



Designation: B618/B618M – 14

Standard Specification for Aluminum-Alloy Investment Castings¹

This standard is issued under the fixed designation B618/B618M; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification covers aluminum-alloy investment castings designated as shown in [Table 1](#).

1.2 This specification is for aluminum-alloy investment castings used in general purpose applications. It may not address the mechanical properties integrity testing and verification required for highly loaded or safety critical applications.

1.3 Alloy and temper designations are in accordance with ANSI H35.1/H35.1 (M). The equivalent Unified Numbering System alloy designations are in accordance with Practice [E527](#).

1.4 Unless the order specifies the “M” specification designation, the material shall be furnished to the inch-pound units.

1.5 For acceptance criteria for inclusion of new aluminum and aluminum alloys and their properties in this specification, see [Annex A1](#) and [Annex A2](#).

1.6 *Units*—The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 The following documents of the issue in effect on the date of purchase form a part of this specification to the extent referenced herein:

2.2 ASTM Standards:²

- [B179](#) Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Casting Processes
- [B275](#) Practice for Codification of Certain Zinc, Tin and Lead Die Castings
- [B557](#) Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
- [B557M](#) Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)
- [B660](#) Practices for Packaging/Packing of Aluminum and Magnesium Products
- [B881](#) Terminology Relating to Aluminum- and Magnesium-Alloy Products
- [B917/B917M](#) Practice for Heat Treatment of Aluminum-Alloy Castings from All Processes
- [B985](#) Practice for Sampling Aluminum Ingots, Billets, Castings and Finished or Semi-Finished Wrought Aluminum Products for Compositional Analysis
- [D3951](#) Practice for Commercial Packaging
- [E29](#) Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- [E34](#) Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys
- [E94](#) Guide for Radiographic Examination
- [E155](#) Reference Radiographs for Inspection of Aluminum and Magnesium Castings
- [E165](#) Practice for Liquid Penetrant Examination for General Industry
- [E527](#) Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)
- [E607](#) Test Method for Atomic Emission Spectrometric Analysis Aluminum Alloys by the Point to Plane Technique Nitrogen Atmosphere (Withdrawn 2011)³
- [E716](#) Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spectrochemical Analysis

¹ This specification is under the jurisdiction of ASTM Committee [B07](#) on Light Metals and Alloys and is the direct responsibility of Subcommittee [B07.01](#) on Aluminum Alloy Ingots and Castings.

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² For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

³ The last approved version of this historical standard is referenced on www.astm.org.

*A Summary of Changes section appears at the end of this standard



TABLE 1 Chemical Composition Requirements

NOTE 1—When single units are shown, these indicate the maximum amounts permitted.
NOTE 2—Analysis shall be made for the elements for which limits are shown in this table.

NOTE 3—The following applies to all specified limits in this table: For purposes of acceptance and rejection, an observed value or a calculated value obtained from analysis should be rounded off to the nearest unit in the last right-hand place of figures used in expressing the specified limit (Practice E29).

Table with columns: Alloy (ANSI/A, UNS), Silicon, Iron, Copper, Manganese, Magnesium, Chromium, Nickel, Zinc, Titanium, Tin, Other Elements (Each, Total), Aluminum. Rows include alloys A02010 through A08520.

ASTM alloy designations are in Practice B275.
Others includes listed elements for which no specific limit is shown as well as unlisted metallic elements. The producer may analyze samples for trace elements not specified in the specification. However, such analysis is not required and may not cover all metallic Others elements. Should any analysis by the producer or the purchaser establish that an Others element exceeds the limit of Each or that the aggregate of several Others elements exceeds the limit of Total, the material shall be considered nonconforming.
Other Elements—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.
Contains silver 0.40–1.0 %.
If iron exceeds 0.45 %, manganese content shall not be less than one half of the iron content.
Contains beryllium 0.003–0.007 %, boron 0.002 % max.
7110.0 formerly A712.0, 712.0 formerly D712.0, 851.0 formerly A850.0, 852.0 formerly B850.0.

- E1251** Test Method for Analysis of Aluminum and Aluminum Alloys by Spark Atomic Emission Spectrometry
- E2422** Digital Reference Images for Inspection of Aluminum Castings
- IEEE/ASTM SI 10** Standard for Use of the International System of Units (SI): The Modern Metric System
- 2.3 *ANSI Standard*.⁴
- H35.1/H35.1 (M)-2006** American National Standard Alloy and Temper Designation Systems for Aluminum
- 2.4 *Military Standards*.⁵
- MIL-STD-129** Marking for Shipment and Storage
- MIL-STD-276** Impregnation of Porous Nonferrous Metal Castings
- 2.5 *Federal Standard*:
- Fed. Std. No. 123** Marking for Shipment (Civil Agencies)⁵
- 2.6 *AMS Standard*.⁶
- AMS 2771** Heat Treatment of Aluminum Alloy Castings
- 2.7 *NAVSEA Standard*.⁷
- S9074-AR-GIB-010/278** Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels
- 2.8 *Other Standards*.⁸
- CEN EN 14242** Aluminum and Aluminum Alloys—Chemical Analysis—Inductively Coupled Plasma Optical Emission Spectral Analysis

3. Terminology

3.1 *Definitions*—Refer to Terminology **B881** for definitions of product terms used in this specification.

3.2 *Definitions of Terms Specific to This Standard*:

3.2.1 *investment casting, n*—a metal object produced by surrounding (investing) an expendable pattern (usually wax or plastic) with a refractory slurry that sets at room temperature, after which the pattern is removed through the use of heat, and then filling the resulting cavity with molten metal and allowing it to solidify.

4. Ordering Information

4.1 Orders for material under this specification shall include the following information (1.4 and 1.6):

4.1.1 This specification designation (which includes the number, the year, and the revision letter, if applicable),

NOTE 1—For inch-pound application, specify Specification B618 and for metric application specify Specification B618M. Do not mix units.

4.1.2 Alloy (Section 7 and Table 1),

4.1.3 Temper (Section 10 and Table 2 [Table 3]),

4.1.4 Applicable drawing or part number, and

⁴ Available from Aluminum Association, Inc., 1525 Wilson Blvd., Suite 600, Arlington, VA 22209, <http://www.aluminum.org>.

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>.

⁶ Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

⁷ Available from Naval Sea Systems Command (NAVSEA), 1333 Isaac Hull Ave., SE, Washington, DC 20376, <http://www.navsea.navy.mil>.

⁸ Available from European Committee for Standardization (CEN), 36 Rue de Stassart, B-1050, Brussels, Belgium, <http://www.cenorm.be>.

4.1.5 The quantity in either pieces or pounds [kilograms].

4.2 Additionally, orders for material to this specification shall include the following information when required by the purchaser:

4.2.1 Whether chemical analysis and tensile property reports are required (Table 1 and Table 2 [Table 3]),

4.2.2 Whether castings, test specimens, or both may be supplied in the artificially aged – T5 temper for alloys 705.0, 707.0, 712.0, and 713.0 (10.2),

4.2.3 Whether test specimens cut from castings are required in addition to or instead of separately cast specimens (10.3 and 11.2),

4.2.4 Whether heat treatment is to be performed in accordance with AMS 2771 (Section 15),

4.2.5 Whether repairs are permissible (16.1),

4.2.6 Whether inspection is required at the producer's works (18.1),

4.2.7 Whether surface requirements shall be checked against observational standards where such standards are established (19.1),

4.2.8 Whether liquid penetrant inspection is required (19.3),

4.2.9 Whether radiographic inspection is required and, if so, the radiographic grade of casting required (19.4 and Table 4),

4.2.10 Whether certification is required (21.1),

4.2.11 Whether foundry control is required (Section 9),

4.2.12 Whether Practices **B660** apply and, if so, the levels of preservation, packaging, and packing required (23.3), and

4.2.13 Whether marking in accordance with Fed. Std. No. 123, Practice **D3951**, or MIL-STD 129 applies (23.3).

5. Responsibility for Quality Assurance

5.1 *Responsibility for Inspection and Tests*—Unless otherwise specified in the contract or purchase order, the producer shall be responsible for the performance of all inspection and test requirements specified herein. Except as otherwise specified in the contract or order, the producer may use his own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to confirm that material conforms to prescribed requirements.

6. Materials and Manufacture

6.1 The responsibility of furnishing castings that can be laid out and machined to the finished dimensions within the permissible variations specified, as shown on the blueprints or drawings, shall rest with the producer, except where pattern equipment is furnished by the purchaser.

6.1.1 Unless otherwise specified, only aluminum alloy conforming to the requirements of Specification **B179** or producer's foundry scrap (identified as being made from alloy conforming to Specification **B179**) shall be used in the remelting furnace from which molten metal is taken for pouring directly into castings. Additions of small amounts of modifiers and grain refining elements or alloys are permitted.

TABLE 2 Tensile Requirements^A (Inch-Pound Units)

NOTE 1—For purposes of determining conformance with this specification, each value for tensile strength and yield strength shall be rounded to the nearest 0.1 ksi and each value for elongation shall be rounded to the nearest 0.5 %, both in accordance with the rounding method of Practice E29.

Alloy		Temper ^B	Tensile Strength, min, ksi	Yield Strength (0.2 % offset) min, ksi	Elongation in 2 in. or 4× diameter, min, %	Typical Brinell Hardness, ^C 500 kgf, 10 mm
ANSI ^D	UNS					
201.0	A02010	T6	60.0	50.0	5.0	...
		T7	60.0	50.0	3.0	...
204.0	A02040	T4	45.0	28.0	6.0	...
		T6	30.0	^E	^E	115
242.0	A02420	O ^F	23.0	^E	^E	70
		T61	32.0	20.0	^E	105
295.0	A02950	T4	29.0	13.0	6.0	60
		T6	32.0	20.0	3.0	75
		T62	36.0	28.0	^B	95
		T7	29.0	16.0	3.0	70
319.0	A03190	F	23.0	13.0	1.5	70
		T6	31.0	20.0	1.5	80
328.0	A03280	F	25.0	14.0	1.0	60
		T6	34.0	21.0	1.0	80
355.0	A03550	T6	32.0	20.0	2.0	80
		T51	25.0	18.0	^E	65
		T71	30.0	22.0	^E	75
C355.0	A33550	T6	36.0	25.0	2.5	...
356.0	A03560	F	19.0	^E	2.0	55
		T6	30.0	20.0	3.0	70
		T7	31.0	^E	^E	75
		T51	23.0	16.0	^E	60
		T71	25.0	18.0	3.0	60
A356.0	A13560	T6	34.0	24.0	3.5	80
443.0	A04430	F	17.0	7.0	3.0	40
B443.0	A24430	F	17.0	6.0	3.0	40
514.0	A05140	F	22.0	9.0	6.0	50
520.0	A05200	T4	42.0	22.0	12.0	75
535.0	A05350	F	35.0	18.0	9.0	70
705.0	A07050	T1 ^G and T5 ^H	30.0	17.0 ^I	5.0	65
707.0	A07070	T1 ^G	33.0	22.0 ^I	2.0	85
		T7	37.0	30.0 ^I	1.0	80
710.0 ^J	A07100	T1 ^G	32.0	20.0	2.0	75
712.0 ^J	A07120	T1 ^G and T5 ^H	34.0	25.0 ^I	4.0	75
713.0	A07130	T1 ^G and T5 ^H	32.0	22.0	3.0	75
771.0	A07710	T5	42.0	38.0	1.5	100
		T51	32.0	27.0	3.0	85
		T52	36.0	30.0	1.5	85
		T6	42.0	35.0	5.0	90
		T71	48.0	45.0	2.0	120
850.0	A08500	T5	16.0	^E	5.0	45
851.0 ^J	A08510	T5	17.0	^E	3.0	45
852.0 ^J	A08520	T5	24.0	18.0	^E	60

^AIf agreed upon by the producer and the purchaser, other mechanical properties may be obtained by other heat treatments such as annealing, aging, or stress relieving.

^BRefer to ANSI H35.1/H35.1 (M) for description of tempers.

^CFor information only, not required for acceptance.

^DASTM alloy designations are in Practice B275.

^ENot required.

^FFormerly designated 222.0-T2 and 242.0-T21.

^GAged 21 days at room temperature.

^HArtificially aged in accordance with Practice B917/B917M.

^IYield strength to be determined only when specified in the contract or purchase order.

^J710.0 formerly A712.0, 712.0 formerly D712.0, 851.0, formerly A850.0, 852.0 formerly B850.0.

6.1.2 Pure materials, recycled materials, and master alloys may be used to make alloys conforming to this specification, provided chemical analysis can be taken and adjusted to conform to Table 1 prior to pouring any castings.

7. Chemical Composition

7.1 The product shall conform to the chemical composition limits prescribed in Table 1. Conformance shall be determined

by the producer by taking samples at the time castings are poured in accordance with Practices E716 and analyzed in accordance with Test Methods E34, E607, or E1251, or EN 14242 (ICP method). If the producer has determined the composition of the material during casting, they shall not be required to sample and analyze the finished product.

7.1.1 A sample for the determination of chemical composition shall be taken to represent the following:

TABLE 3 Tensile Requirements (SI Units) [Metric]^{A,B}

NOTE 1—For purposes of determining conformance with this specification, each value for tensile strength and yield strength shall be rounded to the nearest 1 MPa and each value for elongation shall be rounded to the nearest 0.5 %, both in accordance with the rounding method of Practice E29.

Alloy		Temper ^C	Tensile Strength, min, MPa ^D	Yield Strength (0.2 % offset) min, MPa	Elongation in 5D, min, %	Typical Brinell Hard- ness, ^E 500 kgf, 10 mm
ANSI ^F	UNS					
201.0	A02010	T6	415	345	4.0	...
		T7	415	345	3.0	...
204.0	A02040	T4	310	195	5.0	...
		T6	205	^G	^G	115
242.0	A02420	O ^H	160	^G	^G	70
		T61	220	140	^G	105
295.0	A02950	T4	200	90	5.0	60
		T6	220	140	3.0	75
		T62	250	195	^G	95
		T7	200	110	3.0	70
319.0	A03190	F	160	90	1.5	70
		T6	215	140	1.5	80
328.0	A03280	F	170	95	1.0	60
		T6	235	145	1.0	80
355.0	A03550	T6	220	140	2.0	80
		T51	170	125	^G	65
		T71	205	150	^G	75
C355.0	A33550	T6	250	170	2.5	...
		F	130	^G	2.0	55
356.0	A03560	T6	205	140	3.0	70
		T7	215	^G	^G	75
		T51	160	110	^G	60
		T71	170	125	3.0	60
		T6	235	165	3.5	80
		F	115	50	3.0	40
B443.0	A24430	F	115	40	3.0	40
		F	150	60	5.0	50
514.0	A05140	F	150	60	5.0	50
520.0	A05200	T4	290	150	10.0	75
535.0	A05350	F	240	125	8.0	70
705.0	A07050	T1 ^I and T5 ^J	205	115 ^K	4.0	65
707.0	A07070	T1 ^I	230	150 ^K	2.0	85
		T7	255	205 ^K	1.0	80
710.0 ^L	A07100	T1 ^I	220	140	2.0	75
712.0 ^L	A07120	T1 ^I and T5 ^J	235	170 ^K	4.0	75
713.0	A07130	T1 ^I and T5 ^J	220	150	3.0	75
771.0	A07710	T5	290	260	1.5	100
		T51	220	185	3.0	85
		T52	250	205	1.5	85
		T6	290	240	5.0	90
850.0	A08500	T71	330	310	2.0	120
		T5	110	^G	4.0	45
851.0 ^L	A08510	T5	115	^G	3.0	45
852.0 ^L	A08520	T5	165	125	^G	60

^AIf agreed upon by the producer and the purchaser, other mechanical properties may be obtained by other heat treatments such as annealing, aging, or stress relieving.
^BGuidelines for metric conversion from the "Temperatures for Aluminum and Aluminum Alloys, Metric Edition" (Tan Sheets) Appendix A, were used to convert the tensile and yield values to SI units.⁴

^CRefer to ANSI H35.1/H35.1 (M)-2006 for description of tempers.

^DFor explanation of SI unit "Mpa" see Appendix X2.

^EFor information only, not required for acceptance.

^FASTM alloy designations are in Practice B275.

^GNot required.

^HFormerly designated 222.0-T2 and 242.0-T21.

^IAged 21 days at room temperature.

^JArtificially aged in accordance with Practice B917/B917M.

^KYield strength to be determined only when specified in the contract or purchase order.

^L710.0 formerly A712.0, 712.0 formerly D712.0, 851.0, formerly A850.0, 852.0 formerly B850.0.

7.1.1.1 Not more than 500 lb [225 kg] of clean castings (gates and risers removed) or a single casting poured from one furnace and using only one melt charge.

7.1.1.2 Castings poured continuously from one furnace for not more than eight consecutive hours from a single master heat. A master heat is defined as all the metal of a single

furnace charge without subsequent additions after chemical composition has been determined.

7.2 If it becomes necessary to analyze castings for conformance to chemical composition limits, the method used to sample castings for the determination of chemical composition

TABLE 4 Discontinuity-Level Requirements for Aluminum Castings in Accordance with Film Reference Radiographs E155 or Digital Reference Radiographs E2422

Discontinuity	Radiograph	Grade A		Grade B		Grade C		Grade D	
		Section Thickness, in.							
		1/4	3/4	1/4	3/4	1/4	3/4	1/4	3/4
Gas holes	1.1	none		1	1	2	2	5	5
Gas porosity (round)	1.21	none		1	1	3	3	7	7
Gas porosity (elongated)	1.22	none		1	1	3	4	5	5
Shrinkage cavity	2.1	none		1	1	2	^A	3	^A
Shrinkage porosity or sponge	2.2	none		1	1	2	2	4	3
Foreign material (less dense material)	3.11	none		1	1	2	2	4	4
Foreign material (more dense material)	3.12	none		1	1	2	1	4	3
Segregation	3.2	none		none		none		none	
Cracks	...	none		none		none		none	
Cold shuts	...	none		none		none		none	
Surface irregularity	...			not to exceed drawing tolerance					
Core shift	...			not to exceed drawing tolerance					

^ANot available. Use 1/4-in. [6-mm] for all section thicknesses.

shall be in accordance with Practice B985. Analysis shall be performed in accordance with Practices E716, Test Methods E34, E607, or E1251, or EN 14242 (ICP method).

8. Material Requirements—Castings Produced for Governmental and Military Agencies

8.1 Unless otherwise specified, only aluminum alloy conforming to the requirements of Specification B179 or producer's foundry scrap (identified as being made from alloy conforming to Specification B179) shall be used in the remelting furnace from which molten metal is taken for pouring directly into castings. Additions of small amounts of modifiers and grain refining elements or alloys are permitted.

8.1.1 Pure materials, recycled materials, and master alloys may be used to make alloys conforming to this specification, provided chemical analysis can be performed and the composition of the melt adjusted to conform to Table 1 prior to pouring any castings.

9. Foundry Control—Castings Produced for Governmental or Military Agencies, or Both

9.1 When specified, castings shall be produced under foundry control approved by the purchaser. Foundry control shall consist of examination of castings by radiographic or other approved methods for determining internal discontinuities until the gating, pouring, and other foundry practices have been established to produce castings meeting the quality standards furnished by the purchaser or agreed upon between the purchaser and the producer. When foundry practices have been so established, the production method shall not be significantly changed without demonstrating to the satisfaction of the purchaser that the change does not adversely affect the quality of the castings. Minor changes in pouring temperature of $\pm 50^\circ\text{F}$ [$\pm 28^\circ\text{C}$] from the established nominal temperature are permissible.

10. Tensile Requirements

10.1 The separately cast tension test specimens representing the castings shall meet the mechanical properties prescribed in Table 2.

10.2 Although alloys 705.0, 707.0, 712.0, and 713.0 are most frequently used in the T1 naturally aged temper, by agreement of the producer and purchaser, the castings may be supplied in the T5 artificially aged temper. The producer and the purchaser may also agree to base the acceptance of castings on artificially aged test bars. The conditions of artificial aging shown in Practice B917/B917M shall be employed unless other conditions are accepted by mutual consent.

10.3 When specified, the tensile strength, yield strength, and elongation values of specimens cut from castings shall be not less than 75 % of the tensile and yield strength values and not less than 25 % of the elongation values specified in Table 2 [Table 3]. The measurement of elongation is not required for test specimens cut from castings if 25 % of the specified minimum elongation value published in Table 2 is 0.5 % or less. If grade D quality castings as described in Table 4 are specified, no tensile tests shall be specified nor tensile requirements be met on specimens cut from castings.

11. Test Specimens

11.1 The tension test specimens shall be cast to size in refractory molds of the same material as used for the castings in accordance with the dimensions of the 0.250-in. [6-mm] diameter specimen shown in Fig. 8 of Test Methods B557 [B557M]. They shall not be machined prior to test except to adapt the grip ends in such a manner as to assure axial loading.

11.2 When properties of castings are to be determined, tension test specimens shall be cut from the locations designated on the drawing unless otherwise negotiated. If no locations are designated, one or more specimens shall be taken to include locations having significant variation in cast thickness, except that specimens shall not be taken from areas directly under risers. The tension test specimens shall be the standard 0.500-in. [12.5-mm] diameter specimens shown in Fig. 8 of Test Methods B557 [B557M] or a round specimen of smaller size proportional to the standard specimen. In no case shall the dimensions of the smallest specimen be less than the following: