

Standard Practice for Codification of Unalloyed Magnesium and Magnesium- Alloys, Cast and Wrought¹

This standard is issued under the fixed designation B 951; 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.

1. Scope

1.1 This practice provides a system for designating unalloyed magnesium and magnesium-alloys that have been used commercially since 1952, and thus is intended to be the registration source for unalloyed magnesium and magnesium-alloys. A record of designations along with the established compositions is given in Table 2.

1.2 The equivalent Unified Numbering System (UNS) alloy designations shown in the appendixes are in accordance with Practice E 527.

2. Referenced Documents

2.1 The following documents form a part of this practice to the extent referenced herein:

2.2 *ASTM Standards*:²

B 80 Specification for Magnesium-Alloy Sand Castings

B 90/B 90M Specification for Magnesium-Alloy Sheet and Plate

B 91 Specification for Magnesium-Alloy Forgings

B 92/B 92M Specification for Unalloyed Magnesium Ingot and Stick For Remelting

B 93/B 93M Specification for Magnesium Alloys in Ingot Form for Sand Castings, Permanent Mold Castings, and Die Castings

B 94 Specification for Magnesium-Alloy Die Castings

B 107/B 107M Specification for Magnesium-Alloy Extruded Bars, Rods, Profiles, Tubes, and Wire

B 199 Specification for Magnesium-Alloy Permanent Mold Castings

B 403 Specification for Magnesium-Alloy Investment Castings

¹ This practice 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.

B 843 Specification for Magnesium Alloy Anodes for Cathodic Protection

E 527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

3. Basis of Codification

3.1 The designations for alloys and unalloyed metals are based on their chemical composition limits.

NOTE 1—For unalloyed magnesium, magnesium-alloys, cast and wrought, standard limits for alloying elements and impurities are expressed to the following places:

Less than 0.0001 % (used only for magnesium alloys)	0.0000X
0.0001 to 0.001 %	0.000X
0.001 to 0.01 %	0.00X
0.01 to 0.10 %	
Unalloyed aluminum made by a refining process	0.0XX
Alloys and unalloyed aluminum or magnesium not made by a refining process	0.0X
0.10 through 0.55 %	0.XX
Over 0.55 %	0.X,XX,XX,X

3.2 Designations shall be assigned, revised, and cancelled by Subcommittee B07.04 of ASTM Committee B07 on Light Metals and Alloys on written requests to its chairman. Complete chemical composition limits shall be submitted with request for assignment or revision of designations. Arbitrary assignments by other subcommittees or committees will not be recognized.

4. Alloys

4.1 Designation for alloys shall consist of not more than two letters representing the alloying elements (**Note 2**) specified in the greatest amount, arranged in order of decreasing percentages, or in alphabetical order if of equal percentages, followed by the respective percentages rounded off to whole numbers and a serial letter (**Notes 3**). The full name of the base metal precedes the designation, but it is omitted for brevity when the base metal being referred to is obvious.

NOTE 2—For codification, an alloying element is defined as an element (other than the base metal) having a minimum content greater than zero either directly specified or computed in accordance with the percentages specified.

NOTE 3—The serial letter is arbitrarily assigned in alphabetical sequence starting with “A” (omitting “I” and “O”) and serves to differentiate otherwise identical designations. A serial letter is necessary to complete each designation.

4.2 The letters used to represent the greater of the two alloying elements shall be those in **Table 1**.

4.3 In rounding percentages, the nearest whole number shall be used. If two choices are possible as when the decimal is

TABLE 1 Letters Representing Alloying Elements

A—Aluminum	Q—Silver
C—Copper	S—Silicon
E—Rare earths	T—Tin*
H—Thorium*	V—Gadolinium
J—Strontium	W—Yttrium
K—Zirconium	Z—Zinc
L—Lithium*	*For historical reference
M—Manganese	

followed by a 5 only, or a 5 followed only by zeros, the nearest even whole number shall be used.

4.4 When a range is specified for the alloying element, the rounded mean shall be used in the designation.

4.5 When only a minimum percentage is specified for the alloying element, the rounded minimum percentage shall be used in the designation.

5. Unalloyed Metals

5.1 Designations for unalloyed metals consist of the specified minimum purity, all digits retained but dropping the decimal point, followed by a serial letter (**Note 3**). The full name of the base metal precedes the designation, but it is omitted for brevity when the base metal being referred to is obvious.

6. Keywords

6.1 magnesium; UNS designations

TABLE 2 Unalloyed Magnesium and Magnesium-Alloy Registration
(A Registration Record of Magnesium Alloys with Established Designations and Chemical Composition)

NOTE—Cast or wrought product compositions may differ from casting ingot compositions.

Designation		Chemical Composition, % max unless shown as a range or as a min																			Other Elements		
Practice	UNS	See ASTM	Magnesium	Aluminum	Calcium	Copper	Gadolinium	Iron	Lithium	Manganese	Neodymium	Nickel	Rare Earths	Silicon	Silver	Strontium	Yttrium	Zinc	Zirconium	Specific	Each	Total	
9980A	M19980	B 92/B 92M	99.80 min			0.02				0.10		0.001								0.01 Sn 0.01 Pb 0.006 Na	0.05		
9980B	M19991	B 92/B 92M	99.80 min			0.02				0.10		0.005								0.01 Sn 0.01 Pb	0.05		
9990A	M19990	B 92/B 92M	99.90 min	0.003				0.04		0.004		0.001		0.005						0.01 Pb ^A	0.01		
9995A	M19995	B 92/B 92M	99.95 min	0.01				0.003		0.004		0.001		0.005						0.01 Ti ^A	0.005		
9998A	M19998	B 92/B 92M	99.98 min	0.004		0.0005		0.002		0.002		0.0005		0.003						0.001 Ti ^A 0.00003 B 0.001 Pb	0.005		
AJ52A ^B	M17520	B 94	^C	4.5-5.5		0.010		0.004 ^D		0.24-0.6 ^D		0.001		0.10		1.7-2.3		0.22			0.01		
AJ52A ^{BE}	M17521	B 93/B 93M	^C	4.6-5.5		0.008		0.004		0.25-0.5		0.001		0.08		1.8-2.3		0.20			0.01		
AJ62A ^B	M17620	B 94	^C	5.5-6.6		0.010		0.004 ^D		0.24-0.6 ^D		0.001		0.10		2.0-2.8		0.22			0.01		
AJ62A ^{BE}	M17621	B 93/B 93M	^C	5.6-6.6		0.008		0.004		0.26-0.05		0.001		0.08		2.1-2.8		0.20			0.01		
AM50A	M10500	B 94	^C	4.4-5.4		0.010		0.004 ^D		0.26-0.6 ^D		0.002		0.10				0.22			0.02		
AM50A ^E	M10501	B 93/B 93M	^C	4.5-5.3		0.008		0.004		0.28-0.50		0.001		0.08				0.22			0.01		
AM60A	M10600	B 94	^C	5.5-6.5		0.35				0.13-0.6		0.03		0.50				0.22					
AM60A	M10601	B 93/B 93M	^C	5.6-6.4		0.25				0.15-0.50		0.01		0.20				0.20				0.30	
AM60B	M10602	B 94	^C	5.5-6.5		0.010		0.005 ^D		0.24-0.6 ^D		0.002		0.10				0.22			0.02		
AM60B ^E	M10603	B 93/B 93M	^C	5.6-6.4		0.008		0.004		0.26-0.50		0.001		0.10				0.20			0.01		
AM100A	M10100	B 80 B 199 B 403	^C	9.3-10.7		0.10				0.10-0.35		0.01		0.30				0.30				0.30	
AM100A	M10101	B 93/B 93M	^C	9.4-10.6		0.08				0.13-0.35		0.010		0.20				0.2				0.30	
AS21A	M10210	B 94	^C	1.8-2.5		0.01		0.005		0.18-0.7		0.001		0.7-1.2				0.20			0.01		
AS21A ^E	M10211	B 93/B 93M	^C	1.9-2.5		0.008		0.004		0.2-0.6		0.001		0.7-1.2				0.20			0.01		
AS21B ^B	M10212	B 94	^C	1.8-2.5		0.008		0.0035		0.05-0.15		0.001	0.06-0.25	0.7-1.2				0.25			0.01		
AS21B ^{BE}	M10213	B 93/B 93M	^C	1.9-2.5		0.008		0.0035		0.05-0.15		0.001	0.06-0.25	0.7-1.2				0.25			0.01		
AS41A	M10410	B 94	^C	3.5-5.0		0.06				0.20-0.50		0.03		0.50-1.5				0.12					

TABLE 2 Continued

Designation			Chemical Composition, % max unless shown as a range or as a min																			Other Elements		
Practice	UNS	See ASTM	Magnesium	Aluminum	Calcium	Copper	Gadolinium	Iron	Lithium	Manganese	Neodymium	Nickel	Rare Earths	Silicon	Silver	Strontium	Yttrium	Zinc	Zirconium	Specific	Each	Total		
AS41A	M10411	B 93/B 93M	C	3.7-4.8		0.04				0.22-0.48		0.01		0.60-1.4				0.10				0.30		
AS41B	M10412	B 94	C	3.5-0.7 ^D		0.02		0.0035 ^D		0.35-0.7		0.002		0.50-1.5				0.12			0.02			
AS41B ^E	M10413	B 93/B 93M	C	3.7-4.8		0.015		0.0035		0.35-0.6		0.001		0.60-1.4				0.10			0.01			
AZ31B	M11311	B 90/B 90M B 91 B 107/ B 107M B 843	C	2.5-3.5	0.04	0.05		0.005		0.20-1.0		0.005		0.10				0.6-1.4				0.30		
AZ31C	M11312	B 107/ B 107M B 843	C	2.4-3.6		0.10				0.15-1.0 ^F		0.03		0.10				0.50-1.5				0.30		
AZ31D	M11313	B 843	C	2.5-3.5	0.04	0.04		0.002		0.20-1.0		0.0010		0.05				0.6-1.4			0.01	0.30		
AZ61A	M11610	B 91 B 107/ B 107M	C	5.8-7.2		0.05		0.005		0.15-0.5		0.005		0.10				0.40-1.5				0.30		
AZ63A	M11630	B 80	C	5.3-6.7		0.25				0.15-0.35		0.01		0.30				2.5-3.5				0.30		
AZ63A	M11631	B 93/B 93M	C	5.5-6.5		0.20				0.15-0.35		0.010		0.20				2.7-3.3				0.30		
AZ63B	M11632	B 843	C	5.3-6.7		0.02		0.003		0.15-0.7		0.002		0.10				2.5-3.5				0.30		
AZ63C	M11634	B 843	C	5.3-6.7		0.05		0.003		0.15-0.7		0.003		0.30				2.5-3.5				0.30		
AZ63D	M11636	B 843	C	5.0-7.0		0.10		0.003		0.15-0.7		0.003		0.30				2.0-4.0				0.30		
AZ80A	M11800	B 91 B 107/ B 107M	C	7.8-9.2		0.05		0.005		0.12-0.5		0.005		0.10				0.20-0.8				0.30		
AZ81A	M11810	B 80 B 199 B 403	C	7.0-8.1		0.10				0.13-0.35		0.01		0.30				0.40-1.0				0.30		
AZ81A	M11811	B 93/B 93M	C	7.2-8.0		0.08				0.15-0.35		0.010		0.20				0.5-0.9				0.30		
AZ91A	M11910	B 94	C	8.3-9.7		0.10				0.13-0.50		0.03		0.50				0.35-1.0						
AZ91A	M11911	B 93/B 93M	C	8.5-9.5		0.08				0.15-0.40		0.01		0.20				0.45-0.9				0.30		
AZ91B	M11912	B 94	C	8.3-9.7		0.35				0.13-0.50		0.03		0.50				0.35-1.0						
AZ91B	M11913	B 93/B 93M	C	8.5-9.5		0.25				0.15-0.40		0.01		0.20				0.45-0.9				0.30		
AZ91C	M11914	B 80 B 199 B 403	C	8.1-9.3		0.10				0.13-0.35		0.01		0.30				0.40-1.0				0.30		
AZ91C	M11915	B 93/B 93M	C	8.3-9.2		0.08				0.15-0.35		0.010		0.20				0.45-0.9				0.30		
AZ91D	M11916	B 94	C	8.3-9.7		0.030		0.005 ^D		0.15-0.50 ^D		0.002		0.10				0.35-1.0			0.02			

TABLE 2 Continued

Designation			Chemical Composition, % max unless shown as a range or as a min																				
Practice	UNS	See ASTM	Magnesium	Aluminum	Calcium	Copper	Gadolinium	Iron	Lithium	Manganese	Neodymium	Nickel	Rare Earths	Silicon	Silver	Strontium	Yttrium	Zinc	Zirconium	Other Elements			
																				Specific	Each	Total	
AZ91D ^E	M11917	B 93/B 93M	C	8.5-9.5		0.025		0.004		0.17-0.40		0.001		0.08				0.45-0.9				0.01	
AZ91E	M11919	B 80 B 199 B 403	C	8.1-9.3		0.015		0.005 ^G		0.17-0.35		0.0010		0.20				0.40-1.0				0.01	0.30
AZ91E	M11918	B 93/B 93M	C	8.3-9.2		0.015		0.005		0.17-0.50		0.0010		0.20				0.45-0.9				0.01	0.30
AZ92A	M11920	B 80 B 199	C	8.3-9.7		0.25				0.10-0.35		0.01		0.30				1.6-2.4					0.0
AZ92A	M11920	B 403	C	8.3-9.7		0.10				0-0.35		0.01		0.30				1.6-2.4					0.30
AZ92A	M11921	B 93/B 93M	C	8.5-9.5		0.20				0.13-0.35		0.010		0.20				1.7-2.3					0.30
AZ101A ^H	M11101		C	9.5-10.5		0.05		0.005		0.13-0.05		0.005		0.05				0.75-1.25					0.30
EQ21A	M18330	B 80 B 199 B 403	C			0.05-0.10						0.01	1.5-3.0 ^I		1.3-1.7				0.40-1.0				0.30
EQ21A	M18330	B 93/B 93M	C			0.05-0.10						0.01	1.5-3.0 ^I	0.01	1.3-1.7				0.30-1.0				0.0
EV31A ^J	M12310	B 80	C			0.01	1.0-1.7	0.010			2.6-3.1	0.0020	0.4 ^K		0.05			0.20-0.50	0.40-1.0			0.01	
EV31A ^J	M12311	B 93/B 93M	C			0.01	1.0-1.7	0.010			2.6-3.1	0.0020	0.4 ^K		0.05			0.20-0.50	0.3-1.0			0.01	
EZ33A	M12330	B 80 B 199 B 403	C			0.10						0.01	2.5-4.0 ^L					2.0-3.1	0.50-1.0				0.30
EZ33A	M12331	B 93/B 93M	C			0.03						0.010	2.6-3.9 ^L	0.01				2.0-3.0	0.3-1.0				0.30
K1A	M18010	B 80 B 403	C																0.40-1.0				0.30
K1A	M18011	B 93/B 93M	C			0.03						0.010		0.01				0.30-1.0					0.30
M1A	M15100	B 107/ B 107M	C		0.30	0.05				1.2-2.0		0.01		0.10									0.30
M1C	M15102	B 843	C	0.01		0.02		0.03		0.50-1.3		0.001		0.05								0.05	0.30
QE22A	M18220	B 80 B 199 B 403	C			0.10						0.01	1.8-2.5 ^I		2.0-3.0				0.40-1.0				0.30
QE22A	M18221	B 93/B 93M	C			0.03				0.15		0.010	1.9-2.4 ^I	0.01	2.0-3.0			0.2	0.30-1.0				0.0
WE54A	M18410	B 80	C			0.03			0.2	0.03	1.5-2.0	0.005	2.0 ^M	0.01			4.75-5.5	0.20	0.3-1.0		0.20	0.30	
WE54A	M18410	B 93/B 93M	C			0.03			.20	0.15	1.5-2.0	0.005	2.0 ^M	0.01			4.75-5.5	0.20	0.3-1.0			0.30	
WE54A	M18410	B 107/ B 107M	C			0.03			0.2	0.03	1.5-2.0	0.005	2.0 ^M	0.01			4.75-5.5	0.20	0.40-1.0		0.2		
WE43A	M18430	B 80	C			0.03		0.01	0.2	0.15	2.0-2.5	0.005	1.9 ^M	0.01			3.7-4.3	0.20	0.40-1.0		0.2		
WE43A	M18431	B 93/B 93M	C			0.03			0.18	0.15	2.0-2.5	0.005	1.9 ^M	0.01			3.7-4.3	0.20	0.3-1.0			0.30	

TABLE 2 Continued

Designation			Chemical Composition, % max unless shown as a range or as a min																			
Practice	UNS	See ASTM	Magnesium	Aluminum	Calcium	Copper	Gadolinium	Iron	Lithium	Manganese	Neodymium	Nickel	Rare Earths	Silicon	Silver	Strontium	Yttrium	Zinc	Zirconium	Other Elements		
																				Specific	Each	Total
WE43B	M18432	B 80	C			0.02		0.010	0.2	0.03	2.0-2.5	0.005	1.9 ^M		N		3.7-4.3	0.20 ^N	0.40-1.0		0.01	
WE43B	M18432	B 107/ B 107M	C			0.02		0.010	0.2	0.03	2.0-2.5	0.005	1.9 ^M		N		3.7-4.3	N	0.40-1.0		0.01	
WE43B	M18433	B 93/B 93M	C			0.01			0.18	0.03	2.0-2.5	0.004	1.9 ^M		N		3.7-4.3	N	0.3-1.0		0.01	
ZC63A	M16331	B 80	C			2.4-3.0				0.25-0.75		0.01		0.20				5.5-6.5				0.30
ZC63A	M16331	B 93/B 93M	C			2.4-3.00				0.25-0.75		0.001		0.20				5.5-6.5				0.30
ZE41A	M16410	B 80 B 403	C			0.10				0.15		0.01	0.75-1.75 ^L					3.5-5.0	0.40-1.0			0.30
ZE41A	M16411	B 93/B 93M	C			0.03				0.15		0.01	1.0-1.75 ^L	0.01				3.7-4.8	0.30-1.0			0.30
ZE63A	M16631	B 93/B 93M	C			0.03						0.010	2.0-3.0	0.01				5.5-6.0	0.3-1.0			0.30
ZK40A	M16400	B 107/ B 107M	C															3.5-4.5	0.45 min			0.30
ZK51A	M16510	B 80	C			0.10						0.01						3.6-5.5	0.50-1.0			0.30
ZK51A	M16511	B 93/B 93M	C			0.03						0.010		0.01				3.8-5.3	0.3-1.0			0.30
ZK60A	M16600	B 91 B 107/ B 107M	C															4.8-6.2	0.45 min			0.30

TABLE 2 Continued

Designation			Chemical Composition, % max unless shown as a range or as a min																			
Practice	UNS	See ASTM	Magnesium	Aluminum	Calcium	Copper	Gadolinium	Iron	Lithium	Manganese	Neodymium	Nickel	Rare Earths	Silicon	Silver	Strontium	Yttrium	Zinc	Zirconium	Other Elements		
																				Specific	Each	Total
ZK61A	M16610	B 80 B 403	C			0.10						0.01						5.5-6.5	0.6-1.0			0.30
ZK61A	M16611	B 93/B 93M	C			0.03						0.010		0.01				5.7-6.3	0.3-1.0			0.30

^AFor nuclear applications.

^BAlloys 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.

^CRemainder.

^DFor alloys AS41B, AM50A, AJ52A, AM60B, AJ62A, and AZ91D, if either the minimum Manganese or maximum Iron content is not met, then the permissible Iron to Manganese ratio shall not exceed 0.010, 0.015, 0.021, and 0.032, respectively.

^EBeryllium 0.0005 – 0.0015.

^FManganese minimum limit need not be met if Iron is 0.005 % or less.

^GIf the iron content exceeds 0.005 %, the Iron to Manganese ratio shall not exceed 0.032 for AZ91E alloy.

^HRod for welding AZ91 and AZ92 alloys.

^IRare earth elements are in the form of Didymium, with not less than 70 % Neodymium and remainder substantially Praseodymium.

^JAlloy EV31A is a patented composition, suitable for elevated temperature applications. Interested parties are invited to submit information regarding the identification of alternatives to these compositions to ASTM International. 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.

^KOther Rare Earths may also be present to a total maximum of 0.4 %. These Rare Earths shall principally be Cerium, Lanthanum, and Praseodymium.

^LTotal Rare Earths (TRE) are principally a mixture of Cerium, Lanthanum, Neodymium and Praseodymium. The Cerium content should not be less than 45 % of the TRE.

^MOther Rare Earths shall be principally heavy rare earths, such as Gadolinium, Dysprosium, Erbium, and Ytterbium. Other Rare Earths are derived from the Yttrium, typically 80 % Yttrium and 20 % heavy rare earths.

^NZinc + Silver content shall not exceed 0.20 % in WE43B.



APPENDIX

(Nonmandatory Information)

X1. EXAMPLES OF CODIFICATION

X1.1 *Example 1*—For Alloys AZ91A, B, and C, in Specification **B 93/B 93M**, “A” represents aluminum, the alloying element specified in the greatest amount; “Z” represents zinc, the alloying element specified in the second greatest amount; “9” indicates that the rounded mean aluminum percentage lies between 8.6 and 9.4; “1” signifies that the rounded mean of the zinc lies between 0.6 and 1.4; and “A” as the final letter

indicates that this is the first alloy whose composition qualified assignment of the designation AZ91. The final serial letters B and C signify alloys subsequently developed whose specified compositions differ slightly from the first and from one another but do not differ sufficiently to effect a change in the basic designation.

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