LION® alloy 80A

LION® alloy 80A (UNS N07080/W. Nr. 2.4952 &2. 4631) is a wrought, age-hardenable nickel-chromium alloy, strengthened by additions of titanium, aluminum and carbon, developed for service at temperatures up to 815°C (1500°F). It is produced by high-frequency melting and casting in air for forms to be extruded. Electroslag refined material is used for forms to be forged. Vacuum refined versions are also available. LION alloy 80A is currently used for gas turbine components (blades, rings and discs), bolts, nuclear boiler tube supports, die casting inserts and cores, and for automobile exhaust valves.

The alloy's limiting chemical composition is given in Table 1 (as in British Standard HR1, 201, 401 and 601).

Table 1 - Limiting Chemical Composition, % by Weight

Carbon	0.10 max.
Chromium	18.0-21.0
Silicon	1.0 max
Copper	0.2 max.
Iron	3.0 max.
Manganese	1.0 max.
Titanium	1.8-2.7
Aluminum	1.0-1.8
Cobalt	2.0 max.
Boron	0.008 max.
Zirconium	0.15 max.
Lead	0.0025 max.
Sulfur	0.015 max.
Nickel	Balance*

*Reference to the 'balance' of a composition does not guarantee this is exclusively of the element mentioned but that it predominates and others are present only in minimal quantities.

Physical Properties

Some physical properties for LION alloy 80A are given in Table 2. The density was determined on extruded bar, subsequently forged, and extruded section, subsequently cold rolled, given a heat treatment of 8 hours/1080°C (1976°F)/air cool + 16 hours/700°C (1292°F)/air cool.

The liquidus temperature was determined by inverse cooling techniques, and the solidus by metallographic examination. The accuracy of determination was ±5°C (9°F) for the liquidus temperature and +0, –10°C (18°F) for the solidus.

The magnetic property results were obtained from 4 casts of cold rolled sheet, heat treated 2-3 minutes/1150°C (2102°F)/fluidized bed quenched + 20 minutes/1040°C (1904°F)/air cooled + 4 hours/750°C (1382°F)/air cooled.

The specific heat data in Table 3 are calculated values, using the L.R. Jackson equation.

The thermal conductivity data (Table 4) were calculated from electrical resistance measurements on 4 fully heat treated specimens using the modified Wiedermann-Franz equation obtained by R.W. Powell. The material was cold rolled sheet, heat treated 2-3 minutes/1150°C (2102°F)/fluidized bed quenched + 1 hour/925°C (1697°F)/air cooled + 4 hours/750°C (1382°F)/air cooled.

Linear thermal expansion data (Table 5) were obtained from 5 casts of as-extruded section, subsequently cold rolled.

The electrical resistivity data in Table 6 were obtained from 4 casts of cold rolled sheet, heat treated 2-3 minutes/1150°C (2102°F)/fluidized bed quenched + 1 hour/925°C (1697°F)/air cooled + 4 hours/750°C (1382°F)/air cooled.

Table 2 - Physical Properties

Density, g/cm^3	8.19
lb/in^3	0.296
Melting Range, °C	1320-1365
°F	2410-2490
Magnetic Properties	
Mass Susceptibility	5.85 x 10^{-6} at 1000 gauss
Volume Susceptibility	4.78 x 10^{-5} at 1000 gauss
Magnetic Permeability	1.000601 for 200-2000 oersted

Table 3 - Specific Heat

°C	°F	J/kg °C	Btu/lb °F
20	68	448	0.107
100	212	469	0.112
200	392	494	0.118
300	572	519	0.124
400	752	548	0.131
500	932	573	0.137
600	1112	599	0.143
700	1292	628	0.150
800	1472	653	0.156
900	1652	678	0.162
1000	1832	703	0.168

Physical Properties (continued)

Table 4 - Thermal Conductivity

°C	°F	W/m •°C	Btu/ft•h•°F
20	68	11.2	6.47
100	212	11.6	6.71
200	392	14.4	8.32
300	572	16.1	9.31
400	752	17.8	10.3
500	932	19.4	11.2
600	1112	20.8	12.0
700	1292	22.3	12.9
800	1472	24.5	14.2
900	1652	26.5	15.3
1000	1832	28.4	16.4

Table 5 - Mean Coefficient of Linear Thermal Expansion

°C	10^{-6}/°C		°F	10^{-6}/°F	
	A	B		A	B
20 – 100	12.7	12.8	68 – 212	7.1	7.1
– 200	13.3	13.3	– 392	7.4	7.4
– 300	13.7	13.7	– 572	7.6	7.6
– 400	14.1	14.1	– 752	7.8	7.8
– 500	14.4	14.5	– 932	8.0	8.1
– 600	15.0	15.0	– 1112	8.3	8.3
– 700	15.5	15.5	– 1292	8.6	8.6
– 800	16.2	16.2	– 1472	9.0	9.0
– 900	17.1	17.1	– 1652	9.5	9.5
– 1000	18.1	18.2	– 1832	10.1	10.1

A Heat treated 8 hours/1080°C (1976°F)/air cooled + 16 hours/700°C (1292°F)/air cooled.
B Heat treated 8 hours/1080°C (1976°F)/air cooled + 24 hours/850°C (1562°F)/air cooled+ 16 hours/700°C (1292°F)/air cooled.

Table 6 - Electrical Resistivity

124 µΩ cm (746 Ω/circ mil ft) at 20°C (68°F)

°C	°F	Relative Resistance
20	68	1.000
100	212	1.008
200	392	1.023
300	572	1.040
400	752	1.064
500	932	1.073
600	1112	1.064
700	1292	1.064
800	1472	1.057
900	1652	1.032
1000	1832	1.017

Table 7 - Torsional Modulus

°C	°F	GPa	10^3 ksi
20	68	85	12.3
100	212	84	12.2
200	392	82	11.9
300	572	79	11.5
400	752	77	11.2
500	932	74	10.7
600	1112	70	10.2
700	1292	67	9.7
800	1472	64	9.3
900	1652	58	8.4
1000	1832	53	7.7

Cold rolled sheet (4 casts). Heat treated 2-3 minutes/1150°C (2102°F)/ fluidized bed quenched + 20 minutes/ 1040°C (1904°F)/air cooled + 4 hours/750°C (1382°F)/air cooled.

Table 8 - Dynamic Young's Modulus

Property	Test Program			
	A	B	C	D
	GPa (10^3 ksi)	GPa (10^3 ksi)	GPa (10^3 ksi)	GPa (10^3 ksi)
20 (68)	183 (26.5)	219 (31.8)	214 (31.0)	222 (32.2)
100 (212)	179 (30.0)	216 (31.3)	210 (30.5)	219 (31.8)
200 (392)	173 (25.1)	210 (30.5)	205 (29.7)	213 (30.9)
300 (572)	168 (24.4)	204 (29.6)	199 (28.9)	208 (30.2)
400 (752)	163 (23.6)	197 (28.6)	192 (27.8)	201 (29.2)
500 (932)	157 (22.8)	191 (27.7)	185 (26.8)	194 (28.1)
600 (1112)	150 (21.8)	183 (26.5)	178 (25.8)	188 (27.3)
700 (1292)	142 (20.6)	175 (25.4)	170 (24.7)	180 (26.1)
800 (1472)	134 (19.4)	165 (23.9)	161 (23.3)	170 (24.7)
900 (1652)	123 (17.8)	153 (22.2)	149 (21.6)	159 (23.1)
1000 (1832)	112 (16.2)	141 (20.5)	134 (19.4)	145 (21.0)

A. Extruded bar (12 casts). Heat treated 8 hours/1080°C (1976°F)/air cooled + 16 hours/700°C (1292°F)/air cooled.

B. Extruded bar, subsequently forged (13 casts). Heat treated 8 hours/1080°C (1796°F)/air cooled + 16 hours/700°C (1292°F)/air cooled.

C. Extruded section, subsequently cold rolled (5 casts). Heat treated 8 hours/1080°C (1796°F)/air cooled + 16 hours/700°C (1292°F)/air cooled.

D. Cold rolled sheet (4 casts). Heat treated 2-3 minutes/1150°C (2102°F)/fluidized bed quenched + 20 minutes/1040°C (1904°F)/air cooled + 4 hours/750°C (1382°F)/air cooled. Dynamic moduli are usually about 0.2% higher than static moduli at room temperature, increasing to 1% at 1000°C (1832°F).

Mechanical Properties

The tensile data quoted in Figures 1 to 11 are for bar, section and sheet after the recommended treatments. Statistical data on the scatter of results from tests on production material are shown in Figures 1 to 6.

Strain rate 0.005/min to proof stress at room temperature, 0.002/min to proof stress at elevated temperatures, and 0.1/min therafter.

Note: in Figures 1 to 11
A = Elongation
Rm = Tensile Strength
Rp0.2 = 0.2% Proof Stress
Z = Reduction of Area

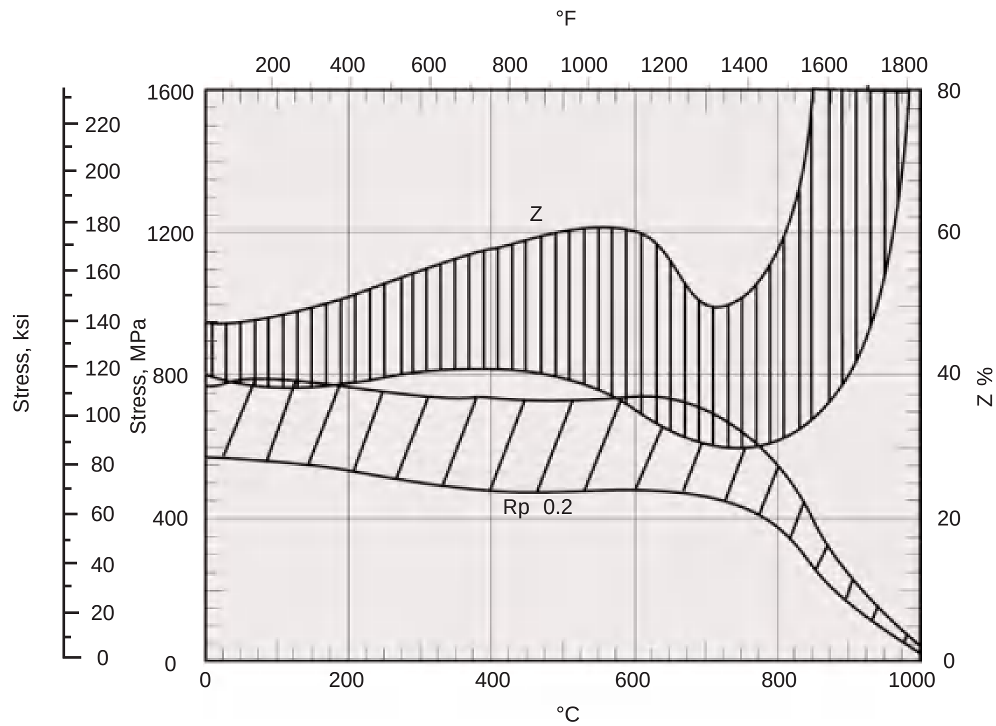


Figure 1. Tensile properties of extruded bar. Heat treated 8 hours/1080°C (1976°F)/air cooled + 16 hours/700°C (1292°F)/air cooled. 98% confidence region calculated on 13 casts.

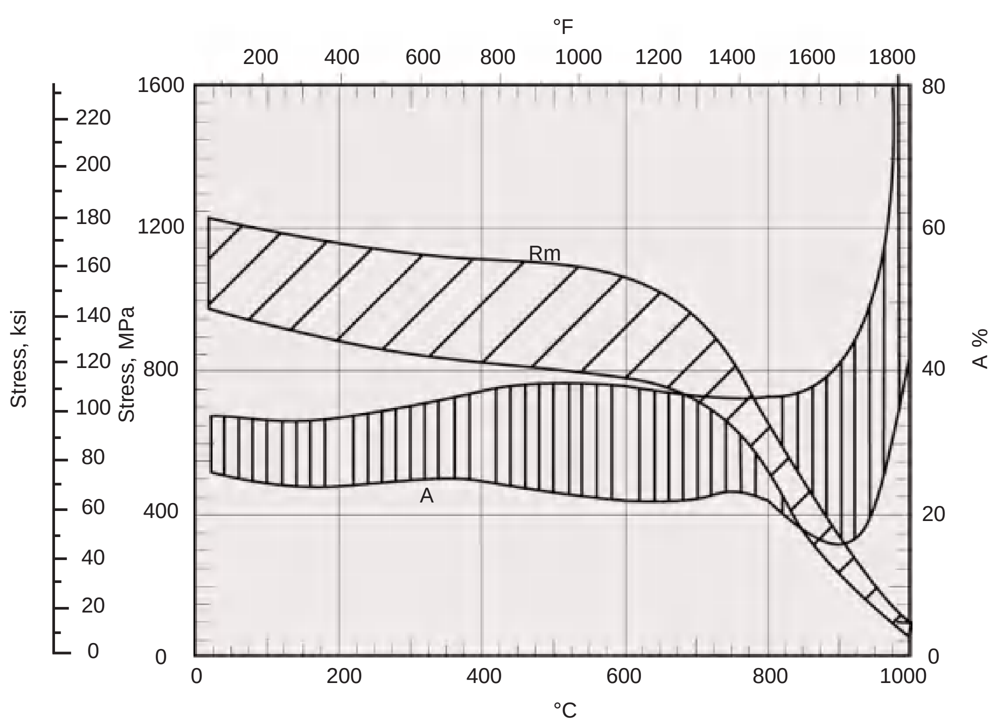


Figure 2. Tensile properties of extruded bar. Heat treated 8 hours/1080°C (1976°F)/air cooled + 16 hours/700°C (1292°F)/air cooled. 98% confidence region calculated on 13 casts.

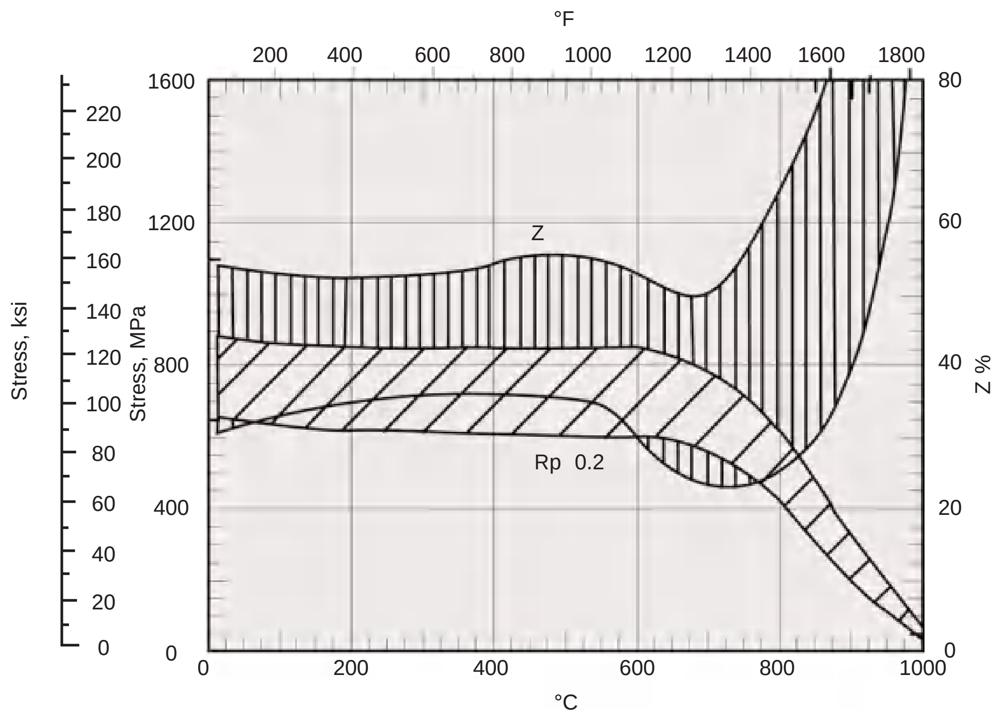


Figure 3. Tensile properties of extruded bar, subsequently forged. Heat treated 8 hours/1080°C (1976°F)/air cooled + 16 hours/700°C (1292°F)/air cooled. 98% confidence region calculated on 15 casts.

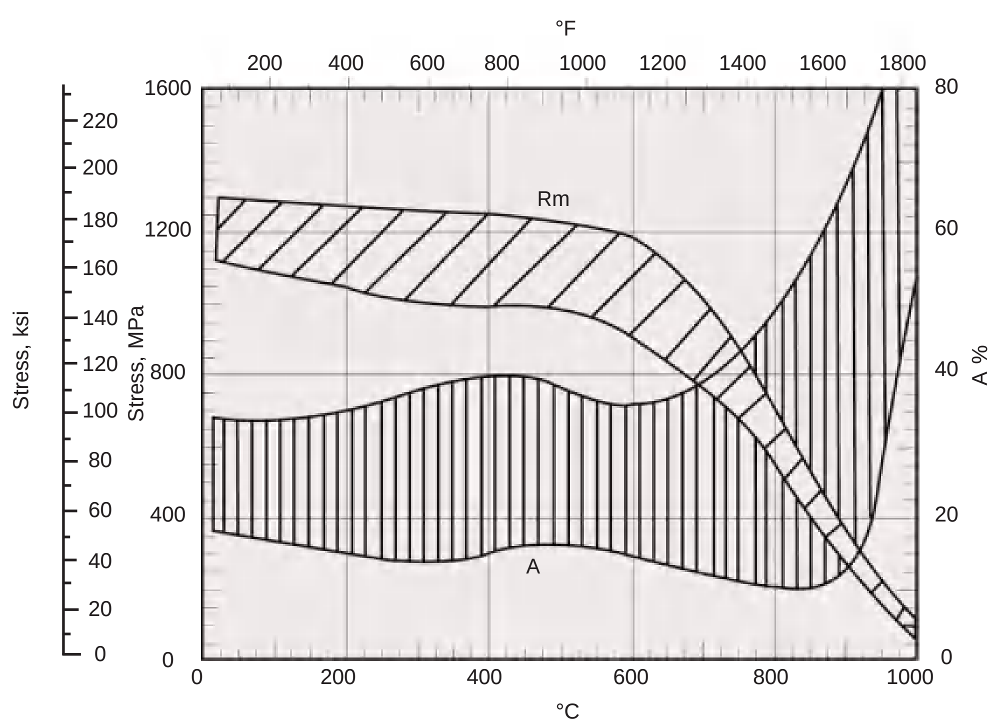


Figure 4. Tensile properties of extruded bar, subsequently forged. Heat treated 8 hours/1080°C (1976°F)/air cooled + 16 hours/700°C (1292°F)/air cooled. 98% confidence region calculated on 15 casts.

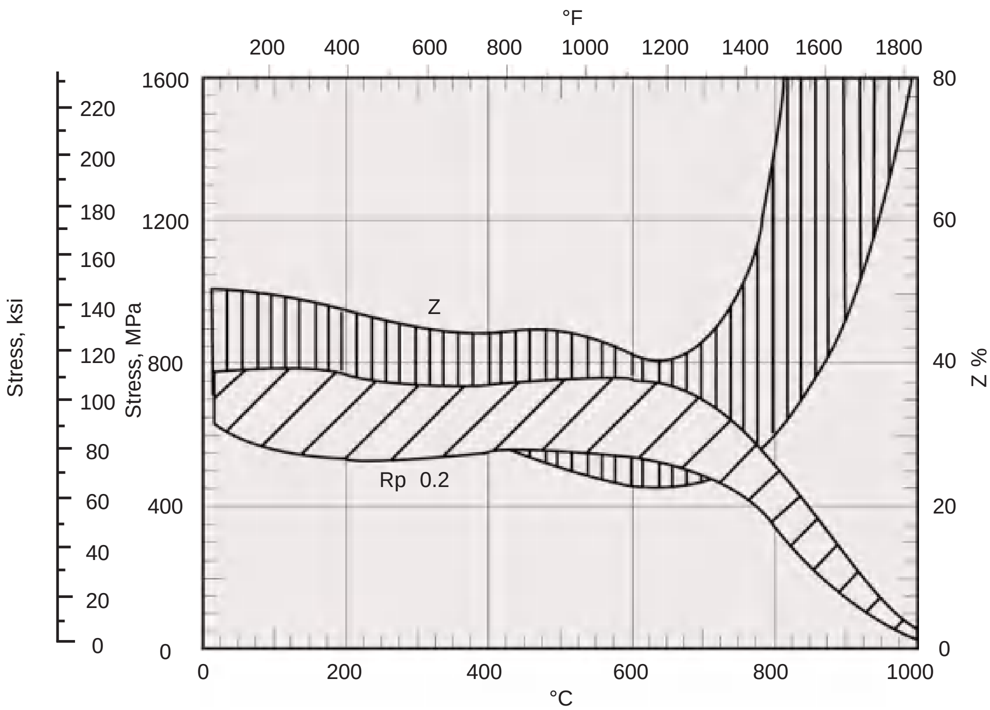


Figure 5. Tensile properties of extruded bar, subsequently forged. Heat treated 8 hours/1080°C (1976°F)/air cooled + 24 hours/850°C (1562°F)/air cooled + 16 hours/700°C (1292°F)/air cooled. 98% confidence region calculated on 11 casts.

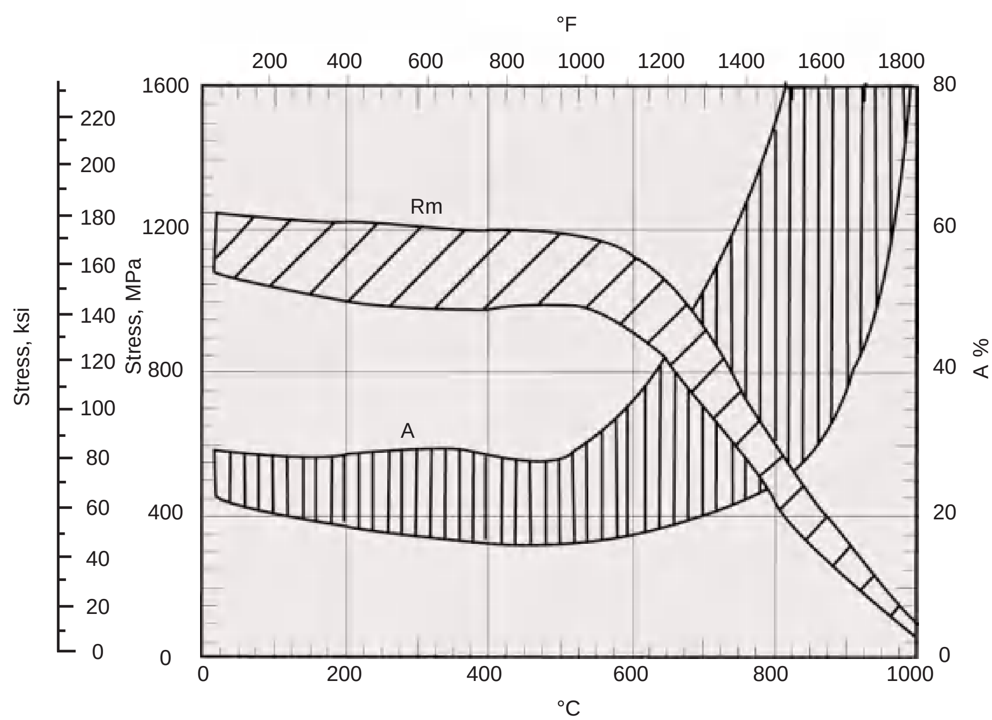


Figure 6. Tensile properties of extruded bar, subsequently forged. Heat treated 8 hours/1080°C (1976°F)/air cooled + 24 hours/850°C (1562°F)/air cooled + 16 hours/700°C (1292°F)/air cooled.

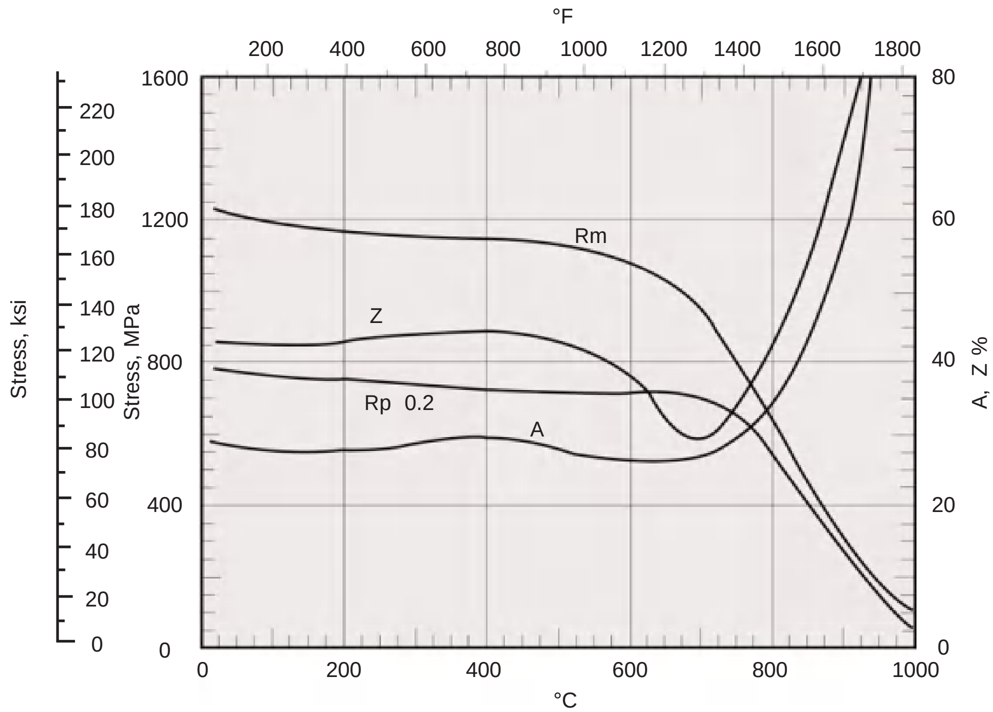


Figure 7. Tensile properties of extruded section, subsequently cold rolled. Heat treated 8 hours/1080°C (1976°F)/air cooled + 16 hours/700°C (1292°F)/air cooled.

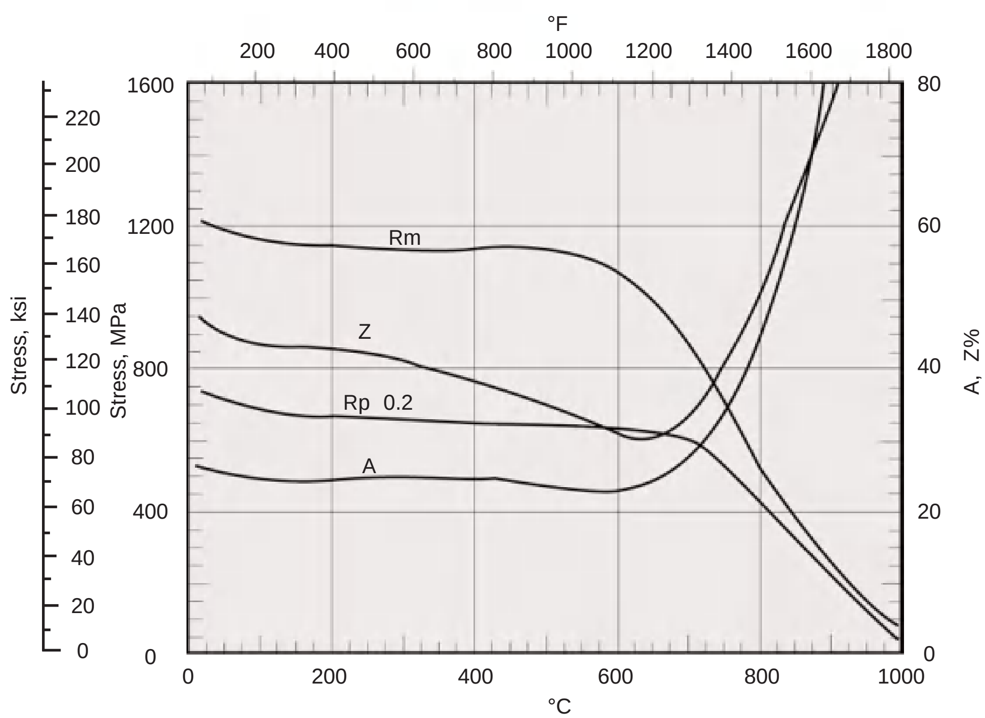


Figure 8. Tensile properties of extruded bar, subsequently cold rolled. Heat treated 8 hours/1080°C (1976°F)/air cooled + 24 hours/850°C (1562°F)/air cooled + 16 hours/700°C (1292°F)/air cooled. Average results of tests calculated on 5 casts.

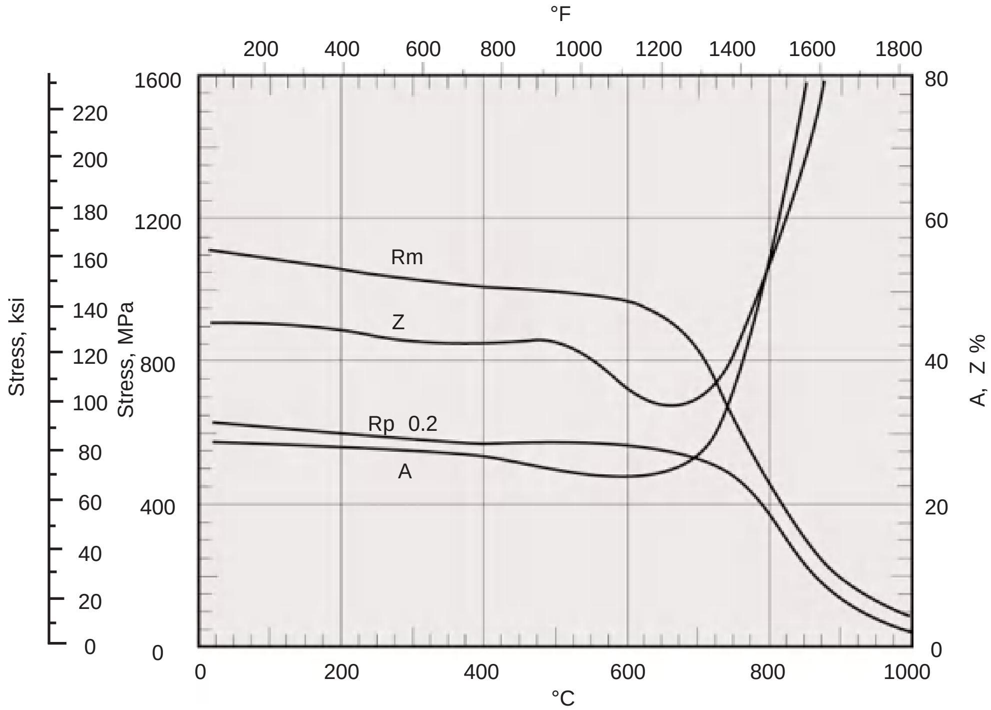


Figure 9 . Tensile properties of extruded bar, subsequently cold stretched. Heat treated 8 hours/1080°C (1976°F)/air cooled + 24 hours/850°C (1562°F)/air cooled + 16 hours/700°C (1292°F)/air cooled. Results from 1 cast.

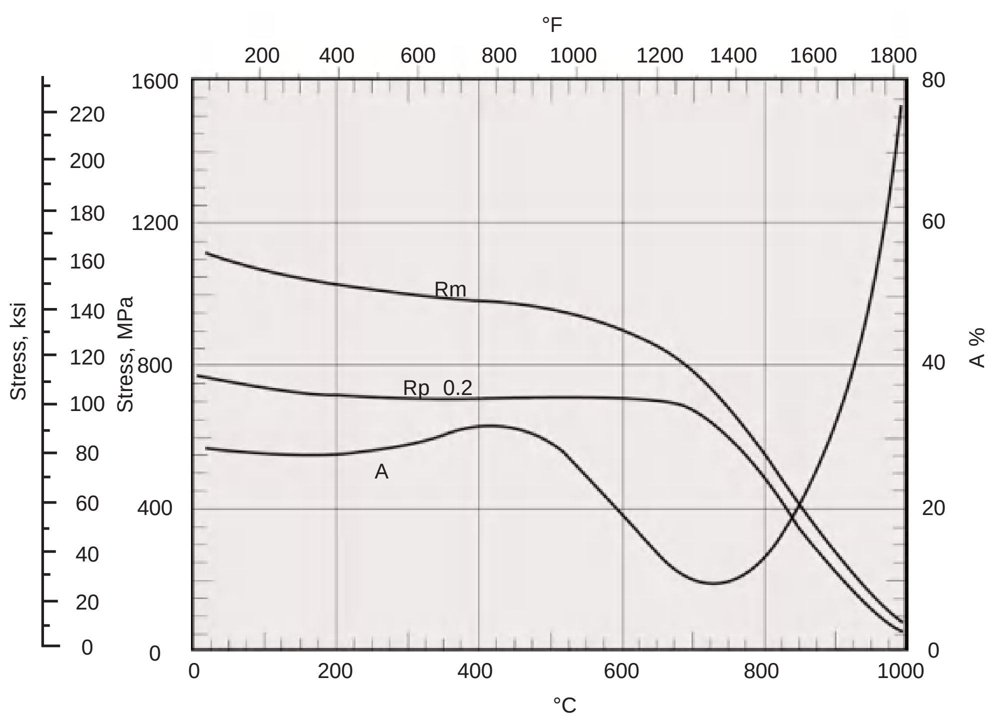


Figure 10. Tensile properties of colled rolled sheet. Heat treated 2 to 3 minutes/1150°C (2102°F)/fluidized bed quenched + 20 minutes/1040°C (1904°F)/air cooled + 4 hours/750°C (1382°F)/air cooled. Average results of tests on 5 casts.

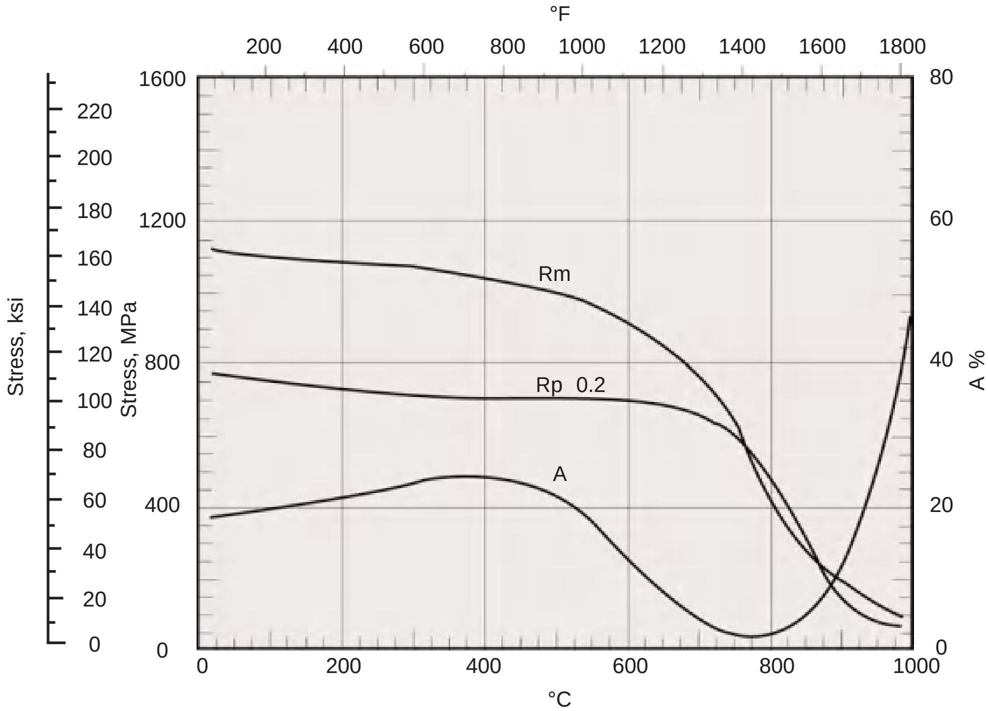


Figure 11 . Tensile properties of cold rolled sheet, welded. Heat treated 2 minutes/1150°C (2102°F)/air cooled + weld + 1 hour/925°C (1697°F)/air cooled + 4 hours/750°C (1382°F)/air cooled. Average result of tests on 4 casts. Sheet thicknesses, 0.7-1.1 mm (0.03-0.04 inch). T.I.G. welded.

Creep Properties

The creep resistance properties of LION alloy 80A have been determined on bar (16-18 casts), section (5 casts), and sheet (1 cast). Total plastic strain data have been determined on extruded section and sheet (1 cast).

Creep properties for extruded bar, subsequently forged, are shown in Figures 12 and 13; for extruded bar, subsequently cold rolled, in Figure 14; and for cold rolled sheet in Figures 13 and 15 by Larson-Miller presentations and Graham and Walles techniques.

The Graham and Walles technique assumes that stress-time test points fall on the continuous series of straight lines for each temperature, with slopes 1/32, 1/16, 1/8, 1/4, 1/2, the change of slope and the distance between the lines being dependent on a time/temperature relationship.

Derived total plastic strain data for extruded section, subsequently cold rolled, and for cold rolled sheet, are shown in Tables 9 and 10. Specimens were 9.1-11.7 mm (0.36-0.46 inch) diameter x 76 mm (3.0 inch) gauge length.

Figure 12 . Creep properties of LION alloy 80A extruded bar, subsequently forged. Heat treatment 8 hours/1080°C (1976°F)/air cooled + 16 hours/700°C (1292°F)/air cooled. 98% confidence region on 16-18 casts.

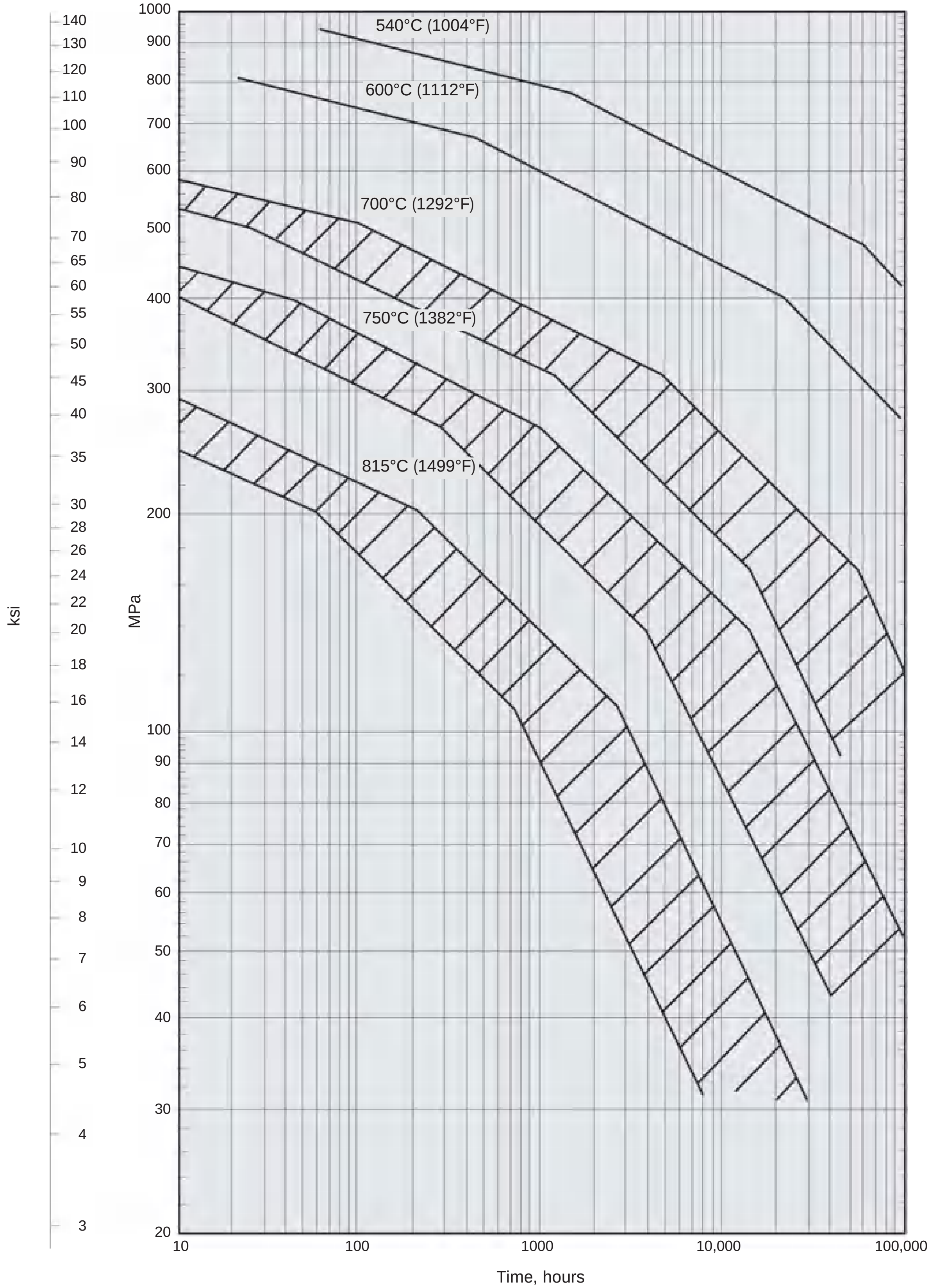
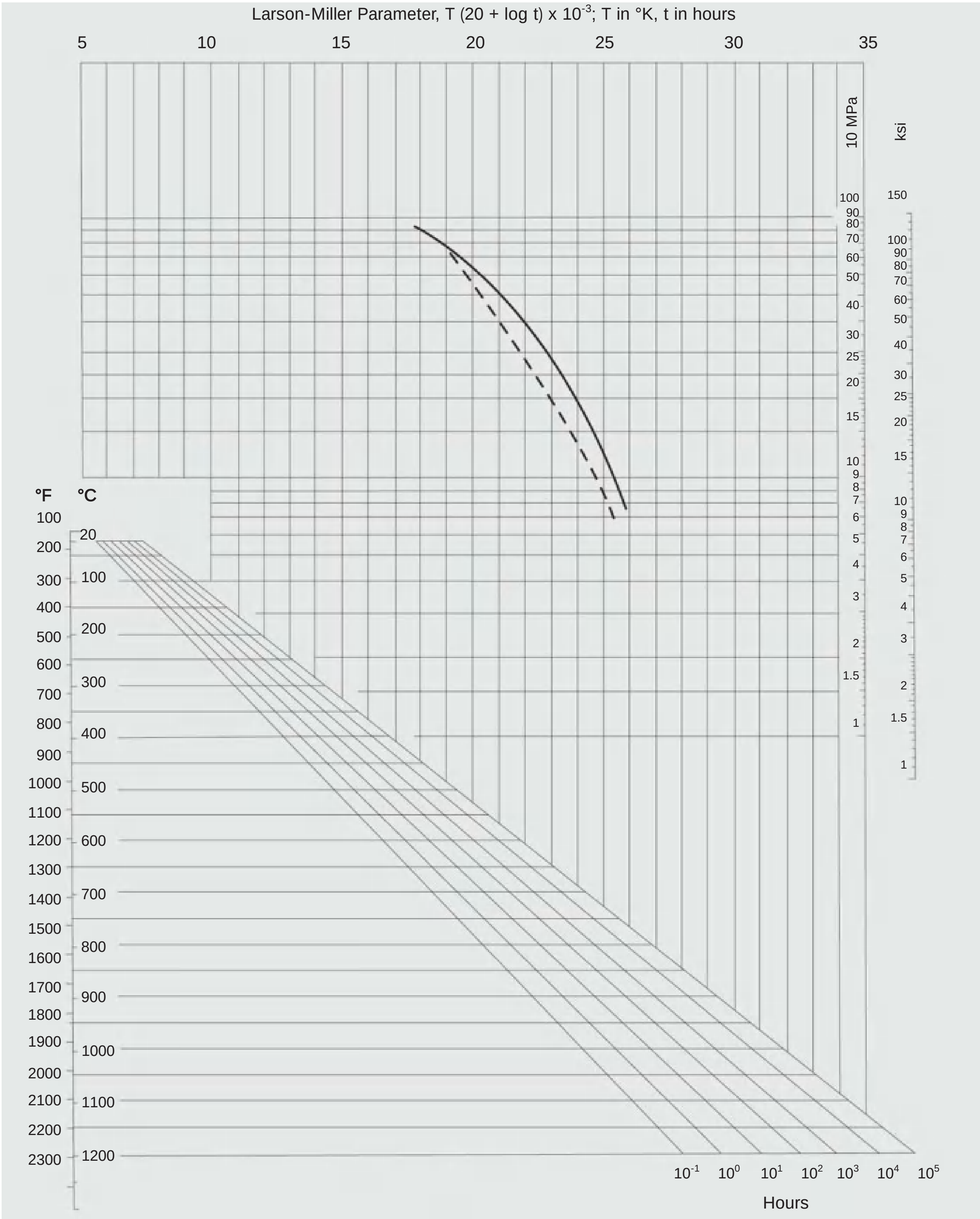


Figure 13. Creep rupture properties of LION alloy 80A bar and sheet.



Extruded bar, subsequently forged. Heat treated 8 hours/1080°C (1976°F)/air cooled + 16 hours/700°C (1292°F)/air cooled. Average results from 16-18 casts.

Cold rolled sheet. Heat treated 2 minutes/1150°C (2102°F)/air cooled + 4 hours 750°C (1382°F)/air cooled. Results from 1 cast. Sheet 1.6mm (0.06 inch) thick.

Figure 14 . Creep properties of LION alloy 80A extruded section, subsequently cold rolled. Average results from 5 casts.

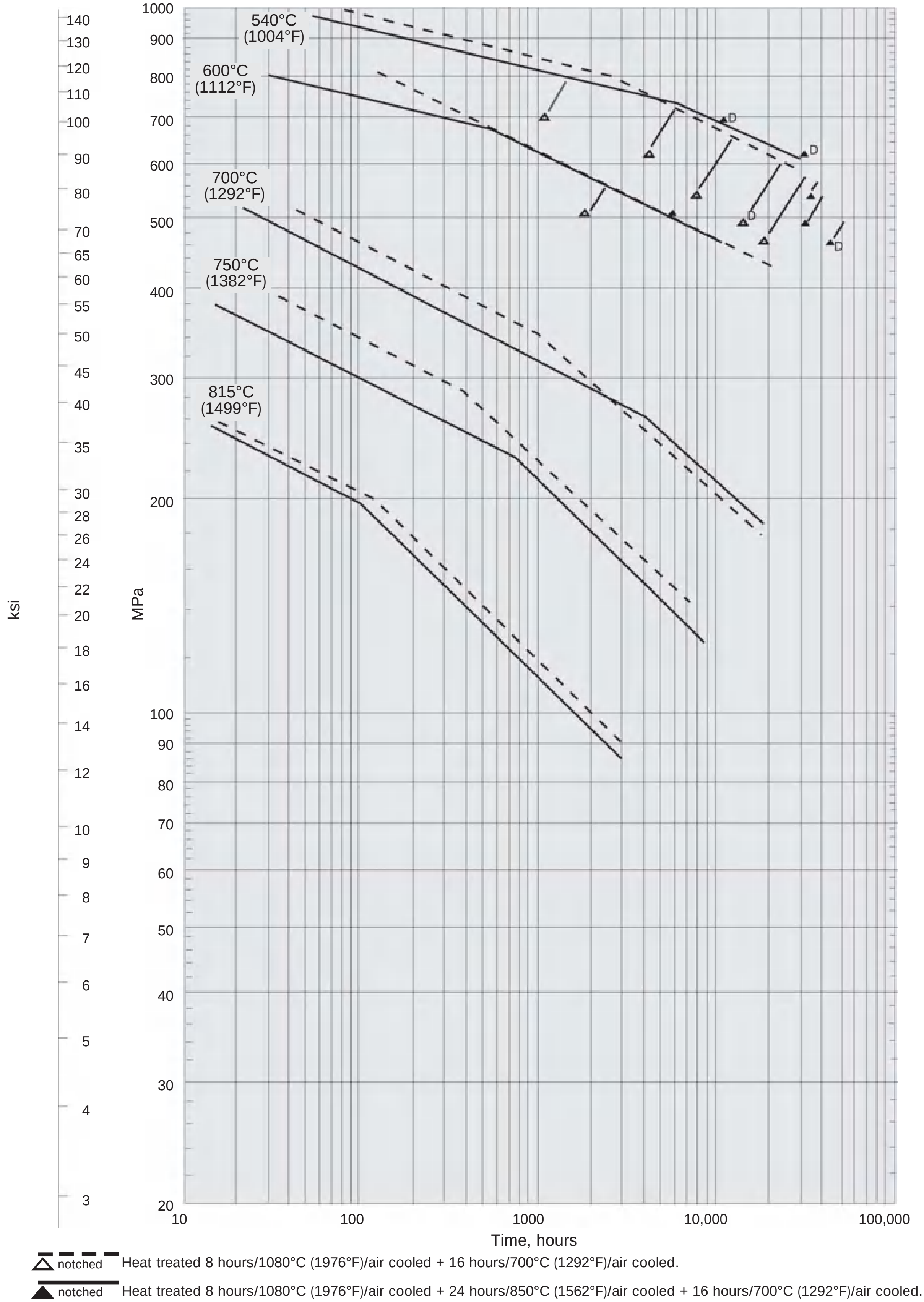
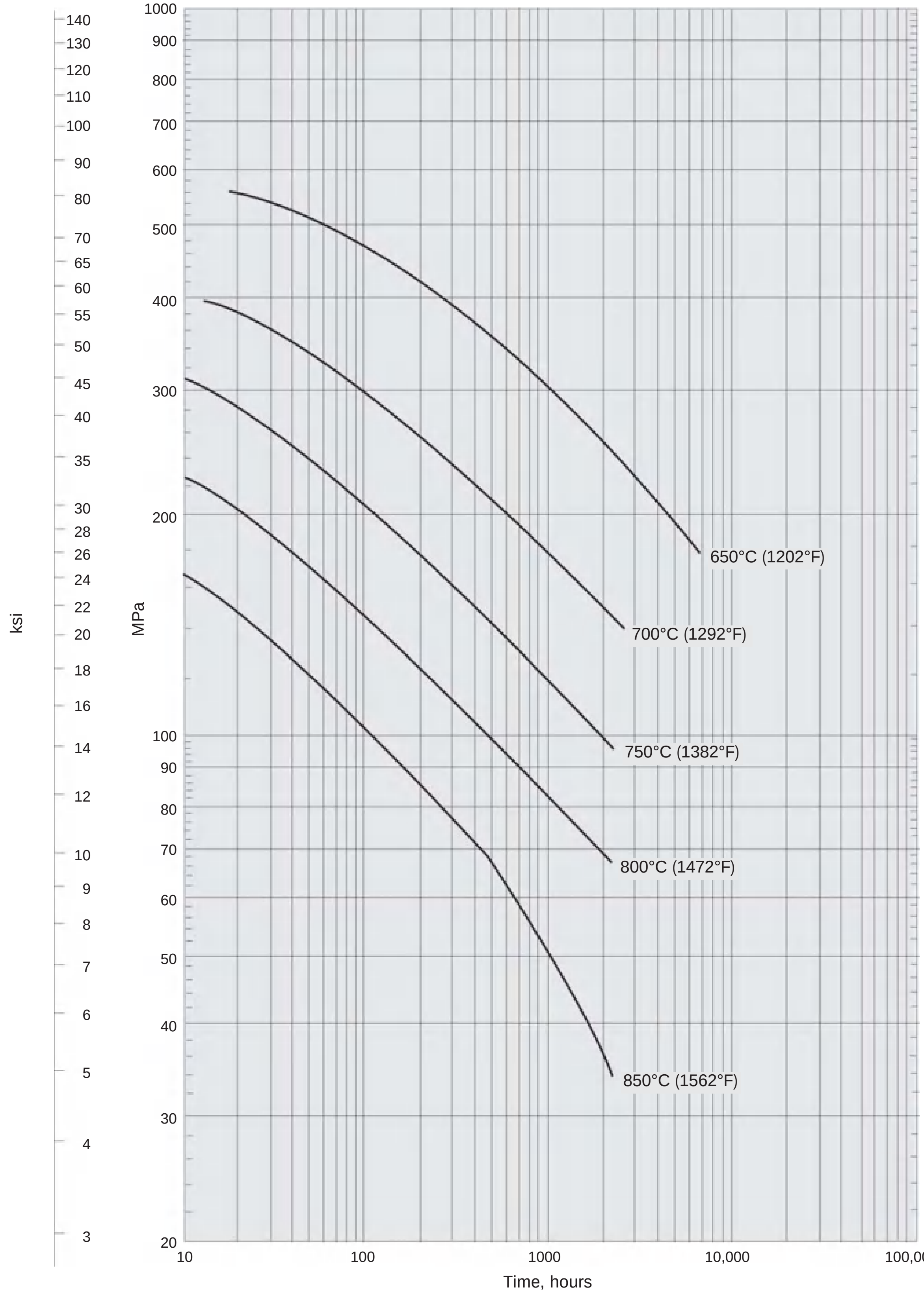


Figure 15. Creep-rupture properties of LION alloy 80A cold rolled sheet, 1.6 mm (0.06 inch) thick. Results from 1 cast.



Heat treated 2 min/1150°C (2102°F)/air cooled + 4 hours/750°C (1382°F)/air cooled.

Table 9 - Total Plastic Strain (Extruded Section, Subsequently Cold Rolled)
Heat treatment 8 hours/1080°C (1976°F)/air cooled + 16 hours/700°C (1292°F)/air cooled

°C (°F)	Strain %	Stress, MPa (ksi), to give total plastic strain in:					
		100h	300h	1000h	3000h	10,000h	30,000h
600 (1112)	0.1	558 (80.9)	511 (74.1)	460 (66.7)	412 (59.7)	371 (53.8)	–
	0.2	599 (86.9)	551 (79.9)	500 (72.5)	453 (65.7)	400 (58.0)	–
	0.5	635 (92.1)	607 (88.0)	574 (83.2)	522 (75.7)	460 (66.7)	402 (58.3)*
650 (1202)	0.1	454 (65.8)	403 (58.4)	347 (50.3)	298 (43.2)	–	–
	0.2	502 (72.8)	451 (65.4)	395 (57.3)	344 (49.9)	289 (41.9)	–
	0.5	–	494 (71.6)	443 (64.2)	385 (55.8)	476 (69.0)	266 (38.6)
700 (1292)	0.1	346 (50.2)	295 (42.8)	238 (34.5)	190 (27.6)	147 (21.3)	–
	0.2	388 (56.3)	337 (48.9)	281 (40.7)	232 (33.6)	178 (25.8)	124 (18.0)*
	0.5	–	369 (53.5)	309 (44.8)	255 (37.0)	195 (28.3)	141 (20.5)*
750 (1382)	0.1	239 (34.7)	192 (27.8)	144 (20.9)	108 (15.7)	74 (10.7)*	–
	0.2	273 (39.6)	227 (32.9)	176 (25.5)	131 (19.0)	88 (12.8)	–
	0.5	300 (43.5)	255 (37.0)	205 (29.7)	159 (23.1)	116 (16.8)	77 (11.2)*
815 (1499)	0.1	124 (18.0)	93 (13.5)	59 (8.6)	36 (5.2)	23 (3.3)	–
	0.2	137 (19.9)	107 (15.5)	73 (10.6)	43 (6.2)	26 (3.8)	15 (2.2)*
	0.5	148 (21.5)	116 (16.8)	80 (11.6)	53 (7.7)	31 (4.5)	19 (2.8)

*Extrapolated

Table 10 - Total Plastic Strain (Cold Rolled Sheet)
Heat treatment 2 min/1150°C (2102°F)/water quenched + 4 hours/750°C (1382°F)/air cooled

°C (°F)	Strain %	Stress, MPa (ksi), to give total plastic strain in:			
		50h	100h	300h	1000h
650 (1202)	0.1	422 (61.2)	377 (54.7)	307 (44.5)	224 (32.5)
	0.2	479 (69.5)	432 (62.6)	366 (53.1)	286 (41.5)
700 (1292)	0.1	275 (39.9)	235 (34.1)	176 (25.5)	125 (18.1)
	0.2	332 (48.1)	289 (41.9)	225 (32.6)	161 (23.3)
750 (1382)	0.1	165 (23.9)	137 (19.9)	102 (14.8)	71 (10.3)
	0.2	205 (29.7)	175 (25.4)	131 (19.0)	91 (13.2)
800 (1472)	0.1	102 (14.8)	85 (12.3)	62 (9.0)	42 (6.1)
	0.2	130 (18.9)	108 (15.7)	77 (11.2)	53 (7.7)
850 (1562)	0.1	73 (10.6)	59 (8.6)	39 (5.7)	23 (3.3)
	0.2	93 (13.5)	74 (10.7)	51 (7.4)	31 (4.5)

Fatigue Properties

Figures 16 to 22 illustrate the fatigue properties of extruded bar, subsequently cold rolled, heat treated 8 hours/1080°C (1976°F)/air cooled + 16 hours/700°C (1292°F)/air cooled, under conditions of uniaxial stressing with varying mean stress.

The abscissae represent the mean stress, and the ordinate fluctuating stress. Thus, a point on the horizontal axis represents the steady stress which will produce fracture in a specific time in a normal creep rupture test. A point on the vertical axis indicates the fluctuating stress required to produce a pure fatigue failure in the same time at the particular stress frequency adopted.

The lines radiating from the origin correspond to stress conditions of the form P ± CP, where P is the steady stress and C is a constant for any lines of 100 and 1000 hours up to 600°C (1112°F), and 100, 300 and 1000 hours up to 750°C (1382°F) for varying stress conditions.

Test frequencies of 100-200 cycles/second were used up to 600°C (1112°F), thereafter 30-40 cycles/second up to 750°C (1382°F).

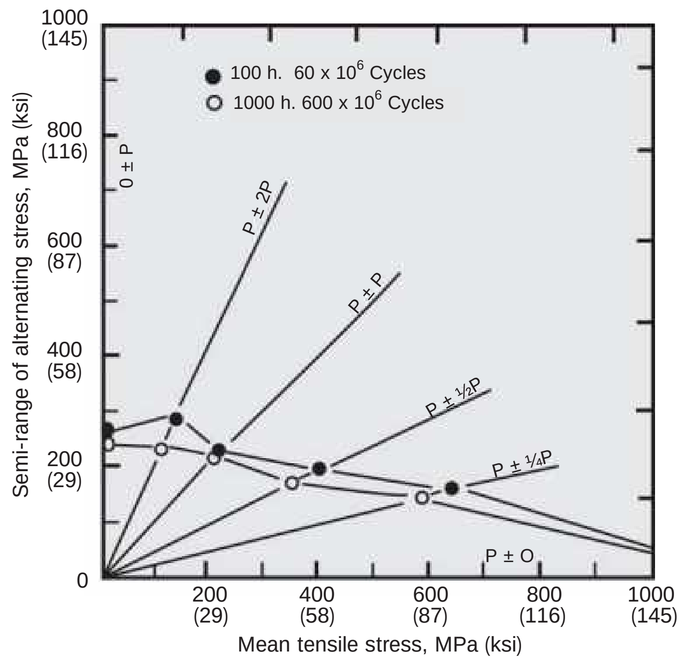


Figure 16. Fatigue test at 20°C (68°F)

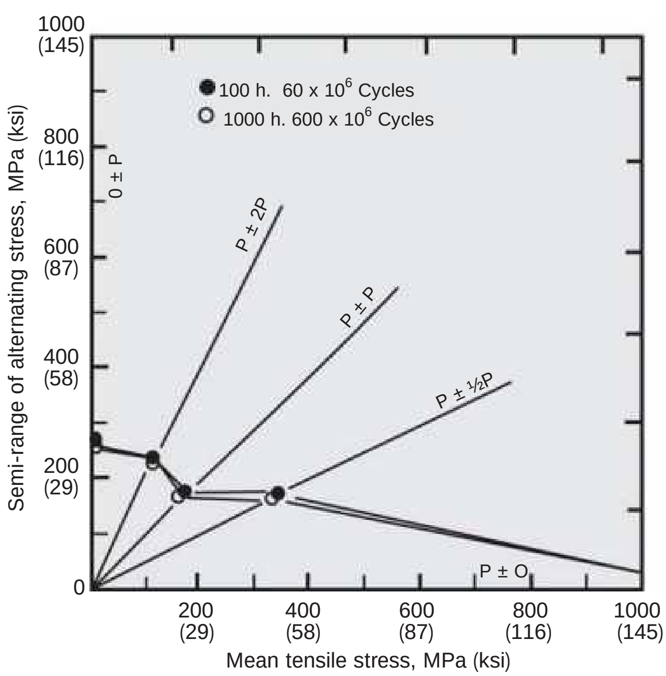


Figure 17. Fatigue test at 300°C (572°F)

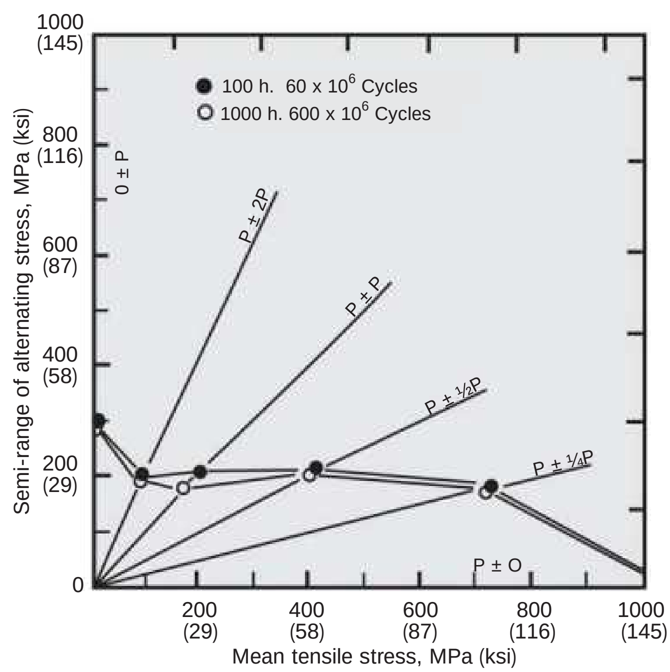


Figure 18. Fatigue test at 480°C (896°F)

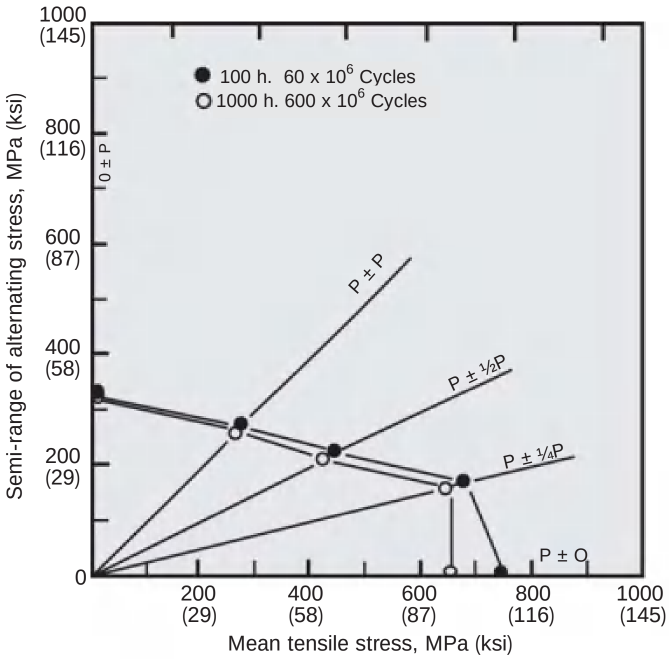


Figure 19. Fatigue test at 600°C (1112°F)

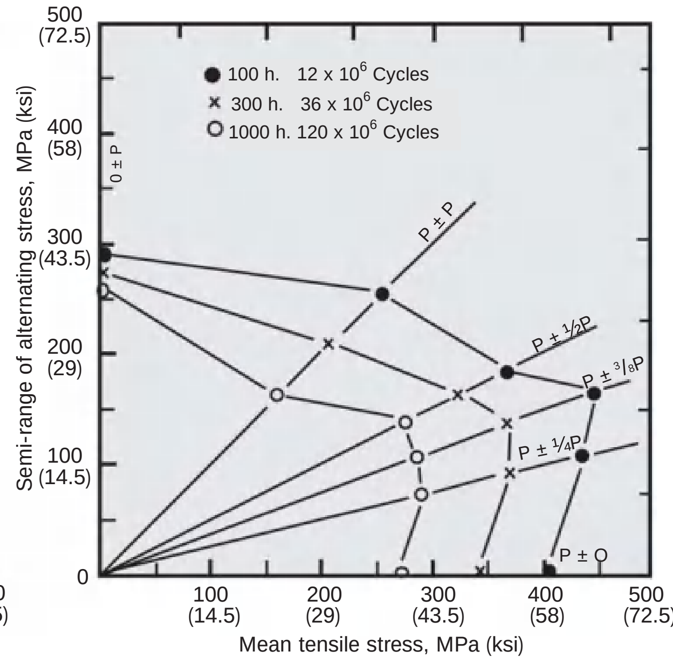


Figure 20. Fatigue test at 700°C (1292°F)

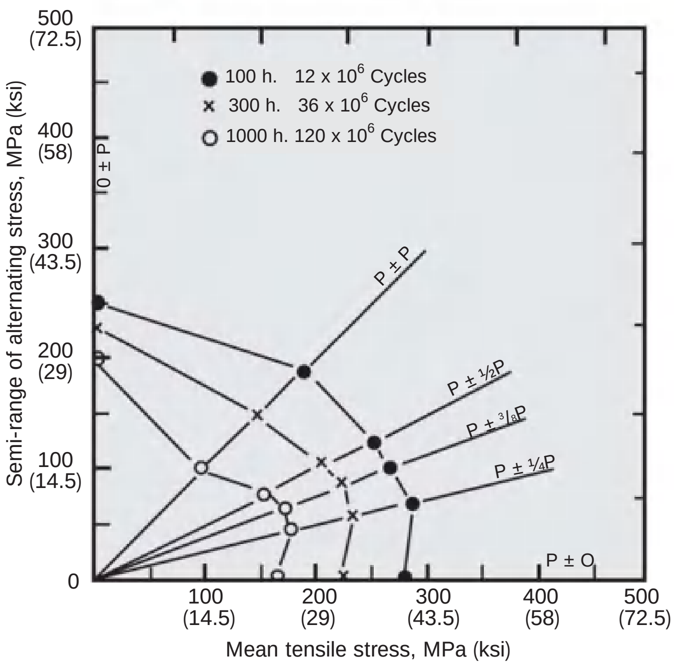


Figure 21. Fatigue test at 750°C (1382°F)

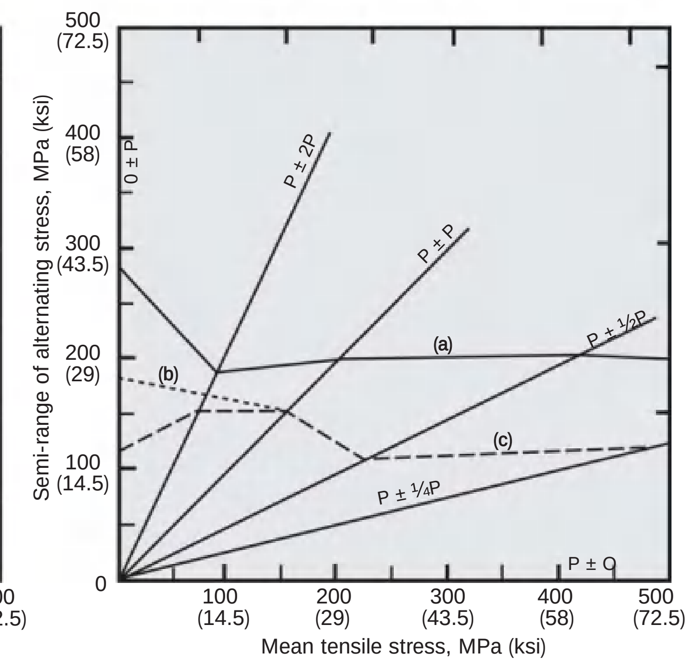


Figure 22. Fatigue test at 480°C (896°F)

(a) Heat treated 8h/1080°C (1976°F)/air cooled + 16h/700°C (1292°F)/air cooled. 100 hours (60 x 10^6 cycles), KT + 1.0.

(b) Notched and heat treated 8h/1080°C (1976°F)/air cooled. 100 hours (60 x 10^6 cycles), KT + 4.0.

(c) Notched and heat treated 16/700°C (1292°F)/air cooled. 100 hours (60 x 10^6 cycles), KT + 4.0.

Stress Relaxation Properties

The stress relaxation data in Figure 23 are for hot-rolled bar, subsequently cold stretched, given the two recommended heat treatments. Data derived from the three-stage heat treatment should be regarded as tentative because only a limited amount of testing has been completed. However, a relative improvement in stress relaxation properties can be seen.

Figure 24 gives the relationship between the number of re-tightenings and re-tightening time. Tests were carried out at an allowable plastic strain of 0.4%, although LION alloy 80A, given the three-stage heat treatment, is capable of 1.0% total plastic strain without serious deterioration in stress relaxation characteristics.

Figure 25 gives the relationship between initial strain, residual stress and time. The residual stress after a given time was greater at the higher level of initial strain, but at a decreasing advantage with time and temperature. This must be weighed against future reloading because high initial stresses result in faster conversion from elastic to plastic deformation, thus exhausting more rapidly the available ductility and reducing the number of times that a bolt can be reloaded.

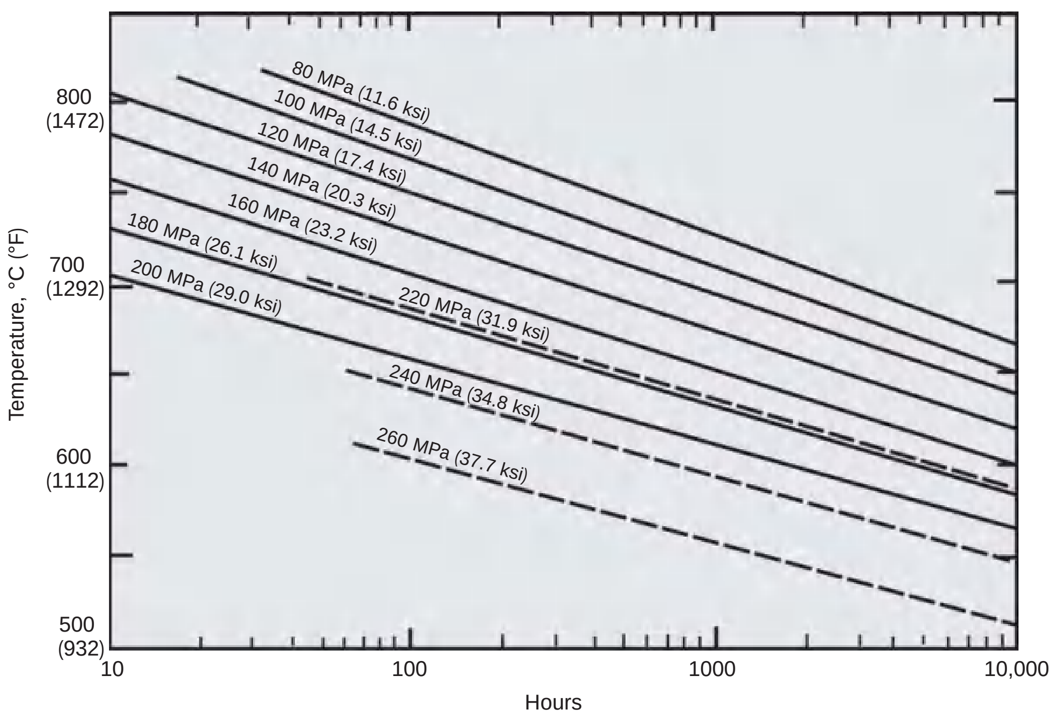


Figure 23. Stress relaxation properties of LION alloy 80A.

Hot rolled bar, heat treated 8h/1080°C (1976°F)/air cooled + 16h/700°C (1292°F)/air cooled.

Extruded bar, cold stretched, heat treated 8h/1080°C (1976°F)/air cooled + 24/850°C (1562°F)/air cooled + 16h/700°C (1292°F)/air cooled.

Initial strain, 0.15%.

Stress Relaxation Properties (continued)

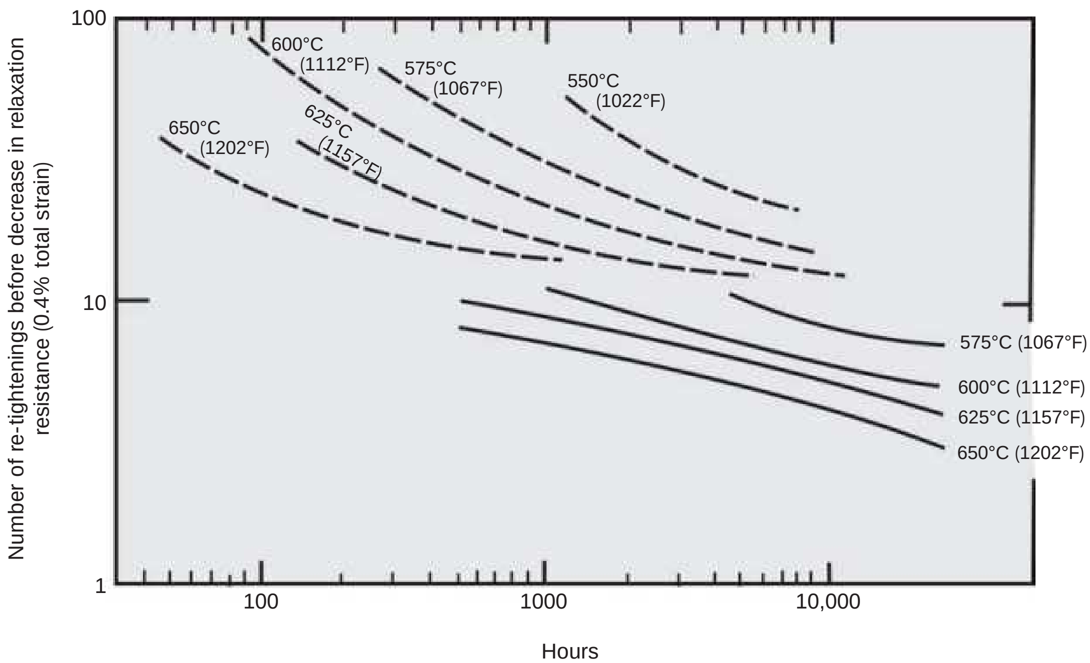


Figure 24. Relationship between re-tightenings and re-tightening time.

Hot rolled bar, heat treated 8h/1080°C (1976°F)/air cooled + 16h/700°C (1292°F)/air cooled.

Extruded bar, cold stretched, heat treated 8h/1080°C (1976°F)/air cooled + 24h/850°C (1562°F)/air cooled + 16h/700°C (1292°F)/air cooled.

Initial and re-tightening strain, 0.15%.
Total strain, 0.4%.

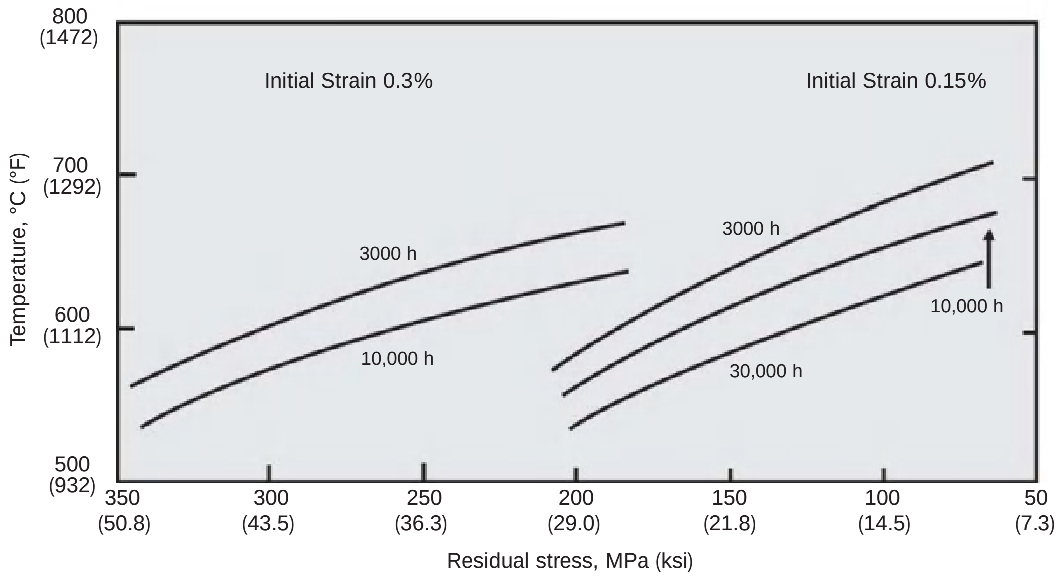


Figure 25. Relationship between initial strain, residual stress and time. LION alloy 80A, heat treated 8h/1080°C (1976°F)/air cooled + 16h/700°C (1292°F)/air cooled).

Corrosion Resistance

The corrosion resistance of LION alloy 80A is presented in Table 11, and Figures 26 and 27.

Table 11 - Oxidation Resistance of LION alloy 80A. Continuous Heating in Air.

Temperature		Descaled Weight Loss (mg/cm^2) in:			
°C	°F	30h	100h	300h	1000h
750	1382	1.8	1.9	2.5	5.3
900	1652	3.9	3.8	4.2	6.6
1000	1832	7.1	7.4	10.5	16.0
1100	2012	8.0	12.9	18.8	21.2
1200	2192	9.1	1.5	20.0	64.5

Corrosion Resistance

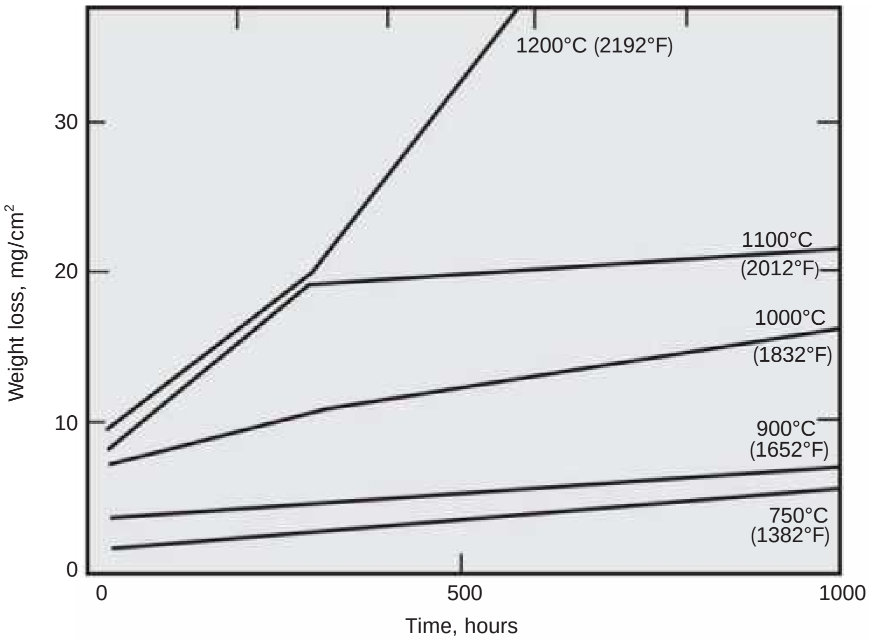


Figure 26. Isothermal oxidation resistance of LION alloy 80A.

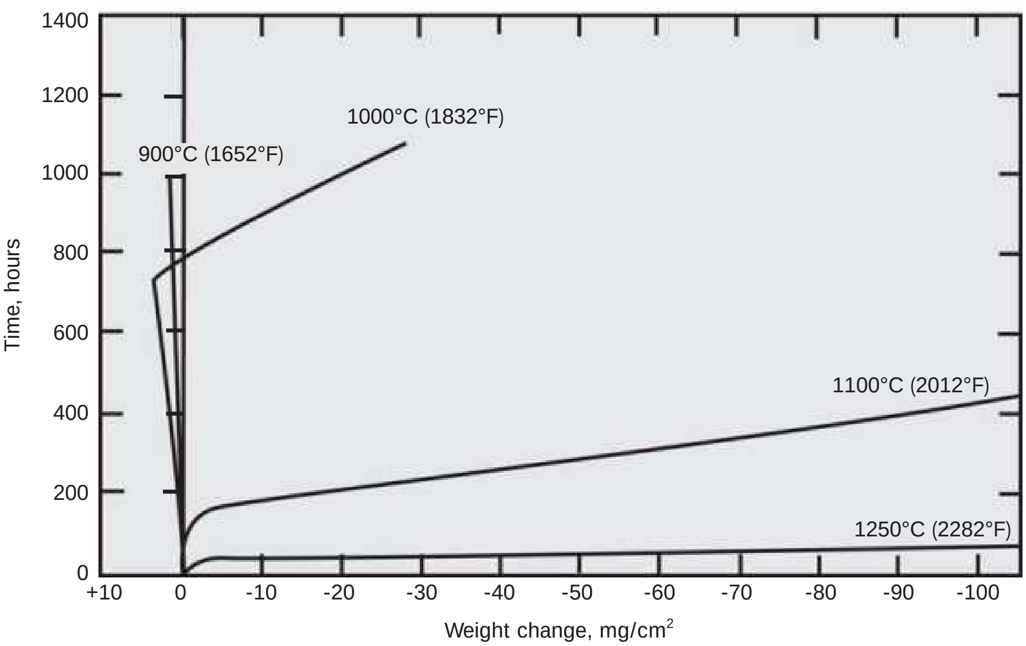


Figure 27. Cyclic oxidation resistance of LION alloy 80A. (20 minutes in furnace, 10 minutes in air.)

Heat Treatment

The heat treatments recommended for LION alloy 80A are as follows:

For extruded bar	8h/1080°C (1976°F)/air cool + 16h/700°C (1292°F)/air cool.
For extruded bar, subsequently cold stretched	8h/1080°C (1976°F)/air cool + 24h/850°C (1562°F)/air cool + 16h/700°C (1292°F)/air cool.
For cold rolled sheet	2-3 minutes/1150°C (2102°F)/ fluidized bed quench + 20 minutes/1040°C (1904°F)/air cool+4h/750°C(1382°F)/air cool.
For welded sheet	2 minutes/1150°C (2102°F)/air cool + weld + 1h/925°C (1697°F)/air cool + 4h/750°C (1382°F)/air cool.
For interstage annealing of sheet	20 minutes/1040°C (1904°F)/air cool.

Data for sheet quoted in this publication have been obtained from material given a second interstage anneal (20 minutes/1040°C (1904°F)/air cool) which is purely a softening treatment. Improved tensile and rupture ductility can be achieved by using 1 h/925°C (1697°F)/air cool as the second stage heat treatment.

Fabrication

Cold Working

Average mechanical properties pertinent to cold forming operations for LION alloy 80A sheet, 0.75/1.65 mm (0.03-0.06 inch) thick, annealed 2-3 minutes/1150°C (2102°F)/fluidized bed quenched, are as follows:

0.1% proof stress	354 MPa (51.3 ksi)
0.2% proof stress	374 MPa (54.2 ksi)
0.5% proof stress	391 MPa (56.7 ksi)
Tensile strength	802 MPa (116.3 ksi)
Elongation on 50 mm (2 in.)	52.0%
Hardness	211 HV
Mean grain size	ASTM 6.0
Erichsen value	12.4 mm (0.48 inch)
Typical plastic anisotropy $\bar{R}$ value	0.89*
Shear strength	553 MPa (80.2 ksi)
Ratio of shear to tensile strength	0.69

*Mean value of plastic anisotropy ratio R for tests at 0, 45, and 90° to the final rolling direction, using the formula $\bar{R} = \frac{1}{4} (R_{0}° + 2R_{45}° = R_{90}°)$.

Hot Working

LION alloy 80A should be hot worked in the range 1050-1200°C (1920-2190°F).

Annealing

Interstage annealing should be carried out at 1040°C (1904°F), followed by water quenching or air cooling.

Machining

LION alloy 80A should be in the fully heat treated condition for all machining operations. The high material hardness in this condition (250-350 HV) requires the use of stringent machining techniques.

Fabrication, continued

Welding

LION alloy 80A sheet is readily joined by any of the resistance welding processes. Fusion welding by conventional processes such as T.I.G. or M.I.G. (dip or pulsed transfer) is satisfactory for section thicknesses up to about 5 mm (0.2 inch). Above this thickness micro-fissuring may occur in the weld and the heat affected zone.

Electron beam, friction, inertia and flash-butt welding have all been successfully used for thickness greater than 5 mm (0.2 inch).

The normal precautions for welding nickel alloys should be observed and welding should be carried out on solution treated material. Post-weld heat treatment is necessary to achieve optimum properties.

High-Temperature Brazing

High-temperature brazing in vacuum, dry hydrogen, or inert atmosphere, is satisfactory and a number of suitable brazing alloys is available.

Available Products and Specifications

LION alloy 80A is designated as UNS N07080 and Werkstoff Numbers 2.4952 and 2.4631. The alloy is available as sheet, round bar, flat bar, forging stock, hexagon, wire, plate and extruded section.

Specifications and designations include:

Rod, Bar, Wire and Forging Stock - BS 3076 & HR 1; ASTM B 637; AECMA PrEn 2188, 2189, 2190, 2396, 2397; AIR 9165-37

Plate, Sheet and Strip - BS HR 201, AECMA PrEn 2191

Pipe and Tube - BS HR 401

Other - BS HR 601, DIN 17742, AFNOR NC 20TA