Contents

Volume 3

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NONFERROUS ALLOYS

	Al
5	Si
1.3	Cu
0.5	Mg

355
C355

1. GENERAL
This heat treatable aluminum casting alloy is one of two alloys whose properties are primarily determined by its high silicon content in combination with magnesium. 355 and its high purity premium strength variety C 355 also contain copper which makes them stronger but less ductile and corrosion resistant than the other alloy of this group, 356. The general properties of these alloys are very similar. They are distinguished by exceptional castability and pressure tightness, high corrosion resistance and good weldability. 355 is available in the form of sand and permanent mold casting alloys, while C 355 is primarily a permanent mold casting. Data in the following paragraphs applies to 355 unless specifically noted C 355.

1.01 Commercial Designations
355 and C 355 (26).

1.02 Alternate Designations
ASTM B26 Sand castings, ASTM B108 Permanent mold castings, UNS A33550 (C 355) (30).

1.03 Specifications
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1.04 Composition
Table 1.04.

1.05 Heat Treatment
1.051 Anneal (Stress relief) for dimensional stability. 650 to 750 F, 2 hr.
1.052 Solution heat treatment and artificial aging, Table 1.052.

1.06 Hardness
See also Tables 3.011 and 3.0212.
1.061 Quenching in boiling water followed by aging develops full hardening in all commercial sizes of 355 and C 355 castings.
1.062 Typical hardness values. (22)

355-T51	65 BHN
355-T6	80 BHN
355-T61	100 BHN
355-T7	85 BHN
355-T71	75 BHN

(500 kg. load, 10 mm. ball.)

1.07 Forms and Conditions Available
1.071 The 355 alloy is available as sand and permanent mold castings, usually without restrictions as to size, shape and section thickness.
1.072 The C 355 alloy is available primarily in the form of permanent mold castings as "premium strength" castings, with properties to be negotiated, depending upon casting design.
1.073 Conditions available, Table 1.073.

1.08 Melting and Casting Practice
These alloys can be melted and cast by all common aluminum alloy casting techniques without special considerations, see 4.01.

1.09 Special Considerations

2. PHYSICAL AND ENVIRONMENTAL EFFECTS

2.01 Thermal Properties
2.011 Melting range. 1015 - 1150F (8, p. 203).
2.012 Phase changes. Alloy is subject to precipitation.
2.0121 Time-temperature-transformation diagrams.
2.013 Thermal conductivity, Table 2.013.
2.014 Thermal expansion, Figure 2.014.
2.015 Specific heat. 0.23 Btu per (lb F), at 212F (15, p. 956).
2.016 Thermal diffusivity.
2.017 Solidification temperature range. 1160-1075F (23).

2.02 Other Physical Properties
2.021 Density. 0.098 lb per cu in, 2.71 gr per cu cm (22).
2.022 Electrical resistivity. Table 2.022.
2.0221 Electrical conductivity. (22). Percent IACS (as cast).

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	T6 Condition	39
	T61 Condition	37
	T62 Condition	38
	T7 Condition	42
	T71 Condition	39
C 355	T61 Condition	39

2.023 Magnetic properties. Alloy is nonmagnetic.
2.024 Emittance.
Emissivity in air at room temperature. 0.035 to 0.07 (16, p. 837).
2.025 Damping capacity.

2.03 Chemical Environment
2.031 Corrosion resistance. The general corrosion resistance of 355 and C 355 alloys is good, although they are inferior to that of 356 because of their higher copper content. These alloys are resistant to attack by rural, industrial and marine atmospheres.
2.032 These alloys exhibit a high resistance to stress corrosion and stress cracking.
2.033 Alloys are resistant to nitric, chromic and most organic acids. They are attacked by hydrochloric and sulfuric acids.
2.034 The alloys are resistant to ammonium hydroxide, but are attacked by sodium, potassium and calcium hydroxides.
2.035 Alloys are resistant to many salts such as sodium bicarbonate; sodium, potassium, calcium and magnesium chlorides; sulfates and nitrates. They are attacked by salts of heavy metals such as ferric chloride and nitrate, mercury salts, silver salts and tin salts (23) (24).

2.04 Nuclear Environment

3. MECHANICAL PROPERTIES

3.01 Specified Mechanical Properties
3.011 AMS specified mechanical properties for 355 alloy, Table 3.011.
3.012 AMS specified tensile properties for C 355 alloy, Table 3.012.
3.013 Aluminum Association mechanical property limits for sand and permanent mold castings of 355 alloy, Table 3.013.
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3.015 Military specified tensile properties of specimens cut from castings, Table 3.015.
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3.02 Mechanical Properties at Room Temperature
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3.0211 Stress-strain diagrams (tensile).
3.0212 Typical mechanical properties of cast test bars, Table 3.0212.
3.0213 Effect of diameter of cylindrical sand castings on tensile properties of specimens machined from the castings, Table 3.0213.
3.0214 Typical tensile properties of specimens cut from 355-T6 sand castings of different thicknesses, Table 3.0214.
3.0215 Typical tensile properties of specimens cut from C 355 premium strength sand castings, Table 3.0215.
3.022 Compression.
3.0221 Stress-strain diagrams (compression).
3.0222 AMS specified minimum mechanical property limits for 355 alloy, see Table 3.011.
3.0223 Producer's minimum mechanical properties for C 355 permanent mold castings, see Table 3.016.
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3.024 Bending.
3.025 Torsion and shear.
3.0251 AMS specified minimum mechanical property limits for

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3.0252 Producer's minimum mechanical properties for C 355 permanent mold castings, see Table 3.016.

3.0253 Typical mechanical properties of cast test bars. see Table 3.0212.

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3.026 Bearing.

3.027 Stress concentration.

3.0271 Notch properties.

3.0272 Fracture toughness.

3.028 Combined properties.

3.03 Mechanical Properties at Various Temperatures

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3.0315 Tensile properties of 355-T6 alloy after long time exposure at test temperature, Figure 3.0315.

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3.0318 Tensile properties of C 355-T61 alloy after long time exposure at test temperature, Figure 3.0318.

3.032 Compression.

3.0321 Stress-strain diagrams.

3.033 Impact.

3.034 Bending.

3.035 Torsion and shear.

3.036 Bearing.

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3.0371 Notch properties.

3.0372 Fracture toughness.

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3.04 Creep and Creep-Rupture Properties

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3.05 Fatigue Properties

3.051 The fatigue properties of aluminum cast alloys vary greatly according to the quality of the casting. Values for permanent mold castings are usually somewhat higher than those obtained on sand castings. For design applications, allowance must be made for the effect of stress raisers. Typical fatigue data reported by alloy producers are given below.

3.052 Scatterbands for fatigue strength of heat treated 355 sand cast test bars, Figure 3.052.

3.053 Average stress range diagrams for heat treated 355 sand cast test bars. Figure 3.053.

3.054 Typical values of fatigue strength of cast test bars at room and elevated temperatures, Table 3.054.

3.055 Typical fatigue properties for sand and permanent mold castings in various conditions, Table 3.055.

3.056 Effect of porosity, sand holes and dross on fatigue properties of 355-T6 sand castings, Figure 3.056.

3.06 Elastic Properties

3.061 Poisson's ratio. 0.33 (15).

3.062 Modulus of elasticity. 10,200 ksi (27).

3.063 Modulus of rigidity. 3,800 ksi.

3.064 Tangent modulus.

3.065 Secant modulus.

4. FABRICATION

4.01 Casting

4.011 Melting of aluminum casting alloys is readily done by all common methods. Gas and oil fired furnaces are most common, and the low frequency induction furnace is also becoming widely used. The furnace may be the lift out refractory crucible type or it may be stationary or tilting. Special considerations in melting must be given to the ease with which aluminum combines with oxygen, hydrogen and common metallic materials. To prevent absorption of iron from cast iron tools, these should be coated by a protective material. Silicon pickup by reduction of firebrick used as hearth linings can be very harmful. High alumina linings reduce this difficulty.

4.012 Hydrogen readily dissolves in molten aluminum from moisture in all forms and from hydrocarbons. It is liberated during solidification causing harmful porosity. Gas absorption increases with increasing temperature of the molten aluminum and with increasing time held at temperature. Any increased contact surface between molten metal and hydrogen forming gases. particularly that caused by stirring, also increases gas absorption.

4.013 Dross forms as a result of oxidation and it may be trapped in the metal and cause defects in the casting, because its density is slightly higher than that of aluminum.

4.014 The oxide film on the aluminum melt, however, gives an excellent protection against further oxidation and gas absorption. On casting, the metal should flow steadily and for a minimum distance to maintain the oxide layer and thus avoid dross inclusions.

4.015 Gaseous or solid fluxes are generally used to remove hydrogen and dross from the melt. Flushing with gaseous fluxes, such as chlorine and nitrogen may be used for this purpose. Solid fluxes are introduced into the melt to form either a gas or a liquid protective coating on top of the melt after thoroughly stirring the metal. This liquid may be either inert or reactive. Generally, the metal is heated to 1250 to 1400F before adding flux. After fluxing, the melt must be allowed to settle for 10 to 20 minutes to allow the flux to float to the top, while the temperature of the liquid is adjusted to the pouring temperature.

4.016 355 and C 355 have excellent castability. These alloys also have excellent fluidity, low solidification shrinkage tendency, high resistance to hot cracking and good pressure tightness. The alloys are suitable for very intricate castings, containing thin and variable sections and sudden section changes.

4.017 Castings can be straightened in either the annealed or T4 Condition.

4.018 For a more complete discussion of fabrication and casting of aluminum alloys, see Reference (28).

4.02 Machining and Grinding. The machinability of this alloy is good, but it is inferior to that of the low silicon aluminum castings. The relatively large amount of silicon makes the alloy abrasive to carbon steel and high speed steel tools, while the alloy can be machined satisfactorily with cemented carbide tools. It will machine best if the speeds and cuts are reduced and the rake angles increased compared to those used for other aluminum alloys.

4.021 Cast alloys 355 and C 355 when machined properly yield curled or easily broken chips and results in good to excellent surface finish (28).

4.022 Grinding of aluminum alloys is accomplished with methods and equipment similar to those used for other metals, but grinding speeds are much higher than those used for ferrous alloys. Abrasive-belt grinding machines are commonly used.

4.023 For a more complete discussion of machining and grinding of aluminum alloys, see Reference (28).

4.03 Joining

4.031 General. In general, the welding techniques employed on aluminum alloy castings are similar to those used for wrought products. Sound welds of good quality can be obtained with proper procedures. 355 and C 355 alloy castings are weldable by all common fusion methods such as gas, electric arc with flux and electric arc with inert gas. The alloys are also weldable with resistance welding techniques. Pressure welding, brazing and soldering are not recommended for these alloys; however, soldering can be accomplished using special techniques.

4.032 Castings containing gas porosity, dross, shrinkage or inclusions will have poor weldability and low weld properties.

4.033 A partial loss in mechanical properties occurs in welding of heat treated alloys such as 355 and C 355. Post-weld re-heatreatment will restore their original properties.

4.044 For selection of proper filler metals and more detailed information on joining of cast aluminum alloys, see Reference (29).

4.04 Surface Treating

4.051 General. The resistance of these alloys to normal atmospheric weathering is good, and protective castings are not usually required. The alloys can be anodized to provide increased resistance to corrosion and abrasion. Other surface finishes such as electroplating, porcelain enameling, and painting can be applied for special purposes if desired (28).

Source	(19)(20)(21)		(19) (20) (21)	
Alloy	355		C 355	
	Percent		Percent	
	Min.	Max.	Min.	Max.
Silicon	4.5	5.5	4.5	5.5
Copper	1.0	1.5	1.0	1.5
Magnesium	0.40	0.6	0.40	0.6
Iron	(a)	0.6	-	0.20
Manganese	(a)	0.5	-	0.10
Zinc	-	0.35	-	0.10
Chromium	-	0.25	-	-
Titanium	-	0.25	-	0.20
Other impurities each	-	0.05	-	0.05
Total	-	0.15	-	0.15
Aluminum	Balance		Balance	

(a) If iron exceeds 0.45 percent, manganese content shall not be less than one-half the iron content.

TABLE 1.04 CHEMICAL COMPOSITIONS.

Al
5 Si
1.3 Cu
0.5 Mg

355
C355

AMS	Alloy	Form	
4210F	355	Castings, Sand (T51 Cond.)	QQ-A-601, Alloy 355, Temp. T51
4212E	355	Castings, Sand (T6 Cond.)	QQ-A-601, Alloy 355, Temp. T6
4214D	355	Castings, Sand (T71 Cond.)	QQ-A-601, Alloy 355, Temp. T71
4280E	355	Castings, Permanent Mold (T71 Cond.)	QQ-A-596, Alloy 355, Temp. T71
4281C	355	Castings, Permanent Mold (T6 Cond.)	QQ-A-596, Alloy 355, Temp. T6
4215B	C355	Castings, Premium Grade	MIL-A-21180c, Alloy C355, Class 12

TABLE 1.03 SPECIFICATIONS.

Source	(8, p.212) (13, p.89, 90)				
Condition	Sand and/or permanent mold castings	ST WQ at 150-212 F (a)		Artificial Age	
		Temp-F	Time-hr (b)	Temp-F	Time-hr (b)
T4	S.C. and P.M.C.	965-985	12	---	---
T51	S.C. and P.M.C.	---	-	430-450	7-9
T6	S.C.	970-990	12	300-320	3-5
T6	P.M.C.	970-990	8	300-320	3-5
T61	S.C.	965-985	12	300-320	8-10
T62	P.M.C.	970-990	8	330-350	14-18
T7	S.C.	970-990	12	430-450	3-5
T7	P.M.C.	970-990	12	430-450	7-9
T71	S.C.	970-990	12	465-485	4-6
T71	P.M.C.	970-990	8	465-485	4-6
C355-T61	P.M.C.	970-990	12	300-320	10-12

(a)212 F preferred.
(b)Exact time influenced by foundry variables and may have to be adjusted from experience.

TABLE 1.052 SOLUTION HEAT TREATMENT AND ARTIFICIAL AGING.

	Al
5	Si
1.3	Cu
0.5	Mg

355
C355

Source	(8) (19)		
Alloy	355		C 355
Form	Sand castings	Permanent Mold Castings	
Condition	T6, T7, T51, T71	T6, T51, T62, T71	T6, T61

TABLE 1.073 CONDITIONS AVAILABLE.

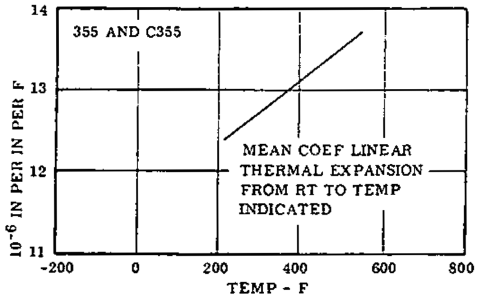

FIG. 2.014 THERMAL EXPANSION (22)

Source		(22)
Alloy	Condition	Thermal Conductivity Btu ft per (hr sq ft F)
355	T51	96.8
	T6	82.3
	T6 (a)	87.1
	T61	84.7
	T62 (a)	84.7
	T7	94.4
	T71	87.1
C 355	T61	87.1

(a) Chill cast samples; all other samples cast in green sand molds.

TABLE 2.013 THERMAL CONDUCTIVITY.

Source	(15, p. 956)	
Alloy	Condition	Electrical Resistivity, microhm-in
355	T51 Sand Cast	1.58
	T6 Sand Cast	1.88
	T61 Sand Cast	1.83
	T7 Sand Cast	1.61
	T6 Permanent Mold Cast	1.74

TABLE 2.022 ELECTRICAL RESISTIVITY.

Source	AMS(1) 7,p.62		AMS(2) 7.p.62		7.p.62		AMS(3) 7,p.62		AMS(5) 7.p.62	7.p.62		7.p.62		AMS(4) 7.p.62	
Alloy	355														
Form	Sand castings								Permanent mold castings						
Condition	T51		T6		T61	T7	T71		T51	T6		T62	T7	T71	
Specimen type	Cast test bars	From casting Avg(a)	Cast test bars	From casting Avg(a)	Cast test bars		Cast test bars	From casting Avg(a)	Cast test bars	Cast test bars	From casting Avg(a)	Cast test bars		Cast test bars	From casting Avg(a)
F_{tu}, min - ksi	25	18.75	32	24	36	35	30(b)	22.5	27	37	27.7	42	36	34	25.5
F_{ty}, min - ksi	18(b)	-	20	15	31	32	22(b)	-	22	23	17	37	27	27	20
e(2in), min-percent	-	-	2	-	-	-	-	-	-	1.5	-	-	-	-	-
e(4D), min-percent	-	-	-	0.5	-	-	-	0.25	-	-	0.4	-	-	-	-
F_{cy}, min - ksi	18(b)	-	21(b)	-	33	34	23(b)	-	22	23(b)	-	37	27	27	-
F_{su}, min - ksi	19(b)	-	24(b)	-	28	25	21(b)	-	22	26(b)	-	34	27	26	-
Hardness, BHN (500 kg, 10 mm)															
min	-	55	-	65	-	-	-	65	-	-	80	-	-	-	70
max	-	-	-	95	-	-	-	86	-	-	110	-	-	-	95

(a) Average values for at least 4, preferably 10 specimens.
(b) Alcoa only.

TABLE 3.011 AMS SPECIFIED MINIMUM MECHANICAL PROPERTY LIMITS FOR 355 ALLOY.

Source	AMS (17)	
Alloy	C355	
Form	Mold type not restricted	
Condition	Solution Treated and Aged (T6)	
Specimen Type	(a)	(b)
F_{tu}, min - ksi	35	37
F_{ty}, min - ksi	28	30
e(2 in) min - percent	2	1

(a) Specimen cut from casting.
(b) Cast specimen.

TABLE 3.012 AMS SPECIFIED TENSILE PROPERTIES FOR C355 ALLOY.

Source	(19) (24)							
Alloy	355 (a)							
Form	Sand Castings				Permanent Mold Castings			
Condition	T51	T6	T7	T71	T51	T6	T62	T71
F_{tu}, min-ksi	25.0	32.0	35.0	30.0	27.0	37.0	42.0	34.0
F_{ty}, min-ksi	-	20.0	-	-	-	-	-	-
e(2 in)min-percent	-	2.0	-	-	-	1.5	-	-
(a) Values represent properties obtained from separately cast test bars.								

TABLE 3.013 ALUMINUM ASSOCIATION MECHANICAL PROPERTY LIMITS FOR SAND AND PERMANENT MOLD CASTINGS OF 355 ALLOY.

Source	(6)					
Alloy	C 355					
Form	Special mold, permanent mold or sand castings					
Condition	T61					
Specimen location in casting	Designated			Any		
Class	I	II(a)	III(a)	X	XI	XII
F_{tu}, min - ksi	41	44	50	41	37	35
F_{ty}, min - ksi	31	33	40	31	30	28
e, min - percent	3	3	5	3	1	1
(a) Obtainable only in a favorable casting configuration and must be negotiated with the foundry.						

TABLE 3.015 MILITARY SPECIFIED TENSILE PROPERTIES OF SPECIMENS CUT FROM CASTINGS.

	Al
5	Si
1.3	Cu
0.5	Mg

355

C355

Source	(19) (24)	
Alloy	C 355 (a)	
Form	Sand Castings	Permanent Mold Castings
Condition	T6	T61
F_{tu}, min - ksi	36.0	40.0
F_{ty}, min - ksi	25.0	-
e(2 in) min-percent	2.5	3.0
(a) Values represent properties obtained from separately cast test bars.		

TABLE 3.014 ALUMINUM ASSOCIATION MECHANICAL PROPERTY LIMITS FOR SAND AND PERMANENT MOLD CASTINGS OF C 355 ALLOY.

Source	(7, p. 64) MIL(6)		
Alloy	C 355		
Form	Permanent mold castings		
Condition	T61		
Specimen	From castings		
Type	(a)	(b)	(c)
F_{tu}, min - ksi	37	41	44
F_{ty}, min - ksi	30	31	33
e(2 in), min -ksi	1	3	3
F_{cy}, min - ksi	30	-	-
F_{su}, min - ksi	26	-	-
(a) Individually cast specimens.			
(b) Cut from designated location in casting.			
(c) Must be negotiated with foundry.			

TABLE 3.016 PRODUCER'S MINIMUM MECHANICAL PROPERTIES FOR C355 PERMANENT MOLD CASTINGS.

Source	(8, p.197) (9, p.198)								
Alloy	355								C355
Form	Sand Castings				Permanent Mold Castings				
Specimen type	Cast test bars								
Condition	T51	T6	T7	T71	T51	T6	T62	T71	T61
F_{tu}, typ - ksi	28	35	38	35	30	42	45	36	46
F_{ty}, typ - ksi	23	25	36	29	24	27	40	31	34
e(2 in), typ - percent	1.5	3	0.5	1.5	2	4.0	1.5	3	6
F_{cy}, typ - ksi	24	26	38	30	24	27	40	31	36
F_{su}, typ - ksi	22	28	28	26	24	34	36	27	32
Hardness - BHN	65	80	85	75	75	90	105	85	100

TABLE 3.0212 TYPICAL MECHANICAL PROPERTIES OF CAST TEST BARS.

Source	(9, p. 58)									
Alloy	355									
Form	Sand cast cylindrical bar									
Condition	T51					T6				
Section thickness-in	Test bar 0.505	3/4	1 1/4	1 3/4	2 1/4	Test bar 0.505	3/4	1 1/4	1 3/4	2 1/4
F_{tu} - ksi	34.8	29.0	26.9	23.2	21.3	27.1	27.3	22.0	19.1	18.1
F_{ty} - ksi	23.4	23.0	22.2	20.8	20.8	-	24.6	20.3	18.8	17.7
e -percent	3.3	1.7	1.0	1.0	1.0	1.3	1.0	1.0	-	1.0

TABLE 3.0213 EFFECT OF DIAMETER OF CYLINDRICAL SAND CASTINGS ON TENSILE PROPERTIES OF SPECIMENS MACHINED FROM THE CASTINGS.

	Al
5	Si
1.3	Cu
0.5	Mg

355
C355

Source	(9, p.57)				
Alloy	355				
Form	Sand castings				
Condition	T6				
Section thickness-in	≤1/8	1/8 to 1/4	1/4 to 1/2	1/2 to 3/4	3/4 to 1
F_{tu} - ksi	36.5	36.0	36.0	35.5	33.0
F_{ty} - ksi	26.0	25.75	25.5	25.0	23.0
e(4D)- percent	4.5	4.0	4.0	3.5	3.5

TABLE 3.0214 TYPICAL TENSILE PROPERTIES OF SPECIMENS CUT FROM 355-T6 SAND CASTINGS OF DIFFERENT THICKNESSES

Source	(10, p. A)		
Alloy	C 355		
Form	Premium strength castings		
Condition	T61		
	(a)	(a)	(b)
F_{tu} - ksi	43	47	50
F_{ty} - ksi	34	36	38
e - percent	4	6	7

(a) Produced in all or part of casting (as desired)
(b) Must be negotiated with foundry

TABLE 3.0215 TYPICAL TENSILE PROPERTIES OF SPECIMENS CUT FROM C355 PREMIUM STRENGTH SAND CASTINGS

Source	(22)			
Alloy	355		C 355	
Type	Sand cast	Permanent mold	Sand cast	Permanent mold
Condition				
T51	22	-	-	-
T6	28	34	-	-
T61	36(a)	-	-	32
T7	28	-	-	-
T71	26	-	-	-
T62	-	36	-	-

(a) Estimated

TABLE 3.0254 TYPICAL VALUES OF SHEAR STRENGTH FOR 355 AND C 355 ALLOYS

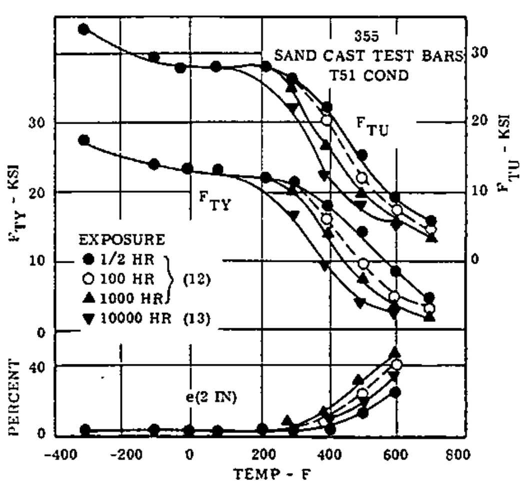

FIG. 3.0312 EFFECT OF EXPOSURE AND TEST TEMPERATURE ON TENSILE PROPERTIES OF 355 SAND CAST TEST BARS IN T51 CONDITION (12)(13, p. 104)

	Al
5	Si
1.3	Cu
0.5	Mg

355
C355

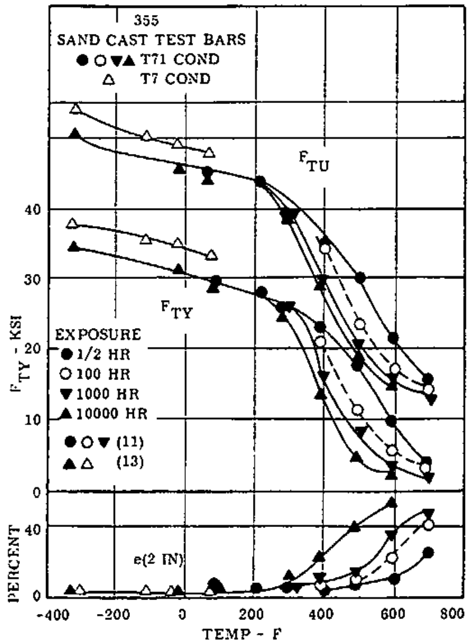

FIG. 3.0313 EFFECT OF EXPOSURE AND TEST TEMPERATURE ON TENSILE PROPERTIES OF 355 CAST TEST BARS IN T7 AND T71 CONDITIONS
(11) (13, p.105, 109)

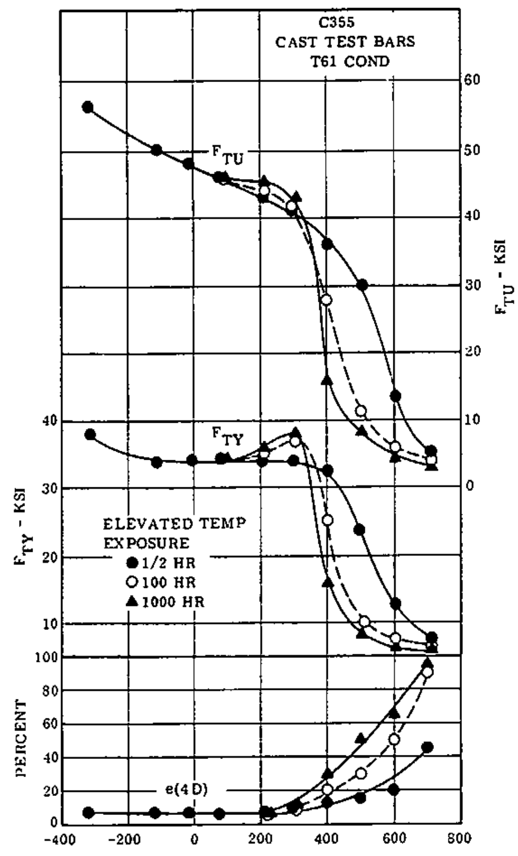

FIG. 3.0314 EFFECT OF EXPOSURE AND TEST TEMPERATURE ON TENSILE PROPERTIES OF C 355 PERMANENT MOLD CAST TEST BARS IN T61 CONDITION.
(10, p.10)

	Al
5	Si
1.3	Cu
0.5	Mg

355
C355

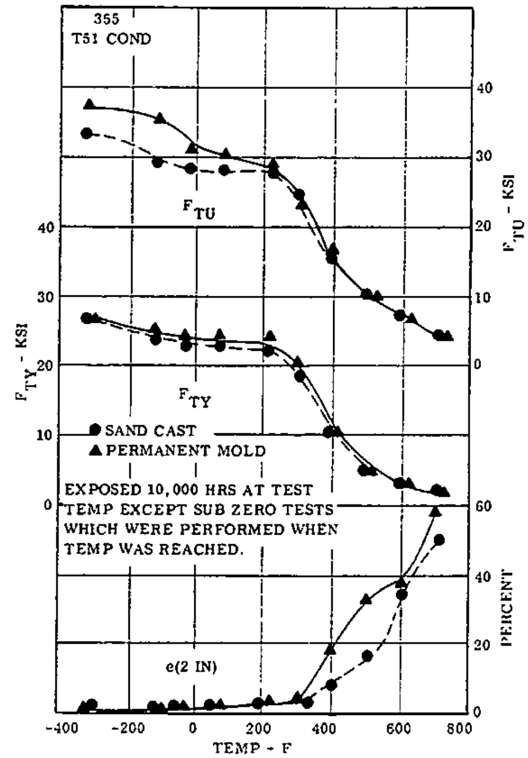

FIG. 3.0316 TENSILE PROPERTIES OF 355-T51 ALLOY AFTER LONG TIME EXPOSURE AT TEST TEMPERATURE.
(22)

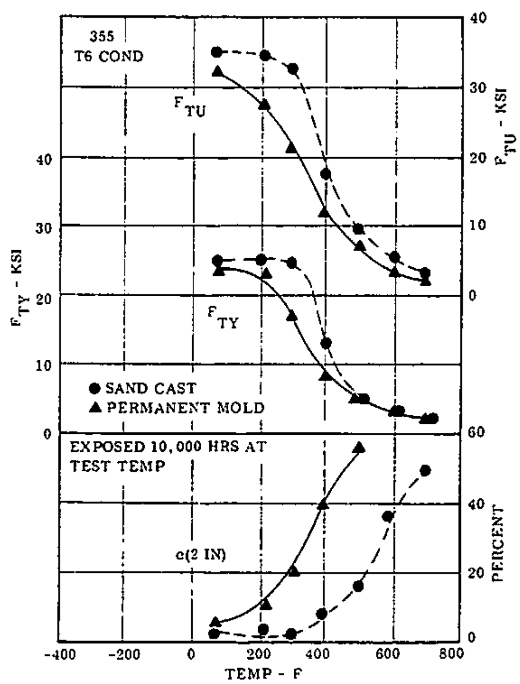

FIG. 3.0315 TENSILE PROPERTIES OF 355 - T6 ALLOY AFTER LONG TIME EXPOSURE AT TEST TEMPERATURE.
(22)

	Al
5	Si
1.3	Cu
0.5	Mg

355
C355

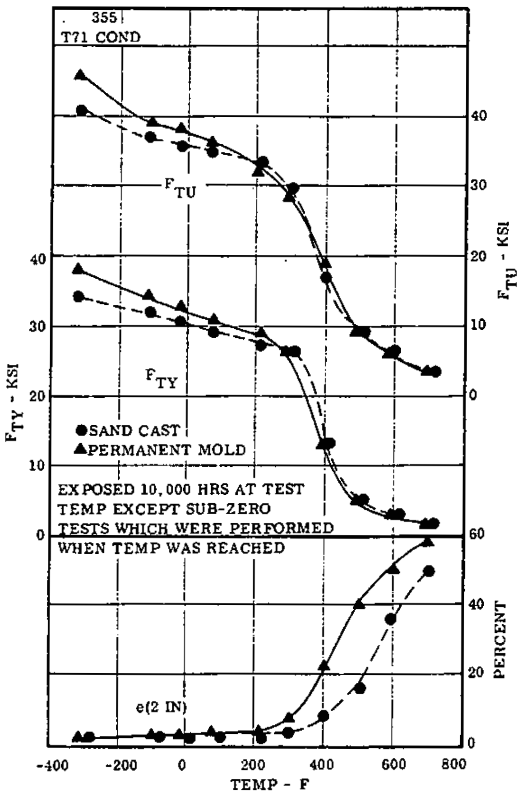

FIG. 3.0317 TENSILE PROPERTIES OF 355-T71 ALLOY AFTER LONG TIME EXPOSURE AT TEST TEMPERATURE. (22)

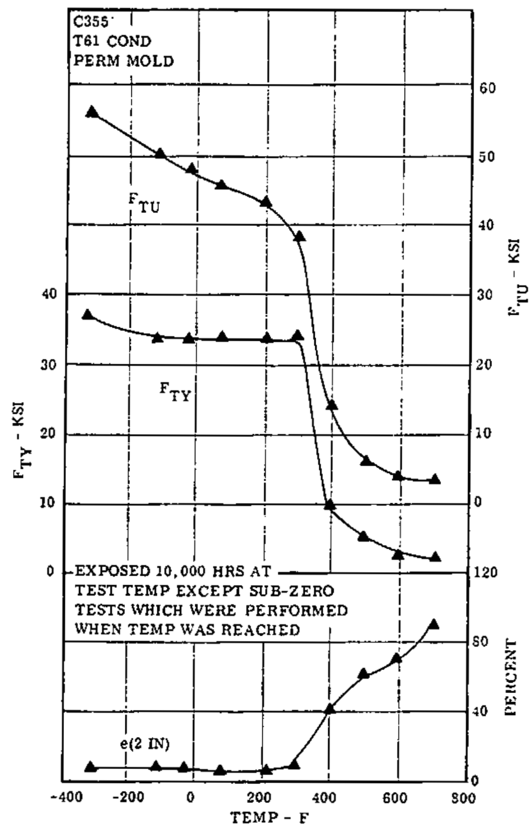

FIG. 3.0318 TENSILE PROPERTIES OF C355-T61 ALLOY AFTER LONG TIME EXPOSURE AT TEST TEMPERATURE. (22)

	Al
5	Si
1.3	Cu
0.5	Mg

355
C355

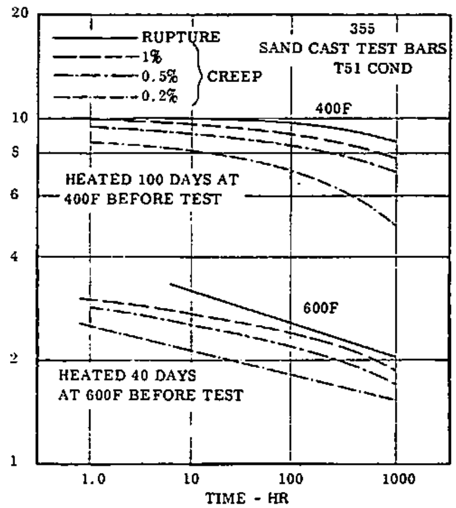

FIG. 3.041 CREEP AND CREEP RUPTURE CURVES AT 400 AND 600F FOR 355 SAND CAST TEST BARS IN T51 CONDITION.
(12)

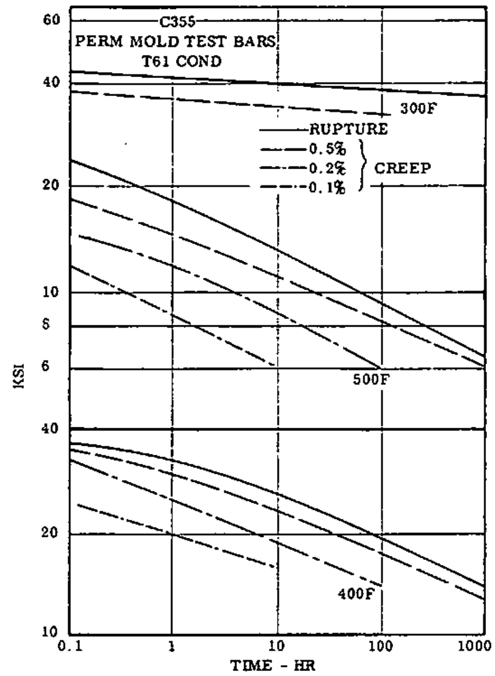

FIG. 3.043 CREEP AND CREEP RUPTURE CURVES AT 300 TO 500F FOR C 355 PERMANENT MOLD TEST BARS.
(10, p.B)

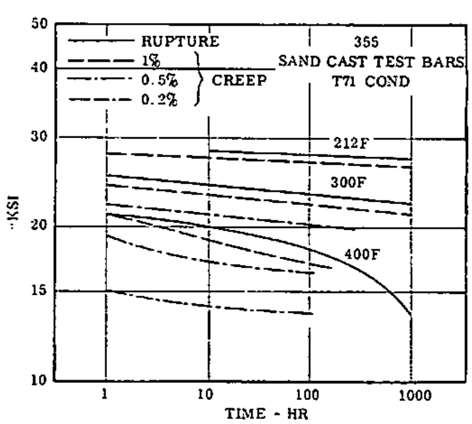

FIG. 3.042 CREEP AND CREEP RUPTURE CURVES AT 212 TO 400F FOR 355 SAND CAST TEST BARS IN T71 CONDITION.
(11)

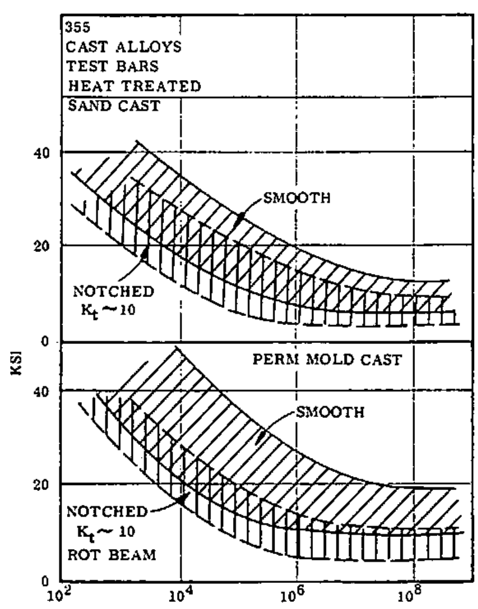

FIG. 3.052 SCATTERBANDS FOR FATIGUE STRENGTH OF HEAT TREATED CAST ALLOY TEST BARS. (9, p.59)

	Al
5	Si
1.3	Cu
0.5	Mg

355
C355

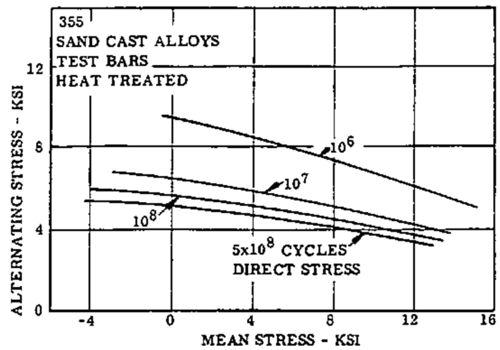

FIG. 3.053 AVERAGE STRESS RANGE DIAGRAMS FOR HEAT TREATED 355 SAND CAST TEST BARS. (8)

Source	(11) (10, p. B)									
Form	Cast test bars									
Alloy	Condition	Temp F	Method	Stress Ratio A	Stress Ratio R	Fatigue strength - ksi at cycles 10^5	10^6	10^7	10^8	$5x10^8$
355 (Sand cast)	T71	RT	Rot beam	∞	-1	21	15	12	11	10.5
		300				18	14	11	10	9.5
		400				17	13	9.5	7.5	7
		500				14	10	7	5	4.5
C355 (Permanent mold)	T61	RT	Rot beam			28	19	16	14.5	14
		300				27	18	13.5	12.5	12
		400				24	16.5	12	10	9
		500				18	11.5	7.5	5.5	5

TABLE 3.054 TYPICAL VALUES OF FATIGUE STRENGTH OF CAST TEST BARS AT ROOM AND ELEVATED TEMPERATURES.

Source	(22) (27)		
Alloy	355		C 355
Form	Sand Cast	Permanent Mold	Permanent Mold
Condition	Endurance Limit - ksi (500 x 10^6 cycles) (a)		
T51	8	-	-
T6	9	10	-
T7	10	-	-
T71	10	10	-
T62	-	10	-
T61	-	-	14
(a) R.R. Moore type rotating beam specimen.			

TABLE 3.055 TYPICAL FATIGUE PROPERTIES FOR SAND AND PERMANENT MOLD CASTINGS IN VARIOUS CONDITIONS

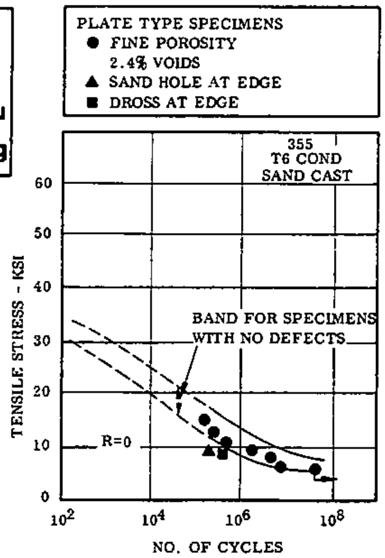

FIG. 3.056 EFFECT OF POROSITY, SAND HOLES AND DROSS ON FATIGUE PROPERTIES OF 355-T6 SAND CASTINGS.

REFERENCES

1. AMS 4210 F (Jan. 15, 1959).
2. AMS 4212 E (Jan. 15, 1959).
3. AMS 4214 D (Jan. 15, 1959).
4. AMS 4280 E (Jan. 15, 1959).
5. AMS 4281 C (Jan. 15, 1959).
6. MIL-C-21180 A (ASG).
7. Alcoa Structural Handbook (1958).
8. Alcoa Aluminum Handbook (1959).
9. Metals Handbook Supplement (1955).
10. Burton, C. L., "Premium Castings", Alcoa Green Letter (Supersedes GL159), Aluminum Company of America, Applications Engineering Division, New Kensington, Pennsylvania.
11. Alcoa Research Laboratories, "Data Sheet" (Sep. 9, 1957).
12. Alcoa Research Laboratories, "Data Sheet" (March 16, 1956).
13. Reynolds Metals Co., "The Aluminum Data Book - Aluminum Alloys and Mill Products" (1958).
14. Heimer, George J., "Time-Temperature Parameters and an Application to Rupture and Creep of Aluminum Alloys", NACA TN 3195 (June 1954).
15. American Society for Metals, "Metals Handbook", 8th Ed. (1961).
16. American Society for Metals, "Metals Handbook", 7th Ed. (1948).
17. AMS 4215 B (Jan. 15, 1962).
18. "Standards for Aluminum Sand and Permanent Mold Castings", 4th Ed., The Aluminum Association (July 1972).
19. "Aluminum Standards and Data - 1976", 5th Ed., The Aluminum Association (Jan. 1976).
20. ASTM B26-75, "Standard Specification for Aluminum-Alloy Sand Castings", American Society for Testing and Materials (1975).
21. ASTM B108-75, "Standard Specification for Aluminum-Alloy Permanent Mold Castings", American Society for Testing and Materials (1975).
22. "Aluminum - Properties, Physical Metallurgy and Phase Diagrams", Vol. 1, Edited by Kent R. Van Horn, American Society for Metals (1967).
23. Everhart, John L., "Aluminum Alloy Castings", Materials in Design Engineering, (Feb. 1958).
24. Materials Engineering, Materials Selector Issue, Vol. 66, No. 5 (Oct. 1967).
25. "Aluminum Construction Manual, Sec. 3, Engineering Data for Aluminum Structures", 2nd Ed., The Aluminum Association (1972).
26. "Standards for Aluminum Sand and Permanent Mold Castings", 6th Ed., The Aluminum Association (1975)
27. "Alcoa Aluminum Handbook", Aluminum Company of America (1962).
28. "Aluminum - Fabrication and Finishing", Vol. 3, Edited by K. R. Van Horn, American Society for Metals (1967).
29. "Welding Aluminum" American Welding Society, 6th Ed. (1972).
30. 1975 Annual Book of ASTM Standards, "Die-Cast Metals; Aluminum and Magnesium Alloys", Part 7 (July 1975).
31. Holt, M., "Some Factors Affecting Fatigue Strength of Aluminum Alloy Sand Castings", Aluminum Company of America (1954).