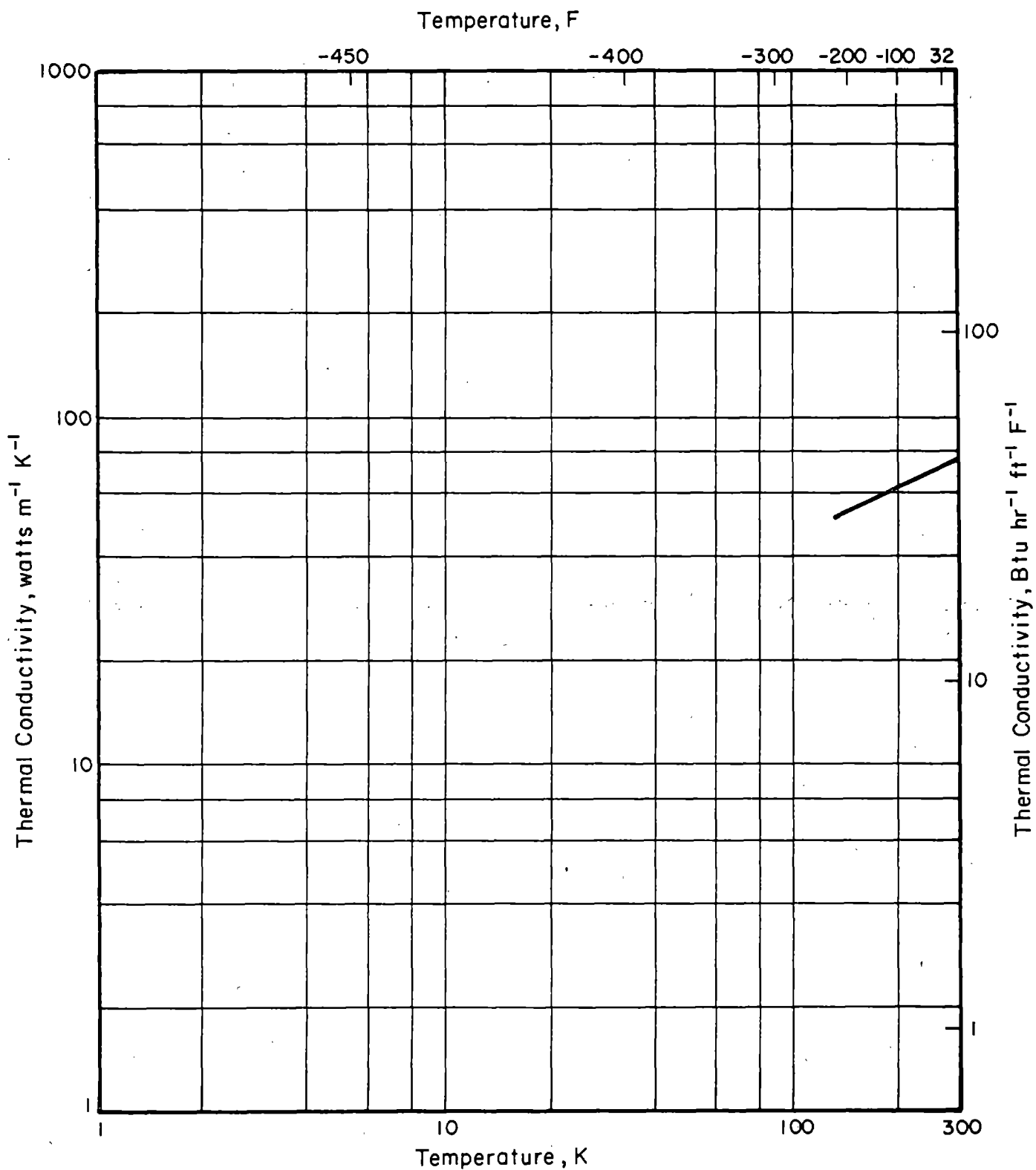


FIGURE 10.3.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR
MAGNESIUM ALLOY AZ 31-B (AN-M-29)

Alloy Designation: Magnesium Alloys with Al and Mn
 Specification:
 Form: Not given
 Dimension, cm(in.): Not given
 Condition: Quenched from 475 C (887 F)

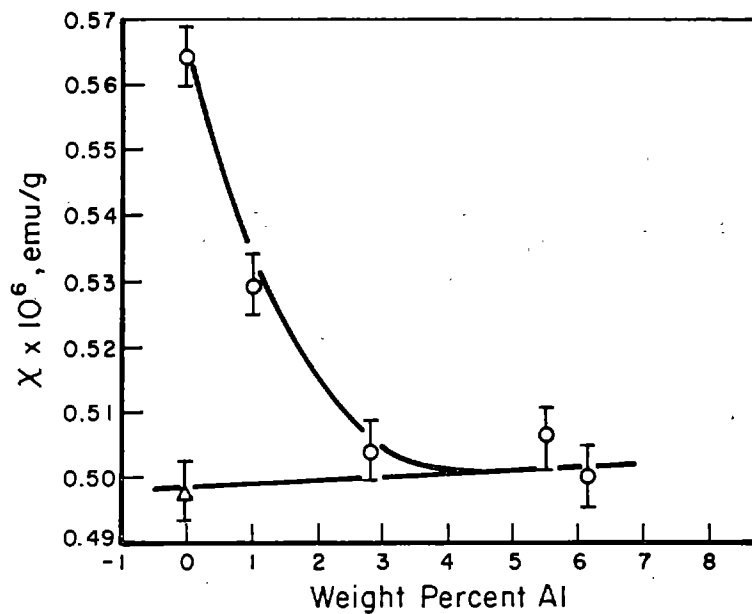


FIGURE 10.3.1-MA1. VALUES OF THE MASS SUSCEPTIBILITY, χ_{cgsem} , FOR SEVERAL TERNARY AND BINARY ALLOYS OF MAGNESIUM. THE LOWER CURVE IS FOR THE BINARY ALLOYS WITH ALUMINUM, WHILE THE UPPER CURVE REPRESENTS THE ADDITION OF A FIXED CONCENTRATION OF MANGANESE OF APPROXIMATELY 0.04 WEIGHT PERCENT [96874]

**INDEX TO MATERIAL CODES FOR
SECTION 11.0**

COMPOSITES

<u>MATERIALS</u>	<u>MATERIAL CODE</u>
GLASS-EPOXY	11.1.0
181/EPON 828	11.1.1
1581/E-787(58-68R)	11.1.2
S-901/NASA RESIN 2	11.1.3
BORON-EPOXY	11.2.0
4 MIL BORON/2387	11.2.1
5.6 MIL BORON/2387	11.2.2
GRAPHITE-EPOXY	11.3.0
AS/NASA RESIN 2	11.3.1
HT-S/X-904	11.3.2
BORON-ALUMINUM	11.4.0
5.6 MIL BORON/6061Al	11.4.1

TABLE 11.1.1-ME1

Composite Class: Glass-Epoxy

Type: 181/Epon 828 (CL)

Specification:

Layup: Balance-weave cloth (57 x 54 count)

Nominal fiber volume fraction:

Nominal ply thickness: 0.254 mm (0.010 in.)

Fiber: S-994 with HTS finish

Matrix: Epon 828(CL)

Nominal density: 1.83 g/cm³ (0.066 lbs/in.³)

Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°)(a)							
TUS, MN/m ² (ksi)	Avg	345 (50)	427 (62)	634 (92)	676 (98)		
	Min						
References: 15							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	24.2 (3.51)	26.4 (3.83)	28.6 (4.15)	31.3 (4.54)		
	Min						
References: 15							
SE ₁ , MN/m ² (ksi)	Avg	152 (22)	138 (20)	179 (26)	234 (34)		
	Min						
References: 15							
E ₂ , GN/m ² (10 ⁶ psi)	Avg	17.1 (2.48)	17.6 (2.56)	17.0 (2.47)	18.2 (2.64)		
	Min						
References: 15							
TPL, MN/m ² (ksi)	Avg						
	Min						
References:							
Failure Strain, 10 ⁻³	Avg						
	Min						
References:							
Poisson's Ratio							
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
Tension, Transverse (90°)(b)							
TUS, MN/m ² (ksi)	Avg						
	Min						
References:							
E ₁ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi)	Avg						
	Min						
References:							
Failure Strain, 10 ⁻³	Avg						
	Min						
References:							
Poisson's Ratio							
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
(a) Warp direction in woven cloth.							
(b) Fill direction in woven cloth.							

11.1.1-1 (11/76)

Composite Class: Glass-Epoxy

Type: 181/Epon 828(CL)

Specification:

Fiber: S-994 with HTS finish

Layup: Balance-weave cloth (57 x 54 count)

Matrix: Epon 828(CL)

Nominal fiber volume fraction:

Nominal density: 1.83 g/cm³ (0.066 lb/in³)

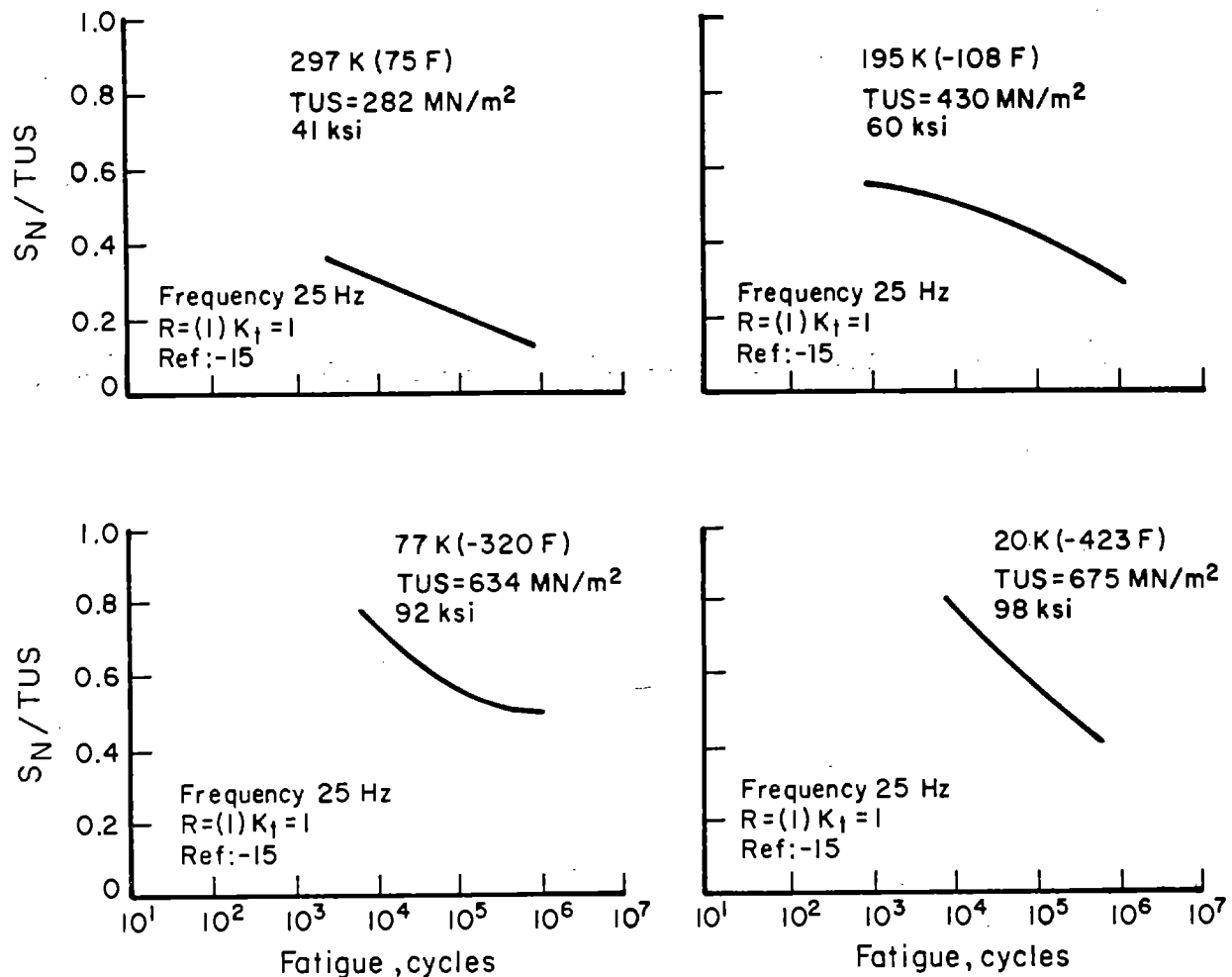
Nominal ply thickness: 0.254 mm (0.010 in.)

Comments:

Fatigue

Load orientation: parallel to warp or fill

Load direction: tension-tension



(1) Min. load 5% of tus.

FIGURE 11.1.1-ME1. FATIGUE LIFE CYCLE FOR GLASS-EPOXY

11.1.1-3 (11/76)

TABLE 11.1.1-TR1

Composite Class: Glass-Epoxy

Type: 181/Epon 828(CL)

Specification:

Layup: Balance-weave cloth (57 x 54 count)

Nominal fiber volume fraction:

Nominal ply thickness: 0.254 mm (0.010 in.)

Fiber: S-994 with HTS finish

Matrix: Epon 828(CL)

Nominal density: 1.83 g/cm³ (0.066 lb/in.³)

Comments:

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity						
Longitudinal (0°)(a)(1)						
Watts m ⁻¹ K ⁻¹	Avg 0.50	0.44	0.26	0.20		
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg 0.29	0.25	0.15	0.12		
References: 16						
Transverse (90°)(b)(1)						
Watts m ⁻¹ K ⁻¹	Avg 0.50	0.44	0.26	0.20		
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg 0.29	0.25	0.15	0.16		
References: 16						
Sheet Normal(c)(1)						
Watts m ⁻¹ K ⁻¹	Avg 0.35	0.30	0.20	0.15		
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg 0.20	0.17	0.12	0.087		
References: 16						
Thermal Expansion						
Longitudinal (0°)(a)						
10 ⁻⁶ ΔL/L	Avg 0	-1300	-2700			
References: 17						
Transverse (90°)(b)						
10 ⁻⁶ ΔL/L	Avg 0	-1300	-2700			
References: 17						
Sheet Normal(c)						
10 ⁻⁶ ΔL/L	Avg					
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹ (1)	Avg 880	640	240			
Btu lb ⁻¹ F ⁻¹	Avg 2100	1500	580			
References: 16						
Electrical Resistivity						
Longitudinal (0°)(a)						
Ohm m	Avg					
References:						
Transverse (90°)(b)						
Ohm m	Avg					
References:						
Sheet Normal(c)						
Ohm m	Avg					
References:						

(a) Warp direction in woven cloth.

(b) Fill direction in woven cloth.

(c) Press cure direction.

(1) Nominal data for glass cloth-epoxy

TABLE 11.1.2-ME1

Composite Class: Glass-Epoxy

Type: 1581/E-787 (58-68R)

Specification:

Layup: Balance-weave cloth (57 x 54 count)

Nominal fiber volume fraction: 0.63

Nominal ply thickness: 0.216 mm (0.0085 in.)

Fiber: S-901

Matrix: E-787 (58-68R)

Nominal density: 1.769 g/cm³ (0.064 lb/in.³)

Comments:

Testing Temperature, K (°F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°)(a)							
TUS, MN/m ² (ksi)	Avg	634 (92)	793 (115)	999 (145)	951 (138)		
	Min	613 (89)	765 (111)	944 (137)	896 (130)		
References: 18							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	22.7 (3.29)	24.1 (3.50)	26.8 (3.98)	29.4 (4.27)		
	Min	21.9 (3.18)	23.2 (3.37)	22.5 (3.26)	26.7 (3.88)		
References: 18							
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi)	Avg						
	Min						
References:							
Failure Strain, 10 ⁻³	Avg	33.7	41.1	50.1	48.1		
	Min	32.5	40.3	48.5	45.0		
References: 18							
Poisson's Ratio							
References:							
NTS, MN/m ² (ksi)	Avg	489 (71)	607 (88)	786 (114)	813 (118)		
K _t = 3	Min	469 (68)	593 (86)	731 (106)	793 (115)		
References: 18							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
Tension, Transverse (90°)(b)							
TUS, MN/m ² (ksi)	Avg	586 (85)	683 (99)	882 (128)	813 (118)		
	Min	558 (81)	620 (90)	862 (125)	806 (117)		
References: 18							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	21.8 (3.17)	23.0 (3.34)	27.4 (3.97)	28.8 (4.18)		
	Min	21.6 (3.13)	22.5 (3.26)	26.6 (3.86)	27.8 (4.04)		
References: 18							
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi)	Avg						
	Min						
References:							
Failure Strain, 10 ⁻³	Avg	33.0	39.6	46.4	44.5		
	Min	31.5	36.0	44.0	43.5		
References: 18							
Poisson's Ratio							
References:							
NTS, MN/m ² (ksi)	Avg	469 (68)	558 (81)	689 (100)	723 (105)		
K _t =	Min	455 (66)	538 (78)	655 (95)	710 (103)		
References: 18							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
(a) Warp direction in woven cloth.							
(b) Fill direction in woven cloth.							

11.1.2-1 (11/76)

Type: 1581/E-787 (58-68R)

Fiber: S-901
Matrix: E-787 (58-68R)
Nominal density: 1.769 g/cm³ (0.064 lb/in.³)
Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)
Compression, Longitudinal (0°) (a)						
CUS, MN/m ² (ksi)	Max	476 (69)	600 (87)	745 (108)	807 (117)	
	Avg	434 (63)	552 (80)	710 (103)	751 (109)	
	Min	400 (58)	503 (73)	655 (95)	696 (101)	
References: 18						
CPL, MN/m ² (ksi)	Max					
	Avg					
	Min					
References:						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
References:						
Compression, Transverse (90°) (b)						
CUS, MN/m ² (ksi)	Max	421 (61)	565 (82)	717 (104)	738 (107)	
	Avg	414 (60)	510 (74)	648 (94)	689 (100)	
	Min	393 (57)	455 (66)	607 (88)	662 (96)	
References: 18						
CPL, MN/m ² (ksi)	Max					
	Avg					
	Min					
References:						
E, GN/m ² (10 ⁶ psi)	Avg					
	Min					
References:						
In-Plane Shear						
SUS, MN/m ² (ksi)	Avg					
	Min					
References:						
SPL, MN/m ² (ksi)	Avg					
	Min					
References:						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
References:						
Interlaminar Shear						
SUS, MN/m ² (ksi)	Avg	54.4 (7.9)	68.9 (10.0)	89.6 (13.0)	77.2 (11.2)	
	Min	50.3 (7.3)	53.8 (7.8)	84.1 (12.2)	71.0 (10.3)	
References: 18						
SPL, MN/m ² (ksi)	Avg					
	Min					
References:						
G, GN/m ² (10 ⁶ psi)	Avg					
	Min					
References:						
Impact, Charpy V(Cv), Izod(I)						
Long., (0°) J (ft-lb) (a)	Avg					
	Min					
References:						
Trans., (90°) J (ft-lb) (b)	Avg					
	Min					
References:						
Sheet, Normal, J (ft-lb) (c)	Avg					
	Min					
References:						
11.1.2-2 (11/76)						
(a) Warp direction in woven cloth.						
(b) Fill direction in woven cloth.						
(c) Press cure direction.						

TABLE 11.1.2-TR1

Composite Class: Glass-Epoxy

Type: 1581/E-787 (58-68R)

Specification:

Layup: Balance-weave cloth (57 x 54 count)

Nominal fiber volume fraction: 0.63

Nominal ply thickness: 0.216 mm (0.0085 in.)

Fiber: S-901

Matrix: E-787 (58-68R)

Nominal density: 1.769 g/cm³ (0.064 lb/in.³)

Comments:

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity						
Longitudinal (0°)(a) (1)						
Watts m ⁻¹ K ⁻¹ Avg	0.50	0.44	0.26	0.20		
Btu hr ⁻¹ ft ⁻¹ F ⁻¹ Avg	0.29	0.25	0.15	0.12		
References: 16						
Transverse (90°)(b) (1)						
Watts m ⁻¹ K ⁻¹ Avg	0.50	0.44	0.26	0.20		
Btu hr ⁻¹ ft ⁻¹ F ⁻¹ Avg	0.29	0.25	0.15	0.16		
References: 16						
Sheet Normal(c) (1)						
Watts m ⁻¹ K ⁻¹ Avg	0.35	0.30	0.20	0.15		
Btu hr ⁻¹ ft ⁻¹ F ⁻¹ Avg	0.20	0.17	0.12	0.087		
References: 16						
Thermal Expansion						
Longitudinal (0°)(a)						
10 ⁻⁶ ΔL/L Avg	0	-1123	-2140	-2463	-2490	
References: 18						
Transverse (90°)(b)						
10 ⁻⁶ ΔL/L Avg	0	-1077	-2033	-2323	-2343	
References: 18						
Sheet Normal(c)						
10 ⁻⁶ ΔL/L Avg						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹ (1) Avg	880	640	240			
Btu lb ⁻¹ F ⁻¹ Avg	2100	1500	580			
References: 16						
Electrical Resistivity						
Longitudinal (0°)(a)						
Ohm m Avg						
References:						
Transverse (90°)(b)						
Ohm m Avg						
References:						
Sheet Normal(c)						
Ohm m Avg						
References:						

(a) Warp direction in woven cloth.

(b) Fill direction in woven cloth.

(c) Press cure direction.

(1) Nominal data for glass cloth-epoxy.

TABLE 11.1.3-ME1

Composite Class: Glass-Epoxy

Type: S-901/NASA Resin 2

Specification:

Layup: Uniaxial tape

Nominal fiber volume fraction: 0.6

Nominal ply thickness: 0.21 mm (0.083 in.)

Fiber: S-901

Matrix: NASA Resin 2(-11)

Nominal density: 2.9 g/cm³ (0.07 lb/in.³)

Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°)(a)							
TUS, MN/m ² (ksi)	Avg	1420 (206)		1953 (283)	1820 (264)	1937 (281)	
	Min	1192 (173)		1716 (249)	1606 (233)	1744 (253)	
References:		8, 10, 11					
E ₁ , GN/m ² (10 ⁶ psi)	Avg	58.7 (8.51)		62.8 (9.11)	77.9 (11.30)	60.1 (8.73)	
	Min	55.4 (8.05)		57.9 (8.40)	71.0 (10.30)	57.6 (8.35)	
References:		8, 10, 11					
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi) ⁽¹⁾	Avg						
	Min						
References:							
Failure Strain, 10 ⁻³	Avg	28.0		31.5	24.0	30.3	
	Min	27.0		27.0	--	27.0	
References:		8, 10					
Poisson's Ratio		0.268		0.269		0.290	
References:		8					
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
Tension, Transverse (90°)(b)							
TUS, MN/m ² (ksi)	Avg	46.9 (6.8)		93.7 (13.6)		78.6 (11.4)	
	Min	44.1 (6.4)		78.6 (11.4)		65.5 (9.5)	
References:		8					
E ₁ , GN/m ² (10 ⁶ psi)	Avg	12.4 (1.80)		21.2 (3.07)		22.0 (3.20)	
	Min	11.7 (1.69)		18.1 (2.63)		19.5 (2.82)	
References:		8					
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi)	Avg	13.8 (2.0)					
	Min	9.0 (1.3)					
References:		8					
Failure Strain, 10 ⁻³	Avg	6.3		4.0		3.7	
	Min	5.0		3.0		3.0	
References:		8					
Poisson's Ratio		0.057		0.098		0.106	
References:		8					
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
(a) Warp direction in woven cloth.							
(b) Fill direction in woven cloth.							
(1) Essentially linear to fracture.							

11.1.3-1 (11/76)

TABLE 11.1.3-ME2

Composite Class: Glass-Epoxy

Type: S-901/NASA Resin 2

Specification:

Layup: Uniaxial tape

Nominal fiber volume fraction: 0.6

Nominal ply thickness: 0.21 mm (0.0083 in.)

Fiber: S-901

Matrix: NASA Resin 2(-11)

Nominal density: 2.0 g/cm³ (0.07 lb/in³)

Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Compression, Longitudinal (0°)(a)							
CUS, MN/m ² (ksi)	Max	562 (81.6)		1648 (239)		1544 (224)	
	Avg	503 (73.0)		1356 (196)		1420 (206)	
	Min	472 (68.5)		1034 (150)		1309 (190)	
References: 8							
CPL, MN/m ² (ksi)	Max			447 (64.8)		380 (55.2)	
	Avg			313 (45.5)		312 (45.2)	
	Min			178 (25.8)		243 (35.3)	
References: 8							
E, GN/m ² (10 ⁶ psi)	Avg	50.6 (7.34)		63.6 (9.23)		60.5 (8.77)	
	Min	40.5 (5.87)		48.3 (7.00)		53.8 (7.81)	
References: 8							
Compression, Transverse (90°)(b)							
CUS, MN/m ² (ksi)	Max	105 (15.3)		311 (45.1)		299 (43.4)	
	Avg	98.6 (14.3)		276 (40.1)		262 (38.1)	
	Min	93.8 (13.6)		234 (34.0)		213 (30.9)	
References: 8							
CPL, MN/m ² (ksi)	Max	55.0 (7.97)		131 (19.0)			
	Avg	45.0 (6.53)		114 (16.5)			
	Min	38.0 (5.51)		92 (13.4)			
References: 8							
E, GN/m ² (10 ⁶ psi)	Avg	11.3 (1.63)		22.8 (3.31)		31.3 (4.54)	
	Min	9.8 (1.42)		19.8 (2.87)		27.2 (3.95)	
References: 8							
In-Plane Shear							
SUS, MN/m ² (ksi)	Avg						
	Min						
References:							
SPL, MN/m ² (ksi)	Avg						
	Min						
References:							
G, GN/m ² (10 ⁶ psi)	Avg	6.2 (0.90)		11.0 (1.60)		12.9 (1.87)	
	Min	--		--		--	
References: 8							
Interlaminar Shear							
SUS, MN/m ² (ksi)	Avg	29.8 (4.32)		64.3 (9.33)	61.0 (8.84)		
	Min	28.7 (4.16)		58.3 (8.45)	58.3 (8.46)		
References: 11							
SPL, MN/m ² (ksi)	Avg						
	Min						
References:							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
Impact, Charpy V(Cv), Izod(I)							
Long., (0°) J (ft-lb)(a)	Avg	111 (82)(I)		91 (67)(I)			
	Min	--		--			
References: 10							
Trans., (90°) J (ft-lb)(b)	Avg						
	Min						
References:							
Sheet, Normal, J (ft-lb)(c)	Avg						
	Min						
References:							
11.1.3-2 (11/76)							

(a) Warp direction in woven cloth.

(b) Fill direction in woven cloth.

(c) Press cure direction.

TABLE 11.1.3-TR1

Composite Class: Glass-Epoxy

Type: S-901/NASA Resin 2

Specification:

Layup: Uniaxial tape

Nominal fiber volume fraction: 0.6

Nominal ply thickness: 0.21 mm (0.0083 in.)

Fiber: S-901

Matrix: NASA Resin 2(-11)

Nominal density: 2.0 g/cm³ (0.07 lb/in.³)

Comments:

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity						
Longitudinal (0°)(a)						
Watts m ⁻¹ K ⁻¹ Avg						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹ Avg						
References:						
Transverse (90°)(b)						
Watts m ⁻¹ K ⁻¹ Avg						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹ Avg						
References:						
Sheet Normal(c)						
Watts m ⁻¹ K ⁻¹ Avg						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹ Avg						
References:						
Thermal Expansion						
Longitudinal (0°)(a)						
10 ⁻⁶ ΔL/L Avg	0	-260	-440	-480		
References: 11						
Transverse (90°)(b)						
10 ⁻⁶ ΔL/L Avg	0	-2770	-3610	-4100		
References: 11						
Sheet Normal(c)						
10 ⁻⁶ ΔL/L Avg						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹ Avg						
Btu lb ⁻¹ F ⁻¹ Avg						
References:						
Electrical Resistivity						
Longitudinal (0°)(a)						
Ohm m Avg						
References:						
Transverse (90°)(b)						
Ohm m Avg						
References:						
Sheet Normal(c)						
Ohm m Avg						
References:						
(a) Warp direction in woven cloth.						
(b) Fill direction in woven cloth.						
(c) Press cure direction.						

TABLE 11.2.1-ME1

Type: 4.0 mil Boron/2387

Fiber: 4.0 mil boron on tungsten
Matrix: 2387
Nominal density: 2.006 g/cm³ (0.0725 lb/in.³)
Comments: Specification SP-272 essentially equivalent properties
(4.0 mil boron/PR-279)

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)
Tension, Longitudinal (0°)(a)					
TUS, MN/m ² (ksi)	Avg 1427 (207) Min 1296 (188)		1502 (218) 1460 (212)	1406 (204) --	
References: 1, 2, 3					
E ₁ , GN/m ² (10 ⁶ psi)	Avg 206.8 (30) Min --		220.6 (32) --	227.5 (33) --	
References: 3					
SE ₁ , MN/m ² (ksi)	Avg Min				
References:					
E ₂ GN/m ² (10 ⁶ psi)	Avg Min				
References:					
TPL, MN/m ² (ksi) (1)	Avg Min				
References:					
Failure Strain, 10 ⁻³	Avg 6.41 Min 6.26				
References: 4, 5					
Poisson's Ratio	0.219				
References: 6					
NTS, MN/m ² (ksi) K _t =	Avg Min				
References:					
NTS, MN/m ² (ksi) K _t =	Avg Min				
References:					
Tension, Transverse (90°)(b)					
TUS, MN/m ² (ksi)	Avg 7.10 (10.30) Min 62.0 (9.0)	70.7 (10.25) --	65.2 (9.46) 62.0 (9.0)	48.3 (7.00) --	
References: 1, 3					
E ₁ , GN/m ² (10 ⁶ psi)	Avg 20.3 (2.95) Min 18.6 (2.70)		32.4 (4.7)	34.5 (5.0)	
References: 3, 4, 5					
SE ₁ , MN/m ² (ksi)	Avg Min				
References:					
E ₂ , GN/m ² (10 ⁶ psi)	Avg Min				
References:					
TPL, MN/m ² (ksi)	Avg 23.4 (3.4) Min --				
References: 4, 5					
Failure Strain, 10 ⁻³	Avg 4.49 Min 4.10				
References: 4, 5					
Poisson's Ratio	0.032				
References: 6					
NTS, MN/m ² (ksi) K _t =	Avg Min				
References:					
NTS, MN/m ² (ksi) K _t =	Avg Min				
References:					
11.2.1-1 (11/76)					
(a) Warp direction in woven cloth. (b) Fill direction in woven cloth. (1) Essentially linear to fracture.					

Type: 4.0 mil Boron/2387

Fiber: 4.0 mil boron on tungsten

Matrix: 2387

Nominal density: 2.006 g/cm³ (0.0725 lb/in³)

**Comments: Specification SP-272 essentially equivalent properties
(4.0 mil boron/PR-279)**

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)
<u>Compression, Longitudinal (0°)(a)</u>					
CUS, MN/m ² (ksi)	Max 2495 (362) Avg 2456 (356) Min 1820 (264)		-- 3026 (439) --	-- 3736 (542) --	
References: 3, 4, 5					
CPL, MN/m ² (ksi)	Max -- Avg 1530 (222) Min --				
References: 4, 5					
E, GN/m ² (10 ⁶ psi)	Avg 206 (30) Min 193 (28)		227 (33) --	214 (31) --	
References: 3, 4, 5					
<u>Compression, Transverse (90°)(b)</u>					
CUS, MN/m ² (ksi)	Max 310 (45) Avg 283 (41) Min 255 (37)		-- 524 (76) --		
References: 3, 4, 5					
CPL, MN/m ² (ksi)	Max -- Avg 100 (14.5) Min --				
References: 4					
E, GN/m ² (10 ⁶ psi)	Avg 22.4 (3.25) Min 20.6 (3.00)		40.0 (5.80) --		
References: 3, 4					
<u>In-Plane Shear</u>					
SUS, MN/m ² (ksi)	Avg 131 (18.95) Min 129 (18.70)				
References: 4					
SPL, MN/m ² (ksi)	Avg -- Min --				
References:					
G, GN/m ² (10 ⁶ psi)	Avg 6.41 (0.93) Min --				
References: 4					
<u>Interlaminar Shear</u>					
SUS, MN/m ² (ksi)	Avg 95.1 (13.8) Min 90.3 (13.1)		120 (17.5) --	138 (20) --	
References: 1, 2, 3					
SPL, MN/m ² (ksi)	Avg -- Min --				
References:					
G, GN/m ² (10 ⁶ psi)	Avg -- Min --				
References:					
<u>Impact, Charpy V(Cv), Izod(I)</u>					
Long., (0°) J (ft-lb)(a)	Avg -- Min --				
References:					
Trans., (90°) J (ft-lb)(b)	Avg -- Min --				
References:					
Sheet, Normal, J (ft-lb)(c)	Avg -- Min --				
References:					
			11.2.1-2 (11/76)		
(a) Warp direction in woven cloth.					
(b) Fill direction in woven cloth.					
(c) Press cure direction.					

Composite Class: Boron-Epoxy

Type: 4.0 mil Boron/2387

Specification: 5505/4

Fiber: 4.0 mil boron on tungsten

Layup: Uniaxial tape

Matrix: 2387

Nominal fiber volume fraction: 0.50

Nominal density: 2.006 g/cm³ (0.0725 lb/in.³)

Nominal ply thickness: 0.132 mm (0.0052 in.)

Comments: Specification SP-272 essentially equivalent properties (4.0 mil boron/PR-279)

Fatigue

Load orientation: 0° (uniaxial)

Load direction: tension-tension

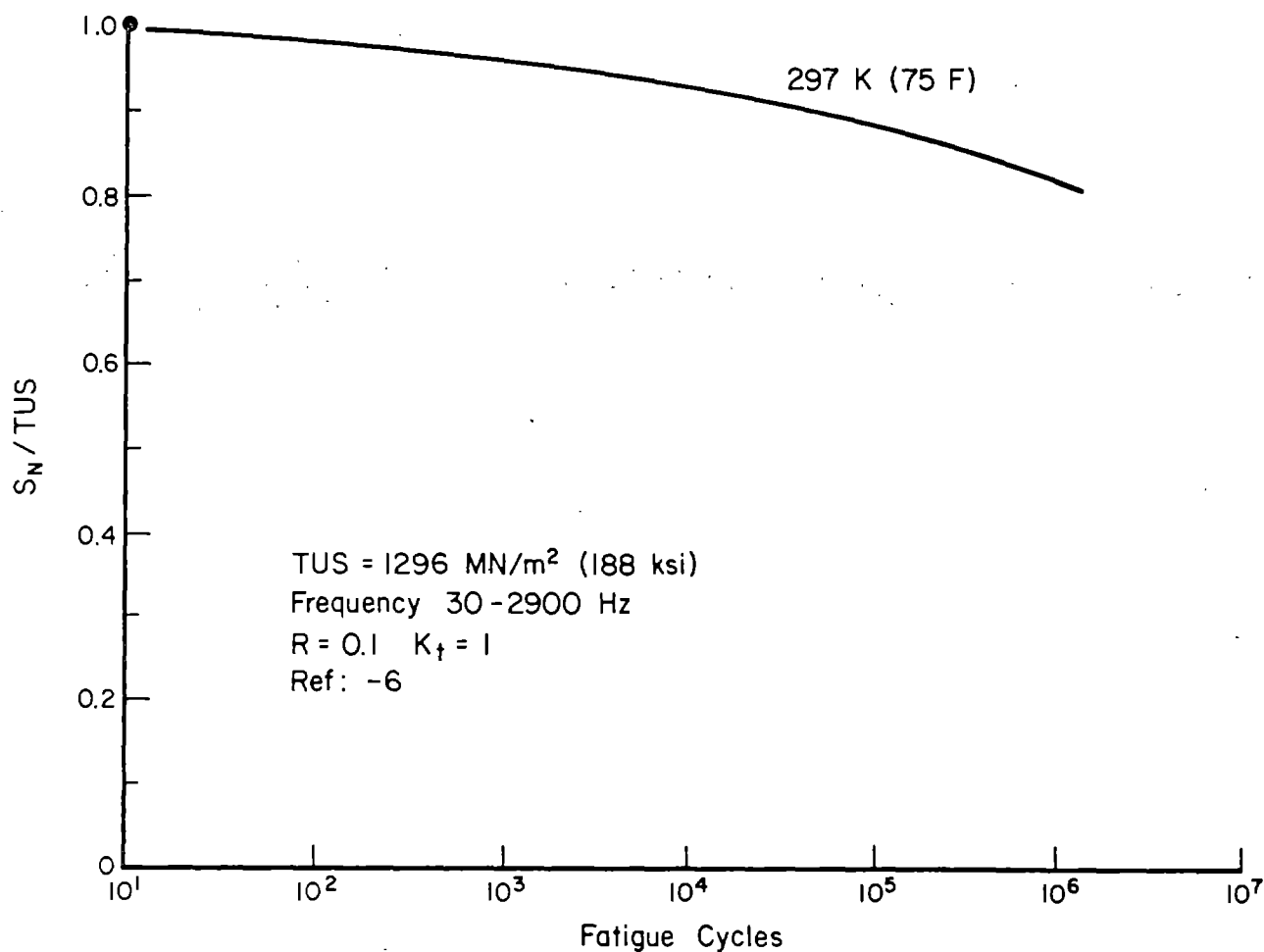


FIGURE 11.2.1-ME1. FATIGUE LIFE CYCLE FOR BORON-EPOXY

TABLE 11.2.1-TR1

Composite Class: Boron-Epoxy

Type: 4.0 mil Boron/2387

Specification: 5505/4

Layup: Uniaxial tape

Nominal fiber volume fraction: 0.50

Nominal ply thickness: 0.132 mm (0.0052 in.)

Fiber: 4.0 mil boron on tungsten

Matrix: 2387

Nominal density: 2.006 g/cm³ (0.0725 lb/in.³)Comments: Specification SP-272 essentially equivalent properties
(4.0 mil boron/PR-279)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity							
Longitudinal (0°)(a)							
Watts m ⁻¹ K ⁻¹	Avg	1.82	1.61	1.55			
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg	1.05	0.93	0.89			
References: 1, 3							
Transverse (90°)(b)							
Watts m ⁻¹ K ⁻¹	Avg	1.04	0.86	0.43			
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg	0.6	0.5	0.27			
References: 3							
Sheet Normal(c)							
Watts m ⁻¹ K ⁻¹	Avg	0.68	0.60	0.40			
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg	0.39	0.35	0.23			
References: 1, 3							
Thermal Expansion							
Longitudinal (0°)(a)							
10 ⁻⁶ ΔL/L	Avg	0	-300	-460			
References: 1, 3							
Transverse (90°)(b)							
10 ⁻⁶ ΔL/L	Avg	0	-1800	-2700			
References: 1, 3							
Sheet Normal(c)							
10 ⁻⁶ ΔL/L	Avg	0	-1600	-2800			
References: 3							
Specific Heat							
Joules kg ⁻¹ K ⁻¹	Avg	1150	700	325			
Btu lb ⁻¹ F ⁻¹	Avg	2740	1670	776			
References: 1, 3							
Electrical Resistivity							
Longitudinal (0°)(a)							
Ohm m	Avg						
References:							
Transverse (90°)(b)							
Ohm m	Avg						
References:							
Sheet Normal(c)							
Ohm m	Avg	109					
References: 1							

(a) Warp direction in woven cloth.

(b) Fill direction in woven cloth.

(c) Press cure direction.

TABLE 11.2.2-ME1

Composite Class: Boron-Epoxy

Type: 5.6 mil Boron/2387

Specification: 5505/5.6

Layup: Uniaxial tape

Nominal fiber volume fraction: 0.50

Nominal ply thickness: 0.1905 mm (0.0075 in.)

Fiber: 5.6 mil boron on tungsten

Matrix: 2387

Nominal density: 1.94 g/cm³ (0.07 lb/in.³)Comments: Specification SP-296 essentially equivalent properties
(5.6 mil Boron/PR 286)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°) (a)							
TUS, MN/m ² (ksi)	Avg	1630 (237)		1680 (243)		1820 (263)	
	Min	1580 (229)		1610 (234)		1770 (257)	
References: 7							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	231 (33.5)		233 (33.9)		238 (34.5)	
	Min	227 (32.9)		229 (33.2)		234 (34.0)	
References: 7							
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi) (1)	Avg						
	Min						
References:							
Failure Strain, 10 ⁻³	Avg	7.3		8.0		8.0	
	Min	7.0		7.0		8.0	
References: 7							
Poisson's Ratio 0.228		0.228		0.241		0.239	
References: 7							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
Tension, Transverse (90°) (b)							
TUS, MN/m ² (ksi)	Avg	47.0 (6.81)		49.0 (7.09)		41.4 (6.01)	
	Min	43.4 (6.29)		45.2 (6.56)		30.3 (4.40)	
References: 7							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	17.5 (2.54)		31.2 (4.53)		35.8 (5.19)	
	Min	16.3 (2.36)		28.9 (4.19)		33.9 (4.92)	
References: 7							
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi) (1)	Avg	34.4 (4.99)					
	Min	24.2 (3.50)					
References: 7							
Failure Strain, 10 ⁻³	Avg	2.7		1.5		1.2	
	Min	2.0		1.0		1.1	
References: 7							
Poisson's Ratio		0.017		0.033		0.034	
References: 7							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
(a) Warp direction in woven cloth.							
(b) Fill direction in woven cloth.							

11.2.2-1 (11/76)

Type: 5.6 mil Boron/2387

Fiber: 5.6 mil boron on tungsten

Matrix: 2387

Nominal density: 1.94 g/cm³ (0.07 lb/in.³)

Comments: Specification SP-296 essentially equivalent properties
(5.6 mil Boron/PR 286)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)
<u>Compression, Longitudinal (0°)(a)</u>						
CUS, MN/m ² (ksi)	Max Avg Min					3660 (531) 2723 (395)
References:						
CPL, MN/m ² (ksi) (1)	Max Avg Min					
References:						
E, GN/m ² (10 ⁶ psi)	Avg Min	214 (31) --		228 (33) --		241 (35) --
References: 8						
<u>Compression, Transverse (90°)(b)</u>						
CUS, MN/m ² (ksi)	Max Avg Min	223 (32.3) 192 (27.9) 141 (20.5)		456 (66.2) 357 (54.5) 180 (26.1)		452 (65.5) 427 (62.0) 408 (59.2)
References: 8						
CPL, MN/m ² (ksi) (1)	Max Avg Min	97.2 (14.1) 71.6 (10.4) 39.5 (5.7)		338 (49.0) 241 (35.0) 166 (24.1)		
References: 8						
E, GN/m ² (10 ⁶ psi)	Avg Min	19.3 (2.80) 13.3 (2.02)		39.2 (5.69) 37.7 (5.46)		40.3 (5.85) 37.8 (5.49)
References: 8						
<u>In-Plane Shear</u>						
SUS, MN/m ² (ksi)	Avg Min					
References:						
SPL, MN/m ² (ksi)	Avg Min					
References:						
G, GN/m ² (10 ⁶ psi)	Avg Min	4.72 (0.68) 4.24 (0.62)		9.19 (1.33) 8.82 (1.28)		9.28 (1.35) 9.09 (1.32)
References: 7, 8						
<u>Interlaminar Shear</u>						
SUS, MN/m ² (ksi)	Avg Min					
References:						
SPL, MN/m ² (ksi)	Avg Min					
References:						
G, GN/m ² (10 ⁶ psi)	Avg Min					
References:						
<u>Impact, Charpy V(Cv), Izod(I)</u>						
Long., (0°) J (ft-lb)(a)	Avg Min					
References:						
Trans., (90°) J (ft-lb)(b)	Avg Min					
References:						
Sheet, Normal, J (ft-lb)(c)	Avg Min					
References:						
11.2.2.2 (11/76)						

(a) Warp direction in woven cloth.
(b) Fill direction in woven cloth.
(c) Press cure direction.
(1) Essentially linear to fracture.

TABLE 11.2.2-TR1

Composite Class: Boron-Epoxy

Type: 5.6 mil Boron/2387

Specification: 5505/5.6

Fiber: 5.6 mil boron on tungsten

Layup: Uniaxial tape

Matrix: 2387

Nominal fiber volume fraction: 0.50

Nominal density: 1.94 g/cm³ (0.07 lb/in.³)

Nominal ply thickness: 0.1905 mm (0.0075 in.)

Comments: Specification SP-296 essentially equivalent properties
(5.6 mil Boron/PR 286)

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity							
Longitudinal (0°)(a)							
Watts m ⁻¹ K ⁻¹	Avg	1.02	1.11	0.913 (82 K)		0.178 (7.8 K)	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg	0.59	0.64	0.528 (82 K)		0.103 (7.8 K)	
References: 9							
Transverse (90°)(b)							
Watts m ⁻¹ K ⁻¹	Avg	0.581	0.553	0.466 (86.7 K)		0.174 (14.7 K)	
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg	0.336	0.320	0.269 (86.7 K)		0.100 (14.7 K)	
References: 9							
Sheet Normal(c)							
Watts m ⁻¹ K ⁻¹	Avg						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg						
References:							
Thermal Expansion							
Longitudinal (0°)(a)							
10 ⁻⁶ ΔL/L	Avg						
References:							
Transverse (90°)(b)							
10 ⁻⁶ Δ L/L	Avg						
References:							
Sheet Normal(c)							
10 ⁻⁶ Δ L/L	Avg						
References:							
Specific Heat							
Joules kg ⁻¹ K ⁻¹	Avg						
Btu lb ⁻¹ F ⁻¹	Avg						
References:							
Electrical Resistivity							
Longitudinal (0°)(a)							
Ohm m	Avg						
References:							
Transverse (90°)(b)							
Ohm m	Avg						
References:							
Sheet Normal(c)							
Ohm m	Avg						
References:							

(a) Warp direction in woven cloth.

(b) Fill direction in woven cloth.

(c) Press cure direction.

TABLE 11.3.1-ME1

Composite Class: Graphite-Epoxy

Type: AS/NASA Resin 2

Specification:
 Layup: Uniaxial tape
 Nominal fiber volume fraction: 0.6
 Nominal ply thickness: 0.207 mm (0.008 in.)

Fiber: Type AS graphite
 Matrix: NASA Resin 2(-11)
 Nominal density: 1.52 g/cm³ (0.055 lb/in.³)
 Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°)(a)							
TUS, MN/m ² (ksi)	Avg	1300 (190)		1230 (178)		1300 (190)	
	Min	1190 (173)		1213 (176)		1260 (183)	
References: 8							
E ₁ , GN/m ² (10 ⁶ psi) ⁽²⁾	Avg	117 (17.0)		101 (14.7)		116 (16.9)	
	Min	112 (16.3)		94 (13.6)		107 (15.5)	
References: 8							
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi) ⁽¹⁾	Avg						
	Min						
References:							
Failure Strain, 10 ⁻³	Avg	9.3		9.3		9.0	
	Min	9.0		9.0		9.0	
References: 8							
Poisson's Ratio		0.347		0.299		0.340	
References: 8							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
Tension, Transverse (90°)(b)							
TUS, MN/m ² (ksi)	Avg	12.8 (1.86)		2.44 (0.354)		3.04 (0.441)	
	Min	10.1 (1.47)		1.62 (0.235)		2.37 (0.344)	
References: 8							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	7.79 (1.13)		10.90 (1.58)		11.25 (1.63)	
	Min	7.10 (1.03)		9.65 (1.40)		10.34 (1.50)	
References: 8							
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi) ⁽¹⁾	Avg						
	Min						
References:							
Failure Strain, 10 ⁻³	Avg	2.0		0.2		0.3	
	Min	2.0		0.2		0.2	
References: 8							
Poisson's Ratio		0.022		0.030		0.029	
References: 8							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
(a) Warp direction in woven cloth.							
(b) Fill direction in woven cloth.							
(1) Essentially linear to fracture.							

11.3.1-1 (11/76)

TABLE 11.3.1-ME2

Composite Class: Graphite-Epoxy

Type: AS/NASA Resin 2

Specification:

Layup: Uniaxial tape

Nominal fiber volume fraction: 0.6

Nominal ply thickness: 0.207 mm (0.008 in.)

Fiber: Type AS graphite

Matrix: NASA Resin 2(-11)

Nominal density: 1.52 g/cm³ (0.055 lb/in.³)

Comments:

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)
<u>Compression, Longitudinal (0°)(a)</u>					
CUS, MN/m ² (ksi)	Max 561 (81.2)		1229 (178)		883 (128)
	Avg 531 (77.0)		897 (130)		694 (100)
	Min 496 (71.9)		668 (97)		600 (87)
References: 8					
CPL, MN/m ² (ksi)	Max 355 (51.5)		504 (73.1)		377 (54.7)
	Avg 283 (41.0)		450 (65.4)		374 (54.2)
	Min 225 (32.6)		395 (57.3)		370 (53.7)
References: 8					
E, GN/m ² (10 ⁶ psi)	Avg 129 (18.7)		122 (17.7)		125 (18.1)
	Min 125 (18.1)		110 (16.0)		124 (18.0)
References: 8					
<u>Compression, Transverse (90°)(b)</u>					
CUS, MN/m ² (ksi)	Max 104 (15.1)		151 (21.9)		150 (21.8)
	Avg 89 (12.8)		136 (19.8)		130 (19.0)
	Min 71 (10.3)		125 (18.1)		100 (14.4)
References: 8					
CPL, MN/m ² (ksi)	Max		116 (16.8)		72 (10.5)
	Avg		95 (13.8)		68 (9.8)
	Min		80 (11.5)		65 (9.4)
References: 8					
E, GN/m ² (10 ⁶ psi)	Avg 11.0 (1.59)		15.3 (2.21)		16.1 (2.34)
	Min 10.8 (1.57)		13.1 (1.89)		14.4 (2.09)
References: 8					
<u>In-Plane Shear</u>					
SUS, MN/m ² (ksi)	Avg 4.14 (0.60)		4.48 (0.65)		5.30 (0.77)
	Min --		--		--
References: 7					
SPL, MN/m ² (ksi)	Avg				
	Min				
References:					
G, GN/m ² (10 ⁶ psi)	Avg				
	Min				
References:					
<u>Interlaminar Shear</u>					
SUS, MN/m ² (ksi)	Avg				
	Min				
References:					
SPL, MN/m ² (ksi)	Avg				
	Min				
References:					
G, GN/m ² (10 ⁶ psi)	Avg				
	Min				
References:					
<u>Impact, Charpy V(Cv), Izod(I)</u>					
Long., (0°) J (ft-lb)(a)	Avg				
	Min				
References:					
Trans., (90°) J (ft-lb)(b)	Avg				
	Min				
References:					
Sheet, Normal, J (ft-lb)(c)	Avg				
	Min				
References:					
11.3.1-2 (11/76)					
(a) Warp direction in woven cloth.					
(b) Fill direction in woven cloth.					
(c) Press cure direction.					

TABLE 11.3.2-ME1

Composite Class: Graphite-Epoxy

Type: HT-S/X-904

Specification:

Layup: Uniaxial tape

Nominal fiber volume fraction: 0.60

Nominal ply thickness: 0.127 mm (0.005 in.)

Fiber: HT-S

Matrix: X-904

Nominal density: 1.65 g/cm³ (0.0595 lb/in.³)

Comments:

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°)(a)							
TUS, MN/m ² (ksi)	Avg	1296 (188)		1013 (147)			
	Min	--		--			
References: 1							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	138 (20.0)		140 (20.3)			
	Min	--		--			
References: 1							
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi)	Avg						
	Min						
References:							
Failure Strain, 10 ⁻³	Avg	9.0		7.3			
	Min	--		--			
References: 1							
Poisson's Ratio		0.32		0.35			
References: 1							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
Tension, Transverse (90°)(b)							
TUS, MN/m ² (ksi)	Avg	16.5 (2.4)		24.1 (3.5)			
	Min	--		--			
References: 1							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	7.86 (1.14)		10.96 (1.59)			
	Min	--		--			
References: 1							
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi)	Avg						
	Min						
References:							
Failure Strain, 10 ⁻³	Avg	2.0		2.1			
	Min	--		--			
References: 1							
Poisson's Ratio		0.01		0.02			
References: 1							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
(a) Warp direction in woven cloth.							

11.3.2.1 (11/76)

TABLE 11.3.2-ME2

Composite Class: Graphite-Epoxy

Type: HT-S/X-904

Specification:

Layup: Uniaxial tape

Nominal fiber volume fraction: 0.60

Nominal ply thickness: 0.127 mm (0.005 in.)

Fiber: HT-S

Matrix: X-904

Nominal density: 1.65 g/cm³ (0.0595 lb/in.³)

Comments:

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Compression, Longitudinal (0°)(a)						
CUS, MN/m ² (ksi)	Max 787 (114) Avg Min		Max 1371 (199) Avg Min			
References: 1						
CPL, MN/m ² (ksi)	Max Avg Min					
References:						
E, GN/m ² (10 ⁶ psi)	Avg 136 (19.8) Min		Avg 128 (18.6) Min			
References: 1						
Compression, Transverse (90°)(b)						
CUS, MN/m ² (ksi)	Max 150 (21.8) Avg Min		Max 253 (36.7) Avg Min			
References: 1						
CPL, MN/m ² (ksi)	Max Avg Min					
References:						
E, GN/m ² (10 ⁶ psi)	Avg 10.4 (1.51) Min		Avg 17.2 (2.50) Min			
References: 1						
In-Plane Shear						
SUS, MN/m ² (ksi)	Avg Min					
References:						
SPL, MN/m ² (ksi)	Avg Min					
References:						
G, GN/m ² (10 ⁶ psi)	Avg Min					
References:						
Interlaminar Shear						
SUS, MN/m ² (ksi)	Avg 95.8 (13.9) Min		Avg 120 (17.4) Min			
References: 1						
SPL, MN/m ² (ksi)	Avg Min					
References:						
G, GN/m ² (10 ⁶ psi)	Avg Min					
References:						
Impact, Charpy V(Cv), Izod(I)						
Long., (0°) J (ft-lb)(a)	Avg Min					
References:						
Trans., (90°) J (ft-lb)(b)	Avg Min					
References:						
Sheet, Normal, J (ft-lb)(c)	Avg Min					
References:						
		11.3.2-2 (11/76)				

(a) Warp direction in woven cloth.

(b) Fill direction in woven cloth.

(c) Press cure direction.

TABLE 11.3.2-TR1

Composite Class: Graphite-Epoxy

Type: HT-S/X-904

Specification:

Layup: Uniaxial tape

Nominal fiber volume fraction: 0.60

Nominal ply thickness: 0.127 mm (0.005 in.)

Fiber: HT-S

Matrix: X-904

Nominal density: 1.65 g/cm³ (0.0595 lb/in.³)

Comments:

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity						
Longitudinal (0°)(a)						
Watts m ⁻¹ K ⁻¹	Avg	13.55	11.50	4.30		
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg	7.83	6.64	2.48		
References: 1						
Transverse (90°)(b)						
Watts m ⁻¹ K ⁻¹	Avg	0.660	0.505	0.267		
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg	0.381	0.291	0.154		
References: 1						
Sheet Normal(c)						
Watts m ⁻¹ K ⁻¹	Avg					
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	Avg					
References:						
Thermal Expansion						
Longitudinal (0°)(a)						
10 ⁻⁶ ΔL/L	Avg	0	+13.9	+41.6		
References: 1						
Transverse (90°)(b)						
10 ⁻⁶ ΔL/L	Avg	0	-1270	-2500		
References: 1						
Sheet Normal(c)						
10 ⁻⁶ ΔL/L	Avg					
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	Avg	890	629	304		
Btu lb ⁻¹ F ⁻¹	Avg	2125	1492	726		
References: 1						
Electrical Resistivity						
Longitudinal (0°)(a)						
Ohm m	Avg	0.3-70*		0.4-90*		
References: 1						
Transverse (90°)(b)						
Ohm m	Avg	190		220		
References: 1						
Sheet Normal(c)						
Ohm m	Avg	1600		1900		
References: 1						

(a) Warp direction in woven cloth.

(b) Fill direction in woven cloth.

(c) Press cure direction.

* Electrical resistivity in fiber direction strongly affected by fiber volume, fiber distribution and moisture content of composite.

TABLE 11.4.1-ME1

Composite Class: Boron-Aluminum

Type: 5.6 mil Boron/6061

Specification:

Layup: Uniaxial tape

Nominal fiber volume fraction: 0.47

Nominal ply thickness: 0.180 mm (0.007 in.)

Fiber: 5.6 mil boron on tungsten

Matrix: 6061 Aluminum

Nominal density: 2.66 g/cm³ (0.095 lb/in.³)

Comments: F Temper, diffusion bonded

Testing Temperature, K (F)		297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Tension, Longitudinal (0°) (a)							
TUS, MN/m ² (ksi)	Avg	1310 (190)		1630 (237)		1606 (233)	
	Min	1206 (175)		1585 (230)		1496 (217)	
References: 6, 7							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	205 (29.8)		196 (28.5)		204 (29.5)	
	Min	194 (28.1)		186 (27.0)		191 (27.7)	
References: 6, 7							
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi) (1)	Avg						
	Min						
References:							
Failure Strain, 10 ⁻³	Avg	6.20		7.75		7.75	
	Min	6.00		7.00		7.00	
References: 6, 7							
Poisson's Ratio		0.29		0.34		0.34	
References: 6, 7							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
Tension, Transverse (90°) (b)							
TUS, MN/m ² (ksi)	Avg	163 (23.6)		244 (35.4)		276 (40.0)	
	Min	145 (21.1)		229 (33.2)		273 (39.6)	
References: 6, 7							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	156 (22.6)		128 (18.5)		150 (21.8)	
	Min	138 (20.0)		100 (14.6)		118 (17.1)	
References: 6, 7							
SE ₁ , MN/m ² (ksi)	Avg						
	Min						
References:							
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
References:							
TPL, MN/m ² (ksi)	Avg	66.2 (9.6)		76.0 (11.0)		72.1 (10.5)	
	Min	53.7 (7.8)		64.8 (9.4)		50.3 (7.3)	
References: 6, 7							
Failure Strain, 10 ⁻³	Avg	6.3		8.3		8.7	
	Min	4.9		8.0		8.0	
References: 6, 7							
Poisson's Ratio		0.22		0.22		0.25	
References: 6, 7							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
References:							
(a) Warp direction in woven cloth.							
(b) Fill direction in woven cloth.							

11.4.1-1 (11/76)

Type: 5.6 mil Boron/6061

Fiber: 5.6 mil boron on tungsten
Matrix: 6061 Aluminum
Nominal density: 2.66 g/cm³ (0.095 lb/in.³)
Comments: F Temper. diffusion bonded

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)
Compression, Longitudinal (0°)(a)					
CUS, MN/m ² (ksi) (1)	Max 2475 (359) Avg 1980 (287) Min 1455 (211)		2868 (416) 2068 (300) 1393 (202)		3260 (473) 2900 (421) 2600 (377)
References: 8, 12, 13					
CPL, MN/m ² (ksi) (2)	Max Avg Min				
References:					
E, GN/m ² (10 ⁶ psi) (1, 3)	Avg (228) (33) Min --				
References: 6					
Compression, Transverse (90°)(b)					
CUS, MN/m ² (ksi) (1)	Max 321 (46.6) Avg 275 (39.8) Min 249 (36.1)		456 (66.2) 436 (63.2) 387 (56.1)		656 (95.1) 623 (90.3) 582 (84.5)
References: 8, 12, 13					
CPL, MN/m ² (ksi) (1)	Max 59.4 (8.61) Avg 57.7 (8.37) Min 54.9 (7.97)		96.7 (14.0) 87.3 (12.7) 81.8 (11.9)		113 (16.4) 108 (15.7) 101 (14.6)
References: 8					
E, GN/m ² (10 ⁶ psi) (1)	Avg 150 (21.8) Min 107 (15.5)		124 (18.0) 89 (12.9)		101 (14.6) 90 (13.0)
References: 8, 12, 13					
In-Plane Shear					
SUS, MN/m ² (ksi)	Avg 155 (22.5) Min 89 (12.9)		162 (23.5) 137 (19.8)		
References: 12					
SPL, MN/m ² (ksi)	Avg Min				
References:					
G, GN/m ² (10 ⁶ psi)	Avg 58 (8.4) Min 57 (8.3)				
References: 12					
Interlaminar Shear					
SUS, MN/m ² (ksi)	Avg 124 (18) Min 97 (14)		132 (19.1) --		
References: 6, 14					
SPL, MN/m ² (ksi)	Avg Min				
References:					
G, GN/m ² (10 ⁶ psi)	Avg Min				
References:					
Impact, Charpy V(Cv), Izod(I)					
Long., (0°) J (ft-lb)(a)	Avg Min				
References:					
Trans., (90°) J (ft-lb)(b)	Avg Min				
References:					
Sheet, Normal, J (ft-lb)(c)	Avg Min				
References:					
11.4.1-2 (11/76)					
(a) Warp direction in woven cloth.					
(b) Fill direction in woven cloth.					
(c) Press cure direction.					
(1) Sandwich beam data not included.					
(2) Essentially linear to fracture.					

Composite Class: Boron-Aluminum

Type: 5.6 mil Boron/6061

Specification:

Fiber: 5.6 mil boron on tungsten

Layup: Uniaxial tape

Matrix: 6061 aluminum

Nominal fiber volume fraction: 0.47

Nominal density: 2.66 g/cm^3 (0.095 lb/in.^3)

Nominal ply thickness: 0.180 mm (0.007 in.)

Comments: F Temper, diffusion bonded

FatigueLoad orientation: 0° (uniaxial)

Load direction: tension-tension

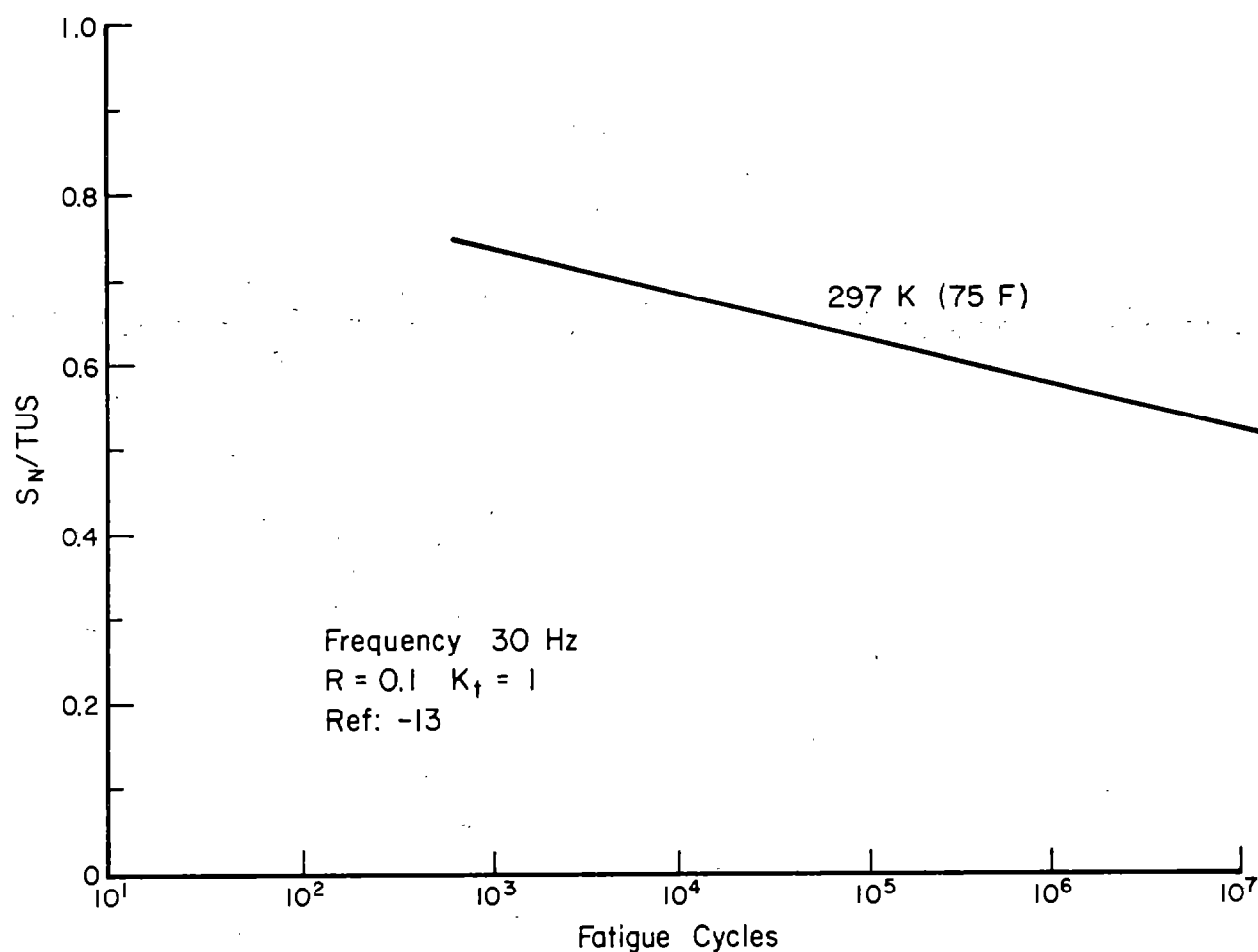


FIGURE 11.4.1-ME1. FATIGUE LIFE CYCLE FOR BORON-ALUMINUM

11.4.1-3 (11/76)

TABLE 11.4.1-TR1

Composite Class: Boron-Aluminum

Type: 5.6 mil Boron/6061

Specification:
 Layup: Uniaxial tape
 Nominal fiber volume fraction: 0.47
 Nominal ply thickness: 0.180 mm (0.007 in.)

Fiber: 5.6 mil boron on tungsten
 Matrix: 6061 Aluminum
 Nominal density: 2.66 g/cm³ (0.095 lb/in.³)
 Comments: F Temper, diffusion bonded

Testing Temperature, K (F)	297 (75)	195 (-108)	77 (-320)	20 (-423)	4 (-452)	
Thermal Conductivity						
Longitudinal (0°)(a)						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
References:						
Transverse (90°)(b)						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
References:						
Sheet Normal(c)						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
References:						
Thermal Expansion						
Longitudinal (0°)(a)						
10 ⁻⁶ ΔL/L						
References: 1, 14						
Transverse (90°)(b)						
10 ⁻⁶ ΔL/L						
References: 1, 14						
Sheet Normal(c)						
10 ⁻⁶ ΔL/L						
References:						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						
Btu lb ⁻¹ F ⁻¹						
References: 14						
Electrical Resistivity						
Longitudinal (0°)(a)						
Ohm m						
References:						
Transverse (90°)(b)						
Ohm m						
References:						
Sheet Normal(c)						
Ohm m						
References:						

(a) Warp direction in woven cloth.

(b) Fill direction in woven cloth.

(c) Press cure direction.

References

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**INDEX TO MATERIAL CODES FOR
SECTION 12.0**

POLYMERS

<u>MATERIALS</u>	<u>MATERIAL CODE</u>
POLYETHYLENE (PE)	12.1.1
POLYTETRAFLUOROETHYLENE (PTFE)	12.1.2
POLYCHLOROTRIFLUOROETHYLENE (PCTFE)	12.1.3
POLYMETHYLMETHACRYLATE (PMM)	12.2.1
POLYSTYRENE (PS)	12.3.1
POLYVINYLACETATE (PVA)	12.4.1

TABLE 12.1.1-TP1

Alloy Designation: Polyethylene

Specification:

Form:

Dimension:

Condition: Amorphous

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						
No. of Spec.						
References:						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-1.3	-1.45	-1.75	-1.75	-1.75
No. of Spec.	1	1	1	1	1	1
References: 94208						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	1600	680	350	100	24.5	19.5
Btu lb ⁻¹ F ⁻¹	(0.382)	(0.163)	(0.0837)	(0.0239)	(0.00586)	(0.00466)
No. of Spec.	1	3	3	3	3	2
References: 94198, 94199, 94203						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

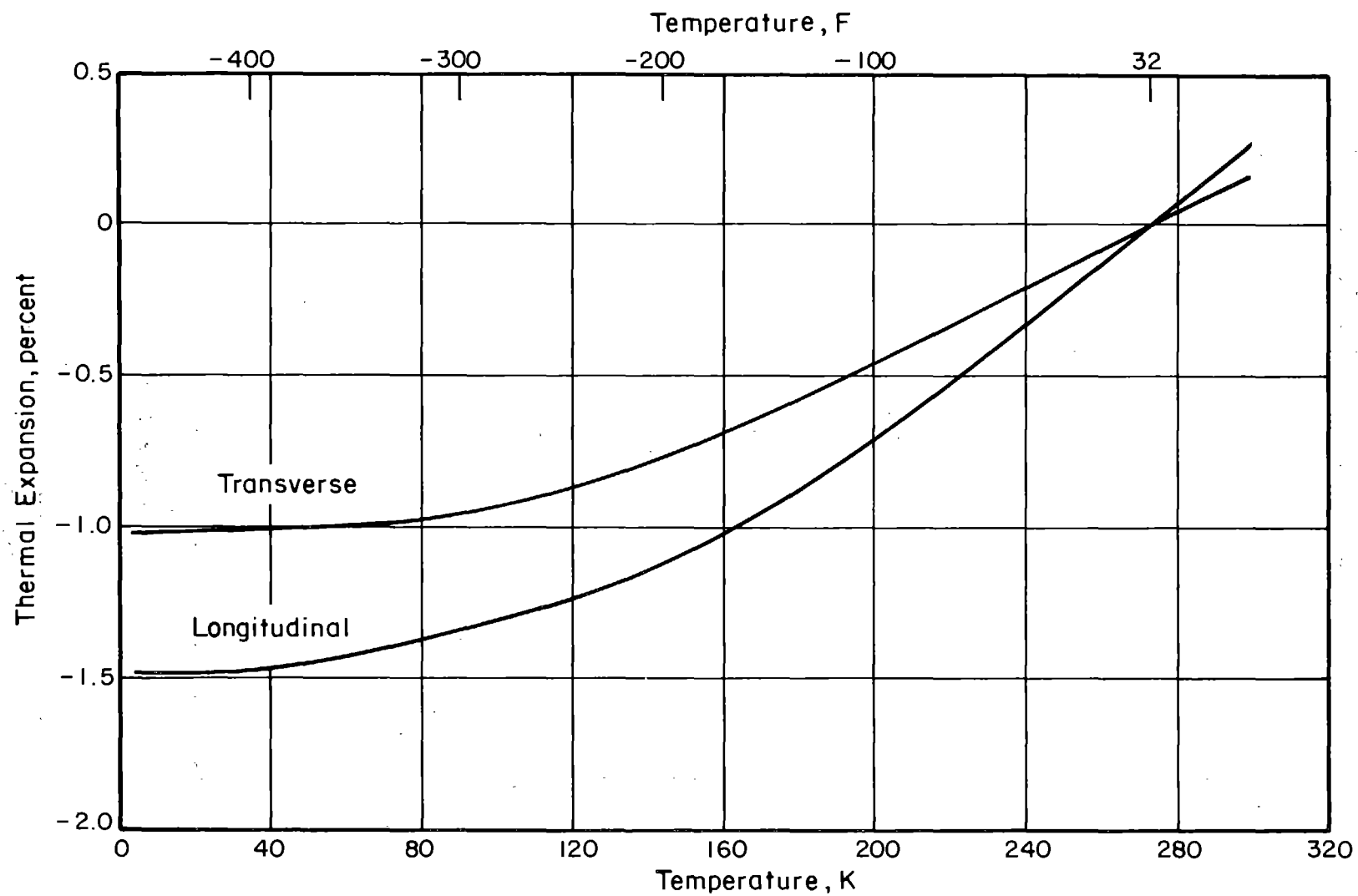


FIGURE 12.1.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR POLYETHYLENE

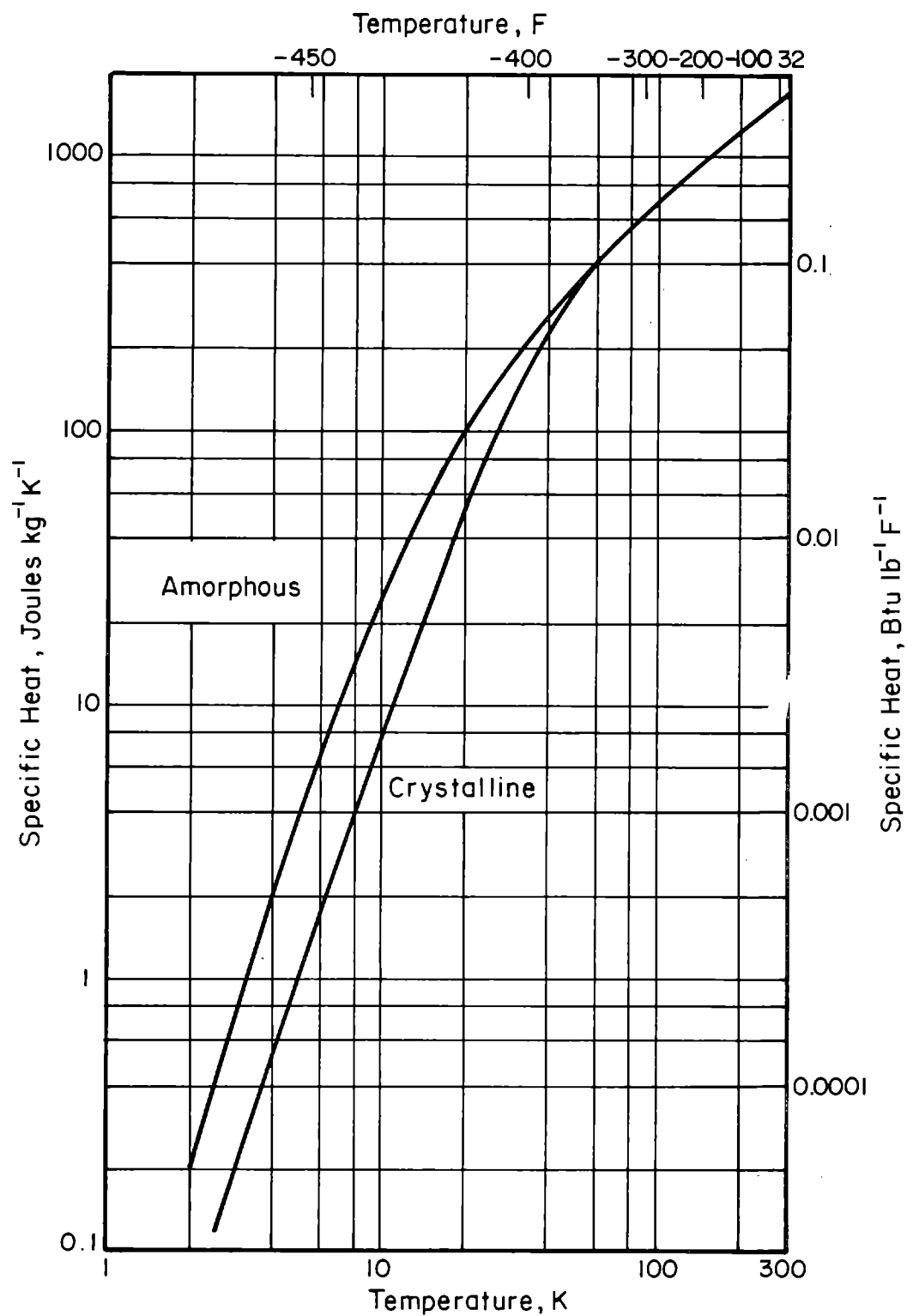


FIGURE 12.1.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR CRYSTALLINE AND AMORPHOUS POLYETHYLENE

TABLE 12.1.2-ME1

Alloy Designation: Polychlorotrifluoroethylene (PCTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 37.6 - 40.0

Testing Temperature, K (F)		297 (75)	195 (-108)	145 (-200)	77 (-320)	20 (-423)	
Tension							
TUS, MN/m ² (ksi)	Avg	37.2 (5.4)	110 (16.0)	150 (21.8)	174 (25.2)	200 (29.0)	
	Min						
Std. Deviation					170 (24.6)		
TYS, MN/m ² (ksi)	Avg	41.4 (6.0)	107 (15.5)	148 (21.5)	171 (24.9)	196 (28.9)	
	Min						
Std. Deviation			102 (14.8)	143 (20.8)	167 (24.2)	193 (28.0)	
Elong, percent	Avg	140	20.0	8.5	5.0	3	
	Min						
No. of Specimens							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	1.59 (0.23)	3.65 (0.53)	5.52 (0.80)	7.58 (1.10)	8.62 (1.25)	
	Min						
					7.52 (1.09)	8.41 (1.22)	
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Specimens							
Compression							
CUS, MN/m ² (ksi)	Avg						
	Min						
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
Flexure							
FUS, MN/m ² (ksi)	Avg						
	Min						
FYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Shear							
G, GN/m ² (10 ⁶ psi)	Avg	0.39 (0.057)	0.97 (0.140)	1.24 (0.180)	1.60 (0.232)	1.81 (0.262)	
	Min						
						1.71 (0.248)	
References: 90205							

TABLE 12.1.2-ME2

Alloy Designation: Polychlorotrifluoroethylene (PCTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 52.6 - 55.0

Testing Temperature, K (F)		297 (75)	195 (-108)	145 (-200)	77 (-320)	20 (-423)	
Tension							
TUS, MN/m ² (ksi)	Avg	34.5 (5.0)	93.1 (13.5)	112 (16.2)	121 (17.5)	141 (20.4)	
	Min				117 (17.0)	139 (20.2)	
Std Deviation							
TYS, MN/m ² (ksi)	Avg	37.9 (5.5)	89.6 (13.0)	110 (16.0)	121 (17.5)	141 (20.5)	
	Min		88.3 (12.8)	108 (15.6)	117 (17.0)		
Std. Deviation							
Elong, percent	Avg	147	15	5	3	1	
	Min	130					
No. of Specimens							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	1.59 (0.23)	3.38 (0.49)	4.83 (0.70)	5.65 (0.82)	8.69 (0.97)	
	Min					6.21 (0.90)	
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
Compression							
CUS, MN/m ² (ksi)	Avg						
	Min						
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
Flexure							
FUS, MN/m ² (ksi)	Avg						
	Min						
FYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Shear							
G, GN/m ² (10 ⁶ psi)	Avg	4.41 (0.640)	1.03 (0.150)	1.19 (0.172)	1.35 (0.196)	1.52 (0.220)	
	Min					1.48 (0.215)	
References: 90205							

TABLE 12.1.2-ME3

Alloy Designation: Polychlorotrifluoroethylene (PCTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 57.6 - 60.0

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
E _{f1} , GN/m ² (10 ⁶ psi)	Avg						
	Min						
E _{f2} , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
<u>Impact</u>							
Charpy V, J (ft-lb)/m (ft-lb/in)	Avg						
	Min						
No. of Specimens							
Izod, J/m (ft-lb/in.)	Avg	74.0 (1.40)	68.7 (1.30)		66.1 (1.25)	71.9 (1.36)	
	Min		65.5 (1.24)		61.3 (1.16)	65.6 (1.24)	
No. of Specimens							
<u>Hardness</u>							
Rockwell	Avg						
	Min						
References: 90205							

TABLE 12.1.2-ME4

Alloy Designation: Polychlorotrifluoroethylene (PCTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 67.6 - 70.0

Testing Temperature, K (F)		297 (75)	195 (-108)	145 (-200)	77 (-320)	20 (-423)	
Tension							
TUS, MN/m ² (ksi)	Avg	31.0 (4.5)	85.5 (12.4)	91.0 (13.2)	109 (15.8)	124 (18.0)	
	Min				107 (15.5)	121 (17.6)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	44.8 (6.5)	82.7 (12.0)	96.5 (14.0)	105 (15.2)	124 (18.0)	
	Min			93.8 (13.6)			
Std. Deviation							
Elong, percent	Avg	47	10	3	1	0.0	
	Min	35					
No. of Specimens							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	1.59 (0.23)	3.52 (0.51)	4.48 (0.65)	5.17 (0.75)	5.65 (0.82)	
	Min					5.38 (0.78)	
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
Compression							
CUS, MN/m ² (ksi)	Avg						
	Min						
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
Flexure							
FUS, MN/m ² (ksi)	Avg						
	Min						
FYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Shear							
G, GN/m ² (10 ⁶ psi)	Avg	0.52 (0.076)	1.00 (0.145)	1.13 (0.164)	1.41 (0.205)	1.60 (0.232)	
	Min					1.55 (0.225)	
References: 90205							

TABLE 12.1.2-ME5

Alloy Designation: Polychlorotrifluoroethylene (PCTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 67.6-70.0

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
E _{f1} , GN/m ² (10 ⁶ psi)	Avg						
	Min						
E _{f2} , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Spec.							
<u>Impact</u>							
Charpy, V, J (ft-lb)/m (ft-lb/in.)	Avg						
	Min						
No. of Spec.							
Izod, J/m (ft-lb/in.)	Avg	58.2 (1.10)	55.5 (1.05)		58.2 (1.10)	65.6 (1.24)	
	Min	51.8 (0.93)	52.9 (1.00)		52.9 (1.00)	59.2 (1.12)	
No. of Spec.							
<u>Hardness</u>							
Rockwell	Avg						
	Min						
References: 90205							

TABLE 12.1.2-TR1

Alloy Designation: Polychlorotrifluoroethylene (Kel-F)

Specification:

Form:

Dimension:

Condition: Amorphous

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹	0.130	0.099	0.079	0.054	0.038	0.0190
Btu hr ⁻¹ ft ⁻¹ F ⁻¹	(0.075)	(0.057)	(0.046)	(0.031)	(0.022)	(0.011)
No. of Spec.	1	1	1	1	1	1
References: 90205, 96881						
Thermal Expansion (T₂₇₃ to T)						
<u>Longitudinal</u>						
Percent	0	-0.725	-0.860			
No. of Spec.	1	1	1			
References: 94202						
Specific Heat						
Joules kg ⁻¹ K ⁻¹						3.72
Btu lb ⁻¹ F ⁻¹						(9.56 x 10 ⁻⁴)
No. of Spec.						1
References: 96881						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

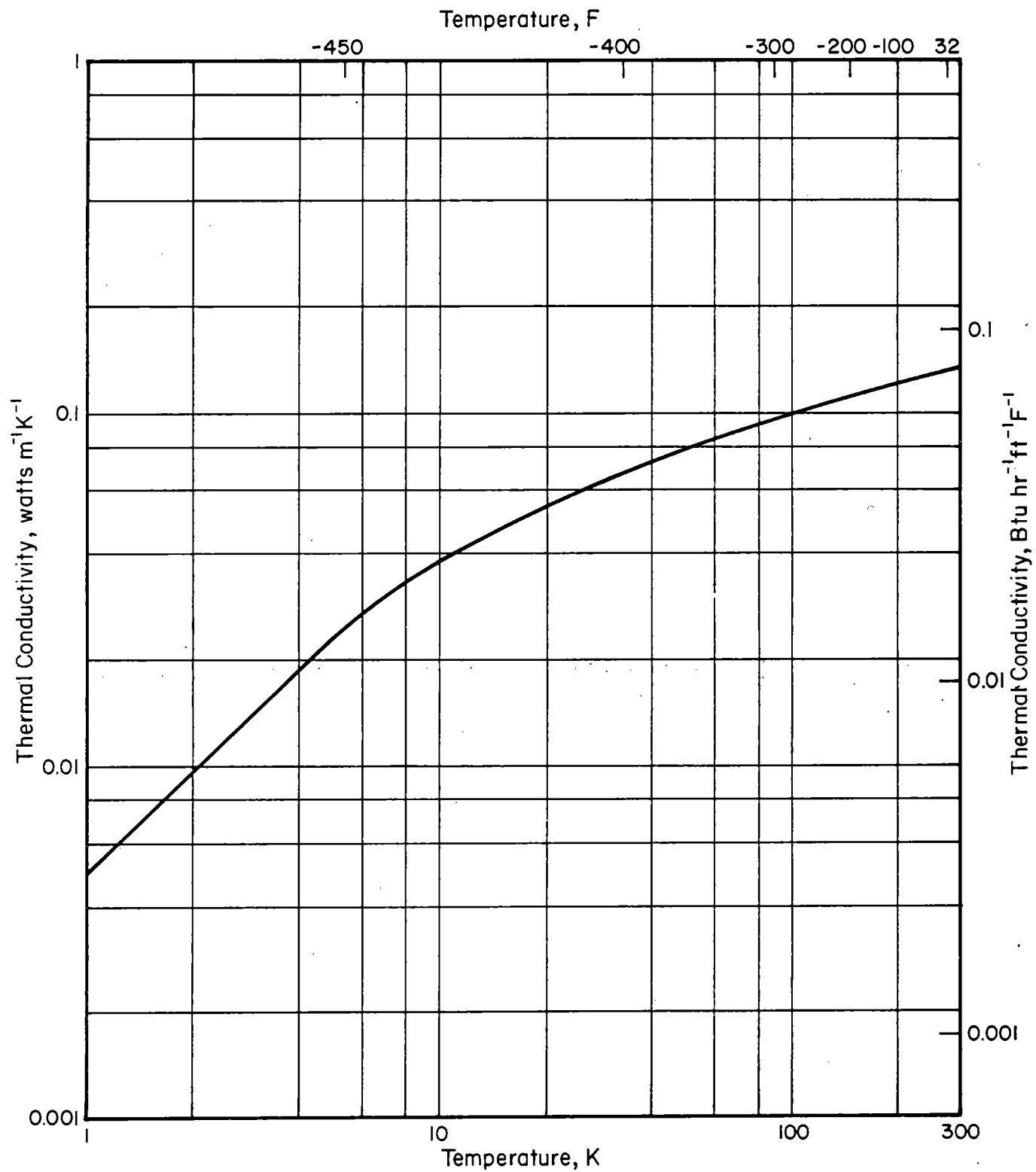


FIGURE 12.1.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR POLYCHLOROTRIFLUORDETHYLENE (KEL-F)

12.1.2-7 (11/75)

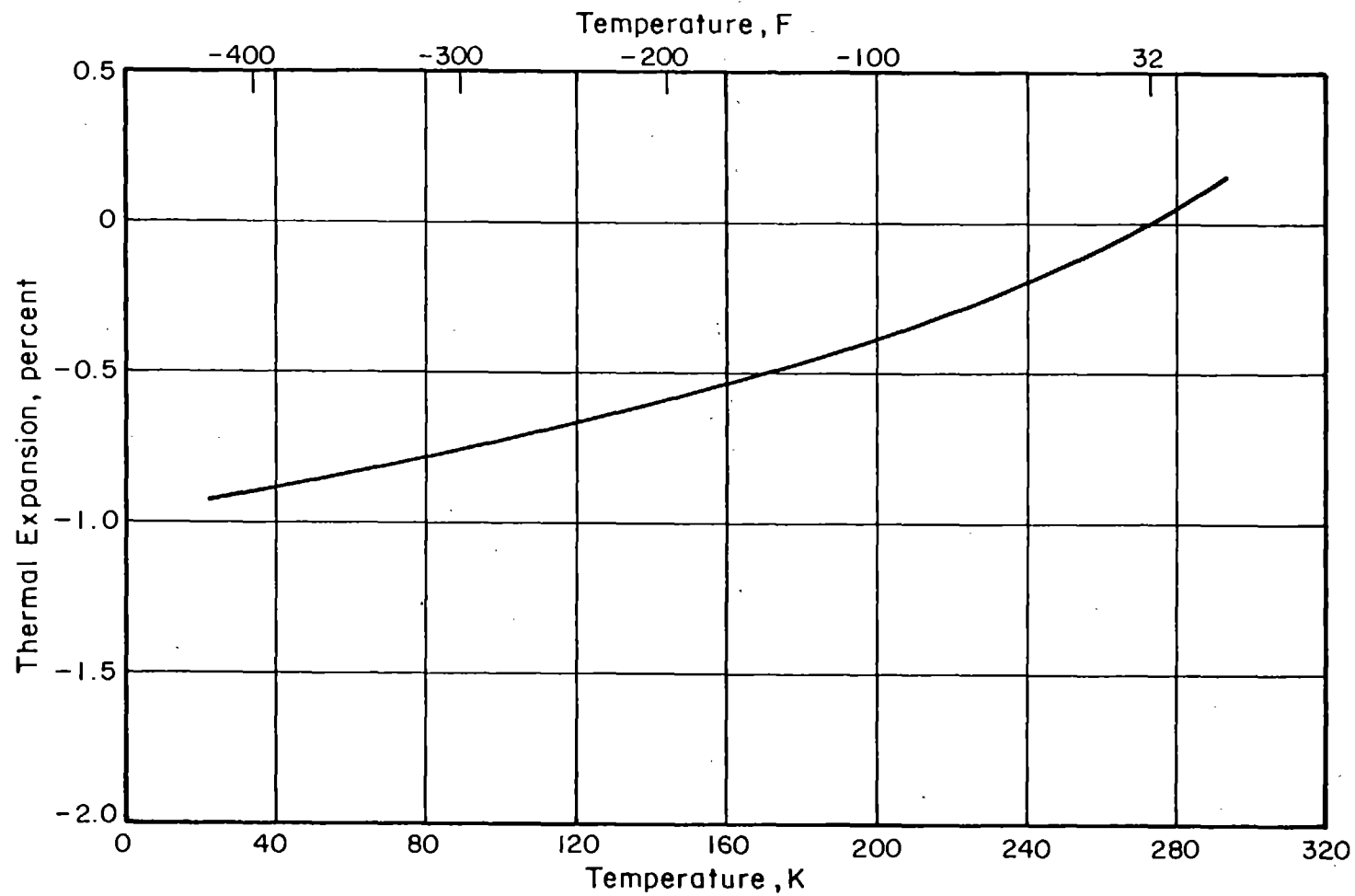


FIGURE 12.1.2-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR POLYCHLOROTRIFLUOROETHYLENE(KEL-F)

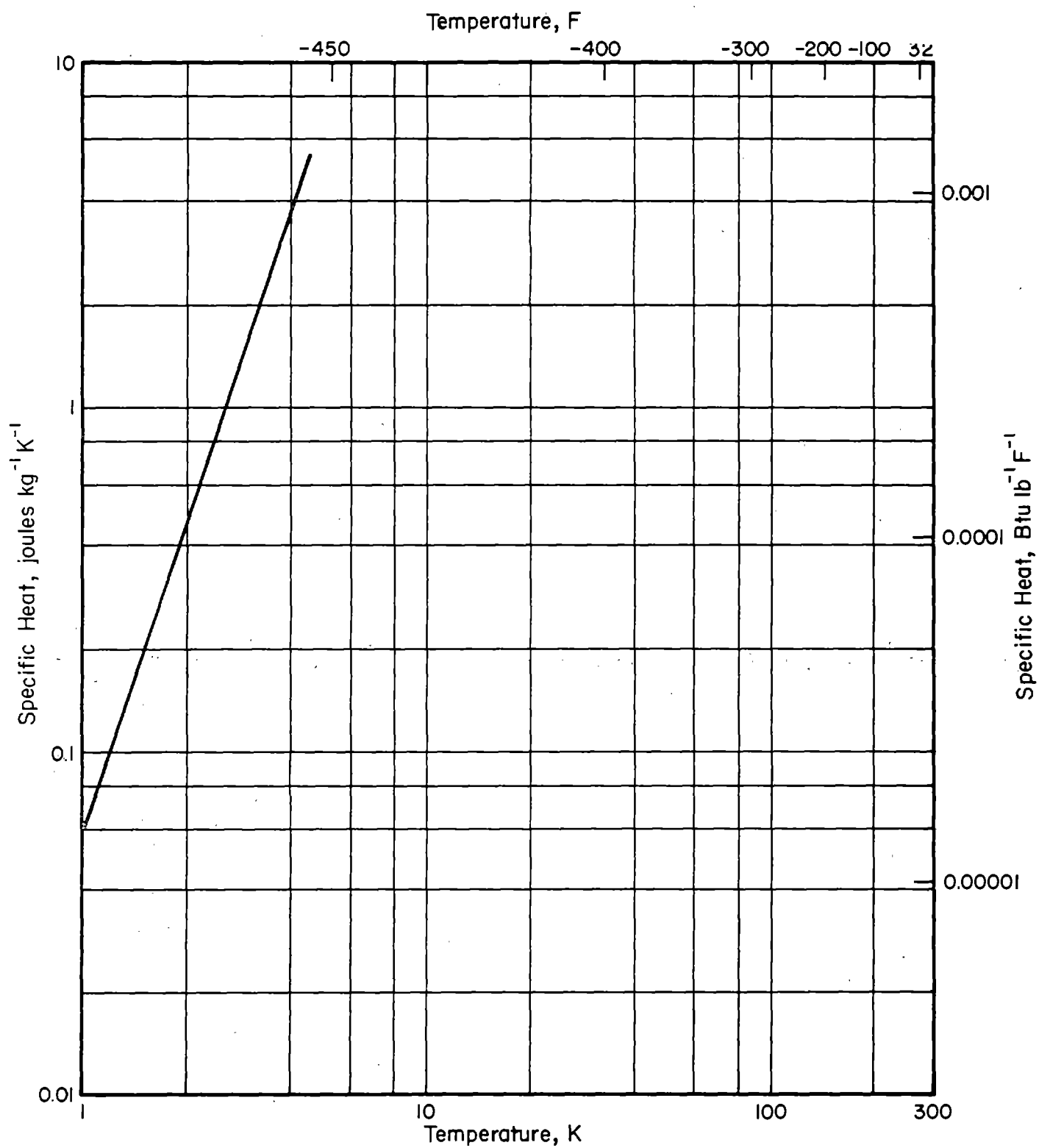


FIGURE 12.1.2-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR POLYCHLOROTRIFLUOROETHYLENE (KEL-F)

TABLE 12.1.3-ME1

Alloy Designation: Polytetrafluoroethylene (PTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 47.6 - 50.0

Testing Temperature, K (F)		297 (75)	195 (-108)	145 (-200)	77 (-320)	20 (-423)	
Tension							
TUS, MN/m ² (ksi)	Avg	32.4 (4.7)	44.1 (6.4)	64.8 (9.4)	124 (18.0)	140 (20.3)	
	Min					135 (19.6)	
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	10.3 (1.5)	36.5 (5.3)	63.4 (9.2)	112 (16.2)	138 (20.0)	
	Min				107 (15.5)	134 (19.5)	
Std. Deviation							
Elong, percent	Avg	112	40	18	6	3	
	Min	58					
No. of Specimens							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	0.34 (0.05)	1.24 (0.18)	2.14 (0.31)	4.00 (0.58)	4.14 (0.60)	
	Min			1.79 (0.26)	3.31 (0.48)	3.86 (0.56)	
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
	Min						
K _t =							
No. of Specimens							
Compression							
CUS, MN/m ² (ksi)	Avg	21 (3.0)	44.3 (6.5)	99.3 (14.4)	138 (20.0)	211 (30.6)	
	Min		41.9 (6.0)	93.1 (13.5)	133 (19.2)	203 (29.5)	
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Ec, GN/M ² (10 ⁶ psi)	Avg	0.41 (0.06)	1.65 (0.29)	3.79 (0.55)	5.17 (0.75)	5.72 (0.83)	
	Min		1.52 (0.22)				
No. of Specimens							
Flexure							
FUS, MN/m ² (ksi)	Avg	28 (4)	38 (5.5)	112 (16.2)	207 (30.0)	232 (33.7)	
	Min		33 (4.8)			228 (33.0)	
FYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
References: 90205							

TABLE 12.1.3-ME2

Alloy Designation: Polytetrafluoroethylene (PTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 47.6 - 50.0

Testing Temperature, K (F)		297 (75)	195 (-108)	145 (-200)	77 (-320)	20 (-423)	
E _{f1} , GN/m ² (10 ⁶ psi)	Avg	0.97 (0.14)	1.52 (0.22)	3.38 (0.49)	5.03 (0.73)	5.38 (0.78)	
	Min						
E _{f2} , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
<u>Impact</u>							
Charpy V, J (ft-lb)J/m (ft-lb/in)	Avg						
	Min						
No. of Specimens							
Izod, J/m (ft-lb/in.)	Avg						
	Min						
No. of Specimens							
<u>Hardness</u>							
Rockwell	Avg						
	Min						
<u>Shear</u>							
G, GN/m ² (10 ⁶ psi)	Avg	0.14 (0.02)	0.43 (0.07)	1.03 (0.15)	1.52 (0.22)	1.86 (0.27)	
	Min					1.72 (0.25)	
References: 90205							

TABLE 12.1.3-ME3

Alloy Designation: Polytetrafluoroethylene (PTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 50.1 - 52.5

Testing Temperature, K (F)		297 (75)	195 (-108)	145 (-200)	77 (-320)	20 (-423)	
Tension							
TUS, MN/m ² (ksi)	Avg	30.3 (4.4)	40.0 (5.0)	62.1 (9.0)	108 (15.6)	131 (19.0)	
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	11.7 (1.7)	33.1 (4.8)	57.9 (8.4)	106 (15.4)	131 (19.0)	
	Min						
Std. Deviation							
Elong, percent	Avg	284	35	11	7	3	
	Min	256					
No. of Specimens							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	0.48 (0.07)	1.10 (0.16)	2.14 (0.31)	3.59 (0.52)	4.48 (0.65)	
	Min						
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
Compression							
CUS, MN/m ² (ksi)	Avg						
	Min						
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Ec, GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
Flexure							
FUS, MN/m ² (ksi)	Avg	21 (3.0)	49.6 (7.2)	107 (15.5)	165 (24.0)	177 (25.7)	
	Min				163 (23.7)	172 (25.0)	
FYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Shear							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
References: 90205							

TABLE 12.1.3-ME4

Alloy Designation: Polytetrafluoroethylene (PTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 50.1 - 52.5

Testing Temperature, K (F)		297 (75)	195 (-108)	145 (-200)	77 (-320)	20 (-423)	
E _{f1} , GN/m ² (10 ⁶ psi)	Avg	1.17 (0.17)	1.79 (0.26)	3.10 (0.45)	4.90 (0.71)	5.03 (0.72)	
	Min						
E _{f2} , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
<u>Impact</u>							
Charpy V, J (ft-lb)J/m (ft-lb/in)	Avg	60.8 (1.15)	63.6 (1.20)		63.6 (1.20)	66.7 (1.26)	
	Min						
No. of Specimens			55.0 (1.04)				
<u>Hardness</u>							
Rockwell	Avg						
	Min						
<u>Shear</u>							
G, GN/m ² (10 ⁶ psi)	Avg	0.14 (0.02)	0.34 (0.05)	0.83 (0.12)	1.31 (0.19)	1.86 (0.27)	
	Min						
References: 90205							

TABLE 12.1.3-ME5

Alloy Designation: Polytetrafluoroethylene (PTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 55.1 - 57.5

Testing Temperature, K (F)		297 (75)	195 (-108)	145 (-200)	77 (-320)	20 (-423)	
<u>Tension</u>							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
TYS, MN/m ² (ksi)	Avg						
	Min						
Std Deviation							
Elong, percent	Avg						
	Min						
No. of Specimens							
E ₁ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
<u>Compression</u>							
CUS, MN/m ² (ksi)	Avg	26.2 (3.8)	(7.5)	114 (16.5)	145 (21.0)	224 (32.5)	
	Min			109 (15.8)	140 (20.2)	203 (29.5)	
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
E _c , GN/m ² (10 ⁶ psi)	Avg	0.76 (0.11)	1.79 (0.26)	3.93 (0.57)	5.52 (0.80)	6.27 (0.91)	
	Min						
No. of Specimens							
<u>Flexure</u>							
FUS, MN/m ² (ksi)	Avg						
	Min						
FYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
<u>Shear</u>							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
References: 90205							

TABLE 12.1.3-ME6

Alloy Designation: Polytetrafluoroethylene (PTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 57.6 - 60.0

Testing Temperature, K (F)		297 (75)	210 (-80)	180 (-135)	110 (-260)	77 (-320)	50 (-370)
Tension							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	11.0 (1.6)				75.8 (11.0)	
	Min						
Std. Deviation							
Elong, percent	Avg	6.0				40.0	
	Min						
No. of Specimens							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	1.03 (0.15)	2.41 (0.35)	4.14 (0.60)	5.79 (0.84)		6.21 (0.90)
	Min						
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
Compression							
CUS, MN/m ² (ksi)	Avg						
	Min						
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
E _c , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
Flexure							
FUS, MN/m ² (ksi)	Avg						
	Min						
FYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Shear							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
References: 90205							

TABLE 12.1.3-ME7

Alloy Designation: Polytetrafluoroethylene (PTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 65.1 - 67.5

Testing Temperature, K (F)		297 (75)	195 (-108)	145 (-200)	77 (-320)	20 (-423)	
Tension							
TUS, MN/m ² (ksi)	Avg	27.6 (4.0)	37.2 (5.4)	59.3 (8.6)	81.4 (11.8)	108 (15.6)	
	Min					105 (15.2)	
Std Deviation							
TYS, MN/m ² (ksi)	Avg	13.8 (2.0)	24.8 (3.6)	42.8 (6.2)	73.8 (10.7)	108 (15.6)	
	Min			40.0 (5.8)		105 (15.2)	
Std Deviation							
Elong, percent	Avg	230	24	8	6	3	
	Min						
No. of Specimens							
E ₁ , GN/m ² (10 ⁶ psi)	Avg	0.69 (0.10)	1.45 (0.21)	2.00 (0.29)	3.03 (0.44)	4.27 (0.62)	
	Min				2.76 (0.40)		
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
Compression							
CUS, MN/m ² (ksi)	Avg						
	Min						
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
E _c , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
Flexure							
FUS, MN/m ² (ksi)	Avg	27.6 (4.0)	56.5 (8.2)	96.5 (14.0)	148 (21.5)	157 (22.8)	
	Min		53.8 (7.8)			153 (22.2)	
FYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Shear							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
References: 90205							

TABLE 12.1.3-ME8

Alloy Designation: Polytetrafluoroethylene (PTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 65.1 - 67.5

Testing Temperature, K (F)		297 (75)	195 (-108)	145 (-200)	77 (-320)	20 (-423)	
E _{f1} , GN/m ² (10 ⁶ psi)	Avg	1.31 (0.19)	1.65 (0.24)	2.90 (0.42)	4.41 (0.69)	4.83 (0.70)	
	Min						
E _{f2} , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
<u>Impact</u>							
Charpy V, J(ft-lb)/J/m (ft-lb/in.)	Avg						
	Min						
No. of Specimens							
Izod, J/m(ft-lb/in.)	Avg						
	Min						
No. of Specimens							
<u>Hardness</u>							
Rockwell	Avg						
	Min						
<u>Shear, psi x 10⁶</u>							
G, GN/m ² (10 ⁶ psi)	Avg	0.21 (0.03)	0.48 (0.07)	0.90 (0.13)	1.38 (0.20)	2.62 (0.38)	
	Min					2.28 (0.33)	
References: 90205							

TABLE 12.1.3-ME9

Alloy Designation: Polytetrafluoroethylene (PTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 67.6 - 70.0

Testing Temperature, K (F)		297 (75)	195 (-108)	145 (-200)	77 (-320)	20 (-423)	
Tension							
TUS, MN/m ² (ksi)	Avg						
	Min						
Std. Deviation							
TYS, MN/m ² (ksi)	Avg	8.3 (1.2)			53.8 (7.8)		
	Min						
Std. Deviation							
Elong, percent	Avg	25			6.0		
	Min						
No. of Specimens							
E ₁ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
E ₂ , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
NTS, MN/m ² (ksi)	Avg						
K _t =	Min						
No. of Specimens							
Compression							
CUS, MN/m ² (ksi)	Avg	31.0 (4.5)	56.5 (8.2)	121 (17.6)	152 (22.0)	231 (33.5)	
	Min			117 (17.0)	148 (21.4)		
CYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
E _c , GN/m ² (10 ⁶ psi)	Avg	0.97 (0.14)	2.14 (0.31)	4.27 (0.62)	5.79 (0.84)	6.76 (0.98)	
	Min						
No. of Specimens							
Flexure							
FUS, MN/m ² (ksi)	Avg						
	Min						
FYS, MN/m ² (ksi)	Avg						
	Min						
No. of Specimens							
Shear							
G, GN/m ² (10 ⁶ psi)	Avg						
	Min						
References: 90205							

TABLE 12.1.3-ME10

Alloy Designation: Polytetrafluoroethylene (PTFE)

Specification:

Form:

Thickness, cm (in.):

Condition:

Crystallinity, percent: 70.1 - 72.5

Testing Temperature, K (F)		297 (75)	195 (-108)		77 (-320)	20 (-423)	
E _{f1} , GN/m ² (10 ⁶ psi)	Avg						
	Min						
E _{f2} , GN/m ² (10 ⁶ psi)	Avg						
	Min						
No. of Specimens							
Impact							
Charpy V, J(ft-lb)/m (ft-lb/in.)	Avg						
	Min						
No. of Specimens							
Izod, J/m(ft-lb/in.)	Avg	140 (2.65)	94.0 (1.78)		72.9 (1.38)	81.9 (1.55)	
	Min		85.8 (1.62)		67.9 (1.28)	76.8 (1.45)	
No. of Specimens							
Hardness							
Rockwell	Avg						
	Min						
References: 90205							

TABLE 12.1.3-TR1

Alloy Designation: Polytetrafluoroethylene (Teflon)

Specification:

Form:

Dimension:

Condition: Amorphous

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						0.032
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						(0.018)
No. of Spec.						1
References: 96881						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0	-1.48	-1.57			
No. of Spec.	1	1	1			
References: 94202						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	940	380	200	75	20.5	2.2
Btu lb ⁻¹ F ⁻¹	(0.225)	(0.0908)	(0.0478)	(0.0179)	(0.00490)	(0.000526)
No. of Spec.	2	2	2	2	2	2
References: 94196, 94203						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec.						
References:						

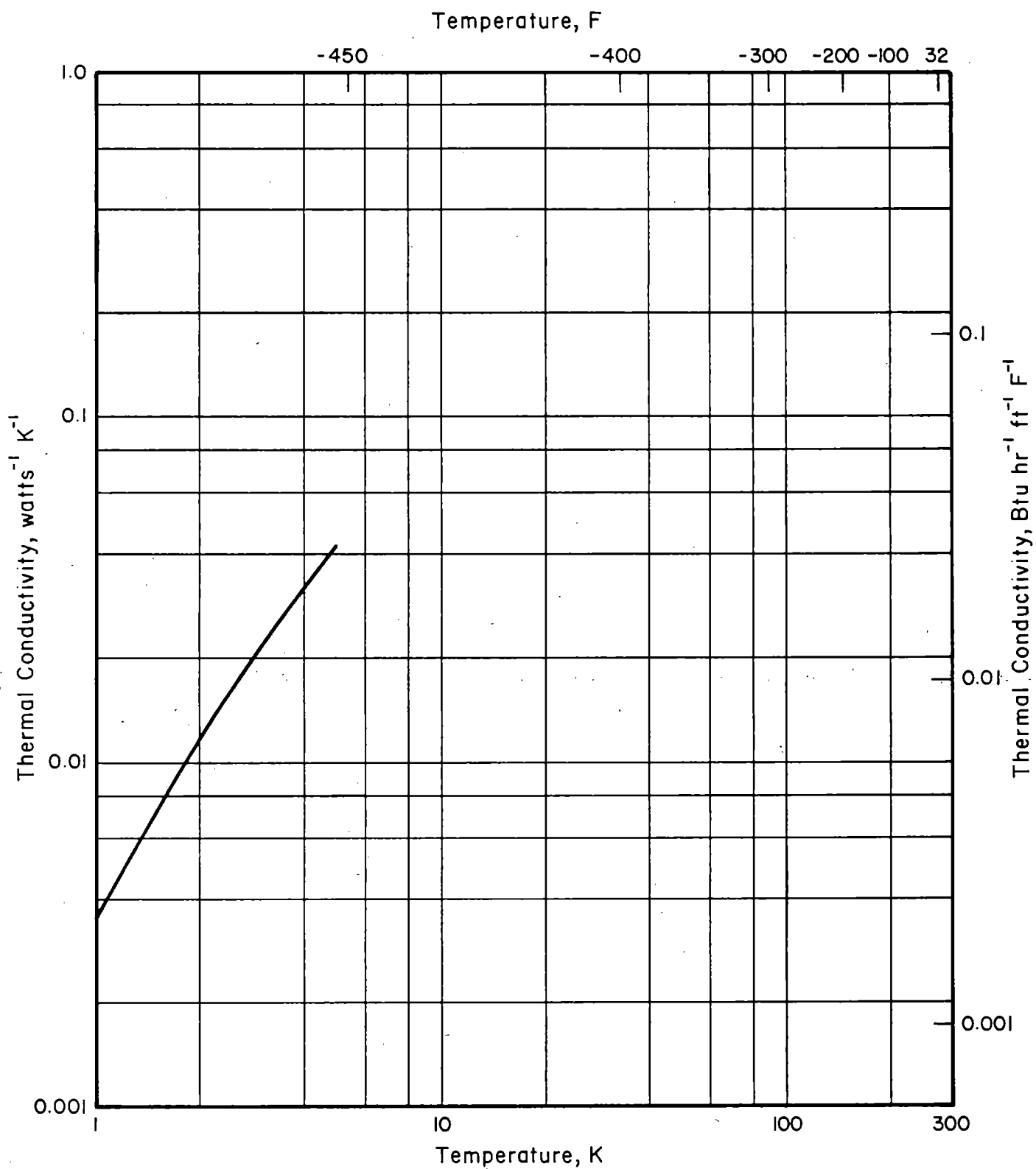


FIGURE 12.1.3-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR POLYTETRAFLUOROETHYLENE (TEFLON)

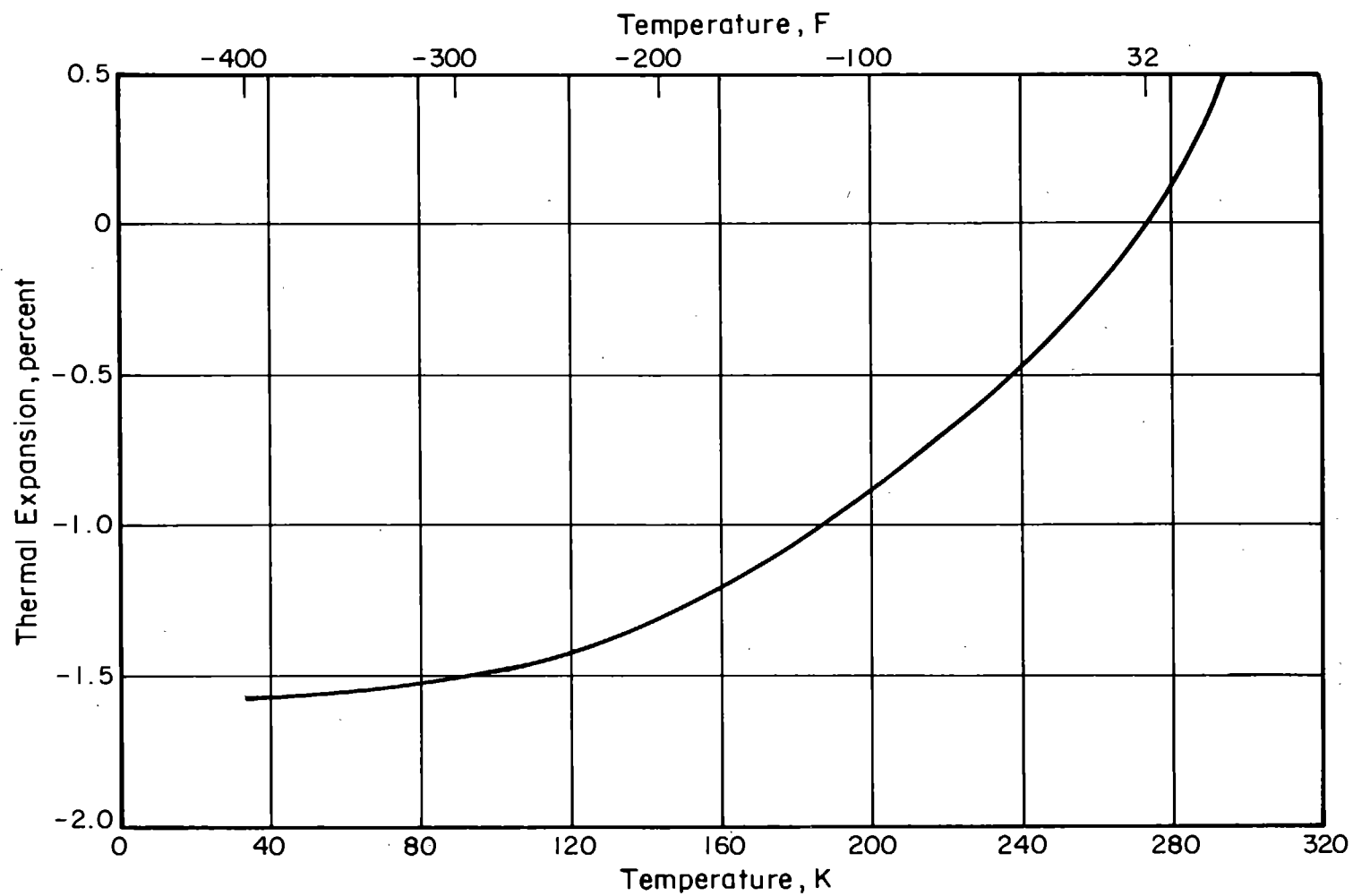


FIGURE 12.1.3-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR POLYTETRAFLUOROETHYLENE (TEFLON)

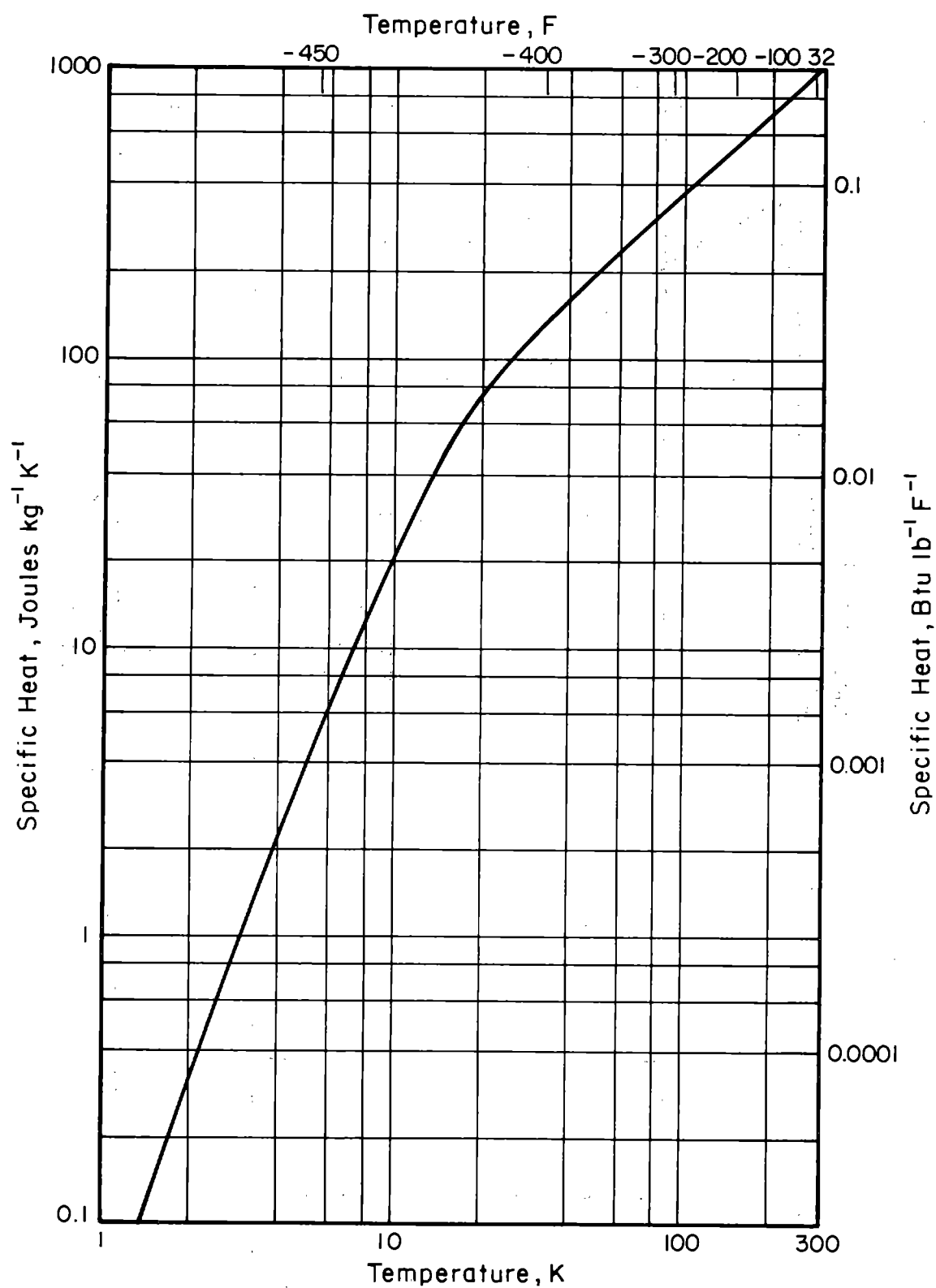


FIGURE 12.1.3-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR POLYTETRAFLUOROETHYLENE (TEFLON)

TABLE 12.1.3-MA1

Polymer Designation: Polytetrafluoroethylene (Teflon)

Specification:

Form: Rod

Diameter, cm(in.): ~1 (?)

Condition: As received, with treatment in boiling aqua regia to remove surface impurities

Volume Susceptibility (k)* as a Function of Temperature and Field Strength

Temperature, K (F)	Low	Medium	Infinite
6.1 (-448)	-105.0×10^{-7}	-106.9×10^{-7}	-108.8×10^{-7}
16.8 (-429)	-107.6×10^{-7}	-109.2×10^{-7}	-110.4×10^{-7}
30.0 (-405)	-109.5×10^{-7}	-110.4×10^{-7}	-111.4×10^{-7}
48.8 (-372)	-109.9×10^{-7}	-110.9×10^{-7}	-111.9×10^{-7}
64.7 (-343)	-110.2×10^{-7}	-111.0×10^{-7}	-111.9×10^{-7}
81.7 (-312)	-109.3×10^{-7}	-109.9×10^{-7}	-110.5×10^{-7}
102.1 (-275)	-109.6×10^{-7}	-110.1×10^{-7}	-110.7×10^{-7}
152.5 (-185)	-109.9×10^{-7}	-110.4×10^{-7}	-110.8×10^{-7}
194.8 (-109)	-110.1×10^{-7}	-109.8×10^{-7}	-110.9×10^{-7}
255.2 (-0.3)	-110.1×10^{-7}	-110.3×10^{-7}	-110.5×10^{-7}
292.0 (66)	-110.0×10^{-7}	-110.1×10^{-7}	-110.3×10^{-7}

Note: $\mu_{\text{mksa}} \sim 12.57 \times 10^{-7}$ for all values of k.

Reference: 96890

* in mksa units.

TABLE 12.2.1-TR1

Alloy Designation: Polymethylmethacrylate (Plexiglas)

Specification:

Form:

Dimension:

Condition: Amorphous

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
<u>Thermal Conductivity</u> Watts m ⁻¹ K ⁻¹ Btu hr ⁻¹ ft ⁻¹ F ⁻¹ No. of Spec. References: 96872, 96880, 96889						0.052 4 (0.030)
<u>Thermal Expansion (T₂₇₃ to T)</u> <u>Longitudinal</u> Percent No. of Spec. References:						
<u>Specific Heat</u> Joules kg ⁻¹ K ⁻¹ Btu lb ⁻¹ F ⁻¹ No. of Spec. References: 94201, 94203	1280 2 (0.306)	550 2 (0.131)	275 2 (0.0657)	79 2 (0.0189)	22 2 (0.00526)	2.4 1 (0.000574)
<u>Electrical Resistivity</u> Ohm m Ohm circular mil ft ⁻¹ No. of Spec. References:						

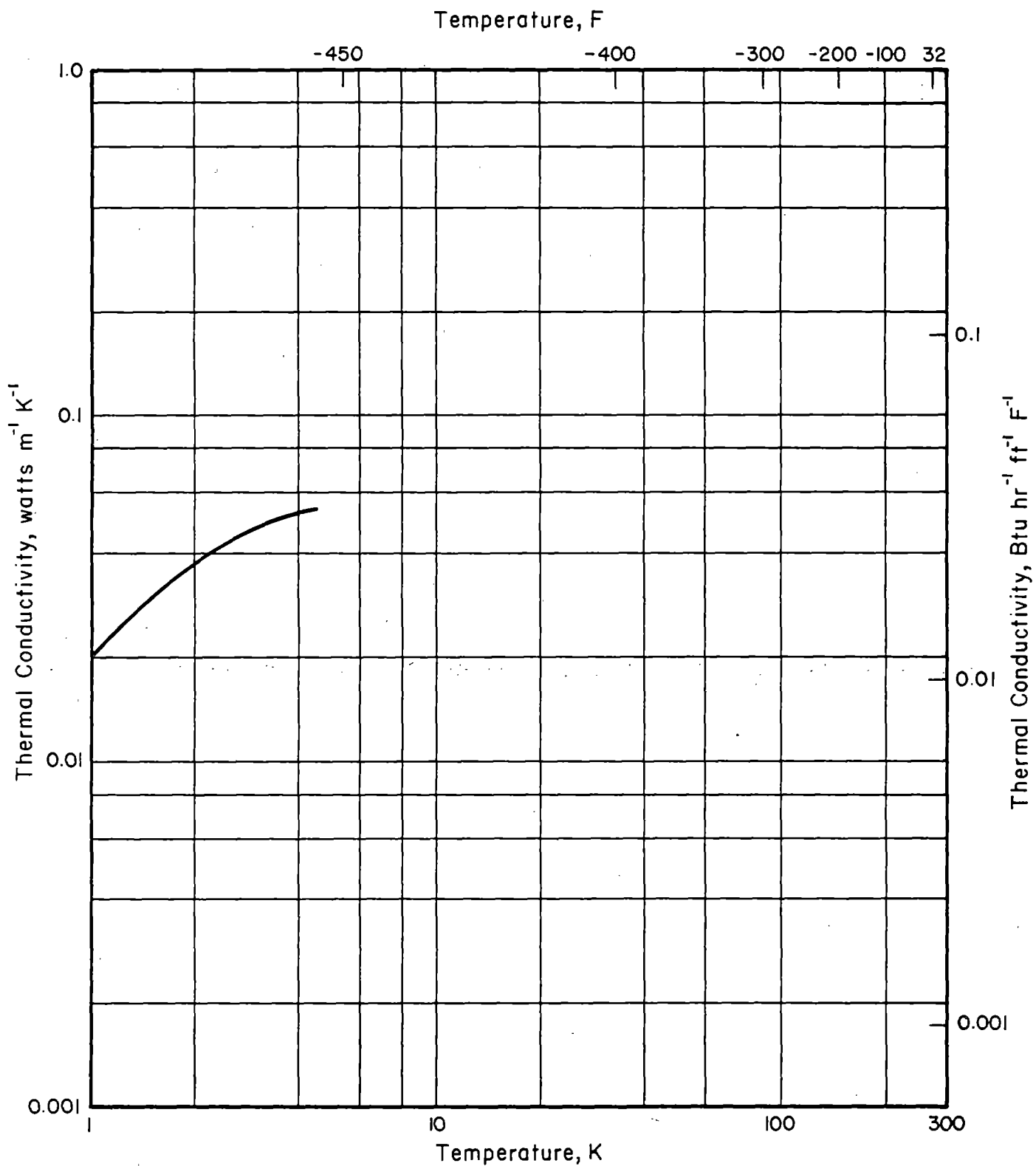


FIGURE 12.2.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR POLYMETHYLMETHACRYLATE (AMORPHOUS)

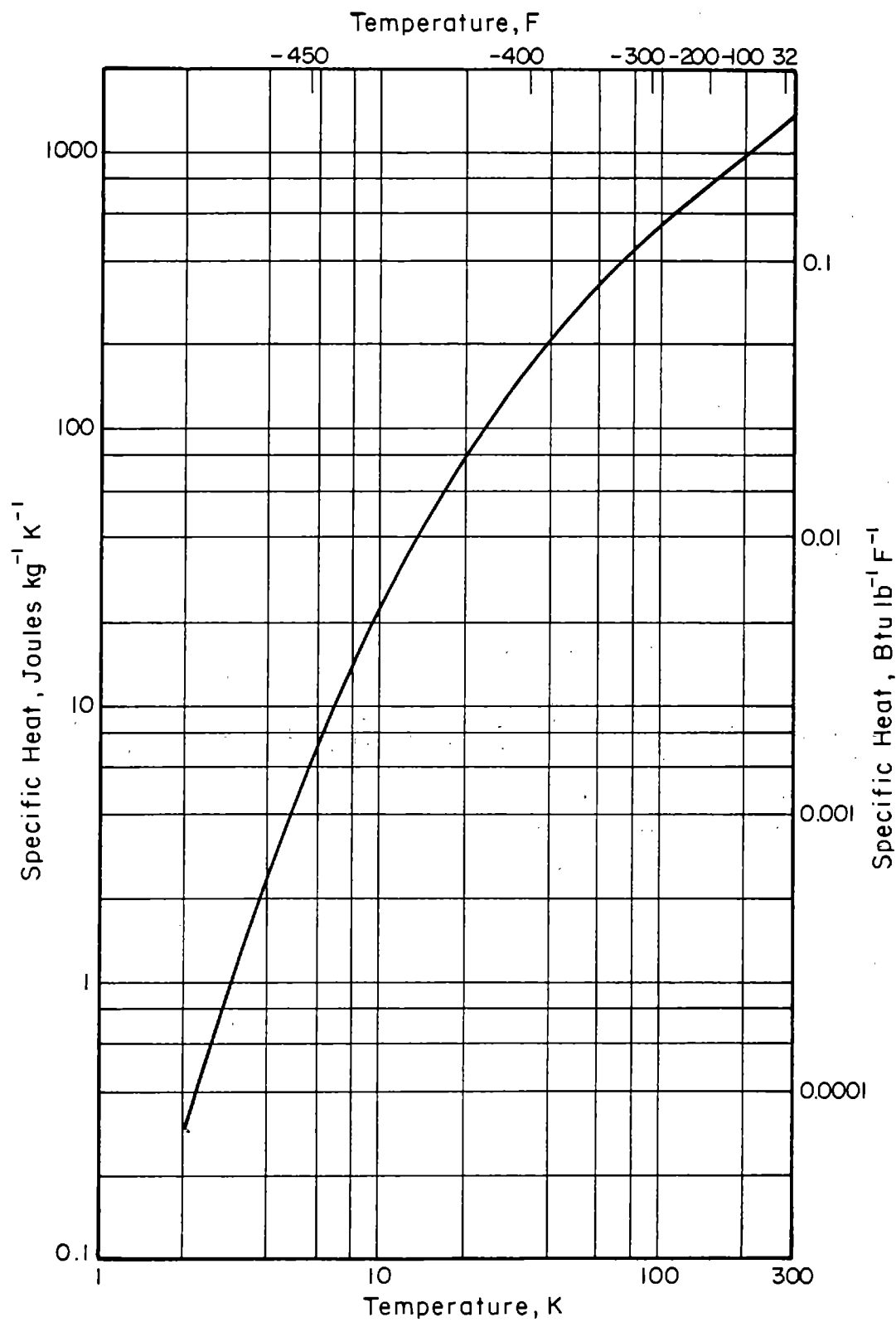


FIGURE 12.2.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR POLYMETHYLMETHACRYLATE (PLEXIGLAS)

TABLE 12.3.1-TR1

Alloy Designation: Polystyrene

Specification:

Form:

Dimension:

Condition: Amorphous

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
Thermal Conductivity						
Watts m ⁻¹ K ⁻¹						0.0266
Btu hr ⁻¹ ft ⁻¹ F ⁻¹						(0.0154)
No. of Spec						3
References: 96872, 96880, 96882						
Thermal Expansion (T₂₇₃ to T)						
Longitudinal						
Percent	0.00	-1.00	-1.23	-1.31	-1.31	-1.32
No. of Spec.	1	1	1	1	1	1
References: 96883						
Specific Heat						
Joules kg ⁻¹ K ⁻¹	1130	455	270	102	32	5.1
Btu lb ⁻¹ F ⁻¹	(0.270)	(0.109)	(0.0645)	(0.0244)	(0.00765)	(0.00122)
No. of Spec	2	2	2	2	2	1
References: 94200, 94203						
Electrical Resistivity						
Ohm m						
Ohm circular mil ft ⁻¹						
No. of Spec						
References: 1						

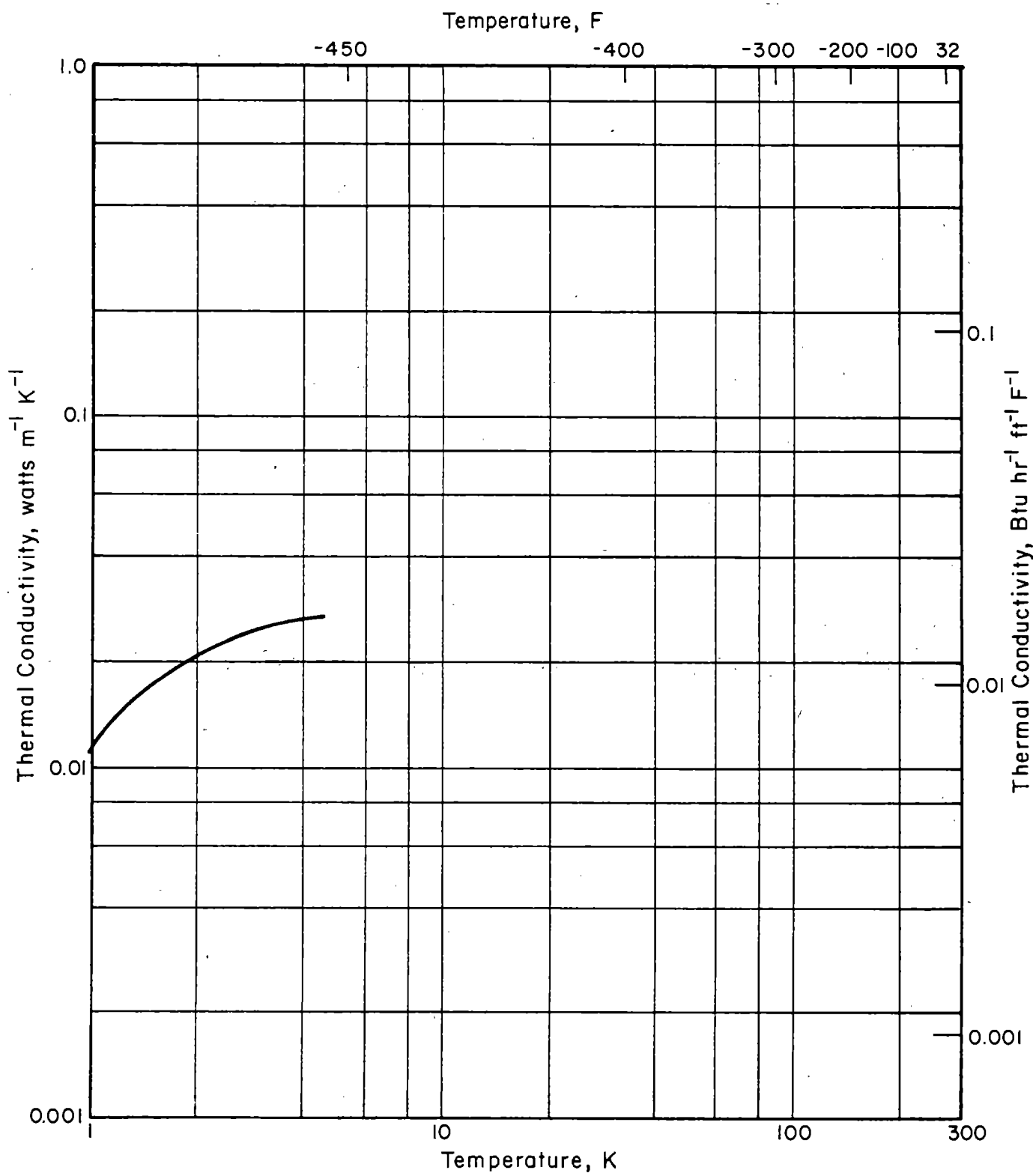


FIGURE 12.3.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR POLYSTYRENE (AMORPHOUS)

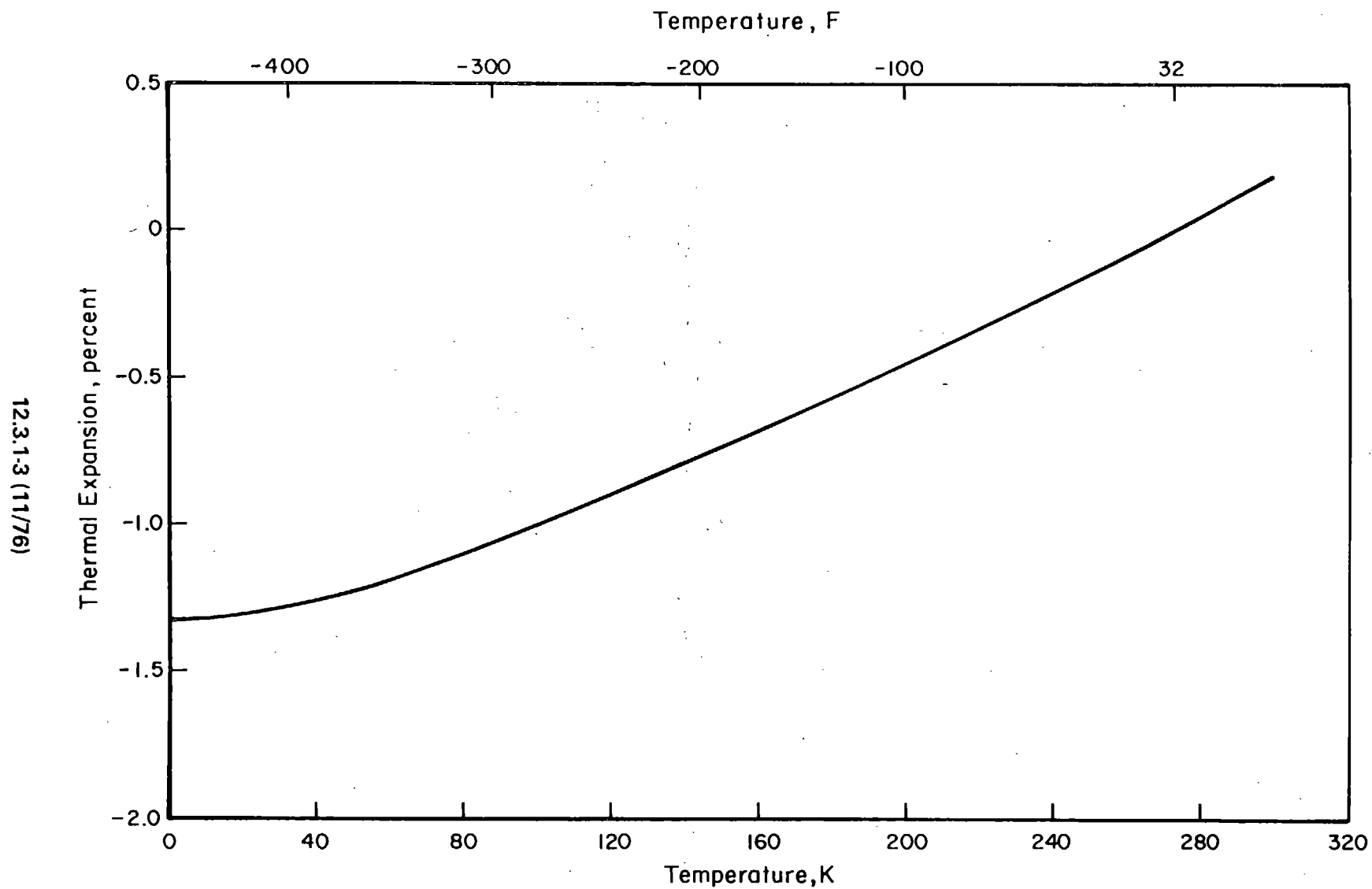


FIGURE 12.3.1-E1. THERMAL EXPANSION VERSUS TEMPERATURE FOR POLYSTYRENE (AMORPHOUS)

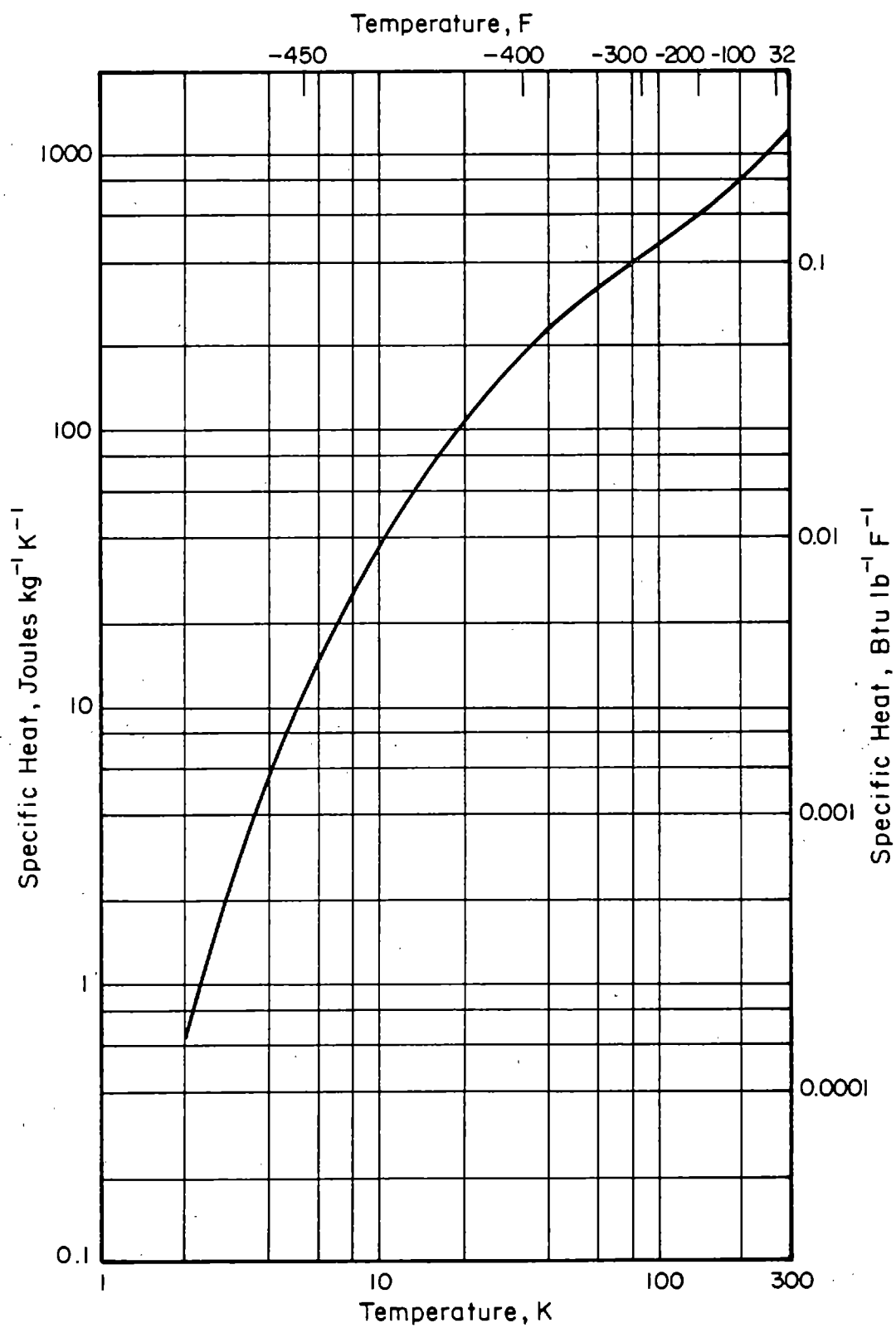


FIGURE 12.3.1-S1. SPECIFIC HEAT VERSUS TEMPERATURE FOR POLYSTYRENE

TABLE 12.4.1-TR1

Alloy Designation: POLYVINYLACETATE

Specification:

Form:

Dimension:

Condition: AMORPHOUS

Testing Temperature K (F)	273 (32)	100 (-280)	50 (-370)	20 (-423)	10 (-442)	4 (-452)
<u>Thermal Conductivity (1)</u> Watts $m^{-1} K^{-1}$ Btu $hr^{-1} ft^{-1} F^{-1}$ No. of Spec References: 96872						0.0179 (0.010) 1
<u>Thermal Expansion (T₂₇₃ to T)</u> <u>Longitudinal</u> Percent No. of Spec. References:						
<u>Specific Heat</u> Joules $kg^{-1} K^{-1}$ Btu $lb^{-1} F^{-1}$ No. of Spec References:						
<u>Electrical Resistivity</u> Ohm m Ohm circular mil ft^{-1} No. of Spec. References:						
(1) Density = 1.20 g/cm^3 Molecular Weight=105,000						

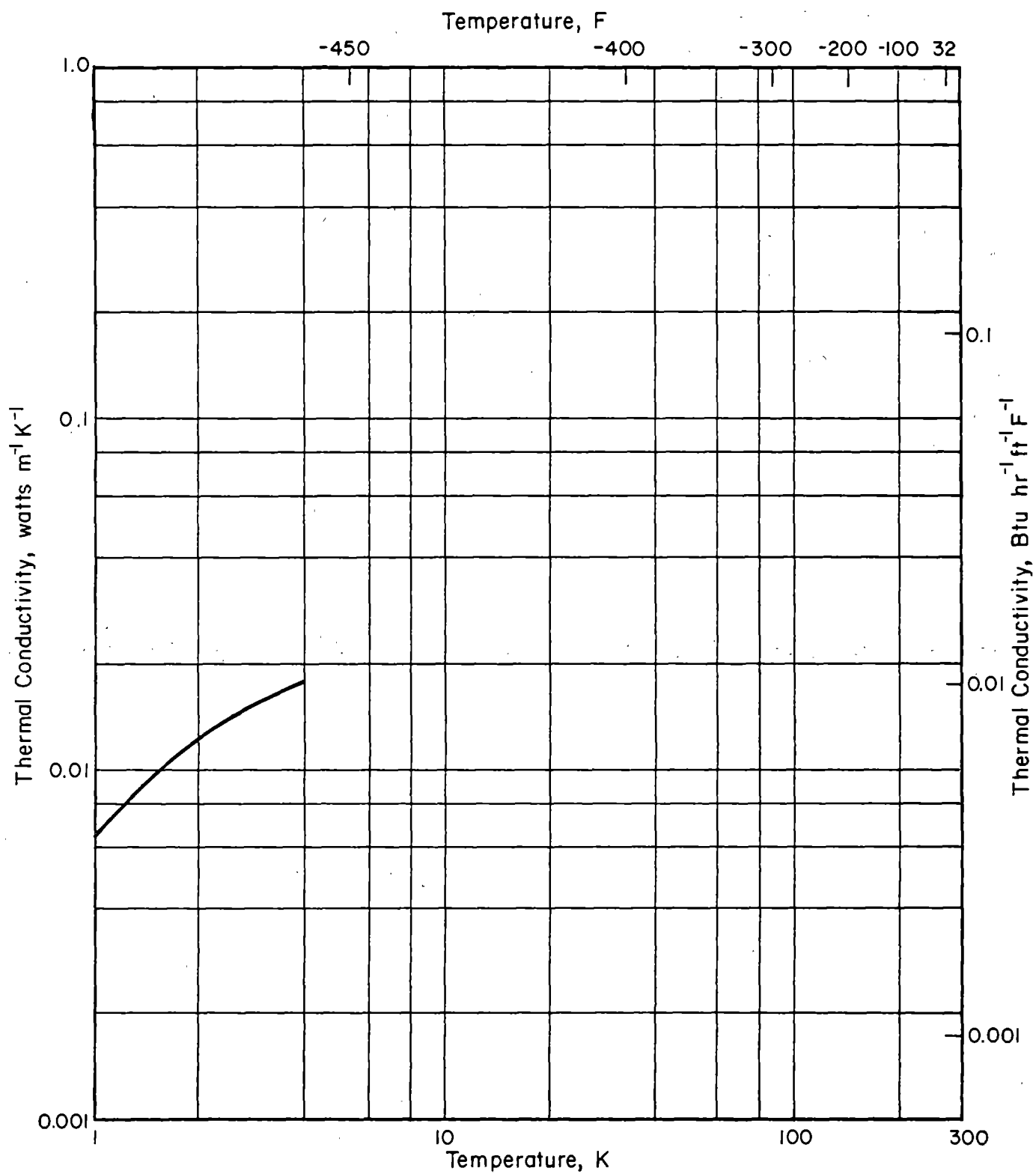


FIGURE 12.4.1-C1. THERMAL CONDUCTIVITY VERSUS TEMPERATURE FOR POLYVINYLACETATE (AMORPHOUS)

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APPENDIX

COMPARISON OF MATERIALS BASED ON CERTAIN PARAMETER RATIOS

Based on recent discussions by ARPA/NBS contractors and designers of superconducting machinery, the ratios of certain mechanical and thermal property data can be used in rating candidate materials for certain cryogenic applications. Among the various parameter ratios that might aid in selecting optimum materials are the yield strength/thermal conductivity and Young's modulus/thermal conductivity ratios obtained over the applicable temperature range.

In order to analyze the data presented in the First Edition of the Handbook, compilations were prepared of the yield strength/thermal conductivity and Young's modulus/thermal conductivity ratios where sufficient data were available to obtain these ratios. The results are presented in Tables A-1 and A-2 where the yield strengths and Young's moduli were taken at room temperature, 20 K, and 4 K, and the values for thermal conductivity were taken at 273, 20, and 4 K. Based on the information presented, use of the ratios is limited for cryogenic applications because of the limited data. In many instances where the mechanical property data are available down to 4 K, thermal conductivity data are not reported. In other instances, the thermal conductivity data that are reported at low temperatures are for specimens in the annealed condition while the most useful condition of the alloy requires some other heat treatment.

These gaps in the data indicate that (a) further effort is needed in recovering additional data from the literature if additional data can be located and (b) that further effort is needed in evaluating the cryogenic properties of certain materials that appear to be advantageous for cryogenic applications.

TABLE A-1. COMPILATION OF YIELD STRENGTH/THERMAL CONDUCTIVITY RATIOS FROM HANDBOOK DATA

Metal	Form	Treatment	273 K(RT)			20 K			4 K		
			YS(a), MN/m ²	T. Cond., Wm ⁻¹ K ⁻¹	YS/ T. Cond.	YS, MN/m ²	T. Cond., Wm ⁻¹ K ⁻¹	YS/ T. Cond.	YS, MN/m ²	T. Cond., Wm ⁻¹ K ⁻¹	YS/ T. Cond.
Al and Al Alloys											
1100-0	Bar	Annealed (-0)	48	205	0.23	65	225	0.29			
2014-T6	Sheet	T6	444	160	2.77	569	32	17.8			
2219-T81	Sheet	T81	348	118	2.95	476	26.3	18.1			
5083-0	Plate	Annealed (-0)				174	17.3	10.0			
7039-T61	Plate	T61	396	150	2.64	516	30	17.2			
Cu and Cu Alloys											
OFHC Cu	Sheet	Annealed	69	400	0.17	140	900	0.15			
	Bar	Annealed	72.5	400	0.18	90.3	900	0.10			
	Bar	Vac. Annealed	30.3	400	0.08				47.6	200	0.24
Phos. Cu	Bar	Annealed	46	201	0.23	58	43	1.35			
90Cu-10Ni	Bar	Annealed				208	14.2	14.6	172	1.2	143
Stainless Steels											
Type 304	Sheet	Annealed	293	14.7	19.9	427	1.95	219			
	Plate	Annealed	328	14.7	22.3	410	1.95	210			
	Bar	Annealed	234	14.7	15.9	418	1.95	214			
Type 304L	Sheet	Annealed	295	14.7	20.0	307	1.95	157			
	Bar	Annealed	406	14.7	27.6	522	1.95	268			
Type 316	Sheet	Annealed	275	14.7	18.7	666	1.90	350			
Ti and Ti Alloys											
Ti-75A	Sheet	Annealed				1193	26.3	45.4			

(a) Longitudinal orientation.

TABLE A-2. COMPILATION OF YOUNG'S MODULUS/THERMAL CONDUCTIVITY RATIOS FROM HANDBOOK DATA

Metal	Form	Treatment	273 K(RT)			20 K			4 K		
			E(a), GN/m ²	T. Cond., Wm ⁻¹ K ⁻¹	E/ T. Cond.	E, GN/m ²	T. Cond., Wm ⁻¹ K ⁻¹	E/ T. Cond.	E, GN/m ²	T. Cond., Wm ⁻¹ K ⁻¹	E/ T. Cond.
Al and Al Alloys											
2014-T6	Sheet	T6	70.5	160	0.44	82.5	32	2.58			
2219-T81	Sheet	T81	68.5	118	0.58	82.0	26.3	3.12			
7039-T6	Sheet	T6, T61	67.7	150	0.45	78.6	30	2.62			
Cu and Cu Alloys											
OFHC Cu	Bar	Vac. Annealed	114	400	0.28				138	200	0.69
Phos. Cu	Bar	Annealed	104	201	0.52	112	43	2.60			
90Cu-10Ni	Bar	Annealed							141	1.2	117
Cu-2Be	Sheet	STA (AT)				1317	10.3	128			

(a) Longitudinal orientation.