

Designation: B108/B108M - 19

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

This standard is issued under the fixed designation B108/B108M; 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 ( $\varepsilon$ ) 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<sup>2</sup> covers aluminum-alloy permanent mold castings designated as shown in Table 1.

1.2 This specification is for aluminum-alloy permanent mold 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 Units—The values stated in either SI units or inchpound 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, health, and environmental 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 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 the date of casting purchase form a part of this specification to the extent referenced herein:

- 2.2 ASTM Standards:<sup>3</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 (Withdrawn 2020)<sup>4</sup>
- **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-MAlloy 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 (Withdrawn 2017)<sup>4</sup>
- E94/E94M Guide for Radiographic Examination Using Industrial Radiographic Film
- E155 Reference Radiographs for Inspection of Aluminum and Magnesium Castings
- E165/E165M Practice for Liquid Penetrant Testing for General Industry
- E607 Test Method for Atomic Emission Spectrometric

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

<sup>&</sup>lt;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>&</sup>lt;sup>2</sup> For ASME Boiler and Pressure Code application see related SB-108.

<sup>&</sup>lt;sup>3</sup> For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>&</sup>lt;sup>4</sup> The last approved version of this historical standard is referenced on www.astm.org.

$ \begin{array}{c c c c c c c c c c c c c c c c c c c $					:			emical Co	Chemical Composition Limits <sup>A,B,C,D</sup>	Limits	<b>S</b> <sup>A</sup> , B, C, D	ā	d	1		ť	Others <sup>E</sup>	rs <sup>E</sup>	
27         10         35-45         0.05         17-20         0.05         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0.15         0.06         0	Si.	Ъe	Cu	Мп	Mg	ò	<del>z</del> teh	Zn	Ξ	Ag	Be	Рр	Sn	Z		FNs	Each	Total <sup>F</sup>	AI. Min
07         10         31-44         0.35         17-25         0.35         17-35         0.35         17-35         0.35         17-35         0.35         17-35         0.35         17-35         0.35         17-35         0.35         17-35         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.35         100         0.36         100         0.36         100         0.36         100         0.36         100         0.36         100         0.36         100         0.36         100         0.36         100         0.36         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100 <t< td=""><td>0.20</td><td>0.35</td><td>4.2-5.0</td><td>0.10</td><td>0.15-0.35</td><td></td><td>0.05</td><td>0.10</td><td>0.15-0.30</td><td></td><td></td><td></td><td>0.05</td><td>:</td><td></td><td>:</td><td>0.05</td><td>0.15</td><td>Rem.</td></t<>	0.20	0.35	4.2-5.0	0.10	0.15-0.35		0.05	0.10	0.15-0.30				0.05	:		:	0.05	0.15	Rem.
0-30         112         40-50         035         016         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035         035<	0.7	1.0	3.5-4.5	0.35	1.2-1.8	0.25	1.7-2.3	0.35	0.25	:	:	:	:	:	:	:	0.05	0.15	Rem.
-0.60         1.0         0.05         1.0         0.05         1.0         0.05         0.00         0.05         0.00         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0	0-3.0	1.2	4.0-5.0	0.35	0.05	:	0.35	0.50	0.25		:	:	:	:	:	:	:	0.35	Rem.
5-16         10         30-40         050         100         030         100         030         100         030         100         030         100         030         100         030         100         030         100         030         100         030         100         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030         030 </td <td>00.0</td> <td>1.0</td> <td>4.0-5.0</td> <td>0.50</td> <td>0.10</td> <td>:</td> <td>ta</td> <td>1.0</td> <td>0.25</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td>0.50</td> <td>Rem.</td>	00.0	1.0	4.0-5.0	0.50	0.10	:	ta	1.0	0.25	:	:	:	:	:	:	:	:	0.50	Rem.
101       12       20-40       050       050-15       050       10       025       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055       055 <t< td=""><td>5-6.5</td><td>1.0</td><td>3.0-4.0</td><td>0.50</td><td>0.10</td><td>:</td><td>0.35</td><td>1.0</td><td>0.25</td><td>:</td><td>:</td><td>:</td><td>:</td><td>:</td><td>:</td><td>:</td><td>:</td><td>0.50</td><td>Rem.</td></t<>	5-6.5	1.0	3.0-4.0	0.50	0.10	:	0.35	1.0	0.25	:	:	:	:	:	:	:	:	0.50	Rem.
0-100         10         0.65         0.64-0.6         0.50         0.65-0.6         0.50         0.66         0.50         0.66         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50         0.50	5 - 10.5	1.2	2.0-4.0	0.50	0.50-1.5		0.50	1.0	0.25	:		:	:	:	:	:	:	0.50	Rem.
0-130         1.2         0.60-15         0.35         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         0.73         75         0.73         0.73         75         0.73         75         0.73         0.73         75         0.73         75         0.73         75         0.75         0.75         0.75         0.75         75         0.75         0.75         75         0.75         75         0.75         75         0.75         0.75         75         0.75         75         0.75         0.75         75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75         0.75	0-10.0	1.0	3.0-4.0	0.50	0.05-0.50	:	0.50	1.0	0.25	:	:	:	:	:	:	:	:	0.50	Rem.
68-34         0.20         14-20         0.10         040-06         0.15         Rem           55-55         0.20         10-15         0.00         0.04         0.15         Rem           55-75         0.20         0.25         0.25         0.25         0.15         Rem           55-75         0.25         0.25         0.25         0.25         0.15         Rem           55-75         0.25         0.25         0.25         0.25         0.15         Rem           55-75         0.20         0.20         0.25         0.25         0.15         Rem           55-75         0.20         0.10         0.40-07         0.16         0.40-07         0.15         Rem           55-70         0.20         0.10         0.40-07         0.16         0.40-07         0.15         Rem	.0-13.0	1.2	0.50-1.5	0.35	0.7-1.3	:	2.0-3.0	0.35	0.25	:	:	:	:	:	:	:	0.05	:	Rem.
15-55       0.06"       10-11.5       0.040-06       0.25       0.040-06       0.25       0.040-06       0.25       0.040-06       0.15       Rem         55-75       0.20       0.040-01       0.055-0.44       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05<	3.6-9.4	0.20	1.6-2.0	0.10	0.40-0.6		da	0.10	0.20	:	:	:	:	:	:	:	0.05	0.15	Rem.
15-55 $020$ $010$ $040-06$ $100$ $020$ $010$ $010-06$ $015$ $100$ $015$ $100$ $015$ $100$ $015$ $100$ $015$ $100$ $015$ $100$ $015$ $100$ $015$ $100$ $015$ $100$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$ $015$	4.5-5.5	0.6 <sup>G</sup>	1.0-1.5	0.50 <sup>G</sup>	0.40-0.6	0.25	rc	0.35	0.25	:	:	:	:	:	:	:	0.05	0.15	Rem.
65-7.5         0.05         0.35         0.20-045         0.05         0.35         0.05-045         0.05         0.15         Rem           65-7.5         0.10         0.35-045         0.05         0.35         0.05-045         0.05         0.15         Rem           65-7.5         0.10         0.35-045         0.05         0.05         0.15         Rem         0.05         0.15         Rem           65-7.5         0.10         0.35-05         0.00         0.35-05         0.00         0.05-01         0.05         0.15         Rem           65-7.5         0.10         0.35-05         0.20         0.00         0.35-05         0.05         0.15         Rem           65-7.5         0.10         0.36-01         0.00         0.35-05         0.35         0.35         Rem         0.35<	4.5-5.5	0.20	1.0-1.5	0.10	0.40-0.6		ls	0.10	0.20	2		:	:	:	:	:	0.05	0.15	Rem.
65-75         0.20         0.01         025-045         0.00         0.03         0.15         Rem           65-75         0.10         0.25-045         0.00         0.04-02         0.00         0.04         0.15         Rem           65-75         0.10         0.20         0.10         0.25-04         0.15         Rem         0.05         0.15         Rem           65-75         0.10         0.20         0.10         0.25-04         0.16         0.05-07         0.15         Rem           65-75         0.10         0.20         0.10         0.25-04         0.16         0.05         0.15         Rem           65-75         0.10         0.26-07         0.26         0.05         0.15         Rem         0.05         0.15         Rem           65-75         0.20         0.10         0.26-04         0.16         0.26         0.15         Rem           65-75         0.20         0.00         0.25         0.14         0.26         0.15         Rem           65-70         0.00         0.00         0.26         0.26         0.26         0.15         Rem           65-70         0.20         0.20         0.20 <td< td=""><td>6.5-7.5</td><td>0.6<sup>G</sup></td><td>0.25</td><td>0.35<sup>G</sup></td><td>0.20-0.45</td><td></td><td>/si</td><td>0.35</td><td>0.25</td><td></td><td></td><td>:</td><td>:</td><td>:</td><td>:</td><td>:</td><td>0.05</td><td>0.15</td><td>Rem.</td></td<>	6.5-7.5	0.6 <sup>G</sup>	0.25	0.35 <sup>G</sup>	0.20-0.45		/si	0.35	0.25			:	:	:	:	:	0.05	0.15	Rem.
65-75         0.05         0.03         0.45-06         0.05         0.03         0.45-06         0.15         Rem.           65-75         0.10         0.20         0.10         0.40-07         0.10         0.40-07         0.15         Rem.           65-75         0.10         0.20         0.10         0.40-07         0.10         0.40-07         0.15         Rem.           65-75         0.10         0.20         0.10         0.40-07         0.10         0.40-07         0.15         Rem.           45-60         0.8         0.15         0.25         0.10         0.40-05         0.15         Rem.         0.05         0.15         Rem.           45-60         0.8         0.16         0.05         0.25         0.25         0.25         0.25         0.15         0.15         0.15         Rem.           55-75         0.8         0.16         0.25         0.25         0.25         0.25         0.25         0.15         Rem.         0.25         Rem.         0.25 <td>6.5-7.5</td> <td>0.20</td> <td>0.20</td> <td>0.10</td> <td>0.25-0.45</td> <td>:</td> <td><u>A</u> ist</td> <td>0.10</td> <td>0.20</td> <td>Ì</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td></td> <td>0.05</td> <td>0.15</td> <td>Rem.</td>	6.5-7.5	0.20	0.20	0.10	0.25-0.45	:	<u>A</u> ist	0.10	0.20	Ì	:	:	:	:	:		0.05	0.15	Rem.
	6.5-7.5	0.15	0.05	0.03	0.45-0.6	:	<u>S</u> /e	0.05	0.20		:	:	:	:	:	:	0.05	0.15	Rem.
65-75         0.10         0.05-0.6         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.05         0.15         Rem           6.5-75         0.00         0.00         0.05         0.05         0.05         0.05         0.15         Rem         Rem         0.05 <td>6.5-7.5</td> <td>0.20</td> <td>0.20</td> <td>0.10</td> <td>0.40-0.7</td> <td></td> <td>T] 06</td> <td>0.10</td> <td>0.04-0.20</td> <td></td> <td>0.04-0.07</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td>0.05</td> <td>0.15</td> <td>Rem.</td>	6.5-7.5	0.20	0.20	0.10	0.40-0.7		T] 06	0.10	0.04-0.20		0.04-0.07	:	:	:	:	:	0.05	0.15	Rem.
65-75         0.10         0.40-07 $0.10$ 0.40-07 $0.10$ 0.40-07 $0.10$ 0.40-07 $0.10$ 0.40-07 $0.10$ 0.40-07 $0.10$ 0.40-07 $0.10$ 0.40-07 $0.10$ 0.40-07 $0.10$ 0.40-07 $0.10$ 0.40-05 $0.15$ 0.40         0.10         0.40-07 $0.15$ 0.40         0.10         0.05         0.15         0.40         0.10         0.05         0.15         0.40         0.10         0.05         0.15         0.40         0.16         0.15         0.16         0.15         0.16         0.15         0.16         0.15         0.16         0.15         0.16         0.15         0.16         0.15         0.16         0.15         0.16         0.15         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0.16         0	6.5-7.5	0.10	: .	0.10	0.55-0.6	:	M 53	ņ	0.10-0.20	:	0.002	:	:	:	:	:	0.05	0.15	Rem.
85-95         0.20         0.20         0.10         0.56         0.25         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15         0.15	6.5-7.5	0.10	0.20	0.10	0.40-0.7	:	B fc	0.10	0.04-0.20		0.002	:	:	:	:	:	0.05	0.15	Rem.
$ \begin{array}{c c c c c c c c c c c c c c c c c c c $	8.5–9.5	0.20	0.20	0.10	0.50-0.7	:	8 <u>1(</u> 1c	0.10	0.20	:	:	:	:	:	:	:	0.05	0.15	Rem.
45-60       0.03       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05       0.05	4.5-6.0	0.8	9.0	0.50	0.05	0.25	<u>)8</u> ;-9	0.50	0.25	:2	:	:	:	:	:	:	:	0.35	Rem.
65-75 $0.20$ $0.10$ $0.03$ $0.24$ $0.10$ $0.10$ $0.03$ $0.15$ Rem. $0.33$ $0.40$ $0.10$ $0.10$ $0.10$ $0.15$ Rem. $0.05$ $0.15$ Rem. $0.20$ $0.40-0.6$ $1.4-1.8$ $0.20-0.40$ $0.1-0.25$ $0.05$ $0.15$ Rem. $0.20$ $0.40-0.6$ $1.4-1.8$ $0.20-0.40$ $0.16$ $0.25$ $0.05$ $0.15$ Rem. $0.20$ $0.40-0.6$ $1.4-2.4$ $0.20-0.50$ $0.35$ $0.15$ $7.0-80.$ $0.25$ $0.05$ $0.15$ $Rem.$ $0.20$ $0.7-1.3$ $0.10$ $0.10$ $0.10$ $0.25$ $Rem.$ $0.05$ $0.15$ $Rem.$ $0.05$	4.5-6.0	0.8	0.15	0.35	0.05	:	3/E 92	0.35	0.25	:	:	:	:	:	:	:	0.05	0.15	Rem.
0.30 $0.40$ $0.30$ $0.40$ $0.30$ $0.40$ $0.30$ $0.40$ $0.35$ $1.5$ Rem. $0.15$ $0.05$ $0.10-0.25$ $1.4-1.2$ $0.005$ $1.5$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.6$ $1.$	6.5-7.5	0.20	0.10	0.10	0.05	:	8 <u>1</u> c5	0.10	0.20	'n	:	:	:	:	:	:	0.05	0.15	Rem.
0.15 $0.15$ $0.05$ $0.10-0.25$ $6.2-75$ $0.20-0.40$ $0.25-0.45$ $0.20-0.40$ $0.16-0.25$ $1.8-1.4$ $0.05$ $1.5$ Rem.         0.20 $0.40-0.6$ $1.8-2.4$ $0.20-0.40$ $0.16-0.25$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.25-0.45$ $0.20-0.50$ $0.25-0.45$ $0.20-0.50$ $0.25-0.45$ $0.20-0.50$ $0.25-0.45$ $0.20-0.50$ $0.25-0.45$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$ $0.20-0.50$	0.30	0.40	0.10	0.30	3.5-4.5	:	<u>08</u> 5-4	1.4-2.2	0.20	: C	:	:	:	:	:	:	0.05	0.15	Rem.
0.20         0.8         0.20         0.40-06         1.4-1.8         0.20-0.40 $1.7$ 2.7-3.3         0.25 $1.1$ $1.1$ $0.20$ $0.40-0.6$ $1.8-2.4$ $0.20$ $1.5$ Rem.           0.20         0.7         0.7-0.13         0.65         0.52.0.40 $0.25$ $0.10$ $0.25$ $1.5$ Rem.           0.7         0.7-1.3         0.70         0.65         0.25-0.50 $0.20$ $0.26$ $0.25$ Rem. $0.36$ $0.25$ Rem. $0.30$ $0.26$ $0.6$ $0.26$ $0.6$ $0.20$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ $0.26$ </td <td>0.15</td> <td>0.15</td> <td>0.05</td> <td>0.10-0.25</td> <td></td> <td>:</td> <td><u>81</u> 4e</td> <td></td> <td>0.10-0.25</td> <td></td> <td>0.003-0.007</td> <td>:</td> <td>:</td> <td>:</td> <td>0.005B</td> <td>:</td> <td>0.05</td> <td>.15</td> <td>Rem.</td>	0.15	0.15	0.05	0.10-0.25		:	<u>81</u> 4e		0.10-0.25		0.003-0.007	:	:	:	0.005B	:	0.05	.15	Rem.
0.20 $0.20$ $0.49-0.6$ $1.8-2.4$ $0.20-0.40$ $0.16$ $1.0-1.0$ $0.05$ $1.5$ Rem. $0.30$ $0.7-1.4$ $0.05$ $0.05$ $0.25-0.45$ $0.25-0.45$ $0.05$ $0.05$ $0.05$ $1.6$ Rem. $0.7$ $0.7$ $0.7$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $1.6$ Rem. $0.7$ $0.7$ $0.7$ $0.06$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ $0.05$ <td>0.20</td> <td>0.8</td> <td>0.20</td> <td>0.40-0.6</td> <td></td> <td>0.20-0.40</td> <td><u>/</u>- 4</td> <td>2.7-3.3</td> <td>0.25</td> <td>:2</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td>:</td> <td>0.05</td> <td>.15</td> <td>Rem.</td>	0.20	0.8	0.20	0.40-0.6		0.20-0.40	<u>/</u> - 4	2.7-3.3	0.25	:2	:	:	:	:	:	:	0.05	.15	Rem.
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	0.20	0.8	0.20	0.40-0.6		0.20-0.40	- <u>1</u> 5 -	4.0-4.5	0.25	÷	:	:	:	:	:	:	0.05	.15	Rem.
0.25 $1.1$ $0.40-1.0$ $0.6$ $0.20-0.50$ $0.35$ $0.15$ $7.0-8.0$ $0.25$ $1.1$ $1.40-1.0$ $0.6$ $0.20$ $1.2$ $1.1$ $0.40-1.0$ $0.10$ $0.25$ $Rem.$ $0.7$ $0.7-1.3$ $0.10$ $0.10$ $0.10$ $0.00$ $1.0$ $0.00$ $1.0$ $0.20$ $Rem.$ $2.0-3.0$ $0.7$ $0.7-1.3$ $0.10$ $0.10$ $0.00$ $1.0$ $0.20$ $1.0$ $0.20$ $Rem.$ $2.0-3.0$ $0.7$ $0.7-1.3$ $0.10$ $0.10$ $0.00$ $1.0$ $0.20$ $1.7$ $1.7-2.3$ $1.0$ $0.30$ $Rem.$ $0.40$ $0.7$ $0.7-1.3$ $0.10$ $0.6-0.9$ $1.7$ $0.9-1.5$ $1.7$ $1.7-2.3$ $1.7-2.3$ $0.10$ $0.30$ $Rem.$ $0.41$ $0.7$ $0.7-1.3$ $0.10$ $0.6-0.9$ $1.7$ $0.9-1.5$ $1.7$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.3$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$ $1.7-2.2$	0.30	0.7-1.4	0.35-0.6	0.05	0.25-0.45	:	<u>9</u> b	6.0-7.0	0.20	:	:	:	:	:	:	:	0.05	.15	Rem.
0.7       0.7       0.7-1.3       0.10       0.10       0.7       0.7-1.3       0.7       0.7-1.3       0.10       0.10       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00       0.00	0.25	<del>.</del> .	0.40-1.0	9.0	0.20-0.50	0.35	0.15	7.0-8.0	0.25		:	:	:	:	:	:	0.10	0.25	Rem.
2.0-3.0       0.7       0.7-1.3       0.10       0.10       0.6-0.9        0.30       Rem.         0.40       0.7       1.7-2.3       0.10       0.6-0.9        0.30       Rem.         Jell be made for the elements for which limits are shown in this table.       0.9-1.5        0.20        0.5.5-7.0         0.30       Rem.         all be made for the elements for which limits are shown in this table.       0.9-1.5        0.20        0.10       0.6-0.9        0.30       Rem.         nig applies to all specified limits in this table.           0.30       Rem.       0.30       Rem.         finitig applies to all specified limits are shown in this table.           0.30       Rem.         finitig applies to all specified limits are shown in this table.           0.30       Rem.         finitig applies to all specified limits are shown in this table.           0.30       Rem.         finitig applies to all specified limits in white table.           0.30	0.7	0.7	0.7-1.3	0.10	0.10	:	0.7-1.3	Ģ	0.20	:	:	:	5.5-7.0	:	:	:	:	0.30	Rem.
0.40 0.7 1.7–2.3 0.10 0.6–0.9 0.3–1.5 0.20 0.20 0.20 0.20 American are shown, they indicate the maximum amounts permitted. Jel units are shown, they indicate the maximum amounts permitted. The for the elements for which limits are shown in this table. In accordance with the rounding-off method of Practice E29. In the Aluminum Association and published in the "Peink Sheets" shall be considered the controlling composition. In the Aluminum Association and published in the "Peink Sheets" shall be considered the controlling composition. In the Relements for which 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, the interverse of the purchaser of the producer or the purchaser establish that an "others" element and row are registration or specification. However, the interverse of the producer or the purchaser establish that an "others" element and any analyses by the producer or the purchaser establish that an "others" element event in the aggregate	2.0-3.0	0.7	0.7–1.3	0.10	0.10	:	0.30-0.7	Y	0.20	:	:	:	5.5-7.0	:	:	:	:	0.30	Rem.
gle units are shown, they indicate the maximum amounts permitted. shall be made for the elements for which limits are shown in this table. wing applies to all specified limits in this table. ight-hand place of figures used in expressing the specified limit in accordance with the rounding-off method of Practice E29. if discrepancy between the values listed in Table 1 and those listed in the "Pink Sheets" and Operation Limits for Aluminum Alloys in the Form of Castings and Ingot ("The Pink Sheets)" the nimits registered with the Aluminum Association and published in the "Pink Sheets" shall be considered the controlling composition. Indices listed elements for which no specified 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, is not required and any not cover all metallic "chements" should any analysis by the producer or the purchaser establish that an "others" element sore the limit the aggregate	0.40	0.7	1.7–2.3	0.10	0.6-0.9		0.9-1.5	Y	0.20	:		:	5.5-7.0	:	:	:	:	0.30	Rem.
shall be made for the elements for which limits are shown in this table. The set of the elements for which limits are shown 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 wing 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 eight-hand place of figures used in expressing the specified limit in accordance with the rounding-off method of Practice E29. I discrete the values listed in Table 1 and those listed in the "Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot ("The Pink Sheets)" the nimits registered with the Aluminum Association and published in the "Pink Sheets" shall be considered the controlling composition. In the Aluminum Association and published in the "Pink Sheets" shall be considered the controlling composition. However, not 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, not describe and any or cover all metallic "others" elements by analysis by the producer or the purchaser establish that an "others" element and the aggregate the control or the purchaser establish that an "others" element as or the aggregate to an end of the structure and the structure and the structure addresses and the structure advected and any analysis the producer or the purchaser establish that an "others" element as a that the aggregate addresses and the structure advected a	igle units a	tre shown,	they indicate	the maximu	im amounts p	ermitted.	<b>43</b> 1		•										
This applies to an specified init in such a performing contonnence to need mines in observed value or a calculated value from analysis shall be rounded to the heatest unit of the performance of figures used in expressing the specified limit in environment of method of Practice E29. If discrepancy between the values listed in Table 1 and those listed in the "Pesignations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot ("The Pink Sheets)" the limits registered with the Aluminum Association and published in the "Pesignations and Chemical Composition. Limits registered with the Ruminum Alloys in the registration or specification. However, cludes 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, the and and and any automatic "other and should any analysis by the producer or the purchaser establish that an "others" element are "each" or that the aggregate	ihall be m	ade for the	elements fo	r which limits	s are shown ir	n this table.	fb	204 04 000		00000		, hotoling	oldo onlo	out poo	oio: looo	4    0 4 0		a to the c	+00000
r discrepancy between the values listed in Table 1 and those listed in the "Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot ('The Pink Sheets)' the limits registered with the Aluminum Association and published in the "Pink Sheets" shall be considered the controlling composition. Initis registered with the Aluminum Association and published in the "Pink Sheets" shall be considered the controlling composition. Initis registered 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, is not required and may not cover all metallic "builds any analysis by the producer or the purchaser establish that an "others" element acceeds the limit of "Each" or that the aggregate	dht-hand	place of fig	ures used in	expressing	the specified	i or uetermini limit in accord	dance with t	the roundinu	iq-off method	of Pract	u value or a cal tice E29.	culated	alue obla	lien Iroll	ii anaiysis	Sliall D	e rounde	a lo lite li	earest uril
limits registered with the Aluminum Association and published in the "Pink Sheets" shall be considered the controlling composition. cludes 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, is is not required and may not cover all metallic "elements. Should any analysis by the producer or the purchaser establish that an "others" element exceeds the limit of "Each" or that the aggregate	discrepa	ncy betwee	en the values	s listed in Ta	ble 1 and tho	se listed in the	he "Designa:	tions and C	Chemical Cor	npositior	n Limits for Alu	minum A	lloys in th	e Form (	of Casting	s and I	ngot ('The	e Pink Sh	neets')" the
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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> The sum of those "Others" metallic elements 0.010 percent or more each, expressed 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> 336.0 formetly A332.0, 513.0 formerly A514.0, 711.0 formerly C712.0, 851.0 formerly A850.0, 852.0 for merly B850.0.

<sup>7</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))."

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Analysis Aluminum Alloys by the Point to Plane Technique Nitrogen Atmosphere (Withdrawn 2011)<sup>4</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

IEEE/ASTM SI 10 Standard for Use of the International System of Units (SI): The Modern Metric System

- 2.3 ANSI Standard:<sup>5</sup>
- H35.1/H35.1(M) Alloy and Temper Designation Systems for Aluminum

2.4 Military Standards:<sup>6</sup>

MIL-STD-129 Marking for Shipment and Storage

- MIL-STD-276 Impregnation of Porous Nonferrous Metal Castings
- NAVSEA S9074-AR-GIB-010/278 Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels
- 2.5 AMS Specification:
- AMS 2771 Heat Treatment of Aluminum Alloy Castings<sup>7</sup> 2.6 *Federal Standard:*<sup>6</sup>
- Fed Std. No. 123 Marking for Shipment (Civil Agencies) 2.7 Aluminum Association Standard:<sup>5</sup>
- Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot (The Pink

Sheets)

2.8 Other Standards:<sup>8</sup>

CEN EN 14242 Aluminum and Aluminum Alloys, Chemical Analysis, Inductively Coupled Plasma Optical Emission Spectral Analysis <u>ASTM B108/E</u>

3. Terminology teh.a/catalog/standards/sist/e063 tel

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

#### 4. Ordering Information

4.1 Orders for material under this specification shall include the following information (see 1.4 and 1.5):

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 B108 and for metric application specify Specification B108M. Do not mix units.

4.1.2 Alloy (see Section 7 and Table 1),

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

4.1.4 Applicable drawing or part number, and

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 foundry control is required (see Section 9),

4.2.2 Whether yield strength tests are required (see 10.1 and Table 2, Footnote C, [Table 4, Footnote D]),

4.2.3 Whether castings or test bars, or both, are to be artificially aged for Alloys 705.0-T5, 707.0-T5, and 713.0-T5 (see 10.3),

4.2.4 Whether test specimens cut from castings are required in addition to or instead of separately cast specimens (see Sections 10, 12.2, 13.2, and 15),

4.2.5 Whether heat treatment is to be performed in accordance with AMS 2771 (see Section 16),

4.2.6 Whether repairs are permissible (see Section 17),

4.2.7 Whether inspection is required at the producer's works (see Section 18),

4.2.8 Whether certification is required (see Section 22),

4.2.9 Whether surface requirements will be checked visually or by observational standards where such standards are established (see 19.1),

4.2.10 Whether liquid penetrant inspection is required (see 19.2),

4.2.11 Whether radiographic inspection is required and, if so, the radiographic grade of casting required (19.3, Table 4), and

4.2.12 Whether Practices B660 applies and, if so, the levels of preservation, packaging, and packing required (see 24.4).

### 5. Responsibility for Quality Assurance

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

#### 6. 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 mold equipment is furnished by the purchaser.

#### 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 Practice E716 and analyzed in accordance with Test Methods E34, E607, or E1251, or CEN EN 14242. If the producer has determined the composition of the material during casting, they shall not be required to sample and analyze the finished product.

<sup>&</sup>lt;sup>5</sup> Available from Aluminum Association, Inc., 1400 Crystal Drive Suite 430 Arlington, VA 22202 http://www.aluminum.org.

<sup>&</sup>lt;sup>6</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>&</sup>lt;sup>7</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

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

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TABLE 2 Tensile Requirements<sup>A,B</sup> (Inch-Pound Units)

Designation <sup>F</sup>	Temper <sup>C</sup>	Tensile Strength, min, ksi	Yield Strength <sup>D</sup> (0.2 % offset), min, ksi (MPa)	Elongation in 2 in. or 4× diameter, min, %	Typical Brinell Hardness, <sup>E</sup> 500 kgf, 10 mm
204.0	T4 separately cast specimens	48.0	29.0	8.0	
242.0	T571	34.0		G	105
	T61	40.0		G	110
296.0	T4	33.0	15.0	4.5	75
	Т6	35.0		2.0	90
	Τ7	33.0	16.0	3.0	
308.0	F	24.0			70
319.0	F	27.0	14.0	2.5	95
332.0 <sup>H</sup>	Т5	31.0		G	105
333.0	F	28.0		G	90
	T5	30.0		G	100
	T6	35.0		G	105
	T7	31.0		G	90
336.0 <sup>H</sup>	T551	31.0		G	105
550.0	T65	40.0		G	125
354.0	T61	40.0			125
004.0		48.0	37.0	3.0	
	separately cast specimens	48.0			
	casting, designated area		36.0	3.0	
	castings, no location designated	43.0	33.0	2.0	
	T62		(0.0		
	separately cast specimens	52.0	42.0	2.0	
	castings, designated area	50.0	42.0	2.0	
	castings, no location designated'	43.0	33.0	2.0	
355.0	T51	27.0		G	75
	T62	42.0		G	105
	Τ7	36.0		G	90
	T71	34.0	27.0	G	80
C355.0	T61				
	separately cast specimens	40.0	30.0	3.0	85-90
	castings, designated area	40.0	30.0	3.0	
	castings, no location designated	37.0	30.0	1.0	85
356.0	F	21.0	10.0	3.0	
00010	T6	33.0	22.0	3.0	85
A356.0	T71 (https://	stand 25.0 CS.	iten.ai	3.0	70
	separately cast specimens	38.0	26.0	5.0	80–90
	castings, designated area	Iment 33.0 rev	26.0	5.0	
	castings, no location designated		26.0	3.0	
357.0	T6	45.0		3.0	
A357.0	T61	40.0		0.0	
A007.0	separately cast specimens	STM B109/F45.0 9M 10	36.0	3.0	100
	castings, designated area	<u>8108/143.0 8M-19</u>	36.0	3.0	100
	castings, no location designated <sup>1</sup>	/e063fc1c-9241.0.4e45-b	b49-131.03ffbd	9b1c/a3.0b10	0 1.100 10
E357.0 <sup>7</sup>		/e0031010-9200-4643-0	049-09-431100	901C/asim-010	8-b108m-19
E357.0	T61				
	a substably a set and a loss a s	45.0	00.0	0.0	100
	separately cast specimens	45.0	36.0	3.0	100
	castings, designated area/	46.0	36.0	3.0	100
5055 - K	castings, designated area <sup>1</sup> castings, no location designated <sup>1</sup>	46.0 41.0		3.0 3.0	100
F357.0 <sup>K</sup>	castings, designated area' castings, no location designated' T6	46.0	36.0	3.0	100
F357.0 <sup><i>K</i> 359.0</sup>	castings, designated area' castings, no location designated' T6 T61	46.0 41.0 45.0	36.0 31.0	3.0 3.0 3.0	
	castings, designated area' castings, no location designated' T6 T61 separately cast specimens	46.0 41.0 45.0 45.0	36.0 31.0 34.0	3.0 3.0 3.0 4.0	100 90
	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area'	46.0 41.0 45.0 45.0 45.0	36.0 31.0 34.0 34.0	3.0 3.0 3.0 4.0 4.0	
	castings, designated area' castings, no location designated' T6 T61 separately cast specimens	46.0 41.0 45.0 45.0	36.0 31.0 34.0	3.0 3.0 3.0 4.0	
	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area'	46.0 41.0 45.0 45.0 45.0	36.0 31.0 34.0 34.0	3.0 3.0 3.0 4.0 4.0	
	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated'	46.0 41.0 45.0 45.0 45.0	36.0 31.0 34.0 34.0	3.0 3.0 3.0 4.0 4.0	
	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62	46.0 41.0 45.0 45.0 45.0 40.0	36.0 31.0 34.0 34.0 30.0	3.0 3.0 3.0 4.0 4.0 3.0	90
	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens	46.0 41.0 45.0 45.0 40.0 47.0	36.0 31.0 34.0 34.0 30.0 38.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0	90
	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area'	46.0 41.0 45.0 45.0 45.0 40.0 47.0 47.0	36.0 31.0 34.0 30.0 38.0 38.0 38.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0	90 100
359.0 443.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area' castings, no location designated' F	46.0 41.0 45.0 45.0 40.0 47.0 47.0 40.0 21.0	36.0 31.0 34.0 34.0 30.0 38.0 38.0 38.0 30.0 7.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0	90 100 45
359.0 443.0 B443.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area' castings, no location designated' F	46.0 41.0 45.0 45.0 45.0 40.0 47.0 47.0 40.0	36.0 31.0 34.0 30.0 38.0 38.0 30.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 3.0	90 100
359.0 443.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area' castings, no location designated' F F T4	46.0 41.0 45.0 45.0 40.0 47.0 47.0 47.0 40.0 21.0 21.0	36.0 31.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0 2.5	90 100 45 45
359.0 443.0 B443.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, no location designated' F F T4 separately cast specimens	46.0 41.0 45.0 45.0 45.0 40.0 47.0 47.0 47.0 40.0 21.0 21.0 20.0	36.0 31.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0 2.5 20	90 100 45 45 
359.0 443.0 B443.0 A444.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, no location designated' F F T4 separately cast specimens castings, designated area'	46.0 41.0 45.0 45.0 40.0 47.0 47.0 47.0 40.0 21.0 21.0 21.0 20.0 20.0	36.0 31.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0 2.5 20 20	90 100 45 45 
359.0 443.0 B443.0 A444.0 513.0 <sup><i>H</i></sup>	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area' castings, no location designated' F F T4 separately cast specimens castings, designated area' F	46.0 41.0 45.0 45.0 40.0 47.0 47.0 47.0 40.0 21.0 21.0 21.0 20.0 20.0 22.0	36.0 31.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0  12.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 2.0 2.5 20 20 2.5	90 100 45 45  60
359.0 443.0 B443.0 A444.0 513.0 <sup>H</sup> 535.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area' castings, no location designated' F F T4 separately cast specimens castings, designated area' F F	46.0 41.0 45.0 45.0 40.0 47.0 47.0 47.0 47.0 21.0 21.0 20.0 20.0 22.0 35.0	36.0 31.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0  12.0 18.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0 2.5 20 20 2.5 8.0	90 100 45 45 
359.0 443.0 B443.0 A444.0 513.0 <sup>H</sup> 535.0 705.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area' castings, no location designated' F F T4 separately cast specimens castings, designated area' F F T4 separately cast specimens castings, designated area' F T1 or T5	46.0 41.0 45.0 45.0 40.0 47.0 47.0 47.0 40.0 21.0 21.0 21.0 20.0 20.0 20.0 22.0 35.0 37.0	36.0 31.0 34.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0  12.0 18.0 17.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0 2.5 20 20 2.5 8.0 10.0	90 100 45 45  60
359.0 443.0 B443.0 A444.0 513.0 <sup>H</sup> 535.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area' castings, no location designated' F F T4 separately cast specimens castings, designated area' F F T1 T1 or T5 T1	46.0 41.0 45.0 45.0 40.0 47.0 47.0 47.0 47.0 21.0 21.0 21.0 20.0 20.0 22.0 35.0 37.0 42.0	36.0 31.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0  12.0 18.0 17.0 25.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0 2.5 20 20 20 2.5 8.0 10.0 4.0	90 100 45 45  60
359.0 443.0 B443.0 A444.0 513.0 <sup>H</sup> 535.0 705.0 707.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, no location designated' F F T4 separately cast specimens castings, designated area' F F T4 separately cast specimens castings, designated area' F T1 or T5 T1 T7	46.0 41.0 45.0 45.0 45.0 40.0 47.0 47.0 47.0 47.0 21.0 21.0 21.0 21.0 20.0 22.0 35.0 37.0 42.0 45.0	36.0 31.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0  12.0 18.0 17.0 25.0 35.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0 2.5 20 20 2.5 8.0 10.0 4.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3	90 100 45 45 45  60 
359.0 443.0 B443.0 A444.0 513.0 <sup><i>H</i></sup> 535.0 705.0 707.0 711.0 <sup><i>H</i></sup>	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area' castings, no location designated' F F T4 separately cast specimens castings, designated area' F F T1 T1 or T5 T1 T7 T1	46.0 41.0 45.0 45.0 45.0 40.0 47.0 47.0 47.0 47.0 21.0 21.0 21.0 20.0 22.0 35.0 37.0 42.0 45.0 28.0	36.0 31.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0  12.0 18.0 17.0 25.0 35.0 18.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0 2.5 20 20 2.5 8.0 10.0 4.0 3.0 7.0	90 100 45 45  60
359.0 443.0 B443.0 A444.0 513.0 <sup><i>H</i></sup> 535.0 705.0 707.0 711.0 <sup><i>H</i></sup> 713.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area' castings, no location designated' F F T4 separately cast specimens castings, designated area' F F T1 or T5 T1 T7 T1 T1 or T5	46.0 41.0 45.0 45.0 40.0 47.0 47.0 47.0 47.0 21.0 21.0 21.0 20.0 22.0 35.0 37.0 42.0 45.0 28.0 32.0	36.0 31.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0  12.0 18.0 17.0 25.0 35.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0 2.5 20 20 2.5 8.0 10.0 4.0 3.0 3.0 3.0 3.0 3.0 3.0 3.0 3	90 100 45 45 45  60 
359.0 443.0 B443.0 A444.0 513.0 <sup><i>H</i></sup> 535.0 705.0 707.0 711.0 <sup><i>H</i></sup>	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area' castings, no location designated' F F T4 separately cast specimens castings, designated area' F F T1 T1 or T5 T1 T7 T1	46.0 41.0 45.0 45.0 45.0 40.0 47.0 47.0 47.0 47.0 21.0 21.0 21.0 20.0 22.0 35.0 37.0 42.0 45.0 28.0	36.0 31.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0  12.0 18.0 17.0 25.0 35.0 18.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0 2.5 20 20 2.5 8.0 10.0 4.0 3.0 7.0	90 100 45 45 45  60 
359.0 443.0 B443.0 A444.0 513.0 <sup><i>H</i></sup> 535.0 705.0 707.0 711.0 <sup><i>H</i></sup> 713.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, designated area' castings, no location designated' F F T4 separately cast specimens castings, designated area' F F T1 or T5 T1 T7 T1 T1 or T5	46.0 41.0 45.0 45.0 40.0 47.0 47.0 47.0 47.0 21.0 21.0 21.0 20.0 22.0 35.0 37.0 42.0 45.0 28.0 32.0	36.0 31.0 34.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0  12.0 18.0 17.0 25.0 35.0 18.0 22.0 	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 2.0 2.5 20 20 2.5 8.0 10.0 4.0 3.0 7.0 4.0	90 100 45 45 45  60 
359.0 443.0 B443.0 A444.0 513.0 <sup>H</sup> 535.0 705.0 707.0 711.0 <sup>H</sup> 713.0 850.0	castings, designated area' castings, no location designated' T6 T61 separately cast specimens castings, designated area' castings, no location designated' T62 separately cast specimens castings, no location designated' F F T4 separately cast specimens castings, designated area' F F T1 or T5 T1 T7 T1 T1 or T5 T5	46.0 41.0 45.0 45.0 40.0 47.0 47.0 47.0 47.0 21.0 21.0 21.0 20.0 20.0 22.0 35.0 37.0 42.0 45.0 28.0 32.0 18.0	36.0 31.0 34.0 34.0 30.0 38.0 38.0 30.0 7.0 6.0  12.0 18.0 17.0 25.0 35.0 18.0 22.0	3.0 3.0 3.0 4.0 4.0 3.0 3.0 3.0 3.0 2.0 2.5 20 20 2.5 8.0 10.0 4.0 3.0 7.0 4.0 8.0	90 100 45 45 45  60 

<sup>A</sup> If agreed upon by manufacturer and the purchaser, other mechanical properties may be obtained by other heat treatments such as annealing, aging, or stress relieving. <sup>B</sup> 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.

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<sup>C</sup> Refer to ANSI H 35.1/H35.1(M) for description of tempers.

<sup>D</sup> Yield strength to be evaluated only when specified in contract or purchase order.

<sup>E</sup> Hardness values given for information only, not required for acceptance.

<sup>G</sup> Not required.

<sup>H</sup> 332.0 formerly F332.0, 336.0 formerly A332.0, 513.0 formerly A514.0, 711.0 formerly C712.0, 851.0 formerly A850.0, 852.0 formerly B850.0.

<sup>1</sup> These properties apply only to castings having section thicknesses not greater than 2 in. except that section thicknesses of <sup>3</sup>/<sub>4</sub> in., max, shall apply to Alloy A444.0. <sup>1</sup> Properties copied from A357.0–T61.

<sup>*K*</sup> Properties copied from 357.0–T6.

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

7.1.2 Not more than 4000 lb [2000 kg] of clean castings or a single casting poured from one furnace. The maximum elapsed time between determinations shall be established for each alloy, but in any case the maximum elapsed time shall not exceed 8 h.

7.1.3 The maximum elapsed time between determinations shall be established for each alloy, but in any case the maximum elapsed time shall not exceed 8 h.

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 shall be accordance with Practice B985, Analysis shall be performed in accordance with Practice E716, Test Methods E34, E607, or E1251, or CEN 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 producers 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 modifying and grain refining elements or alloys are permitted.

8.2 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.

### 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  $\pm 50^{\circ}$ F [ $\pm 28^{\circ}$ 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 [Table 3].

10.2 When specified, the tensile strength and elongation of test specimens cut from castings shall be in accordance with Table 2 [Table 3] for Alloys 354.0, C355.0, A356.0, A357.0, E357.0, 359.0, and A444.0. For other alloys a minimum of 75 % of the tensile and yield strength values and not less than 25 % of the elongation values specified in Table 2 [Table 3] are required. 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 [Table 3] 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.

10.3 Although Alloys 705.0, 707.0, and 713.0 are most frequently used in the naturally aged condition, by agreement of the producer and the purchaser, the castings may be artificially aged. 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 or AMS 2771 shall be employed unless other conditions are accepted by mutual consent.

#### 11. Workmanship, Finish, and Appearance

11.1 The finished castings shall be uniform in composition and free of blowholes, cracks, shrinks, and other discontinuities in accordance with standards designated and agreed upon as acceptable by the purchaser.

#### 12. Test Specimens

12.1 Separately cast test specimens shall be cast in iron molds. A recommended gating method is shown in Fig. 1 [Fig. 2] and Fig. 3 [Fig. 4]. An alternative gating design is shown in Appendix X4. The test section of the tension test specimen shall be cast to size in accordance with the dimensions shown in Fig. 1 [Fig. 2] and Fig. 3 [Fig. 4], and not machined prior to test. Grip ends may be machined to adapt them in such a manner as to ensure axial loading.

12.2 When properties of castings are to be determined, tension test specimens shall be cut from the locations designated on the drawings, unless otherwise negotiated. If no locations are designated, one or more specimens shall be taken to include locations having significant variation in casting thickness, except that specimens shall not be taken from areas

<sup>&</sup>lt;sup>F</sup>ASTM alloy designations are recorded in Practice B275.

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TABLE 3 Tensile Requirements (SI Units)-[Metric]<sup>A,B,C</sup>

Designation**         Temper**         Temper**         Bitmength mm         max         Batemath mm         max         Batemath mm				or Units)—[metric] <sup>-, -,</sup>		
Designation         Tamper         Sample Market Mar			Tensile	Yield Strength <sup>F</sup>	Elongation	Typical Brinell
Ming-ic         Ming-ic         Dim. %         To min. %         To min. %         To min. %         To min. %           242.0         1771         235         200         7.0         101           286.0         T4         235         200         7.0         101           286.0         T4         235         105         4.5         75           380.0         T4         230         105         4.5         75           380.0         F         365         2.5         75           380.0         F         106          7         105           383.0         F         106          7         105           383.0         T5         215          7         105           383.0         T65         275          7         105           384.0         T65         275          7         105           385.0         T61         295         230         20         20           catings, degramma         325         255         3.0         20         20           catings, degramma         325         255         200	Designation <sup>H</sup>	Temper <sup>D</sup>				Hardness <sup>G</sup>
20.0         14         4 separately cast specimens         333         200         7.0            242.0         T51         275          /         105           296.0         T4         275          /         105           296.0         T4         200         105         4.5         75           100         F         240          2.0         90           301.0         F         165         95         2.5         75           332.0         T5         215          /         105           333.0         F         105          /         105           77         215          /         105           35.0         T51         215          /         105           35.0         T61         200         200          105      <	5	- F -		min, MPa <sup>E</sup>		500-kgt load, 10-mm ball
242.0       1771       235						TO-IIIII Dali
286.0       Fig       275        /       103         286.0       Fig       200        2.0       90         308.0       F       165        2.0       90         308.0       F       165         70         308.0       F       165         70         308.0       F       165         70         308.0       F       195        1       90         308.0       F       195        1       90         306.0       Tis       205        1       100         175       205        1       100       100         306.0       Tis       215        1       100         306.0       Tot       171       255       200       2.0       100         306.0       Tot       171       255       230       2.0       100         306.0       Tot       171       255       230       2.0       100         307       Tot       255       230       2.0       100 </td <td></td> <td></td> <td></td> <td>200</td> <td></td> <td></td>				200		
286.0         Ta         230         108         4.5         195           16         230         100          2.0         90           310.0         F         165           100           310.0         F         185         95         2.5         85           323.0         F         215          1         100           16         240          1         105           336.0         T65           1         100           16         240          1         105           356.0         T651         215          1         105           356.0         T651         215          1         105           356.0         T651         215          1         105           356.0         T62         230         20         20         20           171         castering, tocalin designated"         285         230         20         20           171         castering, tocalin designated"         255         200         1         75	242.0					105
To         240          2.0         00           308.0         F         185		T61	275		1	110
To         240          2.0         00           308.0         F         185	296.0	Τ4	230	105	4.5	75
T7         230         110         3.0            319.0         F         165		Т6	240		2.0	90
308.0       F       165						
319.0       F       185       95       2.5       95         332.0       T5       15       105       10       105         333.0       F       105       10       100         T5       205       10       100         350.0       T651       215       100       100         354.0       T651       215       100       100         354.0       T61       215       100       100         aspantely cast specimens       300       225       200       100         castings, no location designated*       295       230       20       100         762       reservers, no location designated*       295       230       20       100         762       reservers, no location designated*       295       230       20       100         774       250       100       400       80       80       80         775       774       250       100       80       80       80         774       250       100       80       80       80       80         774       250       100       30       80       80       80       80	200.0					
332.0 <sup>7</sup> T5       215        /       105         333.0       F       205        /       100         T5       205        /       100         386.0 <sup>7</sup> 77       215        /       90         386.0 <sup>7</sup> 176       215        /       90         386.0 <sup>7</sup> 1781       215        /       90         386.0 <sup>7</sup> 1781       215        /       90         assprately cast specimens       300       225       3.0           assprately cast specimens       360       289       220           T5       separately cast specimens       360       285       230       2.0          T7       235       185              C255.0       T6       177       235       186            assprately cast specimens       255       205       10            C255.0       T6       T6         .						
333.0         r         2.95         1         /         100           333.0         T5         205          /         100           76         240          /         100           336.0"         T551         215         /         105           356.0"         T65         275         /         105           assings, no location designated reat         295         290         2.0           castings, no location designated reat         295         230         2.0           r62         aspartably cast specimens         300         20         2.0           castings, no location designated reat         295         230         2.0         75           T71         250          /         75           T71         250          /         801           castings, no location designated reat         255         200         2.0         75           T71         250          /         75         75           castings, no location designated reat         255         200         1.0         85           S6.0         T61           76 </td <td></td> <td></td> <td></td> <td>95</td> <td></td> <td></td>				95		
3.3.30       rs       105       111       90         76       240       111       90         77       215       111       90         35.00       T551       215       1125         354.0       separately cast specimens       30       255       3.0         assing, designated area*       325       220       2.0         assenting costing, designated area*       345       280       2.0         assenting costing, designated area*       345       280       2.0         assenting costing costing costing area       360       280       2.0         assenting costing costing costing area       360       280       2.0         assenting costing costing costing area       360       280       2.0         77       250       116       10       30         77       250       100       3.0       85-90         77       255       205       3.0       85-90         78       171       255       205       3.0       85         79       70       100       3.0       70       70         71       255       205       1.0       80       80 <t< td=""><td>332.0<sup>7</sup></td><td></td><td>215</td><td></td><td></td><td>105</td></t<>	332.0 <sup>7</sup>		215			105
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	333.0	F	195		1	90
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$		Τ5	205		1	100
33.0."         T7         215          /         90           35.0."         T65         275          /         125           35.4.0         separately cast specimens casting, designated area" casting, designated area" castings, no location designated"         305         255         3.0          125           35.0         T6          285         280         2.0           125           acastings, no location designated"         285         280         2.0 <td< td=""><td></td><td></td><td></td><td></td><td>1</td><td></td></td<>					1	
336.0°       T551       215        /       105         34.0       T65       275        /       125         35.0       T61					1	
T63         275          ?         125           334.0         ************************************	226 OJ				1	
160         275          125           354.0         regarably cast spacimens exating, designated area <sup>4</sup> 325         250         3.0           regarably cast spacimens exating, designated area <sup>4</sup> 325         250         2.0           regarably cast spacimens exatings, designated area <sup>4</sup> 345         290         2.0           355.0         T61         185          7           T62         290         2.0          7           castings, designated area <sup>4</sup> 345         290         2.0           771         250         1.0         7           771         250         1.0         85           771         250         1.0         85           771         250         1.0         85           771         250         1.0         85           771         250         1.0         85           774         170          150         1.0         85           774         170          150         1.0         80         3.0         85           774         76         160         3.0         100          .	330.0				1	
separately cast specimens         330         255         3.0           realing, no location designated"         235         230         2.0           realing, no location designated area"         345         230         2.0           assing, no location designated area"         345         230         2.0           assing, no location designated"         295         230         2.0           355.0         T51         77         75         75           T62         280          1         90           77         78         75         77         80           77         78         75         77         80         80           78         assing, designated area"         255         205         1.0         85           78         assing, designated area"         255         205         1.0         85           79         71         230         70         80         85         70         80         85           76         T6         170         70         70         70         70           76         T6         170         100         30         85           770         T6			275		,	125
asting, designate area <sup>k</sup> 325         250         3.0           reactings, no location designated <sup>k</sup> 295         230         2.0           astings, designated area <sup>k</sup> 345         290         2.0           355.0         T51         186          7           T62         290         2.0         2.0           355.0         T51         186          7           T62         290          7         90           T71         250          7         90           T71         255         165         7         80           assparately cast specimens         275         205         3.0         85-90           assparately cast specimens         275         205         3.0         85           T7         250         10         85         70         85           T61         motocalion designated <sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesignated<sup>reandesi</sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup></sup>	354.0	T61				
asting, designated area <sup>k</sup> 325         250         3.0           reacting, no location designated"         295         230         2.0           astrans, designated area <sup>k</sup> 345         290         2.0           355.0         T51         186         100         100           T62         290         2.0         100         100           771         250         1.1         7         105           777         250         1.1         7         90           771         250         1.1         7         90           771         250         1.0         85           assignately cast specimens         275         10         85           assignately cast specimens         275         10         85           assignately cast specimens         205         1.0         85           76         77         255         1.0         85           76         76         70         1.3         85           76         70         1.3         80         10           76         70         70         10         10         10           assing, designated area <sup>k</sup> 310<		separately cast specimens	330	255	3.0	
realings, no location designated"         295         230         2.0           re2         separately cast specimens         360         290         2.0           astings, no location designated"         295         230         2.0           355.0         T51         295         230         2.0           762         290         2.1         7         75           T62         290         1.1         7         90           771         295         185         90         80           771         295         205         10         85           76         separately cast specimens         255         205         10         85           76         random designated"         255         205         10         85           76         random designated area"         255         205         10         85           76         random designated area"         250         100         80         85           76         random designated area"         160         100         100         100           astings, no location designated"         165         180         30         100           astings, designated area"					3.0	
$\begin{array}{c} re2 \\ resparately cast specimens and $		<b>0</b> . <b>0</b>				
separately cast specimens         360         290         2.0           355.0         T51         285         230         2.0           751         T62         290         1.1         7           762         290         1.1         7         75           77         250         1.1         7         90           771         255         185         90         90           771         255         3.0         85-90         30           castings, no location designated*         255         205         3.0         85           76         76         3.0         85         70         3.0         85           771         170         170         3.0         85         70         3.0         85           76         76         145         160         3.0         85         70         3.0         85           77.0         T6         180         180         4.0         80-90			200	200	2.0	
sestings, designated area <sup>k</sup> 345         290         2.0           355.0         T51         165          /         75           T62         290          /         76           T7         250          /         90           T7         250          /         90           T7         250          /         90           T7         250          /         90           C355.0         T61         separately cast speciment         275         205         3.0         85–90           castings, designated area <sup>K</sup> 275         205         1.0         85         70         70           A56.0         F         T6         10         70         3.0         85           771         71         70          3.0         85           76         T6         30         3.0          70           castings, designated area <sup>K</sup> 195         180         3.0            A57.0         T6         30         3.0             A357.0         T6 <td></td> <td></td> <td>000</td> <td>000</td> <td>0.0</td> <td></td>			000	000	0.0	
separately cast specimens         295         230         2.0           355.0         T51         165          /         75           T62         290          /         90           T71         250         185          90           C355.0         T61          90          90           casting, colocition designated*         255         3.0         85-90          90           356.0         F         T6          145         70         3.0         85           771         170          170          3.0         85           76         171         170          3.0         85           771         180         3.0         85         70         16         86           771         170          180         4.0         80-90            357.0         T6           180         4.0            357.0         T6                357.0         T6						
355.0       Ts1       Ts1       Ts2       290						
355.0         Tot         Tot         185          /         75           Tot         250          90           T71         250          90           C355.0         Tot         255         205         3.0         86-90           castings, designated area*         275         205         3.0         85           356.0         F         145         70         3.0         85           71         255         205         1.0         85           76         100         150         3.0         85           77         260         Previ         180         4.0         80-90           castings, no location designated*         195         180         3.0            s57.0         Tot         30         3.0             s57.0         Tot         3.0 </td <td></td> <td>castings, no location designated<sup><math>\kappa</math></sup></td> <td>295</td> <td>230</td> <td>2.0</td> <td></td>		castings, no location designated <sup><math>\kappa</math></sup>	295	230	2.0	
Te2         290          /         105           T71         235         185         /         80           C355.0         T61         225         185          80           acatings, casings, no location designated *         225         205         1.0         85           366.0         F         145         70         3.0         85           77         180         70         3.0         85           76         170         180         4.0         80-90           assings, no location designated *         190         100         4.0         80-90           assings, no location designated *         190         100         4.0         80-90           assings, no location designated *         190         100         4.0         80-90           assings, no location designated*         190         100         4.0         80-90           assings, no location designated*         250         100         100         100           assings, no location designated*         250         215         3.0         100           assings, no location designated*         255         215         3.0         100           <	355.0	T51	185			75
T7         250          /         90           C355.0         T61         255         185         /         80           castings, designated area <sup>A</sup> 275         205         3.0         85–90           castings, no location designated ''         255         205         10         85           356.0         F         100         100         85           70         170          30         70           A356.0         T61         205         100         85           reastings, olocation designated area <sup>A</sup> 230         70         100         80           A357.0         T6         310          30         70           A357.0         T6         310          30         100           castings, no location designated <sup>K</sup> 135         250         3.0            castings, no location designated <sup>K</sup> 135         250         3.0            castings, no location designated <sup>K</sup> 255         250         3.0            castings, cleagnated area <sup>K</sup> 310         255         3.0            casting					1	
17'         230					1	
C355.0         Total separately cast specimens castings, designated area         S2         Total 25         3.0         85-90           366.0         F         F         205         3.0         85-90           366.0         F         Total         25         205         1.0         85           70         3.0         Total         3.0         85         70         3.0         85           77.0         3.0         Total         230         70         3.0         85           77.0         3.0         Total         3.0         85         70         3.0         70           A356.0         Total         Separately cast specimens         230         180         4.0         80-90           357.0         Total         Separately cast specimens         310          3.0            4357.0         Total         Separately cast specimens         310         250         3.0         100           castings, no location designated"         285         215         3.0         100            castings, no location designated"         275         205         3.0         100            separately cast specimens						
separately cast specimens castings, no location designated <sup>*K</sup> 356.0 F T6 T71 T71 A356.0 A356.0 A356.0 T61 Separately cast specimens castings, no location designated <sup>*K</sup> 150 A357.0 T61 Separately cast specimens castings, no location designated <sup>*K</sup> 150 Castings, designated area <sup>*K</sup> 150 Castings, designated			235	185		80
castings, no location designated*         275         205         3.0           356.0         F         145         205         1.0         85           A36.0         T61         230         170         1.0         85           A36.0         T61         230         180         4.0         80-90           castings, no location designated area*         230         180         4.0         80-90           castings, no location designated area*         230         180         4.0         180         180         3.0         170           A357.0         T6         310          3.0         170         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0         1.0	C355.0					
castings, no location designated*         255         205         1.0         85           366.0         F         https://stan_230         70         3.0         70           A356.0         F6         170         3.0         85           771         30         70         3.0         85           772         castings, designated area         250         180         4.0         80-90           castings, no location designated*         195         180         3.0         170         170           A357.0         T6         ASTM BIOK HOMEND         250         3.0         100         110           A357.0         T61         ASTM BIOK HOMEND         250         3.0         100         100           castings, no location designated area         ASTM BIOK HOMEND         250         3.0         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100		separately cast specimens		205	3.0	85–90
castings, no location designated*         255         205         1.0         85           366.0         F         https://stan_230         70         3.0         70           A356.0         F6         170         3.0         85           771         30         70         3.0         85           772         castings, designated area         250         180         4.0         80-90           castings, no location designated*         195         180         3.0         170         170           A357.0         T6         ASTM BIOK HOMEND         250         3.0         100         110           A357.0         T61         ASTM BIOK HOMEND         250         3.0         100         100           castings, no location designated area         ASTM BIOK HOMEND         250         3.0         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100         100		castings, designated area $\kappa$	275	205	3.0	
$\begin{array}{c} 366.0 \\ F \\ 76 \\ 77 \\ A366.0 \\ 76 \\ 77 \\ A366.0 \\ 76 \\ 77 \\ A366.0 \\ 76 \\ 77 \\ A367.0 \\ 76 \\ A357.0 \\ 76 \\ 76 \\ 76 \\ 76 \\ 76 \\ 76 \\ 76 \\ 7$			255	205		85
$\begin{array}{c} \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$	256.0					00
T71         T70          3.0         70           A356.0         T61         separately cast specimens         260         Previous         80         4.0         80-90           castings, no location designated area         195         180         3.0          30         70           357.0         T6         310          30          30            separately cast specimens         310         250         3.0         100          100           castings, no location designated area         315         250         3.0         100          100           castings, chasignated area         310         250         3.0         100           100           castings, no location designated area         315         250         3.0         100           100             100               100	330.0			10		05
$ \begin{array}{c} \mbox{A356.0} & \begin{tabular}{ c c c c } & \begin{tabular}{ c c c c c } & \begin{tabular}{ c c c c c c c } & \begin{tabular}{ c c c c c c c c c c c c c c c c c c c$				150		
separately cast specimens         CUMP (260)         Previous (280)         180         4.0         80-90           357.0         76         310          3.0            A357.0         761         Separately cast specimens         310          3.0         100           separately cast specimens         310          250         3.0         100           castings, no location designated area (% set of 0.51 cl or 1.50 cl			170		3.0	70
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	A356.0	T61				
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		separately cast specimens	260	180	4.0	80–90
castings, no location designated <sup>rk</sup> 195         180         3.0           357.0         T61         310          3.0            separately cast specimens         310         250         3.0         1.00           castings, no location designated area <sup>K</sup> 310         250         3.0         1.00           castings, no location designated <sup>K</sup> 285         215         3.0            castings, no location designated <sup>K</sup> 285         215         3.0         1.00           castings, no location designated <sup>K</sup> 285         215         3.0         1.00           castings, no location designated <sup>K</sup> 316         250         3.0         100           castings, no location designated <sup>K</sup> 316         250         3.0         100           castings, no location designated <sup>K</sup> 275         205         3.0         100           castings, no location designated <sup>K</sup> 275         205         3.0         100           castings, no location designated <sup>K</sup> 275         205         3.0         100           castings, no location designated <sup>K</sup> 275         205         3.0         100           castings, no location des		castings designated area <sup>K</sup>				
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		castings, no location designated <sup><math>K</math></sup>				
A357.0         T61         ASTM B108/M-10         250         3.0         100           separately cast specimens         310         250         943 fbb d90         3.0         mail           castings, no location designated area <sup>K</sup> 285         215         3.0            E357.0 <sup>4</sup> 761         250         3.0         100            eastings, no location designated area <sup>K</sup> 315         250         3.0         100           castings, no location designated area <sup>K</sup> 315         250         3.0         100           castings, no location designated area <sup>K</sup> 310         235         3.0         100           separately cast specimens         310         235         4.0         90           castings, no location designated area <sup>K</sup> 310         235         4.0         90           castings, no location designated area <sup>K</sup> 325         200         3.0         100           castings, no location designated area <sup>K</sup> 325         200         3.0         100           castings, no location designated area <sup>K</sup> 325         200         3.0         100           castings, no location designated area <sup>K</sup> 325         200         3.	057.0					
separately cast specimens 310 226 250 3.0 100 castings, designated area <sup>rs</sup> 310 250 943 fbd 9b1 3.0 stm b1 08-b1 0.01-19 castings, on location designated <sup>rs</sup> 285 215 3.0 T61			310		3.0	
K, Styte0631c1 c 315 c 5-4e45-bb 250 09431bd9b1 3.0 stm-b108-b108m-19 castings, no location designated <sup>K</sup> 285         215         3.0            E357.0 <sup>4</sup> T61         separately cast specimens         310         250         3.0         100           castings, designated area <sup>K</sup> 315         250         3.0         100           castings, no location designated <sup>K</sup> 285         215         3.0           F357.0 <sup>44</sup> T6         310         30         30           separately cast specimens         310         235         4.0         90           castings, designated area <sup>K</sup> 325         205         3.0         100           castings, no location designated <sup>K</sup> 275         205         3.0         1443.0         F           443.0         F         145         40         2.5         45           513.0 <sup>7</sup> F         140         18.0 <td>A357.0</td> <td></td> <td><math>\sqrt{1}</math> B108/B108V</td> <td>1-19</td> <td></td> <td></td>	A357.0		$\sqrt{1}$ B108/B108V	1-19		
castings, no location designated <sup>K</sup> 285         215         3.0            E357.0 <sup>4</sup> T61						100
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$			3 tc   c-315 co-4e	43-664250694311	bd9b13.01stm-b1	108-b108m-19
E357.0 <sup>4</sup> T61       30       250       3.0       100         separately cast specimens       315       250       3.0       100         castings, designated area <sup>K</sup> 285       215       3.0       30         359.0       T61       310       235       4.0       90         castings, designated area <sup>K</sup> 310       235       4.0       90         castings, designated area <sup>K</sup> 310       235       4.0       90         castings, designated area <sup>K</sup> 310       235       4.0       90         castings, no location designated area <sup>K</sup> 310       235       4.0       90         castings, no location designated area <sup>K</sup> 325       260       3.0       100         castings, no location designated area <sup>K</sup> 325       260       3.0       100         castings, no location designated area <sup>K</sup> 325       260       3.0       100         castings, no location designated area <sup>K</sup> 145       50       2.0       45         A444.0       F       145       50       2.0       45         A444.0       T4       150       80       2.5       60         535.0       F		castings, no location designated <sup><math>\kappa</math></sup>	285	215	3.0	
separately cast specimens castings, designated area <sup>K</sup> 310         250         3.0         100           F357.0 <sup>M</sup> T6         310         3.0         3.0         3.0         3.0           359.0         T61         310         3.0         3.0         3.0         3.0           359.0         T61         3.0         3.0         3.0         3.0         3.0           Castings, designated area <sup>K</sup> 310         2.35         4.0         90           castings, designated area <sup>K</sup> 310         2.35         4.0         90           castings, designated area <sup>K</sup> 310         2.35         4.0         90           castings, no location designated <sup>K*</sup> 2.75         2.05         3.0         100           castings, no location designated <sup>K*</sup> 325         2.60         3.0         100           castings, no location designated <sup>K*</sup> 325         2.00         3.0         100           castings, no location designated <sup>K*</sup> 325         2.60         3.0         1.0           castings, no location designated area <sup>K*</sup> 145         40         2.5         45           B443.0         F         145         50         2.5	E357.0 <sup>L</sup>					
$\begin{array}{cccc} \mbox{castings, designated area}^{\kappa} & 315 & 250 & 3.0 \\ \mbox{castings, no location designated}^{\kappa} & 285 & 215 & 3.0 \\ \mbox{359.0} & {\sf T61} & & & & & & & & & & & & & & & & & & &$			310	250	3.0	100
castings, no location designated <sup>K</sup> 285         215         3.0           F357.0 <sup>M</sup> T6         3.0         3.0           359.0         T6         3.0         3.0           359.0         T61         3.0         3.0           separately cast specimens         310         235         4.0         90           castings, designated area <sup>K</sup> 310         235         4.0         90           castings, designated area <sup>K</sup> 310         235         4.0         90           castings, designated area <sup>K</sup> 325         260         3.0         100           castings, designated area <sup>K</sup> 325         260         3.0         100           castings, no location designated <sup>K</sup> 275         205         3.0         443.0         F         145         50         2.0         45           B443.0         F         145         40         2.5         45         444           A444.0         T4          18.0          1.0           castings, designated area <sup>K</sup> 140          18.0          1.0           513.0 <sup>rd</sup> F         50         80         2.5						100
F357.0 <sup>M</sup> T6       310       3.0         359.0       T61            separately cast specimens       310       235       4.0          castings, designated area <sup>K</sup> 310       235       4.0          castings, designated area <sup>K</sup> 275       205       3.0          separately cast specimens       325       260       3.0          castings, designated area <sup>K</sup> 325       260       3.0          separately cast specimens       325       260       3.0          castings, designated area <sup>K</sup> 325       205       3.0          443.0       F       145       40       2.5       45         A444.0       T4        18.0          castings, designated area <sup>K</sup> 140        18.0          707.0 </td <td></td> <td></td> <td></td> <td></td> <td></td> <td></td>						
359.0       T61         separately cast specimens       310       235       4.0       90         castings, designated area <sup>K</sup> 310       235       4.0       90         castings, no location designated <sup>K</sup> 275       205       3.0       762         separately cast specimens       325       260       3.0       100         castings, designated area <sup>K</sup> 325       260       3.0       205         castings, designated area <sup>K</sup> 325       205       3.0       30         443.0       F       145       50       2.0       45         B443.0       F       145       40       2.5       45         A444.0       T4       separately cast specimens       140        18.0          separately cast specimens       140        18.0           castings, designated area <sup>K</sup> 140        18.0           513.0 <sup>rd</sup> F       150       80       2.5       60          505.0       F       150       80       2.5       60          707.0       T1       or T5		70		215		
separately cast specimens         310         235         4.0         90           castings, designated area <sup>K</sup> 310         235         4.0           castings, no location designated <sup>K</sup> 275         205         3.0           T62         separately cast specimens         325         260         3.0         100           castings, designated area <sup>K</sup> 325         260         3.0         100           castings, no location designated <sup>K</sup> 275         205         3.0         100           castings, no location designated <sup>K</sup> 275         205         3.0         100           castings, no location designated <sup>K</sup> 275         205         3.0         100           castings, no location designated area <sup>K</sup> 275         205         3.0         100           443.0         F         145         40         2.5         45           A444.0         T4          18.0          160            separately cast specimens         140          18.0          160            513.0'         F         240         125         7.0			310		3.0	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$	359.0	T61				
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		separately cast specimens	310	235	4.0	90
castings, no location designated <sup>K</sup> 275         205         3.0           T62               separately cast specimens         325         260         3.0         100           castings, designated area <sup>K</sup> 325         260         3.0            castings, no location designated <sup>K</sup> 275         205         3.0            443.0         F          145         50         2.0         45           B443.0         F          145         40         2.5         45           A444.0         T4           18.0            castings, designated area <sup>K</sup> 140          18.0            castings, designated area <sup>K</sup> 140          18.0            castings, designated area <sup>K</sup> 140          18.0            513.0 <sup>J</sup> F          150         80         2.5         60           535.0         F                707.0         T1 or T5         255<		castings, designated area <sup><math>\kappa</math></sup>				
$\begin{array}{c c c c c c c c c c c c c c c c c c c $						
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			210	200	0.0	
$\begin{array}{cccc} castings, designated area^{\kappa} & 325 & 260 & 3.0 \\ castings, no location designated^{\kappa} & 275 & 205 & 3.0 \\ 443.0 & F & 145 & 50 & 2.0 & 45 \\ B443.0 & F & 145 & 40 & 2.5 & 45 \\ A444.0 & T4 & & & & & & \\ & separately cast specimens & 140 & \dots & 18.0 & \dots \\ castings, designated area^{\kappa} & 140 & \dots & 18.0 & \dots \\ castings, designated area^{\kappa} & 140 & \dots & 18.0 & \dots \\ 513.0^J & F & 150 & 80 & 2.5 & 60 \\ 535.0 & F & 240 & 125 & 7.0 & \dots \\ 705.0 & T1 \text{ or } T5 & 255 & 115 & 9.0 & & \\ 707.0 & T1 & 290 & 170 & 4.0 & & \\ T7 & 310 & 240 & 3.0 & & \\ 711.0^J & T1 & 195 & 125 & 6.0 & 70 \\ 713.0 & T1 \text{ or } T5 & 220 & 150 & 4.0 & & \\ 850.0 & T5 & 125 & \dots & 7.0 & & \\ 851.0^J & T5 & 125 & \dots & 7.0 & & \\ T6 & 125 & \dots & 7.0 & & \\ \end{array}$			005	000	0.0	100
$\begin{array}{c c c c c c c c c c c c c c c c c c c $						100
$\begin{array}{cccccccccccccccccccccccccccccccccccc$			325	260	3.0	
$\begin{array}{cccccccccccccccccccccccccccccccccccc$		castings, no location designated <sup><math>\kappa</math></sup>	275	205	3.0	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$						45
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	443.0	F	140			
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$				40	2.5	45
$\begin{array}{c cccc} castings, designated area & 140 & \dots & 18.0 & \dots \\ 513.0^J & F & 150 & 80 & 2.5 & 60 \\ 535.0 & F & 240 & 125 & 7.0 & \dots \\ 705.0 & T1 \text{ or } T5 & 255 & 115 & 9.0 & & \\ 707.0 & T1 & 290 & 170 & 4.0 & & \\ T7 & 310 & 240 & 3.0 & & \\ 711.0^J & T1 & 195 & 125 & 6.0 & 70 \\ 713.0 & T1 \text{ or } T5 & 220 & 150 & 4.0 & & \\ 713.0 & T1 \text{ or } T5 & 220 & 150 & 4.0 & & \\ 850.0 & T5 & 125 & \dots & 7.0 & & \\ 851.0^J & T5 & 115 & \dots & 3.0 & & \\ T6 & 125 & \dots & 7.0 & & \\ \end{array}$	B443.0	F		40	2.5	45
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B443.0	F T4	145			
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B443.0	F T4 separately cast specimens	145 140		18.0	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B443.0 A444.0	F T4 separately cast specimens castings, designated area <sup>K</sup>	145 140 140		18.0 18.0	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B443.0 A444.0 513.0 <sup>J</sup>	F T4 separately cast specimens castings, designated area <sup>K</sup> F	145 140 140 150	 80	18.0 18.0 2.5	
$ \begin{array}{cccccccccccccccccccccccccccccccccccc$	B443.0 A444.0 513.0 <sup>J</sup>	F T4 separately cast specimens castings, designated area <sup>K</sup> F	145 140 140 150	 80	18.0 18.0 2.5	 60
T7         310         240         3.0           711.0 <sup>J</sup> T1         195         125         6.0         70           713.0         T1 or T5         220         150         4.0           850.0         T5         125          7.0           851.0 <sup>J</sup> T5         115          3.0           T6         125          7.0	B443.0 A444.0 513.0 <sup>-/</sup> 535.0	F T4 separately cast specimens castings, designated area <sup>K</sup> F F	145 140 140 150 240	80 125	18.0 18.0 2.5 7.0	 60
711.0 <sup>J</sup> T1       195       125       6.0       70         713.0       T1 or T5       220       150       4.0         850.0       T5       125        7.0         851.0 <sup>J</sup> T5       115        3.0         T6       125        7.0	B443.0 A444.0 513.0 <sup>J</sup> 535.0 705.0	F T4 separately cast specimens castings, designated area <sup>K</sup> F F T1 or T5	145 140 140 150 240 255	80 125 115	18.0 18.0 2.5 7.0 9.0	 60
713.0       T1 or T5       220       150       4.0         850.0       T5       125       7.0         851.0 <sup>J</sup> T5       115       3.0         T6       125        7.0	B443.0 A444.0 513.0 <sup>J</sup> 535.0 705.0	F T4 separately cast specimens castings, designated area <sup>K</sup> F F T1 or T5 T1	145 140 150 240 255 290	80 125 115 170	18.0 18.0 2.5 7.0 9.0 4.0	 60
850.0         T5         125         7.0           851.0 <sup>7</sup> T5         115         3.0           T6         125         7.0	B443.0 A444.0 513.0 <sup>-/</sup> 535.0 705.0 707.0	F T4 separately cast specimens castings, designated area <sup>K</sup> F F T1 or T5 T1 T7	145 140 150 240 255 290 310	80 125 115 170 240	18.0 18.0 2.5 7.0 9.0 4.0 3.0	 60 
850.0         T5         125         7.0           851.0 <sup>7</sup> T5         115         3.0           T6         125         7.0	B443.0 A444.0 513.0 <sup>-/</sup> 535.0 705.0 707.0 711.0 <sup>-/</sup>	F T4 separately cast specimens castings, designated area <sup>K</sup> F F T1 or T5 T1 T7 T1	145 140 150 240 255 290 310 195	80 125 115 170 240 125	18.0 18.0 2.5 7.0 9.0 4.0 3.0 6.0	 60 
851.0 <sup>J</sup> T5         115         3.0           T6         125         7.0	B443.0 A444.0 513.0 <sup>-/</sup> 535.0 705.0 707.0 711.0 <sup>-/</sup>	F T4 separately cast specimens castings, designated area <sup>K</sup> F F T1 or T5 T1 T7 T1	145 140 150 240 255 290 310 195	80 125 115 170 240 125	18.0 18.0 2.5 7.0 9.0 4.0 3.0 6.0	 60 
T6 125 7.0	B443.0 A444.0 513.0 <sup>-/</sup> 535.0 705.0 707.0 711.0 <sup>-/</sup> 713.0	F T4 separately cast specimens castings, designated area <sup>K</sup> F F T1 or T5 T1 T7 T1 T7 T1	145 140 150 240 255 290 310 195 220	80 125 115 170 240 125 150	18.0 18.0 2.5 7.0 9.0 4.0 3.0 6.0 4.0	 60 
	B443.0 A444.0 513.0 <sup>-7</sup> 535.0 705.0 707.0 711.0 <sup>-7</sup> 713.0 850.0	F T4 separately cast specimens castings, designated area <sup>K</sup> F F T1 or T5 T1 T7 T1 T1 or T5 T5	145 140 150 240 255 290 310 195 220 125	80 125 115 170 240 125 150	18.0 18.0 2.5 7.0 9.0 4.0 3.0 6.0 4.0 7.0	 60 
852.0 <sup><i>J</i></sup> T5 185 3.0	B443.0 A444.0 513.0 <sup>-7</sup> 535.0 705.0 707.0 711.0 <sup>-7</sup> 713.0 850.0	F T4 separately cast specimens castings, designated area <sup>K</sup> F F T1 or T5 T1 T7 T1 T1 T1 or T5 T5 T5	145 140 150 240 255 290 310 195 220 125 115	80 125 115 170 240 125 150	18.0 18.0 2.5 7.0 9.0 4.0 3.0 6.0 4.0 7.0 3.0	 60 

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<sup>A</sup> If agreed upon by manufacturer and the purchaser, other mechanical properties may be obtained by other heat treatments such as annealing, aging, or stress relieving. <sup>B</sup> 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.

<sup>C</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>6</sup> <sup>D</sup> Refer to ANSI H 35.1/H35.1(M) for description of tempers.

<sup>E</sup> For explanation of the SI Unit "MPa" see Appendix X2.

F Yield strength to be evaluated only when specified in contract or purchase order.

<sup>G</sup> Hardness values given for information only, not required for acceptance.

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

<sup>1</sup>Not required.

<sup>J</sup> 332.0 formerly F332.0, 336.0 formerly A332.0,513.0 formerly A514.0, 711.0 formerly C712.0, 851.0 formerly A850.0, 852.0 formerly B850.0.

<sup>K</sup> These properties apply only to castings having section thicknesses not greater than 2 in. except that section thicknesses of 19-mm max, shall apply to Alloy A444.0. <sup>L</sup> Properties copied from A357.0-T61.

<sup>M</sup> Properties copied from 357.0-T6.

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

	Grade A <sup>A</sup>	G	rade B	G	rade C	G	rade D
Discontinuity			Section	on Thickness, ir	n. (mm)		
	<sup>1</sup> ⁄ <sub>4</sub> to <sup>3</sup> ⁄ <sub>4</sub> (6.4 to 19.0)	<sup>1</sup> / <sub>4</sub> (6.4)	<sup>3</sup> ⁄ <sub>4</sub> (19.0)	<sup>1/4</sup> (6.4)	<sup>3</sup> ⁄ <sub>4</sub> (19.0)	<sup>1</sup> / <sub>4</sub> (6.4)	<sup>3</sup> ⁄ <sub>4</sub> (19.0)
Gas holes	none	1	1	2	2	5	5
Gas porosity (round)	none	1	1	3	3	7	7
Gas porosity (elongated)	none	1	1	3	4	5	5
Shrinkage cavity	none	1	В	2	В	3	В
Shrinkage porosity or sponge	none	1	1	2	2	4	3
Foreign material (less dense material)	none	1	1	2	2	4	4
Foreign material (more dense material)	none	1	1	2	1	4	3
Segregation	none		none		none		none
Cracks	none		none		none		none
Cold shuts	none		none		none		none
Surface irregularity			not to exceed o	drawing tolerand	e		
Core shaft			not to exceed o	drawing tolerand	e		

<sup>A</sup> Caution should be exercised in requesting grade A because of the difficulty in obtaining this level.

<sup>B</sup> No radiographs available. Use <sup>1</sup>/<sub>4</sub>-in. [6-mm] for all thicknesses.

directly under risers. The tension test specimens shall be the standard 0.500-in. [12.5 mm] diameter specimens shown in Fig. 9 of Test Methods B557 [B557M] or a round specimen of smaller size proportional to the standard specimens. In no case shall the dimensions of the smallest specimen be less than the following:

	in.	mm
Diameter of reduced section.	0.250	[6.00]
Length of reduced section	11/4	[32]
Radius of fillet	3⁄16	[5]
Diameter of end section	3/8	[10]
Overall length:		
With shouldered ends	23/8	[60]
With threaded ends	3	[75]
With plain cylindical ends	4	[100]

12.3 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,	1/4	[6]
Length of reduced section,	11/4	[32]
Radius of fillet,	1/4	[6]
Overall length,	4	[100]

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

12.4 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 obtained on the castings, the test specimens shall be taken from the castings after heat treatment.

#### 13. Number of Tests

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

13.1.1 Not more than 4000 lb [2000 kg] of clean castings (gates and risers removed) or a single casting poured from one furnace.

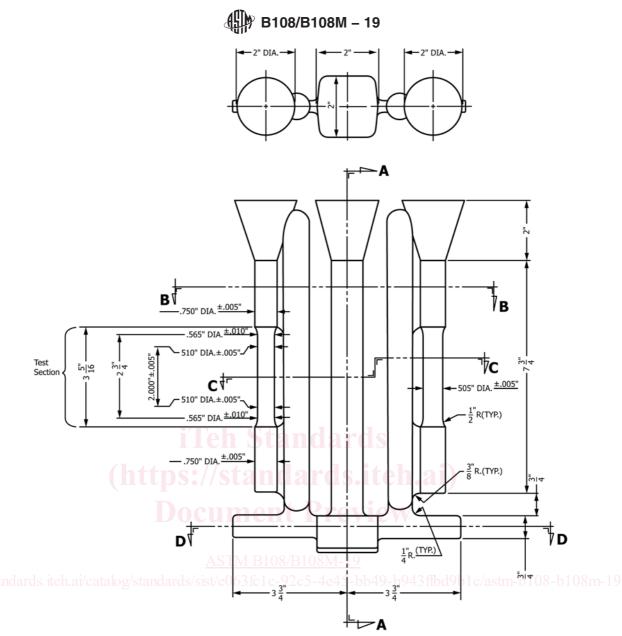
13.1.2 The castings poured continuously from one furnace in not more than eight consecutive hours.

13.2 When tensile properties of castings are to be determined, one per melt-heat combination shall be tested unless otherwise shown on the drawing or specified in the purchase order.

13.3 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 a replacement specimen.

#### 14. Test Methods

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



Nominal draft angle to be 20° on all square or rectangular sections in direction transverse to parting line.

Note 1—Test section of test bar: this section to be gradually tapered from the ends towards the center. FIG. 1 Tension Test Specimen Casting (Inch-Pounds)

#### 15. Retests

15.1 If the results of the tension test do not conform to the requirements prescribed in Table 2 [Table 4], 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 4].

#### 16. Heat Treatment

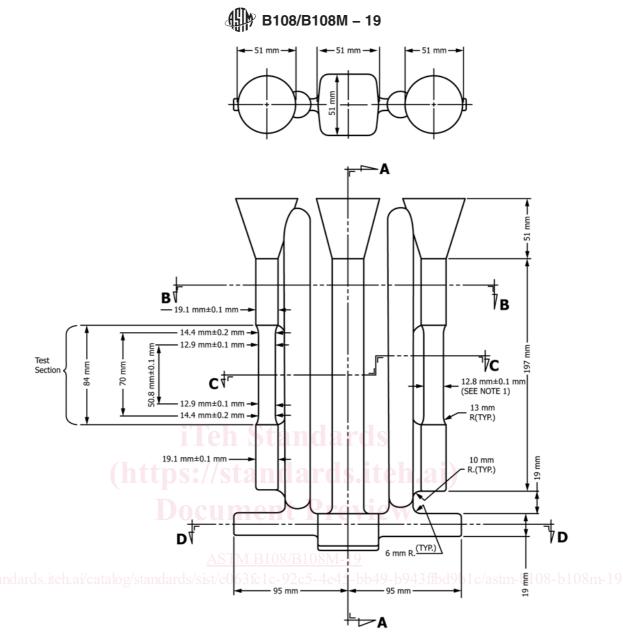
16.1 Heat treatment of castings shall be performed in accordance with Practice B917/B917M.

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

#### 17. Repair of Castings

17.1 Castings may be repaired only by processes approved and agreed upon by the producer and purchaser, such as 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.

17.2 *Repairing of Castings Produced for Governmental and Military Agencies:* 



Nominal draft angle to be 20° on all square or rectangular sections in direction transverse to parting line.

Note 1—Test section of test bar: this section to be gradually tapered from the ends towards the center. FIG. 2 Tension Test Specimen Casting [Metric]

#### 17.2.1 Welding:

17.2.1.1 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.

17.2.1.2 All welding shall be done by qualified welders and by methods approved by the purchaser.

17.2.1.3 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.

17.2.1.4 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.

17.2.1.5 All welds shall be free from cracks, lack of fusion, and meet the same quality requirements as the parent material.

17.2.1.6 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 no larger than  $\frac{1}{4}$  in. (6 mm) in outside diameter. All welded areas shall be encircled with a ring or white paint prior to submission for final inspection.

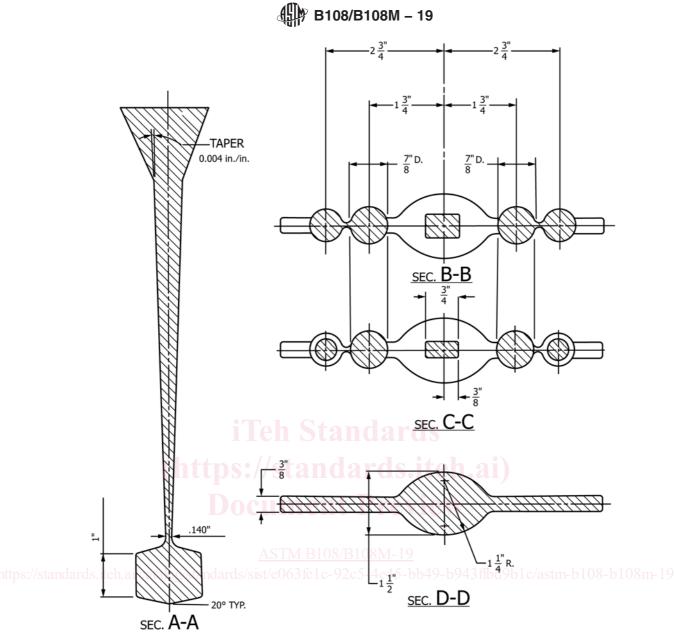


FIG. 3 Tension Test Specimen Casting (Cross Section) (Inch-Pounds)

17.2.1.7 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.

17.3 *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 porosity in excess of accepted standards. 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".

17.4 *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 the 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 a Maltese cross approximately <sup>1</sup>/<sub>4</sub> in. [6 mm] high.

17.5 *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 drawings.

#### **18. Source Inspection**

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

18.2 If the purchaser elects to have an 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