



# Standard Specification for Aluminum-Alloy Investment Castings<sup>1</sup>

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 ( $\epsilon$ ) 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:<sup>2</sup>

- [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)<sup>3</sup>
- [E716](#) Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spectrochemical Analysis

<sup>1</sup> 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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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* volume information, refer to the standard’s Document Summary page on the ASTM website.

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://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 various alloy grades like A02010, A02040, etc.

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*.<sup>4</sup>

**H35.1/H35.1 (M)-2006 American National Standard Alloy and Temper Designation Systems for Aluminum**

2.4 *Military Standards*.<sup>5</sup>

**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)**<sup>5</sup>

2.6 *AMS Standard*.<sup>6</sup>

**AMS 2771 Heat Treatment of Aluminum Alloy Castings**

2.7 *NAVSEA Standard*.<sup>7</sup>

**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*.<sup>8</sup>

**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

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

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

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

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

<sup>8</sup> 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<sup>A</sup> (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 <sup>B</sup>	Tensile Strength, min, ksi	Yield Strength (0.2 % offset) min, ksi	Elongation in 2 in. or 4× diameter, min, %	Typical Brinell Hardness, <sup>C</sup> 500 kgf, 10 mm
ANSI <sup>D</sup>	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	<sup>E</sup>	<sup>E</sup>	115
242.0	A02420	O <sup>F</sup>	23.0	<sup>E</sup>	<sup>E</sup>	70
		T61	32.0	20.0	<sup>E</sup>	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	<sup>B</sup>	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	<sup>E</sup>	65
		T71	30.0	22.0	<sup>E</sup>	75
C355.0	A33550	T6	36.0	25.0	2.5	...
356.0	A03560	F	19.0	<sup>E</sup>	2.0	55
		T6	30.0	20.0	3.0	70
		T7	31.0	<sup>E</sup>	<sup>E</sup>	75
		T51	23.0	16.0	<sup>E</sup>	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 <sup>G</sup> and T5 <sup>H</sup>	30.0	17.0 <sup>I</sup>	5.0	65
707.0	A07070	T1 <sup>G</sup>	33.0	22.0 <sup>I</sup>	2.0	85
		T7	37.0	30.0 <sup>I</sup>	1.0	80
710.0 <sup>J</sup>	A07100	T1 <sup>G</sup>	32.0	20.0	2.0	75
712.0 <sup>J</sup>	A07120	T1 <sup>G</sup> and T5 <sup>H</sup>	34.0	25.0 <sup>I</sup>	4.0	75
713.0	A07130	T1 <sup>G</sup> and T5 <sup>H</sup>	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	<sup>E</sup>	5.0	45
851.0 <sup>J</sup>	A08510	T5	17.0	<sup>E</sup>	3.0	45
852.0 <sup>J</sup>	A08520	T5	24.0	18.0	<sup>E</sup>	60

<sup>A</sup>If 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.

<sup>B</sup>Refer to ANSI H35.1/H35.1 (M) for description of tempers.

<sup>C</sup>For information only, not required for acceptance.

<sup>D</sup>ASTM alloy designations are in Practice B275.

<sup>E</sup>Not required.

<sup>F</sup>Formerly designated 222.0-T2 and 242.0-T21.

<sup>G</sup>Aged 21 days at room temperature.

<sup>H</sup>Artificially aged in accordance with Practice B917/B917M.

<sup>I</sup>Yield strength to be determined only when specified in the contract or purchase order.

<sup>J</sup>710.0 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]<sup>A,B</sup>**

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 <sup>C</sup>	Tensile Strength, min, MPa <sup>D</sup>	Yield Strength (0.2 % offset) min, MPa	Elongation in 5D, min, %	Typical Brinell Hard- ness, <sup>E</sup> 500 kgf, 10 mm
ANSI <sup>F</sup>	UNS					
201.0	A02010	T6	415	345	4.0	...
		T7	415	345	3.0	...
204.0	A02040	T4	310	195	5.0	...
		T6	205	<sup>G</sup>	<sup>G</sup>	115
242.0	A02420	O <sup>H</sup>	160	<sup>G</sup>	<sup>G</sup>	70
		T61	220	140	<sup>G</sup>	105
295.0	A02950	T4	200	90	5.0	60
		T6	220	140	3.0	75
		T62	250	195	<sup>G</sup>	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	<sup>G</sup>	65
		T71	205	150	<sup>G</sup>	75
		T6	250	170	2.5	...
356.0	A03560	F	130	<sup>G</sup>	2.0	55
		T6	205	140	3.0	70
A356.0	A13560	T7	215	<sup>G</sup>	<sup>G</sup>	75
		T51	160	110	<sup>G</sup>	60
		T71	170	125	3.0	60
		T6	235	165	3.5	80
		F	115	50	3.0	40
		F	115	40	3.0	40
443.0	A04430	F	115	50	3.0	40
		F	115	40	3.0	40
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 <sup>I</sup> and T5 <sup>J</sup>	205	115 <sup>K</sup>	4.0	65
707.0	A07070	T1 <sup>I</sup>	230	150 <sup>K</sup>	2.0	85
		T7	255	205 <sup>K</sup>	1.0	80
		T1 <sup>I</sup>	220	140	2.0	75
710.0 <sup>L</sup>	A07100	T1 <sup>I</sup> and T5 <sup>J</sup>	235	170 <sup>K</sup>	4.0	75
712.0 <sup>L</sup>	A07120	T1 <sup>I</sup> and T5 <sup>J</sup>	220	150	3.0	75
713.0	A07130	T1 <sup>I</sup> and T5 <sup>J</sup>	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
		T71	330	310	2.0	120
		T5	110	<sup>G</sup>	4.0	45
850.0	A08500	T5	115	<sup>G</sup>	3.0	45
851.0 <sup>L</sup>	A08510	T5	115	<sup>G</sup>	3.0	45
852.0 <sup>L</sup>	A08520	T5	165	125	<sup>G</sup>	60

<sup>A</sup>If 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.  
<sup>B</sup>Guidelines 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.<sup>4</sup>

<sup>C</sup>Refer to ANSI H35.1/H35.1 (M)-2006 for description of tempers.

<sup>D</sup>For explanation of SI unit "Mpa" see Appendix X2.

<sup>E</sup>For information only, not required for acceptance.

<sup>F</sup>ASTM alloy designations are in Practice B275.

<sup>G</sup>Not required.

<sup>H</sup>Formerly designated 222.0-T2 and 242.0-T21.

<sup>I</sup>Aged 21 days at room temperature.

<sup>J</sup>Artificially aged in accordance with Practice B917/B917M.

<sup>K</sup>Yield strength to be determined only when specified in the contract or purchase order.

<sup>L</sup>710.0 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	<sup>A</sup>	3	<sup>A</sup>
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					

<sup>A</sup>Not 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:



	In.	mm
Diameter of reduced section, in.	0.250	[6 mm]
Length of reduced section, in.	1¼	[32 mm]
Radius of fillet, in.	3/16	[5 mm]
Diameter of end section, in.	3/8	[10 mm]
Overall length, in.:		
With shouldered ends	2¾	[60 mm]
With threaded ends	3	[75 mm]
With plain cylindrical ends	4	[100 mm]

When necessary, a rectangular specimen may be used proportional to that shown for the 0.500-in. [12.5-mm] wide specimen in Fig. 6 of Test Methods B557 [B557M], but in no case shall its dimensions be less than the following:

	In.	mm
Width of reduced section, in.	0.250	[6 mm]
Length of reduced section, in.	1¼	[32 mm]
Radius of fillet, in.	¼	[6 mm]
Overall length, in.	4	[100 mm]

The specified elongation values shall not apply to tests of rectangular specimens.

11.3 If the castings are to be heat treated and separately cast specimens are to be used, the specimens representing such castings shall be heat treated with the castings they represent. If castings are to be heat treated and tests are to be made on the castings, the test specimens shall be taken from the castings after heat treatment.

## 12. Number of Tests and Retests

12.1 Unless otherwise agreed upon by the purchaser and producer, two tension test specimens shall be separately cast and tested to represent the following:

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

12.1.2 The castings poured continuously from one furnace in not more than eight consecutive hours from a single master heat.

12.2 When tensile properties of castings are to be determined, the number of castings to be tested shall be as shown on the drawing or as specified in the purchase order.

12.3 If any test specimen shows defective machining or flaws, it may be discarded; in which case the purchaser and the producer shall agree upon the selection of another specimen in its stead.

12.4 If the results of the tension tests do not conform to the requirements prescribed in Table 2 [Table 3]; the test bars representative of the castings may be retested in accordance with the replacement tests and retest provisions of Test Methods B557 [B557M], and the results of retests shall conform to the requirements as to mechanical properties specified in Table 2 [Table 3].

## 13. Test Methods

13.1 The determination of chemical composition shall be made in accordance with suitable chemical (Test Methods E34), or spectrochemical (Test Methods E607 and E1251), methods. Other methods may be used only when no published ASTM method is available. In case of dispute, the methods of analysis shall be agreed upon between the producer and purchaser.

13.2 The tensile properties shall be determined in accordance with Test Methods B557 [B557M].

## 14. Workmanship and Finish

14.1 The finished castings shall be uniform in composition and free of blowholes, cracks, shrinks, and other injurious defects except as designated and agreed upon as acceptable by the purchaser.

## 15. Heat Treatment

15.1 Heat treatment of castings shall be performed in accordance with Practice B917/B917M.

15.2 When specified, heat treatment shall be in accordance with AMS 2771.

## 16. Repair of Castings

16.1 Castings may be repaired only by processes approved and agreed upon by the producer and purchaser, that is, welding, impregnation, peening, blending, soldering, and so forth. Limitations on the extent and frequency of such repairs, and methods of inspection of repaired areas should also be agreed upon.

## 17. Repairing of Castings—Produced for Governmental and Military Agencies

### 17.1 Welding:

17.1.1 When welding is permitted, it shall be done by methods suitable for the particular alloy. Welding methods shall be in accordance with such specifications as are referenced on the applicable drawings, or as are required by the contract or order.

17.1.2 All welding shall be done by qualified welders approved by the purchaser.

17.1.3 When castings are to be supplied in the heat-treated condition, they shall be heat treated to the required temper after welding, except that small arc welds may be performed without subsequent heat treatment upon approval of the purchaser.

17.1.4 Unless otherwise specified, castings that have been repaired by welding shall have the welded areas examined radiographically after all reworking and heat treatment have been completed.

17.1.5 All welds shall be free of cracks, excess gas, porosity, lack of fusion and meet the same quality requirements as the parent material.

17.1.6 Welded castings shall be marked with a symbol of three concentric circles with a letter or number designating the welder adjacent to the symbol. The outer circle of the symbol shall be not larger than ¼ in. [6 mm] in outside diameter. All welded areas shall be encircled with a ring of white paint prior to submission for final inspection.

17.1.7 *Naval Shipboard Applications*—Repair welding of castings used in Naval shipboard pressure vessels, piping systems and machinery shall be performed in accordance with requirements for repair of castings specified in NAVSEA Technical Publication S9074-AR-GIB-010/278.

17.2 *Impregnation*—When impregnation is permitted, it shall be to correct general seepage leaks only and shall not be

used to correct poor foundry technique or significant porosity. It shall be accomplished in accordance with MIL-STD-276. Unless otherwise authorized by the purchaser, castings which have been impregnated shall be marked “IMP.”

17.3 *Peening*—When peening is permitted, it shall be to correct localized minor seepage leaks and small surface imperfections only, or to disclose subsurface voids for purpose of inspection. Peening will not be permitted to repair cracks, cold shuts, shrinks, misruns, defects due to careless handling, or other similar major defects. Peening may be accomplished either hot or cold and shall be performed by methods which are acceptable to the purchaser. Peened castings shall be marked with Maltese cross approximately ¼ in. [6 mm] high.

17.4 *Blending*—Blending with suitable grinders or other tools will be permitted for the removal of surface imperfections only, and shall not result in dimensions outside the tolerances shown on the applicable drawing.

## 18. Source Inspection

18.1 If the purchaser desires to make an inspection of the casting at the producer’s works, it shall be so stated in the contract or order.

18.2 If the purchaser elects to have inspection made at the producer’s works, the producer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

## 19. Foundry Inspection

19.1 Requirements such as surface finish, snagging projections where gates and risers were removed, and so forth, may be checked visually. It is advisable to have agreed upon observational standards representing both acceptable and unacceptable material.

19.2 If the purchaser elects to have inspection made at the producer’s works, the producer shall afford the inspector all reasonable facilities to satisfy him that the material is being furnished in accordance with this specification. All tests and inspection shall be so conducted as not to interfere unnecessarily with the operation of the works.

### 19.3 *Liquid Penetrant Inspection:*

19.3.1 When specified, liquid penetrant inspection shall be in accordance with Test Method **E165**, and the required sensitivity shall be specified.

19.3.2 Acceptance standards for discontinuities shall be agreed upon, including size and frequency per unit area and location.

### 19.4 *Radiographic Inspection:*

19.4.1 Radiographic inspection shall be in accordance with Guide **E94** and Reference Radiographs **E155**.

19.4.2 When agreed upon between the manufacturer and purchaser digital radiographic inspection shall be in accordance with Guide **E94** and Digital Reference Radiographs **E2422**.

19.4.3 Radiographic acceptance shall be in accordance with requirements selected from **Table 4**. Any modifications of this table and the frequency per unit area and location should also be agreed upon.

19.4.4 The number, film size, and orientation of radiographs and the number of castings radiographically inspected shall be agreed upon by the producer and purchaser.

## 20. Rejection and Rehearing

20.1 Castings that show unacceptable defects revealed by operations subsequent to acceptance and within an agreed time may be rejected, and shall be replaced by the producer.

20.2 In the case of dissatisfaction regarding rejections based on chemical composition and mechanical properties specified in Sections **7** and **10**, respectively, the producer may make claim for rehearing as the basis of arbitration within a reasonable time after receipt by the producer of the rejection notification.

## 21. Certification

21.1 The producer shall, on request, furnish to the purchaser a certificate stating that each lot has been sampled, tested, and inspected in accordance with this specification, and has met the requirements.

## 22. Identification and Repair Marking—Castings Produced for Government and Military Agencies

22.1 *Identification*—Unless otherwise specified, each casting shall be marked with the applicable drawing or part number. The marking shall consist of raised Arabic numerals, and when applicable capital letters, cast integral. The location of the identification marking shall be as specified on the applicable drawing. When the location is not specified on the drawing, the drawing/part number shall be placed in a location mutually agreeable to the purchaser and producer.

22.1.1 *Lot Identification*—When practicable, each casting shall also be marked with the melt of inspection lot number.

22.2 *Lot*—A lot shall consist of all of the cleaned castings poured from the same heat or melt when subsequent heat treatment is not required.

22.2.1 When the castings consist of alloys which require heat treatment, the lot shall consist of all castings from the same melt or heat which have been heat treated in the same furnace charge, or if heat treated in a continuous furnace, all castings from the same melt or heat that are discharged from the furnace during a 4 h period.

22.3 *Repair Markings*—All identification markings indicating repairs as specified in **17.1.6**, **17.2**, and **17.3** shall be made with a waterproof marking fluid.

## 23. Packaging, Marking, and Shipping

23.1 The material shall be packaged to provide adequate protection during normal handling and transportation, and each package shall contain only castings of the same configuration unless otherwise agreed upon. The type of packaging and gross weight of containers shall, unless otherwise agreed upon, be at the producers discretion, provided they are such as to ensure



acceptance by common or other carriers for safe transportation at the lowest rate to the delivery point.

23.2 Each package or container shall be marked with the purchase order number, drawing number, quantity, specification number, alloy and temper, gross and net weights, and the name of the producer.

23.3 When specified in the contract or purchase order, castings shall be preserved, packaged, and packed in accordance with the requirements of Practices B660.

The applicable levels shall be specified in the contract or order. Marking for shipment of such material shall be in accordance with Fed. Std. No. 123 or Practice D3951 for civil agencies and MIL-STD-129 for military agencies.

## 24. Keywords

24.1 aluminum; investment casting

## ANNEXES

### (Mandatory Information)

#### A1. BASIS FOR INCLUSION OF PROPERTY LIMITS

A1.1 Limits are established at a level at which a statistical evaluation of the data indicates that 99 % of the population obtained from all standard material meets the limit with 95 % confidence. For the products described, mechanical property limits for the respective size ranges are based on the analyses of at least 100 data from standard production material with no

more than ten data from a given lot. All tests are performed in accordance with the appropriate ASTM test methods. For informational purposes, refer to “Statistical Aspects of Mechanical Property Assurance” in the Related Material section of the *Annual Book of ASTM Standards*, Vol 02.02.<sup>2</sup>

#### A2. ACCEPTANCE CRITERIA FOR INCLUSION OF NEW ALUMINUM AND ALUMINUM ALLOYS IN THIS SPECIFICATION

A2.1 Prior to acceptance for inclusion in this specification, the composition of wrought or cast aluminum or aluminum alloy shall be registered in accordance with ANSI H35.1/H35.1 (M). The Aluminum Association<sup>4</sup> holds the Secretariat of ANSI H35 Committee and administers the criteria and procedures for registration.

A2.2 If it is documented that the Aluminum Association could not or would not register a given composition, an alternative procedure and the criteria for acceptance shall be as follows:

A2.2.1 The designation submitted for inclusion does not utilize the same designation system as described in ANSI H35.1/H35.1 (M). A designation not in conflict with other designation systems or a trade name is acceptable.

A2.2.2 The aluminum or aluminum alloy has been offered for sale in commercial quantities within the prior twelve months to at least three identifiable users.

A2.2.3 The complete chemical composition limits are submitted.

A2.2.4 The composition is, in the judgment of the responsible subcommittee, significantly different from that of any other aluminum or aluminum alloy already in this specification.

A2.2.5 For codification purposes, an alloying element is any element intentionally added for any purpose other than grain

refinement and for which minimum and maximum limits are specified. Unalloyed aluminum contains a minimum of 99.00 % aluminum.

A2.2.6 Standard limits for alloying elements and impurities are expressed to the following decimal places:

Less than 0.001 %	0.000X
0.001 to but less than 0.01 %	0.00X
0.01 to but less than 0.10 %	
Unalloyed aluminum made by a refining process	0.0XX
Alloys and unalloyed aluminum not made by a refining process	0.0X
0.10 through 0.55 %	0.XX
(It is customary to express limits of 0.30 through 0.55 % as 0.X0 or 0.X5)	
Over 0.55 %	0.X, X.X, and so forth

(Except that combined Si + Fe limits for 99.00 % minimum aluminum must be expressed as 0.XX or 1.XX)

A2.2.7 Standard limits for alloying elements and impurities are expressed in the following sequence: Silicon; Iron; Copper; Manganese; Magnesium; Chromium; Nickel; Zinc; Titanium (Note A2.1); Other Elements, Each; Other Elements, Total; Aluminum (Note A2.2).

NOTE A2.1—Additional specified elements having limits are inserted in alphabetical order of their chemical symbols between Titanium and Zinc, or are specified in footnotes.

NOTE A2.2—Aluminum is specified as *minimum* for unalloyed aluminum and as a *remainder* for aluminum alloys.

**APPENDIXES**
**(Nonmandatory Information)**
**X1. ALLOY PROPERTIES AND CHARACTERISTICS**

X1.1 The data in **Table X1.1** are approximate and are supplied for general information only.

**TABLE X1.1 Properties and Characteristics (Inch-Pound Units) (SI Units) [Metric]**

NOTE 1—1 indicates best of group, 5 indicates poorest of group.

Alloy		Pattern Shrinkage Allowance, in. ft <sup>A</sup> [mm/m]	Approximate Melting Range, °F <sup>B</sup> [°C]	Resistance to Hot Cracking <sup>C</sup>	Pressure Tightness	Fluidity <sup>D</sup>	Solidification Shrinkage Tendency <sup>E</sup>	Normally Heat Treated	Resistance to Corrosion <sup>F</sup>	Machining <sup>G</sup>	Polishing <sup>H</sup>	Electroplating <sup>I</sup>	Anodizing (Appearance) <sup>J</sup>	Chemical Oxide Coating (Protection) <sup>K</sup>	Strength at Elevated Temperature <sup>L</sup>	Suitability for Welding <sup>M</sup>	Suitability for Brazing <sup>N</sup>
ANSI <sup>O</sup>	UNS																
201.0	A02010	<sup>5</sup> / <sub>32</sub> [13]	1050–1200 [566-649]	4	3	3	4	yes	4	1	1	1	2	2	1	4	no
204.0	A02040	<sup>5</sup> / <sub>32</sub> [13]	985–1200 [529-649]	4	3	3	4	yes	4	1	2	1	3	4	1	4	no
242.0	A02420	<sup>5</sup> / <sub>32</sub> [13]	990–1175 [532-635]	4	3	3	4	yes	4	2	2	1	3	4	1	4	no
295.0	A02950	<sup>5</sup> / <sub>32</sub> [13]	970–1190 [521-643]	4	4	3	3	yes	3	2	2	1	2	3	3	3	no
319.0	A03190	<sup>5</sup> / <sub>32</sub> [13]	950–1125 [510-607]	2	2	2	2	yes	3	3	4	2	4	3	3	2	no
328.0	A03280	<sup>5</sup> / <sub>32</sub> [13]	960–1135 [516-613]	1	1	1	1	yes	3	4	5	2	4	2	2	2	no
355.0	A03550	<sup>5</sup> / <sub>32</sub> [13]	1015–1150 [546-621]	1	1	1	1	yes	3	3	3	1	4	2	2	2	no
C355.0	A33550	<sup>5</sup> / <sub>32</sub> [13]	1015–1150 [546-621]	1	1	1	1	yes	3	3	3	1	4	2	2	2	no
356.0	A33560	<sup>5</sup> / <sub>32</sub> [13]	1035–1135 [557-613]	1	1	1	1	yes	2	4	5	2	4	2	3	2	no
A356.0	A13560	<sup>5</sup> / <sub>32</sub> [13]	1035–1135 [557-621]	1	1	1	1	yes	2	4	5	2	4	2	3	2	no
443.0	A04430	<sup>5</sup> / <sub>32</sub> [13]	1065–1170 [574-632]	1	1	1	1	no	3	5	5	2	5	2	4	1	ltd
		<sup>5</sup> / <sub>32</sub> [13]	1065–1170 [574-632]	1	1	1	1	no	3	5	5	2	5	2	4	1	ltd
B443.0	A24430	<sup>5</sup> / <sub>32</sub> [13]	1065–1170 [574-632]	1	1	1	1	no	2	5	5	2	5	2	4	1	ltd
514.0	A05140	<sup>5</sup> / <sub>32</sub> [13]	1110–1185 [599-640]	4	5	5	5	no	1	1	1	5	1	1	2	4	no
520.0	A05200	<sup>5</sup> / <sub>32</sub> [13]	840–1120 [449-604]	3	4	3	4	no	1	2	2	4	2	1	3	4	no
535.0	A05350	<sup>1</sup> / <sub>10</sub> [8]	1020–1165 [549-629]	2	5	4	5	yes	1	1	1	4	1	1	<sup>P</sup>	5	no
705.0	A07050	<sup>5</sup> / <sub>32</sub> [13]	1105–1180 [596-638]	3	5	5	5	no	1	1	1	5	1	1	3	4	no
707.0	A7070	<sup>3</sup> / <sub>16</sub> [16]	1085–1165 [585-629]	5	3	4	4	aged only	2	1	1	3	2	2	5	4	yes
710.0 <sup>Q</sup>	A07100	<sup>3</sup> / <sub>16</sub> [16]	1105–1195 [596-646]	5	3	4	4	yes	2	1	1	3	2	2	5	4	yes
712.0 <sup>Q</sup>	A07120	<sup>3</sup> / <sub>16</sub> [16]	1110–1185 [599-641]	5	3	4	4	aged only	2	1	1	2	2	3	5	4	yes
713.0	A07130	<sup>3</sup> / <sub>16</sub> [16]	1100–1185 [593-641]	5	3	4	4	aged only	2	1	1	2	2	3	5	4	yes
771.0	A07710	<sup>3</sup> / <sub>16</sub> [16]	1120–1190 [604-643]	5	3	4	4	yes	2	1	1	3	2	2	5	4	yes
850.0	A08500	<sup>5</sup> / <sub>32</sub> [13]	435–1200 [224-649]	5	5	5	5	aged only	3	1	1	5	4	5	<sup>P</sup>	5	no
851.0 <sup>Q</sup>	A08510	<sup>5</sup> / <sub>32</sub> [13]	440–1165 [227-629]	4	4	5	4	aged only	3	1	1	5	4	5	<sup>P</sup>	5	no
852.0 <sup>Q</sup>	A08520	<sup>5</sup> / <sub>32</sub> [13]	400–1175 [204-635]	5	5	5	5	aged only	3	1	1	5	4	5	<sup>P</sup>	5	no

<sup>A</sup>Allowances for average castings. Shrinkage requirements will vary with intricacy of design and dimensions.

<sup>B</sup>Temperatures of solidus and liquidus are indicated; pouring temperatures will be higher.

<sup>C</sup>Ability of alloy to withstand contraction stresses while cooling through hot-short or brittle-temperature range.

<sup>D</sup>Ability of liquid alloy to flow readily in mold and fill thin sections.

<sup>E</sup>Decrease in volume accompanying freezing of alloy and measure of amount of compensating feed metal required in form of risers.

<sup>F</sup>Based on alloy resistance in standard-type salt-spray test.

<sup>G</sup>Composite rating based on ease of cutting, chip characteristics, quality of finish, and tool life. Ratings in the case of heat-treatable alloys, based on – T6 Temper. Other tempers, particularly the annealed temper, may have lower rating.

<sup>H</sup>Composite rating based on ease and speed of polishing and quality of finish provided by typical polishing procedure.

<sup>I</sup>Ability of casting to take and hold an electroplate applied by present standard methods.

<sup>J</sup>Rated on lightness of color, brightness, and uniformity of clear anodized coating applied in sulfuric acid electrolyte.

<sup>K</sup>Rated on combined resistance of coating and base alloy to corrosion.

<sup>L</sup>Rating based on tensile and yield strengths at temperatures up to 500°F [260°C], after prolonged heating at testing temperature.

<sup>M</sup>Based on ability of material to be fusion welded with filler rod of same alloy.

<sup>N</sup>Refers to suitability of alloy to withstand brazing temperatures without excessive distortion or melting.

<sup>O</sup>ASTM alloy designations are in Practice B275.

<sup>P</sup>Not recommended for service at elevated temperatures.

<sup>Q</sup>710.0 formerly A712.0, 712.0 formerly D712.0, 851.0 formerly A850.0, 852.0 formerly B850.0.

## X2. METRIC EQUIVALENTS

X2.1 The SI unit for strength properties now shown is in accordance with the International System of Units (SI) (**IEEE/ASTM SI 10**). The derived SI unit for force is the newton (N), which is defined as that force which when applied to a body having a mass of 1 kg gives it an acceleration of 1 m/s<sup>2</sup> (N = kg·m/s<sup>2</sup>). The derived SI unit for pressure or stress is the

newton per square metre (N/m<sup>2</sup>), which has been named the pascal (Pa) by the General Conference on Weights and Measures. Since 1 ksi = 6 894 757 Pa, the metric equivalents are expressed as megapascal (MPa), which is the same as MN/m<sup>2</sup> and N/mm<sup>2</sup>.

## X3. INACTIVE ALLOYS

X3.1 *Alloys Listed as Inactive by the Aluminum Association—208.0 and 222.0.* Listing the composition limits, mechanical properties, and characteristics of the

alloys is a method of preserving this data should it be needed at some future date (**Tables X3.1-X3.4**).

**TABLE X3.1 Chemical Composition Requirements—Inactive Alloys**

Alloy		Composition, %										Other <sup>A</sup> Elements		Aluminum
ANSI <sup>B</sup>	UNS	Silicon	Iron	Copper	Man-ganese	Magne-sium	Chromium	Nickel	Zinc	Tin	Titanium	Each	Total <sup>C</sup>	
208.0	A02080	2.5-3.5	1.2	3.5-4.5	0.50	0.10	...	0.35	1.0	...	0.25	...	0.50	remainder
222.0	A02220	2.0	1.5	9.2-10.7	0.50	0.15-0.35	...	0.50	0.8	...	0.25	...	0.35	remainder

<sup>A</sup>“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.

<sup>B</sup>ASTM alloy designations are in Practice B275.

<sup>C</sup>Other Elements—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.

**TABLE X3.2 Tensile Requirements<sup>A</sup> (Inch-Pound Units)—Inactive Alloys**

Alloy		Temper <sup>B</sup>	Tensile Strength, min, ksi	Yield Strength (0.2 % offset), min, ksi	Elongation in 2 in. or 4 x diameter, min, %	Typical Brinell Hard-ness, <sup>C</sup> 500 kgf, 10 mm
ANSI <sup>D</sup>	UNS					
208.0	A02080	F	19.0	12.0	1.5	55
222.0	A02220	O <sup>E</sup>	23.0	F	F	80
		T6	30.0	F	F	115

<sup>A</sup>If 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.

<sup>B</sup>Refer to ANSI H35.1/H35.1 (M) for description of tempers.

<sup>C</sup>For information only, not required for acceptance.

<sup>D</sup>ASTM alloy designations are in Practice B275.

<sup>E</sup>Formerly designated 222.0-T2 and 242.0-T21.

<sup>F</sup>Not required.

**TABLE X3.3 Tensile Requirements (SI Units) [Metric]<sup>A,B</sup>—Inactive Alloys**

NOTE 1—All applicable notes and footnotes can be found in Table 3.

Alloy <sup>C</sup>		Temper <sup>D</sup>	Tensile Strength, min, MPa <sup>E</sup>	Yield Strength (0.2 % offset), min, MPa	Elongation in 4 x diameter, min, %	Typical Brinell Hard- ness, <sup>F</sup> 500 kgf, 10 mm
ANSI	UNS					
208.0	A02080	F	130	80	1.5	55
222.0	A02220	O <sup>G</sup>	160	<sup>H</sup>	<sup>H</sup>	80
		T6	205	<sup>H</sup>	<sup>H</sup>	115

<sup>A</sup>If 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.

<sup>B</sup> Guidelines for metric conversion from the “Tempers for Aluminum and Aluminum Alloys, Metric Edition” (Tan Sheets) Appendix A, were used to convert the tensile and yield values to SI units.<sup>4</sup>

<sup>C</sup> ASTM alloy designations are in Practice B275.

<sup>D</sup> Refer to ANSI H35.1/H35.1 (M)-2006 for description of tempers.

<sup>E</sup> For explanation of SI unit “MPa” see Appendix X2.

<sup>F</sup> For information only, not required for acceptance.

<sup>G</sup> Formerly designated 222.0-T2 and 242.0-T21.

<sup>H</sup> Not required.

**TABLE X3.4 Properties and Characteristics (Inch-Pound Units) (SI Units) [Metric]—Inactive Alloys**

Alloy <sup>A</sup>		Pattern Shrinkage Allowance, <sup>B</sup> in./ft [mm/m]	Approximate Melting Range, <sup>C</sup> °F [°C]	Resist- ance to Hot Crack- ing <sup>D</sup>	Pressure Tightness	Fluid- ity <sup>E</sup>	Solidi- fication Shrink- age Tend- ency <sup>F</sup>	Normally Heat Treated	Resist- ance to Corro- sion <sup>G</sup>	Machin- ing <sup>H</sup>	Polish- ing <sup>I</sup>	Electro- plating <sup>J</sup>	Anodiz- ing (Ap- pear- ance) <sup>K</sup>	Chemical Oxide Coating (Protec- tion) <sup>L</sup>	Strength at Ele- vated Tempera- ture <sup>M</sup>	Suitabil- ity for Weld- ing <sup>N</sup>	Suitabil- ity for Brazing <sup>O</sup>
ANSI <sup>O</sup>	UNS																
208.0	A02080	<sup>5</sup> / <sub>32</sub> [13]	970-1160 [521-627]	2	2	2	2	yes	4	3	3	2	3	3	3	2	no
222.0	A02220	<sup>5</sup> / <sub>32</sub> [13]	965-1155 [518-624]	3	3	3	3	yes	4	1	2	1	3	4	1	4	no

<sup>A</sup>ASTM alloy designations are in Practice B275.

<sup>B</sup> Allowances for average castings. Shrinkage requirements will vary with intricacy of design and dimensions.

<sup>C</sup> Temperatures of solidus and liquidus are indicated; pouring temperatures will be higher.

<sup>D</sup> Ability of alloy to withstand contraction stresses while cooling through hot-short or brittle-temperature range.

<sup>E</sup> Ability of liquid alloy to flow readily in mold and fill thin sections.

<sup>F</sup> Decrease in volume accompanying freezing of alloy and measure of amount of compensating feed metal required in form of risers.

<sup>G</sup> Based on alloy resistance in standard-type salt-spray test.

<sup>H</sup> Composite rating based on ease of cutting, chip characteristics, quality of finish, and tool life. Ratings in the case of heat-treatable alloys, based on – T6 Temper. Other tempers, particularly the annealed temper, may have lower rating.

<sup>I</sup> Composite rating based on ease and speed of polishing and quality of finish provided by typical polishing procedure.

<sup>J</sup> Ability of casting to take and hold an electroplate applied by present standard methods.

<sup>K</sup> Rated on lightness of color, brightness, and uniformity of clear anodized coating applied in sulfuric acid electrolyte.

<sup>L</sup> Rated on combined resistance of coating and base alloy to corrosion.

<sup>M</sup> Rating based on tensile and yield strengths at temperatures up to 500°F [260°C], after prolonged heating at testing temperature.

<sup>N</sup> Based on ability of material to be fusion welded with filler rod of same alloy.

<sup>O</sup> Refers to suitability of alloy to withstand brazing temperatures without excessive distortion or melting.

## SUMMARY OF CHANGES

Committee B07 has identified the location of selected changes to this standard since the last issue (B618/B618M – 11a) that may impact the use of this standard. (Approved Oct. 1, 2014.)

(1) Reference to Practice B985 was added to Subsections 2.2 and 7.2.

(2) Subsection 7.3 was deleted.

(3) Subsections 8.1, 8.1.1, and 8.1.2 were moved into Subsection 7.1.



## **B618/B618M – 14**

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