



Designation: B179 – 18

# Standard Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Casting Processes<sup>1</sup>

This standard is issued under the fixed designation B179; 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 commercial aluminum alloys in ingot form for remelting and molten form for the manufacture of castings. The specific gravity of these alloys does not exceed 3.0 and they are designated as shown in [Table 1](#).

NOTE 1—Throughout this specification the use of “ingot” in a general sense includes sow, T-bar, T-ingot, and pig.

1.2 Alloy designations are in accordance with ANSI H35.1/H35.1(M).

NOTE 2—Supplementary data pertaining to the alloys covered by this specification when used in the form of castings are given in Specifications [B26/B26M](#), [B85/B85M](#), [B108/B108M](#), [B618/B618M](#), [B686/B686M](#), [B955/B955M](#), and [B969/B969M](#).

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

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

1.5 The values stated in inch-pound units are to be regarded as standard. No other units of measurement are included in this standard.

1.6 *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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.7 *This international standard was developed in accordance with internationally recognized principles on standardization 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 date of material purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*<sup>2</sup>

[B26/B26M](#) Specification for Aluminum-Alloy Sand Castings

[B85/B85M](#) Specification for Aluminum-Alloy Die Castings

[B108/B108M](#) Specification for Aluminum-Alloy Permanent Mold Castings

[B618/B618M](#) Specification for Aluminum-Alloy Investment Castings

[B666/B666M](#) Practice for Identification Marking of Aluminum and Magnesium Products

[B686/B686M](#) Specification for Aluminum Alloy Castings, High-Strength

[B955/B955M](#) Specification for Aluminum-Alloy Centrifugal Castings

[B969/B969M](#) Specification for Aluminum-Alloy Castings Produced by Squeeze Casting, Thixocast and Rheocast Semi-Solid Casting Processes

[B985](#) Practice for Sampling Aluminum Ingots, Billets, Castings and Finished or Semi-Finished Wrought Aluminum Products for Compositional Analysis

[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>

[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

<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 Limits of Aluminum Alloys in Ingot and Molten Forms for All Casting Processes<sup>A,B,C,D</sup>

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Only composition limits which are identical to those listed herein or are registered with the Aluminum Association should be designated as "AA" alloys.

DESIG. <sup>S</sup>	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Ag	Be	Pb	Sn	Zr	FNs	OTHERS <sup>E</sup> Each Total <sup>F</sup>	Al Min.
100.1*	0.15	0.6-0.8	0.10	...	...	...	...	0.05	...	...	...	...	...	...	...	0.03	0.10 99.00 <sup>G</sup>
130.1*	...	...	0.10	...	...	...	...	0.05	...	...	...	...	...	...	...	0.03	0.10 99.30 <sup>G</sup>
150.1*	...	...	0.05	...	...	...	...	0.05	...	...	...	...	...	...	...	0.03	0.10 99.50 <sup>G</sup>
160.1	0.10	0.25	...	...	...	...	...	0.05	...	...	...	...	...	...	...	0.03	0.10 99.60 <sup>G</sup>
170.1*	...	...	...	...	...	...	...	0.05	...	...	...	...	...	...	...	0.03	0.10 99.70 <sup>G</sup>
201.2	0.10	0.10	4.0-5.2	0.20-0.50	0.20-0.55	...	...	...	0.15-0.35	0.40-1.0	...	...	...	...	...	0.05	0.10 Rem.
A201.1	0.05	0.07	4.0-5.0	0.20-0.40	0.20-0.35	...	...	...	0.15-0.35	0.40-1.0	...	...	...	...	...	0.03	0.10 Rem.
203.2	0.20	0.35	4.8-5.2	0.20-0.30	0.10	...	1.3-1.7	0.10	0.15-0.25	...	...	...	...	0.20-0.30 Co, 0.20-0.30 Sb, 0.50 Ti + Zr	...	0.05	0.20 Rem.
204.2	0.15	0.10-0.20	4.2-4.9	0.05	0.20-0.35	...	0.03	0.05	0.15-0.25	...	...	...	0.05	...	...	0.05	0.15 Rem.
205.2 <sup>L</sup>	0.07	0.05	4.2-5.0	...	0.25-0.33	...	...	...	0.50	0.6-0.9	...	...	...	...	...	0.08	0.17 Rem.
206.2	0.10	0.10	4.2-5.0	0.20-0.50	0.20-0.35	...	0.03	0.05	0.15-0.25	...	...	...	0.05	...	...	0.05	0.15 Rem.
A206.2	0.05	0.07	4.2-5.0	0.20-0.50	0.20-0.35	...	0.03	0.05	0.15-0.25	...	...	...	0.05	...	...	0.05	0.15 Rem.
B206.2	0.05	0.07	4.2-5.0	0.20-0.50	0.20-0.35	...	0.03	0.05	0.05	...	...	...	0.05	...	...	0.05	0.15 Rem.
240.1	0.50	0.40	7.0-9.0	0.30-0.7	5.6-6.5	...	0.300.7	0.10	0.20	...	...	...	...	...	...	0.05	0.15 Rem.
242.1	0.7	0.8	3.5-4.5	0.35	1.3-1.8	0.25	1.7-2.3	0.35	0.25	...	...	...	...	...	...	0.05	0.15 Rem.
242.2	0.6	0.6	3.5-4.5	0.10	1.3-1.8	...	1.7-2.3	0.10	0.20	...	...	...	...	...	...	0.05	0.15 Rem.
A242.1	0.6	0.6	3.7-4.5	0.10	1.3-1.7	0.15-0.25	1.8-2.3	0.10	0.07-0.20	...	...	...	...	...	...	0.05	0.15 Rem.
A242.2	0.35	0.6	3.7-4.5	0.10	1.3-1.7	0.15-0.25	1.8-2.3	0.10	0.07-0.20	...	...	...	...	...	...	0.05	0.15 Rem.
295.1	0.7-1.5	0.8	4.0-5.0	0.35	0.03	...	...	0.35	0.25	...	...	...	...	...	...	0.05	0.15 Rem.
295.2	0.7-1.2	0.8	4.0-5.0	0.30	0.03	...	...	0.30	0.20	...	...	...	...	...	...	0.05	0.15 Rem.
296.1	2.0-3.0	0.9	4.0-5.0	0.35	0.05	...	0.35	0.50	0.25	...	...	...	...	...	...	...	0.35 Rem.
296.2	2.0-3.0	0.8	4.0-5.0	0.30	0.03	...	...	0.30	0.20	...	...	...	...	...	...	0.05	0.15 Rem.
301.1 <sup>L,M</sup>	9.5-10.5	0.8-1.2	3.0-3.5	0.50-0.8	0.30-0.50	...	1.0-1.5	0.05	0.20	...	...	...	...	...	...	0.03	0.10 Rem.
302.1 <sup>L,M</sup>	9.5-10.5	0.20	2.8-3.2	...	0.8-1.2	...	1.0-1.5	0.05	0.20	...	...	...	...	...	...	0.03	0.10 Rem.
303.1 <sup>L,M</sup>	9.5-10.5	0.8-1.2	0.20	0.50-0.8	0.50-0.7	...	...	0.05	0.20	...	...	...	...	...	...	0.03	0.10 Rem.
304.1 <sup>M</sup>	9.5-11.5	0.8-1.0	0.05-0.08	0.30-0.50	0.35-0.50	0.05	0.03	0.20	0.03-0.18	...	...	...	0.03	...	...	0.03	0.15 Rem.
308.1 <sup>M</sup>	5.0-6.0	0.8	4.0-5.0	0.50	0.10	...	...	1.0	0.25	...	...	...	...	...	...	...	0.50 Rem.
308.2 <sup>M</sup>	5.0-6.0	0.8	4.0-5.0	0.30	0.10	...	...	0.50	0.20	...	...	...	...	...	...	...	0.50 Rem.
318.1 <sup>M</sup>	5.5-6.5	0.8	3.0-4.0	0.50	0.15-0.6	...	0.35	0.9	0.25	...	...	...	...	...	...	...	0.50 Rem.
319.1 <sup>M</sup>	5.5-6.5	0.8	3.0-4.0	0.50	0.10	...	0.35	1.0	0.25	...	...	...	...	...	...	...	0.50 Rem.
319.2 <sup>M</sup>	5.5-6.5	0.6	3.0-4.0	0.10	0.10	...	0.10	0.10	0.20	...	...	...	...	...	...	...	0.20 Rem.
A319.1 <sup>M</sup>	5.5-6.5	0.8	3.0-4.0	0.50	0.10	...	0.35	3.0	0.25	...	...	...	...	...	...	...	0.50 Rem.
B319.1 <sup>M</sup>	5.5-6.5	0.9	3.0-4.0	0.8	0.15-0.50	...	0.50	1.0	0.25	...	...	...	...	...	...	...	0.50 Rem.
320.1 <sup>M</sup>	5.0-8.0	0.9	2.0-4.0	0.8	0.10-0.6	...	0.35	3.0	0.25	...	...	...	...	...	...	...	0.50 Rem.
328.1 <sup>M</sup>	7.5-8.5	0.8	1.0-2.0	0.20-0.6	0.25-0.6	0.35	0.25	1.5	0.25	...	...	...	...	...	...	...	0.50 Rem.
332.1 <sup>M</sup>	8.5-10.5	0.9	2.0-4.0	0.50	0.6-1.5	...	0.50	1.0	0.25	...	...	...	...	...	...	...	0.50 Rem.
332.2 <sup>M</sup>	8.5-10.0	0.6	2.0-4.0	0.10	0.9-1.3	...	0.10	0.10	0.20	...	...	...	...	...	...	...	0.30 Rem.
333.1 <sup>M</sup>	8.5-10.0	0.8	3.0-4.0	0.50	0.10-0.50	...	0.50	1.0	0.25	...	...	...	...	...	...	...	0.50 Rem.
A333.1 <sup>M</sup>	8.5-10.0	0.8	3.0-4.0	0.50	0.10-0.50	...	0.50	3.0	0.25	...	...	...	...	...	...	...	0.50 Rem.
336.1 <sup>M</sup>	11.0-13.0	0.9	0.50-1.5	0.35	0.8-1.3	...	2.0-3.0	0.35	0.25	...	...	...	...	...	...	0.05	...
336.2 <sup>M</sup>	11.0-13.0	0.9	0.50-1.5	0.10	0.9-1.3	...	2.0-3.0	0.10	0.20	...	...	...	...	...	...	0.05	0.15 Rem.
339.1 <sup>M</sup>	11.0-13.0	0.9	1.5-3.0	0.50	0.6-1.5	...	0.50-1.5	1.0	0.25	...	...	...	...	...	...	...	0.50 Rem.
354.1 <sup>M</sup>	8.6-9.4	0.15	1.6-2.0	0.10	0.45-0.6	...	...	0.10	0.20	...	...	...	...	...	...	0.05	0.15 Rem.
354.2 <sup>M</sup>	8.6-9.4	0.06	1.6-2.0	0.10	0.45-0.6	...	...	0.10	0.20	...	...	...	...	...	...	0.05	0.15 Rem.
355.1 <sup>M</sup>	4.5-5.5	0.50 <sup>I</sup>	1.0-1.5	0.50 <sup>I</sup>	0.45-0.6	0.25	...	0.35	0.25	...	...	...	...	...	...	0.05	0.15 Rem.
355.2 <sup>M</sup>	4.5-5.5	0.14-0.25	1.0-1.5	0.05	0.50-0.6	...	...	0.05	0.20	...	...	...	...	...	...	0.05	0.15 Rem.





TABLE 1 Continued

DESIG. <sup>S</sup> AA No.	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Ag	Be	Pb	Sn	Zr	FNs	OTHERS <sup>A,E</sup> Each Total <sup>F</sup> Al Min.
A355.2 <sup>M</sup>	4.5–5.5	0.06	1.0–1.5	0.03	0.50–0.6	...	...	0.03	0.04–0.20	...	...	...	...	...	...	0.03 0.10 Rem.
C355.1 <sup>M</sup>	4.5–5.5	0.15	1.0–1.5	0.10	0.45–0.6	...	...	0.10	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
C355.2 <sup>M</sup>	4.5–5.5	0.13	1.0–1.5	0.05	0.50–0.6	...	...	0.05	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
356.1 <sup>M</sup>	6.5–7.5	0.50 <sup>I</sup>	0.25	0.35 <sup>I</sup>	0.25–0.45	...	...	0.35	0.25	...	...	...	...	...	...	0.05 0.15 Rem.
356.2 <sup>M</sup>	6.5–7.5	0.13–0.25	0.10	0.05	0.30–0.45	...	...	0.05	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
A356.1 <sup>M</sup>	6.5–7.5	0.15	0.20	0.10	0.30–0.45	...	...	0.10	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
A356.2 <sup>M</sup>	6.5–7.5	0.12	0.10	0.05	0.30–0.45	...	...	0.05	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
B356.2 <sup>M</sup>	6.5–7.5	0.06	0.03	0.03	0.30–0.45	...	...	0.03	0.04–0.20	...	...	...	...	...	...	0.03 0.10 Rem.
C356.2 <sup>M</sup>	6.5–7.5	0.04	0.03	0.03	0.30–0.45	...	...	0.03	0.04–0.20	...	...	...	...	...	...	0.03 0.10 Rem.
F356.2 <sup>M</sup>	6.5–7.5	0.12	0.10	0.05	0.17–0.25	...	...	0.05	0.04–0.20	...	...	...	...	...	...	0.05 0.15 Rem.
357.1 <sup>M</sup>	6.5–7.5	0.12	0.05	0.03	0.45–0.6	...	...	0.05	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
A357.2 <sup>M</sup>	6.5–7.5	0.12	0.10	0.05	0.45–0.7	...	...	0.05	0.04–0.20	...	0.04–0.07	...	...	...	...	0.03 0.10 Rem.
B357.2 <sup>M</sup>	6.5–7.5	0.06	0.03	0.03	0.45–0.6	...	...	0.03	0.04–0.20	...	...	...	...	...	...	0.03 0.10 Rem.
C357.2 <sup>M</sup>	6.5–7.5	0.06	0.03	0.03	0.50–0.7	...	...	0.03	0.04–0.20	...	0.40–0.07	...	...	...	...	0.03 0.10 Rem.
E357.1 <sup>M</sup>	6.5–7.5	0.07	...	0.10	0.6–0.7	...	...	...	0.10–0.20	...	0.002	...	...	...	...	0.05 0.15 Rem.
E357.2 <sup>M</sup>	6.5–7.5	0.07	...	0.10	0.6–0.7	...	...	...	0.10–0.20	...	0.0003	...	...	...	...	0.05 0.15 Rem.
F357.1 <sup>M</sup>	6.5–7.5	0.07	0.20	0.10	0.45–0.7	...	...	0.10	0.04–0.20	...	0.002	...	...	...	...	0.05 0.15 Rem.
F357.2 <sup>M</sup>	6.5–7.5	0.07	0.20	0.10	0.45–0.7	...	...	0.10	0.04–0.20	...	0.0003	...	...	...	...	0.05 0.15 Rem.
358.2 <sup>M</sup>	7.6–8.6	0.20	0.10	0.10	0.45–0.6	0.05	...	0.10	0.12–0.20	...	0.15–0.30	...	...	...	...	0.05 0.15 Rem.
359.2 <sup>M</sup>	8.5–9.5	0.12	0.10	0.10	0.55–0.7	...	...	0.10	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
A359.1 <sup>L,M</sup>	8.5–9.5	0.20	0.20	0.10	0.45–0.6	...	...	0.05	0.20	...	...	...	...	...	...	0.03 0.10 Rem.
360.2 <sup>M</sup>	9.0–10.0	0.7–1.1	0.10	0.10	0.45–0.6	...	0.10	0.10	...	...	...	...	0.10	...	...	0.20 Rem.
A360.1 <sup>J,M</sup>	9.0–10.0	1.0	0.6	0.35	0.45–0.6	...	0.50	0.40	...	...	...	...	0.15	...	...	0.25 Rem.
A360.2 <sup>M</sup>	9.0–10.0	0.6	0.10	0.05	0.45–0.6	...	...	0.05	...	...	...	...	...	...	...	0.05 0.15 Rem.
361.1 <sup>M</sup>	9.5–10.5	0.8	0.50	0.25	0.45–0.6	0.20–0.30	0.20–0.30	0.40	0.20	...	...	...	0.10	...	...	0.05 0.15 Rem.
362.1 <sup>N</sup>	10.5–11.5	0.30	0.20	0.25–0.35	0.6–0.7	...	0.10	0.10	0.20	...	...	0.25	0.10	...	...	0.05 0.15 Rem.
363.1 <sup>M</sup>	4.5–6.0	0.8	2.5–3.5	...	0.20–0.40	...	0.25	3.0–4.5	0.20	...	0.02–0.04	...	0.25	...	...	0.30 Rem.
364.2 <sup>M</sup>	7.5–9.5	0.7–1.1	0.20	0.10	0.25–0.40	0.25–0.50	0.15	0.15	0.04–0.15	...	...	...	0.15	...	...	0.05 0.15 Rem.
365.1 <sup>N</sup>	9.5–11.5	0.12	0.03	0.50–0.8	0.15–0.50	...	...	0.07	0.10	...	...	...	...	...	...	0.03 0.10 Rem.
A365.1 <sup>N</sup>	9.5–11.5	0.15–0.20	0.02	0.30–0.6	0.15–0.6	...	...	0.03	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
366.1 <sup>M,O</sup>	6.5–7.5	0.12	0.05	0.03	0.6–1.2	...	...	0.05	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
367.1 <sup>N</sup>	8.5–9.5	0.20	0.25	0.25–0.35	0.35–0.50	...	...	0.10	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
368.1 <sup>N</sup>	8.5–9.5	0.20	0.25	0.25–0.35	0.15–0.30	...	...	0.10	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
369.1 <sup>M</sup>	11.0–12.0	1.0	0.50	0.35	0.30–0.45	0.30–0.40	0.05	0.9	...	...	...	...	0.10	...	...	0.05 0.15 Rem.
380.2 <sup>M</sup>	7.5–9.5	0.7–1.1	3.0–4.0	0.10	0.10	...	0.10	0.10	...	...	...	...	0.10	...	...	0.05 0.15 Rem.
A380.1 <sup>J,M</sup>	7.5–9.5	1.0	3.0–4.0	0.50	0.10	...	0.50	2.9	...	...	...	...	0.10	...	...	0.20 Rem.
A380.2 <sup>M</sup>	7.5–9.5	0.6	3.0–4.0	0.10	0.10	...	0.10	0.10	...	...	...	...	0.35	...	...	0.50 Rem.
B380.1 <sup>M</sup>	7.5–9.5	1.0	3.0–4.0	0.50	0.10	...	0.50	0.9	...	...	...	...	0.35	...	...	0.50 Rem.
C380.1 <sup>M</sup>	7.5–9.5	1.0	3.0–4.0	0.50	0.15–0.30	...	0.50	2.9	...	...	...	...	0.35	...	...	0.50 Rem.
D380.1 <sup>M</sup>	7.5–9.5	1.0	3.0–4.0	0.50	0.15–0.30	...	0.50	0.9	...	...	...	...	0.35	...	...	0.50 Rem.
E380.1 <sup>M</sup>	7.5–9.5	1.0	3.0–4.0	0.50	0.30	...	0.50	2.9	...	...	...	...	0.35	...	...	0.50 Rem.
381.2 <sup>M</sup>	9.0–10.0	0.7–1.0	3.0–4.0	0.50	0.13	0.15	0.50	2.9	0.20	...	...	0.15	0.15	...	...	0.50 Rem.
383.1 <sup>M</sup>	9.5–11.5	1.0	2.0–3.0	0.50	0.10	...	0.30	2.9	...	...	...	...	0.15	...	...	0.50 Rem.
383.2 <sup>M</sup>	9.5–11.5	0.6–1.0	2.0–3.0	0.10	0.10	...	0.10	0.10	...	...	...	...	0.10	...	...	0.20 Rem.
A383.1 <sup>M</sup>	9.5–11.5	1.0	2.0–3.0	0.50	0.15–0.30	...	0.30	2.9	...	...	...	...	0.15	...	...	0.50 Rem.
B383.1 <sup>M</sup>	9.5–11.5	1.0	2.0–3.0	0.50	0.30	...	0.30	2.9	...	...	...	...	0.15	...	...	0.50 Rem.
384.1 <sup>M</sup>	10.5–12.0	1.0	3.0–4.5	0.50	0.10	...	0.50	2.9	...	...	...	...	0.35	...	...	0.50 Rem.
384.2 <sup>M</sup>	10.5–12.0	0.6–1.0	3.0–4.5	0.10	0.10	...	0.10	0.10	...	...	...	...	0.10	...	...	0.20 Rem.
A384.1 <sup>M</sup>	10.5–12.0	1.0	3.0–4.5	0.50	0.10	...	0.50	0.9	...	...	...	...	0.35	...	...	0.50 Rem.
B384.1 <sup>M</sup>	10.5–12.0	1.0	3.0–4.5	0.50	0.15–0.30	...	0.50	0.9	...	...	...	...	0.35	...	...	0.50 Rem.
C384.1 <sup>M</sup>	10.5–12.0	1.0	3.0–4.5	0.50	0.15–0.30	...	0.50	2.9	...	...	...	...	0.35	...	...	0.50 Rem.
390.2 <sup>M</sup>	16.0–18.0	0.6–1.0	4.0–5.0	0.10	0.50–0.65 <sup>H</sup>	...	...	0.10	0.20	...	...	...	...	...	...	0.10 0.20 Rem.
A390.1 <sup>M</sup>	16.0–18.0	0.40	4.0–5.0	0.10	0.50–0.65 <sup>H</sup>	...	...	0.10	0.20	...	...	...	...	...	...	0.10 0.20 Rem.
B390.1 <sup>M</sup>	16.0–18.0	1.0	4.0–5.0	0.50	0.50–0.65 <sup>H</sup>	...	0.10	1.4	0.20	...	...	...	...	...	...	0.10 0.20 Rem.
391.1 <sup>M</sup>	18.0–20.0	0.9	0.20	0.30	0.45–0.7	...	...	0.10	0.20	...	...	...	...	...	...	0.10 0.20 Rem.
A391.1 <sup>M</sup>	18.0–20.0	0.50	0.20	0.30 <sup>G</sup>	0.45–0.7	...	...	0.10	0.20	...	...	...	...	...	...	0.10 0.20 Rem.





TABLE 1 Continued

DESIG. <sup>S</sup> AA No.	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Ag	Pb	Sn	Zr	—	FNs	OTHERS <sup>A,E</sup> Each Total <sup>F</sup> Al Min.
B391.1 <sup>M</sup>	18.0–20.0	0.15	0.20	0.30	0.45–0.7	...	...	0.10	0.20	...	...	...	...	...	...	0.10 0.20 Rem.
392.1 <sup>M</sup>	18.0–20.0	1.1	0.40–0.8	0.20–0.6	0.9–1.2	...	0.50	0.40	0.20	...	...	0.30	...	...	...	0.15 0.50 Rem.
393.1 <sup>M</sup>	21.0–23.0	1.0	0.7–1.1	0.10	0.8–1.3	...	2.0–2.5	0.10	0.10–0.20	...	...	...	...	0.08–0.15 V	...	0.05 0.15 Rem.
393.2 <sup>M</sup>	21.0–23.0	0.8	0.7–1.1	0.10	0.8–1.3	...	2.0–2.5	0.10	0.10–0.20	...	...	...	...	0.08–0.15 V	...	0.05 0.15 Rem.
413.2 <sup>M</sup>	11.0–13.0	0.7–1.1	0.10	0.10	0.07	...	0.10	0.10	...	...	...	0.10	...	...	...	0.20 Rem.
A413.1 <sup>J,M</sup>	11.0–13.0	1.0	1.0	0.35	0.10	...	0.50	0.40	...	...	...	0.15	...	...	...	0.25 Rem.
A413.2 <sup>M</sup>	11.0–13.0	0.6	0.10	0.05	0.05	...	0.05	0.05	...	...	...	0.05	...	...	...	0.10 Rem.
B413.1 <sup>M</sup>	11.0–13.0	0.40	0.10	0.35	0.05	...	0.05	0.10	0.25	...	...	...	...	...	...	0.05 0.20 Rem.
443.1 <sup>M</sup>	4.5–6.0	0.6	0.6	0.50	0.05	0.25	...	0.50	0.25	...	...	...	...	...	...	0.35 Rem.
443.2 <sup>M</sup>	4.5–6.0	0.6	0.10	0.10	0.05	...	...	0.10	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
A443.1 <sup>M</sup>	4.5–6.0	0.6	0.30	0.50	0.05	0.25	...	0.50	0.25	...	...	...	...	...	...	0.35 Rem.
B443.1 <sup>M</sup>	4.5–6.0	0.6	0.15	0.35	0.05	...	0.50	0.35	0.25	...	...	...	...	...	...	0.05 0.15 Rem.
C443.1 <sup>M</sup>	4.5–6.0	1.1	0.6	0.35	0.10	...	...	0.40	...	...	...	0.15	...	...	...	0.25 Rem.
C443.2 <sup>M</sup>	4.5–6.0	0.7–1.1	0.10	0.10	0.05	...	...	0.10	...	...	...	...	...	...	...	0.05 0.15 Rem.
444.2 <sup>M</sup>	6.5–7.5	0.13–0.25	0.10	0.05	0.05	...	...	0.05	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
A444.1 <sup>M</sup>	6.5–7.5	0.15	0.10	0.10	0.05	...	...	0.10	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
A444.2 <sup>M</sup>	6.5–7.5	0.12	0.05	0.05	0.05	...	...	0.05	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
505.1 <sup>P</sup>	0.40–0.8	0.50	0.15–0.40	0.15	0.9–1.2	0.04–0.35	...	0.25	0.15	...	...	...	...	...	...	0.05 0.15 Rem.
511.1	0.30–0.7	0.40	0.15	0.35	3.6–4.5	...	...	0.15	0.25	...	...	...	...	...	...	0.05 0.15 Rem.
511.2	0.30–0.7	0.30	0.10	0.10	3.6–4.5	...	...	0.10	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
512.2	1.4–2.2	0.30	0.10	0.10	3.6–4.5	...	...	0.10	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
513.2	0.30	0.30	0.10	0.10	3.6–4.5	...	...	1.4–2.2	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
514.1	0.35	0.40	0.15	0.35	3.6–4.5	...	...	0.15	0.25	...	...	...	...	...	...	0.05 0.15 Rem.
514.2	0.30	0.30	0.10	0.10	3.6–4.5	...	...	0.10	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
515.2	0.50–1.0	0.6–1.0	0.10	0.40–0.6	2.7–4.0	...	...	0.05	...	...	...	...	...	...	...	0.05 0.15 Rem.
516.1	0.30–1.5	0.35–0.7	0.30	0.15–0.40	2.6–4.5	...	0.25–0.40	0.20	0.10–0.20	...	0.10	0.10	...	...	...	0.05 — Rem.
518.1	0.35	1.1	0.25	0.35	7.6–8.5	...	0.15	0.15	...	...	...	0.15	...	...	...	0.25 Rem.
518.2	0.25	0.7	0.10	0.10	7.6–8.5	...	0.05	...	...	...	...	0.05	...	...	...	0.10 Rem.
520.2	0.15	0.20	0.20	0.10	9.6–10.6	...	...	0.10	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
535.2	0.10	0.10	0.05	0.10–0.25	6.6–7.5	...	...	...	0.10–0.25	...	0.003–0.007	...	...	0.002 B	...	0.05 0.15 Rem.
A535.1	0.20	0.15	0.10	0.10–0.25	6.6–7.5	...	...	...	0.25	...	...	...	...	...	...	0.05 0.15 Rem.
B535.2	0.10	0.12	0.05	0.05	6.6–7.5	...	...	...	0.10–0.25	...	...	...	...	...	...	0.05 0.15 Rem.
705.1	0.20	0.6	0.20	0.40–0.6	1.5–1.8	0.20–0.40	...	2.7–3.3	0.25	...	...	...	...	...	...	0.05 0.15 Rem.
707.1	0.20	0.6	0.20	0.40–0.6	1.9–2.4	0.20–0.40	...	4.0–4.5	0.25	...	...	...	...	...	...	0.05 0.15 Rem.
709.1 <sup>P</sup>	0.40	0.40	1.2–2.0	0.30	2.2–2.9	0.18–0.28	...	5.1–6.1	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
709.2 <sup>P</sup>	0.15	0.20	1.2–2.0	0.15	2.2–2.9	0.18–0.28	...	5.1–6.0	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
710.1	0.15	0.40	0.35–0.6	0.05	0.65–0.8	...	...	6.0–7.0	0.25	...	...	...	...	...	...	0.05 0.15 Rem.
711.1	0.30	0.7–1.1	0.35–0.6	0.05	0.30–0.45	...	...	6.0–7.0	0.20	...	...	...	...	...	...	0.05 0.15 Rem.
712.2	0.15	0.40	0.25	0.10	0.50–0.65 <sup>H</sup>	0.40–0.6	...	5.0–6.5	0.15–0.25	...	...	...	...	...	...	0.10 0.20 Rem.
713.1	0.25	0.8	0.40–1.0	0.6	0.25–0.50	0.35	0.15	7.0–8.0	0.25	...	...	...	...	...	...	0.05 0.25 Rem.
771.2	0.10	0.10	0.10	0.10	0.85–1.0	0.06–0.20	...	6.5–7.5	0.10–0.20	...	...	...	...	...	...	0.05 0.15 Rem.
772.2	0.10	0.10	0.10	0.10	0.65–0.8	0.06–0.20	...	6.0–7.0	0.10–0.20	...	...	...	...	...	...	0.05 0.15 Rem.
850.1	0.7	0.50	0.7–1.3	0.10	0.10	...	0.7–1.3	...	0.20	...	...	5.5–7.0	...	...	...	0.30 Rem.
851.1	2.0–3.0	0.50	0.7–1.3	0.10	0.10	...	0.30–0.7	...	0.20	...	...	5.5–7.0	...	...	...	0.30 Rem.
852.1	0.40	0.50	1.7–2.3	0.10	0.7–0.9	...	0.9–1.5	...	0.20	...	...	5.5–7.0	...	...	...	0.30 Rem.
853.2	5.5–6.5	0.50	3.0–4.0	0.10	...	...	...	...	0.20	...	...	5.5–7.0	...	...	...	0.30 Rem.

<sup>A</sup> Where single units are shown, these indicate the maximum amounts permitted.<sup>B</sup> Analysis shall be made for those elements for which limits are shown in this table.<sup>C</sup> The following applies to all specified limits in the table: For purposes of acceptance or rejection an observed value or a calculated value obtained from analysis should 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, Registered Alloys in the Form of XXX.1 Ingot and XXX.2 Ingot.<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" should 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 registration or 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.





TABLE 1 Continued

<sup>G</sup> The aluminum content for unalloyed aluminum not made by a refining process is the difference between 100.00 % and the sum of all other analyzed metallic elements together with silicon present in amounts of 0.010 % or more each, expressed to the second decimal before determining the sum. For alloys and unalloyed aluminum not made by a refining process, when the specified maximum limit is 0.XX, an observed value or a calculated value greater than 0.005 but less than 0.010 % is rounded off and shown as "less than 0.01".

<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 A1.2.6.

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

<sup>J</sup> A360.1, A380.1 and A413.1 ingot is used to produce 360.0 and A360.0; 380.0 and A380.0; 413.0 and A413.0 castings, respectively.

<sup>K</sup> P 0.001 % max, Sr 0.010 – 0.020 %.

<sup>L</sup> Primarily used for making metal matrix composite.

<sup>M</sup> Identifiers for Certain 3xx.x and 4xx.x Foundry Ingot Containing Structure Modifiers:

One of the applicable suffixes in the table below should be added to the registered alloy designation whenever a structure modifier is intentionally added to that alloy.

Alloy Designation Suffix	Structure Modifying Element	Chemical Composition Limits	
		Min. (%)	Max. (%)
N	Na	0.003	0.08
S	Sr	0.005	0.08
C	Ca	0.005	0.15
P	P	—	0.060

• The letter suffix follows and is separated from the registered foundry ingot designations by a hyphen (for example, "A356.1-S").

• In cases where more than one modifier is intentionally added, only the modifier of greater concentration shall be identified by suffix letter affixed to the registered alloy designation.

• When a foundry alloy is sold with a suffix added to its alloy designation, the modifying element's concentration is not to be included in "Others, Each" or "Others, Total".

• It is not intended that these structure modifier identifiers be treated as new alloy registration, nor should these designations be listed in the Registration Record.

<sup>N</sup> Identifiers for Certain 3xx.x and 4xx.x Foundry Ingot Containing Structure Modifiers: One of the applicable suffixes in the table below should be added to the registered alloy designation whenever a structure modifier is intentionally added to that alloy.

Alloy Designation Suffix	Structure Modifying Element	Chemical Composition Limits	
		Min. (%)	Max. (%)
N	Na	0.003	0.08
C	Ca	0.005	0.15

• The letter suffix follows and is separated from the registered foundry ingot designations by a hyphen (for example: "365.1-N").

• In cases where more than one modifier is intentionally added, only the modifier of greater concentration shall be identified by suffix letter affixed to the registered alloy designation.

• When a foundry alloy is sold with a suffix added to its alloy designation, the modifying element's concentration is not to be included in "Others, Each" or "Others, Total".

• It is not intended that these structure modifier identifiers be treated as new alloy registration, nor should these designations be listed in the Registration Record.

<sup>O</sup> Used for semi-solid formed products.

<sup>P</sup> Used for centrifugally cast products.

<sup>Q</sup> P 0.001 % max. Sr range to be determined between producer and purchaser to allow for potential burn out at caster's facility.

<sup>R</sup> P 0.001 % max.

<sup>S</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')".

\*Rated minimum conductivities for rotor ingot (electrical motor armatures) and other high conductivity applications:

Ingot	Percent IACS
100.1	54
130.1	55
150.1	57
170.1	59

The rating of ingot metal for minimum conductivity characteristic is based on established relations between electrical conductivity and metal composition.



## **E1251** Test Method for Analysis of Aluminum and Aluminum Alloys by Spark Atomic Emission Spectrometry

2.3 *ANSI Standard*:<sup>4</sup>

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

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

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

2.5 *Other Standards*:<sup>5</sup>

## **EN 14242** Aluminum and Aluminum Alloys — Chemical Analysis — Inductively Coupled Plasma Optical Emission Spectral Analysis

### **3. Ordering Information**

3.1 Orders for material under this specification shall include the following information:

- 3.1.1 This specification designation (which includes the number, the year, and the revision letter, if applicable),
- 3.1.2 Alloy (Section 6, **Table 1**), and
- 3.1.3 The quantity in pieces or pounds [kilograms].

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

- 3.2.1 Form—the approximate form and weight of each ingot may be specified by agreement between the purchaser and the manufacturer, and for molten metal the weight may be specified,
- 3.2.2 Whether marking for identification is required, including marking ingot if required (see Sections 11 and 12.2),
- 3.2.3 Whether inspection is required at the manufacturer's works (see 8.2),
- 3.2.4 Whether certification or analysis is required (see Section 11), and
- 3.2.5 Whether SPC data is required (see 10.2).

### **4. Process**

4.1 The alloys may be made by any approved process.

### **5. Quality**

5.1 The material covered by this specification shall be of uniform quality and shall be free from dross, slag, and other harmful contamination.

### **6. Chemical Composition**

6.1 The ingots or molten metal shall conform to the chemical composition limits prescribed in **Table 1**. Conformance shall be determined by the producer by taking samples at the time the ingots are poured into molds or as the molten alloy is poured into the crucible(s) prior to shipment in accordance with Practice **E716** and analyzed in accordance with Test Methods **E34**, **E607**, or **E1251**, or EN 14242. If the chemical composition of the material has been determined during the

course of manufacture, the manufacturer shall not be required to additionally sample and analyze the ingots or the delivered crucible of molten metal after delivery.

6.1.1 The number of samples taken for determination of chemical composition shall be as follows:

6.1.2 When samples are taken at the time the ingots are poured, at least one sample shall be taken from the first, middle and last third of each lot of ingots poured from the same source of molten metal. The analytical results of each sample taken during the pouring of the ingots shall conform to the composition limits shown in **Table 1**. The analytical results of all samples taken during pouring of the ingots shall be averaged and that average reported as the composition of that lot of alloy.

6.1.3 *Molten Metal*—Samples are taken at the time the molten metal is poured into the crucible(s) and at least one sample shall be taken for each group of crucible(s) continuously poured from the same source of molten metal, but unless otherwise specified in the contract or purchase order at least one sample shall be taken for every 30 000 lb [15 000 kg] or fraction thereof.

6.2 If it becomes necessary to analyze ingot for conformance to chemical composition limits, the method used to sample for the determination of chemical composition shall be in accordance with Practice **B985**. Analysis shall be performed in accordance with Practice **E716**, Test Methods **E34**, **E607**, or **E1251**, or EN 14242 (ICP method).

### **7. Electrical Conductivity**

7.1 The control of chemical requirements in **Table 1** ensures the capability of Alloys 100.1, 130.1, 150.1, and 170.1 to meet rated but not measured minimum conductivity in ingot form. The rated minimum conductivities for rotor ingot (electric motor armatures) and other high conductivity applications are listed in the footnote (\*) of **Table 1**.

### **8. Inspection**

8.1 Unless otherwise specified in the contract or purchase order, the producer is 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 ensure that material conforms to prescribed requirements.

8.2 If the purchaser desires that inspection be made at the manufacturer's works where the material is made, it shall be so stated in the contract or purchase order.

8.3 If the purchaser elects to have inspection made at the manufacturer's works, the manufacturer shall afford the inspector representing the purchaser 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.

<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 European Committee for Standardization (CEN), 36 rue de Stassart, B-1050, Brussels, Belgium, <http://www.cen.eu>.



## **9. Rejection**

9.1 Material that does not conform to the requirements of this specification may be rejected and, if rejected, shall be replaced by the manufacturer. The full weight of the rejected material shall be returned to the manufacturer.

## **10. Certification**

10.1 The manufacturer shall upon request, furnish to the purchaser either a certificate stating that each lot has been sampled, tested, and inspected in accordance with this specification and has met the requirements or an analysis for each lot of material.

10.2 If the purchaser elects to receive SPC data for each lot of material being delivered, it shall be so stated in the purchase order.

## **11. Marking for Identification**

11.1 Unless otherwise specified, each bundle of ingots shall be marked with the applicable alloy designation and batch number in Arabic numerals and when applicable capital letters. When the location is not specified on the purchase order or purchasing specification the alloy designation and batch number shall be placed in a location mutually agreeable to the purchaser and producer. When identification marking of ingots is specified on the order, ingots shall be marked in accordance with Practice **B666/B666M**.

## **12. Packaging, Marking, and Shipping**

12.1 The material shall be packaged in such a manner as to prevent damage in ordinary handling and transportation. The type of packaging and gross weight of individual containers shall be left to the discretion of the manufacturer unless otherwise agreed upon. Packaging methods and containers shall be so selected as to permit maximum utility of mechanical equipment in unloading and subsequent handling. Each package or container shall contain only one size or alloy of material when packed for shipment unless otherwise agreed upon.

12.2 Each package or container shall be legibly marked with the purchase order number; quantity; specification number; alloy, gross, and net weights; and the name of the manufacturer.

12.3 Packages or containers shall be such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery.

12.4 Material intended for prolonged storage in unheated locations shall be adequately packed and protected to avoid deterioration and damage.

## **13. Keywords**

13.1 aluminum; ingot; molten metal



**ANNEXES****(Mandatory Information)****A1. ACCEPTANCE CRITERIA FOR INCLUSION OF NEW ALUMINUM AND ALUMINUM ALLOYS IN THIS SPECIFICATION**

A1.1 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 holds the Secretariat of ANSI H35 Committee<sup>4</sup> and administers the criteria and procedures for registration.

A1.2 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:

A1.2.1 The designation submitted for inclusion does not utilize the same designation system as described in ANSI H35.1. A designation not in conflict with other designation systems or a trade name is acceptable.

A1.2.2 The aluminum or aluminum alloy has been offered for sale in commercial quantities within the prior twelve months to at least three identifiable users.

A1.2.3 The complete chemical composition limits are submitted.

A1.2.4 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.

A1.2.5 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.

A1.2.6 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 % (It is customary to express limits of 0.30 through 0.55 % as 0.X0 or 0.X5.)	0.XX
Over 0.55 %	0.X, X.X,
(except that combined Si + Fe limits for 99.00 % minimum aluminum must be expressed as 0.XX or 1.XX)	etc.

A1.2.7 Standard limits for alloying elements and impurities are expressed in the following sequence: Silicon; Iron; Copper; Manganese; Magnesium; Chromium; Nickel; Zinc; Titanium, (**Note A1.1**); Other Elements, Each; Other Elements, Total: Aluminum (**Note A1.2**).

NOTE A1.1—Additional specified elements having limits are inserted in alphabetical order of their chemical symbols between Titanium, and Other Elements, Each, or are specified in footnotes.

NOTE A1.2—Aluminum is specified as *minimum* for unalloyed aluminum and as a *remainder* for aluminum alloys.

**A2. INACTIVE ALLOYS****TABLE A2.1 Inactive Alloys**

DESIGNATION	DATE RECLASSIFIED
202.2	04/22/88
208.1	08/15/95
208.2	08/15/95
213.1	08/15/95
222.1	08/15/95
224.2	08/15/95
238.1	04/22/88
238.2	04/22/88
243.1	08/15/95
249.2	04/22/88
305.2	08/15/95
A305.1	08/15/95
A305.2	08/15/95
324.1	08/15/95
324.2	08/15/95
343.1	08/15/95
D355.2	11/18/74
385.1	01/20/03



TABLE A2.2 Registered Chemical Composition Limits of Inactive Original Alloys<sup>A,B,C,D</sup>

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

DESIG. <sup>S</sup>	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Ag	Be	Pb	Sn	Zr	FNs	OTHERS <sup>E</sup> Each Total <sup>F</sup>	Al Min.
202.2	0.10	0.10	4.0–5.2	0.20–0.8	0.20–0.55	0.20–0.6	...	...	0.15–0.35	0.40–1.0	...	...	...	...	...	0.05	0.10
208.1	2.5–3.5	0.9	3.5–4.5	0.50	0.10	...	0.35	1.0	0.25	...	...	...	...	...	...	...	0.50
208.2	2.5–3.5	0.8	3.5–4.5	0.30	0.03	...	...	0.20	0.20	...	...	...	...	...	...	...	0.30
213.1	1.0–3.0	0.9	6.0–8.0	0.6	0.10	...	0.35	2.5	0.25	...	...	...	...	...	...	...	0.50
222.1	2.0	1.2	9.2–10.7	0.50	0.20–0.35	...	0.50	0.8	0.25	...	...	...	...	...	...	...	0.35
224.2	0.02	0.04	4.5–5.5	0.20–0.50	...	...	...	...	0.25	...	...	...	...	0.10–0.25	0.05–0.15V	0.03	0.10
238.1	3.5–4.5	1.2	9.0–11.0	0.60	0.20–0.35	...	1.0	1.5	0.25	...	...	...	...	...	...	...	0.50
238.2	3.5–4.5	1.2	9.5–10.5	0.50	0.20–0.35	...	0.50	0.50	0.20	...	...	...	...	...	...	...	0.50
243.1	0.35	0.30	3.5–4.5	0.15–0.45	1.9–2.3	0.20–0.40	1.9–2.3	0.05	0.06–0.20	...	...	...	...	...	0.06–0.20V	0.05	0.15
249.2	0.05	0.07	3.8–4.6	0.25–0.50	0.30–0.50	...	...	2.5–3.5	0.02–0.12	...	...	...	...	...	...	0.03	0.10
305.2 <sup>M</sup>	4.5–5.5	0.14–0.25	1.0–1.5	0.05	...	...	...	0.05	0.20	...	...	...	...	...	...	0.05	0.15
324.1 <sup>M</sup>	7.0–8.0	0.9	0.40–0.6	0.05	0.45–0.7	...	0.30	1.0	0.20	...	...	...	...	...	...	0.15	0.20
324.2 <sup>M</sup>	7.0–8.0	0.6	0.40–0.6	0.10	0.45–0.7	...	0.10	0.10	0.20	...	...	...	...	...	...	0.05	0.15
343.1 <sup>M</sup>	6.7–7.7	0.9	0.50–0.9	0.50	0.10	0.10	...	1.2–1.9	...	...	...	...	...	...	...	0.10	0.35
385.1 <sup>M</sup>	11.0–13.0	1.1	2.0–4.0	0.50	0.30	...	0.50	2.9	...	...	...	...	0.50	...	...	...	0.50



## SUMMARY OF CHANGES

Committee B07 has identified the location of selected changes to this standard since the last issue (B179 – 17) that may impact the use of this standard. (Approved May 15, 2018.)

(1) Revised Sections 11 and 12.

Committee B07 has identified the location of selected changes to this standard since the last issue (B179 – 14) that may impact the use of this standard. (Approved Oct. 1, 2017.)

(1) Reformatted and revised **Table 1** and **Table A2.2**.

(2) Removed reference to Practice E527 1.2 & 2.2.

(3) Moved Notes 1-4 in **Table 1** to footnotes A, B, C, and D.

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