XI. MECHANICAL PROPERTIES

CONTENTS

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  6. 347

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(OVER)
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3. Polyester
4. High-Temperature Polyester
5. Silicone

H. Titanium
ABBREVIATIONS AND TERMS

UTS  ultimate tensile strength
PSI  pounds per square inch
KSI  1000 pounds per square inch
°F  degrees Fahrenheit
HR  hour, hours
MIN  minute, minutes
IN.  inch, inches
MM  millimeter, millimeters
DIA  diameter
FT-LB  foot-pounds
BTU  British Thermal Units
WQ  water quench
OQ  oil quench
AC  air cool
FC  furnace cool
R  stress ratio (minimum stress/maximum stress in fatigue tests)
Kₜ  theoretical stress concentration factor, according to Peterson's data
LONG.  longitudinal grain direction
TRANS  transverse grain direction
DPH  Diamond Pyramidal Hardness
NOL  Naval Ordnance Laboratory
All of the mechanical properties data in this section are presented graphically. For the materials listed the following properties are included where available:

a. Yield Strength (0.2% offset)
b. Tensile Strength
c. Elongation
d. Weld Tensile Strength
e. Stress-strain Diagram
f. Modulus of Elasticity
g. Impact Strength
m. Compressive Strength
o. Fatigue Strength

The data sheets marked "**" have been reproduced from:

"Cryogenic Materials Handbook"
AD 609 562
F.R. Swartzberg, et al.
The Martin Company
Denver, Colorado
August 1964

The attached list of references are given as the original sources of the material presented in the above document.
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XI-vii


**


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**
YIELD STRENGTH OF 1100 ALUMINUM

**

XI-A-1.1
TENSILE STRENGTH OF 1100 ALUMINUM
ELONGATION OF 1100 ALUMINUM

NOTE: BAR.
STRESS-STRAIN DIAGRAM FOR 1100 ALUMINUM
MODULUS OF ELASTICITY OF 1100 ALUMINUM

IMPACT STRENGTH OF 1100 ALUMINUM
FATIGUE STRENGTH OF 1100 ALUMINUM
FLEXURE; 3/4 IN DIA ROD; CONDITION NOTED,

TENSILE STR: 195 KSI; R = -1, 2000 GPM;

CYCLES NOTED [30]

FATIGUE STRENGTH OF 1100 ALUMINUM
STRESS RUPTURE CURVE OF 1100 ALUMINUM
YIELD STRENGTH OF 6061 ALUMINUM

NOTE: T6 EXCEPT WHERE NOTED.
TENSILE STRENGTH OF 6061 ALUMINUM

NOTE: T6, EXCEPT WHERE NOTED.
ELONGATION OF 6061 ALUMINUM
WELD TENSILE STRENGTH OF 6061 ALUMINUM

**

XI-A-2.4
MODULUS OF ELASTICITY OF 6061 ALUMINUM

IMPACT STRENGTH OF 6061 ALUMINUM

XI-A-2.5
FATIGUE STRENGTH OF 6061 ALUMINUM
YIELD STRENGTH OF 302 STAINLESS STEEL
TENSILE STRENGTH OF 302 STAINLESS STEEL
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NOTE: COLD REDUCED, 0.750-IN. DIA BAR (B).
MODULUS OF ELASTICITY OF 302 STAINLESS STEEL

IMPACT STRENGTH OF 302 STAINLESS STEEL
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**XI-B-2.2**
MODULUS OF ELASTICITY OF 303 STAINLESS STEEL

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XI-B-2.4
YIELD STRENGTH OF 304 STAINLESS STEEL

**XI-B-3.1**
YIELD STRENGTH OF 304 STAINLESS STEEL

**XI-B-3.2**
TENSILE STRENGTH OF 304 STAINLESS STEEL
TENSILE STRENGTH OF 304 STAINLESS STEEL
NOTE: ANNEALED.

0.750-IN. DIA BAR (2)

BAR (59)

(36)

(35, 55)

TEMPERATURE (°F)

ELONGATION (PERCENT)

ELONGATION OF 304 STAINLESS STEEL
NOTE: EXTRA LOW CARBON GRADE, 0.063-IN. SHEET (115).

ELONGATION OF 304 STAINLESS STEEL
WELD TENSILE STRENGTH OF 304 STAINLESS STEEL
STRESS-STRAIN DIAGRAM FOR 304 STAINLESS STEEL

NOTE: ANNEALED, LOW CARBON, 0.750-IN. DIA BAR (O).
MODULUS OF ELASTICITY OF 304 STAINLESS STEEL
TEMPERATURE DEPENDENCE OF YOUNG'S MODULUS
THE BULK MODULUS, AND POISSON'S RATIO
304 STAINLESS STEEL
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NOTE: ANNEALED EXCEPT AS NOTED.

LOW CARBON, SUBSIZE CHARPY V, 0.750-IN. DIA BAR (2)

CHARPY K, 0.750-IN. DIA BAR (75)

CHARPY K, 0.500-IN. PLATE (20)

SUBSIZE CHARPY V (22)

20% COLD REDUCED, CHARPY K, 0.562-IN. DIA BAR (25)

COLD REDUCED (211 KSI UTS), CHARPY K, 0.750-IN. DIA BAR (15, 20, 25, 36)

ENERGY ABSORBED (FT-LB)

TEMPERATURE (°F)

ENERGY ABSORBED (FT-LB)

TEMPERATURE (°F)
FATIGUE STRENGTH OF 304 STAINLESS STEEL
AXIAL FATIGUE LIFE CURVE FOR NOTCHED 304L STAINLESS STEEL BAR (94208A) (UP TO 2.540CM (1.000IN) DIAMETER)
EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 304L STAINLESS STEEL
EFFECT OF TEMPERATURE ON THE STRENGTH OF TYPE 304 STAINLESS STEEL
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NOTE: ANNEALED, 0.750-IN., DIA BAR (2).

XI-B-5.1
ELONGATION OF 321 STAINLESS STEEL

REDUCTION OF AREA OF 321 STAINLESS STEEL

**

XI-B-5.2
STRESS-STRAIN DIAGRAM FOR 321 STAINLESS STEEL

NOTE: ANNEALED, 0.750-IN. DIA BAR (2),

XI-B-5.3
TEMPERATURE (°F)

MODULUS OF ELASTICITY OF 321 STAINLESS STEEL

ENERGY ABSORBED (FT-LB)

IMPACT STRENGTH OF 321 STAINLESS STEEL
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STRENGTH OF 347 STAINLESS STEEL
ELONGATION OF 347 STAINLESS STEEL

REDUCTION OF AREA OF 347 STAINLESS STEEL
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NOTE: ANNEALED, 0.750-IN. DIA BAR (2).

XI-B-6.3
MODULUS OF ELASTICITY OF 347 STAINLESS STEEL

IMPACT STRENGTH OF 347 STAINLESS STEEL

XI-B-6.4
FATIGUE STRENGTH OF 347 STAINLESS STEEL
YIELD STRENGTH OF INCONEL
TENSILE STRENGTH OF INCONEL

XI-c-1.2
ELONGATION OF INCONEL

REDUCTION OF AREA OF INCONEL
STRESS-STRAIN DIAGRAM FOR INCONEL

NCTE: 20% COLD REDUCTION, 0.750-IN. DIA BAR (3).
**

XI-C-1.5
FATIGUE STRENGTH OF INCONEL

NOTE: COLD ROLLED (135 KSI UTS), FLEXURE, R = -1, 0.035-IN. SHEET (A).
YIELD STRENGTH OF INCONEL-X
TENSILE STRENGTH OF INCONEL-X
ELONGATION OF INCONEL-X

NOTE: SOLUTION TREATED AND AGED
0.060-IN, SHEET (1)
0.750-IN, DIA, BAR (2)
0.063-IN, SHEET (11)
BAR (91)
TEMPERATURE (°F)

STRESS (10^3 PSI)

WELD TENSILE STRENGTH OF INCONEL-X

SOLUTION TREATED AND AGED AS-TIG WELDED, AUTO, INCONEL X ROD, 0.080-IN. SHEET (1)

LONG, TRANS
STRESS-STRAIN DIAGRAM FOR INCONEL X

NOTE: SOLUTION TREATED AND AGED (1300°F/20 HR, AC AGE), 0.780-IN. DIA BAR (A).
TEMPERATURE (°F)

MODULUS OF ELASTICITY OF INCONEL X

TEMPERATURE (°F)

IMPACT STRENGTH OF INCONEL X

XI-C-2.6
FATIGUE STRENGTH OF INCONEL X
YIELD STRENGTH OF K MONEL

XI-C-3.1
TENSILE STRENGTH OF K MONEL

XI-C-3.2
WELD TENSILE STRENGTH OF MONEL

AGED AFTER WELDING (1000°F/1675°F, AC), TIG WELDED, AUTO, NO FILLER, 0.020-IN.-THICKNESS
STRESS-STRAIN DIAGRAM FOR K MONEL

NOTE: SOLUTION TREATED AND AGED (1190°F/21 HR + 1000°F/8 HR, AC AGE), 0.750-IN. DIA BAR (2)
MODULUS OF ELASTICITY OF K MONEL

IMPACT STRENGTH OF K MONEL
NOTE: COLD ROLLED HALF-HARD AND AGED (182 KSI UTS) FLEXURE, R = -1, 0.031-IN. SHEET (4).

FATIGUE STRENGTH OF K MONEL
YIELD STRENGTH OF 2800 (9%Ni) STEEL
TEMPERATURE (°F)

STRESS (10^3 PSI)

TENSILE STRENGTH OF 2800 (9% Ni) STEEL

NOTE: DOUBLE NORMALIZED AND STRESS RELIEVED.

- 0.500-IN. PLATE (65)
- 0.750-IN. DIA BAR (30)

XI-D-1.2
ELONGATION OF 2800 (9% Ni) STEEL

REDUCTION OF AREA OF 2800 (9% Ni) STEEL
STRESS-STRAIN DIAGRAM FOR 2800 (9%Ni) STEEL

NOTE: DOUBLE NORMALIZED AND STRESS RELIEVED, 0.750-IN., DIA BAR (2).
MODULUS OF ELASTICITY OF 2800 (9% Ni) STEEL

NOTE: DOUBLE NORMALIZED AND STRESS RELIEVED, CHARPY V, 0.750-IN., DIA BAR (330)

IMPACT STRENGTH OF 2800 (9% Ni) STEEL

XI-D-1.5
YIELD STRENGTH OF COPPER
TENSILE STRENGTH OF COPPER
ELONGATION OF COPPER
REDUCTION OF AREA OF COPPER
Elongation of Copper

Reduction of Area of Copper

XI-E-1.6
MODULUS OF ELASTICITY OF COPPER

IMPACT STRENGTH OF COPPER
STRESS-STRAIN DIAGRAM FOR COPPER

NOTE: OFHC, ANNEALED 0.740-IN.
DIA BAR (2).
FATIGUE STRENGTH OF COPPER

NOTES: OFHC, ANNEALED [100°F], AXIAL LOAD, $R = -1$.
0.062-in. DIA HUG. - - - (112), -- - - (110).

FATIGUE LIFE (CYCLES)

FATIGUE STRENGTH (ksi)
FATIGUE BEHAVIOR OF COPPER

AXIAL LOAD, ETP, ANNEALED

[369]
FATIGUE BEHAVIOR OF COPPER

STRESS, psi

FATIGUE LIFE, cycles

AXIAL LOAD, ETP, ANNEALED [369]

-452°F

-424°F

-297°F

ROOM TEMP.
Stress-Strain Curves of Copper-Nickel (Cu-10 Ni), Annealed
EFFECT OF TEMPERATURE ON THE STRENGTH OF 90 Cu-10Ni ALLOY
TEMPERATURE, °F

STRENGTH OF BERYLCO* 25

XI-E-2.1
YIELD STRENGTH OF BERYLLIUM COPPER
YIELD STRENGTH OF BERYLLIUM COPPER
TENSILE STRENGTH OF BERYLLIUM COPPER

XI-E-2.4
TENSILE STRENGTH OF BERYLLIUM COPPER
ELONGATION OF BERYLLIUM COPPER

XI-E-2.6
ELONGATION OF BERYLLIUM COPPER
STRESS-STRAIN DIAGRAM FOR BERYLLIUM COPPER

NOTE: CONDITION A, 0.750-IN, DIA BAR (2),
This curve is representative of all forms and includes treatments A, AT, \( \frac{1}{2} \text{H} \), \( \frac{1}{2} \text{HT} \) \[109, 453, 749\].

For explanation of treatments see page C.I. ob.

**MODULUS OF ELASTICITY OF BERYLCO**

**IMPACT ENERGY OF BERYLCO**

*THE BERYLLIUM CORPORATION OF AMERICA*
MODULUS OF ELASTICITY OF BERYLLIUM COPPER

IMPACT STRENGTH OF BERYLLIUM COPPER
EFFECT OF TEMPERATURE ON THE STRENGTH OF CU-2 BE ALLOY
IMPACT STRENGTH OF BERYLLIUM COPPER

MODULUS OF RIGIDITY OF BERYLLIUM COPPER

XI-E-2.14
7. **STANDARD DEVIATION BASED ON 4 TESTS AT -423°F**: ± 0.036 x 10^6 PSI
   - CONDITION H:
     - STANDARD DEVIATION BASED ON 5 TESTS AT -320°F: ± 0.051 x 10^6 PSI
     - STANDARD DEVIATION BASED ON 8 TESTS AT -107°F: ± 0.010 x 10^6 PSI
     - STANDARD DEVIATION BASED ON 11 TESTS AT 75°F: ± 0.021 x 10^6 PSI

   \[\text{STANDARD DEVIATION} = \sqrt{\frac{\Sigma G^2}{n} - (\bar{G})^2}\]

\[n = \text{NO. OF TESTS AND } G = \text{MODULUS OF RIGIDITY.}\]

**TEMPERATURE, °F**

**MODULUS OF RIGIDITY OF BERYLCO \(\ast 25\)**

\(\ast\) THE BERYLLIUM CORPORATION OF AMERICA
FATIGUE STRENGTH OF BERYLLIUM COPPER

NOTE: CONDITION AT (175 KSI UT8), FLEXURE, R = -1, 0.005-IN., SHEET (S).
FATIGUE STRENGTH OF DERYLLIUM COPPER

NOTE: CONDITION 1/2 HT (191 KSI UTS), FLEXURE, R = -1,
0.012-IN. SHEET (I).
FLEXURE; 0.020 IN. SHEET, CONDITION AT, TENSILE STR:
178,000 PSI, R = -1, 1800 CPM AT 70°, -110° & -320°F,
3450 CPM AT -423°F. [905]

STRESS, psi

FATIGUE LIFE, cycles

FATIGUE BEHAVIOR OF BERYLCO* 25

*THE BERYLLIUM CORPORATION OF AMERICA
FATIGUE LIFE, cycles
FATIGUE BEHAVIOR OF BERYLCO* 25

*THE BERYLLIUM CORPORATION OF AMERICA
FATIGUE BEHAVIOR OF BERYLCO® 25

*THE BERYLLIUM CORPORATION OF AMERICA
FATIGUE BEHAVIOR OF BERYLCO®25

THE BERYLLIUM CORPORATION OF AMERICA
FATIGUE BEHAVIOR OF BERYLCO*25

* THE BERYLLIUM CORPORATION OF AMERICA
FATIGUE BEHAVIOR OF BERYLCO*25

*THE BERYLLIUM CORPORATION OF AMERICA
FATIGUE BEHAVIOR OF BERYLCO*25

*THE BERYLLIUM CORPORATION OF AMERICA
FLEXURE, ALL CURVES 0.062 IN. SHEET, CONDITION AND CYCLES NOTED, R = -1, 1800 CPM [6]

STRESS, psi

TEMPERATURE, °F

FATIGUE STRENGTH OF BERYLCO® 25

*THE BERYLLIUM CORPORATION OF AMERICA

XI-E-2.25
FLEXURE, 0.076 IN SHEET, CONDITION
\( \frac{1}{2} \) HT, TENSILE STR. 191,000 PSI, \( R = -1 \),
1800 & 3450 CPM; CYCLES NOTED [B05]

FATIGUE STRENGTH OF BERYLCO\textsuperscript{X} 25

*THE BERYLLIUM CORPORATION OF AMERICA

XI-E-2.26
FATIGUE STRENGTH OF BERYLCO® 25

*THE BERYLLIUM CORPORATION OF AMERICA
STRENGTH OF 70/30 BRASS

XII-E-3.2
ELONGATION OF 70/30 BRASS
ELONGATION OF 70/30 BRASS

REDUCTION OF AREA OF 70/30 BRASS
STRESS-STRAIN DIAGRAM FOR 70/30 BRASS

NOTE: 3/4-HARD, 0.750-IN. DIA BAR (2).
MODULUS OF ELASTICITY OF 70/30 BRASS
IMPACT STRENGTH OF 70/30 BRASS
FATIGUE STRENGTH OF 70/30 BRASS

NOTE: COLD ROLLED AND STRESS RELIEVED (195 ksi UTS), PLANE HEAT, K = -1, 0.060 IN. SHEET (4).
FATIGUE BEHAVIOR OF 70/30 BRASS
FLEXURE; .032 IN. STRIP; GOLD ROLLED 60%
GRAIN SIZE .075 MM, TENSILE STR: NOTED;
R = -1,900 CPM; ROOM TEMP.; ANGLE TO
ROLLING DIRECTION NOTED [801]

FATIGUE BEHAVIOR OF 70/30 BRASS
FATIGUE BEHAVIOR OF 70/30 BRASS

FLEXURE, 0.020 IN SHEET;
R = -1, 1500 RPM; ROOM TEMP. [324]
FATIGUE STRENGTH OF 70/30 BRASS

XI-E-3.12

FLEXURE, 0040 IN SHEET, TENSILE STR:
95,000 PSI; R=-1, 1800, 3450 & 5175
CPM, CYCLES NOTED [805].
STANDARD DEVIATION = $\sqrt{\frac{\sum g^2}{n} - \overline{g}^2}$ WHERE

n = NO. OF TESTS AND G = MODULUS OF RIGIDITY.

STANDARD DEVIATION BASED ON 8 TESTS AT -424°F: ± 0.0255 x 10^6 PSI
STANDARD DEVIATION BASED ON 7 TESTS AT -320°F: ± 0.0269 x 10^6 PSI
STANDARD DEVIATION BASED ON 5 TESTS AT -110°F: ± 0.0165 x 10^6 PSI
STANDARD DEVIATION BASED ON 6 TESTS AT 75°F: ± 0.0184 x 10^6 PSI

MODULUS OF RIGIDITY OF 70/30 BRASS

XI-E-3.13
CREEP BEHAVIOR OF 70/30 BRASS

STRESS, PSI

CREEP RATE, inches per inch per hour

40 x 10^3
35
30
25
20
15
10
5
0

10^-9
10^-8
10^-7
10^-6
10^-5

ANNEALED, GRAIN SIZE 0.016 mm [329]

ANNEALED, GRAIN SIZE 0.085 mm [329]

300°F
400°F
500°F
STRENGTH OF INVAR
**ELONGATION OF INVAR**

**REDUCTION OF AREA OF INVAR**
STRESS-STRAIN DIAGRAM FOR INVAR

NOTE: 12-15% COLD REDUCTION
0.750-IN. DIA BAR (1).

STRESS (10^3 PSI)

STRAIN (INCHES PER INCH)
MODULUS OF ELASTICITY OF INVAR

IMPACT STRENGTH OF INVAR
STRENGTH OF NYLON

TYPE 101, 2.5% WATER, CROSSHEAD RATE:
1.00-IN. MIN.-70°F
0.10-IN. MIN.- -320°F
0.062-IN. SHEET (3)

TYPE 101, 0.5-IN.
DIA ROD (D)

0.25-IN.
DIA ROD (23, 24)

TENSILE

YIELD

STRESS (10^3 PSI)

TEMPERATURE (°F)
TEMPERATURE (°F)

ELONGATION (PERCENT)

ELONGATION OF NYLON

TYPE 101, 2.5% WATER,
CROSSHEAD RATE:
1.00-IN. MIN=70°F
0.10-IN. MIN=320°F
0.062-IN. SHEET (δ)

0.25-IN. DIA
ROD (23, 24)
MODULUS OF ELASTICITY OF NYLON

IMPACT STRENGTH OF NYLON
TEMPERATURE (°F)

MODULUS OF RIGIDITY OF NYLON

TEMPERATURE (°F)

COMPRESSIVE STRENGTH OF NYLON
YIELD STRENGTH OF MYLAR*

* T.M. E. I. DUPONT DE NEMOURS AND CO.
**TENSILE STRENGTH OF MYLAR**

* T.M.
E. I. DUPONT DE NEMOURS AND CO.

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**NOTE:**

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<th>Thermal History</th>
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<td>15</td>
<td>1.35</td>
<td>AS RECEIVED</td>
</tr>
<tr>
<td>55</td>
<td>1.39</td>
<td>AS RECEIVED + 480°F/1 HR, SLOW COOL</td>
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CROSSHEAD RATE: 1-IN./MIN—70°F, 0.1-IN./MIN—LOWER TEMPERATURES

0.002-IN. FILM (3),

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**STRESS (10^3 PSI)**

**TEMPERATURE (°F)**

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**XI-F-2.2**
NOTE:

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<th>SPECIFIC GRAVITY</th>
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<tr>
<td>15</td>
<td>1.35</td>
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</tr>
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CROSSHEAD RATE: 1-IN./MIN=70°F, 0.1-IN./MIN=LOWER TEMPERATURES.

0.002-IN. FILM (3).

15% CRISTALLINITY

55% CRISTALLINITY

ELONGATION OF MYLAR*

* T.M. E. I. DUPONT DE NEMOURS AND CO.
2.8
d.0

CROSSHEAD RATE: 1-IN./MIN-70F, 0.1-IN./MIN-
LOWER TEMPERATURES
0.002-IN. FILM (3).

0 100
-100
-200
-300
-400

XI-F-2.4

* T.M.
E. I. DU PONT DE NEMOURS AND CO.
NOTE: TFE TEFLON

<table>
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<th>THERMAL TREATMENT</th>
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<td>MOLDED 720F/30 MIN, QUICK QUENCHED</td>
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<tr>
<td>52.5-56</td>
<td>2.159-2.171</td>
<td>AS ABOVE + 585F/5 HR</td>
</tr>
<tr>
<td>66.2-71</td>
<td>2.199-2.226</td>
<td>AS ABOVE + 618F/20 HR</td>
</tr>
</tbody>
</table>

CROSSHEAD RATE: 1-IN./MIN-70F, 0.1 IN./MIN - LOWER TEMPERATURES

0.002-IN. SHEET (3).

YIELD STRENGTH OF TEFLON*

* T.M.
E. I. DUPONT DE NEMOURS AND CO.

XI-F-3.1
YIELD STRENGTH OF TEFLOQ*

* T.M. E. T: DUPONT DE NEMOURS AND CO.
YIELD STRENGTH OF TEFLOM

* T.M.
E. I. DUPONT DE NEMOURS AND CO.

XI-F-3.3
YIELD STRENGTH OF TEFLOM*

* T.M. E. I., DUPONT DE NEMOURS AND CO.
NOTE: TFE TEFLOLL

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</tbody>
</table>

CROSSHEAD RATE—SEE G.1.A, 0.062-1IN, SHEET (3).
TENSILE STRENGTH OF TEFLOM

NOTE: TFE TEFLOM, CROSSHEAD
RATE-SEE G.J.A., 0.062-IN.
SHEET (0).

* T.M.
* E. I. DUpont De nemours And co.

XI-F-3.6
TENSILE STRENGTH OF TEFLON*
TENSILE STRENGTH OF TEFлон*

* T.M.
E. I. DUPONT DE NEMOURS AND CO.
NOTE: TFE TEFON

<table>
<thead>
<tr>
<th>CRYSTALLINITY, %</th>
<th>SPECIFIC GRAVITY</th>
<th>THERMAL TREATMENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>49-50</td>
<td>2.148-2.152</td>
<td>MOLDED 720°F/30 M.IN., QUICK QUENCHED</td>
</tr>
<tr>
<td>52-56</td>
<td>2.159-2.171</td>
<td>AS ABOVE + 585°F/5 HR</td>
</tr>
<tr>
<td>56-71</td>
<td>2.199-2.226</td>
<td>AS ABOVE + 618°F/20 HR</td>
</tr>
<tr>
<td>CROSSHEAD RATE-SEE G.3.A, 0.002-IN. SHEET (3).</td>
<td></td>
<td></td>
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</tbody>
</table>

TEMPERATURE (°F) vs. ELONGATION (PERCENT IN 0.2 IN.)

ELONGATION OF TEFLOM

* T.M.
** E.I. DUPONT DE NEMOURS AND CO.

XI-F-3.9
ELONGATION OF Teflon*

* T.M.
E.I. DUPONT DE NEMOURS AND CO.

NOTE: TFE Teflon, Crosshead Rate—See 0.3 A, 0.062-in. Sheet (3).
ELONGATION OF TEFLOM

*T.M., DUDU DE HEMOURS AND CO.

XI-F-3.11
COMPRESSIVE STRENGTH OF TEFLO\textsuperscript{*}

\textsuperscript{*}T.M. E. I. DUFONT DE HEMOURS AND CO.
COMPRESSIVE STRENGTH OF TEFION*

* T.M. E.I. DURONT DE NEMOURS AND CO.
TEMPERATURE (°F)

STRESS (10^3 PSI)

COMPRESSION STRENGTH OF TEFLO®

* T.M.
E. I. DUPONT DE NEMOURS AND CO.

XI-F-3.14
TEMPERATURE (°F)

STRESS (10^3 PSI)

COMPRESSIVE STRENGTH OF TEFLOM*

*T.M.
E. I. DUNPONT DE NEMOURS AND CO.
STRESS-STRAIN DIAGRAM FOR TEFLON*

* T.M., E. I. DUPONT DE NEMOURS AND CO.
MODULUS OF ELASTICITY OF TEFLO\textsuperscript{*}

\textsuperscript{*}TM; E.I. DUPONT DE NEMOURS AND CO.
MODULUS OF ELASTICITY OF TEFLON*

*T.M.
E.I. DUPONT DE NEMOURS AND CO.

XI-F-3.18
NOTE: 116 GLASS CLOTH REINFORCEMENT, CROSSHEAD RATE—SEE G.3.A, 0.062-IN., SHEET (0).

MODULUS OF ELASTICITY OF TEFLOW

* T.M. E. I. DUPONT DE NEMOURS AND CO.
IMPACT STRENGTH OF TEFLOM®

*T.M.

E.T. D. DUPONT DE NEMOURS AND CO.

XI-F-3.20
NOTE: TFE TEFLO, STANDARD IZOD, 0.250-IN. SHEET (3).

15% GRAPHITE FILLED
65% BRONZE FILLED
25% ASBESTOS FILLED

ENERGY ABSORBED (FT-LB/IN. OF NOTCH)

TEMPERATURE (°F)

NOTE: STANDARD IZOD, 0.250-IN. SHEET (3).

FEP, 25% GLASS FILLED
TFE, 25% GLASS FILLED

TEMPERATURE (°F)

IMPACT STRENGTH OF TEFLO

* T.M.
E. I. DUPONT DE NEMOURS AND CO.

XI-F-3.21
YIELD STRENGTH OF KEL-F*

* T.M.
MINNESOTA MINING AND MFG. CO.

XI-F-4.1
TEMPERATURE (°F)

STRESS (10^3 PSI)

NOTE:

<table>
<thead>
<tr>
<th>CRYSTALLINITY, %</th>
<th>SPECIFIC GRAVITY</th>
<th>THERMAL HISTORY</th>
</tr>
</thead>
<tbody>
<tr>
<td>40</td>
<td>2.10</td>
<td>MOLDED 525°F/5 MIN, QUENCHED</td>
</tr>
<tr>
<td>55</td>
<td>2.12</td>
<td>AS-RECEIVED + 300°F/4 HR, SLOW COOL</td>
</tr>
<tr>
<td>70</td>
<td>2.14</td>
<td>AS-RECEIVED + 395°F/24 HR, SLOW COOL</td>
</tr>
</tbody>
</table>

CROSSHEAD RATE: 1-IN./MIN-70°F, 0.1-IN./MIN-LOWER TEMPERATURES
0.062-IN. SHEET (3).

TENSILE STRENGTH OF KEL-F*

* T.M.
MINNESOTA MINING AND MFG. CO.

XI-F-4.2
NOTE:

<table>
<thead>
<tr>
<th>CRISTALLINITY, %</th>
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<th>THERMAL HISTORY</th>
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<td>AS-RECEIVED + 300F/4 HR, SLOW COOL</td>
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<tr>
<td>70</td>
<td>2.14</td>
<td>AS-RECEIVED + 300F/24 HR, SLOW COOL</td>
</tr>
</tbody>
</table>

CROSSHEAD RATE: 1-IN./MIN-70F, 0.1-IN./MIN-LOWER TEMPERATURES
0.002-IN. SHEET (3).

40% CRYSTALLINITY

55% CRYSTALLINITY

70% CRYSTALLINITY

ELONGATION OF KEL-F*

* T.M. MINNESOTA MINING AND MFG. CO.

XI-F-4.3
STRESS-STRAIN DIAGRAM FOR KEL-F

* T.M. MINNESOTA MINING AND MFG. CO

XI-F-4.4
NOTE:  

<table>
<thead>
<tr>
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<td>70</td>
<td>2.14</td>
<td>AS-RECEIVED + 395°F/24 HR, SLOW COOL</td>
</tr>
</tbody>
</table>

CROSSHEAD RATE: 1-IN./MIN-70°F, 0.1-IN./MIN-LOWER TEMPERATURES 0.062-IN. SHEET (3).

MODULUS OF ELASTICITY OF KEL-F*

* T.M., MINNESOTA MINING AND MFG., CO.
**IMPACT STRENGTH OF KEL-F**

* T.M. MINNESOTA MINING AND MFG. CO.

NOTE:

<table>
<thead>
<tr>
<th>CRISTALLINITY</th>
<th>THERMAL HISTORY</th>
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</thead>
<tbody>
<tr>
<td>60</td>
<td>MOLDED 525F/5 MIN, QUENCHED</td>
</tr>
<tr>
<td>70</td>
<td>AS-RECEIVED + 395F/24 HR, SLOW COOL</td>
</tr>
</tbody>
</table>

STANDARD IZOD, 0.250-IN. PLATE (3).
NOTE: CRYSTALLINITY, %

<table>
<thead>
<tr>
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<th>THERMAL HISTORY</th>
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<tbody>
<tr>
<td>50</td>
<td>MOLDED 525°F/5 MIN, QUENCHED</td>
</tr>
<tr>
<td>60</td>
<td>AS-RECEIVED + 300°F/4 HR, SLOW COOL</td>
</tr>
<tr>
<td>70</td>
<td>AS-RECEIVED + 395°F/24 HR, SLOW COOL</td>
</tr>
</tbody>
</table>

CROSSHEAD RATE: 0.05-IN./MIN, 0.5-IN. DIA ROD (3).

TEMPERATURE (°F)

STRESS (10^3 PSI)

60% CRYSTALLINITY

70% CRYSTALLINITY

50% CRYSTALLINITY

COMPRESSIVE STRENGTH OF KEL-F*

* T.M.
MINNESOTA MINING AND MFG, CO.

XI-F-4.7
TENSILE STRENGTH OF EPOXY – FIBERGLASS LAMINATE

NOTE: 181 GLASS CLOTH REINFORCEMENT, 0.125-in. NOMINAL PANEL THICKNESS (114)

EPON 1001 RESIN, 34.9–38.2% RESIN CONTENT

EPON 828 RESIN, 32.9–40.0% RESIN CONTENT

TEMPERATURE (°F)

STRESS (10^3 PSI)
TEMPERATURE (°F)

TENSILE STRENGTH OF EPOXY-FIBERGLASS FILAMENT WOUND RINGS

XI-G-1.2
TEMPERATURE (°F)

STRESS (10³ PSI)

COMPRRESSIVE STRENGTH OF EPOXY - FIBERGLASS LAMINATE

NOTE: 181 GLASS CLOTH REINFORCEMENT, 0.500-IN., NOMINAL PANEL THICKNESS (114)
FATIGUE STRENGTH OF EPOXY-FIBERGLAS LAMINATE

NOTE: EPON 862 RESIN/908 GLASS CLOTH REINFORCEMENT, 32.5-40.0% RESIN CONTENT, 0.125-INV. NOMINAL PANEL THICKNESS, AXIAL LOAD, R = 0.05

FATIGUE LIFE (CYCLES)

STRESS (10^3 PSI)
TENSILE MODULUS OF ELASTICITY OF UNFILLED, GLASSFIBER-REINFORCED AND FILLED EPOXIES
NOTE: 181 GLASS CLOTH REINFORCEMENT, 0.125-IN, NOMINAL PANEL THICKNESS (114)

TENSILE STRENGTH OF PHENOLIC - FIBERGLAS LAMINATE

STRESS ($10^3$ PSI)

TEMPERATURE (°F)

NARMCO 506 RESIN, 27.2-34.4% RESIN CONTENT

CTL 91 LD RESIN, 22.6-28.3% RESIN CONTENT
TENSILE STRENGTH OF PHENOLIC-FIBERGLASS FILAMENT WOUND RINGS

XI-G-2.2
STRESS (10^3 PSI)

TEMPERATURE (°F)

COMPRRESSIVE STRENGTH OF PHENOLIC - FIBERGLASS LAMINATE

NOTE: 181 GLASS CLOTH REINFORCEMENT, 0.150-IN. NOMINAL PANEL THICKNESS (114)
FATIGUE STRENGTH OF PHENOLIC-FIBERGLASS LAMINATE

NOTE: NARMCO 508 RESIN/181 GLASS CLOTH REINFORCEMENT, 21.3-34.4% RESIN CONTENT, .035-IN. NOMINAL PANEL THICKNESS, AXIAL LOAD, R = 0.05 (114).
NOTE: 181 GLASS CLOTH REINFORCEMENT, 0.125-IN, NOMINAL PANEL THICKNESS

TENSILE STRENGTH OF POLYESTER - FIBERGLAS LAMINATE

XI-G-3.1
TEMPERATURE (°F)

STRESS ($10^3$ PSI)

NOTE: 11H GLASS CLOTH REINFORCEMENT, 0.0006-IN, NOMINAL PANEL THICKNESS

PARAPLEX P43 RESIN, 34.5-42.5% RESIN CONTENT

HERON 42 RESIN, 42.5-52.5% RESIN CONTENT

COMPRESSIVE STRENGTH OF POLYESTER – FIBERGLAS LAMINATE

XI-G-3.2
FATIGUE STRENGTH OF POLYESTER-FIBERGLAS LAMINATE

NOTE: PARAPLEX P15 RESIN/Glass Cloth Reinforcement. 34.1% Resin Content. 0.125" Nominal Panel Thickness. Axial Load. R = 0.05 (114).

STRESS ($10^3$ PSI) vs. FATIGUE LIFE (CYCLES)

320°F

300°F
NOTE: 181 GLASS CLOTH REINFORCEMENT, 0.125-IN. NOMINAL PANEL THICKNESS (114).

TENSILE STRENGTH OF HIGH TEMPERATURE POLYESTER - FIBERGLAS LAMINATE
COMPRESSION STRENGTH OF HIGH TEMPERATURE POLYESTER - FIBERGLAS LAMINATE
FATIGUE STRENGTH OF HIGH TEMPERATURE POLYESTER-FIBERGLAS LAMINATE

NOTE: VIBRIN 125 RESIN/81 GLASS CLOTH REINFORCEMENT, 32.4-34.6\% RESIN CONTENT, 0.125-\text{IN.} NOMINAL PANEL THICKNESS, AXIAL LOAD, R = 0.05 (114).
NOTE: 181 GLASS CLOTH REINFORCEMENT, 0.125-IN. NOMINAL PANEL THICKNESS

TENSILE STRENGTH OF SILICONE - FIBERGLAS LAMINATE

XII-G-5.1
TENSILE STRENGTH OF SILICONE-FIBERGLASS FILAMENT WOUND RINGS
COMPRESSIVE STRENGTH OF SILICONE - FIBERGLASS LAMINATE

NOTE: 181 GLASS CLOTH REINFORCEMENT, 0.500-IN. NOMINAL PANEL THICKNESS (114)

NARMCRO 313 RESIN, 35.8% RESIN CONTENT

TREVARNO F130 RESIN, 30-32% RESIN CONTENT

STRESS (10^3 PSI)

TEMPERATURE (°F)
FATIGUE STRENGTH OF SILICONE-FIBERGLAS LAMINATE
STRESS-STRAIN DIAGRAM FOR C-120-AV TITANIUM
STANDARD DEVIATION BASED ON 21 TESTS AT 75°F. ± 0.032 x 10^6 PSI
STANDARD DEVIATION BASED ON 3 TESTS AT -106°F. ± 0.048 x 10^6 PSI
STANDARD DEVIATION BASED ON 6 TESTS AT -320°F. ± 0.027 x 10^6 PSI
STANDARD DEVIATION BASED ON 3 TESTS AT -423°F. ± 0.024 x 10^6 PSI

\[ \text{STANDARD DEVIATION} = \sqrt{\frac{\sum G^2}{n} - (\bar{G})^2} \]

\( n = \text{NO. OF TESTS} \) AND \( G = \text{MODULUS OF RIGIDITY} \)

MODULUS OF RIGIDITY OF C-120-AV TITANIUM
MODULUS OF ELASTICITY OF C-120·AV TITANIUM

IMPACT ENERGY OF C-120·AV TITANIUM
FLEXURE, 0.072 IN SHEET, TENSILE STR: 136,000 PSI, R = -1, 1800 CPM AT 70°F, -110°F & -320°F, 3450 CPM AT -423°F (BOY).  

FATIGUE LIFE, cycles  
FATIGUE BEHAVIOR OF G-120-AV TITANIUM