

SELECTION AND USE OF ALUMINUM ALLOY CASTINGS (NOT PART OF THE SPECIFICATIONS)

GM4000M

1 GENERAL CHARACTERISTICS. Permanent mold castings, sand castings and die castings can be produced to a variety of metallurgical properties. The Aluminum Association publishes a handbook (See NOTE 1), Standards for Aluminum, Sand and Permanent Mold Castings, which discusses these in some detail. While this publication provides an excellent guide to designers and others dealing with aluminum, it is appropriate to add here that in considering the use of aluminum for parts currently made from ferrous materials, the following factors should be remembered since some redesign may be required.

- A. Fatigue strength is usually lower.
- B. Compressive yield strength is lower, possibly resulting in brinelling or indentation problems.
- C. Galvanic corrosion may result where aluminum is assembled directly with other metals and exposed to water or some other electrolyte.
- D. Thermal expansion is greater.
- E. Strength is reduced as operating temperature increases, with the rate of loss increasing very markedly over 150 C.
- F. Elongation increases as operating temperatures are reduced below freezing for some of the alloys. This property makes aluminum worthy of consideration for specialized applications.
- G. Modulus of elasticity is lower.
- H. Galling may be encountered during press fitting or heavy bearing loads.

1.1 The necessary factors required in deciding which casting to use, sand, permanent mold, or die casting is dependant upon the mechanical properties and dimensional tolerances required, the number of castings to be made, the surface finish desired and the amount of machining necessary.

1.2 Sand castings usually are used when the number required is small, when a smooth surface is not required or can be secured economically by machining, and when close tolerances on as-cast dimensions are not essential.

1.3 Permanent mold castings usually have a smoother finish and may thus require less machining, can be cast to closer tolerances, and, for the same composition, generally have slightly higher mechanical properties.

1.4 Die castings can be held to much closer tolerances than either sand or permanent mold castings and are produced with very smooth surfaces. Many drilling operations are eliminated through complex coring. The lower machining and finishing costs of die castings are important factors in determining the volumes necessary to justify die costs.

1.5 Typical characteristics of aluminum casting alloys are listed in Table III from both the foundryman's and user's points of view.

1.6 Lost foam castings are used where intricate and complex castings are required. The lost foam process provides design

flexibility and capability to combine parts into a single casting while providing good dimensional control.

2 TEMPER DESIGNATION SYSTEM. The standard temper designation system used for cast aluminum is based on the sequence of basic treatments used to produce the various tempers. The temper designation follows the alloy designation, the 2 being separated by a dash; i.e., UNS A07130-T5.

2.1 Basic temper designations consist of letters which are sometimes followed by 1 or more numbers which indicate changes from the originally developed treatment.

2.1.1 The basic temper designations for castings are as follows:

- A. -F (As Cast). Cooled naturally from the mold in room temperature air with no further heat treatment.
- B. -T2 (Annealed). Applies to products which are thermally treated to improve ductility and dimensional stability.
- C. -T4 (Solution heat treated and naturally aged). Applies to products which are in a substantially stable condition. Mechanical properties and stability may change over a long period of time.
- D. -T5 (Artificially aged only). Naturally cooled from the mold and then artificially aged to attain improved mechanical properties and dimensional stability.
- E. -T6 (Solution heat treated and artificially aged). Applies to products that are thermally treated to attain optimum mechanical properties and generally good dimensional stability.
- F. -T7 (Solution heat treated and over aged). Applies to products which are stabilized to carry them beyond the point of max strength to provide good dimensional stability.

3 SIMILAR SPECIFICATIONS OF ALUMINUM CASTING ALLOYS. Table I lists the UNS/AA specifications with equivalent specifications of other systems, and equivalent GM specifications which should be discontinued in favor of the UNS/AA writings. Values for UNS numbers were taken from the Aluminum Association (AA) handbook.

4 TYPICAL USES. See Table II.

5 CHEMICAL COMPOSITION. Composition of each alloy is shown in the tables of the specifications for aluminum alloy castings which immediately follow Selection and Use of Aluminum Alloy Castings.

6 MECHANICAL AND PHYSICAL PROPERTIES. Mechanical and physical properties of each alloy are shown in the specifications for aluminum alloy castings which immediately follow Selection and Use of Aluminum Alloy Castings. It should be noted that hardness limits are specified only in GM specifications; other systems list typical hardness only.

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7 TYPICAL THERMAL TREATMENT. Typical thermal treatments for sand castings and permanent mold castings are shown in Table IV.

Rev	Date	Description	Div
C	4/89	Editorial to CD Rom System	
D	12/89	Added Lost Foam Castings	Met

8 GENERAL INFORMATION. This standard was issued in September 1959. The latest revisions include the following:

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TABLE I – SIMILAR ALUMINUM ALLOY CASTING DESIGNATIONS

UNS Number ¹	GM Number ²	SAE Number	AA Designation	Former ASTM Designation ³	Former Commercial Designation	Federal ⁴	AMS	Type of Casting ⁵
A02010		382	201	CQ51A	K01		4228, 4229	S, PM
A02040								S, PM
A02080	4232M		208	CS43A	108			S, PM
A02130		33	213	CS74A	C113			S, PM
A02220		34	222	CG100A	122	Class 7, Class 2		S, PM
A02240			224					PM
A02380			238	CS104A				PM
A02420	4231M	39	242	CN42A	142	Class 6, Class 3	4222	S, PM
	4224M	300		CS66A	152			PM
A02490			249					PM
A02950	4147M	38	295	C4A	195	Class 4	4230, 4231	S
A03080			308		A108			S, PM
	6012M							D
A03190	4227M	326	319	SC84D	319 (all cast)	Class 18		S, PM
	3996M		319		319	Class 18		S
A03240			324					PM
A03280		327	328	SC82A	Red X-8	Class 20		S
		328		SC122A	B132			PM
A03330		331	333	SC94A	333	Class 17		PM
A03540			354	SC92A	354			PM
A03550	4322M	322	355	SC51A	355	Class 10, Class 6	4210, 4212, 4214, 4280, 4281	S, PM
A03560	4323M	323	356	SG70A	356	Class 3, Class 8	4217, 4284, 4286	S, PM
A03570			357		357			S, PM
A03590			359	SG91A	359			S, PM
A03600			360	SG100B	360			D
A03630			363					
A03640			364		364			D
A03800		308	380	SC84B	380	Alloy 380		D
A03830		383	383	SC102A				D
A03840		303	384	SC114A	384	Alloy 384		D

Notes listed at end of table.

(Table I—Continued)
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TABLE I (Continued)

UNS Number ¹	GM Number ²	SAE Number	AA Designation	Former ASTM Designation ³	Former Commercial Designation	Federal ⁴	AMS	Type of Casting ⁵
	6182-M							D
A03900			390					D
A03920			392					D
A03930			393					S, PM, D
A04130			413	S12B	13			D
A04430	4210-M	35	443	S5B	43	Class 2, Class 7		S, PM
	3995-M				F214			S
A05140		320	514	G4A	214	Class 5		S
A05180	4219-M		518	G8A	218			D
A05200	4197-M	324	520	G10A	220	Class 16	4240	S
A05350			535	GM70B	B218, ALMAG 35			S, PM
A07050		311	705	ZG32A	603, Ternalloy 5	Class 24, Class 13		S, PM
A07070		312	707	ZG42A	607, Ternalloy 7	Class 25, Class 14		S, PM
A07130		315	713	ZC81A	613, Tenzaloy	Class 22, Class 12		S, PM
				ZC81B				
A07710			771	ZG71B	71A			S
A08500			850		750			S, PM
A12400			A240					S
A12420			A242					S
A13190			A319					
A13320	4145-M	321	A332	SN122A	A132	Class 9		PM
A13330			A333					
A13560		336	A356	SG70B	A356		4218	S, PM
A13570			A357		A357			S, PM
A13600		309	A360	SG100A	A360	Alloy A360		D
	3994-M							D
A13800	4199-M	306	A380	SC84A	380	Alloy A380	4291 Comp 2	D
A13840			A384		384			D
	6011-M							D
A13900			A390					S, PM
A14130	4097-M	305	A413	S12A	A13	Alloy A13		D
A14430			A443	S5B (0.30 Cu)	43			S, PM
A14440			A444	S7A	A344			PM
A15140			A514	GZ42A	A214			PM
A15350			A535					S
A17120		313	A712	ZG61B	A612	Class 23		S

Notes listed at end of table.

(Table I--Continued)

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TABLE I (Continued)

UNS Number ¹	GM Number ²	SAE Number	AA Designation	Former ASTM Designation ³	Former Commercial Designation	Federal ⁴	AMS	Type of Casting ⁵
A18500			A850		A750			S, PM
A22950		380	B295		B195	Class 4	4282, 4283	PM
A23580			B358					S, PM
A23800			B380					D
A23840			B384					
A24430			B443	S5A	43			S, PM
A25140			B514	GS42A	B214			S, PM
A25350			B535		B218			S,
A27710			B771		71B			S,
A28500			B850		B750			S, PM
A33550		335	C355	SC51B	C355		4215	S, PM
A34430		304	C443	S5C	A43	Alloy 43		D
A37120		314	C712	ZC60A	C612			PM
A47120	3950-M	310	D712	ZG61A	D612, 40E	Class 17		S
A63320	4334-M	332	F332	SC103A	F132			PM
A63560			F356					
A65140			F514		F214			S
		334	Z332		E132			PM

¹ A unified numbering system which incorporates the current "AA" designation.

² Users should discontinue the use of these GM numbers in favor of the UNS number; GM numbers should be used for materials not covered by UNS.

³ ASTM B26 covers all sand casting specifications; ASTM B85 all die casting specifications ASTM B108 all permanent mold castings.

⁴ Federal specification QQ-A801 covers all sand casting specifications; QQ-A596 all permanent mold castings; QQ-A591 all die casting specifications.

⁵ S = Sand Cast, PM = Permanent Mold, D = Die Cast