Aluminum Die Casting Alloys

Commercial: ANSI/AA	360 360.0	A360 A360.0	380 380.0	A380 EF A380.0	383 E 383.0	384 384.0	390* B390.0	13 413.0	A13 A413.0	43 C443.0	218 518.0
Mechanical Properties											
Ultimate Tensile Strength ksi (MPa)	44 (303)	46 (317)	46 (317)	47 (324)	45 (310)	48 (330)	46 (317)	43 (300)	42 (290)	33 (228)	45 (310)
Yield Strength a ksi (MPa)	25 (170)	24 (170)	23 (160)	23 (160)	22 (150)	24 (165)	36 (250)	21 (140)	19 (130)	14 (97)	28 (193)
Elongation % in 2in. (51mm)	2.5	3.5	3.5	3.5	3.5	2.5	<1	2.5	3.5	9.0	5.0
Hardness b BHN	75	75	80	80	75	85	120	80	80	65	80
Shear Strength ksi (MPa)	28 (190)	26 (180)	28 (190)	27 (190)	–	29 (200)	–	25 (170)	25 (170)	19 (130)	29 (200)
Impact Strength ft-lb (J)	–	–	3 (4)	–	3 d (4)	–	–	–	–	–	7 (9)
Fatigue Strength c ksi (MPa)	20 (140)	18 (120)	20 (140)	20 (140)	21 (145)	20 (140)	20 (140)	19 (130)	19 (130)	17 (120)	20 (140)
Young's Modulus psi x 10^6 (GPa)	10.3 (71)	10.3 (71)	10.3 (71)	10.3 (71)	10.3 (71)	–	11.8 (81.3)	10.3 (71)	–	10.3 (71)	–
Physical Properties											
Density lb/in ^{3} (g/cm ^{3})	0.095 (2.63)	0.095 (2.63)	0.099 (2.74)	0.098 (2.71)	0.099 (2.74)	0.102 (2.82)	0.098 (2.71)	0.096 (2.66)	0.096 (2.66)	0.097 (2.69)	0.093 (2.57)
Melting Range °F (°C)	1035-1105 (557-596)	1035-1105 (557-596)	1000-1100 (540-595)	1000-1100 (540-595)	960-1080 (516-582)	960-1080 (516-582)	950-1200 (510-650)	1065-1080 (574-582)	1065-1080 (574-582)	1065-1170 (574-632)	995-1150 (535-621)
Speci☒c Heat BTU/lb °F (J/kg °C)	0.230 (963)	0.230 (963)	0.230 (963)	0.230 (963)	0.230 (963)	–	–	0.230 (963)	0.230 (963)	0.230 (963)	–
Coef☒cient of Thermal Expansion ☒in/in°F (☒m/m°K)	11.6 (21.0)	11.6 (21.0)	12.2 (22.0)	12.1 (21.8)	11.7 (21.1)	11.6 (21.0)	10.0 (18.0)	11.3 (20.4)	11.9 (21.6)	12.2 (22.0)	13.4 (24.1)
Thermal Conductivity BTU/ft hr°F (W/m °K)	65.3 (113)	65.3 (113)	55.6 (96.2)	55.6 (96.2)	55.6 (96.2)	55.6 (96.2)	77.4 (134)	70.1 (121)	70.1 (121)	82.2 (142)	55.6 (96.2)
Electrical Conductivity % IACS	30	29	27	23	23	22	27	31	31	37	24
Poisson's Ratio	0.33	0.33	0.33	0.33	0.33	–	–	–	–	0.33	–

a 0.2% offset. b 500 kg load, 10mm ball. c Rotary Bend 5 x 10^8 cycles. d Notched Charpy. Sources: ASTM B85-92a; ASM; SAE; Wabash Alloys. E A 0.3% Mg version of A380 and 383 have been registered with the Aluminum Association as E380 and B383. F Higher levels of Mg and the addition of Sr to alloy A380 have shown positive results. The limited data on page 3-7 shows the effect.

* Two other aluminum alloys, 361 & 369, are being utilized in limited applications where vibration and wear are of concern. There are also other heat treatable specialty alloys available for structural applications, such as the Silafonts and AA365. Contact your alloy producer for more information. More information can also be obtained from Microstructures and Properties of Aluminum Die Casting Alloys Book, NADCA Publication #215 and the High Integrity Aluminum Die Casting Book, NADCA Publication #307.

Alloy Data

Die casting alloy selection requires evaluation not only of physical and mechanical properties, and chemical composition, but also of inherent alloy characteristics and their effect on die casting production as well as possible machining and final surface finishing.

This table includes selected die casting and other special characteristics which are usually considered in selecting an aluminum alloy for a specific application.

The characteristics are rated from (1) to (5), (1) being the most desirable and (5) being the least. In applying these ratings, it should be noted that all the alloys have sufficiently good charac teristics to be accepted by users and producers of die castings. A rating of (5) in one or more categories would not rule out an alloy if other attributes are particularly favorable, but ratings of (5) may present manufacturing difficulties.

The benefits of consulting a custom die caster experienced in casting the aluminum alloy being considered are clear.

Table A-3-3 Die Casting And Other Characteristics: Al Alloys
(1 = most desirable, 5 = least desirable)

	Aluminum Die Casting Alloys										
Commercial: ANSI/AA	360 360.0	A360 A360.0	380 380.0	A380 A380.0	383 383.0	384 384.0	390* B390.0	13 413.0	A13 A413.0	43 C443.0	218 518.0
Resistance to Hot Cracking a	1	1	2	2	1	2	4	1	1	3	5
Pressure Tightness	2	2	2	2	2	2	4	1	1	3	5
Die-Filling Capacity b	3	3	2	2	1	1	1	1	1	4	5
Anti-Soldering to the Die c	2	2	1	1	2	2	2	1	1	4	5
Corrosion Resistance d	2	2	4	4	3	5	3	2	2	2	1
Machining Ease & Quality e	3	3	3	3	2	3	5	4	4	5	3
Polishing Ease & Quality f	3	3	3	3	3	3	5	5	5	4	1
Electroplating Ease & Quality g	2	2	1	1	1	2	3	3	3	2	5
Anodizing (Appearance) h	3	3	3	3	3	4	5	5	5	2	1
Chemical Oxide Protective Coating i	3	3	4	4	4	5	5	3	3	2	1
Strength at Elevated Temp. j	1	1	3	3	2	2	3	3	3	5	4

a Ability of alloy to withstand stresses from contraction while cooling through hot-short or brittle temperature ranges. b Ability of molten alloy to *flow* readily in die and *fill* thin sections. c Ability of molten alloy to *flow* without sticking to the die surfaces. Ratings given for anti-soldering are based on nominal iron compositions of approximately 1%. d Based on resistance of alloy in standard type salt spray test. e Composite rating based on ease of cutting, chip characteristics, quality of *finish*, and tool life. f Composite rating based on ease and speed of polishing and quality of *finish* provided by typical polishing procedure. g Ability of the die casting to take and hold an electroplate applied by present standard methods. h Rated on lightness of color, brightness, and uniformity of clear anodized coating applied in sulphuric acid electrolyte. I Rated on combined resistance of coating and prolonged heating at testing temperature. Sources: ASTM B85-92a; ASM; SAE

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Note: Die castings are not usually solution heat treated. Low-temperature aging treatments may be used for stress relief or dimensional stability. A T2 or T5 temper may be given to improve properties. Because of the severe chill rate and *ultra-fine* grain size in die castings, their "as-cast" structure approaches that of the solution heat-treated condition. T4 and T5 temper results in properties quite similar to those which might be obtained if given a full T6 temper. Die castings are not generally gas or arc welded or brazed.

Additional A380 Alloy Tensile Data
(Data is from separately cast specimines in the naturally aged condition)

Alloys	Tensile ksi (MPa)	Yield ksi (MPa)	Elong %
A380 at 0.09% Mg	45.5 (243)	23.8 (135)	2.6
A380 with 0.26% Mg	47.0 (201)	26.6 (183)	2.8
A380 with 0.33% Mg + 0.035% Sr*	45.7 (177)	28.5 (196)	2.4

* *Identified* as AMC380* in research being conducted by WPI and funded by DoD/DLA.
The values in this table are the average mean values and are provided to indicate the effect of a higher magnesium content and additional strontium. The properties shown do not represent design minimums and should be used for reference only.