

1. GENERAL
Ti-7Al-4Mo is a heat treatable alpha-beta type alloy. It is used primarily in the form of light and intermediate forgings and extrusions at temperatures up to 850F. Its strength is higher than that of Ti-6Al-4V by about 15 ksi in the annealed condition and about 25 ksi in the solution treated and aged condition. The depth of hardening of this alloy is essentially the same as that of Ti-6Al-4V. Welding of this alloy is not recommended.

1.01 Commercial Designation
7Al-4Mo Titanium Alloy.

1.02 Alternate Designations
C-135AMo, Ti(6 to 7)Al-(3 to 4)Mo, MST 7Al-4Mo, RS-135, RMI-7Al-4Mo, HA-7146.

1.03 Specifications
Table 1.03.

TABLE 1.03

Form	Condition	Specifications	
		AMS (1)	Company
Bar, forgings forging stock	Ann	-	General Electric Co. B50T52-53
	ST + aged	AMS 4970A	-

1.04 Composition

1.041 AMS specified composition, Table 1.041.

TABLE 1.041

Source	AMS (1)	
	Min	Max
Aluminum	6.50	7.30
Carbon	-	0.10
Hydrogen	-	0.013
Iron	-	0.30
Molybdenum	3.50	4.50
Nitrogen	-	0.05
Oxygen	-	0.20
Other elements Total*	-	0.40
Titanium	Balance	

* Need not be reported

1.042 Producer's specified composition, Table 1.042.

TABLE 1.042

Source	(2)(3)(4)	
	Min	Max
Aluminum	6.5	7.3
Carbon	-	0.08
Hydrogen	-	0.0125 **
Iron	-	0.25
Molybdenum	3.5	4.5
Nitrogen	-	0.05
Oxygen *	-	-
Titanium	Balance	

* Not specified

** Biller, 0.0100% maximum

1.043 Users' specified composition, Table 1.043.

TABLE 1.043

Source	(5)	
	Min	Max
Aluminum	6.5	7.3
Carbon	-	0.15
Hydrogen	-	0.0125
Iron *	-	-
Molybdenum	3.5	4.5
Nitrogen	-	0.07
Oxygen	-	0.20
Titanium	Balance	

* Not specified

	Ti
7	Al
4	Mo

1.05 Heat Treatment

1.051 Anneal.

1.0511 For maximum formability. 1450F, 1 hour, furnace cool at 300F per hour maximum to 1050F maximum, air cool.

1.0512 For maximum creep properties. 1450F, 1 hour, furnace cool at 300F per hour maximum to 1050F, air cool + 1050F, 24 hours, air cool.

1.052 Stress relief. 900 to 1300F, 1 to 8 hours, using highest temperature at which oxidation is no problem, air cool.

1.053 Solution treat. 1700 to 1800F, 30 minutes to 2 hours, water quench.

1.0531 Effect of solution treat temperature on room temperature tensile properties of unaged bar, Fig. 1.0531.

1.0532 Effect of solution treat temperature on room temperature tensile properties of aged bar, Fig. 1.0532.

1.054 Age. 1000F to 1200F, 2 to 8 hours, air cool. Aging response of bar, Fig. 1.054.

1.06 Hardness

In sections up to 4 inches, the hardenability of this alloy is essentially identical to that of Ti-6Al-4V. Its strength at full hardness, however, exceeds that of Ti-6Al-4V.

1.061 Effect of as-quenched section size on room temperature tensile properties of aged bar, Fig. 1.061.

1.062 Hardness. Typical. 32 to 38 RC.

1.07 Forms and Conditions Available

1.071 Alloy is available in the full commercial range of sizes for bar, forgings and extrusions.

1.072 Some of the special products which are available on a commercial basis are sheet, plate and wire.

1.073 All products are supplied in the annealed condition. Bar is additionally supplied in the heat treated condition, (9).

1.08 Melting and Casting Practice

1.081 Consumable electrode double vacuum melt, (1)(9).

1.09 Special Considerations

See Ti, Commercially Pure.

2. PHYSICAL AND CHEMICAL PROPERTIES

2.01 Thermal Properties

2.011 Melting range. Approximately 3000F.

2.012 Phase changes. This alloy transforms on cooling from beta to alpha plus beta at 1815F to 1865F, (3)(4).

2.013 Thermal conductivity, Fig. 2.013.

2.014 Thermal expansion, Fig. 2.014.

2.015 Instantaneous specific heat, Fig. 2.015.

2.016 Thermal diffusivity

2.02 Other Physical Properties

2.021 Density. 0.162 lb per cu in; 4.48 gr per cu cm, (3)(4) (10)(11)(12).

2.0211 Time-temperature-transformation diagrams

2.022 Electrical resistivity, Fig. 2.022.

	Ti
7	Al
4	Mo

- 2.023 Magnetic properties. Alloy is nonmagnetic.
 2.024 Emissivity
 2.025 Damping capacity

- 2.03 Chemical Properties
 See Ti, Commercially Pure.

3. MECHANICAL PROPERTIES

- 3.01 Specified Mechanical Properties
 3.011 AMS specified mechanical properties, Table 3.011.

TABLE 3.011

Source	AMS (1)				
Alloy	Ti-7Al-4Mo				
Form	Bars and forgings				
Condition	1725F ± 25, 1 to 2 hr, WQ+ 1200F + 25F, 16 hr, AC				
Diameter or thickness - in	F _{tu} , ksi - min	F _{ty} , ksi - min	e(4D), % - min	RA, % - min	
≤ 1.00	170	150	10	20	
> 1.00 to 2.00	165	150	10	20	
> 2.00 to 3.00	155	145	10	20	

Hardness shall not be lower than RC 30

See Reference(1) for stress rupture and creep stability specifications

- 3.02 Mechanical Properties at Room Temperature
 See section 3.03 also.

- 3.021 Tension
 3.0211 Stress-strain diagrams
 3.0212 Tensile properties for bar.
 3.02121 Effect of exposure to elevated temperatures with and without load on tensile properties of annealed bar, Table 3.02121.

TABLE 3.02121

Source	(10)(13)				
Alloy	Ti-7Al-4Mo				
Form	Bar				
Condition	1450F, 1hr, FC300F per hr to 1050F, AC+1000F, 24hr				
1000 hr exposure at	Tested at RT				
Temp-F	Load, ksi	F _{tu} , ksi	F _{ty} , ksi	e(2 in) %	RA, %
RT	-	149	137	6	-
600	-	149	137	13 to 15	25 to 46
	80	146	141	16	46
800	-	149	137	13 to 15	25 to 46
	50	148	144	16	45
1000	15	152	148	14	54

- 3.012 Producer's guaranteed mechanical properties for annealed material, Table 3.012.

TABLE 3.012

Source	(13)		
Alloy	Ti-7Al-4Mo		
Form	Bar		
Condition	Ann		
Thickness - in	≤ 2	2 to 3	
F _{tu} , min-ksi	145	140	
F _{ty} , min-ksi	135	130	
e, (4D) min-%	10	10	
RA, min-%	20	20	
Hardness, RC - max	38	38	

- 3.013 Producer's guaranteed mechanical properties for material solution treated and aged, Table 3.013.

TABLE 3.013

Source	(10)(13)				
Alloy	Ti-7Al-4Mo				
Form	Bar				
Condition	HT				
Section size - in	F _{tu} - ksi	F _{ty} - ksi	e(1 in) - %	RA - %	Test Location
≤ 1 max	170	160	8	20	Center
> 1 to 2 max	160	150	8	20	Mid-radius
> 2 to 4 max	150	140	8	20	Mid-radius
≤ 1 max	195	180	5	12	Center
> 1 to 2 max	175	160	5	12	Mid-radius
> 2 to 4 max	165	150	5	12	Mid-radius

3.02122 Effect of exposure to elevated temperatures with load on tensile properties of annealed bar, Table 3.02122.

TABLE 3.02122

Source								
(12)								
Alloy								
Ti-7Al-4Mo								
Form								
Bar								
Condition								
Ann 1475F, 2 hr, FC to 1000F, AC								
Temp - F	Exposure conditions			% e at temp - F	Subsequent RT tensile properties			
	Stress, ksi	Time - hr			F _{tu} , ksi	F _{ty} , ksi	e(4D), %	RA, %
None	None	None	None	None	156	147	13	38
800	90	815	8.0	167	161	10	34	
900	60	145	1.0	156	144	17	39	
900	30	500	0.75	160	151	14	42	
1000	30	145	1.0	157	149	16	41	
1000	6	500	0.32	164	157	13	38	

Ti
7 Al
4 Mo

3.02123 Effect of exposure to elevated temperatures with load on tensile properties of solution treated and aged bar, Table 3.02123.

TABLE 3.02123

Source								
(12)								
Alloy								
Ti-7Al-4Mo								
Form								
Bar								
Condition								
ST 1700F, 4 hr, WQ + age 1100F, 6 hr, AC								
Temp - F	Exposure conditions			e% at temp - F	Subsequent RT tensile properties			
	Stress, ksi	Time - hr			F _{tu} , ksi	F _{ty} , ksi	e(4D), %	RA, %
None	None	None	None	None	173	158	10	23
800	102	770	10.0	194	179	7	20	
900	60	145	1.0	178	152	11	24	
900	35	500	0.52	177	153	12	19	
1000	30	145	3.0	175	157	10	30	
1000	13	500	0.48	175	162	10	30	

3.02124 Effect of extrusion temperature on tensile properties of as-extruded and extruded-plus-annealed bar, Fig. 3.02124.

3.0213 Tensile properties for forgings

3.02131 Effect of exposure to elevated temperatures with load on tensile properties of annealed upset press forgings, Table 3.02131.

TABLE 3.02131

Source							
(14)							
Alloy							
Ti-7Al-4Mo							
Form							
Upset press forged							
Condition							
Press forged 2 to 1 to 3/4 in from 1750F, AC + 1450F, 1 hr, FC to 1050F, AC							
Direction	150 hr exposure at		Total creep def. %	Subsequent RT tensile properties			
	Temp - F	Stress - ksi		F _{tu} , ksi	F _{ty} , ksi	e(4D), %	RA, %
Rad	None	None	None	150	140	13	31
Tang	None	None	None	154	145	12	31
Rad	750	80	0.56	153	142	15	33
Tang	750	80	0.63	156	144	13	23
Rad	850	45	0.43	151	139	12	29
Tang	850	45	0.44	157	142	16	27
Rad	950	25	0.92	158	146	12	27
Tang	950	25	0.74	158	145	11	19

7	Ti
4	Al
	Mo

- 3.02132 Effect of exposure to elevated temperatures with load on tensile properties of solution treated and aged upset press forging, Table 3.02132.

TABLE 3.02132

Source (14)							
Alloy Ti-7Al-4Mo							
Form Upset press forged							
Condition Press forged 2 to 1 to 3/4 in from 1750F, AC + 1750F, AC + 1750, 1hr, WQ + 1100F, 8 hr, AC							
Direction	150 hr exposure at		Total creep def, %	Subsequent RT tensile properties			
	Temp - F	Stress, ksi		F _{TU} , ksi	F _{TY} , ksi	e(4D), %	RA, %
Rad	None	None	None	179	161	8	12
Tang	None	None	None	179	162	9	13
Rad	750	80	0.25	178	162	5	10
Tang	750	80	*	186	167	9	14
Rad	850	45	0.27	181	163	8	10
Tang	850	45	*	175	154	8	18
Rad	950	25	0.39	183	165	6	9
Tang	950	25	*	177	162	5	12

* Not measured

- 3.02133 Effect of exposure to elevated temperature with load on tensile properties of annealed compressor blade forging, Table 3.02133.

TABLE 3.02133

Source (6)						
Alloy Ti-7Al-4Mo						
Form Compressor blade forging						
Condition Forge 1700-1750F + Ann 1450F, 1 hr argon, FC at 100F/hr max to 1050F, AC						
Temp - F	Stress-ksi	Total elongation, %	Subsequent RT tensile properties (Spec gage section 0.160 in dia x 0.650 in length)			
			F _{TU} , ksi	F _{TY} , ksi	e, %	RA, %
None			151	144	17	56
850	40	0.97% in 209 hr	156	146	22	53

- 3.02134 Effect of exposure to elevated temperatures with load on tensile properties of solution treated and aged compressor blade forgings, Table 3.02134.

TABLE 3.02134

Source (6)						
Alloy Ti-7Al-4Mo						
Form Compression blade forgings						
Condition Forge 1700 - 1750F + ST 1560F, 30 min argon, AC + age 1020F, 24 Hr, AC						
Temp - F	Stress-ksi	Total Elongation, %	SUBSEQUENT RT TENSILE PROPERTIES (Spec gage section 0.160 inch dia x 0.650 in length)			
			F _{TU} , ksi	F _{TY} , ksi	e, %	RA, %
None			162	156	17	53
850	40	0.71% in 120 hr	164	154	20	26
950	12	0.46% in 57 hr	164	-	18	46

- 3.02135 Effect of aging on short time tensile properties of upset forgings, Fig. 3.02135. 3.026 Bearing
- 3.0214 Effect of extrusion temperature on as-extruded tensile properties of extrusions, Fig. 3.0214. 3.027 Stress concentration
- 3.022 Compression 3.0271 Notch properties
- 3.0221 Stress-strain diagrams 3.0272 Fracture toughness
- 3.023 Impact. See 3.033. 3.028 Combined properties
- 3.024 Bending 3.03 Mechanical Properties at Various Temperatures
- 3.025 Torsion and shear 3.031 Tension
- 3.0251 Shear properties, Table 3.0251. 3.0311 Stress-strain diagrams
- 3.0312 Tensile properties for forgings

TABLE 3.0251

Source (10)(15)				
Alloy Ti-7Al-4Mo				
Form 1/2 in bar				
Condition Ann 1650F, WQ+ 1000F, 4 hr				
Pin dia-in	3/16	3/8	3/16	3/8
F _{su} , -ksi	104	104	117	114
	to	to	to	to
	115	105	120	118

3.03121 Typical room temperature and 572F short time tensile properties of annealed upset forgings, Table 3.03121.

TABLE 3.03121
(10)

Source	Ti-7Al-4Mo		
Alloy	Ti-7Al-4Mo		
Form	Upset forging		
Condition	Forge 1750F + Ann 1450F, 1 1/2 hr, FC 300F/hr max to 1050F, AC		
Upset ratio	Test temp - F	F _{TU} , ksi	F _{TY} , ksi
3:2	RT	150	140
	572F	110	92
3:1	RT	153	144
	572F	114	94

- 3.03125 Effect of subzero and elevated temperature on short time tensile properties of 3:1 upset forging, Fig. 3.03125.
- 3.03126 Effect of test temperature on tensile properties of annealed and aged compressor wheel forgings, Fig. 3.03126.
- 3.03127 Effect of test temperature on tensile properties of annealed and aged compressor blade forgings, Fig. 3.03127.
- 3.0313 Tensile properties for bar
- 3.03131 Effect of elevated temperatures on tensile properties of annealed and heat treated bars, Fig. 3.03131.
- 3.03132 Effect of elevated temperatures on tensile properties of bar for two heat treatments, Fig. 3.03132.
- 3.03133 Influence of test temperature and forging history on tensile properties of heat treated bars, Fig. 3.03133.
- 3.0314 Effect of subzero temperatures on smooth and notch tensile properties of annealed sheet and bar from same heat, Fig. 3.0314.
- 3.0315 Effect of elevated temperatures on tensile properties of extrusions, Fig. 3.0315.

	Ti
7	Al
4	Mo

3.03122 Average 572F short time tensile properties of upset forgings aged at two different temperatures, Table 3.03122.

TABLE 3.03122
(10)

Source	Ti-7Al-4Mo					
Alloy	Ti-7Al-4Mo					
Form	Upset forging					
Condition	Forge 1750F, + Ann 1450F, 1 1/2 hr, FC 300F/hr max to 1050F, AC + ST 1750F, 1 1/2 hr, WQ + age as indicated					
Age temp - F	Age time - hr	Upset ratio	F _{TU} , ksi	Tested at 572F F _{TY} , ksi	e, %	RA, %
1050	4	3:2	152	119	12	49
		3:1	149	116	14	54
1100	4	3:2	139	111	13	44
		3:1	141	110	13	54

3.03123 Effect of exposure at 850F, 45 ksi on 750F short time tensile properties of annealed compressor wheel forgings, Table 3.03123.

TABLE 3.03123
(16)

Source	Ti-7Al-4Mo				
Alloy	Ti-7Al-4Mo				
Form	Compressor wheel forging				
Condition	Forge below beta transus + Ann 1450F, 1 hr, FC at 300F/hr max to 1050F, AC				
Exposure conditions:	850F, 45 ksi		Subsequent 750F properties		
Exposure time, hr	Approximate plastic creep, %	F _{TU} , ksi	F _{TY} , ksi	e, %	RA, %
0	0	103	85	19	63
20	0.19	107	84	18	56
100	0.43	111	86	18	55
300	0.69	114	89	18	57

3.03124 Effect of exposure at 850F, 45 ksi on 750F short time tensile properties of heat treated compressor wheel forgings, Table 3.03124.

TABLE 3.03124
(16)

Source	Ti-7Al-4Mo				
Alloy	Ti-7Al-4Mo				
Form	Compressor wheel forging				
Condition	Forge below beta transus + Ann 1450F, 1 hr, FC at 300F/hr max to 1050F, AC + ST 1560F, 30 min, AC + age 1020F, 24 hr, AC				
Exposure conditions:	850F, 45 ksi		Subsequent 750F properties		
Exposure time, hr	Approximate plastic creep, %	F _{TU} , ksi	F _{TY} , ksi	e, %	RA, %
0	0	110	87	16	51
20	0.15	111	86	18	57
100	0.27	115	89	19	57
300	0.42	116	89	19	53

	Ti
7	Al
4	Mo

- 3.032 Compression
 3.0321 Stress-strain diagrams
 3.033 Impact
 3.0331 Impact properties of bar at subzero and elevated temperatures, Fig. 3.0331.
 3.034 Bending
 3.035 Torsion and shear
 3.036 Bearing
 3.037 Stress concentration. See Fig. 3.0314.
 3.0371 Notch properties
 3.0372 Fracture toughness
 3.038 Combined properties

- 3.04 Creep and Creep Rupture Properties
 3.041 Creep and creep rupture properties for forgings
 3.0411 Creep and creep stability properties of heat treated upset forgings, Table 3.0411.

- 3.063 Modulus of rigidity
 3.0631 Modulus of rigidity at room and elevated temperatures, Fig. 3.0631.
 4. FABRICATION
 4.01 Formability
 4.011 Forging. For best combination of strength and ductility; starting temperature 1850F maximum, finishing temperature 1500F minimum. Reduction of 25 to 40 percent should be performed in the alpha + beta range in the final forging operation. Subsequent reheating such as required for sizing operations, should not exceed a temperature of about 200F below the beta to alpha + beta transformation temperature, (8).

TABLE 3.0411

Source		(10)					
Alloy		Ti-7Al-4Mo					
Form		Upset forging					
Condition		Forge 1750F + Ann 1450F, 1 1/2 hr, FC at 300F/hr max to 1050F, AC + ST 1750F, 1 1/2 hr, WQ + age 1120F, 4 hr, AC					
Heat	Creep test conditions: 850F, 45ksi		Upset ratio	RT properties subsequent to 150 hr creep tests			
	Total creep in			F _{TU} , ksi	F _{TY} , ksi	e, %	RA, %
	30 hr, %	150 hr, %					
A	0.198	0.356	3:2	193	167	8	13
B	0.226	0.366		182	161	11	24
A	0.175	0.315	3:1	193	169	8	19
B	0.200	0.352		183	160	10	16

- 3.0412 Master curves for creep and creep rupture of annealed compressor blade forgings, Fig. 3.0412.
 3.0413 Master curve for creep and creep rupture of aged compressor blade forgings, Fig. 3.0413.
 3.0414 Master curves for creep and creep rupture of annealed and aged compressor wheel forgings, Fig. 3.0414.
 3.0415 Master curves for creep in upset forgings, Fig. 3.0415.
 3.042 Creep and creep rupture properties for bar
 3.0421 Creep rupture curves for bar at 1020 and 1200F, Fig. 3.0421.
 3.0422 Minimum creep rate curves for bar at 1020 and 1200F, Fig. 3.0422.
 3.0423 Isochronous stress-strain curves in tension at 600 to 1000F for bar, Fig. 3.0423.
 3.0424 Total strain curves at various temperatures for annealed bar, Fig. 3.0424.
 3.0425 Total strain curves at various temperatures for solution treated and aged bar, Fig. 3.0425.
 3.05 Fatigue Properties
 3.051 Fatigue properties for smooth and notched bar, Table 3.051.
 4.012 For best creep and creep rupture properties, at some sacrifice in ductility, forging in the beta region is effective, (8).
 4.013 Casting this alloy is not done at the present time, (1966), (8).
 4.02 Machining and Grinding
 See Ti, Commercially Pure
 4.03 Welding
 4.031 General. Since this alloy is heat hardenable it is not generally recommended for welded assemblies, (6).
 4.04 Heat Treatment
 See Ti-6Al-4V.
 4.05 Surface Treatment
 See Ti, Commercially Pure

TABLE 3.051

Source		(10)(13)			
Form		1/2 to 3/4 in bar			
Condition		Ann			
Temp, F	Method	Stress Ratio		Stress Concentration	Fatigue strength-ksi at cycles 10 ⁷
		A	R		
RT	Rot bend	∞	-1	K _t = 1 K _t = 3.9	97
					29

- 3.052 Stress range diagram for bar at room temperature to 900F, Fig. 3.052.
 3.053 Overstress ratio versus cycles to failure at room temperature for both bending and torsion, Fig. 3.053.
 3.06 Elastic Properties
 3.061 Poisson's ratio
 3.062 Modulus of elasticity
 3.0621 Static modulus of elasticity at room and elevated temperatures, Fig. 3.0621.
 3.0622 Dynamic modulus of elasticity at elevated temperatures, Fig. 3.0622.

	Ti
7	Al
4	Mo

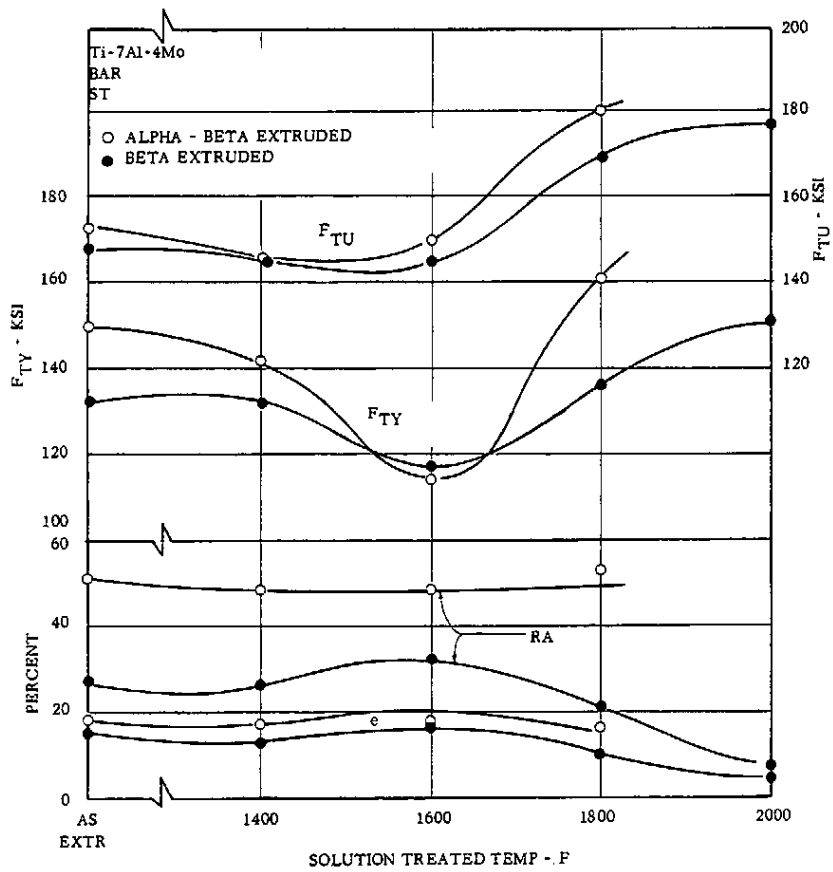


FIG. 1.0531 EFFECT OF SOLUTION TREAT TEMPERATURE ON ROOM TEMPERATURE TENSILE PROPERTIES OF UNAGED BAR (7,p.11,12)

	Ti
7	Al
4	Mo

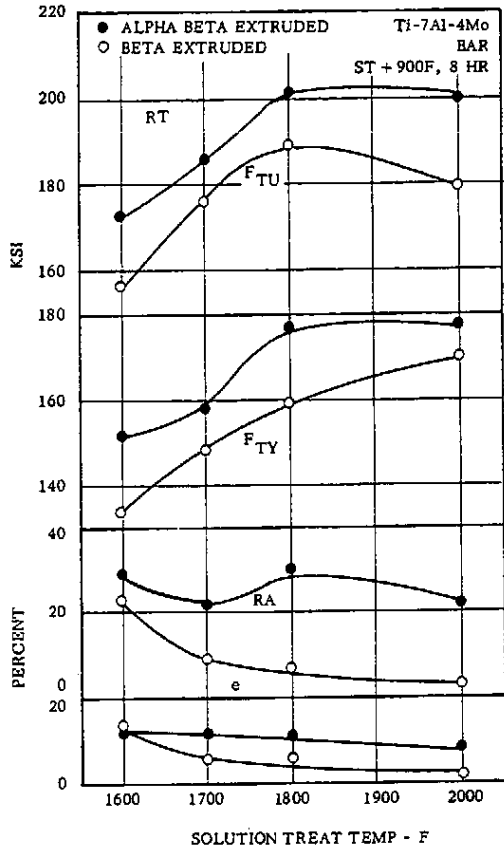


FIG. 1.0532 EFFECT OF SOLUTION TREAT TEMPERATURE ON ROOM TEMPERATURE TENSILE PROPERTIES OF AGED BAR (7, p.13)

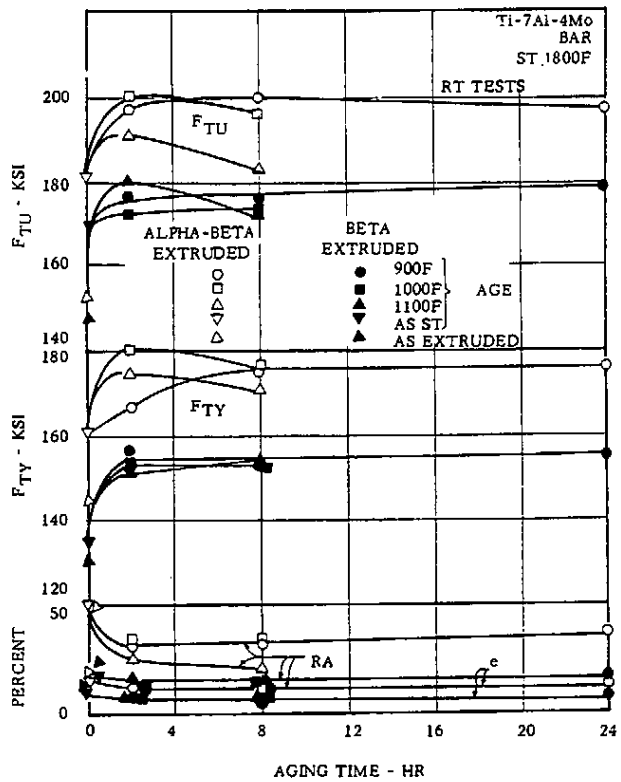


FIG. 1.054 AGING RESPONSE OF BAR

(7, p.14, 15)

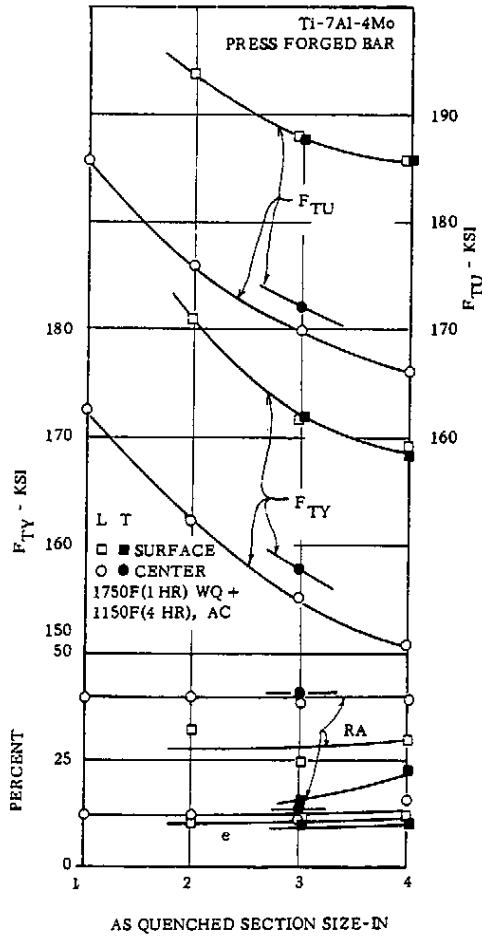


FIG. 1.061 EFFECT OF AS-QUENCHED SECTION SIZE ON ROOM TEMPERATURE TENSILE PROPERTIES OF AGED BAR (8, p. 7 to 11)

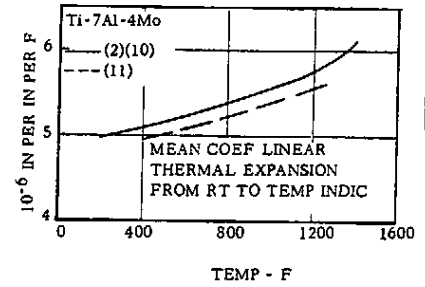


FIG. 2.014 THERMAL EXPANSION (2, p. 2)(11)(10, p. 3)

	Ti
7	Al
4	Mo

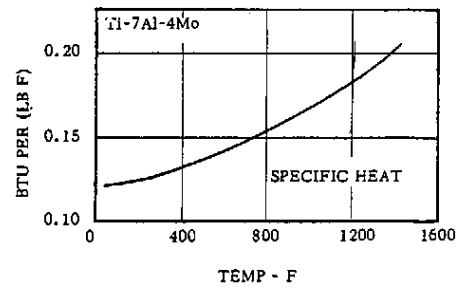


FIG. 2.015 INSTANTANEOUS SPECIFIC HEAT (2, p. 2)(10, p. 3)

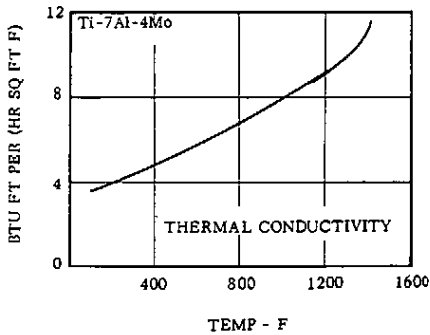


FIG. 2.013 THERMAL CONDUCTIVITY

(2, p. 1)(10, p. 2, 3)

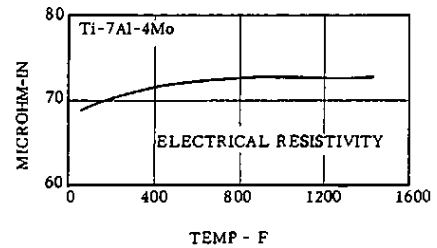


FIG. 2.022 ELECTRICAL RESISTIVITY

(2, p. 2)(10, p. 4)

	Ti
7	Al
4	Mo

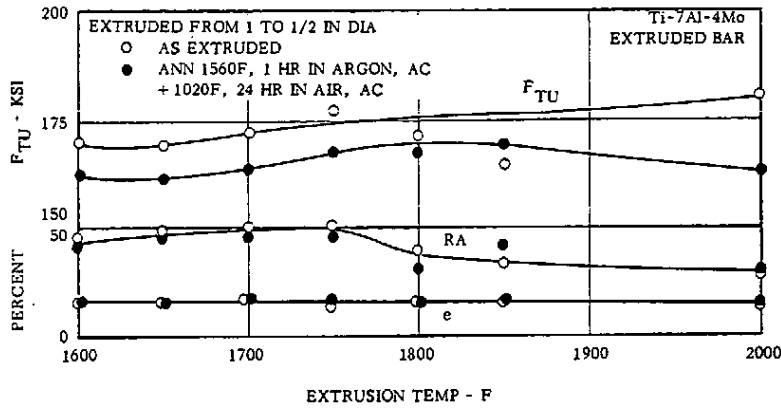


FIG. 3.02124 EFFECT OF EXTRUSION TEMPERATURE ON TENSILE PROPERTIES OF AS-EXTRUDED AND EXTRUDED -PLUS-ANNEALED BAR (7, p. 33)

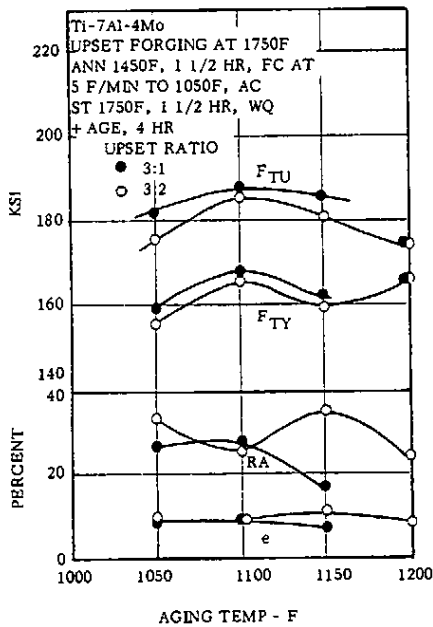


FIG. 3.02135 EFFECT OF AGING ON SHORT TIME TENSILE PROPERTIES OF UPSET FORGING (10, p. 7)

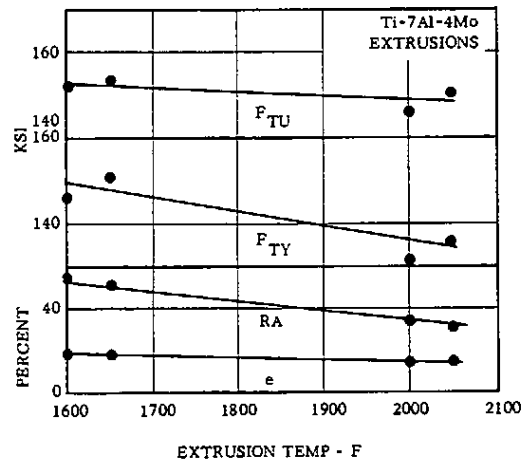
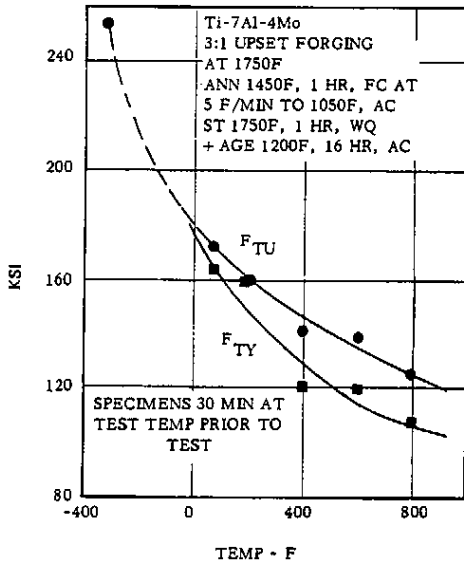


FIG. 3.0214 EFFECT OF EXTRUSION TEMPERATURE ON AS-EXTRUDED TENSILE PROPERTIES OF EXTRUSIONS (7, p. 26)



	Ti
7	Al
4	Mo

FIG. 3.03125 EFFECT OF SUBZERO AND ELEVATED TEMPERATURE ON SHORT TIME TENSILE PROPERTIES OF 3:1 UPSET FORGING (10, p.8)

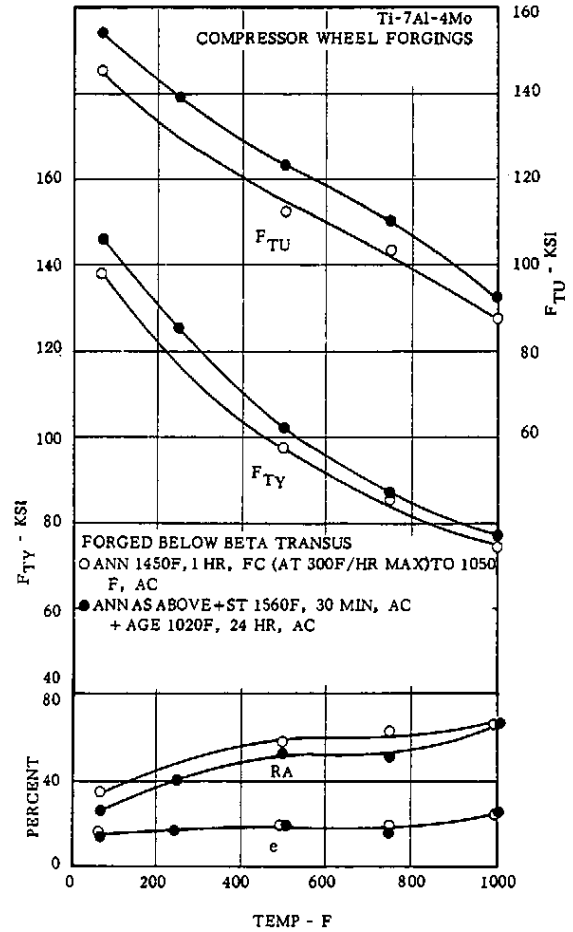


FIG. 3.03126 EFFECT OF TEST TEMPERATURE ON TENSILE PROPERTIES OF ANNEALED AND AGED COMPRESSOR WHEEL FORGINGS (16, p. C. 2.6. c 2.7)

	Ti
7	Al
4	Mo

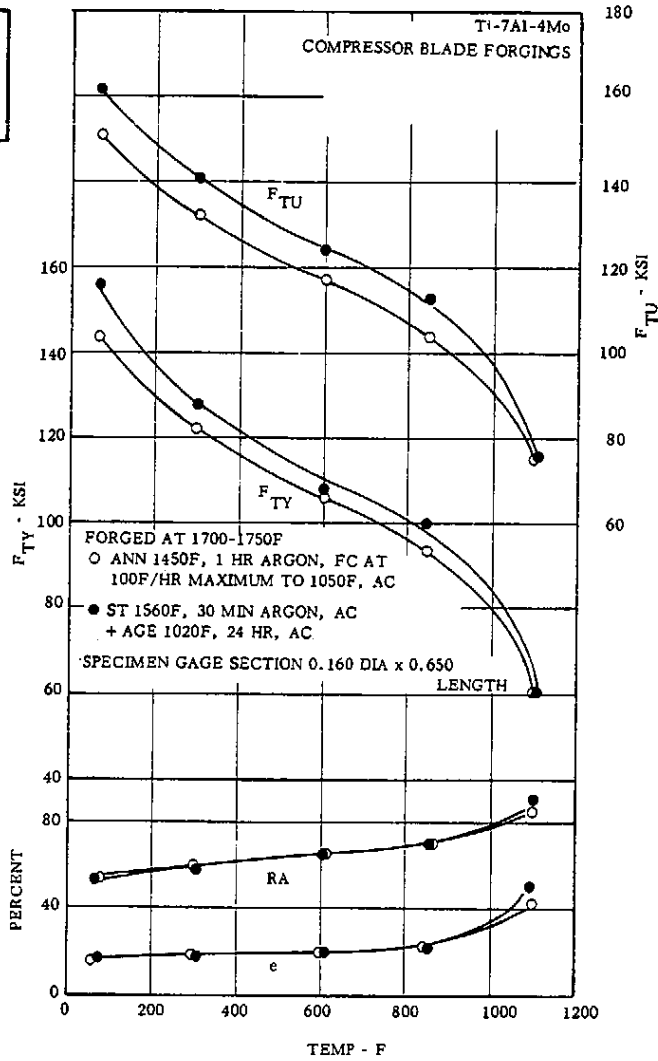


FIG. 3.03127 EFFECT OF TEST TEMPERATURE ON TENSILE PROPERTIES OF ANNEALED AND AGED COMPRESSOR BLADE FORGINGS (6, p.c.19, c.1.10)

	Ti
7	Al
4	Mo

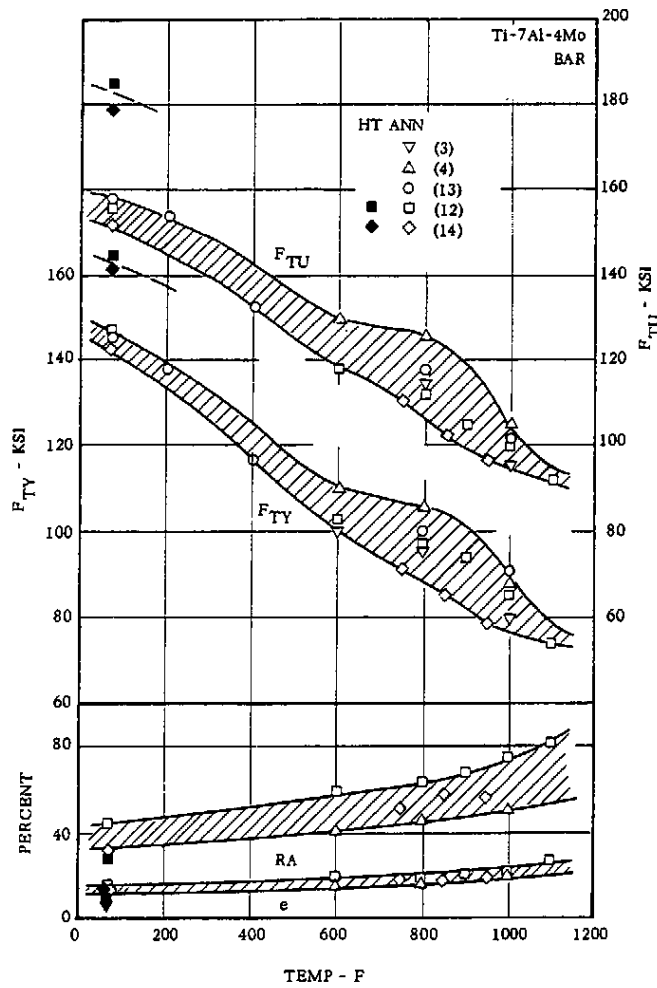


FIG. 3.03131 EFFECT OF ELEVATED TEMPERATURE ON TENSILE PROPERTIES OF ANNEALED AND HEAT TREATED BAR
(3, p. 16)(4, p. 24)(12, p. 20)(13, p. 4)(14, p. 7)

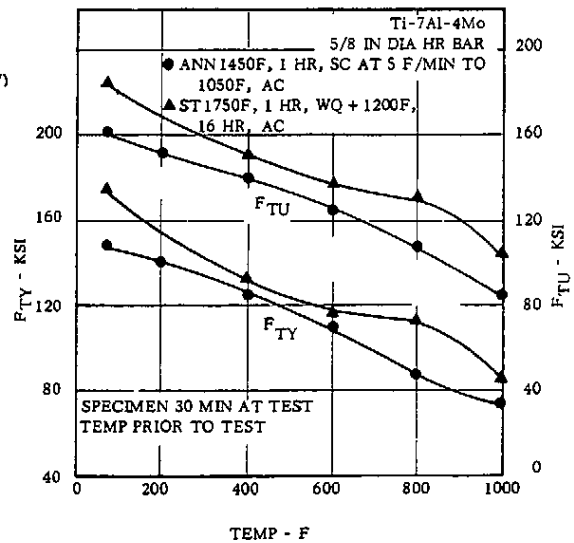


FIG. 3.03132 EFFECT OF ELEVATED TEMPERATURES ON TENSILE PROPERTIES OF BAR FOR TWO HEAT TREATMENTS
(10, p. 5)

	Ti
7	Al
4	Mo

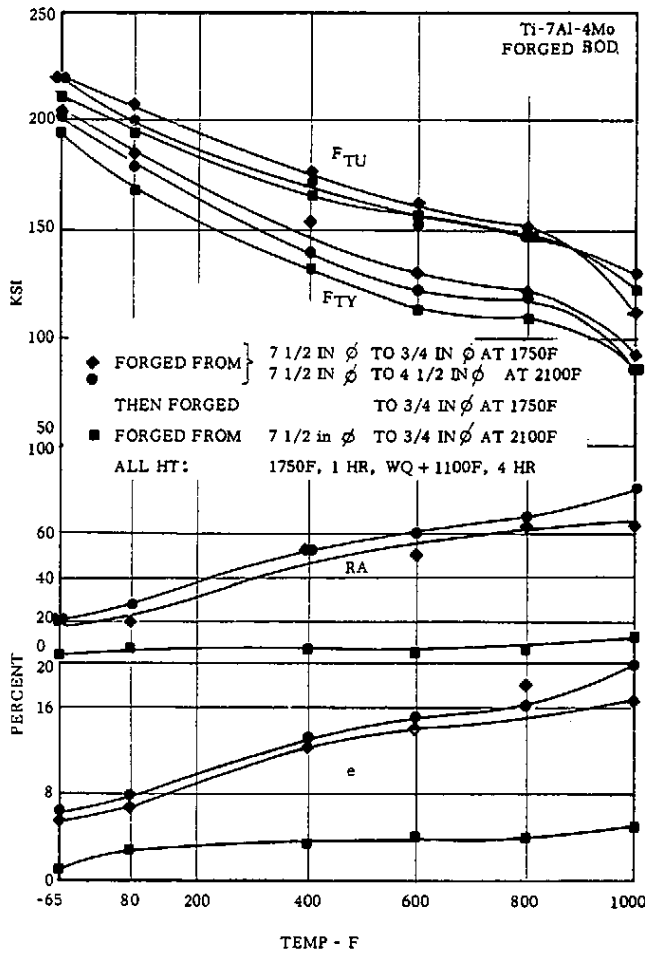
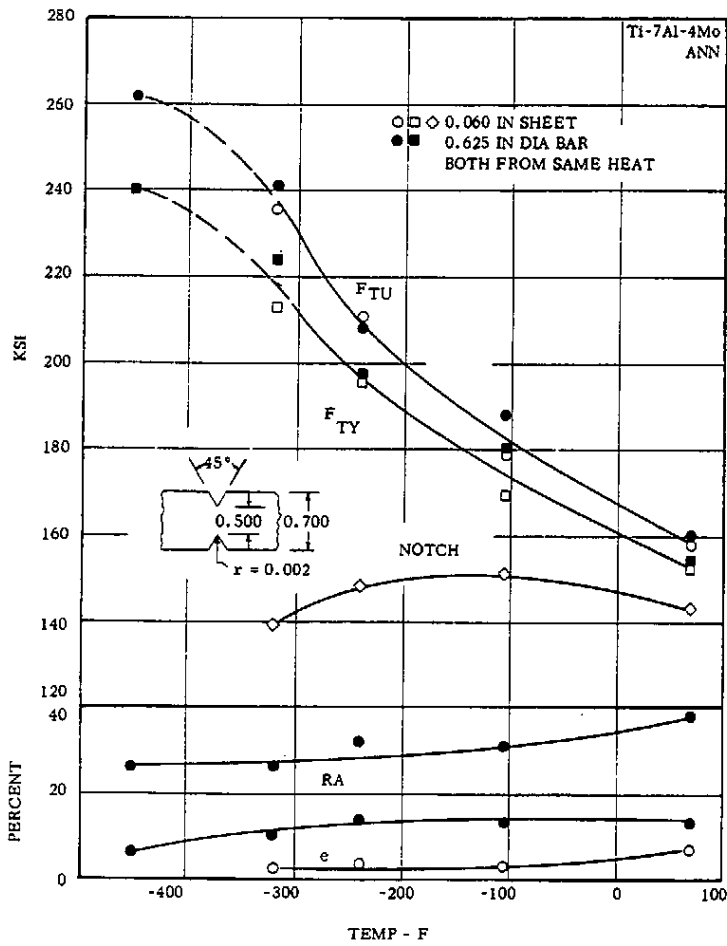


FIG. 3.03133 INFLUENCE OF TEST TEMPERATURE AND FORGING HISTORY ON TENSILE PROPERTIES OF HEAT TREATED BARS (17)



	Ti
7	Al
4	Mo

FIG. 3.0314 EFFECT OF SUBZERO TEMPERATURES ON SMOOTH AND NOTCH TENSILE PROPERTIES OF ANNEALED SHEET AND BAR FROM SAME HEAT (18, p.4-5)

Ti
7 Al
4 Mo

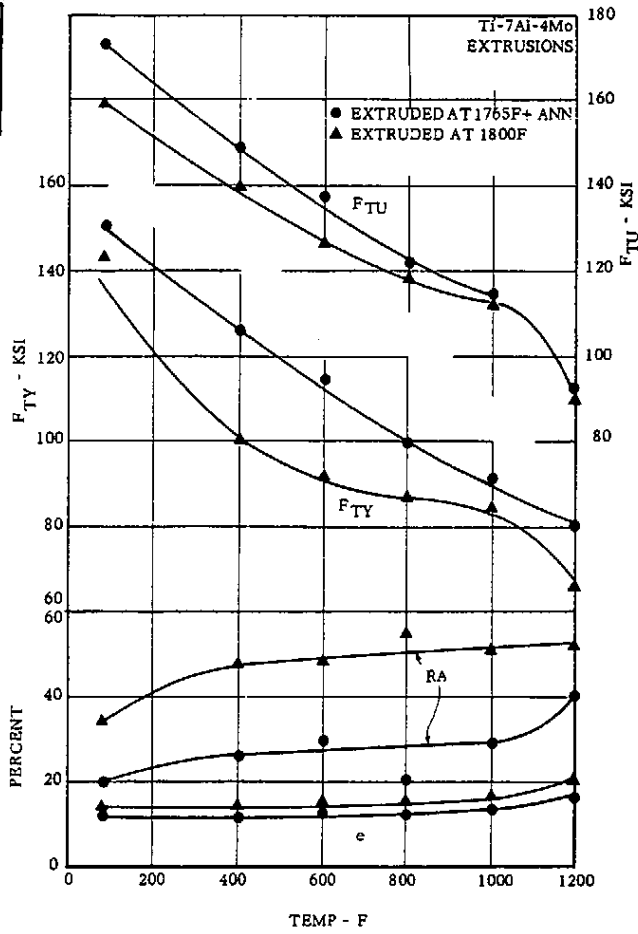


FIG. 3.0315 EFFECT OF ELEVATED TEMPERATURES ON TENSILE PROPERTIES OF EXTRUSIONS (7, p. 53, 54)

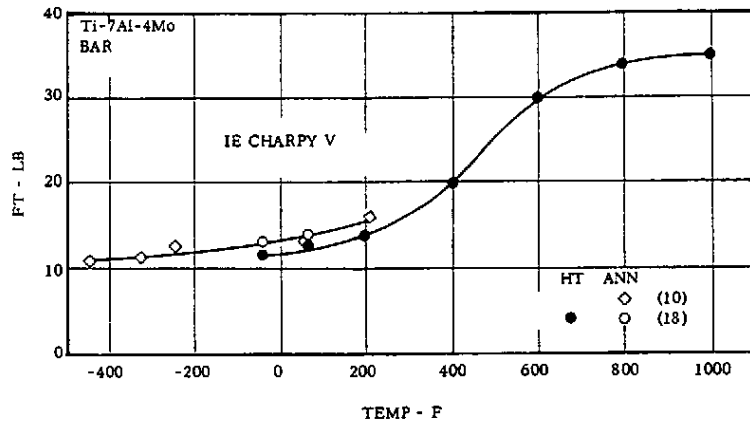


FIG. 3.0331 IMPACT PROPERTIES OF BAR AT SUBZERO AND ELEVATED TEMPERATURES (10, p. 13)(18, p. 4)

	Ti
7	Al
4	Mo

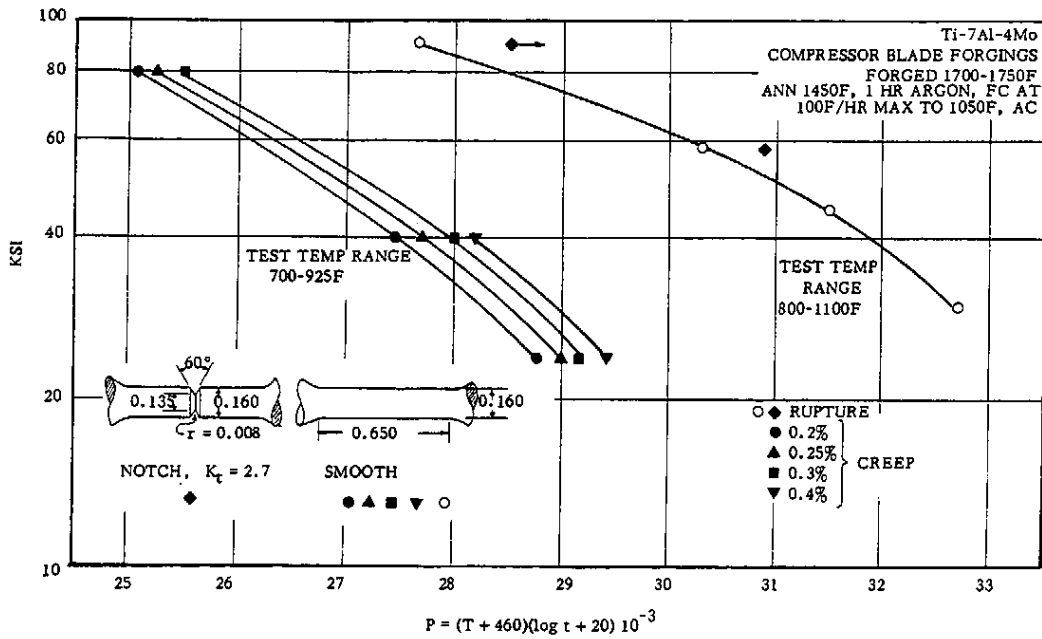


FIG. 3.0412 MASTER CURVES FOR CREEP AND CREEP RUPTURE OF ANNEALED COMPRESSOR BLADE FORGINGS

(6, p. c.1.11 and c.1.13)

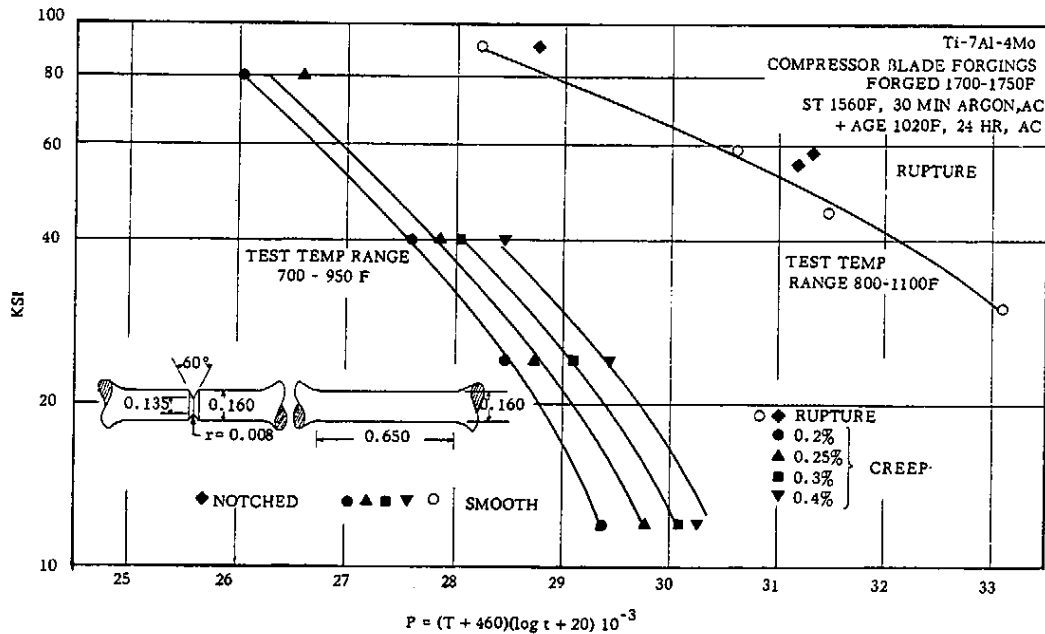


FIG. 3.0413 MASTER CURVE FOR CREEP AND CREEP RUPTURE OF AGED COMPRESSOR BLADE FORGINGS

(6, p. 6.1.12, c.L.14)

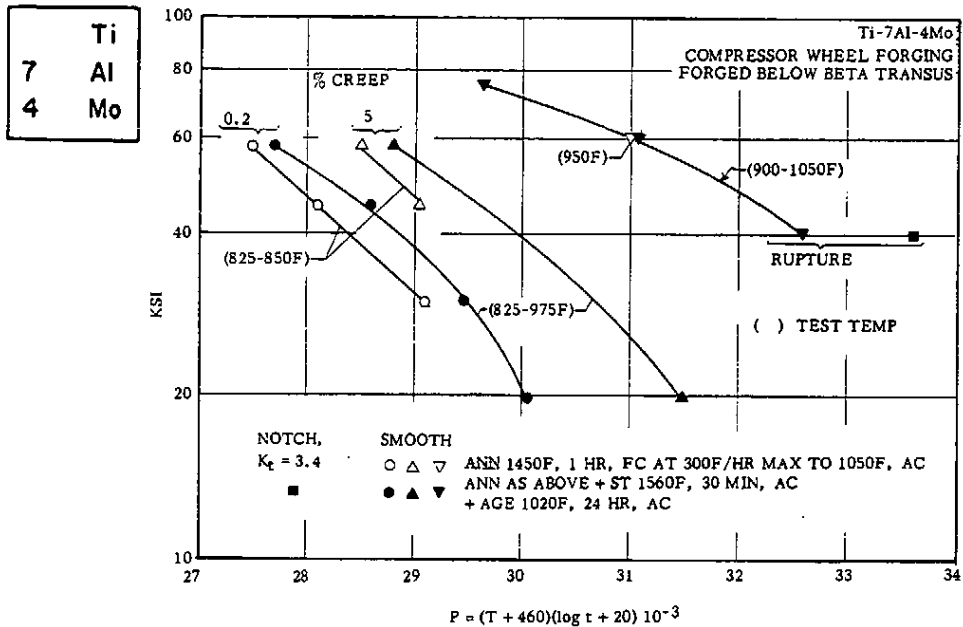


FIG. 3.0414 MASTER CURVES FOR CREEP AND CREEP RUPTURE OF ANNEALED AND AGED COMPRESSOR WHEEL FORGINGS (16, p. c. 2.11, c. 2.12, c. 2.19, c. 2.20)

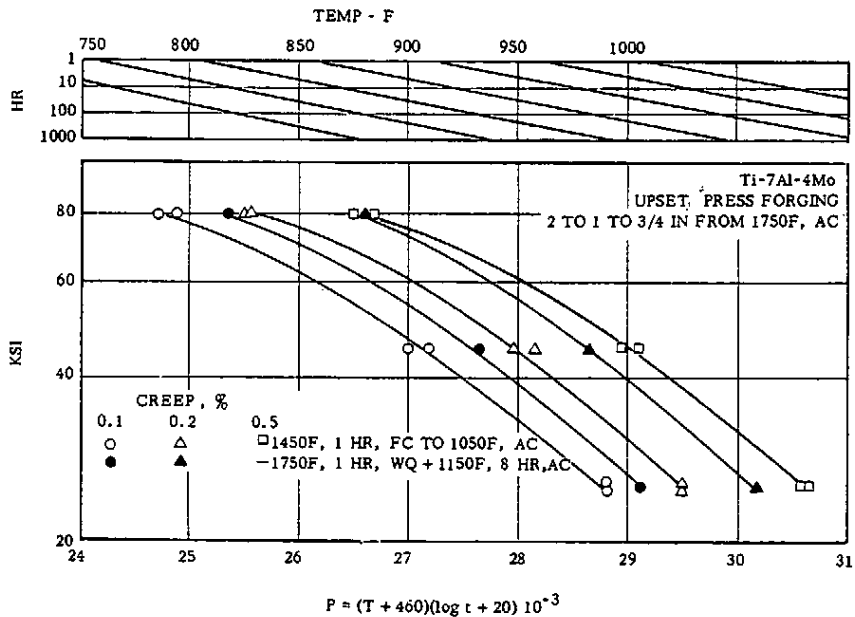


FIG. 3.0415 MASTER CURVES FOR CREEP IN UPSET FORGINGS

(14)

	Ti
7	Al
4	Mo

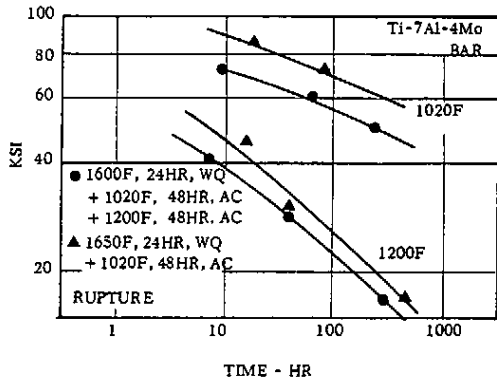


FIG. 3.0421 CREEP RUPTURE CURVES FOR BAR AT 1020 AND 1200F (15, p. 128)

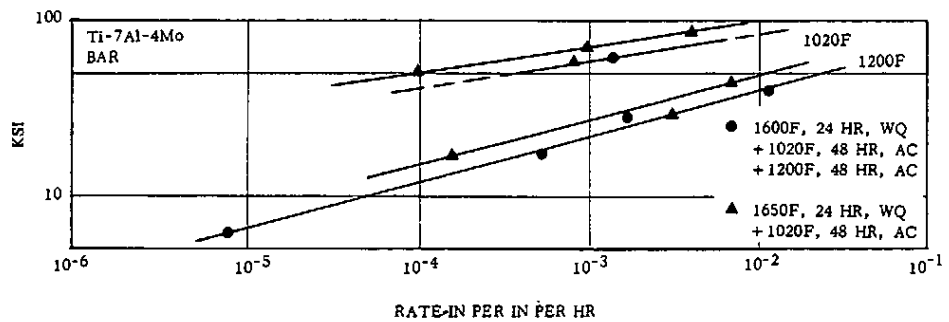


FIG. 3.0422 MINIMUM CREEP RATE CURVES FOR BAR AT 1020 AND 1200F

(15, p. 129)

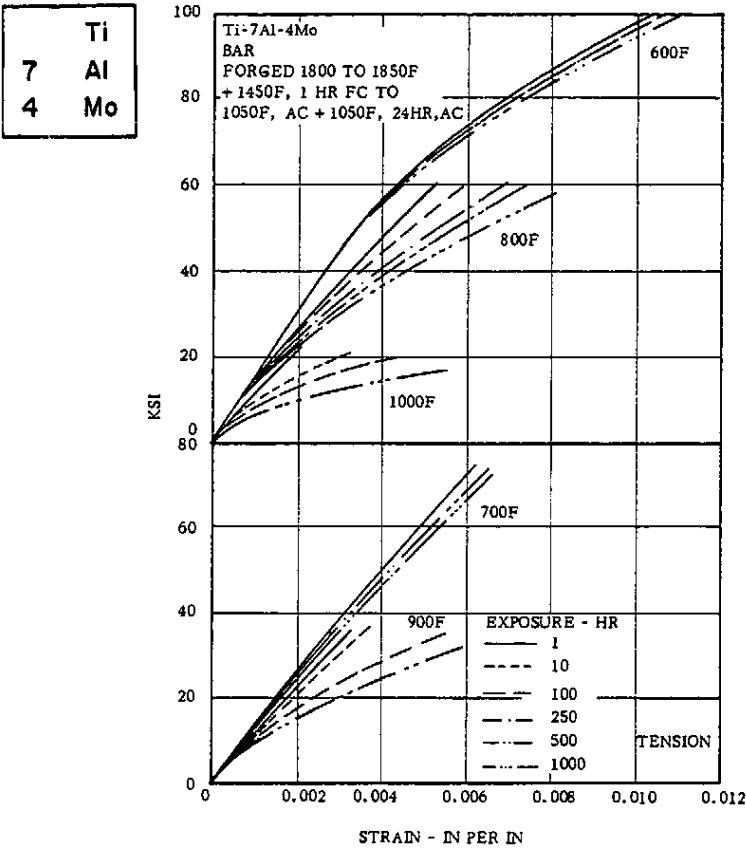


FIG. 3.0423 ISOCHRONOUS STRESS-STRAIN CURVES IN TENSION AT 600 TO 1000F FOR BAR (13, pp.10-14)

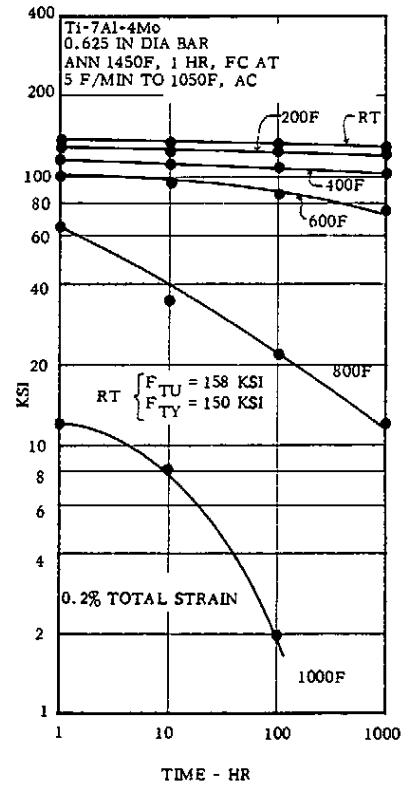
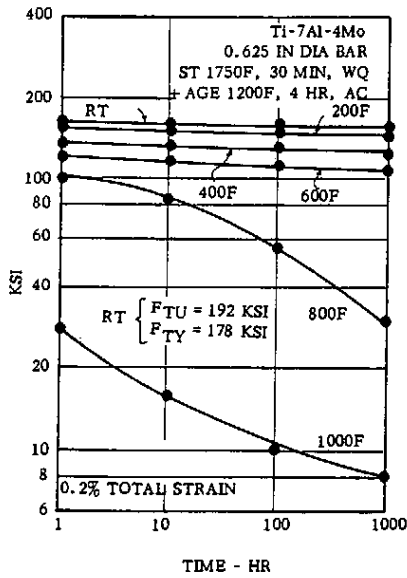


FIG. 3.0424 TOTAL STRAIN CURVES AT VARIOUS TEMPERATURES FOR ANNEALED BAR (10, p.8-9)



	Ti
7	Al
4	Mo

FIG. 3.0425 TOTAL STRAIN CURVES AT VARIOUS TEMPERATURES FOR SOLUTION TREATED AND AGED BAR (10, pp.8, 9)

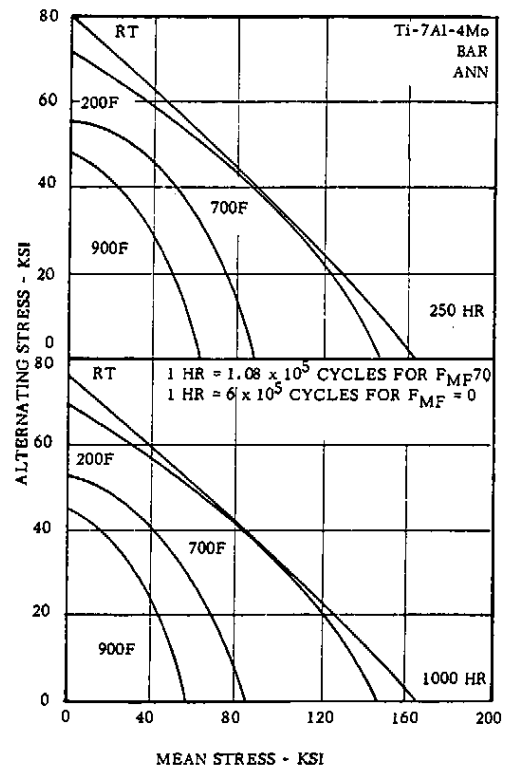


FIG. 3.052 STRESS RANGE DIAGRAMS FOR BAR AT ROOM TEMPERATURE TO 900F (11)

	Ti
7	Al
4	Mo

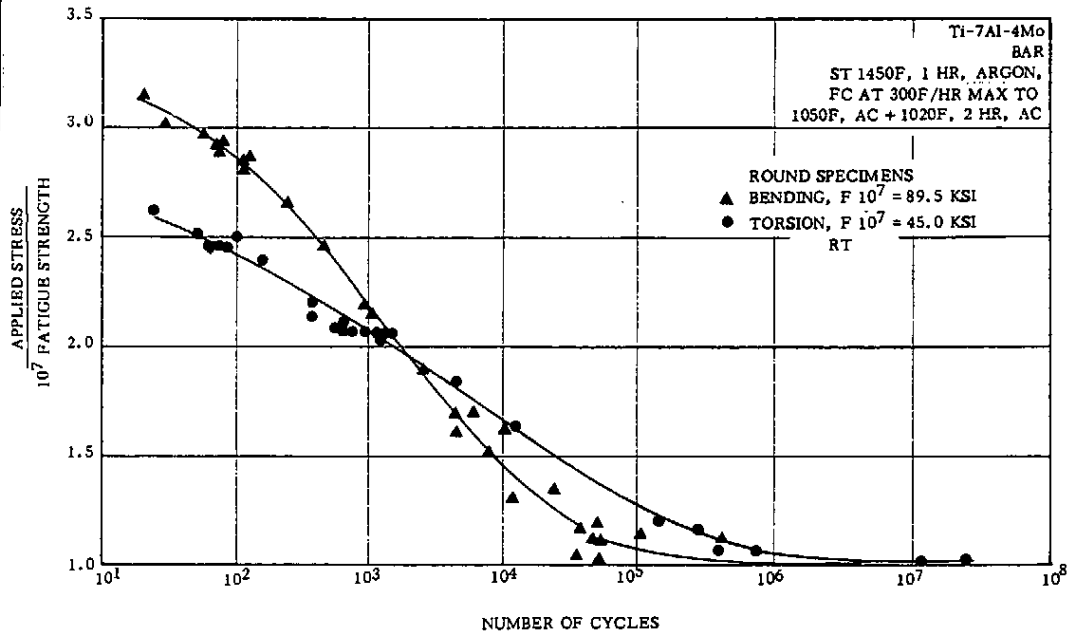


FIG. 3.053 OVERSTRESS RATIO VERSUS CYCLES TO FAILURE AT ROOM TEMPERATURE FOR BOTH BENDING AND TORSION (19)

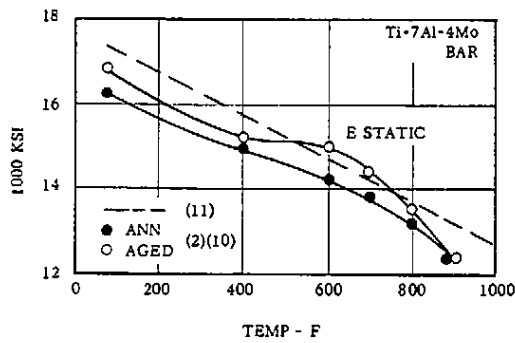


FIG. 3.0621 STATIC MODULUS OF ELASTICITY AT ROOM AND ELEVATED TEMPERATURES (2, p. 3)(10, p. 2)(11)

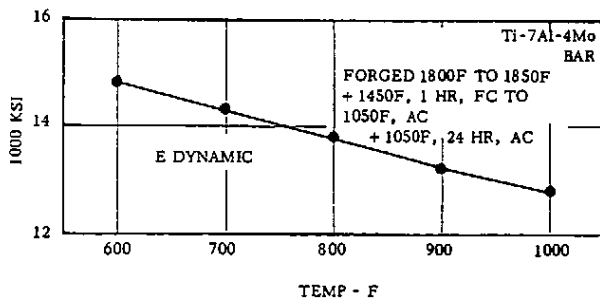


FIG. 3.0622 DYNAMIC MODULUS OF ELASTICITY AT ELEVATED TEMPERATURES (13, p. 10-14)

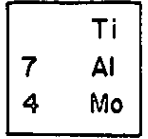
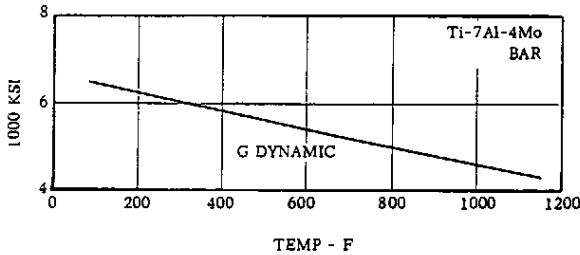


FIG. 3.0631 MODULUS OF RIGIDITY AT ROOM AND ELEVATED TEMPERATURES (11)

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