Designation: B 91 – 97

Standard Specification for Magnesium-Alloy Forgings[1]

This standard is issued under the fixed designation B 91; 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 Department of Defense.

1. Scope *

1.1 This specification covers magnesium alloy forgings designated as shown in Table 1.

1.2 The values stated in inch-pound units are the standard. The SI values in parentheses are provided for information only.

2. Referenced Documents

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

2.2 *ASTM Standards:*

B 275 Practice for Codification of Certain Nonferrous Metals and Alloys, Cast and Wrought[2]

B 557 Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products[2]

B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products[2]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[3]

E 35 Test Methods for Chemical Analysis of Magnesium and Magnesium Alloys[4]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[4]

2.3 *Federal Standards:*

No. 123 Marking for Shipment (Civil Agencies)[5]

No. 184 Identification Marking of Aluminum, Magnesium, and Titanium.

2.4 *Military Standards:*

MIL-M-3171 Magnesium Alloy, Processes for Pretreatment and Prevention of Corrosion on

MIL-STD-129 Marking for Shipment and Storage[5]

3. Terminology

3.1 *Definitions:*

3.1.1 *forging*—a metal part worked to a predetermined shape by one or more such processes as hammering, upsetting, pressing, or rolling.

3.1.2 *die forging*—a forging formed to the required shape and size by working in impression dies.

3.1.3 *hammer forging*—a forging produced by repeated blows in a forging hammer.

3.1.4 *hand forging*—a forging worked between flat or simply shaped dies by repeated strokes or blows and manipulation of the piece.

4. Ordering Information

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

4.1.1 Quantity of each forging,

4.1.2 Alloy (Section 6 and Table 1),

4.1.3 Temper (Section 7 and Table 2),

4.1.4 Drawing showing dimensions of all die forgings and for all hand forgings not simple disks, rounds, squares, or rectangles (the amount of stock left for machine finish should be indicated),

4.1.5 Surface treatment (see 9.1),

4.1.6 Whether inspection is required at the manufacturer's works (see 10.1),

4.1.7 Special inspection requirements (see 10.2),

4.1.8 Whether certification is required (see 12.1), and

4.1.9 Whether marking for identification is required (see 13.1).

5. Quality Assurance

5.1 The manufacturer shall be responsible for the performance of all inspection and tests required by this specification, prior to shipment of the material.

6. Chemical Composition

6.1 *Limits*—The material shall conform to the chemical composition limits prescribed in Table 1. The manufacturer shall determine conformance by analyzing samples taken when the ingots are poured, or by analyzing samples taken from the finished or semifinished product. If the manufacturer has determined the chemical composition during the course of manufacture, he shall not be required to sample and analyze the finished product.

[1] 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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[2] *Annual Book of ASTM Standards*, Vol 02.02.

[3] *Annual Book of ASTM Standards*, Vol 14.02.

[4] *Annual Book of ASTM Standards*, Vol 03.05.

[5] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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

TABLE 1 Chemical Composition Limits[A,B]

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 should be rounded to the nearest unit in the last right-hand place of figures used in expressing the specified limit.

Element	Composition, %			
	Alloy AZ31B (UNS No. M11311)	Alloy AZ61A (UNS No. M11610)	Alloy AZ80A (UNS No. M11800)	Alloy ZK60A (UNS No. M16600)
Magnesium	remainder	remainder	remainder	remainder
Aluminum	2.5–3.5	5.8–7.2	7.8–9.2	...
Manganese	0.20–1.0	0.15–0.5	0.12–0.5	...
Zinc	0.6–1.4	0.40–1.5	0.20–0.8	4.8–6.2
Thorium	...	...	...	...
Zirconium, min	...	...	...	0.45
Silicon	0.10	0.10	0.10	...
Copper	0.05	0.05	0.05	...
Nickel	0.005	0.005	0.005	...
Iron	0.005	0.005	0.005	...
Calcium	0.04	...	...	...
Other impurities[C]	0.30	0.30	0.30	0.30

[A] Limits are in weight percent maximum unless shown as a range or stated otherwise.
[B] These alloy designations were established in accordance with Practice B 275.
[C] Includes listed elements for which no specific limit is shown.

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 (0.7 MPa) 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 and Temper	Tensile Strength, min, ksi (MPa)	Yield Strength[A] (0.2 % offset), min, ksi (MPa)	Elongation in 2 in. (51 mm), or 4 × dia, min, %
AZ31B–F	34.0 (234)	19.0 (131)	6
AZ61A–F	38.0 (262)	22.0 (152)	6
AZ80A–F	42.0 (290)	26.0 (179)	5
AZ80A–T5	42.0 (290)	28.0 (193)	2
ZK60A-T5 die forgings[B]	42.0 (290)	26.0 (179)	7
ZK60A-T6 die forgings[B]	43.0 (296)	32.0 (221)	4

[A] See X1.1.6.
[B] Applicable only to die forgings not more than 3 in. (76 mm) in thickness. The tensile requirements for hand forgings will be lower and as agreed upon by the purchaser and manufacturer.

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

6.2.1 When samples are taken at the time the ingots are poured, at least one sample shall be taken for each group of ingots poured simultaneously from the same source of molten metal.

6.2.2 When samples are taken from the finished or semifinished product, a sample shall be taken to represent each 2000 lb (905 kg), or fraction thereof, in the shipment, except that not more than one sample shall be required per piece.

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

6.3.1 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 Practice E 55.

6.3.2 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.

6.4 *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 Test Methods E 35 or any other standard methods of analysis approved by ASTM unless some other method is agreed upon.

7. Tensile Properties

7.1 *Limits*—The forgings shall conform to the tensile properties prescribed in Table 2.

7.2 *Number of Specimens*—One tension test specimen shall be taken to represent each 1000 lb (455 kg) or fraction thereof of each part number in the shipment or inspection lot.

7.2.1 When specified, a grain flow pattern and tensile-property survey shall be made on a forging representative of the first production parts (see 7.3.1). It shall be repeated after any major change in forging technique.

7.3 *Test Specimens*—Tension test specimens shall be taken from a forging or from a separately forged coupon made from material representative of the forgings, in such a manner that the longitudinal axis of the specimen is parallel to the direction of maximum flow of the metal in the forging. The specimens shall be machined to the form and dimensions shown in Fig. 8 of Test Methods B 557 or in the case of thin material may be machined to the form and dimensions shown for the ½ in. (12.7 mm) wide sheet-type specimen in Fig. 6 of Test Methods B 557.

7.3.1 If required, a die forging representative of the first production parts shall be selected after forging techniques have been established, and shall be tested as follows: