



Designation: B969/B969M – 18<sup>ε1</sup>

# Standard Specification for Aluminum-Alloy Castings Produced by Squeeze Casting, and the Semi-Solid Thixocast and Rheocast Casting Processes<sup>1</sup>

This standard is issued under the fixed designation B969/B969M; 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.

<sup>ε1</sup> NOTE—Footnote C of Tables X2.2, X2.4, and X2.6 was revised editorially in August 2018.

## 1. Scope\*

1.1 This specification covers aluminum-alloy castings, produced by Squeeze Casting, and the Semi-Solid Thixocast and Rheocast casting processes, designated as shown in [Table 1](#).

1.2 This specification is for aluminum-alloy squeeze castings, and semi-solid Thixocast and Rheocast 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).

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 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 non-conformance 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.*

1.8 *This international standard was developed in accordance with internationally recognized principles on standard-*

*ization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 2. Referenced Documents

2.1 The following documents of the issue in effect on the date of casting 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](#)

[B666/B666M Practice for Identification Marking 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](#)

[E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

[E23 Test Methods for Notched Bar Impact Testing of Metallic Materials](#)

<sup>1</sup> This test method 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.

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



TABLE 1 Chemical Composition Limits<sup>A,B,C,D</sup>

DESIGNATION <sup>I</sup>	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Ag	Be	Pb	Sn	Zr	FNS	OTHERS <sup>F</sup>	
																Each	Total <sup>F</sup>
319.0	5.5-6.5	1.0	3.0-4.0	0.50	0.10	...	0.35	1.0	0.25	...	...	...	0.50	...	...	...	0.50
355.0	4.5-5.5	0.6 <sup>G</sup>	1.0-1.5	0.50 <sup>G</sup>	0.40-0.6	0.25	...	0.35	0.25	...	...	0.05	0.15	...	...	...	0.15
356.0	6.5-7.5	0.6 <sup>G</sup>	0.25	0.35 <sup>G</sup>	0.20-0.45	...	...	0.35	0.25	...	...	0.05	0.15	...	...	...	0.15
A356.0	6.5-7.5	0.20	0.20	0.10	0.25-0.45	...	...	0.10	0.20	...	...	0.05	0.15	...	...	...	0.15
357.0	6.5-7.5	0.15	0.05	0.03	0.45-0.6	...	...	0.05	0.20	...	...	0.05	0.15	...	...	...	0.15
366.0	6.5-7.5	0.15	0.05	0.03	0.5-1.2	...	...	0.05	0.20	...	...	0.05	0.15	...	...	...	0.15
380.0	7.5-9.5	2.0	3.0-4.0	0.50	0.10	...	0.50	3.0	...	0.35	...	...	0.50	...	...	...	0.50
A390.0	16.0-18.0	0.50	4.0-5.0	0.10	0.45-0.65 <sup>H</sup>	...	...	0.10	0.20	...	...	0.10	0.20	...	...	...	0.20

<sup>A</sup> When single units are shown, they indicate the maximum amounts permitted.

<sup>B</sup> Analysis shall be made for the elements for which limits are shown in this table.

<sup>C</sup> The following applies to all specified limits in this table: For purposes of determining conformance to these limits, an observed value or a calculated value obtained from analysis shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the specified limit in accordance with the rounding-off method of Practice E29.

<sup>D</sup> In case of discrepancy between the values listed in Table 1 and those listed in the "Designations and Composition Limits for Aluminum Alloys in the Form of Castings and Ingot (known as the "Pink Sheets")", the composition limits registered with the Aluminum Association and published in the "Pink Sheets" shall be considered the controlling composition.

<sup>E</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>F</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.

<sup>G</sup> If iron exceeds 0.45, manganese content shall not be less than one-half iron content.

<sup>H</sup> The Aluminum Association ruling on the number of decimal places to which Mg percent is expressed is exempted for some long standing alloys. See A2.2.6.

<sup>I</sup> For a cross reference of current and former alloy designations see the Aluminum Association's "Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot (The Pink Sheets)".

- 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 (Withdrawn 2017)<sup>3</sup>
- E94 Guide for Radiographic Examination Using Industrial Radiographic Film
- E155 Reference Radiographs for Inspection of Aluminum and Magnesium Castings
- E165 Practice for Liquid Penetrant Examination for General Industry
- E505 Reference Radiographs for Inspection of Aluminum and Magnesium Die Castings
- 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 Spark Atomic Emission Spectrometry
- E1251 Test Method for Analysis of Aluminum and Aluminum Alloys by Spark Atomic Emission Spectrometry
- E2422 Digital Reference Images for Inspection of Aluminum Castings

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 *NADCA Standards:*<sup>5</sup>

- #403 Product Specification Standards for Die Castings Produced by the Semi-Solid and Squeeze Casting Processes
- 2.5 *NADCA Product Specification Standards for Die Castings:*

- Engineering and Design: Coordinate Dimensioning
- S-4A-1-15 Linear Dimensions: Standard Tolerances
- S-4A-2-15 Parting Line: Standard Tolerances
- S-4A-3-15 Moving Die Components (MDC): Standard Tolerances
- S-4A-4-15 Draft Requirements: Standard Tolerances
- S-4A-5-15 Flatness Requirements: Standard Tolerances
- S-4A-6-15 Cored Holes for Cut Threads: Standard Tolerances
- S-4A-8-15 Cored Holes for Pipe Threads: Standard Tolerances
- P-4A-1-15 Linear Dimensions: Precision Tolerances
- P-4A-2-15 Parting Line: Precision Tolerances
- P-4A-3-15 Moving Die Components (MDC): Precision Tolerances
- P-4A-4-15 Draft Requirements: Precision Tolerances
- P-4A-5-15 Flatness Requirements: Precision Tolerances
- P-4A-6-15 Cored Holes for Cut Threads: Precision Tolerances
- P-4A-7-15 Cored Holes for Formed Threads: Precision Tolerances

- S/P-4-9-15 Machining Stock Allowances (Standard and Precision) Engineering and Design: Additional Specification Guidelines
- G-6-1-15 Pressure Tightness in Die Cast Parts
- G-6-2-15 Fillets, Ribs and Corners in Die Cast Parts (1 of 2)
- G-6-3-15 Fillets, Ribs and Corners in Die Cast Parts (2 of 2)
- G-6-4-15 Ejector Pins, Pin Marks and Pin Flash
- G-6-5-15 Casting Flash removal
- G-6-6-15 Surface Finish, As Cast
- G-6-7-15 Die Cast Lettering and Ornamentation

2.6 *Federal Standard:*<sup>6</sup>

- Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

2.7 *Military Standard:*<sup>6</sup>

- MIL-STD-129 Marking for Shipment and Storage (Military Agencies)
- MIL-STD-276 Impregnation of Porous Nonferrous Metal Castings

2.8 *SAE Standard:*

- AMS 2771 Heat Treatment of Aluminum Alloy Castings

2.9 *Naval Standard:*

- NAVSEA Technical Publication S9074-AR-GIB-010/278

2.10 *Aluminum Association Standard:*<sup>4</sup>

- Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot (The Pink Sheets)

2.11 *Other Standards:*<sup>7</sup>

- 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 *die casting, n*—a casting produced by introducing molten metal under substantial pressure into a metal die and characterized by a high degree of fidelity to the die cavity.

3.2.2 *rheocasting, n*—semi-solid casting process in which the thixotropic aluminum alloy feed-stock is produced at the die cast machine and injected whilst in its thixotropic state into a metal die cavity without an intermediate solidification stage.

3.2.3 *semi-solid casting (SSM), n*—a casting process wherein a partially solidified metal slurry is injected into a die cavity to form cast components.

3.2.4 *semi-solid slurry, n*—a mixture of solid spherical or globular primary phase dispersed in liquid, and which exhibits thixotropic behavior.

3.2.5 *slurry, n*—a thick suspension of solids in a liquid.

3.2.6 *squeeze casting, n*—a process whereby a metal product is produced by injecting molten metal at a relatively slow

<sup>3</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>4</sup> Available from Aluminum Association, Inc., 1400 Crystal Drive Suite 430 Arlington, VA 22202, <http://www.aluminum.org>.

<sup>5</sup> Available from North American Die Casting Association, (NADCA,) 241 Holbrook Drive, Wheeling, IL 60090 ([www.diecasting.org](http://www.diecasting.org)).

<sup>6</sup> Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://dodssp.daps.dla.mil>.

<sup>7</sup> Available from European Committee for Standardization (CEN), 36 Rue de Stassart, B-1050, Brussels, Belgium, <http://www.cenorm.be>.