



Designation: B 93/B 93M – 04

Standard Specification for Magnesium Alloys in Ingot Form for Sand Castings, Permanent Mold Castings, and Die Castings¹

This standard is issued under the fixed designation B 93/B 93M; 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 alloys in ingot form for remelting for the manufacture of sand castings, permanent mold castings, investment castings, and die castings.

NOTE 1—Supplementary information pertaining to the alloys covered by this specification when used in the form of castings is given in Specifications B 80, B 94, B 199 and B 403.

1.2 The values stated in either inch-pound units or SI units are to be regarded separately as standard. The values stated in each system are not exact equivalents; therefore, each system shall be used independently of the other.

1.3 *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 and health practices and determine the applicability of regulatory limitations prior to use.*

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:*²

- B 80 Specification for Magnesium-Alloy Sand Castings
- B 94 Specification for Magnesium-Alloy Sand Castings
- B 199 Specification for Magnesium-Alloy Sand Castings
- B 275 Practice for Codification of Certain Nonferrous Metals and Alloys, Cast and Wrought
- B 403 Specification for Magnesium-Alloy Sand Castings
- B 881 Specification for Magnesium-Alloy Sand Castings

- E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E 35 Test Methods for Chemical Analysis of Magnesium and Magnesium Alloys
- E 88 Practice for Sampling Nonferrous Metals and Alloys in Cast Form for Determination of Chemical Composition
- E 527 Practice for Numbering Metals and Alloys (UNS)

3. Ordering Information

3.1 Orders for ingot to this specification shall include the following information:

- 3.1.1 Quantity in pounds (kilograms)
- 3.1.2 Alloy (Section 4 and Table 1 or Table 2), and
- 3.1.3 Form: as agreed upon between the purchaser and seller. Some forms in commercial use are:

Form	Approximate Size Length by Width by Height, in. (mm)	Approximate Weight, lb (kg)
Five-segment	23 by 2¾ by 1¼ (583 by 70 by 44)	5 (2.3)
Four-segment	28 by 4½ by 4 (711 by 114 by 102)	20 (9.1)
Self-Palletizing	26½ by 6¾ by 2¾ (672 by 168 by 67)	25 (11.3)

3.1.4 Inspection required at the manufacturer's works (see 8.1).

3.1.5 For inch-pound orders specify B93; for metric orders specify B93M. Do not mix units.

4. Chemical Composition

4.1 The ingots shall conform to the chemical composition limits prescribed in Table 1 for sand cast alloys and permanent mold-cast alloys and in Table 2 for die-cast alloys. Conformance shall be determined by the manufacturer by analyzing samples taken at the time the ingots are poured or samples taken from the ingots. If the manufacturer has determined the chemical composition of the material during manufacture, he shall not be required to sample and analyze the ingots.

4.2 The alloys shall conform to the chemical composition requirements prescribed in Table 1 and Table 2 (Note 2 and Note 3).

NOTE 2—Analysis shall regularly be made only for the elements specifically mentioned in the tables. If, however, the presence of other elements is suspected or indicated in the course of routine analysis, further

¹ This specification is under the jurisdiction of ASTM Committee B07 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 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 Requirements for Alloy Ingot for Remelt to Sand, Permanent, Mold and Investment Castings—Composition %

Alloy ^A ASTM	UNS	Mag- nesium	Alumi- num	Manga- nese	Zinc	Yttrium	Rare Earths	Zir- conium	Silicon, max	Copper, max	Nickel, max	Silver	Iron, max	Others each max ^B	Total Others, max ^B
AM100A	M10101	remainder	9.4–10.6	0.13–0.35	0.2 max	...	...	...	0.20	0.08	0.010	...	...	...	0.30
AZ63A	M11631	remainder	5.5–6.5	0.15–0.35	2.7–3.3	...	...	...	0.20	0.20	0.010	...	...	...	0.30
AZ81A	M11811	remainder	7.2–8.0	0.15–0.35	0.5–0.9	...	...	...	0.20	0.08	0.010	...	...	...	0.30
AZ91C	M11915	remainder	8.3–9.2	0.15–0.35	0.45–0.9	...	...	...	0.20	0.08	0.010	...	...	...	0.30
AZ91E	M11918	remainder	8.3–9.2	0.17–0.50	0.45–0.9	...	...	...	0.20	0.015	0.0010	...	0.005	0.01	0.30
AZ92A	M11921	remainder	8.5–9.5	0.13–0.35	1.7–2.3	...	...	...	0.20	0.20	0.010	...	...	...	0.30
EQ21A	M18330	remainder	...	...	...	...	1.5–3.0 ^C	0.3–1.0	0.01	0.05–0.10	0.01	1.3–1.7	...	...	0.30
EZ33A	M12331	remainder	...	...	2.0–3.0	...	2.6–3.9	0.3–1.0	0.01	0.03	0.010	...	...	...	0.30
K1A	M18011	remainder	...	...	...	...	...	0.3–1.0	0.01	0.03	0.010	...	...	...	0.30
QE22A	M18221	remainder	...	0.15 max	0.2 max	...	1.9 ^C –2.4 ^C	0.3–1.0	0.01	0.03	0.010	2.0–3.0	...	...	0.30
WE43A ^{DE}	M18431	remainder	...	0.15 max	0.20 max	3.7–4.3	2.4– 4.4 ^E	0.3–1.0	0.01	0.03	0.005	...	...	...	0.30
WE43B ^{DE}	M18433	remainder	...	0.03 max	...	3.7–4.3	2.4–4.4 ^E	0.3–1.0	...	0.01	0.004	...	...	0.01	...
WE54A ^{DE}	M18410	remainder	...	0.15 max	0.20 max	4.75–5.5	1.5–4.0 ^E	0.3–1.0	0.01	0.03	0.005	...	...	...	0.30
ZC63A	M16331	remainder	...	0.25–0.75	5.5–6.5	...	...	...	0.20	2.4–3.00	0.001	...	...	...	0.30
ZE41A	M16411	remainder	...	0.15 max	3.7–4.8	...	1.0–1.75	0.3–1.0	0.01	0.03	0.010	...	...	...	0.30
ZE63A	M16631	remainder	...	...	5.5–6.0	...	2.0–3.0	0.3–1.0	0.01	0.03	0.010	...	...	...	0.30
ZK51A	M16511	remainder	...	...	3.8–5.3	...	...	0.3–1.0	0.01	0.03	0.010	...	...	...	0.30
ZK61A	M16611	remainder	...	...	5.7–6.3	...	...	0.3–1.0	0.01	0.03	0.010	...	...	...	0.30

^A These alloy designations were established in accordance with Practice B 275. UNS designations were established in accordance with Practice E 527.

^B Includes listed elements for which no specific limit is shown.

^C Rare earth elements are in the form of didymium, not less than 70 % Nd balance substantially Pr.

^D Lithium content for WE43A/WE43B shall be 0.18 % max, and WE54A shall be 0.20 % max.

^E Rare earths are 2.0 to 2.5 % and 1.5 to 2.0 % neodymium for WE43A and WE54A, respectively, the remainder being principally heavy rare earths.

^F Zinc + Silver shall be 0.15 % max.

TABLE 2 Chemical Requirements for Alloys Used for Die Castings^A

Alloy		Composition, %													
Designa- tion ^B	UNS	Alumi- num	Manga- nese	Rare Earth	Strontium	Zinc	Copper, max	Iron, max	Silicon	Nickel, max	Beryllium	Other Metallic impuri- ties, max each ^C	Other Impuri- ties, max	Magnesium	
AS41A	M10411	3.7–4.8	0.22–0.48	...	...	0.10 max	0.04	...	0.60–1.4	0.01	...	...	0.30	remainder
AS41B	M10413	3.7–4.8	0.35–0.6	...	...	0.10 max	0.015	0.0035	0.60–1.4	0.001	0.0005- 0.0015	0.01	...	remainder
AM50A	M10501	4.5–5.3	0.28–0.50	...	...	0.20 max	0.008	0.004	0.08 max	0.001	0.0005- 0.0015	0.01	...	remainder
AM60A	M10601	5.6–6.4	0.15–0.50	...	...	0.20 max	0.25	...	0.20 max	0.01	...	...	0.30	remainder
AM60B	M10603	5.6–6.4	0.26–0.50	...	...	0.20 max	0.008	0.004	0.08 max	0.001	0.0005- 0.0015	0.01	...	remainder
AZ91A	M11911	8.5–9.5	0.15–0.40	...	...	0.45–0.9	0.08	...	0.20 max	0.01	...	...	0.30	remainder
AZ91B	M11913	8.5–9.5	0.15–0.40	...	...	0.45–0.9	0.25	...	0.20 max	0.01	...	...	0.30	remainder
AZ91D	M11917	8.5–9.5	0.17–0.40	...	...	0.45–0.9	0.025	0.004	0.08 max	0.001	0.0005- 0.0015	0.01	...	remainder
AJ52A ^D	M17521	4.6–5.5	0.26–0.5	...	1.8–2.3	0.20 max	0.008	0.004	0.08 max	0.001	0.0005- 0.0015	0.01	...	remainder	
AJ62A ^D	M17621	5.6–6.6	0.26–0.5	...	2.1–2.8	0.20 max	0.008	0.004	0.08	0.001	0.0005- 0.0015	0.01	...	remainder	
AS21A	M10211	1.9–2.5	0.2–0.6	...	...	0.20 max	0.008	0.004	0.7–1.2	0.001	0.0005- 0.0015	0.01	...	remainder
AS21B ^D	M10213	1.9–2.5	0.05–0.15	0.06–0.25	...	0.25 max	0.008	0.0035	0.7–1.2	0.001	0.0005- 0.0015	0.01	...	remainder	

^A 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 in accordance with the rounding-off procedure prescribed in Practice E 29.

^B ASTM alloy designations were established in accordance with Practice B 275. UNS Numbers were established in accordance with Practice E 527.

^C Includes listed elements for which no specific limit is shown.

^D Alloys AJ52A, AJ62A, and AS21B are patented compositions for elevated temperature applications. Interested parties are invited to submit information regarding the identification of alternatives to these compositions to ASTM International. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this specification. Users of this specification are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

analysis shall be made to determine that the total of these other elements is not in excess of the limits specified in the last column of the table.

NOTE 3—The following applies to all specified limits in the tables: For

purposes of acceptance and rejection, an observed value or a calculated value obtained from analysis shall be rounded off in accordance with the rounding off method of Practice E 29 to the nearest unit in the last