

1 GENERAL
 This alloy is one of a series of age hardening steels which combines high strength, at temperatures up to 800 F and higher, with the corrosion resistance of stainless steels. In the annealed condition the alloy is austenitic. Upon forming at room temperature the alloy work hardens very rapidly because of martensite formation during working. Formation of martensite can be avoided by working at temperatures of about 300 F or higher, in which case the alloy forms in much the same manner as conventional austenitic stainless steels. AM-355 is a companion alloy to AM-350 differing from it by a slightly lower chromium content and a higher amount of carbon. Although designed primarily to meet the demand for heavier sections including plate, bar, and forgings, it is also available in sheet form which is the principal field for AM-350. While the compositions of the two alloys are very similar, the small differences account for significant changes in structure. For example, the AM-350 has 5 to 20 percent delta ferrite; AM-355 usually has little or none.

1.01 **Commercial Designation**
 AM-355.

1.02 **Alternate Designations**
 None.

1.03 **Specifications**
 1.031 AMS Specifications, Table 1.031.

1.04 **Composition**
 1.041 Composition of cast and wrought forms, Table 1.041.

1.05 **Heat Treatment**
 1.051 AM-355 in bar or billet form can be supplied by the producers in several heat treated conditions for specific purposes. The subsequent final heat treatments made by the user in order to attain desirable mechanical properties, machinability, or resistance to stress corrosion have to correspond to a specific mill heat treatment. The relationships between the mill heat treatments and the final treatments applied by the users are shown in Table 1.0514.

1.0512 Sheet, strip, and tubing are supplied in the annealed condition: 1850 to 1900 F, 3/4 hr minimum per inch of thickness, rapid air cool.

1.0513 Plate is supplied in Condition H for maximum structural stability and formability. If not subsequently severely cold formed, it should be equalized before annealed to Condition L and aged to Condition SCT.

1.0514 Mill supplied conditions and user heat treatments for all forms according to alloy producer, Table 1.0514.

1.0515 AMS specified heat treatments for bars, forgings, plate, sheet, and strip, Table 1.0515.

1.052 Heat treatment of castings.

1.0521 Homogenize sand castings at 2000 F, 2 to 4 hours (investment castings at 1900 F, 1 hour) air cool up to 1 inch thickness, oil or water quench sections above 1 inch. For optimum structure and maximum corrosion resistance, subzero cool for 3 hours at -100 F.

1.0522 Equalize for improved machinability after homogenization and subzero cooling treatment. 1375 to 1475 F, 3 hours, air cool to 80 F maximum plus 1000 to 1150 F, 3 hours, air cool.

1.0523 Condition anneal 1750 to 1850 F, 1 hour per inch thickness, water quench plus subzero cool (-100 F) 3 hours.

1.0524 Age to Condition SCT. Same as wrought products, see 1.051.

1.0525 AMS specified heat treatments for sand and investment castings, Table 1.0525.

1.053 Subzero cool and age Condition L to Condition SCT. Cool to -100 F, hold 3 hr minimum plus 850 to 1050 F, 3 hr minimum. Effect of aging temperature on tensile properties of various forms, Figure 1.053.

1.06 **Hardness**
 1.061 Effect of test temperature on Brinell hardness of alloy in Condition SCT, Figure 1.061.

1.062 Alloy hardens fully in large section sizes after heat treating to Condition SCT.

1.07 **Forms and Condition Available**
 AM-355 is available as forging, billet, and bar heat treated as shown in Table 1.0514. It is also available in other forms. Sheet and strip are available in Condition H or in the cold rolled temper (CRT).

1.08 **Melting Practice**
 Electric arc furnace melt followed by argon-oxygen-decarburizing (AOD). Consumable electrode remelt or electroslag remelt are used for billet and bar products and are optional for sheet products.

1.09 **Special Considerations**
 1.091 Heating to temperatures above those specified for Condition H should be avoided because of grain coarsening and less of a response to hardening.

1.092 Dimensional changes on heat treating require special consideration.

1.093 AM-355, when hardened by the carbide solution subzero treatment (see 1.055), has stress corrosion resistance superior to that of AM-350 in the SCT (850) Condition and comparable to that of AM-350 in the SCT (1000) Condition.

2 PHYSICAL AND CHEMICAL PROPERTIES

2.01 **Thermal Properties**
 2.011 Melting range. 2500 to 2550 F.
 2.012 Phase changes. Transformation temperatures. On cooling from 1710 F the M_s point is about 250 F and the M_f point is slightly below room temperature on rapid cooling. On cooling from 1375 F the M_s point is between 700 and 400 F and the martensite transformation is complete at room temperature.

2.013 Thermal conductivity, Figure 2.013.

2.014 Thermal expansion, Figure 2.014.

2.015 Specific heat, 0.12 Btu per lb F.

2.016 Dimensional changes. Equalized and aged material to Condition SCT, about 0.0015 inch per inch growth. Condition CRT to Condition SCT, about 0.00275 inch per inch growth (8).

Fe
15.5 Cr
4.5 Ni
3 Mo

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Fe 15.5 Cr 4.5 Ni 3 Mo	2.02	<u>Other Physical Properties</u>	3.0212	Effect of percent cold roll on tensile and compressive properties of sheet in CRT Condition, Figure 3.0212.
	2.021	Density, Table 2.021.		
	2.022	Electrical resistivity of alloy in Condition SCT 850, Figure 2.022.	3.0213	Typical tensile properties of alloy for various heat treated conditions, Table 3.0213.
	2.023	Magnetic properties, Table 2.023.	3.0214	Effect of consumable electrode melting on transverse properties of bar, Table 3.0214.
	2.024	Emittance.		
	2.025	Damping capacity.	3.0215	Effect of exposure to elevated temperatures on tensile properties of bar in Conditions SCT 850 and SCT 1000, Figure 3.0215.
AM-355	2.03	<u>Chemical Environments</u>		
	2.031	<u>Corrosion resistance.</u>		
	2.0311	General corrosion resistance of this alloy is between that of Type 410 and Type 302.	3.0216	Effect of exposure to elevated temperatures under load on tensile properties of sheet in Condition SCT 850, Table 3.0216.
	2.0312	The alloy appears to be relatively free from intergranular corrosion in the SCT (1000) Condition.	3.0217	Effect of percent cold roll on tensile properties of alloy in Condition CRT, Figure 3.0217.
	2.0313	This alloy has been shown to be susceptible to hydrogen embrittlement under laboratory conditions when heat treated to 180 ksi ultimate tensile strength. Therefore, the alloy should be considered to be sensitive to hydrogen embrittlement (41). Testing in high-pressure (10,000 psi) hydrogen has shown degradation in mechanical properties for some stainless steels (42). Therefore, the possibility of loss in mechanical properties should be considered when using this alloy in contact with high pressure hydrogen.	3.0218	Effect of annealing temperature and percent cold roll on longitudinal and transverse properties of CRT alloy, Figure 3.0218.
	2.032	Oxidation resistance up to 850 F and higher is comparable to that of austenitic stainless steels.	3.022	Compression. See 3.032 and 3.0212.
	2.033	Stress corrosion resistance. The SCT (850) Condition should not be used when stress corrosion resistance is important. The SCT (1000) Condition has improved but erratic resistance to stress corrosion which varies with the metallurgical structure of the material. If the material contains continuous intergranular precipitated carbides, intergranular stress corrosion failures may occur. If the structure is free from intergranular carbides, the material has excellent resistance to stress corrosion when tempered at 1000 F. Consumable electrode melted material should be hardened by using the carbide solution subzero treatment (see 1.055) which will consistently produce a homogenous structure free of continuous intergranular carbides. When hardened by this heat treatment, all AM-355 wrought products, welds, and castings have excellent resistance to stress corrosion. This has been demonstrated by stress corrosion tests on all of these products, stressed to 90 percent of F_{Ty} and exposed for more than 300 days in salt spray without cracking (35).	3.023	Impact. (See also 3.033.) Effect of exposure time and temperature on impact energy measured at room temperature for bar in SCT Condition, Figure 3.023.
	2.034		3.024	Bending. Relationship between tensile yield strength and transverse bend factor, Figure 3.024.
			3.025	Torsion and shear. See 3.035.
			3.026	Bearing. See 3.036.
			3.027	Stress concentration.
			3.0271	Notch properties.
			3.02711	Effect of tempering temperature on smooth and notched bar tensile properties for alloy in Condition SCT, Figure 3.02711.
			3.02712	Effect of annealing temperature and percent cold roll on longitudinal and transverse notch strength and notch strength ratio of CRT alloy, Figure 3.02712.
			3.02713	Effect of rate of loading on calculated stress intensity factor at failure for CRT alloy tested at room temperature in longitudinal direction, Figure 3.02713.
			3.0272	Fracture toughness.
			3.028	Combined properties.
			3.03	<u>Mechanical Properties at Various Temperatures</u>
			3.031	<u>Tension.</u>
			3.0311	Stress-strain curves in tension at room and elevated temperatures for sheet in CRT Condition, Figure 3.0311.
			3.0312	Stress-strain curves in tension at room and elevated temperatures for sheet in SCCRT Condition, Figure 3.0312.
			3.0313	Stress-strain curves in tension at room and elevated temperatures for sheet in Condition XH, Figure 3.0313.
			3.0314	Effect of test temperature on tensile properties of sheet in Condition SCT 850, Figure 3.0314.
			3.0315	Effect of test temperature on tensile properties of bar and forged disks in Conditions SCT 850 and SCT 1000, Figure 3.0315.
			3.0316	Effect of test temperature on tensile properties of bar in Condition SCT 850, Figure 3.0316.
			3.0317	Effect of exposure time and temperature on tensile properties of bar in SCT 850 Condition, Figure 3.0317.
			3.0318	Effect of test temperature and test direction on tensile properties of sheet in Condition CRT, Figure 3.0318.
	2.04	<u>Nuclear Environments</u>		
	3	<u>MECHANICAL PROPERTIES</u>		
	3.01	<u>Specified Mechanical Properties</u>		
	3.011	AMS specified mechanical properties for sand and investment castings, Table 3.011.	3.0315	Effect of test temperature on tensile properties of bar and forged disks in Conditions SCT 850 and SCT 1000, Figure 3.0315.
	3.012	AMS specified mechanical properties for bars, forgings, plate, sheet, and strip, Table 3.012.	3.0316	Effect of test temperature on tensile properties of bar in Condition SCT 850, Figure 3.0316.
	3.013	Producer's guaranteed mechanical properties, Table 3.013.	3.0317	Effect of exposure time and temperature on tensile properties of bar in SCT 850 Condition, Figure 3.0317.
	3.02	<u>Mechanical Properties at Room Temperature</u>		
	3.021	<u>Tension.</u>	3.0318	Effect of test temperature and test direction on tensile properties of sheet in Condition CRT, Figure 3.0318.
	3.0211	Stress-strain diagrams, see 3.0311.		

Fe
15.5 Cr
4.5 Ni
3 Mo

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- 3.0319 Effect of test temperature and test direction on tensile properties of sheet in SCCRT Condition, Figure 3.0319.
- 3.03110 Effect of test temperature on transverse tensile properties of sheet in Condition XH, Figure 3.03110.
- 3.03111 Effect of test temperature and tempering temperature on tensile properties of sand cast keel blocks. Figure 3.03111.
- 3.032 Compression.
- 3.0321 Stress-strain curves in compression at room and elevated temperatures for sheet in CRT Condition, Figure 3.0321.
- 3.0322 Stress-strain curves in compression at room and elevated temperatures in SCCRT Condition, Figure 3.0322.
- 3.0323 Effect of test temperature and test direction on compressive yield strength of sheet in Conditions SCT, CRT, and SCCRT, Figure 3.0323.
- 3.033 Impact.
- 3.0331 Effect of test temperature on impact strength for bar in SCT Conditions, Figure 3.0331.
- 3.0332 Effect of test temperature on impact strength for bar in various SCT Conditions, Figure 3.0332.
- 3.0333 The effect of special heat treatments on the impact strength in the longitudinal and transverse direction, Figure 3.0333.
- 3.0333 Bending.
- 3.034 Torsion and shear.
- 3.035 Effect of test and exposure temperature on shear strength of sheet and bar in SCT 850 Condition, Figure 3.0351.
- 3.0352 Effect of test temperature on stress intensity factor at failure in tear test of CRT alloy in longitudinal and transverse direction, Figure 3.0352.
- 3.036 Bearing.
- 3.0361 Effect of test temperature on bearing properties of sheet in SCT Condition, Figure 3.0361.
- 3.037 Stress concentration.
- 3.0371 Effect of test temperature on notch strength of bar in Condition SCT 850, Figure 3.0371.
- 3.0372 Fracture toughness of plate for various age Conditions, Figure 3.0372.
- 3.038 Combined properties.

- 3.04 **Creep and Creep Rupture Properties**
- 3.041 General.
- 3.042 Creep-rupture properties.
- 3.0421 Creep-rupture curves for sheet in various Conditions, Figure 3.0421.
- 3.0422 Creep-rupture curves for bar and castings in various Conditions, Figure 3.0422.
- 3.043 Creep deformation.
- 3.0431 Effect of stress on creep rate at 600 and 800 F for sheet in Condition SCT 850, Figure 3.0431.
- 3.0432 Total creep data at 700 and 800 F for alloy in Condition CRT, Figure 3.0432.
- 3.0433 Effect of temperature on stress to produce creep rate of 1 percent per 100,000 hours, Figure 3.0433.
- 3.0434 Isochronous stress-strain curves at 600 to 800 F for sheet in Condition SCT 850, Figure 3.0434.

- 3.05 **Fatigue Properties**
- 3.051 Fatigue properties of bar and sheet in SCT

- 3.052 Conditions, Table 3.051.
- 3.052 Reversed bending fatigue curve for bar in Condition SCT 850, Figure 3.052.
- 3.053 Fatigue strength at 10⁸ cycles for SCT 850 and SCT 1000 F Conditions, Table 3.053.
- 3.054 Combined stress diagram for AM-355 SCT (1000 F), Figure 3.054.

- 3.06 **Elastic Properties**
- 3.061 Poisson's ratio.
- 3.062 Modulus of elasticity.
- 3.0621 Modulus of elasticity for bar in Condition SCT 850 at room and elevated temperatures, Figure 3.0621.
- 3.0622 Effect of test temperature on tensile and compressive elastic modulus of alloy in Condition SCT, Figure 3.0622.
- 3.0623 Modulus of elasticity for sheet in CRT Condition at room and elevated temperatures, Figure 3.0623.
- 3.0624 Modulus of elasticity for sheet in Condition SCCRT at room and elevated temperatures, Figure 3.0624.
- 3.063 Modulus of rigidity for bar in Condition SCT 850 at room and elevated temperatures, Figure 3.063.
- 3.064 Tangent modulus.
- 3.0641 Tangent modulus in compression at 600 F for exposure times from 1/2 hour to 1000 hours for bar stock in Condition SCT 850, Figure 3.0641.
- 3.0642 Tangent modulus in compression at 800 F for exposure times from 1/2 hour to 1000 hours for bar stock in Condition SCT 850, Figure 3.0642.
- 3.0643 Tangent modulus in compression at 900 F for exposure times from 1/2 hour to 1000 hours for bar stock in Condition SCT 850, Figure 3.0643.
- 3.0644 Tangent modulus in compression at 1000 F for exposure times from 1/2 hour to 1000 hours for bar stock in Condition SCT 850, Figure 3.0644.

- 4 **FABRICATION**
- Sec AM-350 also. Only different and complementary information given below.

- 4.01 **Forming**
- Upon forming at room temperature the alloy work hardens very rapidly because of martensite formation during working. The formation of martensite can be avoided by working at about 300 F or higher. Using this procedure, the alloy forms in a manner similar to the austenitic stainless steels.

- 4.02 **Machining and Grinding**

- 4.03 **Welding**
- 4.031 Bar, plate, and forgings in all Conditions are normally fusion welded with the addition of filler rod. The alloy remains ductile during cooling although its structure changes from austenite to one containing about 5 percent ferrite. Any austenitic steel filler rod or electrode may be used unless high strength in the joint is required. Welds heat treated to

Fe
15.5 Cr
4.5 Ni
3 Mo

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- Condition SCT approaching 100 percent efficiency can be obtained with AM-355 welding wire or coated electrodes. Alloy is highly resistant to weld cracking. Consequently preheating, control of interpass temperature, and postheating are not required. A specially compounded submerged arc welding flux (Arcosite S-12) can be used with AM-355 wire to deposit AM-355 weld metal. The carbide solution sub-zero treatment is fully applicable to welded AM-355.
- 4.032 Fusion welding of sheet in Conditions CRT and SCCRT destroys the effects of cold rolling in any section heated above 900 F.
- 4.033 Resistance welding of sheet is possible in all conditions.
- 4.034 Typical weldment and weld metal properties for various methods, Table 4.034.
- 4.04 Heat Transfer
- 4.05 Surface Treatment
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- 4 AMS 5549D (Apr. 1, 1981)
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AMS	Form	Condition
5359B	Sand Castings	Solution Treated
5368A	Investment Castings	Solution Treated
5743E	Bars and Forgings	Solution Treated Equalized and Overtempered
5744B	Bars and Forgings	Heat Treated to F _{tu} = 170 ksi Solution Treated
5549D	Plate	
5547D	Sheet and Strip	
5780A	Welding Wire	
5781A	Covered Electrodes	

Fe
15.5 Cr
4.5 Ni
3 Mo

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TABLE 1.031. AMS SPECIFICATIONS

Source Form	AMS					
	Castings (1) (2)		Bar. Forgings, Plate, Sheet, and Strip (3) (4) (5)		Welding Wire and Covered Electrodes (6) (7)	
	Min	Max	Min	Max	Min	Max
C	0.08	0.15	0.10	0.15	0.010	0.15
Mn	0.040	1.10	0.50	1.25	0.50	1.25
Si	-	0.75	-	0.05	-	0.50
P	-	0.04	-	0.040	-	0.040
S	-	0.03	-	0.030	-	0.030
Cr	14.5	15.5	15.00	16.00	15.00	16.00
Ni	3.5	4.5	4.00	5.00	4.00	5.00
Mo	2.0	2.6	2.50	3.25	2.50	3.25
N	0.05	0.13	0.07	0.13	0.07	0.13
C and Ni	0.15	0.25	-	-	-	-
Cu	-	-	-	-	-	0.050
Fe	Balance		Balance		Balance	

TABLE 1.041. COMPOSITION OF CAST AND WROUGHT PRODUCTS

Alloy	Fe-15.5Cr-4.5Ni-3Mo		
Form	All		
Mill Supplied Conditions	Heat Treatment by Mill		Purpose
Equalized and overtempered E + OT	2-4 hr at 1425 ± 50°, oil or water quench or air cool to 50 F max plus 2-4 hr at 1075 F ± 25°, air cooled		Preparation for machining
Carbide solutioned, equalized and overtempered S + (E+OT)	1-3 hr at 1900 F ± 25°, water quenched* plus 3 hr at -100 F plus equalized and overtempered		Preparation for machining with optimum microstructure for stress corrosion resistance when followed by subsequent L anneal plus SCT
Fully hardened SCT (1000 F) FH	1-3 hr at 1900 F ± 25°, water quenched* plus 3 hr at -100 F plus L anneal plus SCT (1000 F)		Heat treatment by user not required. Material has good machinability and optimum microstructure for stress corrosion resistance
H	Solution treated at 1950 F and water quenched		Preparation for reforging by user
Mill Supplied Condition Prior to User Heat Treatment	Condition Through User Treatment	Heat Treatment by User	Purpose
Any	L	1675-1775 F, rapid air cool or water quench	Preparation for hardening
Any	L + SCT	L plus subzero cool 3 hr at -100 F and temper for 3 hr at 850 or 1000 F	Hardening for highest strength 850 F, or highest toughness (1000 F)
E + OT	Carbide solution hardening treatment	1-3 hr at 1900 F ± 25°, water quenched* plus 3 hr at -100 F plus L anneal plus SCT (1000 F)	Hardened for optimum microstructure and best resistance to stress corrosion
Carbide Solutioned E + OT Carbide Solutioned, + L + SCT (1000 F)	Carbide solution hardening treatment + SCT	L plus SCT (1000 F)	Hardened for optimum microstructure and resistance to stress corrosion
H		None Following user fabrication stress relieving treatment up to 1000 F maximum may be employed	Hardened for good machinability, high toughness and optimum microstructure for stress corrosion resistance
Forging should be controlled to finish working at a low temperature to produce fine grain size. Following forging, carbide solution hardening treatment is recommended. However, the L + SCT treatment may be used without prior carbide solutioning treatment if a microstructure free of grain boundary carbides is not essential.			

*A minimum cooling rate of 100° per minute to 1200 F must be used to avoid precipitation of grain boundary carbides.

TABLE 1.0514. MILL SUPPLIED CONDITIONS AND USER HEAT TREATMENTS FOR ALL FORMS ACCORDING TO ALLOY PRODUCER (37)

Fe
15.5 Cr
4.5 Ni
3 Mo
AM-355

Form Condition	Bars and Forgings		Plate	Sheet and Strip
	Solution Treat	Equalize and Overtemper	Solution Treat	Solution Treat
	1875-1925 F. 1 to 3 hr. WQ	ST + 1375 to 1475 F. 3 hr AC (< 80 F) + 1050 to 1100 F. 3 hr AC	1875-1925 F. 1 to 3 hr. WQ	1875-1925 F. 3/4 hr. WQ
Condition		1000 SCT ST + 1725 to 1775 F. 10 to 60 min. WQ + 3 hr at -100 F. Air Warm + 975 to 1025 F. 3 hr AC	1000 SCT ST + 2 hr at -100 F. Air Warm + 1725 to 1775 F. 10 to 60 min. WQ + 3 hr at -100 F. Air Warm + 975 to 1025 F. 3 hr AC	1000 SCT See Plate

TABLE 1.0515. AMS SPECIFIED HEAT TREATMENTS FOR BARS, FORGINGS, PLATE, SHEET, AND STRIP (3) (4) (5)

Form Condition	Sand Castings (2)(a)	Investment Castings (2)
	Solution Treat	Solution Treat
	1950-2050 F. 1 hr AC for Sections < 1 in., WQ or OQ for Sections > 1 in.	1850-1975 F. 1 hr. AC for Sections < 1 in., WQ or OQ for Sections > 1 in.
Condition	Equalize or overtemper ST + 1350 F to 1450 F. 3 hr min., AC + 1025 to 1075 F. 3 hr AC	850 SCT ST 1750 to 1825 F. 1 hr. WQ + 3 hr at -100 F. Air Warm 825 to 875 F. 3 hr AC
Condition	1000 SCT ST + 1725 to 1850 F. 1 hr. WQ + 3 hr at -100 F. Air Warm + 975 to 1025 F. 3 hr AC	

(a) Separately cast specimens or specimens cut from castings.

TABLE 1.0525. AMS SPECIFIED HEAT TREATMENTS FOR SAND AND INVESTMENT CASTINGS (1) (2)

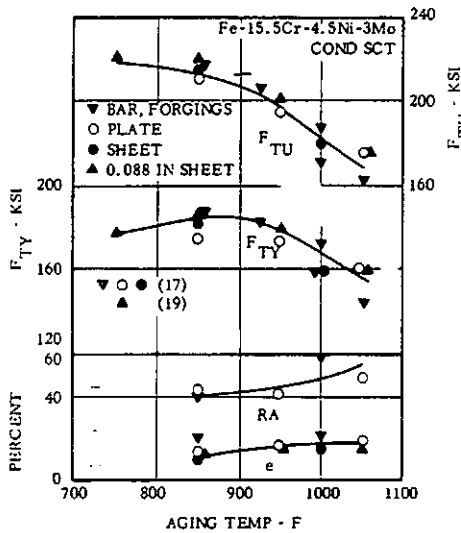


FIG. 1.053. EFFECT OF AGING TEMPERATURE ON TENSILE PROPERTIES OF VARIOUS FORMS (17) (19)

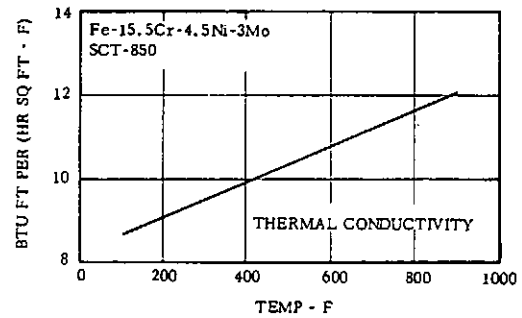


FIG. 2.013 THERMAL CONDUCTIVITY (20, p. 12)

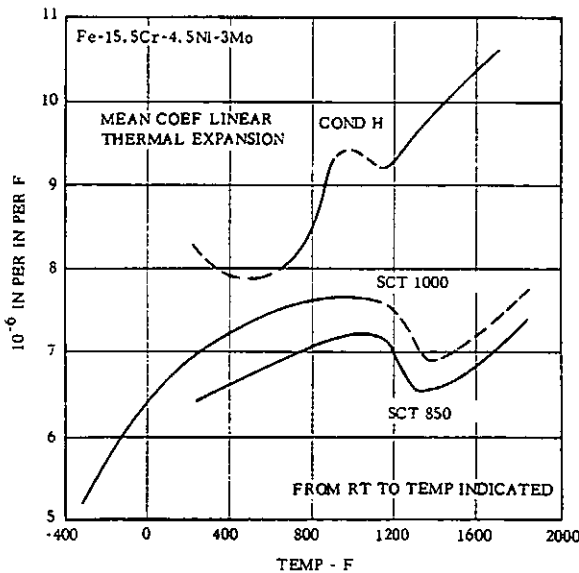


FIG. 2.014 THERMAL EXPANSION (21)

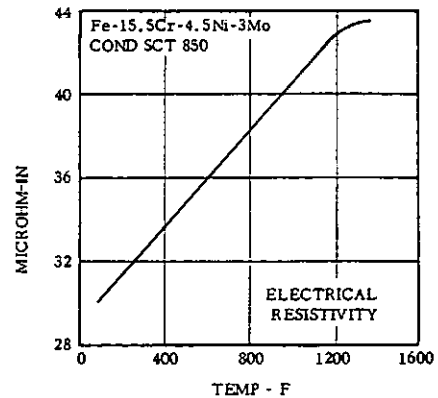


FIG. 2.022 ELECTRICAL RESISTIVITY OF ALLOY IN CONDITION SCT 850 (14)

Condition	Density	
	lb per cu in	gr per cu cm
H (1875F)	0.286	7.91
Equalized and aged	0.283	7.82
SCT 850	0.281	7.79
CRT	0.284	7.86
SCCRT	0.2805	7.76

TABLE 2.021 DENSITY (8)

Condition	SCT 850	SCT 1000
Max permeability	87	150
Induction at 200 oersteds	9660	11508

TABLE 2.023 MAGNETIC PROPERTIES

Fe
15.5 Cr
4.5 Ni
3 Mo

AM-355

Source	AMS 5368(1)	AMS 5359(2)
Form	Sand Castings	Investment Castings
Condition	SCT (1000)	SCT (850)
F _{tu} , Min. ksi	165	200
F _{ty} , Min. ksi	140	150
Elongation, 4D, Min. percent	8	8(a)
Hardness, RC, Min	37	40

(a) Elongation in 1 inch or 4D.

TABLE 3.011 AMS SPECIFIED MECHANICAL PROPERTIES FOR AM-355 SAND AND INVESTMENT CASTINGS

Source	AMS 5743(3)	AMS 5749(4)	AMS 5747(5)
Form	Bars and Forgings	Plate	Sheet and Strip
Condition	SCT (1000)	SCT (1000)	SCT (1000)
F _{tu} , Min. ksi	170	165	165
F _{ty} , 0.2% offset, Min. ksi	155	140	140
Elongation, 2 in. or 4D, Min. percent	12	12	10(a)
Reduction in Area, Min. percent	25	-	-
Hardness, RC	37-44(b)	37-44(b)	37 (Min)

(a) Up to 0.010 inch thick inclusive, the elongation is not specified but is "as agreed upon". The elongation for sheet and strip over 0.010 to 0.1875 inch thick exclusive, is 10 percent minimum.
 (b) Not to be rejected on hardness requirement if the tensile properties meet specification.

TABLE 3.012 AMS SPECIFIED MECHANICAL PROPERTIES FOR AM-355 BARS, FORGINGS, PLATE, SHEET, AND STRIP

Alloy		Fe-15.5Cr-4.5Ni-3Mo						
Form		Sheet, strip**		Plate		Bar, forgings		Castings Sand, Investment
		H	SCT(850)	H	SCT(1000)	SCT(850)	SCT(1000)	SCT(850)
Melt		-		Cons. elect		Cons. electrode		-
Condition		H	SCT(850)	H	SCT(1000)	SCT(850)	SCT(1000)	SCT(850)
F _{tu}	min-ksi L	-	190	-	170	200	170	200
	T	-	190	-	170	200	170	-
F _{ty}	min-ksi L	-	165	-	155	165	155	150
	T	-	165	-	155	165	155	-
e.	min-percent L	-	-	-	12	10	12	8
	T	-	-	-	12	5	-	-
RA.	min-percent L	-	-	-	-	20	25	-
	T	-	-	-	-	5	-	-
Hardness, RC	min	-	43	-	37	40	37	40
	max	35	53	35	43	50	44	-

* Depends on thickness

** Commercial to 0.010 in thickness, experimental to 0.1875 in thickness.

TABLE 3.013 PRODUCER'S GUARANTEED MECHANICAL PROPERTIES (17)

Fe
15.5 Cr
4.5 Ni
3 Mo

AM-355

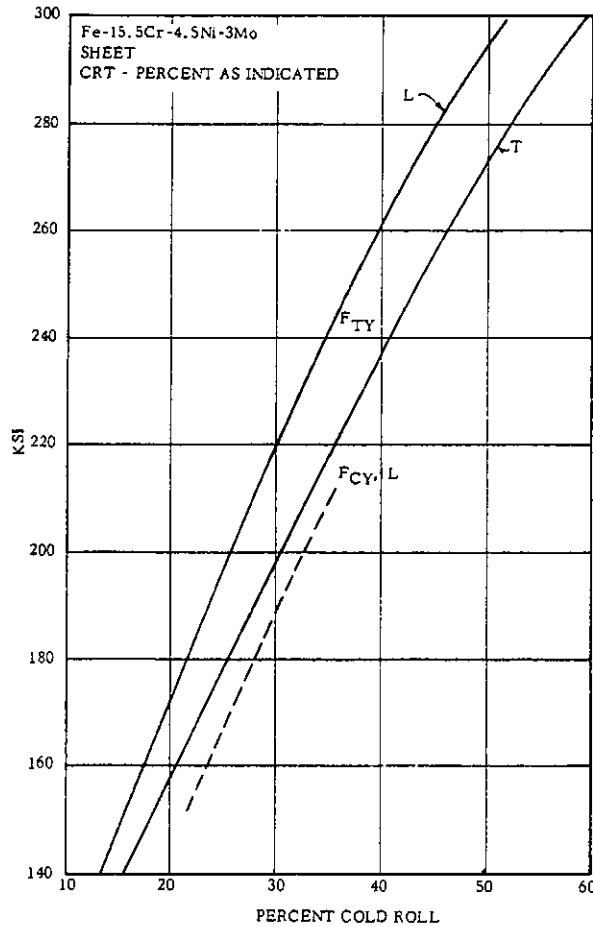


FIG. 3.0212 EFFECT OF PERCENT COLD ROLL ON TENSILE AND COMPRESSIVE PROPERTIES OF SHEET IN CRT CONDITION (30)

Form	Sheet		Plate			Bar		Cast		
	T	SCT	Avg L, T			Forgings		Test Bars		
Condition	H	850	1000	H	850	1000	850	1000	850	1000
F _{TU} -ksi	186	219	178	160	210	180	216	186	218	175
F _{TY} -ksi	55	181	160	57	174	170	182	171	173	159
e(2in) -percent	29.5	13	13	26	14	17	19	19	16	14
RA -percent	-	-	-	-	40	50	38.5	57	35	40

TABLE 3.0213 TYPICAL TENSILE PROPERTIES OF ALLOY FOR VARIOUS HEAT TREATED CONDITIONS (17)

Form	4 to 10 in sq bar		
	SCT 850		
Condition	Air	Cons. El.	Cons. El.
Melt			
F _{TU} -ksi T	208	220	185
F _{TY} -ksi T	168.5	185	169
RA -percent T	7.6	20.5	39.5
e(2in) -percent T	5.3	11.5	14.8
No. of tests*	14	40	40
No. of heats	2	18	25

* Specimens taken from center

TABLE 3.0214 EFFECT OF CONSUMABLE ELECTRODE MELTING ON TRANSVERSE PROPERTIES OF BAR (17)

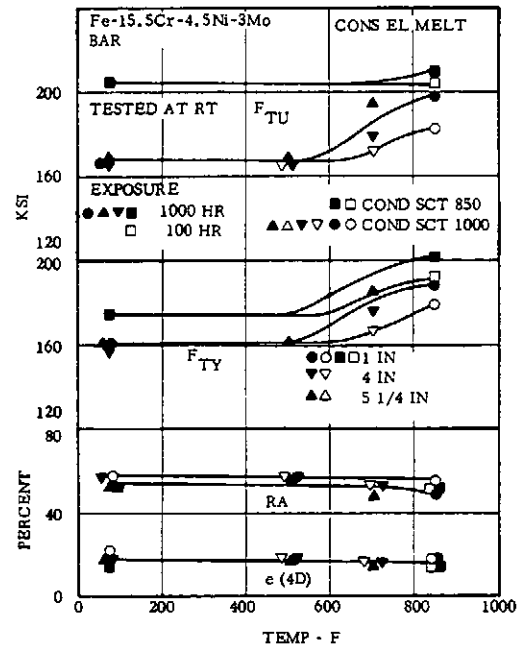


FIG. 3.0215 EFFECT OF EXPOSURE TO ELEVATED TEMPERATURES ON TENSILE PROPERTIES OF BAR IN CONDITIONS SCT 850 AND SCT 1000 (17)

Form	0.050 in sheet						
Condition	SCT 850						
Exposure Temp-F	RT	600		700		800	
Exposure Load-ksi	-	66	148, 5	64, 6	145, 4	62, 1	139, 8
Property	-	Change from RT value, in 1000 hr					
		Tested at RT					
F _{TU} , -ksi	211.4	+ 2	+ 2	+ 6	+ 7	+16	+16
F _{TY} , -ksi	169.4	+10	+31	+ 8	+48	+30.5	+51
e(2in), -percent	11.5	+0.5	- 4	- 1	- 6	+ 1	-2.5

TABLE 3.0216 EFFECT OF EXPOSURE TO ELEVATED TEMPERATURES UNDER LOAD ON TENSILE PROPERTIES OF SHEET IN CONDITION SCT 850 (17)

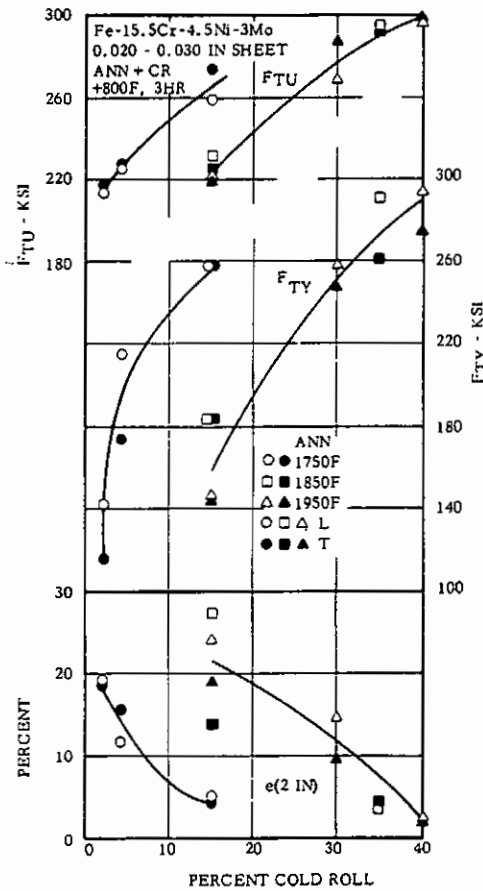


FIG. 3.0218 EFFECT OF ANNEALING TEMPERATURE AND PERCENT COLD ROLL ON LONGITUDINAL AND TRANSVERSE TENSILE PROPERTIES OF CRT ALLOY (27)

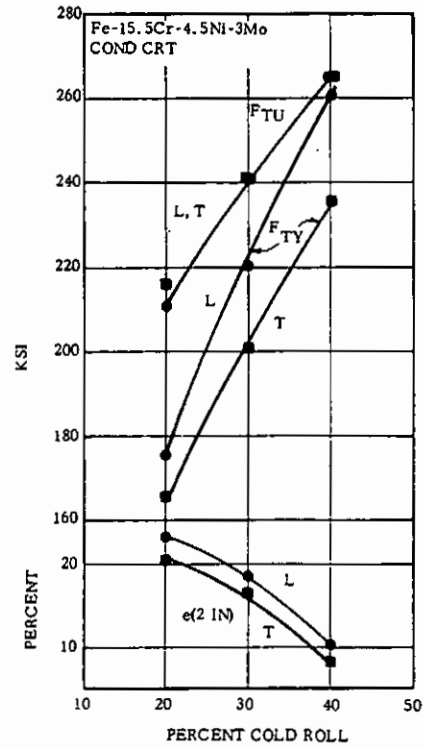


FIG. 3.0217 EFFECT OF PERCENT COLD ROLL ON TENSILE PROPERTIES OF ALLOY IN CONDITION CRT (26, p. 21)

Fe
15.5 Cr
4.5 Ni
3 Mo
AM-355

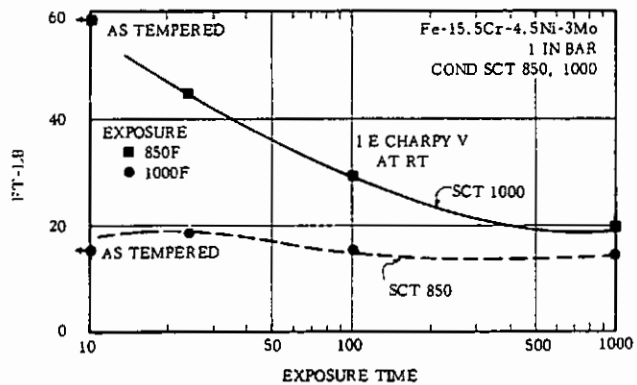


FIG. 3.023 EFFECT OF EXPOSURE TIME AND TEMPERATURE ON IMPACT ENERGY MEASURED AT ROOM TEMPERATURE FOR BAR IN SCT CONDITION (21, Table XV)

Fe
15.5 Cr
4.5 Ni
3 Mo
AM-355

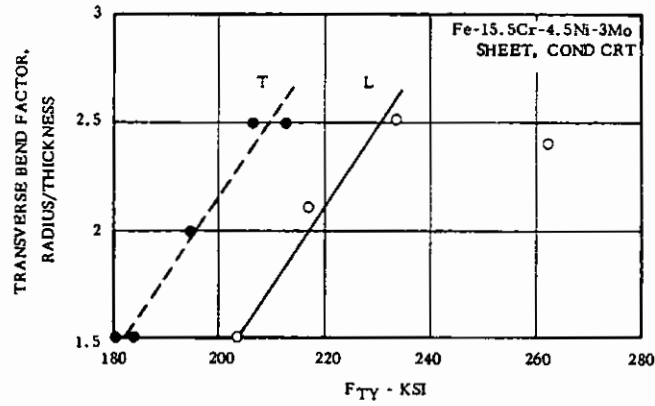


FIG. 3.024 RELATIONSHIP BETWEEN TENSILE YIELD STRENGTH AND TRANSVERSE BEND FACTOR FOR SHEET IN CONDITION CRT (30)

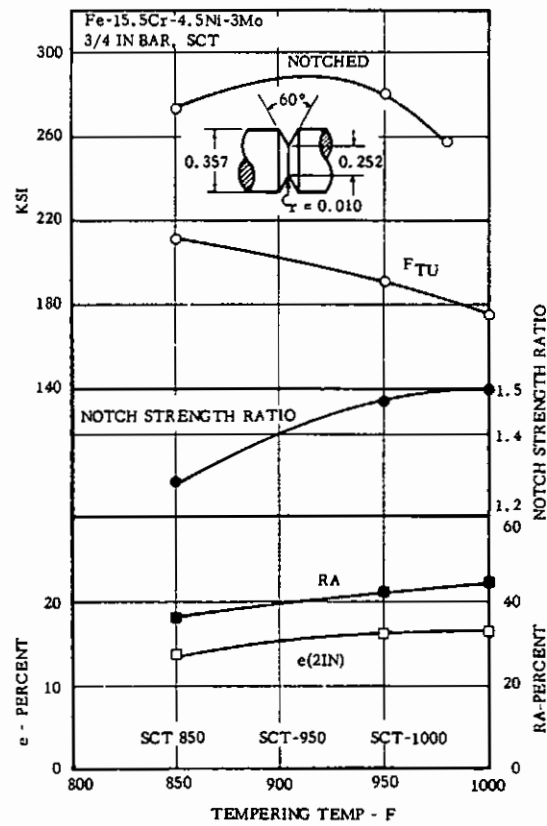
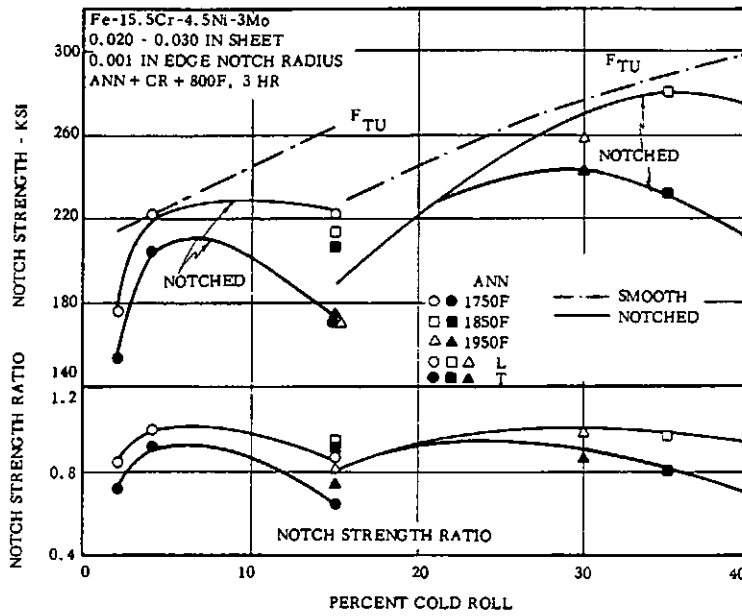


FIG. 3.02711 EFFECT OF TEMPERING TEMPERATURE ON SMOOTH AND NOTCHED BAR TENSILE PROPERTIES FOR ALLOY IN CONDITION SCT (32)



Fe
15.5 Cr
4.5 Ni
3 Mo
AM-355

FIG. 3.02712 EFFECT OF ANNEALING TEMPERATURE AND PERCENT COLD ROLL ON LONGITUDINAL AND TRANSVERSE NOTCH STRENGTH AND NOTCH STRENGTH RATIO OF CRT ALLOY (27)

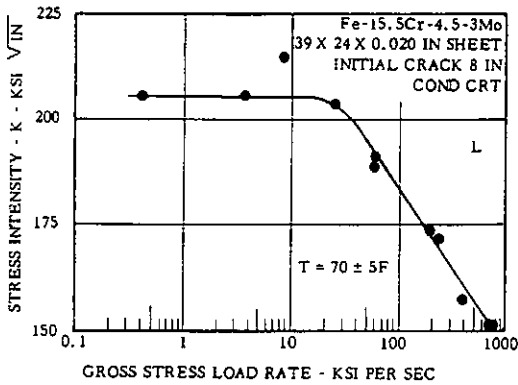


FIG. 3.02713 EFFECT OF RATE OF LOADING ON CALCULATED STRESS INTENSITY FACTOR AT FAILURE FOR CRT ALLOY TESTED AT ROOM TEMPERATURE IN LONGITUDINAL DIRECTION (31)

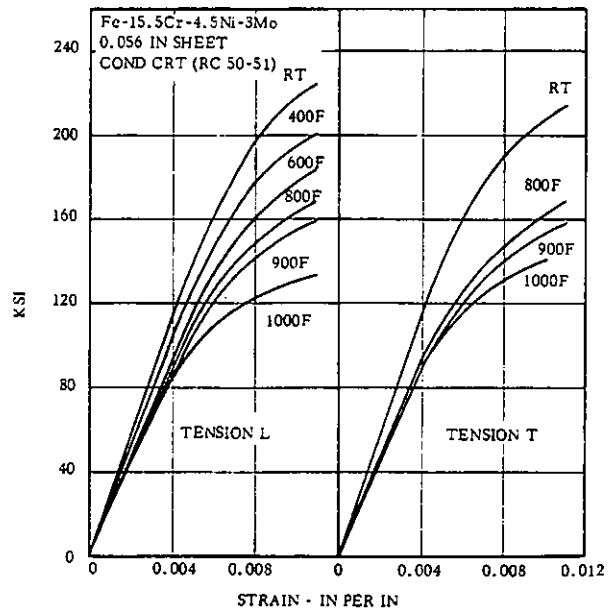


FIG. 3.0311 STRESS-STRAIN CURVES IN TENSION AT ROOM AND ELEVATED TEMPERATURES FOR SHEET IN CRT CONDITION (28)

Fe
15.5 Cr
4.5 Ni
3 Mo

AM-355

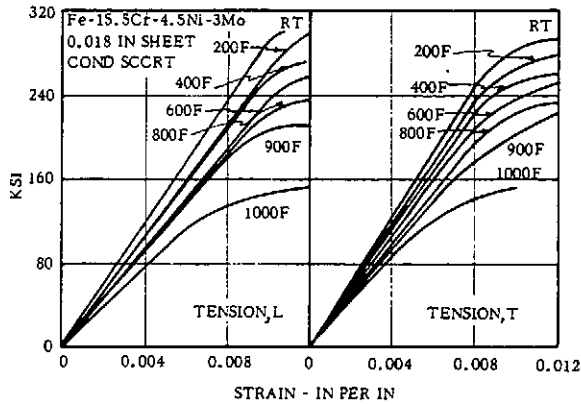


FIG. 3.0312 STRESS-STRAIN CURVES IN TENSION AT ROOM AND ELEVATED TEMPERATURES FOR SHEET IN SCCRT CONDITION (13)

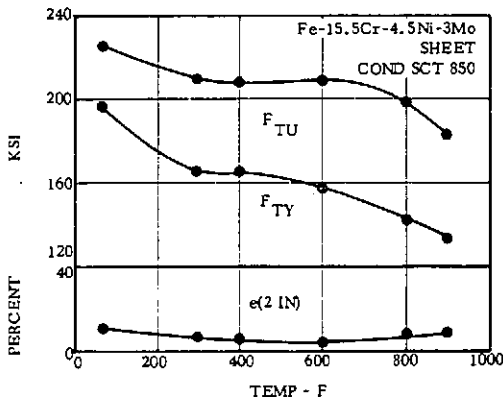


FIG. 3.0314 EFFECT OF TEST TEMPERATURE ON TENSILE PROPERTIES OF SHEET IN CONDITION SCT 850 (13)

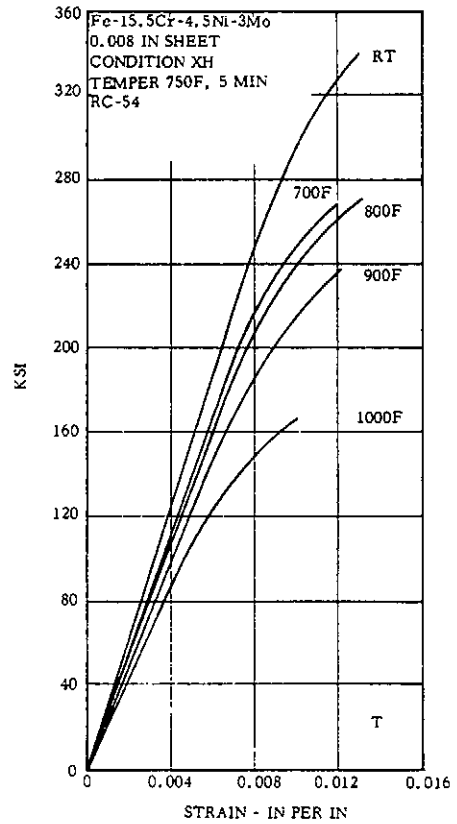


FIG. 3.0313 STRESS-STRAIN CURVES IN TENSION AT ROOM AND ELEVATED TEMPERATURES FOR SHEET IN CONDITION XH (29)

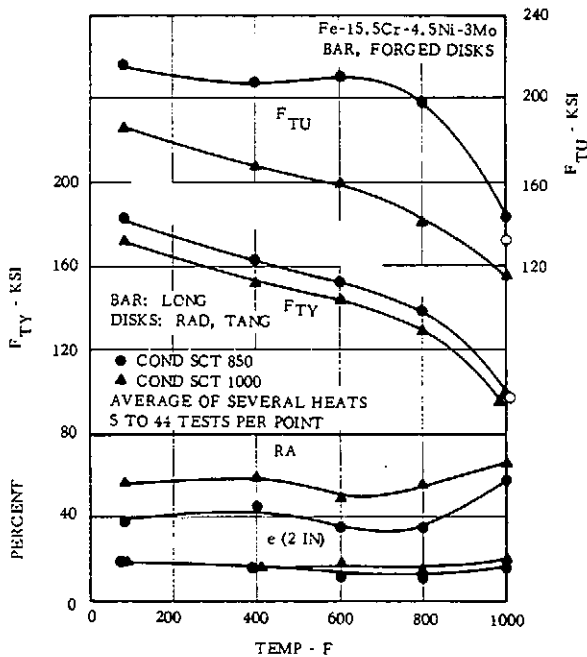


FIG. 3.0315 EFFECT OF TEST TEMPERATURE ON TENSILE PROPERTIES OF BAR AND FORGED DISKS IN CONDITIONS SCT 850 AND SCT 1000 (17)

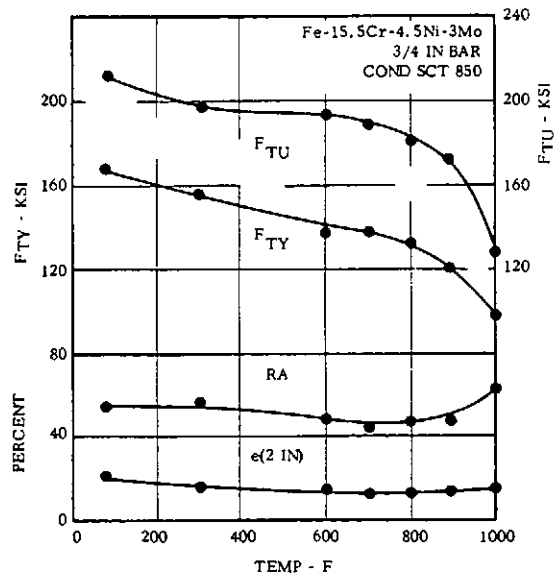


FIG. 3.0316 EFFECT OF TEST TEMPERATURE ON TENSILE PROPERTIES OF BAR IN CONDITION SCT 850 (17)

Fe
15.5 Cr
4.5 Ni
3 Mo
AM-355

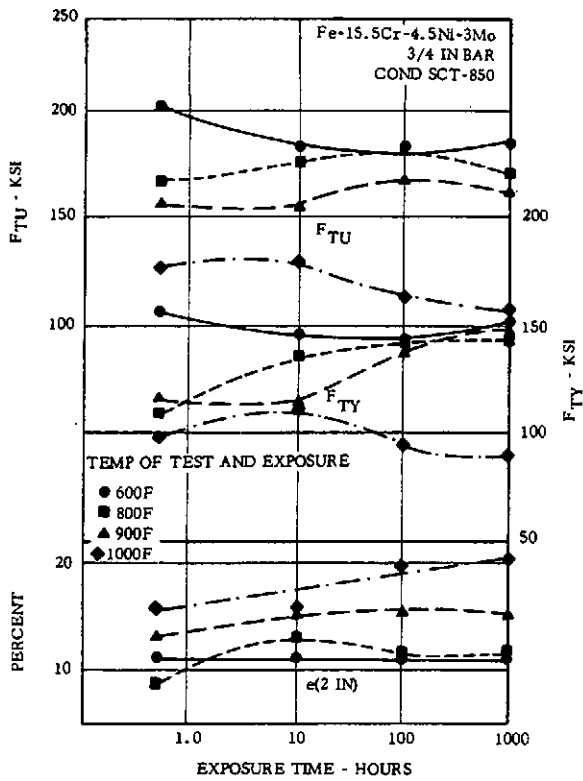


FIG. 3.0317 EFFECT OF EXPOSURE TIME AND TEMPERATURE ON TENSILE PROPERTIES OF BAR IN SCT-850 CONDITION (25, p. 87-90, 99-102, 111-114)

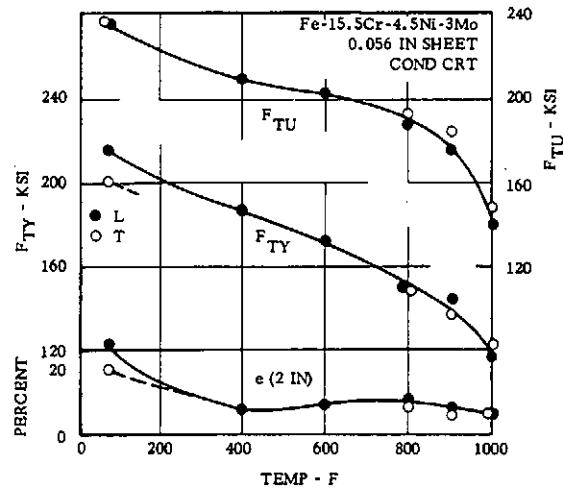


FIG. 3.0318 EFFECT OF TEST TEMPERATURE AND TEST DIRECTION ON TENSILE PROPERTIES OF SHEET IN CONDITION CRT (15)

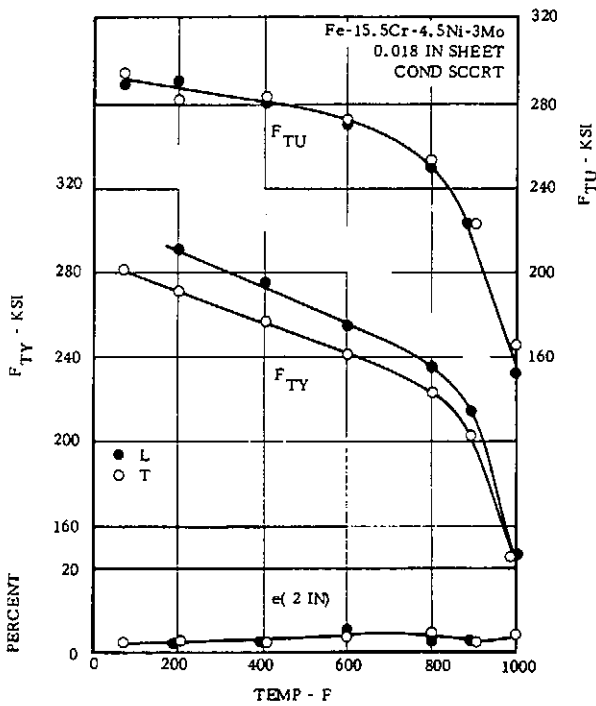


FIG. 3.0319 EFFECT OF TEST TEMPERATURE AND TEST DIRECTION ON TENSILE PROPERTIES OF SHEET IN SCCRT CONDITION (13)

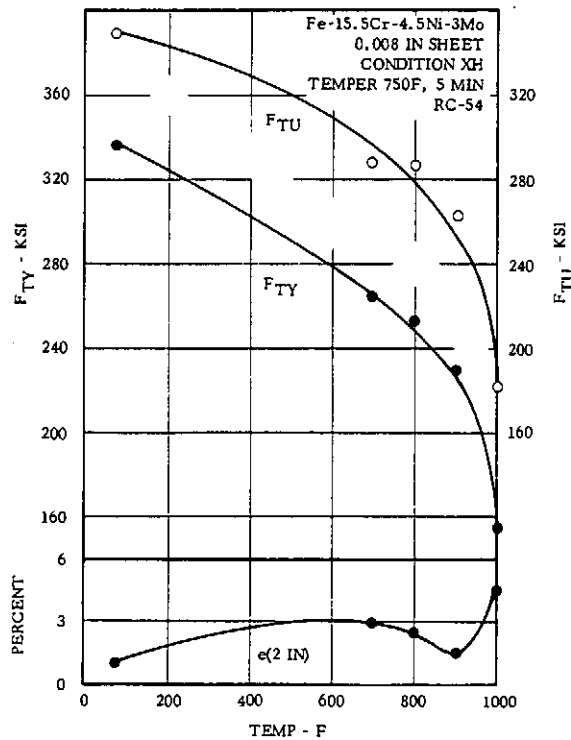


FIG. 3.03110 EFFECT OF TEST TEMPERATURE ON TRANSVERSE TENSILE PROPERTIES OF SHEET IN CONDITION XH (29)

Fe
15.5 Cr
4.5 Ni
3 Mo

AM-355

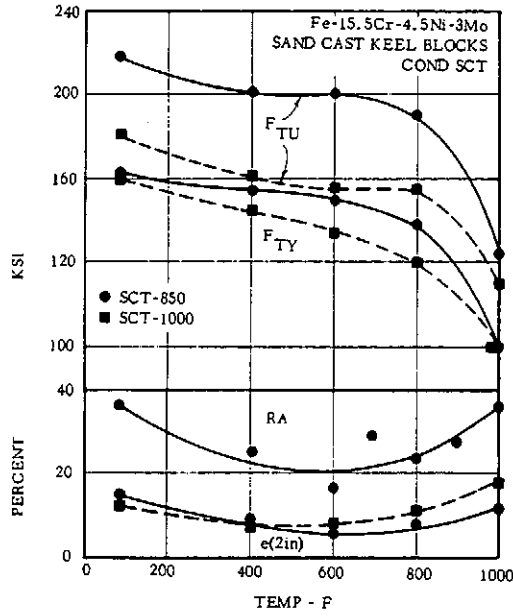


FIG. 3.0311 EFFECT OF TEST TEMPERATURE AND TEMPERING TEMPERATURE ON TENSILE PROPERTIES OF SAND CAST KEEL BLOCKS (26, p. B-2-3)(21, Table X)

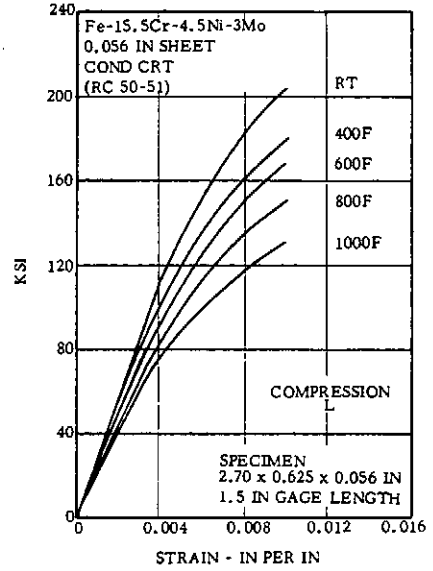


FIG. 3.0321 STRESS-STRAIN CURVES IN COMPRESSION AT ROOM AND ELEVATED TEMPERATURES FOR SHEET IN CRT CONDITION (28)

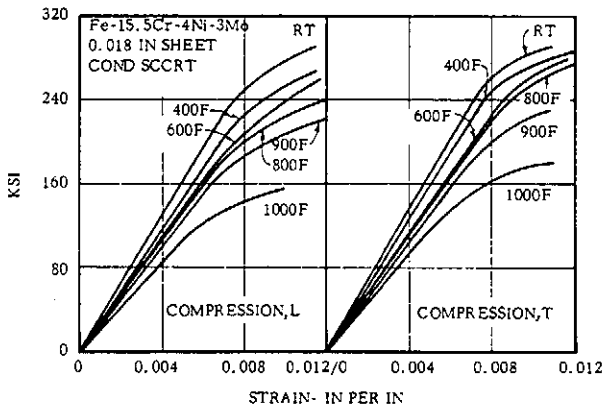


FIG. 3.0322 STRESS-STRAIN CURVES IN COMPRESSION AT ROOM AND ELEVATED TEMPERATURES FOR SHEET IN SCCRT CONDITION (13)

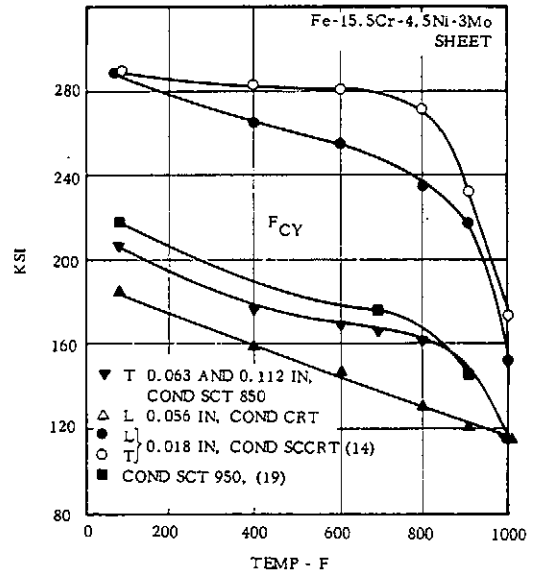


FIG. 3.0323 EFFECT OF TEST TEMPERATURE AND TEST DIRECTION ON COMPRESSIVE YIELD STRENGTH OF SHEET IN CONDITIONS SCT, CRT AND SCCRT (14)(19)

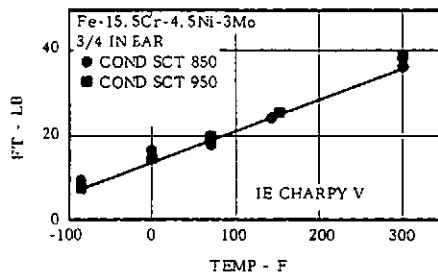


FIG. 3.0331 EFFECT OF TEST TEMPERATURE ON IMPACT STRENGTH FOR BAR IN SCT CONDITIONS (18)

Fe
15.5 Cr
4.5 Ni
3 Mo

AM-355

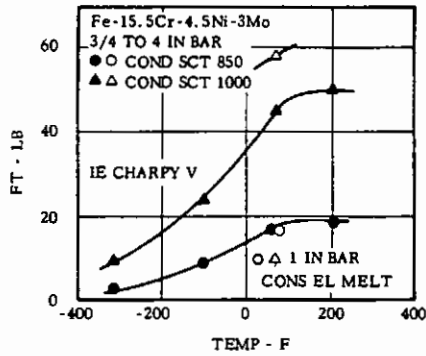


FIG. 3.0332 EFFECT OF TEST TEMPERATURE ON IMPACT STRENGTH FOR BAR IN VARIOUS SCT CONDITIONS (17)

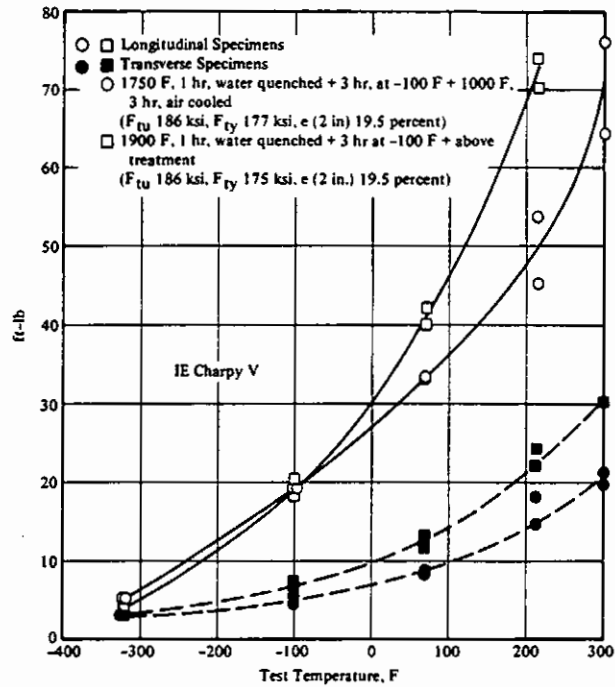


FIG. 3.0333 THE EFFECT OF SPECIAL HEAT TREATMENT ON IMPACT STRENGTH IN LONGITUDINAL AND TRANSVERSE DIRECTION (40)

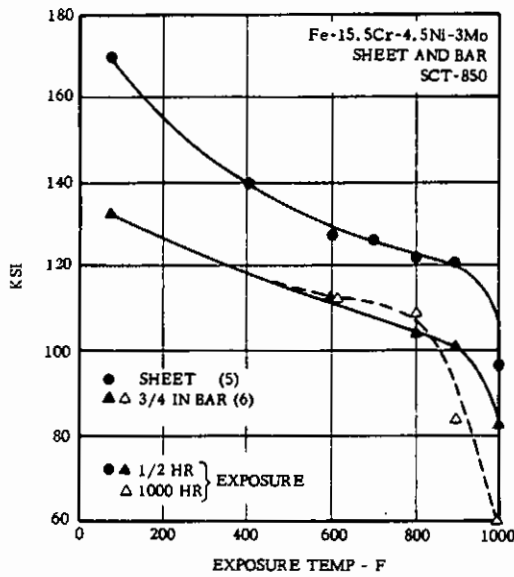


FIG. 3.0351 EFFECT OF TEST AND EXPOSURE TEMPERATURE ON SHEAR STRENGTH OF SHEET AND BAR IN SCT 850 CONDITION (25)(26)

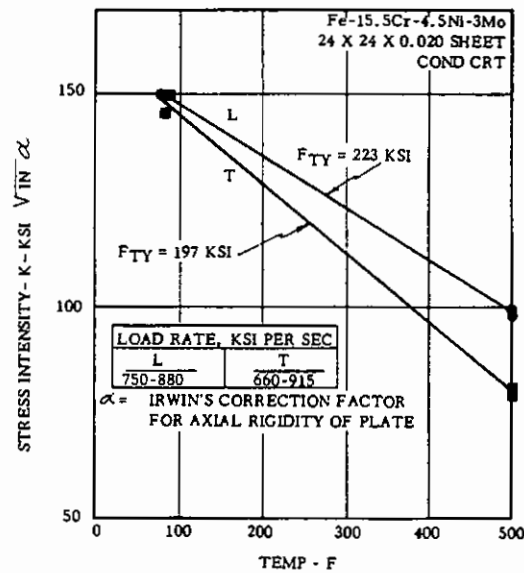


FIG. 3.0352 EFFECT OF TEST TEMPERATURE ON STRESS INTENSITY FACTOR AT FAILURE IN TEAR TEST OF CRT ALLOY IN LONGITUDINAL AND TRANSVERSE DIRECTION (31)

Fe
15.5 Cr
4.5 Ni
3 Mo
AM-355

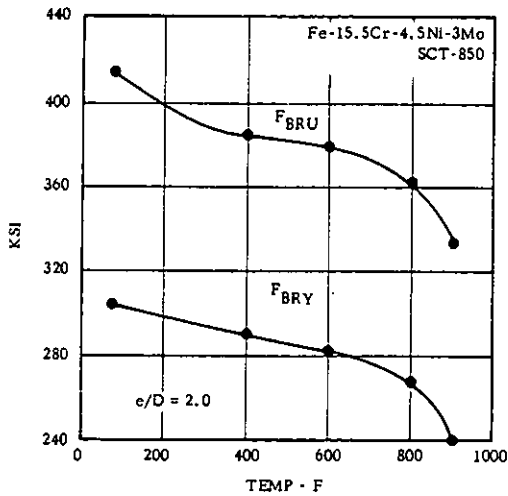


FIG. 3.0361 EFFECT OF TEST TEMPERATURE ON BEARING PROPERTIES OF SHEET IN SCT CONDITION (26, p. B-2-5)

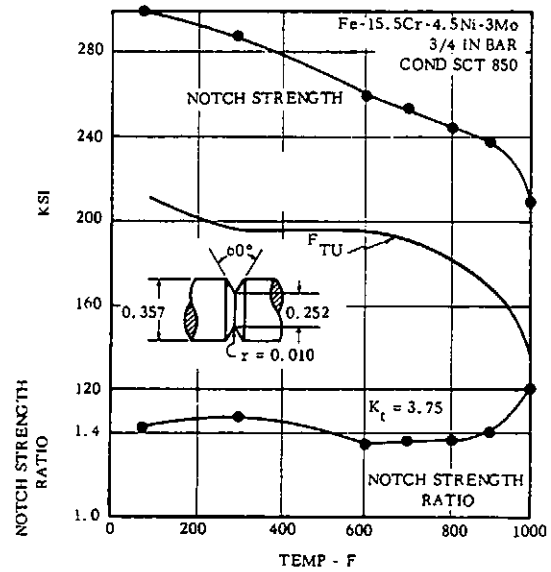


FIG. 3.0371 EFFECT OF TEST TEMPERATURE ON NOTCH STRENGTH OF BAR IN CONDITION SCT 850 (16)

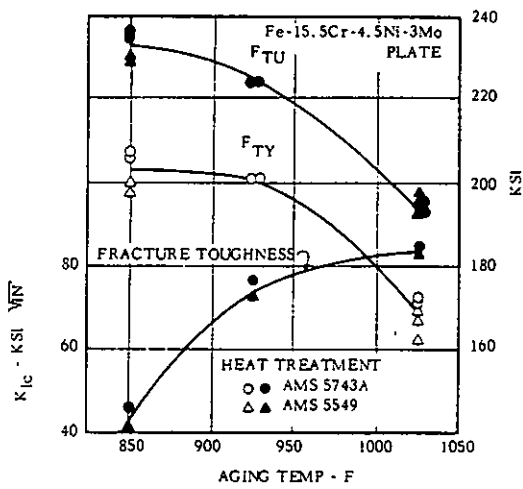


FIG. 3.0372 FRACTURE TOUGHNESS OF PLATE FOR VARIOUS AGE CONDITIONS (36)

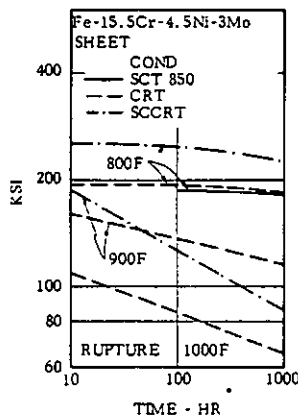


FIG. 3.0421 CREEP RUPTURE CURVES FOR SHEET IN VARIOUS CONDITIONS (14)

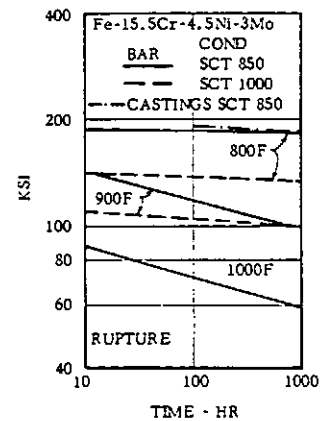


FIG. 3.0422 CREEP RUPTURE CURVES FOR BAR AND CASTINGS IN VARIOUS CONDITIONS (14)

Fe
15.5 Cr
4.5 Ni
3 Mo
AM-355

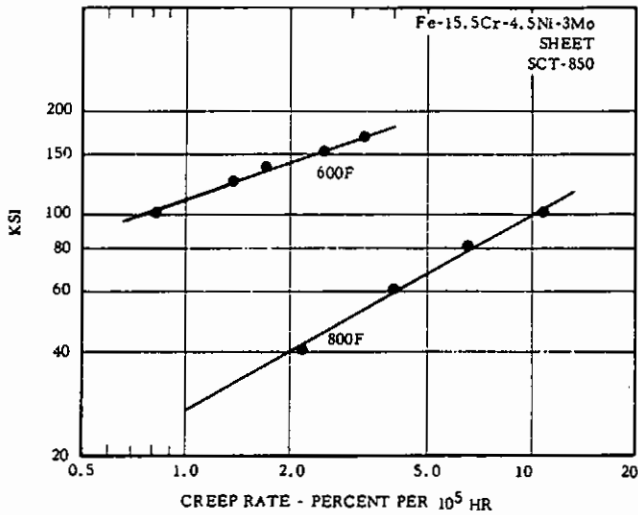


FIG. 3.0431 EFFECT OF STRESS ON CREEP RATE AT 600 AND 800F FOR SHEET IN CONDITION SCT-850 (32, p. 49)

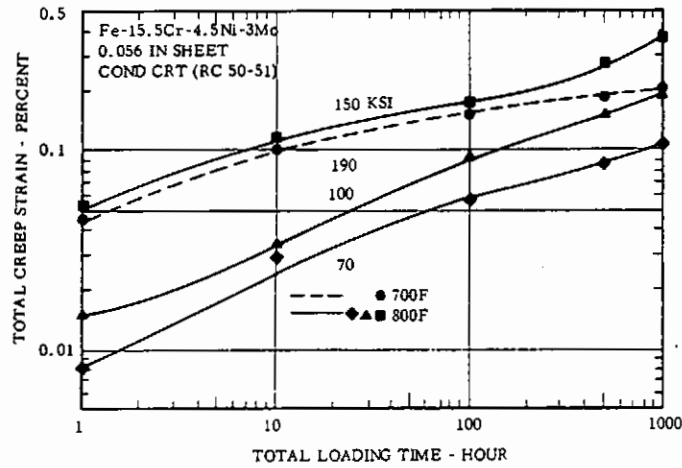


FIG. 3.0432 TOTAL CREEP DATA AT 700 AND 800F FOR ALLOY IN CONDITION CRT (33)

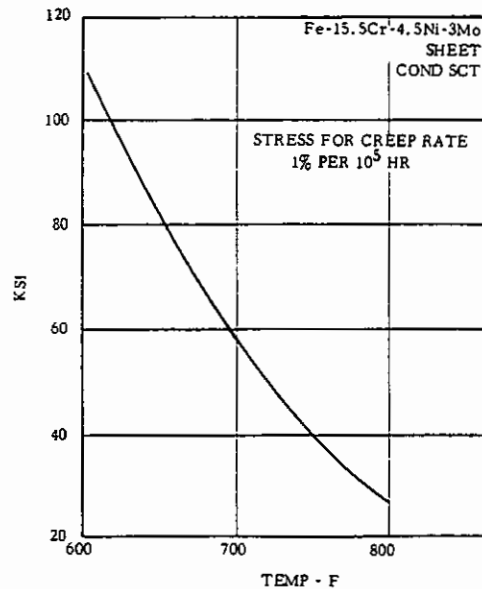


FIG. 3.0433 EFFECT OF TEMPERATURE ON STRESS TO PRODUCE CREEP RATE OF 1 PERCENT PER 10⁵ HOUR (32, p. 46)

Fe
15.5 Cr
4.5 Ni
3 Mo

AM-355

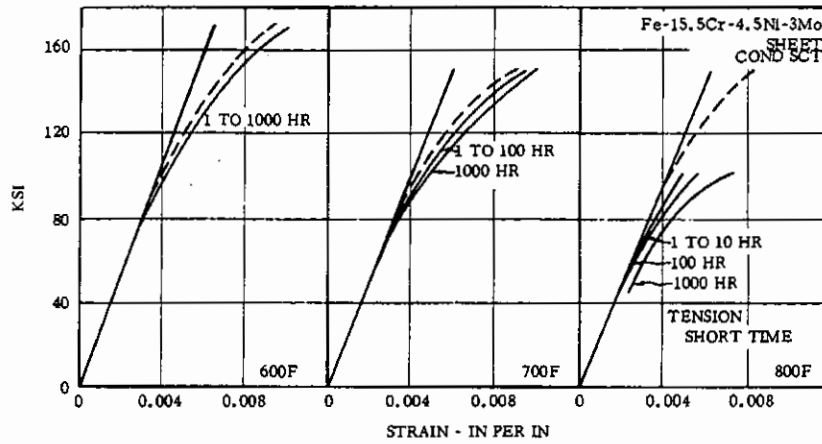


FIG. 3.0434 ISOCHRONOUS STRESS-STRAIN CURVES AT 600 TO 800F FOR SHEET IN CONDITION SCT 850 (16)

Source	A (1)		B (2)		C(3)			
Form	Bar		Bar		Sheet			
Condition	(a) SCT 850		(b) SCT 1000		(c) SCT 850			
Test temp-F	Stress ratio		Stress Concentration	Fatigue strength, max, ksi at cycles				
	A	R		10 ⁴	10 ⁵	10 ⁶	10 ⁷	10 ⁸
(A) RT	-1	Smooth		116	98	90		
800		K = 1			79	65	57	
(B) RT	-1	K = 1		120	106	104		
(C) RT	-1	K = 1		147	136	136		
RT L, T	1	0,6	K = 3.5	91	67	55	55	

TABLE 3.051 FATIGUE PROPERTIES OF BAR AND SHEET IN SCT CONDITIONS

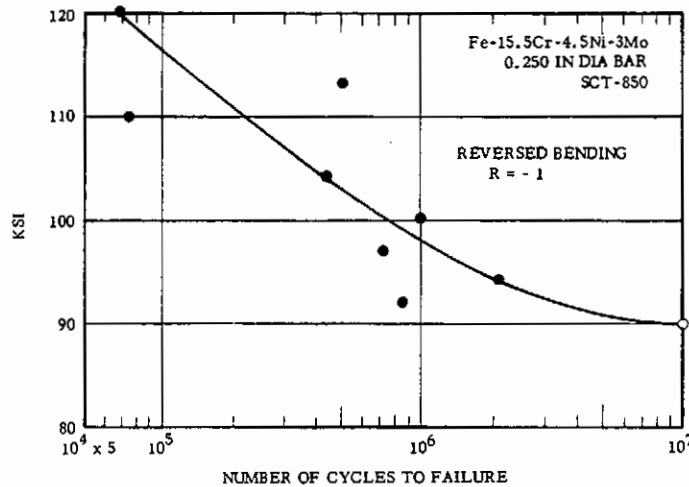


FIG. 3.052 REVERSED BENDING FATIGUE CURVE FOR BAR IN CONDITION SCT-850 (32, p. 45)

Form	0.25 in. Specimens, R = -1	
Condition	SCT 850 F	SCT 1000 F
F _{tu} , ksi	214	164
F _{ty} , ksi	176	156
Fatigue Strength at 10 ⁸ Cycles, ksi	108	97

TABLE 3.053. FATIGUE STRENGTH AT 10⁸ CYCLES FOR SCT 850 AND SCT 1000 F CONDITIONS (37)

Fe
15.5 Cr
4.5 Ni
3 Mo

AM-355

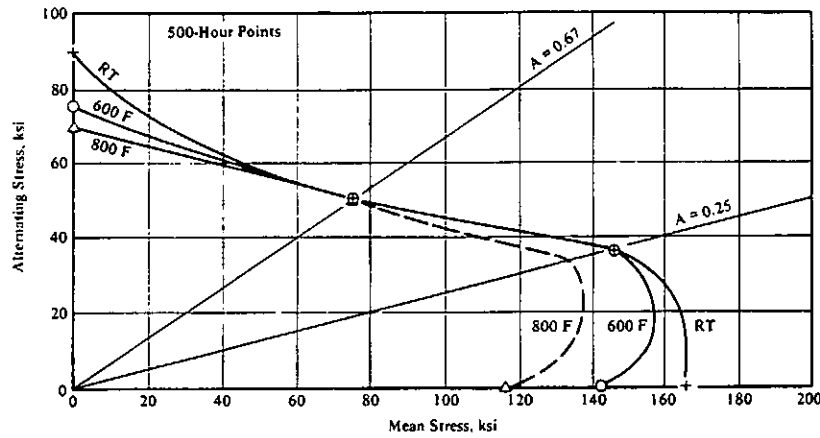


FIG. 3.054 COMBINED STRESS DIAGRAM FOR AM-355 SCT (1000 F) (38)

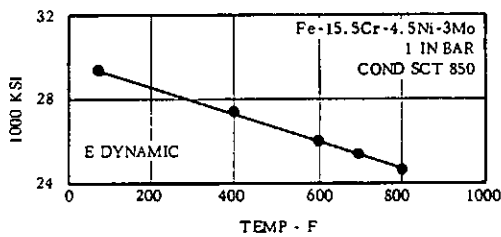


FIG. 3.0621 MODULUS OF ELASTICITY FOR BAR IN CONDITION SCT 850 AT ROOM AND ELEVATED TEMPERATURES (14)

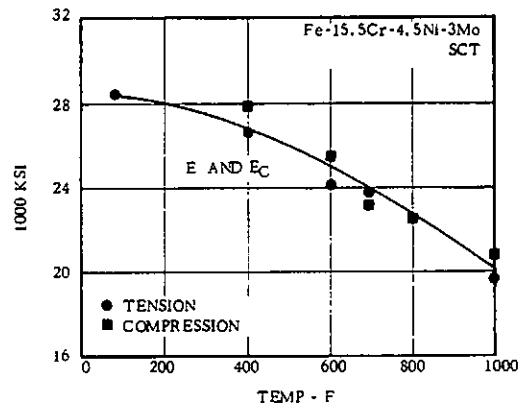


FIG. 3.0622 EFFECT OF TEST TEMPERATURE ON TENSILE AND COMPRESSIVE ELASTIC MODULUS OF ALLOY IN CONDITION SCT (26, p. B-2-4)

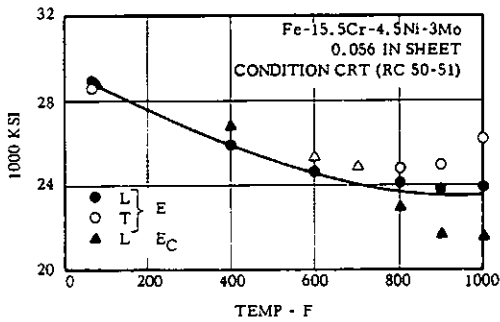


FIG. 3.0623 MODULUS OF ELASTICITY FOR SHEET IN CRT CONDITION AT ROOM AND ELEVATED TEMPERATURES (28)

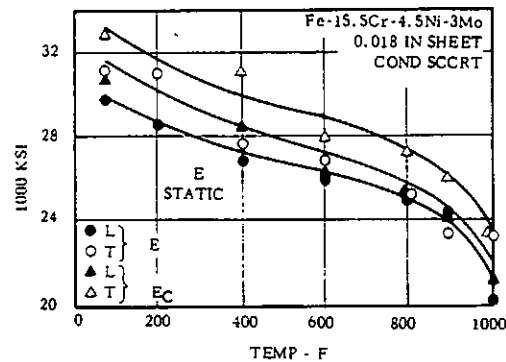


FIG. 3.0624 MODULUS OF ELASTICITY FOR SHEET IN CONDITION SCCRT AT ROOM AND ELEVATED TEMPERATURES (13)

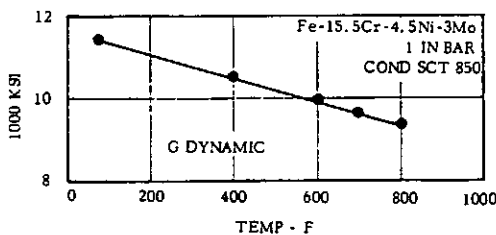


FIG. 3.063 MODULUS OF RIGIDITY FOR BAR IN CONDITION SCT 850 AT ROOM AND ELEVATED TEMPERATURES (14)

Fe
15.5 Cr
4.5 Ni
3 Mo

AM-355

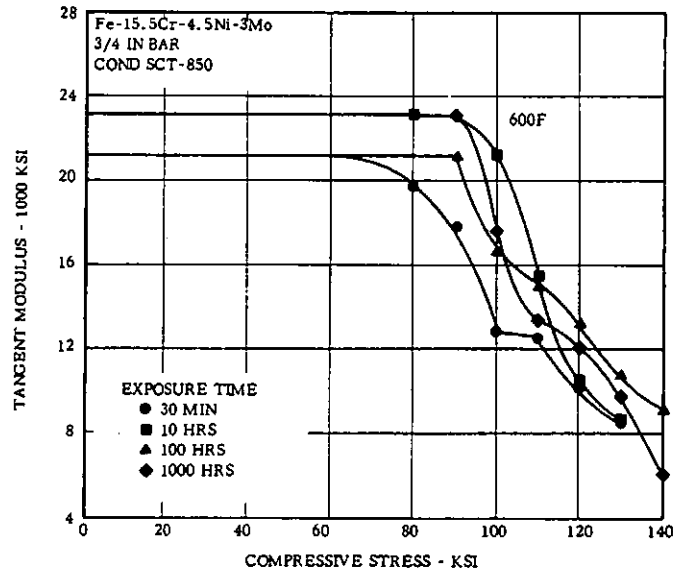


FIG. 3.0641 TANGENT MODULUS IN COMPRESSION AT 600F FOR EXPOSURE TIMES FROM 30 MINUTES TO 1000 HOURS FOR BAR STOCK IN COND SCT-850 (25, p. 138)

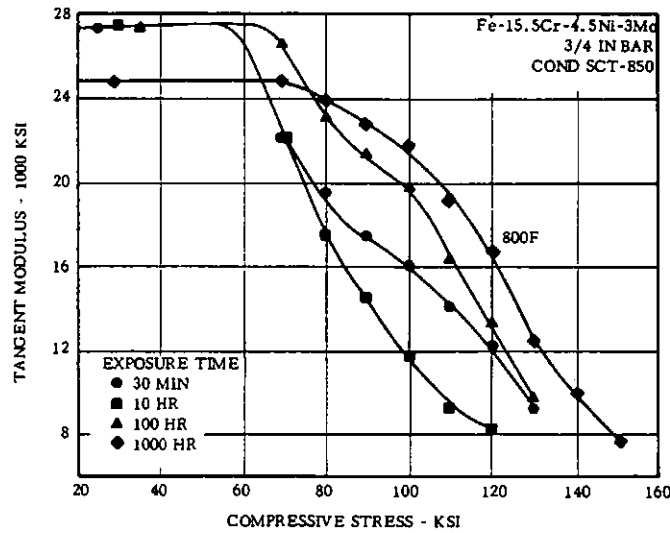


FIG. 3.0642 TANGENT MODULUS IN COMPRESSION AT 800F FOR EXPOSURE TIMES FROM 30 MIN TO 1000 HOURS FOR BAR STOCK IN COND SCT-850 (25, p. 139)

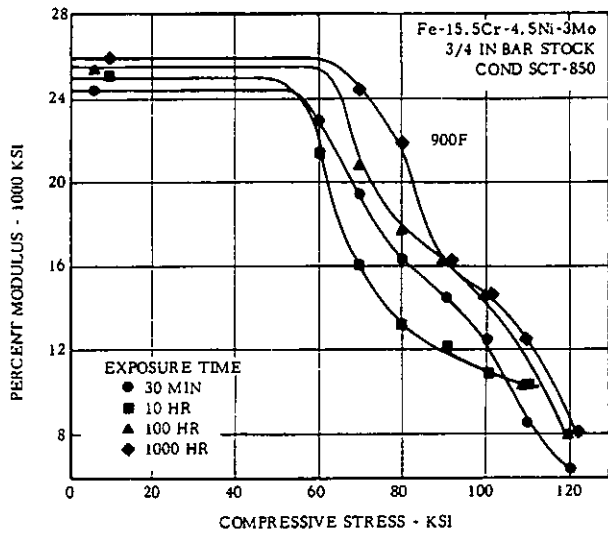


FIG. 3.0643 TANGENT MODULUS IN COMPRESSION AT 900F FOR EXPOSURE TIME FROM 30 MINUTES TO 1000 HOURS FOR BAR STOCK IN COND SCT-850 (25, p. 140)

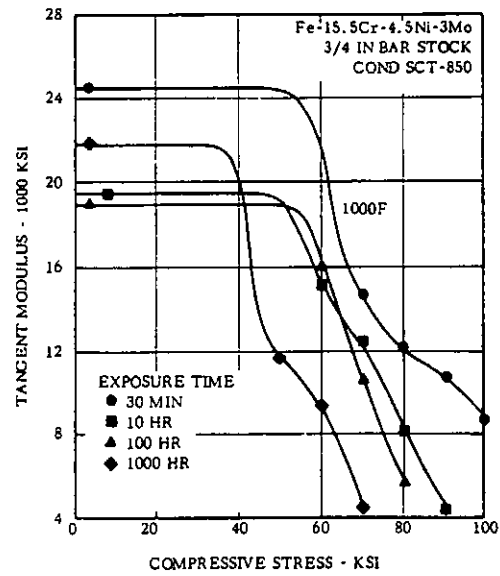


FIG. 3.0644 TANGENT MODULUS IN COMPRESSION AT 1000F FOR EXPOSURE TIMES FROM 30 MINUTES TO 1000 HOURS FOR BAR STOCK IN COND SCT-850 (25, p. 141)

Fe
15.5 Cr
4.5 Ni
3 Mo
AM-355

Welding Process	Heat Treatment(a)	Yield Strength, ksi		Ultimate Tensile Strength, ksi	Elong. in 2 in., %	Red. in. Area, %	Charpy V-Notch Impact, ft-lb	Hardness Rockwell C	Location of Fracture
		0.02% Offset, ksi	0.2% Offset, ksi						
Gas Tungsten-Arc Welding AM-355 wire Transversely welded 1/2-inch plate tensiles	1710 F + SCT (850 F)	132	173	205	4	-	-	43	Weld
	1375 F, 3 hr. AC + 1710 F + SCT (850 F)	138	176	208	7	-	-	43	Weld
Gas Metal-Arc Welding AM-355 wire All-weld-metal tensiles	1710 F + SCT (850 F)	137	180	216	6	18	-	45	
AM-355 Covered Electrodes All-weld-metal tensiles	1375 F, 3 hr. AC + 1710 F + SCT (850 F)	121	163	198	12	26	-	44	
	1375 F, 3 hr. AC + 1710 F + SCT (1000 F)	134	159	175	13	30	11	41	
Submerged Arc Welding AM-355 wire Arcosite S-12 flux All-weld-metal tensiles	1375 F, 3 hr. AC + 1710 F + SCT (850 F)	136	170	195	11	24	-	42	
	1375 F, 3 hr. AC + 1710 F + SCT (1000 F)	145	169	187	10	29	8	38	

(a) Post weld heat treatment.

TABLE 4.034. TYPICAL WELDMENT & WELD METAL PROPERTIES FOR VARIOUS WELDING METHODS (39)

Fe
15.5 Cr
4.5 Ni
3 Mo

AM-355

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