



Designation: B 199 – 99

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

This standard is issued under the fixed designation B 199; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

### 1. Scope

1.1 This specification covers magnesium alloy permanent mold casting alloys designated as shown in Table 1.

1.2 The values stated in inch-pound units are to be regarded as the standard. The SI values given in parentheses are provided for information only.

### 2. Referenced Documents

2.1 The following documents of the issue in effect on date of order acceptance form a part of this specification to the extent referenced herein:

#### 2.2 ASTM Standards:

B 275 Practice for Codification of Certain Nonferrous Metals and Alloys, Cast and Wrought<sup>2</sup>

B 296 Practice for Temper Designations of Magnesium Alloys, Cast and Wrought<sup>2</sup>

B 557 Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products<sup>2</sup>

B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products<sup>2</sup>

B 661 Practice for Heat Treatment of Magnesium Alloys<sup>2</sup>

E 8 Test Methods of Tension Testing of Metallic Materials<sup>3</sup>

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specification<sup>4</sup>

E 35 Test Methods for Chemical Analysis of Magnesium and Magnesium Alloys<sup>5</sup>

E 88 Practice for Sampling Nonferrous Metals and Alloys in Cast Form for Determination of Chemical Composition<sup>5</sup>

E 94 Guide for Radiographic Testing<sup>6</sup>

E 155 Reference Radiographs for Inspection of Aluminum and Magnesium Castings<sup>6</sup>

E 165 Test Methods for Liquid Penetrant Examination<sup>6</sup>

E 527 Practice for Numbering Metals and Alloys (UNS)<sup>7</sup>

#### 2.3 Federal Standards:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)<sup>8</sup>

#### 2.4 Military Specification:

MIL-M-6857 Heat Treatment of Magnesium Alloy Castings<sup>8</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *permanent mold casting*—a metal object produced by introducing molten metal by gravity or low pressure into a mold constructed of durable material, usually iron or steel, and allowing it to solidify.

3.1.2 *semipermanent mold casting*—a permanent mold casting which is made using an expendable core such as bonded sand.

### 4. Ordering Information

4.1 Orders for castings under this specification shall include the following information:

4.1.1 Quantity of each casting,

4.1.2 Alloy (Section 7 and Table 1),

4.1.3 Temper (Section 8 and Table 2),

4.1.4 Minimum properties of specimens cut from castings, if required (see section 9.3),

4.1.5 Drawing showing dimensions of the castings (the amount of stock left for machine finish should be indicated),

4.1.6 Surface treatment (see 10.1),

4.1.7 Whether inspection is required at the manufacturer's works (see section 11.1.1),

4.1.8 Special inspection requirements (see 11.2),

4.1.9 Whether certification is required (see 13.1), and

4.1.10 Whether marking for identification is required (see 14.1).

### 5. Manufacture

5.1 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 supplier, except when molds are furnished by the purchaser. Sufficient stock shall be allowed for shrinkage, and where requested, for finishing; castings of excessive weight shall not be furnished.

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B-7 on Light Metals and Alloys and is the direct responsibility of Subcommittee B07.04 on Magnesium Alloy Cast and Wrought Products.

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<sup>2</sup> *Annual Book of ASTM Standards*, Vol 02.02.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 03.01.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 03.05.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 03.03.

<sup>7</sup> *Annual Book of ASTM Standards*, Vol 01.01.

<sup>8</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

**TABLE 1 Chemical Composition Limits<sup>A</sup>**

NOTE 1—Analysis shall regularly be made only for the elements specifically mentioned in this table. If, however, the presence of other elements is suspected or indicated in amounts greater than the specified limits, further analysis shall be made to determine that these elements are not present in excess of the specified limits.

NOTE 2—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 shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the specified limit.

| ASTM               | UNS                 | Iron               | Magnesium | Aluminum    | Manganese | Zinc        | Rare Earths             | Zirconium   | Silicon | Copper    | Nickel | Total <sup>C</sup><br>Other<br>Impuri-<br>ties | Others<br>Each |
|--------------------|---------------------|--------------------|-----------|-------------|-----------|-------------|-------------------------|-------------|---------|-----------|--------|--|----------------|
|                    |                     |                    |           |             |           |             |                         |             |         |           |        |  |                |
| AM100A             | M10100              | ...                | remainder | 9.3 to 10.7 | 0.10–0.35 | 0.30        | ...                     | ...         | 0.30    | 0.10      | 0.01   | 0.30   | ...            |
| AZ81A              | M11810              | ...                | remainder | 7.0 to 8.1  | 0.13–0.35 | 0.40 to 1.0 | ...                     | ...         | 0.30    | 0.10      | 0.01   | 0.30   | ...            |
| AZ91C              | M11914              | ...                | remainder | 8.1 to 9.3  | 0.13–0.35 | 0.40 to 1.0 | ...                     | ...         | 0.30    | 0.10      | 0.01   | 0.30   | ...            |
| AZ91E              | M11919              | 0.005 <sup>D</sup> | remainder | 8.1 to 9.3  | 0.17–0.35 | 0.40 to 1.0 | ...                     | ...         | 0.20    | 0.015     | 0.0010 | 0.30   | 0.01           |
| AZ92A              | M11920              | ...                | remainder | 8.3 to 9.7  | 0.10–0.35 | 1.6 to 2.4  | ...                     | ...         | 0.30    | 0.25      | 0.01   | 0.30   | ...            |
| EQ21A <sup>E</sup> | M18330              | ...                | remainder | ...         | ...       | ...         | 1.5 to 3.0 <sup>F</sup> | 0.40 to 1.0 | ...     | 0.05–0.10 | 0.01   | 0.30   | ...            |
| EZ33A              | M12330              | ...                | remainder | ...         | ...       | 2.0 to 3.1  | 2.5 to 4.0              | 0.50 to 1.0 | ...     | 0.10      | 0.01   | 0.30   | ...            |
| QE22A <sup>G</sup> | M18220 <sup>F</sup> | ...                | remainder | ...         | ...       | ...         | 1.8 to 2.5 <sup>F</sup> | 0.40 to 1.0 | ...     | 0.10      | 0.01   | 0.30   | ...            |

<sup>A</sup> Limits are in weight percent max unless shown as a range or stated otherwise.

<sup>B</sup> ASTM alloy designations were established in accordance with Practice B 275. UNS designations were established in accordance with Practice E 527.

<sup>C</sup> Includes listed elements for which no specific limit is shown.

<sup>D</sup> If iron exceeds 0.005 %, the iron to manganese ratio shall not exceed 0.032.

<sup>E</sup> Silver content for Alloy EQ21A (M18330) shall be 1.3 to 1.7 %.

<sup>F</sup> Rare earth elements are in the form of didymium.

<sup>G</sup> Silver content for Alloy QE22A (M18220) shall be 2.0 to 3.0, inclusive.

**TABLE 2 Tensile Requirements**

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 E 29.

| Alloy Number |        | Temper <sup>A</sup> | Tensile Strength, min.<br>ksi (MPa) | Yield Strength <sup>B</sup> (0.2 %<br>offset) min. ksi (MPa) | Elongation in<br>2 in., (50.8 mm)<br>min., % |
|--------------|--------|---------------------|-------------------------------------|--|--|
| ASTM         | UNS    |                     |                                     |  |  |
| AM100A       | M10100 | F                   | 20.0 (138)                          | 10.0 (69)  | <sup>C</sup>                                 |
|              |        | T4                  | 34.0 (234)                          | 10.0 (69)  | 6  |
|              |        | T6                  | 34.0 (234)                          | 15.0 (103)   | 2  |
|              |        | T61                 | 34.0 (234)                          | 17.0 (117)   | <sup>C</sup>                                 |
| AZ81A        | M11810 | T4                  | 34.0 (234)                          | 11.0 (76)  | 7  |
|              |        | F                   | 23.0 (158)                          | 11.0 (76)  | <sup>C</sup>                                 |
| AZ91C        | M11914 | T4                  | 34.0 (234)                          | 11.0 (76)  | 7  |
|              |        | T5                  | 23.0 (158)                          | 12.0 (83)  | 2  |
|              |        | T6                  | 34.0 (234)                          | 16.0 (110)   | 3  |
|              |        | T6                  | 34.0 (234)                          | 16.0 (110)   | ...  |
|              |        | F                   | 23.0 (158)                          | 11.0 (76)  | <sup>C</sup>                                 |
|              |        | T4                  | 34.0 (234)                          | 11.0 (76)  | 6  |
| AZ91E        | M11919 | T5                  | 23.0 (158)                          | 12.0 (83)  | <sup>C</sup>                                 |
|              |        | T6                  | 34.0 (234)                          | 18.0 (124)   | <sup>C</sup>                                 |
|              |        | T6                  | 34.0 (234)                          | 25.0 (172)   | ...  |
|              |        | F                   | 23.0 (158)                          | 14.0 (96)  | 2  |
| AZ92A        | M11920 | T4                  | 34.0 (234)                          | 11.0 (76)  | 6  |
|              |        | T5                  | 23.0 (158)                          | 12.0 (83)  | <sup>C</sup>                                 |
|              |        | T6                  | 34.0 (234)                          | 18.0 (124)   | <sup>C</sup>                                 |
|              |        | T6                  | 34.0 (234)                          | 25.0 (172)   | 2  |
| EQ21A        | M18330 | T6                  | 34.0 (234)                          | 25.0 (172)   | ...  |
| EZ33A        | M12330 | T5                  | 20.0 (138)                          | 14.0 (96)  | 2  |
| QE22A        | M18220 | T6                  | 35.0 (241)                          | 25.0 (172)   | 2  |

<sup>A</sup> These temper designations were established in accordance with Practice B 296.

<sup>B</sup> See X1.3.

<sup>C</sup> Not required.

5.2 The castings may be subjected to the heat treatment necessary to produce material that will conform to the requirements specified. Heat treatment shall be performed on the whole of a casting, never on a part only, and shall be applied in a manner that will produce the utmost uniformity.

## 6. General Quality

6.1 The castings shall be of uniform quality and condition, free of cracks or other injurious defects, and shall be well cleaned by sand blasting or any other approved process before inspection.

## 7. Chemical Composition

7.1 *Limits*—The material shall conform to the chemical composition limits prescribed in Table 1. Conformance shall be determined by analyzing samples taken when the castings are poured, or by analyzing samples taken from the finished product. If the chemical composition has been determined during the course of manufacture, sampling and analysis of the finished product is not necessary.

7.2 *Number of Samples*—The number of samples taken for determination of chemical composition shall be as follows:

7.2.1 When samples are taken at the time the castings are poured, at least one sample shall be taken from each melt of 2000 lb (907 kg) or fraction thereof.

7.2.2 When samples are taken from the castings or test bars, a sample shall be taken to represent each 2000 lb (907 kg) or fraction thereof in the shipment except that not more than one sample shall be required per casting.

7.3 *Methods of Sampling*—Samples for determination of chemical composition shall be taken in accordance with one of the following methods:

7.3.1 Samples for chemical analysis shall be taken from the material by drilling, sawing, milling, turning, or clipping a representative piece or pieces to obtain a weight of prepared sample not less than 75 g. Sampling shall be in accordance with Method E 88.

7.3.2 Samples for spectrochemical or other methods of analysis shall be taken by methods suitable for the form of material being analyzed and the type of analytical method used.

7.4 *Methods of Chemical Analysis*—Any suitable method of chemical analysis may be used. In case of dispute, the analysis shall be made by methods given in Methods E 35 or any other standard methods of analysis approved by ASTM unless some other method is agreed upon.

## 8. Heat Treatment

8.1 Unless otherwise specified, heat treatment for the applicable tempers designated in Table 2 shall be in accordance with Practice B 661 or with Military Specification MIL-M-6857.

## 9. Tensile Requirements

9.1 *Limits*—The tension test specimens representing the castings shall conform to the requirements of Table 2.

9.2 *Number of Tests*—At least one tension test specimen shall be cast from each melt of 2 000 lb (907 kg) or fraction thereof to represent the castings poured from the same melt. If the castings are to be heat treated, the specimens shall be heat treated with production castings of the same alloy and in the same temper as the specimens. The specimens shall then be tested to judge the response of their corresponding melts to the type of heat treatment to which the specimens were subjected.

9.2.1 Each heat-treating furnace charge shall include at least one tension test specimen poured from a production melt. Such specimens shall be of the same alloy and in the same temper as the castings, and shall be tested to judge the quality of the heat-treating operation given the furnace charge.

9.3 If test bars are cut from castings, the number and location shall be as agreed upon between the supplier and the purchaser. Depending on the radiographic quality specified (see 11.4), test bars cut from casting may not meet the requirements of Table 2. Mechanical property limits from cut bars shall be agreed to by the supplier and purchaser.