	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

1 **GENERAL**

7175 is a wrought, heat treatable aluminum forging alloy produced by special techniques involving control of impurities, forging, and heat treating procedures. The alloy 7175 was developed to provide improvements in mechanical properties, fracture toughness, and stress-corrosion resistance when compared to 7075. It is available only in the form of die and hand forgings. Die forgings are available in the T66 and T74 tempers, while hand forgings are available in the T74 and T7452 tempers. The higher strength temper, T66, has longitudinal strength and fracture toughness approximately 15 percent higher than 7075-T6 but, like 7075-T6, its resistance to stress corrosion is relatively low. Die and hand forgings in the T74 condition develop static strengths about equal to those of 7075-T6 forgings, with fracture toughness and fatigue properties equal or superior to those of 7075-T73 forgings, plus high resistance to stress-corrosion cracking.

1.01 **Commercial Designations**

7175-T66 (die forgings)
7175-T74 (formerly T736) (die forgings)
7175-T74 (formerly T736) (hand forgings)
7175-T7452 (formerly T73652) (hand forgings).

1.02 **Alternate Designations**

UNS A97175.

1.03 **Specifications**

7175-T66 die forgings: AMS 4148A (19)
7175-T736 (T74) die forgings: AMS 4149A (20)
7175-T736 (T74) hand forgings: AMS 4149A (20)
7175-T73652 (T7452) hand forgings: AMS 4179A (21).

1.04 **Composition**

Chemical composition of 7175, Table 1.04.

1.05 **Heat Treatment**

1.051 The heat treatments for this alloy are proprietary to the producer, Alcoa (7). In general, the T66 temper indicates solution treatment followed by artificial aging. The T74 temper indicates solution treatment followed by stabilization (overaging). The T7452 temper indicates solution treatment, stress relieved by compressing to produce a permanent set of 1 to 5 percent, and precipitation heat treatment (21,22).

1.06 **Hardness**

1.061 Specified minimum hardness:
T66 die forgings, 140 Brinell (500-kg load, 10-mm ball) (19)
T74 die and hand forgings, 135 Brinell (500-kg load, 10-mm ball) (20)
T7452 hand forgings, 135 Brinell (500-kg load, 10-mm ball) (21).

1.062 Rockwell hardness of forgings, Table 1.062.

1.07 **Forms and Conditions Available**

Alloy 7175 is available as T66 and T74 die forgings and as T74 and T7452 hand forgings in section thicknesses up to 6 inches.

1.08 **Melting and Casting Practice**

The material can be melted and alloyed in oil-fired, gas-fired, or electric-induction furnaces and cast into ingot molds of any desired size for subsequent working into forging stock.

1.09 **Special Considerations**

1.091 Residual stresses are normally introduced into 7175-T66 and 7175-T74 forgings, as well as other aluminum forging alloys, in quenching from the solution heat treat temperature. A detailed study has shown that a 7175-T74 landing-gear cylinder forging had residual compressive stress on the outside surface from 9 to 15 ksi and on the inside surface from 6 to 12 ksi. These stresses are not believed to significantly influence resistance to stress corrosion, but they are sufficient to introduce distortion during machining, which must be taken into consideration in selecting and fabricating this alloy. Test programs are under way to evaluate stress relief treatments that will provide the optimum level of mechanical properties combined with acceptable levels of stress relief (2,3).

The forged properties are directional, the short-transverse mechanical properties and stress corrosion resistance being lower than those in the longitudinal and long-transverse directions.

2 **PHYSICAL AND CHEMICAL PROPERTIES**

2.01 **Thermal Properties**

2.011 Melting range, 893 to 1180 F (6).

2.012 Phase changes, alloy is subject to precipitation.

2.0121 Time-temperature-transformation diagrams.

2.0122 In the as-cast, annealed, or as-fabricated condition, the alpha matrix contains a coarse second phase of $MgZn_2$ which goes into solution during solution heat treatment. Artificial aging causes the formation first of Guinier-Preston Zones high in manganese and zinc and, subsequently, particularly at aging temperatures above 300 F, of finely divided precipitates of $MgZn_2$ and $MgZn_2Al_2$. With overaging (stabilization) copper also precipitates in finely divided form. The copper precipitate is believed to have a strongly favorable effect on resistance to stress corrosion (6,9).

2.013 Thermal conductivity:
76 Btu/ft/hr/ft²/F at 77 F for T66 temper
90 Btu/ft/hr/ft²/F at 77 F for T74 temper
90 Btu/ft/hr/ft²/F at 77 F for T7452 temper (16).

2.014 Thermal expansion:
12.5×10^{-6} in./in./F at 68 to 250 F (11)
12.9×10^{-6} in./in./F at 68 to 212 F (16).

2.015 Specific heat, 0.23 Btu/lb/F at 212 F (16).

2.016 Thermal diffusivity.

2.02 **Other Physical Properties**

2.021 Density, 0.101 lb/in.³ (11,16).

2.022 Electrical properties, Table 2.022.

2.023 Magnetic properties, nonmagnetic.

2.024 Emittance.

2.0241 Essentially the same as 7075 alloy in comparable tempers (10). (See 7075, Code 3207, Section 2.016.)

2.025 Damping capacity.

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

2.03 **Chemical Properties**

2.031 The alloy is subject to general corrosion in marine atmospheres (4).

2.032 Effects of specimen orientation, heat treatment, and stress on time to stress corrosion failure in alternate immersion tests in salt water, Table 2.032.

2.033 Effects of 84 days exposure to stress corrosion by alternate immersion in salt water on short-transverse residual strength and ductility of two forgings, Table 2.033.

2.034 Loss in long-transverse tensile strength as a result of various types of corrosion and stress corrosion exposures, Table 2.034.

2.035 Results of stress-corrosion tests on short-transverse specimens exposed to alternate 10-minute immersions in 3.5 percent sodium chloride solution and 50-minute drying periods, Figure 2.035.

2.036 Percent of short-transverse specimens, stressed at 42 ksi and 35 ksi, surviving alternate 10-minute immersions in 3.5 percent sodium chloride solution and 50-minute drying periods, Figure 2.036.

2.037 Crack-growth rate in precracked double cantilever beam specimens with stress applied in short-transverse direction; specimens were wet three times per day with 3.5 percent sodium chloride solution, Figure 2.037.

2.038 Stress-corrosion resistance of die forgings to 3.5 percent NaCl alternate immersion and to Federal Test Method 823, Figure 2.038.

2.0381 Results of stress-corrosion tests on die forgings in 3.5 percent NaCl alternate immersion, Figure 2.0381.

2.039 Results of stress corrosion tests on die forgings in an industrial atmosphere, Figure 2.039.

2.04 **Nuclear Properties**

(See 7075, Code 3207, Section 2.041.)

3 **MECHANICAL PROPERTIES**

3.01 **Specified Mechanical Properties**

3.011 AMS specified mechanical properties for T66 and T74 die forgings at room temperature, Table 3.011.

3.012 AMS specified mechanical properties for T74 and T7452 hand forgings at room temperature, Table 3.012.

3.013 Design mechanical properties for die forgings at room temperature, Table 3.013.

3.014 Design mechanical properties for hand forgings at room temperature, Table 3.014.

3.015 Specified mechanical properties for forgings at room temperature, Table 3.015.

3.02 **Mechanical Properties at Room Temperature**

3.021 Tension.

3.0211 Stress-strain diagrams. Typical stress-strain curves for die forgings and hand forgings at room temperature, Figure 3.0211.

3.0212 Tensile properties of forgings of various sizes, Table 3.0212.

3.0213 Tensile properties of Model 727 support elevator forging in two heat treated conditions, Table 3.0213.

3.0214 Tentative minimum tensile, fracture toughness, and stress-corrosion properties of T74 forgings, Table 3.0214.

3.022 Compression. (See also Tables 3.013, 3.014, and 3.015.)

3.0221 Stress-strain diagrams. (See Figure 3.0211.)

3.0222 Compressive yield strength of Model 727 support elevator forging in two heat treated conditions, Table 3.0222.

3.023 Impact.

3.0231 Charpy V-notch impact strength. (See Figure 3.0331.)

3.024 Bending.

3.025 Torsion and shear. (See also Tables 3.013, 3.014, and 3.015.)

3.0251 Longitudinal, T74 condition, F_{su} = 47.5 ksi (1); transverse, T74 condition, F_{su} = 49.2 ksi (1).

3.026 Bearing. (See Tables 3.013, 3.014, and 3.015.)

3.027 Stress concentration.

3.0271 Notch properties.

3.0272 Fracture toughness. (See also Table 3.0214.)

3.02721 Variations in plane strain fracture toughness with different heat treatments and specimen orientations, Table 3.02721.

3.02722 Fracture toughness of 7175-T66 die forgings, Table 3.02722.

3.02723 Fracture toughness of 7175-T74 die forgings, Table 3.02723.

3.02724 Fracture toughness of 7175-T74 and T7452 hand forgings, Table 3.02724.

3.028 Combined properties.

3.03 **Mechanical Properties at Various Temperatures**

3.031 Tension.

3.0311 Stress-strain diagrams.

3.03111 Tensile stress-strain curves at various temperatures, Figure 3.03111.

3.0312 Effect of temperature on tensile properties, Figure 3.0312.

3.0313 Effect of temperature on tensile properties of T74 die forgings, Figure 3.0313.

3.0314 Effect of test temperature on tensile properties of forged bar, Figure 3.0314.

3.032 Compression.

3.0321 Stress-strain diagrams.

3.03211 Compressive stress-strain curves at various temperatures, Figure 3.03211.

3.0322 Effect of temperature on compressive yield strength, Figure 3.0322.

3.033 Impact.

3.0331 Charpy V-notch impact properties at low temperatures, Figure 3.0331.

3.034 Bending.

3.035 Torsion and shear.

3.036 Bearing.

3.037 Stress concentration.

3.0371 Notch properties.

3.0372 Fracture toughness.

3.03721 Fracture toughness of forged bar at several temperatures, Table 3.03721.

3.038 Combined properties.

3.04 **Creep and Creep-Rupture Properties**

3.041 Creep and creep-rupture curves, Figure 3.041.

3.042 Minimum creep rate curves, Figure 3.042.

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

3.05 **Fatigue Properties**

3.051 Axial fatigue properties for forgings in T74 and T66 conditon, Figure 3.051.

3.052 Constant fatigue-life diagram for smooth, axially loaded, shot-peened specimens in T74 condition, Figure 3.052.

3.053 Constant fatigue-life diagram for notched, axially loaded specimens in T74 condition, Figure 3.053.

3.054 Axial fatigue properties at various temperatures for forgings in T74 condition, Figure 3.054.

3.055 Rotating beam fatigue properties for forgings in T74 and T66 conditions, Figure 3.055.

3.056 Fatigue crack-growth rates for T74 forgings at room temperature and elevated temperatures, Figure 3.056.

3.057 Fatigue crack-growth rates for T74 forgings at room temperature and at low temperatures, Figure 3.057.

3.06 **Elastic Properties**

3.061 Poisson's ratio, $\mu = 0.33$ (16).

3.062 Modulus of elasticity:
$E = 10.2 \times 10^3$ ksi
$E_c = 10.7 \times 10^3$ ksi (16).

3.0621 Effect of temperature on tensile modulus of elasticity, Figure 3.0621.

3.0622 Effect of temperature on compressive modulus of elasticity, Figure 3.0622.

3.0623 Compressive tangent modulus curves at various temperatures, Figure 3.0623.

3.0624 Typical compressive tangent modulus curves for T74 die forging and hand forgings at room temperature, Figure 3.0624.

3.063 Modulus of rigidity, $G = 3.9 \times 10^3$ ksi (3,16).

4 FABRICATION

4.01 **Forming**
(See 7075, Code 3207, Section 4.01.)

4.02 **Machining and Grinding**
Although detailed studies of the machining characteristics of 7175 have not been carried out, indications are that it has excellent machinability in both heat treated conditions similar to the 7075 alloy, which can be machined to excellent surface finish at high speeds and feeds while maintaining excellent tool life (13).

4.03 **Joining**
Welding. The weldability of 7175 alloy is comparable to that of 7075, which has a relatively low weldability rating (10). (See 7075, Code 3207, Sections 4.031 and 4.032.)

4.04 **Surface Treating**
Although little or no work on surface treating of 7175 has been done, it is expected that it will be susceptible to anodizing and to any other treatments applicable to 7075.

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	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

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Alloy	7175 Al		
	Percent	Percent	
Element	Nominal	Min	Max
Zn	5.6	5.1	6.1
Mg	2.5	2.1	2.9
Cu	1.6	1.2	2.0
Cr	0.23	0.18	0.28
Fe	–	–	0.20
Si	–	–	0.15
Mn	–	–	0.10
Ti	–	–	0.10
Others, Each	–	–	0.05
Total	–	–	0.15
Al	Balance	Balance	

TABLE 1.04. AMS CHEMICAL COMPOSITION OF 7175 Al (3,19,20,21)

Alloy	7175 Al	
Form	Forgings	
Condition	T66	T74
HRB	92	88
HRE	110	108

TABLE 1.062. ROCKWELL HARDNESS OF FORGINGS (3,5)

Alloy	7175 Al	
Form	Forgings	
Condition	T66	T74
Electrical Conductivity, percent IACS	29.8	38.7
megmhos/in.^{3}	0.440	0.570
Electrical Resistivity microhm, in.	2.28	1.76

TABLE 2.022. ELECTRICAL PROPERTIES (4,5,6)

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

Alloy	7175 Al					
Form	Forgings					
Condition	T66			T74		
Specimen Orientation	Stress (F_{ty}) ksi	Stress (F_{ty}) percent	Days to Stress Corrosive Failure[a]	Stress (F_{ty}) ksi	Stress (F_{ty}) percent	Days to Stress Corrosive Failure[a]
Longitudinal	21.0	25.0	NF[b]	55.5	75.0	NF[b]
	21.0	25.0	NF[b]	55.5	75.0	NF[b]
	42.0	50.0	NF[b]	55.5	75.0	NF[b]
	42.0	50.0	NF[b]	66.6	90.0	NF[b]
	63.0	75.0	NF[b]	66.6	90.0	NF[b]
	63.0	75.0	NF[b]	66.6	90.0	NF[b]
Long Transverse	19.75	25.0	NF	36.0	50.0	NF
	19.75	25.0	NF	36.0	50.0	>90
	19.75	25.0	7	36.0	50.0	NF
	29.63	37.5	7	54.0	75.0	NF
	29.63	37.5	NF	54.0	75.0	NF
	29.63	37.5	14.3	54.0	75.0	NF
	39.5	50.0	7	59.4	82.5	NF
	39.5	50.0	NF	59.4	82.5	NF
	39.5	50.0	1.3	59.4	82.5	NF
	59.25	75.0	1	64.8	90.0	NF
	59.25	75.0	2	64.8	90.0	NF
	59.25	75.0	1	64.8	90.0	NF
Short Transverse	8.75	12.5	NF	33.5	50.0	NF
	8.75	12.5	NF	33.5	50.0	NF
	8.75	12.5	NF	33.5	50.0	NF
	17.5	25.0	52.3	50.25	75.0	7
	17.5	25.0	14.3	50.25	75.0	8.25
	17.5	25.0	7	50.25	75.0	23
	35.0	50.0	2	60.3	90.0	1
	35.0	50.0	2	60.3	90.0	1.29
	35.0	50.0	2	60.3	90.0	1

(a) Alternate 10-minute immersions in 3.5 percent sodium chloride solution and 50-minute drying periods. Failure defined as the time at which the first crack was visually detected at 10X.

(b) NF means no failure in 105 days maximum test time.

TABLE 2.032. EFFECTS OF SPECIMEN ORIENTATION, HEAT TREATMENT, AND STRESS ON TIME TO STRESS CORROSION FAILURE IN ALTERNATE IMMERSION TESTS IN SALT WATER (4)

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

Alloy		7175Al		
Condition		T74		
Form		Forgings		
Specimen Orientation		Short Transverse		
Ultimate Tensile Strength, ksi	Elongation (1 in.), percent	Exposure Stress, ksi	Residual* F_{tu}, ksi	Residual*, Elongation (1 in.)
73.1	5.8	25.0	70.1	3.0
73.1	5.8	25.0	70.4	4.4
73.1	5.8	25.0	63.7	3.1
73.1	5.8	30.0	63.4	1.6
73.1	5.8	30.0	59.8	0.9
73.1	5.8	30.0	63.3	1.1
76.1	6.2	35.0	56.5	1.6
76.1	6.2	35.0	63.1	1.8
76.1	6.2	35.0	54.9	1.7
76.1	6.2	40.0	61.2	0.9
76.1	6.2	40.0	50.2	1.0
76.1	6.2	40.0	63.6	1.2

*After 84 days alternate 10-minute immersions in 3.5 percent sodium chloride solution and 50-minute drying periods at indicated exposure stresses.

TABLE 2.033. EFFECTS OF 84 DAYS EXPOSURE TO STRESS CORROSION BY ALTERNATE IMMERSION IN SALT WATER ON SHORT-TRANSVERSE RESIDUAL STRENGTH AND DUCTILITY OF TWO FORGINGS (5)

Alloy		7175Al		
Condition		T74		
Form		Forgings		
Specimen Orientation		Long Transverse		
Environment	Exposure Stress, ksi	Exposure Stress, percent of F_{ty}	Days Exposed	Loss in F_{tu}, percent
Marine Atmosphere (Kure Beach, NC 80-ft lot)	50.9	75	392	8
	33.8	50	392	5
	0	0	392	4
Alternate Immersion in 3 percent NaCl sol	50.9	75	61	12
	0	0	62	6
Alternate Immersion in 1N NaCl Sol + 0.3 percent H_2O_2	50.9	75	61	16
	0	0	61	5

Note: Each data point is an average of three tests. No specimens fractured in stress corrosion during exposure.

TABLE 2.034. LOSS IN LONG-TRANSVERSE TENSILE STRENGTH AS A RESULT OF VARIOUS TYPES OF CORROSION AND STRESS CORROSION EXPOSURES (12)

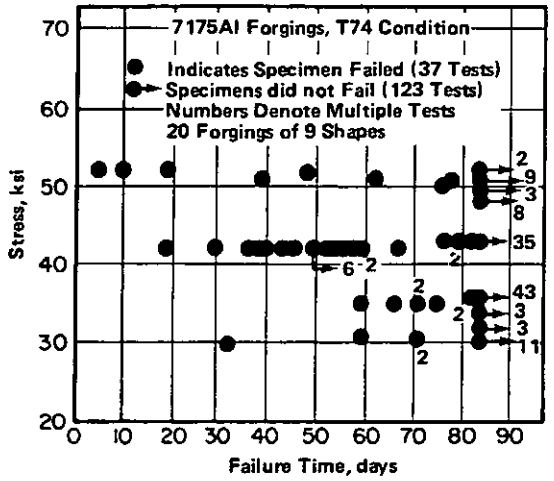

FIGURE 2.035. RESULTS OF STRESS-CORROSION TESTS ON SHORT-TRANSVERSE SPECIMENS EXPOSED TO ALTERNATE 10-MINUTE IMMERSIONS IN 3.5 PERCENT SODIUM CHLORIDE SOLUTION AND 50-MINUTE DRYING PERIODS (3)

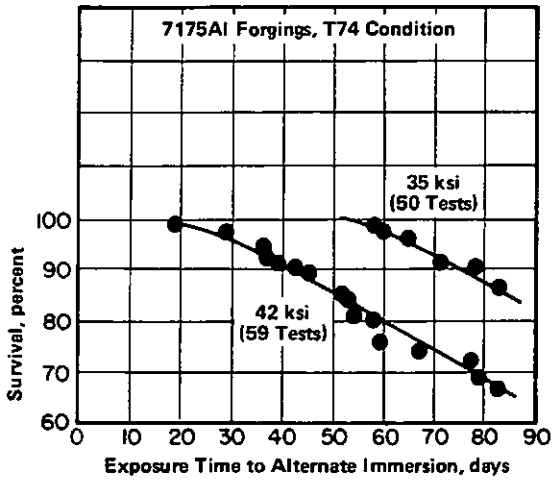

FIGURE 2.036. PERCENT OF SHORT-TRANSVERSE SPECIMENS, STRESSED AT 42 KSI AND 35 KSI, SURVIVING ALTERNATE 10-MINUTE IMMERSIONS IN 3.5 PERCENT SODIUM CHLORIDE SOLUTION AND 50-MINUTE DRYING PERIODS (3)

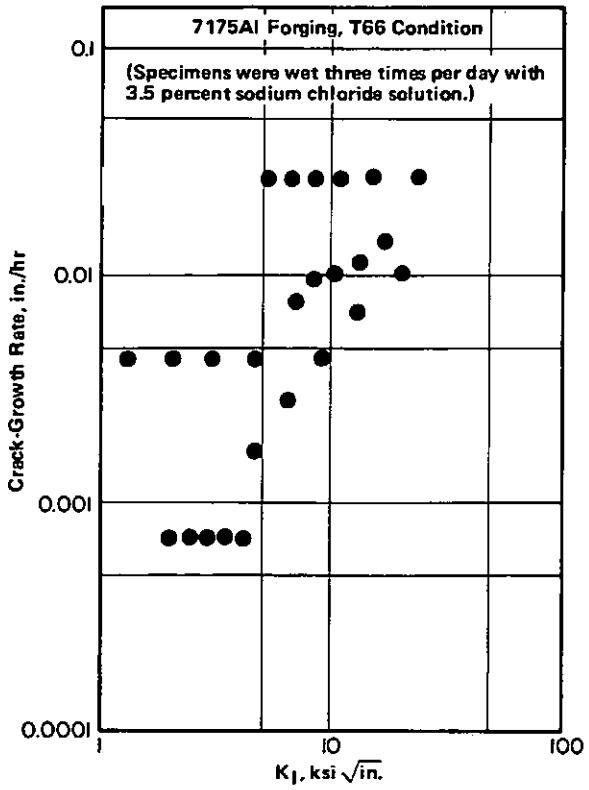

FIGURE 2.037. CRACK-GROWTH RATE IN PRECRACKED DOUBLE CANTILEVER BEAM SPECIMENS WITH STRESS APPLIED IN SHORT-TRANSVERSE DIRECTION (4,15)

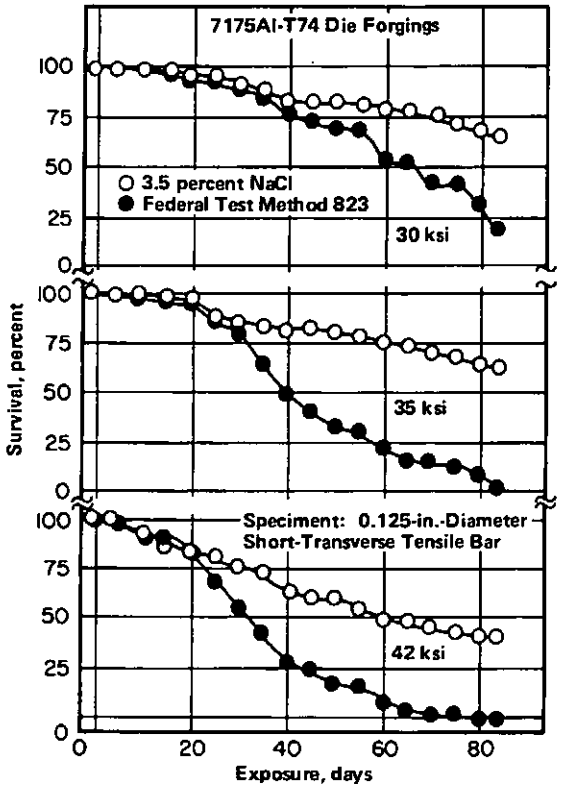

FIGURE 2.038. STRESS-CORROSION RESISTANCE OF DIE FORGINGS TO 3.5 PERCENT NaCl ALTERNATE IMMERSIONS AND TO FEDERAL TEST METHOD 823 (30)

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

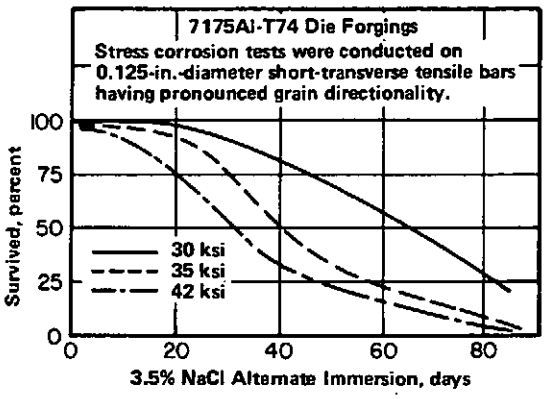

FIGURE 2.0381. RESULTS OF STRESS CORROSION-TESTS ON DIE FORGINGS IN 3.5 PERCENT NaCl ALTERNATE IMMERSION (30)

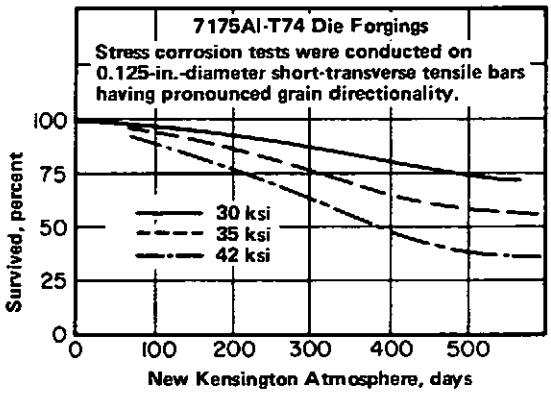

FIGURE 2.039. RESULTS OF STRESS-CORROSION TESTS ON DIE FORGING IN A INDUSTRIAL ATMOSPHERE (30)

Alloy		7175Al				
Specification		AMS 4148A	AMS 4149A			
Form		Die Forgings	Die Forgings			
Condition		T66	T74			
Thickness, in.		≤3.000	≤3.000	3.001-4.000	4.001-5.000	5.001-6.000
Ultimate Strength, ksi (Min)	L	86	76	73	70	68
	T	77	71	70	68	65
	A	77	71	70	68	65
Yield Strength, ksi (Min)	L	76	66	63	61	58
	T	66	62	60	58	55
	A	66	62	60	58	55
Elongation (2 in. or 4D), percent (Min)	L	7	7	7	7	7
	T	4	4	4	4	4
	A	4	4	4	4	4

L = Axis of specimen not more than 15° from parallel to forging flow lines.
T = Axis of specimen not more than 15° from perpendicular to forging flow lines.
A = Axis of specimen more than 15° from parallel and from vertical to flow lines.

TABLE 3.011. AMS SPECIFIED MECHANICAL PROPERTIES FOR T66 AND T74 DIE FORGINGS AT ROOM TEMPERATURE (19,20)

Alloy		7175Al									
Specification		AMS 4149A					AMS 4179A				
Condition		T74					T7452				
Form		Hand Forgings[a]					Hand Forgings[a]				
Thickness, in.		≤2.000	2.001-3.000	3.001-4.000	4.001-5.000	5.001-6.000	≤2.000	2.001-3.000	3.001-4.000	4.001-5.000	5.001-6.000
Ultimate Strength, ksi (Min)	L	73	73	71	68	65	71	71	68	65	63
	T	71	71	70	67	64	69	69	67	64	61
	ST	–	69	68	66	63	–	67	65	63	60
Yield Strength, ksi (Min)	L	63	63	61	57	54	61	61	57	54	51
	T	60	60	58	56	52	58	58	55	52	49
	ST	–	60	57	55	52	–	54	51	49	46
Elongation (2 in. or 4D), percent (Min)	L	9	9	9	8	8	9	9	9	8	8
	T	5	5	5	5	5	5	5	5	5	5
	ST	–	4	4	4	4	–	4	4	4	4

(a) Cross section not exceeding 156 $in.^2$.

TABLE 3.012. AMS SPECIFIED MECHANICAL PROPERTIES FOR T74 AND T7452 HAND FORGINGS AT ROOM TEMPERATURE (20,21)

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

Alloy		7175 Al	
Form		Die Forgings	
Specification		AMS 4148A	AMS 4149A
Condition		T66	T74
Thickness, in.		≤3.000	≤3.000
Ultimate Strength, ksi	L	86	76
	T(a)	77	71
Yield Strength, ksi	L	76	66
	T(a)	66	62
Compressive Yield Strength, ksi	L	–	67
	T(a)	–	63
Shear Strength, ksi		–	43
Ultimate Bearing Strength, ksi(b)			
e/D = 1.5		–	106
e/D = 2.0		–	140
Bearing Yield Strength, ksi(b)			
e/D = 1.5		–	86
e/D = 2.0		–	102
Elongation, percent	L	7	7
	T(a)	4	4

(a) T indicates grain direction not within ±15° of parallel to forging flow lines. F_{cy} (T) values are based upon short transverse test data.
(b) Bearing values are "dry pin" values.

TABLE 3.013. DESIGN MECHANICAL PROPERTIES FOR DIE FORGINGS AT ROOM TEMPERATURE (16)

Alloy		7175 Al							
Form		Hand Forgings							
Specification		AMS 4109(b)				AMS 4179			
Condition		T74				T7452			
Thickness, in.		≤3.000	3.001-4.000	4.001-5.000	5.001-6.000	≤3.000	3.001-4.000	4.001-5.000	5.001-6.000
Ultimate Strength, ksi	L	73	71	68	65	71	68	65	63
	LT	71	70	67	64	69	67	64	61
	ST	69	68	66	63	67	65	63	60
Yield Strength, ksi	L	63	61	57	54	61	57	54	51
	LT	60	58	56	52	58	55	52	49
	ST	60	57	55	52	54	51	49	46
Compressive Yield Strength, ksi	L	64	62	58	–	–	–	–	–
	LT	63	61	59	–	–	–	–	–
	ST	63	60	58	–	–	–	–	–
Shear Strength, ksi		42	41	39	–	–	–	–	–
Ultimate Bearing Strength, ksi(a)									
e/D = 1.5		103	101	97	–	–	–	–	–
e/D = 2.0		135	133	127	–	–	–	–	–
Bearing Yield Strength ksi(a)									
e/D = 1.5		84	81	78	–	–	–	–	–
e/D = 2.0		99	96	92	–	–	–	–	–
Elongation, percent	L	9	9	8	8	9	9	8	8
	LT	5	5	5	5	5	5	5	5
	ST	4	4	4	4	4	4	4	4

(a) Bearing values are "dry pin" values.
(b) The requirements of AMS 4109 are now embodied in AMS 4149A.

TABLE 3.014. DESIGN MECHANICAL PROPERTIES FOR HAND FORGINGS AT ROOM TEMPERATURE (16)

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

Alloy		7175Al	
Form		Forgings	
Size		Up 3 in. in Max Thickness	
Condition		T66	T74
Ultimate Strength, ksi (Min)	L	86	76
	ST	77	71
Yield Strength, ksi (Min)	L	76	66
	ST	66	62
Compressive Yield Strength, ksi (Min)	L	76	66
	ST	71	65
Shear Strength, ksi (Min)		47	42
Ultimate Bearing Strength, ksi (Min)			
e/D = 1.5		120	110
e/D = 2.0		150	141
Bearing Yield Strength, ksi (Min)			
e/D = 1.5		99	89
e/D = 2.0		110	99
Elongation (2 in.), percent (Min)	L	7	7
	ST	4	4

Note: For die forgings, the L and ST values for the directions parallel (within ±15°) and not parallel (as close as possible to the short-transverse direction), respectively, to the forging flow lines.

TABLE 3.015. SPECIFIED MECHANICAL PROPERTIES FOR FORGINGS AT ROOM TEMPERATURE (2,3,5)

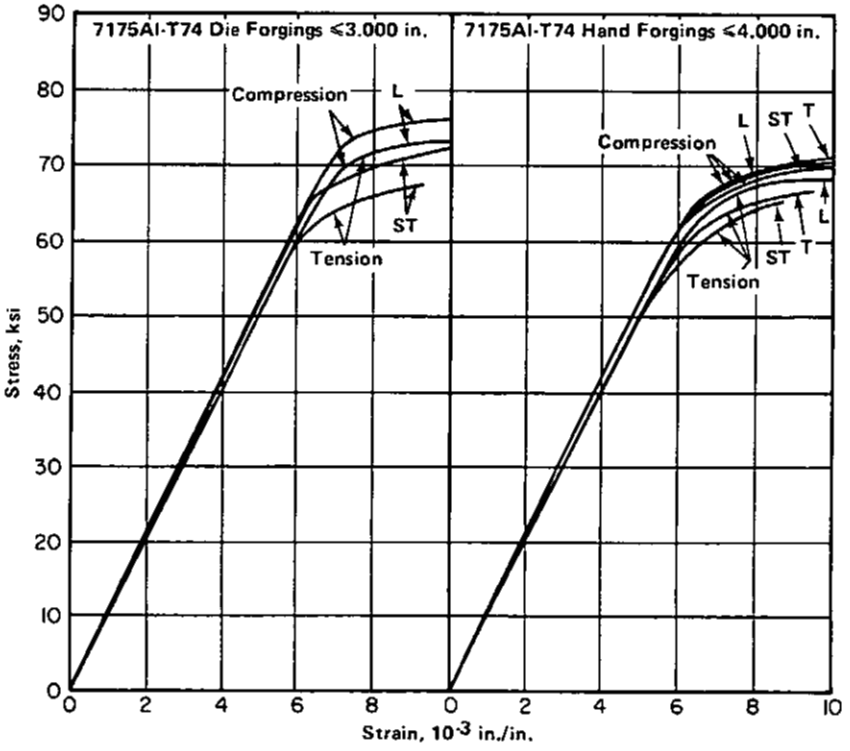

FIGURE 3.0211. TYPICAL STRESS-STRAIN CURVES FOR DIE FORGINGS AND HAND FORGINGS AT ROOM TEMPERATURE (29)

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

Alloy	7175Al					
Condition	T66			T74		
Property	Ultimate Strength, ksi	Yield Strength, ksi	Elongation (2 in.), percent	Ultimate Strength, ksi	Yield Strength, ksi	Elongation (2 in.), percent
Form	5- to 10-lb (Approx) Die Forgings					
Longitudinal	90.0	81.0	12.0	81.0	72.0	11.0
Form	38-lb Rib Forging					
Longitudinal	93.2	83.9	13.8	81.0	73.5	14.0
Transverse	81.7	70.4	11.0	74.4	65.7	11.5
Form	74-lb Spar Forging					
Longitudinal				79.6	72.8	13.8
Transverse				75.3	66.1	9.9
Form	96-lb Landing Gear Cylinder Forging					
Longitudinal				78.3	71.9	13.7
Transverse				75.3	67.5	9.0
Form	156-lb Spar Forging					
Longitudinal				80.1	72.6	12.8
Transverse				75.7	67.8	8.4
Form	620-lb Wing Spar Forging					
Longitudinal				79.4	71.9	13.9
Transverse				75.3	66.1	13.0

TABLE 3.0212. TENSILE PROPERTIES OF FORGING OF VARIOUS SIZES (3)

Alloy	7175Al							
Form	Model 727 Support Elevator Forgings							
Condition	T66				T74			
Specimen Condition	Ultimate Strength, ksi	Yield Strength, ksi	Elongation (2 in.), percent	Reduction in Area, percent	Ultimate Strength, ksi	Yield Strength, ksi	Elongation (2 in.), percent	Reduction in Area, percent
Longitudinal	93.0	83.9	11.0	14.4	80.1	73.8	12.8	35.9
Long Transverse	89.9	79.3	13.1	21.6	79.3	71.9	13.1	36.9
Short Transverse	84.0	70.2	9.7	14.8	76.5	66.8	8.9	16.4

TABLE 3.0213. TENSILE PROPERTIES OF MODEL 727 SUPPORT ELEVATOR FORGING IN TWO HEAT TREATED CONDITIONS (4)

Alloy		7175Al					
Condition		T74[b]					
Form		Forgings		Die Forgings			
Thickness, in.		≤3.000	≤3.000	≤3.000	3.001-4.000	4.001-5.000	5.001-6.000
Ultimate Strength, ksi	L	76	78	76	73	70	68
	T	71	–	71	70	68	65
	ST	–	–	–	–	–	–
Yield Strength, ksi	L	66	69	66	63	61	58
	T	62	–	62	60	58	55
Fracture Toughness K_{Ic}, ksi $\sqrt{in.}$	L	34	30-35	32-36	–	–	–
	T	31	–	32	–	–	–
	ST	–	19-26	23-33	–	–	–
Stress Corrosion Threshold Strength, ksi[a]	L	50	–	–	–	–	–
	T	50	–	–	–	–	–
	ST	35	≈25	35	–	–	–

(a) Highest sustained tensile stress at which a smooth test specimen will not fail in 3.5 percent NaCl alternate immersion test.

(b) Tentative minimum mechanical properties – applicable to parts with a maximum cross-section of 100 $in.^2$.

TABLE 3.0214. TENTATIVE MINIMUM TENSILE, FRACTURE TOUGHNESS AND STRESS-CORROSION PROPERTIES OF T74 FORGINGS (26,27,28)

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

Alloy	7175 Al	
Form	Model 727 Support Elevator Forging	
Condition	T66	T74
Specimen Orientation	Compressive Yield Strength, ksi	Ultimate Compressive Strength, ksi
Longitudinal	90.5	80.0
Long Transverse	84.2	75.4
Short Transverse	80.2	73.3

TABLE 3.0222. COMPRESSIVE YIELD STRENGTH OF MODEL 727 SUPPORT ELEVATOR FORGING IN TWO HEAT TREATED CONDITIONS (4)

Alloy	7175 Al	
Form	Forgings	
Condition	T66	T74
Specimen Orientation	K_{Ic}, ksi $\sqrt{in.}$	K_{Ic}, ksi $\sqrt{in.}$
Longitudinal	33.0	37.0
Long Transverse	24.4	31.5
Short Transverse	21.0	27.0

TABLE 3.02721. VARIATIONS IN PLANE STRAIN FRACTURE TOUGHNESS WITH DIFFERENT HEAT TREATMENTS AND SPECIMEN ORIENTATIONS (14)

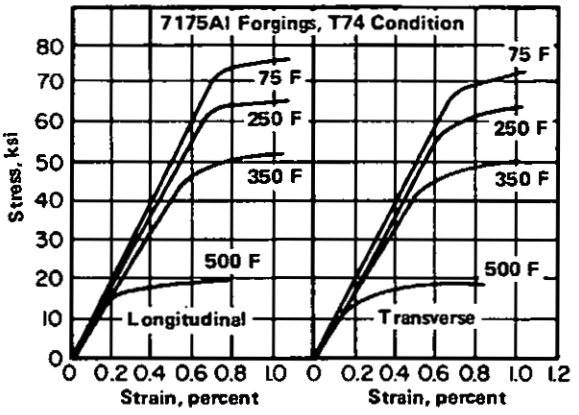

FIGURE 3.03111. TENSILE STRESS-STRAIN CURVES AT VARIOUS TEMPERATURES (1)

Alloy		7175 Al			
Form		Die Forgings			
Condition		T66			
Test		Plane Strain Fracture Toughness[a]			
Test Temperature, F	Yield Strength, ksi	Product Thickness, in.	Specimen Thickness, in.	Orientation[b]	K_{Ic}, ksi $\sqrt{in.}$
89	80.4	0.500	0.500	L-T	34.7
89	82.2	0.500	0.500	T-L	25.7
75	70.4	1.000	0.500	S-L	21.1
75	80.2	1.000	0.500	T-L	23.2
75	82.4	1.000	0.500	L-T	36.3
75	73.0	1.000	0.500	S-L	20.6

(a) Compact tension specimen. Test procedures as per ASTM E399.
(b) Specimen orientation as per ASTM E399.

TABLE 3.02722. FRACTURE TOUGHNESS OF 7175-T66 DIE FORGINGS (24)

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

Alloy		7175 Al			
Form		Die Forgings			
Condition		T74			
Test		Plane Strain Fracture Toughness[a]			
Test Temperature, F	Yield Strength, ksi	Product Thickness, in.	Specimen Thickness, in.	Orientation[b]	K_{Ic}, ksi $\sqrt{in.}$
84	70.6	0.500	0.500	L-T	27.3
89	67.1	0.500	0.500	S-L	27.1
84	66.3	0.750	0.500	S-L	27.5
82	66.3	1.000	0.500	S-L	26.0
75	65.7	1.000	0.500	S-L	25.5
75	73.0	1.000	0.500	T-L	31.5
82	76.9	1.500	0.500	L-T	31.5
82	67.9	1.500	0.499	S-L	24.1
82	65.2	1.500	0.750	S-L	26.0
78	68.0	2.000	0.750	L-T	27.4
80	66.7	2.000	0.750	S-L	24.1
81	63.8	2.500	0.750	S-L	28.2
83	66.3	3.000	0.750	S-L	26.5
84	66.3	2.000	1.000	L-T	34.7
82	73.8	2.750	1.000	T-L	24.6

(a) Compact tension specimen. Test procedures per ASTM E399.
(b) Specimen orientation as per ASTM E399.

TABLE 3.02723. FRACTURE TOUGHNESS OF 7175-T74 DIE FORGINGS (24)

Alloy		7175 Al				
Form		Hand Forgings				
Test		Plane Strain Fracture Toughness[a]				
Condition	Test Temperature, F	Yield Strength, ksi	Product Thickness, in.	Specimen Thickness, in.	Orientation[b]	K_{Ic}, ksi $\sqrt{in.}$
T74	82	66.4	2.000	0.749	S-L	26.3
	76	65.6	3.000	0.998	S-L	23.0
	76	65.7	3.000	0.998	T-L	25.4
	82	61.4	4.000	0.998	S-L	21.9
	82	59.9	4.000	1.000	T-L	27.0
	84	62.1	5.000	1.500	L-T	33.6
	84	70.0	5.000	1.500	T-L	28.2
T7452	82	62.9	3.750	2.000	L-T	39.8

(a) Compact tension specimen. Test procedures per ASTM E399.
(b) Specimen orientation per ASTM E399.

TABLE 3.02724. FRACTURE TOUGHNESS OF 7175-T74 AND T7452 HAND FORGINGS (24)

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

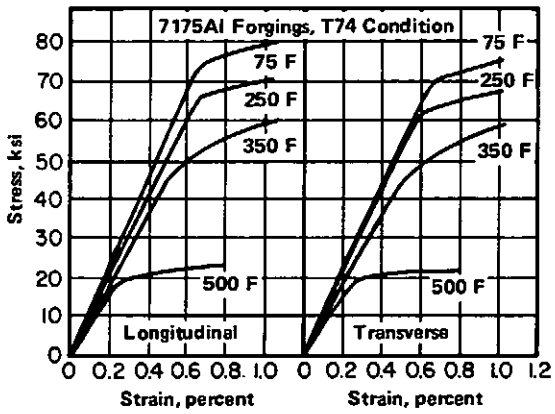

FIGURE 3.03211. COMPRESSIVE STRESS-STRAIN CURVES AT VARIOUS TEMPERATURES (1)

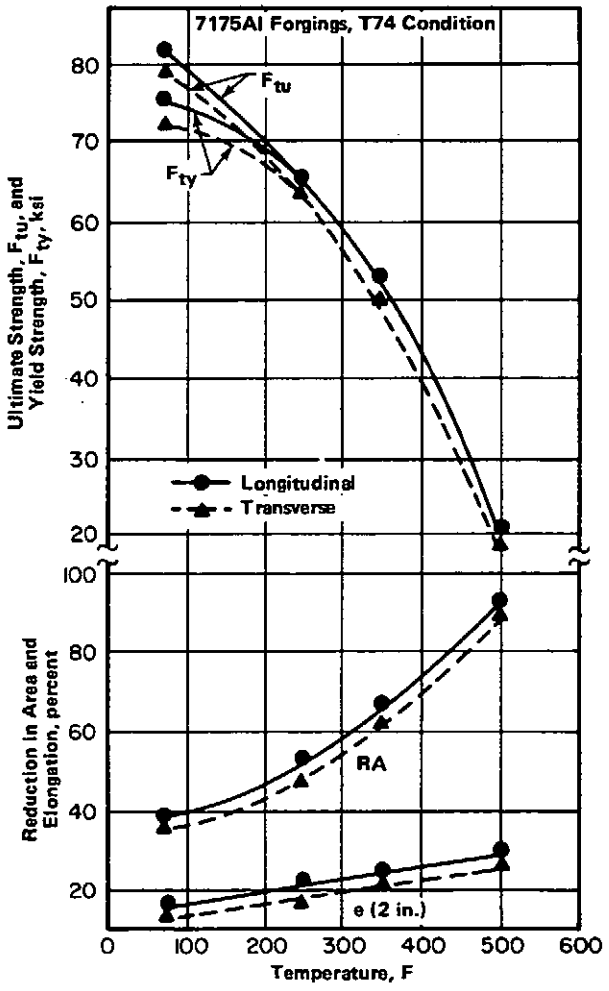

FIGURE 3.0312. EFFECT OF TEMPERATURE ON TENSILE PROPERTIES (1)

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

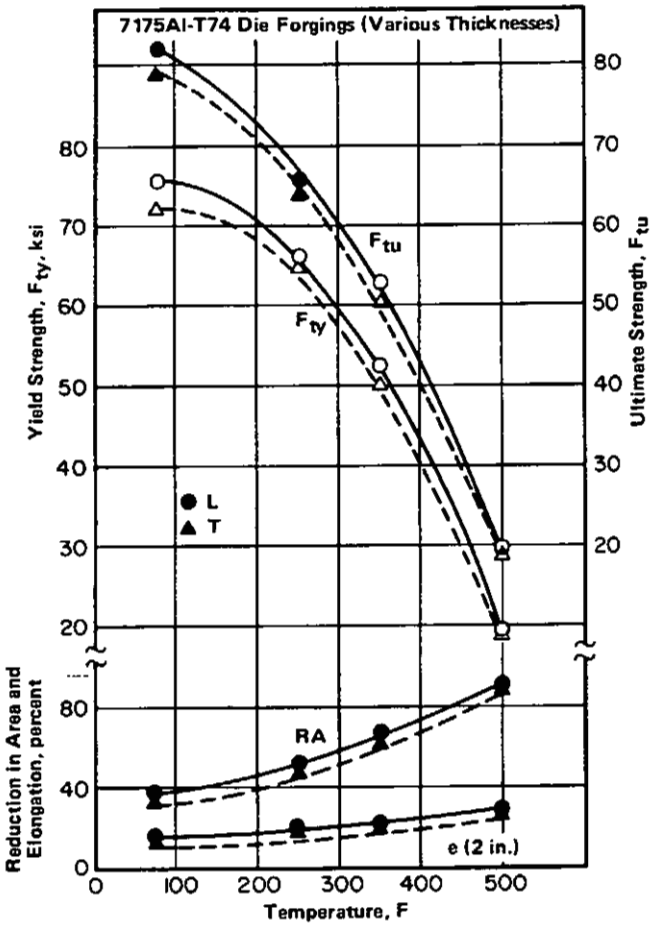

FIGURE 3.0313. EFFECT OF TEMPERATURE ON TENSILE PROPERTIES OF T74 DIE FORGINGS (23)

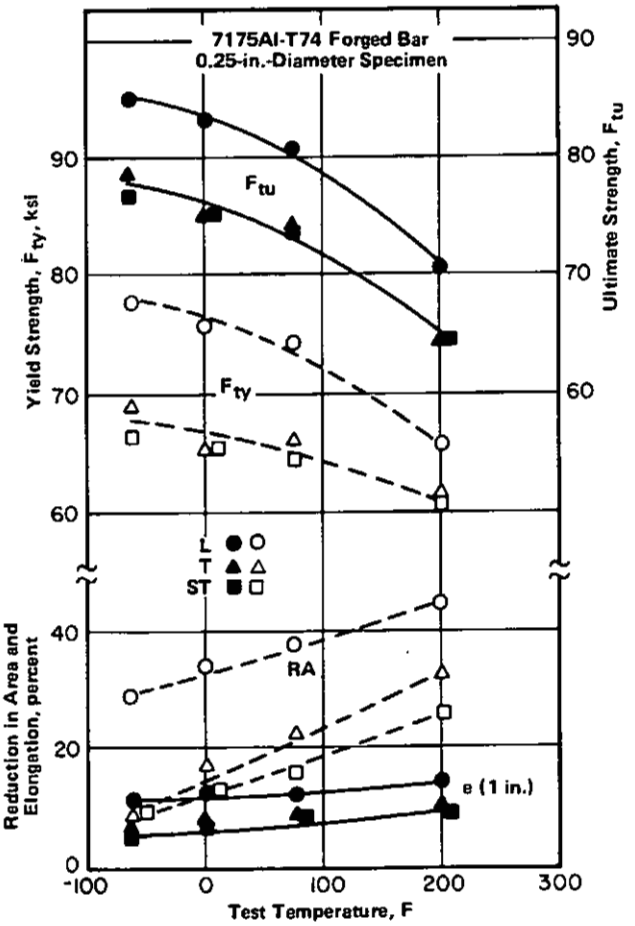

FIGURE 3.0314. EFFECT OF TEST TEMPERATURE ON TENSILE PROPERTIES OF FORGED BAR (25)

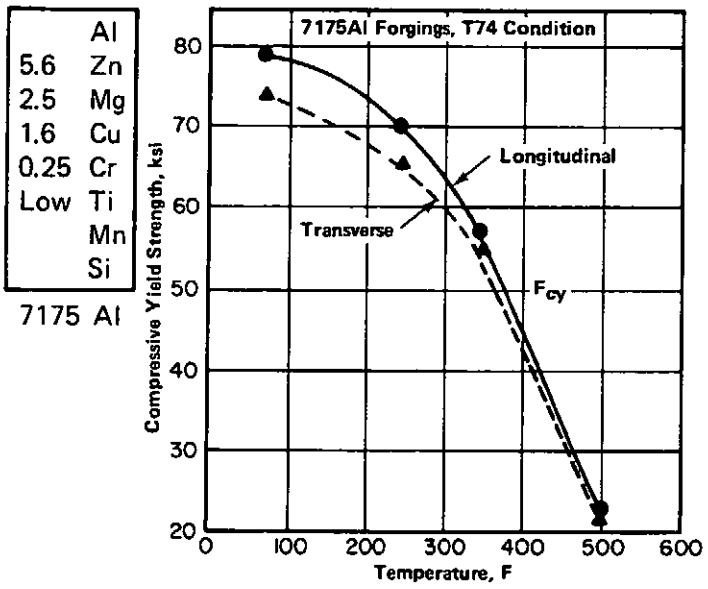

FIGURE 3.0322. EFFECT OF TEMPERATURE ON COMPRESSIVE YIELD STRENGTH (1)

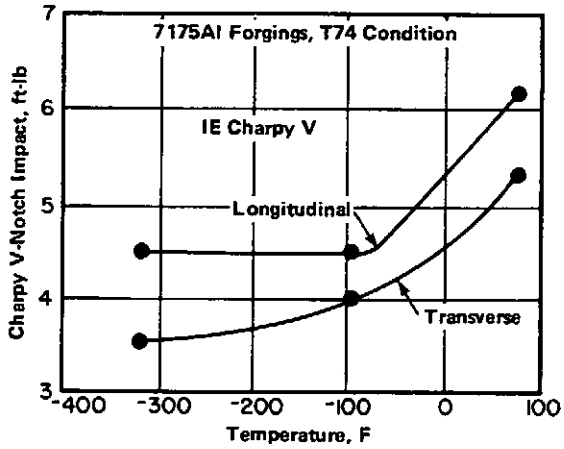

FIGURE 3.0331. CHARPY V-NOTCH IMPACT PROPERTIES AT LOW TEMPERATURES (1)

Alloy	7175Al		
Form	Forged Bar[a]		
Condition	T74		
Test	Plane Strain Fracture Toughness		
Test Temperature, F	Yield Strength, ksi	Orientation	K_{Ic},[b] ksi $\sqrt{in.}$
RT	66.3	T	22.7
RT	64.9	ST	31.9
-65	66.6	ST	26.3
0	65.9	ST	26.3
200	60.5	ST	34.1

(a) Average cross section of bar was 2.5 x 2.5 in.
(b) Compact tension specimens as per ASTM E399.

TABLE 3.03721. FRACTURE TOUGHNESS OF FORGED BAR AT SEVERAL TEMPERATURES (25)

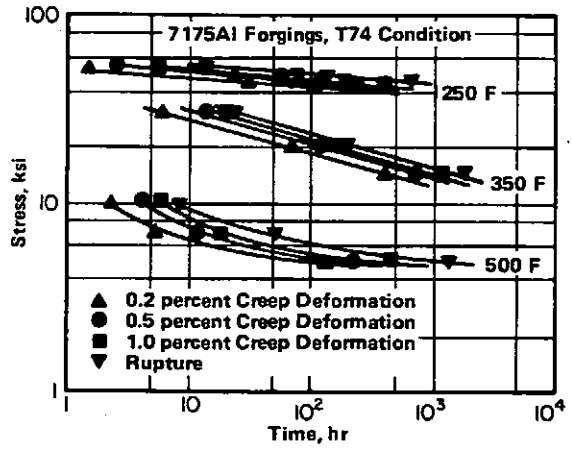

FIGURE 3.041. CREEP AND CREEP-RUPTURE CURVES (1)

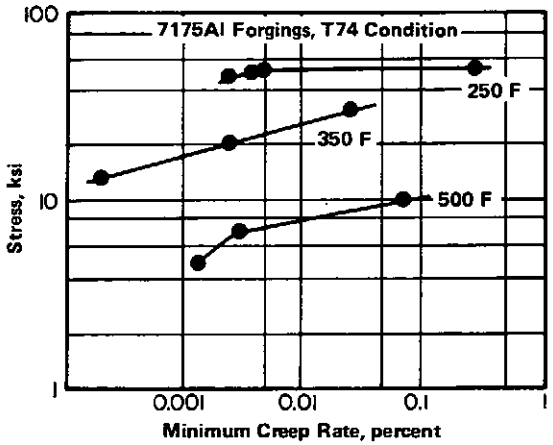

FIGURE 3.042. MINIMUM CREEP RATE CURVES (1)

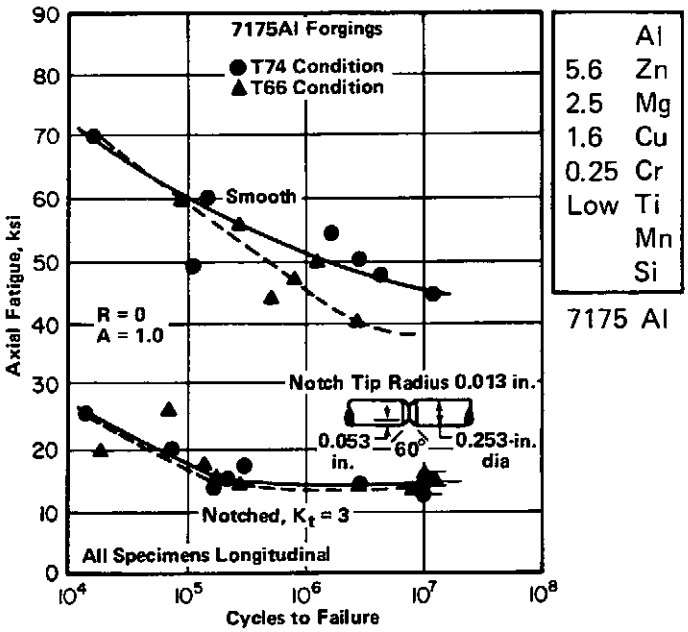

FIGURE 3.051. AXIAL FATIGUE PROPERTIES FOR FORGINGS IN T74 AND T66 CONDITION (3)

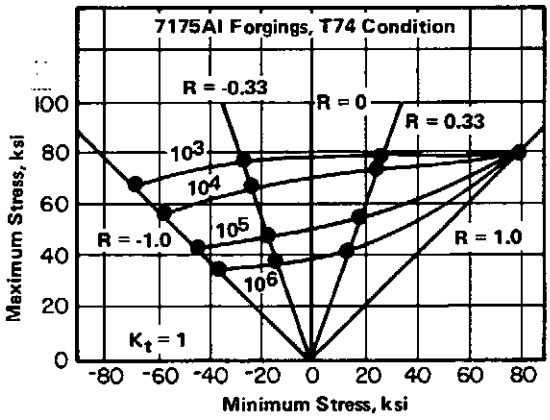

FIGURE 3.052. CONSTANT FATIGUE-LIFE DIAGRAM FOR SMOOTH, AXIALLY LOADED, SHOT-PEENED SPECIMENS IN T74 CONDITION (2)

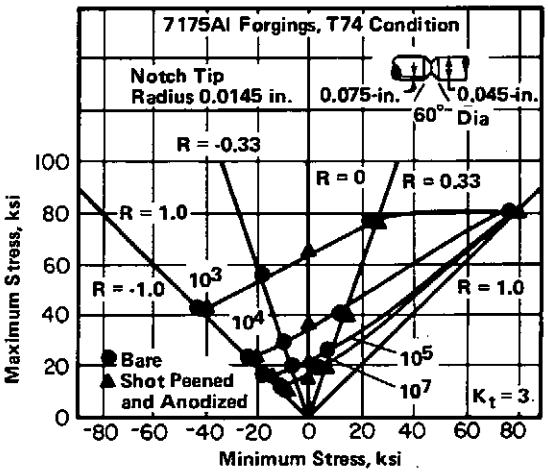

FIGURE 3.053. CONSTANT FATIGUE-LIFE DIAGRAM FOR NOTCHED, AXIALLY LOADED SPECIMENS IN T74 CONDITION (2)

	Al
5.6	Zn
2.5	Mg
1.6	Cu
0.25	Cr
Low	Ti
	Mn
	Si

7175 Al

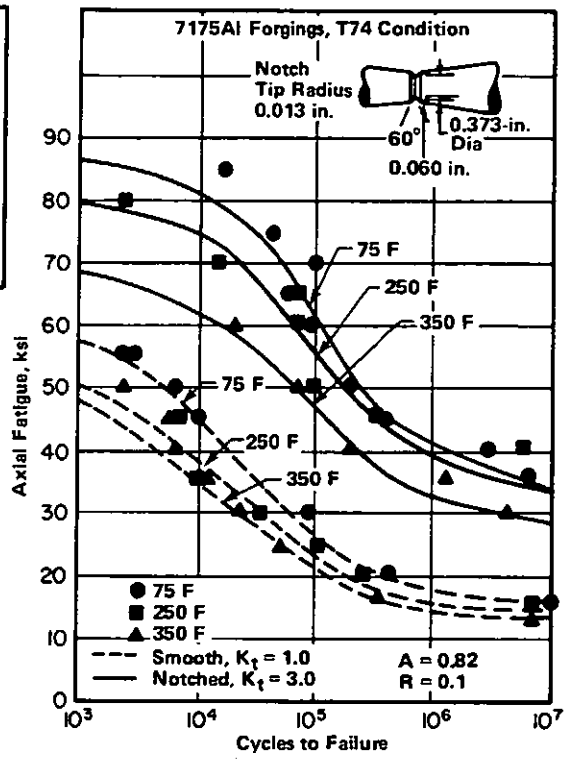

FIGURE 3.054. AXIAL FATIGUE PROPERTIES AT VARIOUS TEMPERATURES FOR FORGINGS IN T74 CONDITION (1)

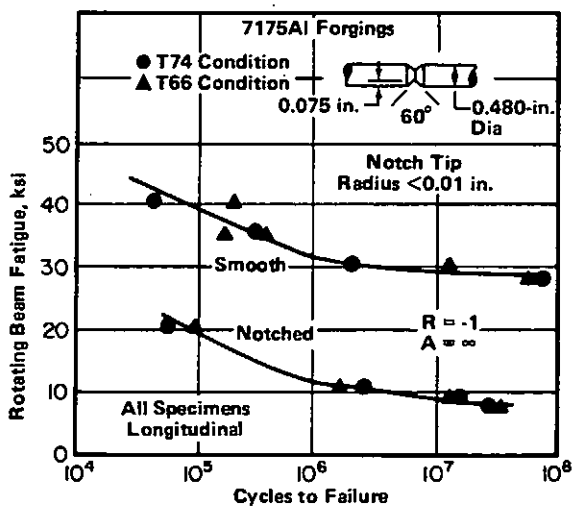

FIGURE 3.055. ROTATING BEAM FATIGUE PROPERTIES FOR FORGINGS IN T74 AND T66 CONDITIONS (3)

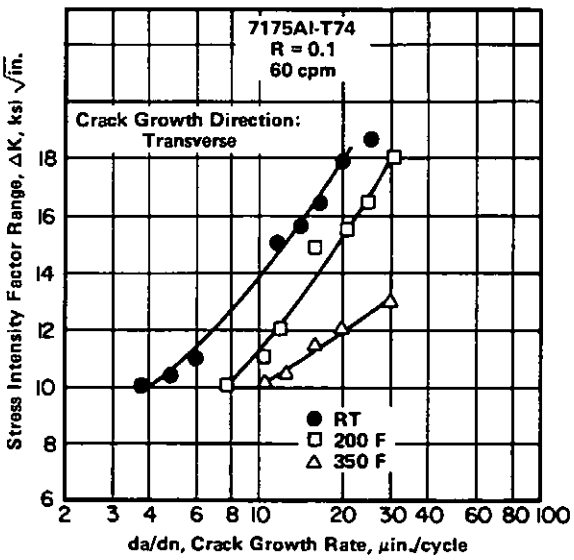

FIGURE 3.056. FATIGUE CRACK-GROWTH RATES FOR T74 FORGINGS AT ROOM TEMPERATURE AND ELEVATED TEMPERATURES (25)

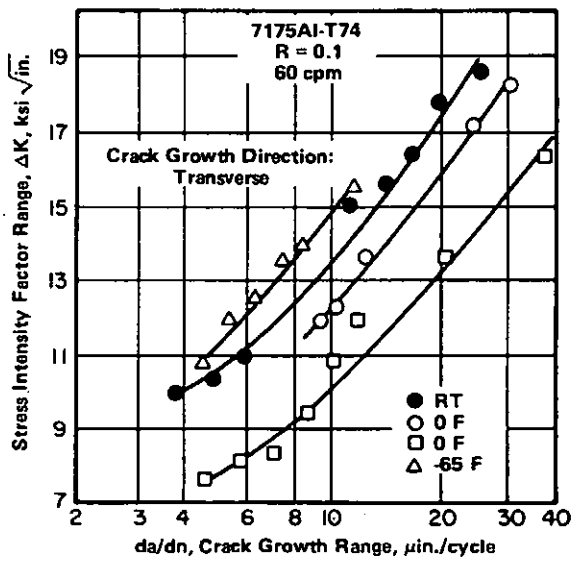

FIGURE 3.057. FATIGUE CRACK-GROWTH RATES FOR T74 FORGINGS AT ROOM TEMPERATURE AND AT LOW TEMPERATURES (25)

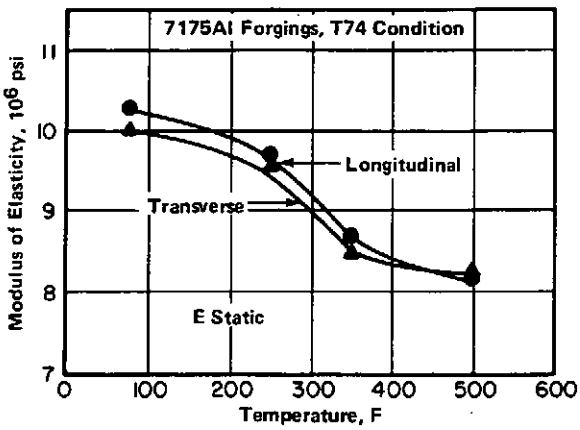

FIGURE 3.0621. EFFECT OF TEMPERATURE ON TENSILE MODULUS OF ELASTICITY (1)

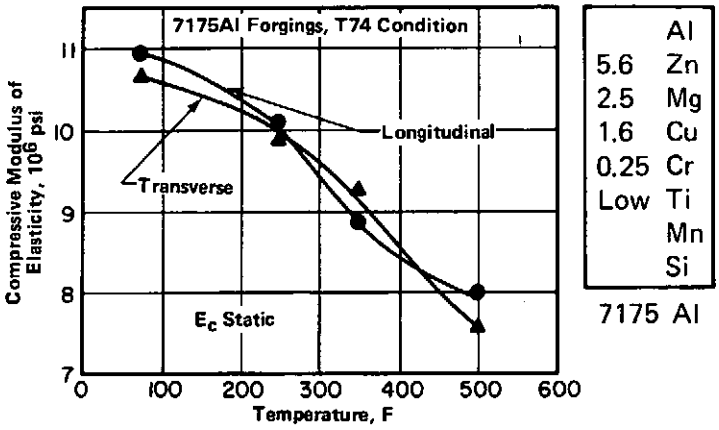

FIGURE 3.0622. EFFECT OF TEMPERATURE ON COMPRESSIVE MODULUS OF ELASTICITY (1)

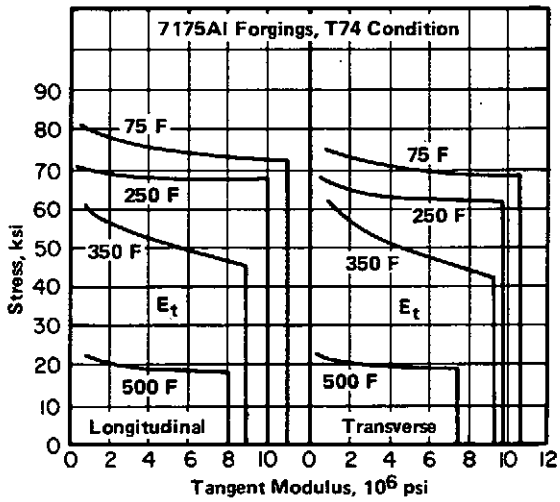

FIGURE 3.0623. COMPRESSIVE TANGENT MODULUS CURVES AT VARIOUS TEMPERATURES (1)

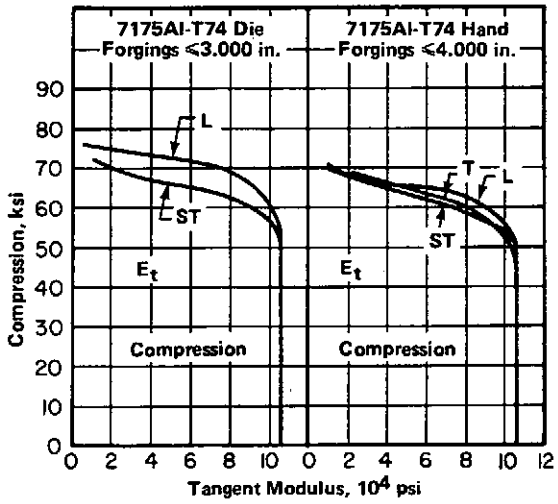

FIGURE 3.0624. TYPICAL COMPRESSIVE TANGENT MODULUS CURVES FOR T74 DIE FORGINGS AND HAND FORGINGS AT ROOM TEMPERATURE (29)