**Designation: ~~B618/B618M – 14~~ B618/B618M – 18**

# Standard Specification for Aluminum-Alloy Investment Castings[1]

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

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

## 1. Scope*

1.1 This specification covers aluminum-alloy investment castings designated as shown in Table 1.

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

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

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

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

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

1.7 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate ~~safety~~ safety, health, and ~~health~~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 purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[2]

B179 Specification for Aluminum Alloys in Ingot and Molten Forms for Castings from All Casting Processes
B275 Practice for Codification of Certain Zinc, Tin and Lead Die Castings
B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
B557M Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)
B660 Practices for Packaging/Packing of Aluminum and Magnesium Products
B666/B666M Practice for Identification Marking of Aluminum and Magnesium Products
B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products
B917/B917M Practice for Heat Treatment of Aluminum-Alloy Castings from All Processes
B985 Practice for Sampling Aluminum Ingots, Billets, Castings and Finished or Semi-Finished Wrought Aluminum Products for Compositional Analysis
D3951 Practice for Commercial Packaging
E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

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

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

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

## TABLE 1 Chemical Composition Requirements

NOTE 1—When single units are shown, these indicate the maximum amounts permitted.

NOTE 2—Analysis shall be made for the elements for which limits are shown in this table.

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

| Alloy | Composition, % | | ANSI[A] | UNS | Silicon | Iron | Copper | Manganese | Magnesium | Chromium | Nickel | Zinc | Titanium | Tin | | Other[B] Elements | Aluminum |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Each | Total[C] | | | | | | | | | | | | | | | | |
| 201.0 | A02010 | 0.10 | 0.15 | 4.0–5.2 | 0.20–0.50 | 0.15–0.55 | ... | ... | ... | 0.15–0.35 | ... | [D] | 0.05 | 0.10 | remainder | | |
| 204.0 | A02040 | 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 | remainder | | |
| 242.0 | A02420 | 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 | remainder | | |
| 295.0 | A02950 | 0.7–1.5 | 1.0 | 4.0–5.0 | 0.35 | 0.03 | ... | ... | 0.35 | 0.25 | ... | | 0.05 | 0.15 | remainder | | |
| 319.0 | A03190 | 5.5–6.5 | 1.0 | 3.0–4.0 | 0.50 | 0.10 | ... | 0.35 | 1.0 | 0.25 | ... | | ... | 0.50 | remainder | | |
| 328.0 | A03280 | 7.5–8.5 | 1.0 | 1.0–2.0 | 0.20–0.6 | 0.20–0.6 | 0.35 | 0.25 | 1.5 | 0.25 | ... | | ... | 0.50 | remainder | | |
| 355.0 | A03550 | 4.5–5.5 | 0.6[E] | 1.0–1.5 | 0.50[E] | 0.40–0.6 | 0.25 | ... | 0.35 | 0.25 | ... | | 0.05 | 0.15 | remainder | | |
| C355.0 | A33550 | 4.5–5.5 | 0.20 | 1.0–1.5 | 0.10 | 0.40–0.6 | ... | ... | 0.10 | 0.20 | ... | | 0.05 | 0.15 | remainder | | |
| 356.0 | A03560 | 6.5–7.5 | 0.6[E] | 0.25 | 0.35[E] | 0.20–0.45 | ... | ... | 0.35 | 0.25 | ... | | 0.05 | 0.15 | remainder | | |
| A356.0 | A13560 | 6.5–7.6 | 0.20 | 0.20 | 0.10 | 0.25–0.45 | ... | ... | 0.10 | 0.20 | ... | | 0.05 | 0.15 | remainder | | |
| 443.0 | A04430 | 4.5–6.0 | 0.8 | 0.6 | 0.50 | 0.05 | 0.25 | ... | 0.50 | 0.25 | ... | | ... | 0.35 | remainder | | |
| B443.0 | A24430 | 4.5–6.0 | 0.8 | 0.15 | 0.35 | 0.05 | ... | ... | 0.35 | 0.25 | ... | | 0.05 | 0.15 | remainder | | |
| 514.0 | A05140 | 0.35 | 0.50 | 0.15 | 0.35 | 3.5–4.5 | ... | ... | 0.15 | 0.25 | ... | | 0.05 | 0.15 | remainder | | |
| 520.0 | A05200 | 0.25 | 0.30 | 0.25 | 0.15 | 9.5–10.6 | ... | ... | 0.15 | 0.25 | ... | | 0.05 | 0.15 | remainder | | |
| 535.0 | A05350 | 0.15 | 0.15 | 0.05 | 0.10–0.25 | 6.2–7.5 | ... | ... | ... | 0.10–0.25 | ... | [F] | 0.05 | 0.15 | remainder | | |
| 705.0 | A07050 | 0.20 | 0.8 | 0.20 | 0.40–0.6 | 1.4–1.8 | 0.20–0.40 | ... | 2.7–3.3 | 0.25 | ... | | 0.05 | 0.15 | remainder | | |
| 707.0 | A07070 | 0.20 | 0.8 | 0.20 | 0.40–0.6 | 1.8–2.4 | 0.20–0.40 | ... | 4.0–4.5 | 0.25 | ... | | 0.05 | 0.15 | remainder | | |
| 710.0[G] | A07100 | 0.15 | 0.50 | 0.35–0.65 | 0.05 | 0.6–0.8 | ... | ... | 6.0–7.0 | 0.25 | ... | | 0.05 | 0.15 | remainder | | |
| 712.0[G] | A07120 | 0.30 | 0.50 | 0.25 | 0.10 | 0.50–0.65 | 0.40–0.6 | ... | 5.0–6.5 | 0.15–0.25 | ... | | 0.05 | 0.20 | remainder | | |
| 713.0 | A07130 | 0.25 | 1.1 | 0.40–1.0 | 0.6 | 0.20–0.50 | 0.35 | 0.15 | 7.0–8.0 | 0.25 | ... | | 0.10 | 0.25 | remainder | | |
| 771.0 | A07710 | 0.15 | 0.15 | 0.10 | 0.10 | 0.8–1.0 | 0.06–0.20 | ... | 6.5–7.5 | 0.10–0.20 | ... | | 0.05 | 0.15 | remainder | | |
| 850.0 | A08500 | 0.7 | 0.7 | 0.7–1.3 | 0.10 | 0.10 | ... | 0.7–1.3 | ... | 0.20 | 5.5–7.0 | | ... | 0.30 | remainder | | |
| 851.0[G] | A08510 | 2.0–3.0 | 0.7 | 0.7–1.3 | 0.10 | 0.10 | ... | 0.3–0.7 | ... | 0.20 | 5.5–7.0 | | ... | 0.30 | remainder | | |
| 852.0[G] | A08520 | 0.40 | 0.7 | 1.7–2.3 | 0.10 | 0.6–0.9 | ... | 0.9–1.5 | ... | 0.20 | 5.5–7.0 | | ... | 0.30 | remainder | | |

**TABLE 1 Chemical Composition Requirements**[A,B,C,D]

| Desig[J] | Si | Fe | Cu | Mn | Mg | Cr | Ni | Zn | Ti | Ag | Be | Pb | Sn | Zr | | FNs | Others[E] | | Al. Min. | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | | | | | | | | | | | Each | Total[F] | | |
| 201.0 | 0.10 | 0.15 | 4.0–5.2 | 0.20–0.50 | 0.15–0.55 | . . . | . . . | . . . | 0.15–0.35 | 0.40–1.0 | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.10 | Rem. | |
| 204.0 | 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. | |
| 242.0 | 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. | |
| 295.0 | 0.7–1.5 | 1.0 | 4.0–5.0 | 0.35 | 0.03 | . . . | . . . | 0.35 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.15 | Rem. | |
| 319.0 | 5.5–6.5 | 1.0 | 3.0–4.0 | 0.50 | 0.10 | . . . | 0.35 | 1.0 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.50 | Rem. | |
| 328.0 | 7.5–8.5 | 1.0 | 1.0–2.0 | 0.20–0.6 | 0.20–0.6 | 0.35 | 0.25 | 1.5 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.50 | Rem. | |
| 355.0 | 4.5–5.5 | 0.6[G] | 1.0–1.5 | 0.50[G] | 0.40–0.6 | 0.25 | . . . | 0.35 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.15 | Rem. | |
| C355.0 | 4.5–5.5 | 0.20 | 1.0–1.5 | 0.10 | 0.40–0.6 | . . . | . . . | 0.10 | 0.20 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.15 | Rem. | |
| 356.0 | 6.5–7.5 | 0.6[G] | 0.25 | 0.35[G] | 0.20–0.45 | . . . | . . . | 0.35 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.15 | Rem. | |
| A356.0 | 6.5–7.5 | 0.20 | 0.20 | 0.10 | 0.25–0.45 | . . . | . . . | 0.10 | 0.20 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | 0.05 | 0.15 | Rem. |
| A443.0 | 4.5–6.0 | 0.8 | 0.30 | 0.50 | 0.05 | 0.25 | . . . | 0.50 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.35 | Rem. | |
| B443.0 | 4.5–6.0 | 0.8 | 0.15 | 0.35 | 0.05 | . . . | . . . | 0.35 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.15 | Rem. | |
| 514.0 | 0.35 | 0.50 | 0.15 | 0.35 | 3.5–4.5 | . . . | . . . | 0.15 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.15 | Rem. | |
| 520.0 | 0.25 | 0.30 | 0.25 | 0.15 | 9.5–10.6 | . . . | . . . | 0.15 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | | 0.05 | 0.15 | Rem. |
| 535.0 | 0.15 | 0.15 | 0.05 | 0.10–0.25 | 6.2–7.5 | . . . | . . . | . . . | 0.10–0.25 | . . . | 0.003–0.007 | . . . | . . . | . . . | 0.005B | . . . | 0.05 | 0.15 | Rem. | |
| 705.0 | 0.20 | 0.8 | 0.20 | 0.40–0.6 | 1.4–1.8 | 0.20–0.40 | . . . | 2.7–3.3 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.15 | Rem. | |
| 707.0 | 0.20 | 0.8 | 0.20 | 0.40–0.6 | 1.8–2.4 | 0.20–0.40 | . . . | 4.0–4.5 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.15 | Rem. | |
| 710.0[I] | 0.15 | 0.50 | 0.35–0.6 | 0.05 | 0.6–0.8 | . . . | . . . | 6.0–7.0 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.15 | Rem. | |
| 712.0[I] | 0.30 | 0.50 | 0.25 | 0.10 | 0.50–0.65[H] | 0.40–0.6 | . . . | 5.0–6.5 | 0.15–0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.20 | Rem. | |
| 713.0 | 0.25 | 1.1 | 0.40–1.0 | 0.6 | 0.20–0.50 | 0.35 | 0.15 | 7.0–8.0 | 0.25 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.10 | 0.25 | Rem. | |
| 771.0 | 0.15 | 0.15 | 0.10 | 0.10 | 0.8–1.0 | 0.06–0.20 | . . . | 6.5–7.5 | 0.10–0.20 | . . . | . . . | . . . | . . . | . . . | . . . | . . . | 0.05 | 0.15 | Rem. | |
| 850.0 | 0.7 | 0.7 | 0.7–1.3 | 0.10 | 0.10 | . . . | 0.7–1.3 | . . . | 0.20 | . . . | . . . | . . . | 5.5–7.0 | . . . | . . . | . . . | . . . | 0.30 | Rem. | |
| 851.0[I] | 2.0–3.0 | 0.7 | 0.7–1.3 | 0.10 | 0.10 | . . . | 0.3–0.7 | . . . | 0.20 | . . . | . . . | . . . | 5.5–7.0 | . . . | . . . | . . . | . . . | 0.30 | Rem. | |
| 852.0[I] | 0.40 | 0.7 | 1.7–2.3 | 0.10 | 0.6–0.9 | . . . | 0.9–1.5 | . . . | 0.20 | . . . | . . . | . . . | 5.5–7.0 | . . . | . . . | . . . | . . . | 0.30 | Rem. | |

[A] When single units are shown, they indicate the maximum amounts permitted.

[B] Analysis shall be made for the elements for which limits are shown in this table.

[C] ~~ASTM alloy designations are in~~ The following applies to all specified limits in this table: For purposes of determining conformance to these limits, an observed value or a calculated value obtained from analysis shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the specified limit in accordance with the rounding-off method of Practice ~~B275~~E29.

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

[E] "Others" includes listed elements for which no specific limit is shown as well as unlisted metallic elements. The producer may analyze samples for trace elements not specified in the specification. However, such analysis is not required and may not cover all metallic "Others" elements. Should any analysis by the producer or the purchaser establish that an "Others" element exceeds the limit of "Each" or that the aggregate of several "Others" elements exceeds the limit of "Total," the material shall be considered nonconforming.

[F] Other Elements—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.

[D] ~~Contains silver 0.40–1.0 %.~~

[G] If iron exceeds 0.45 %, manganese content shall not be less than one half of the iron content.

[H] ~~Contains beryllium 0.003–0.007 %, boron 0.002 % max.~~ The Aluminum Association ruling on the number of decimal places to which Mg percent is expressed is exempted for some long standing alloys. See A2.2.6.

[I] 710.0 formerly A712.0, 712.0 formerly D712.0, 851.0 formerly A850.0, 852.0 formerly B850.0.

[J] 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)."

E34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys (Withdrawn 2017)[3]
E94 Guide for Radiographic Examination Using Industrial Radiographic Film
E155 Reference Radiographs for Inspection of Aluminum and Magnesium Castings
E165 Practice for Liquid Penetrant Examination for General Industry
~~E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)~~
E607 Test Method for Atomic Emission Spectrometric Analysis Aluminum Alloys by the Point to Plane Technique Nitrogen Atmosphere (Withdrawn 2011)[3]
E716 Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by 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:*[4]
H35.1/H35.1 (M)-2006 American National Standard Alloy and Temper Designation Systems for Aluminum

2.4 *Military Standards:*[5]
MIL-STD-129 Marking for Shipment and Storage
MIL-STD-276 Impregnation of Porous Nonferrous Metal Castings

2.5 *Federal Standard:*
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[5]

2.6 *AMS Standard:*[6]
AMS 2771 Heat Treatment of Aluminum Alloy Castings

2.7 *NAVSEA Standard:*[7]
S9074-AR-GIB-010/278 Requirements for Fabrication Welding and Inspection, and Casting Inspection and Repair for Machinery, Piping, and Pressure Vessels

2.8 *Aluminum Association Standard:*[4]
Designations and Chemical Composition Limits for Aluminum Alloys in the Form of Castings and Ingot (The Pink Sheets)

2.9 *Other Standards:*[8]
CEN EN 14242 Aluminum and Aluminum Alloys—Chemical Analysis—Inductively Coupled Plasma Optical Emission Spectral Analysis



## 3. Terminology

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

3.2 *Definitions of Terms Specific to This Standard:*

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

## 4. Ordering Information

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

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

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

4.1.2 Alloy (Section 7 and Table 1),

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

4.1.4 Applicable drawing or part number, and

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

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

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

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

[3] The last approved version of this historical standard is referenced on www.astm.org.
[4] Available from Aluminum Association, Inc., ~~1525 Wilson Blvd., Suite 600,~~1400 Crystal Drive Suite 430 Arlington, VA ~~22209,~~22202, http://www.aluminum.org.
[5] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.
[6] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.
[7] Available from Naval Sea Systems Command (NAVSEA), 1333 Isaac Hull Ave., SE, Washington, DC 20376, http://www.navsea.navy.mil.
[8] Available from European Committee for Standardization (CEN), 36 Rue de Stassart, B-1050, Brussels, Belgium, http://www.cenorm.be.

**TABLE 2 Tensile Requirements[A,B] (Inch-Pound Units)**

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

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

| ~~Alloy~~Designation[E] | Temper[B,C] | Tensile Strength, ~~min,~~ min, ksi | Yield Strength (0.2 % offset) min, ksi | Elongation in 2 in. or 4× diameter, min, % | Typical Brinell ~~Hard-ness,~~Hardness,[C,D] ~~500 kgf, 10 mm~~500 kgf, 10 mm | |
|---|---|---|---|---|---|---|
| ~~ANSI[D]~~ | ~~UNS~~ | | | | | |
| | | T51 | 32.0 | 27.0 | 3.0 | 85 |
| | | T52 | 36.0 | 30.0 | 1.5 | 85 |
| | | T6 | 42.0 | 35.0 | 5.0 | 90 |
| | | ~~T71~~ | ~~48.0~~ | ~~45.0~~ | ~~2.0~~ | ~~120~~ |
| | | T71 | 48.0 | 45.0 | 2.0 | 120 |
| ~~850.0~~ | ~~A08500~~ | ~~T5~~ | ~~16.0~~ | [E] | ~~5.0~~ | ~~45~~ |
| 850.0 | T5 | 16.0 | [F] | 5.0 | 45 | |
| ~~851.0[J]~~ | ~~A08510~~ | ~~T5~~ | ~~17.0~~ | [E] | ~~3.0~~ | ~~45~~ |
| 851.0[K] | T5 | 17.0 | [F] | 3.0 | 45 | |
| ~~852.0[J]~~ | ~~A08520~~ | ~~T5~~ | ~~24.0~~ | ~~18.0~~ | [E] | ~~60~~ |
| 852.0[K] | T5 | 24.0 | 18.0 | [F] | 60 | |

[A] If agreed upon by the producer and the purchaser, other mechanical properties may be obtained by other heat treatments such as annealing, aging, or stress relieving.
[B] 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.
[C] Refer to ANSI H35.1/H35.1 (M) for description of tempers.
[D] For information only, not required for acceptance.
[E] ASTM alloy designations are in Practice B275.
[F] Not required.
[G] Formerly designated 222.0-T2 and 242.0-T21.
[H] Aged 21 days at room temperature.
[I] Artificially aged in accordance with Practice B917/B917M.
[J] Yield strength to be determined only when specified in the contract or purchase order.
[K] 710.0 formerly A712.0, 712.0 formerly D712.0, 851.0, formerly A850.0, 852.0 formerly B850.0.



4.2.3 Whether test specimens cut from castings are required in addition to or instead of separately cast specimens (10.3 and 11.2),
4.2.4 Whether heat treatment is to be performed in accordance with AMS 2771 (Section 15),
4.2.5 Whether repairs are permissible (16.1),
4.2.6 Whether inspection is required at the producer's works (18.1),
4.2.7 Whether surface requirements shall be checked against observational standards where such standards are established (19.1),
4.2.8 Whether liquid penetrant inspection is required (19.3),
4.2.9 Whether radiographic inspection is required and, if so, the radiographic grade of casting required (19.4 and Table 4),
4.2.10 Whether certification is required (21.1),
4.2.11 Whether foundry control is required (Section 9),
4.2.12 Whether Practices B660 apply and, if so, the levels of preservation, packaging, and packing required (~~23.3~~24.4), and
4.2.13 Whether marking in accordance with Fed. Std. No. 123, Practice D3951, or MIL-STD 129 applies (~~23.3~~24.4).

## 5. Responsibility for Quality Assurance

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

## 6. Materials and Manufacture

6.1 The responsibility of furnishing castings that can be laid out and machined to the finished dimensions within the permissible variations specified, as shown on the blueprints or drawings, shall rest with the producer, except where pattern equipment is furnished by the purchaser.
6.1.1 Unless otherwise specified, only aluminum alloy conforming to the requirements of Specification B179 or producer's foundry scrap (identified as being made from alloy conforming to Specification B179) shall be used in the remelting furnace from which molten metal is taken for pouring directly into castings. Additions of small amounts of modifiers and grain refining elements or alloys are permitted.
6.1.2 Pure materials, recycled materials, and master alloys may be used to make alloys conforming to this specification, provided chemical analysis can be taken and adjusted to conform to Table 1 prior to pouring any castings.

**TABLE 3 Tensile Requirements (SI Units) [Metric]**[A,B,C]

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

| Alloy | Temper[C] | Tensile Strength, min, MPa[D] | Yield Strength (0.2 % offset) min, MPa | Elongation in 5D, min, % | Typical Brinell Hard- ness,[E] 500 kgf, 10 mm | |
|---|---|---|---|---|---|---|
| Designation[G] | Temper[D] | Tensile Strength, min, MPa[E] | Yield Strength (0.2 % offset) min, MPa | Elongation in 5D, min, % | Typical Brinell Hardness,[F] 500 kgf, 10 mm | |
| ANSI[F] | UNS | | | | | |
| 201.0 | A02010 | T6 | 415 | 345 | 4.0 | ... |
| 201.0 | T6 | 415 | 345 | 4.0 | . . . | |
| | | T7 | 415 | 345 | 3.0 | ... |
| | | T7 | 415 | 345 | 3.0 | . . . |
| 204.0 | A02040 | T4 | 310 | 195 | 5.0 | ... |
| 204.0 | T4 | 310 | 195 | 5.0 | . . . | |
| | | T6 | 205 | G | G | 115 |
| | | T6 | 205 | H | H | 115 |
| 242.0 | A02420 | O[H] | 160 | G | G | 70 |
| 242.0 | O[I] | 160 | H | H | 70 | |
| | | T61 | 220 | 140 | G | 105 |
| | | T61 | 220 | 140 | H | 105 |
| 295.0 | A02950 | T4 | 200 | 90 | 5.0 | 60 |
| 295.0 | T4 | 200 | 90 | 5.0 | 60 | |
| | | T6 | 220 | 140 | 3.0 | 75 |
| | | T62 | 250 | 195 | G | 95 |
| | | T62 | 250 | 195 | H | 95 |
| | | T7 | 200 | 110 | 3.0 | 70 |
| 319.0 | A03190 | F | 160 | 90 | 1.5 | 70 |
| 319.0 | F | 160 | 90 | 1.5 | 70 | |
| | | T6 | 215 | 140 | 1.5 | 80 |
| 328.0 | A03280 | F | 170 | 95 | 1.0 | 60 |
| 328.0 | F | 170 | 95 | 1.0 | 60 | |
| | | T6 | 235 | 145 | 1.0 | 80 |
| 355.0 | A03550 | T6 | 220 | 140 | 2.0 | 80 |
| 355.0 | T6 | 220 | 140 | 2.0 | 80 | |
| | | T51 | 170 | 125 | G | 65 |
| | | T51 | 170 | 125 | H | 65 |
| | | T71 | 205 | 150 | G | 75 |
| | | T71 | 205 | 150 | H | 75 |
| C355.0 | A33550 | T6 | 250 | 170 | 2.5 | ... |
| C355.0 | T6 | 250 | 170 | 2.5 | . . . | |
| 356.0 | A03560 | F | 130 | G | 2.0 | 55 |
| 356.0 | F | 130 | H | 2.0 | 55 | |
| | | T6 | 205 | 140 | 3.0 | 70 |
| | | T7 | 215 | G | G | 75 |
| | | T7 | 215 | H | H | 75 |
| | | T51 | 160 | 110 | G | 60 |
| | | T51 | 160 | 110 | H | 60 |
| | | T71 | 170 | 125 | 3.0 | 60 |
| A356.0 | A13560 | T6 | 235 | 165 | 3.5 | 80 |
| A356.0 | T6 | 235 | 165 | 3.5 | 80 | |
| 443.0 | A04430 | F | 115 | 50 | 3.0 | 40 |
| 443.0 | F | 115 | 50 | 3.0 | 40 | |
| B443.0 | A24430 | F | 115 | 40 | 3.0 | 40 |
| B443.0 | F | 115 | 40 | 3.0 | 40 | |
| 514.0 | A05140 | F | 150 | 60 | 5.0 | 50 |
| 514.0 | F | 150 | 60 | 5.0 | 50 | |
| 520.0 | A05200 | T4 | 290 | 150 | 10.0 | 75 |
| 520.0 | T4 | 290 | 150 | 10.0 | 75 | |
| 535.0 | A05350 | F | 240 | 125 | 8.0 | 70 |
| 535.0 | F | 240 | 125 | 8.0 | 70 | |
| 705.0 | A07050 | T1[J] and T5[J] | 205 | 115[K] | 4.0 | 65 |
| 705.0 | T1[J] and T5[K] | 205 | 115[L] | 4.0 | 65 | |
| 707.0 | A07070 | T1[J] | 230 | 150[K] | 2.0 | 85 |
| 707.0 | T1[J] | 230 | 150[L] | 2.0 | 85 | |
| | | T7 | 255 | 205[K] | 1.0 | 80 |
| | | T7 | 255 | 205[L] | 1.0 | 80 |
| 710.0[L] | A07100 | T1[J] | 220 | 140 | 2.0 | 75 |
| 710.0[M] | T1[J] | 220 | 140 | 2.0 | 75 | |
| 712.0[L] | A07120 | T1[J] and T5[J] | 235 | 170[K] | 4.0 | 75 |
| 712.0[M] | T1[J] and T5[K] | 235 | 170[L] | 4.0 | 75 | |
| 713.0 | A07130 | T1[J] and T5[J] | 220 | 150 | 3.0 | 75 |
| 713.0 | T1[J] and T5[K] | 220 | 150 | 3.0 | 75 | |
| 771.0 | A07710 | T5 | 290 | 260 | 1.5 | 100 |

| | | | | | | |
|---|---|---|---|---|---|---|
| 771.0 | T5 | 290 | 260 | 1.5 | 100 | |
| | | T51 | 220 | 185 | 3.0 | 85 |
| | | T52 | 250 | 205 | 1.5 | 85 |
| | | T6 | 290 | 240 | 5.0 | 90 |
| | | T71 | 330 | 310 | 2.0 | 120 |
| ~~850.0~~ | ~~A08500~~ | ~~T5~~ | ~~110~~ | ~~G~~ | ~~4.0~~ | ~~45~~ |
| 850.0 | T5 | 110 | H | 4.0 | 45 | |
| ~~851.0~~ L | ~~A08510~~ | ~~T5~~ | ~~115~~ | ~~G~~ | ~~3.0~~ | ~~45~~ |
| 851.0 M | T5 | 115 | H | 3.0 | 45 | |
| ~~852.0~~ L | ~~A08520~~ | ~~T5~~ | ~~165~~ | ~~125~~ | ~~G~~ | ~~60~~ |
| 852.0 M | T5 | 165 | 125 | H | 60 | |

A If agreed upon by the producer and the purchaser, other mechanical properties may be obtained by other heat treatments such as annealing, aging, or stress relieving.
B 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.[4]
C 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.
D Refer to ANSI H35.1/H35.1 (M)-2006 for description of tempers.
E For explanation of SI unit " Mpa" see Appendix X2.
F For information only, not required for acceptance.
G ASTM alloy designations are in Practice B275.
H Not required.
I Formerly designated 222.0-T2 and 242.0-T21.
J Aged 21 days at room temperature.
K Artificially aged in accordance with Practice B917/B917M.
L Yield strength to be determined only when specified in the contract or purchase order.
M 710.0 formerly A712.0, 712.0 formerly D712.0, 851.0, formerly A850.0, 852.0 formerly B850.0.

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

| Discontinuity | Radiograph | Grade A | | Grade B | | Grade C | | Grade D | |
|---|---|---|---|---|---|---|---|---|---|
| | | Section Thickness, in. | | | | | | | |
| | | ¼ | ¾ | ¼ | ¾ | ¼ | ¾ | ¼ | ¾ |
| Gas holes | 1.1 | none | | 1 | 1 | 2 | 2 | 5 | 5 |
| Gas porosity (round) | 1.21 | none | | 1 | 1 | 3 | 3 | 7 | 7 |
| Gas porosity (elongated) | 1.22 | none | | 1 | 1 | 3 | 4 | 5 | 5 |
| Shrinkage cavity | 2.1 | none | | 1 | 1 | 2 | A | 3 | A |
| Shrinkage porosity or sponge | 2.2 | none | | 1 | 1 | 2 | 2 | 4 | 3 |
| Foreign material (less dense material) | 3.11 | none | | 1 | 1 | 2 | 2 | 4 | 4 |
| Foreign material (more dense material) | 3.12 | none | | 1 | 1 | 2 | 1 | 4 | 3 |
| Segregation | 3.2 | none | | none | | none | | none | |
| ~~Cracks~~ | ~~...~~ | ~~none~~ | | ~~none~~ | | ~~none~~ | | ~~none~~ | |
| Cracks | ... | none | | none | | none | | none | |
| ~~Cold shuts~~ | ~~...~~ | ~~none~~ | | ~~none~~ | | ~~none~~ | | ~~none~~ | |
| Cold shuts | ... | none | | none | | none | | none | |
| ~~Surface irregularity~~ | ~~...~~ | | | ~~not to exceed drawing tolerance~~ | | | | | |
| Surface irregularity | ... | | | not to exceed drawing tolerance | | | | | |
| ~~Core shift~~ | ~~...~~ | | | ~~not to exceed drawing tolerance~~ | | | | | |
| Core shift | ... | | | not to exceed drawing tolerance | | | | | |

A Not available. Use ¼-in. [6-mm] for all section thicknesses.



## 7. Chemical Composition

7.1 The product shall conform to the chemical composition limits prescribed in Table 1. Conformance shall be determined by the producer by taking samples at the time castings are poured in accordance with Practices E716 and analyzed in accordance with Test Methods E34, E607, or E1251, or EN 14242 (ICP method). If the producer has determined the composition of the material during casting, they shall not be required to sample and analyze the finished product.

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

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

7.1.1.2 Castings poured continuously from one furnace for not more than eight consecutive hours from a single master heat. A master heat is defined as all the metal of a single furnace charge without subsequent additions after chemical composition has been determined.

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

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

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

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

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

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

## 10. Tensile Requirements

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

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

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

## 11. Test Specimens



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

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

| | In. | mm |
|---|---|---|
| Diameter of reduced section, in. | 0.250 | [6 mm] |
| Length of reduced section, in. | 1¼ | [32 mm] |
| Radius of fillet, in. | 3⁄16 | [5 mm] |
| Diameter of end section, in. | ⅜ | [10 mm] |
| Overall length, in.: | | |
| With shouldered ends | 2⅜ | [60 mm] |
| With threaded ends | 3 | [75 mm] |
| With plain cylindrical ends | 4 | [100 mm] |

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

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

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

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

## 12. Number of Tests and Retests

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

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

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

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

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

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

## 13. Test Methods

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

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

## 14. Workmanship and Finish

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



## 15. Heat Treatment

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

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



## 16. Repair of Castings

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

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

17.1 *Welding:*

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

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

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

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

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

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

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

17.2 *Impregnation*—When impregnation is permitted, it shall be to correct general seepage leaks only and shall not be used to correct poor foundry technique or significant porosity. It shall be accomplished in accordance with MIL-STD-276. Unless otherwise authorized by the purchaser, castings which have been impregnated shall be marked “IMP.”