

## Aluminum Castings

Many foundries only run a handful of common alloys. At Warner Bros. Foundry Company our reputation is on running a wide range of aluminum and copper-based alloys.

If you don't see any alloy of interest, listed below, please let us know. We are happy to quote other alloys. Only the highest quality Certified Ingot is used for the production of our Aluminum casting.

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## Aluminum Alloy Specs

### Composition

Designations and nominal compositions of common aluminum alloys used for sand casting.

AA Number	Former AA designations	Former ASTM number	Cu	Mg	Mn	Si	Others
A206.0	...	...	4.6	0.25	0.35	0.05 (Max)	0.22 Ti, 0.10 Fe (Max)
319.0	319, Allcast	SC64D	3.50	...	...	6.00	...
C355.0	C355	SG51B	1.20	0.50	0.10 (Max)	5.00	0.60 Fe (Max), 0.35 Zn (Max)
A356.0	A356	SG70B	0.20 (Max)	0.35	0.10 (Max)	7.00	0.20 Fe (Max), 0.10 Zn (Max)
A357.0	A357	...	...	0.60	...	7.00	0.15 Ti, 0.005 Be
535.0	Almag 35	GM70B	...	6.80	0.18	...	0.18 Ti
713.0	613, Tenzaloy	ZC81A,B	0.70	0.35	...	...	7.5 Zn, 0.7 Cu
771.0	Precedent 71A	ZG71B	...	0.90	...	...	7.0 Zn, 0.13 Cr, 0.115 Ti
850.0	750	...	1.00	...	...	...	6.2 Sn, 1.0 Ni

### Characteristics

Characteristics of common aluminum alloys used in sand casting.

Alloy	Fluidity	Resistance to hot cracking	Pressure tightness	Heat Treatment	Strength at elevated temperatures	General corrosion resistance	Machining	Polishing	Anodizing Apperance	Weldability
319.0	2	2	2	Optional	3	3	3	4	4	2
C355.0	1	1	1	Yes	2	3	3	3	4	1
A356.0	1	1	1	Yes	3	2	3	4	4	1
A357.0	1	1	1	Yes	2	2	3	4	4	1
535.0	5	4	5	Optional	3	1	1	1	1	4
713.0	3	4	4	No	4	3	1	1	1	4
771.0	3	4	4	Yes	4	3	1	1	1	4
850.0	4	5	5	Yes	5	4	1	3	...	5

*Characteristics are comparatively rated from 1 to 5; 1 is the highest or best possible rating.*

## Alloy Uses

Alloy	Uses
A206.0	Gear housings, truck spring hanger, cylinder heads, turbine, supercharger impellers
319.0	Engine crankcase covers, electrical boxes, gear boxes
C355.0	Air-compressor fittings, crankcase, gear housings, hydraulic fittings
A356.0	Automobile transmission cases, oil pans and rear-axle housings
A357.0	Pump bodies, cylinder blocks for water cooled engines
535.0	Marine industry, corrosive prone applications
713.0	General-purpose casting alloy for applications that require strength without heat treament or that involve brazing

## Test Bar

Typical Tensile Properties for separately cast test bars of common aluminum casting alloys.

Tensile strength				Yield strength		Shear strength		Compressive yield strength		
Alloy	Temper	Mpa	ksi	Mpa	ksi	Mpa	ksi	Mpa	ksi	Elongation %
A206.0	T7	435	63	345	50	257	37	372	54	11.7
319.0	F	185	27	125	18	150	22	130	19	2
319.0	T6	250	36	165	24	200	29	170	25	2
355.0	T6	240	35	175	25	195	28	180	26	3
355.0	T7	265	38	250	36	195	28	260	38	0.5
356.0	T6	230	33	165	24	180	26	170	25	3.5
356.0	T7	235	34	210	30	165	24	215	31	2
535.0	F	275	40	140	20	190	27.5	162	23.5	13
713.0	T5	210	30	150	22	180	26	170	25	3
771.0	T71	330	48	310	45	...	...	370	54	2

## Typical Properties & Characteristics of Aluminum Sand Casting

Typical Aluminum Alloys (a)					Resistance to Corrosion (b)					Typical Mechanical Properties						
AA	Former AA Designation	ASTM Spec. No.	Federal Spec. No.	SAE Alloy No.	Approx. Weight, lb./in.3	General	Stress Corrosion Cracking	Relative Machinability (c)	Castability (k)	Weldability (Arc) (d)	Ultimate Tensile Strength, ksi (i)	Yield Strength Tension, ksi (e) (i)	Elongation, Percentage in 2 in. (Round Specimen, 1/2" Dia.) (f) (i)	Shear Strength, ksi (g)	Fatigue Endurance Limit, ksi (h)	Brinell Hardness (500-kg Load, 10-mm Ball) (j)
206.0-T4	...	B26	QQ-A-601	...	0.101	2	B	3	2	2	51	36	7	40	9.5	104
A206.0-T7	...	B26	QQ-A-601	...	0.101	2	B	3	2	2	63	50	3	37	10	122
319.0-F	319, Allcast	B26	QQ-A-601	329	0.101	3	B	4	4	4	27	18	2	22	10	70
319.0-T5	319, Allcast	...	....	...	0.101	3	B	3	2	2	30	26	1.5	24	11	80
319.0-T6	319, Allcast	B26	QQ-A-601	329	0.101	3	C	3	2	2	36	24	2	29	11	80
355.0-T6	355	B26	....	322	0.098	3	A	3	1	2	35	25	3	28	9	80
355.0-T7	355	B26	QQ-A-601	...	0.098	3	A	3	1	2	38	36	0.5	38	10	85
C355.0-T6	C355	B26	....	...	0.098	3	A	3	1	2	38	28	5	28	10	90
356.0-T6	356	B26	QQ-A-601	323	0.098	2	A	4	1	2	33	24	3.5	26	8.5	70
356.0-T7	356	B26	QQ-A-601	...	0.098	2	A	4	1	2	34	30	2	24	9	75
A356.0-T6	A356	...	....	...	0.096	2	A	4	1	2	37	27	5	20	8.5	80
535.0-F	Almag 35	B26	QQ-A-601	324	0.095	1	A	1	5	4	40	21	13	28	10	70
713.0-T5	613, Tenzaloy	B26	QQ-A-601	315	0.102	2	B	1	4	4	35	25	4	26	9	74
771.0-T5	Precedent 71A	B26	QQ-A-601	...	0.102	2	B	1	4	4	42	38	1.5	...	...	100
771.0-T6	Precedent 71A	B26	QQ-A-601	...	0.102	2	B	1	4	4	42	35	5	...	...	90

### Footnotes:

(a) For all Alcoa casting alloys, the following data apply: (a) Young's modulus of elasticity may be taken as 10,300,000 pounds per square inch (710 gram-pascals); (b) Modulus of rigidity may be taken as 3,800,000 pounds per square inch (262 gram-pascals); (c) Poisson's ratio is 33; (d) Bearing strength is equal to 1.8 times tensile strength, provided edge distance, in direction of stressing, is not less than twice the diameter of the hole.

(b) Relative ratings of general corrosion resistance 1 through 5 are in decreasing order of merit, based on exposures to sodium chloride solution intermittent spray or immersion. Relative ratings of resistance to stress corrosion cracking are based on service experience and on laboratory tests of specimens exposed to the 3.5 percent sodium chloride alternate immersion test.

A – No known instance of stress corrosion cracking in service when properly manufactured; B – Stress corrosion cracking not anticipated in service from residual stresses or from design and assembly stresses kept below about 45 percent of the minimum guaranteed yield strength given in applicable specifications; C – Stress corrosion failures have occurred in service with either the specific alloy and temper or with alloys and tempers of this type. Designers should be aware of the potential stress corrosion cracking problem that exists when using these alloys and tempers under adverse conditions.

(c) Composite rating based on ease of cutting, chip characteristics, quality of finish and tool life. 1 – indicates best; 5 – indicates not recommended

(d) Based on ability of alloy to be fusion welded prior to heat treatment with filler rod of same alloy. 1 – indicates best; 5 – indicates welding not recommended

(e) Yield strength is the stress at which the material exhibits a permanent set of 0.2 percent.

(f) For die casting alloys, 1/4 inch (6.35 mm) diameter.

(g) Shearing strengths are single-shear values obtained from double-shear tests.

(h) Fatigue endurance values are based on withstanding 500 million cycles of completely reversed stress using the R.R. Moore type of machine and specimen.

(i) Mechanical properties are obtained on separately cast ASTM specimens. Since minimum guaranteed values vary with the applicable specifications, they are not given on this table.

(j) From tests made approximately 30 days after casting.

(k) Castability is rated on a scale of 1 through 5, in which higher numbers indicate lower merit. For sand and permanent-mold alloys, the ratings take into account resistance to hot cracking, fluidity and feeding ability. For die castings, the resistance to hot cracking, fluidity, die soldering and cast surface finish are considered. Even the alloys with the lowest rating of 5 may be successfully used with the proper techniques to produce commercial castings.

## Zinc Alloy Properties

ALLOY	ZA-8	ZA-12	ZA-27
Mechanical Properties	Sand Cast / Perm Mold / Die Cast	Sand Cast / Perm Mold / Die Cast	Sand Cast / Perm Mold / Die Cast
Ultimate Tensile Strength psi x 103	38/32-37/54	40-46/45-50/58	58-64/45-47/61
Yield Strenght-0.2% Offset psi x 103	29/30/42	31/39/46	54/37/55
Elongation % in 2"	1-2/1-2/6-10	1-3/1-3/4-7	3-6/8-11/1-3
Shear Strength psi x 103	na/35/40	37/na/43	42/33/47
Hardness Brinell	85/85-90/95-110	89-105/89-105/95-115	110-120/90-110/105-125
Impact Strength ft-lb	156/na/313	193/na/213	353/433/93
Fatigue Strength Rotary Bend (psi x 10 <sup>3</sup> ) 5 x 108 cycles	na/7.5/15	15/na/17	25/15/21
Compressive Yield Strength 0.1% Offset psi x 103	29/31/37	33/34/39	48/37/52
Modulus of Elasticity psi x 106	12.4/12.47/na	na/12^7/na	na/11.37/na
Poisson's Ratio	na/0.29/na	na/.3/na	na/.32/na
Physical Properties			
Density lb/cu in	0.227	0.218	0.181
Melting Range 0F	707-759	710-810	708-903

Electrical Conductivity %IACS	27.7	28.3	29.7
Thermal conductivity BTU/ft/hr/ 0F	66.3	67.1	72.5
Coefficient of thermal Expan 68-2120Fµin/in/ 0F	12.9	13.4	14.4
Specific Heat BTU/lb/ 0F Pattern or Die Shrinkage in/in	0.104 na/ 1/8 in/ft/ .007	0.107 1/8in/ft /5/32in /ft/.0075	0.125 5/32in/ft /5/32in/ft /.008

### Chemical & North American Color Code Requirements

ASTM B240	ZA-8 ZA-8	ZA-12 ZA-12	ZA-27 ZA-27
Aluminum	8.2-8.8	10.8-11.5	25.5-28.0
Magnesium	0.02-0.03	0.02-0.03	0.012-0.020
Copper	0.9-1.3	0.5-1.2	2.0-2.5
Iron, Max	0.035	0.05	0.07
Lead, Max	0.005	0.005	0.005
Cadmium, Max	0.005	0.005	0.005
Tin, Max	0.002	0.002	0.002
Nickel	...	0.005-0.020	...
Zinc	Remainder	Remainder	Remainder

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