Designation: B951 – 11

Standard Practice for Codification of Unalloyed Magnesium and Magnesium-Alloys, Cast and Wrought[1]

This standard is issued under the fixed designation B951; 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 E527.

2. Referenced Documents

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

2.2 *ASTM Standards:*[2]

B80 Specification for Magnesium-Alloy Sand Castings

B90/B90M Specification for Magnesium-Alloy Sheet and Plate

B91 Specification for Magnesium-Alloy Forgings

B92/B92M Specification for Unalloyed Magnesium Ingot and Stick For Remelting

B93/B93M Specification for Magnesium Alloys in Ingot Form for Sand Castings, Permanent Mold Castings, and Die Castings

B94 Specification for Magnesium-Alloy Die Castings

B107/B107M Specification for Magnesium-Alloy Extruded Bars, Rods, Profiles, Tubes, and Wire

B199 Specification for Magnesium-Alloy Permanent Mold Castings

B403 Specification for Magnesium-Alloy Investment Castings

B843 Specification for Magnesium Alloy Anodes for Cathodic Protection

E527 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,X.X,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 (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.

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.

[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.

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

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 two greatest amounts of the 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 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.

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	

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

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
9980A	M19980	B92/ B92M	99.80 min			0.02				0.10		0.001								0.01 Sn 0.01 Pb 0.006 Na	0.05	
9980B	M19991	B92/ B92M	99.80 min			0.02				0.10		0.005								0.01 Sn 0.01 Pb	0.05	
9990A[A]	M19990	B92/ B92M	99.90 min	0.003				0.04		0.004		0.001		0.005							0.01	
9995A[A]	M19995	B92/ B92M	99.95 min	0.01				0.003		0.004		0.001		0.005						0.01 Ti	0.005	
9998A[A]	M19998	B92/ B92M	99.98 min	0.004		0.0005		0.002		0.002		0.0005		0.003						0.001 Ti 0.001 Pb	0.005	
AJ52A[B]	M17520	B94	[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	B93/ B93M	[C]	4.6-5.5		0.008		0.004		0.26 - 0.5		0.001		0.08		1.8-2.3		0.20			0.01	
AJ62A[B]	M17620	B94	[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	B93/ B93M	[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	B94	[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	B93/ B93M	[C]	4.5-5.3		0.008		0.004		0.28-0.50		0.001		0.08				0.20†			0.01	
AM60A	M10600	B94	[C]	5.5-6.5		0.35				0.13-0.6		0.03		0.50				0.22				
AM60A	M10601	B93/ B93M	[C]	5.6-6.4		0.25				0.15-0.50		0.01		0.20				0.20				0.30
AM60B	M10602	B94	[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	B93/ B93M	[C]	5.6-6.4		0.008		0.004		0.26-0.50		0.001		0.08†				0.20			0.01	
AM100A	M10100	B80 B199 B403	[C]	9.3-10.7		0.10				0.10-0.35		0.01		0.30				0.30				0.30
AM100A	M10101	B93/ B93M	[C]	9.4-10.6		0.08				0.13-0.35		0.010		0.20				0.2				0.30
AS21A	M10210	B94	[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	B93/ B93M	[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	B94	[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	B93/ B93M	[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	B94	[C]	3.5-5.0		0.06				0.20-0.50		0.03		0.50-1.5				0.12				
AS41A	M10411	B93/ B93M	[C]	3.7-4.8		0.04				0.22-0.48		0.01		0.60-1.4				0.10				0.30
AS41B	M10412	B94	[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	B93/ B93M	[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	B90/ B90M B91 B107/ B107M B843	[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

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
AZ31C	M11312	B107/ B107M	[C]	2.4-3.6		0.10				0.15-1.0[F]		0.03		0.10				0.50-1.5				0.30
AZ31D	M11313	B843	[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	B91 B107/ B107M	[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	B80	[C]	5.3-6.7		0.25				0.15-0.35		0.01		0.30				2.5-3.5				0.30
AZ63A	M11631	B93/ B93M	[C]	5.5-6.5		0.20				0.15-0.35		0.010		0.20				2.7-3.3				0.30
AZ63B	M11632	B843	[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	B843	[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	B843	[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	B91 B107/ B107M	[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	B80 B199 B403	[C]	7.0-8.1		0.10				0.13-0.35		0.01		0.30				0.40-1.0				0.30
AZ81A	M11811	B93/ B93M	[C]	7.2-8.0		0.08				0.15-0.35		0.010		0.20				0.5-0.9				0.30
AZ91A	M11910	B94	[C]	8.3-9.7		0.10				0.13-0.50		0.03		0.50				0.35-1.0				
AZ91A	M11911	B93/ B93M	[C]	8.5-9.5		0.08				0.15-0.40		0.01		0.20				0.45-0.9				0.30
AZ91B	M11912	B94	[C]	8.3-9.7		0.35				0.13-0.50		0.03		0.50				0.35-1.0				
AZ91B	M11913	B93/ B93M	[C]	8.5-9.5		0.25				0.15-0.40		0.01		0.20				0.45-0.9				0.30
AZ91C	M11914	B80 B199 B403	[C]	8.1-9.3		0.10				0.13-0.35		0.01		0.30				0.40-1.0				0.30
AZ91C	M11915	B93/ B93M	[C]	8.3-9.2		0.08				0.15-0.35		0.010		0.20				0.45-0.9				0.30
AZ91D	M11916	B94	[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	
AZ91D[E]	M11917	B93/ B93M	[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	B80 B199 B403	[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	B93/ B93M	[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	B80 B199	[C]	8.3-9.7		0.25				0.10-0.35		0.01		0.30				1.6-2.4				0.30
AZ92A	M11920	B403	[C]	8.3-9.7		0.10				0-0.35		0.01		0.30				1.6-2.4				0.30
AZ92A	M11921	B93/ B93M	[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		0.005		0.05				0.75-1.25				0.30
EQ21A	M18330	B80 B199 B403	[C]			0.05-0.10						0.01	1.5-3.0[I]		1.3-1.7				0.40-1.0			0.30
EQ21A	M18330	B93/ B93M	[C]			0.05-0.10						0.01	1.5-3.0[I]	0.01	1.3-1.7				0.30-1.0			0.30†
EV31A[J]	M12310	B80	[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	

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
EV31A[J]	M12311	B93/ B93M	[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	B80 B199 B403	[C]			0.10						0.01	2.5-4.0[L]					2.0-3.1	0.50-1.0			0.30
EZ33A	M12331	B93/ B93M	[C]			0.03						0.010	2.6-3.9[L]	0.01				2.0-3.0	0.3-1.0			0.30
K1A	M18010	B80 B403	[C]																0.40-1.0			0.30
K1A	M18011	B93/ B93M	[C]			0.03						0.010		0.01					0.30-1.0			0.30
M1A	M15100	B107/ B107M	[C]		0.30	0.05				1.2-2.0		0.01		0.10								0.30
M1C	M15102	B843	[C]	0.01		0.02		0.03		0.50-1.3		0.001		0.05							0.05	0.30
QE22A	M18220	B80 B199 B403	[C]			0.10						0.01	1.8-2.5[I]		2.0-3.0				0.40-1.0			0.30
QE22A	M18221	B93/ B93M	[C]			0.03				0.15		0.010	1.9-2.4[I]	0.01	2.0-3.0			0.2	0.30-1.0			0.30
WE54A	M18410	B80	[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		0.20	
WE54A	M18410	B93/ B93M	[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	B107/ B107M	[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	B80	[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	B93/ B93M	[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
WE43B	M18432	B80	[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	M18432	B107/ B107M	[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	B93/ B93M	[C]			0.01			0.18	0.03	2.0-2.5	0.004	1.9[M]		[O]		3.7-4.3	[O]	0.3-1.0		0.01	
WE43C	M18434	B90/ B90M B107/ B107M	[C]			0.02	[P]	0.005	0.05	0.03	2.0 - 2.5	0.0020	0.30-1.0[P]				3.7 - 4.3	0.06	0.2 - 1.0		0.01	
ZC63A	M16331	B80	[C]			2.4-3.0				0.25-0.75		0.01		0.20				5.5-6.5				0.30
ZC63A	M16331	B93/ B93M	[C]			2.4-3.00				0.25-0.75		0.001		0.20				5.5-6.5				0.30
ZE41A	M16410	B80 B403	[C]			0.10				0.15		0.01	0.75-1.75[L]					3.5-5.0	0.40-1.0			0.30
ZE41A	M16411	B93/ B93M	[C]			0.03				0.15		0.01	1.0-1.75[L]	0.01				3.7-4.8	0.30-1.0			0.30
ZK40A	M16400	B107/ B107M	[C]															3.5-4.5	0.45 min			0.30
ZK51A	M16510	B80	[C]			0.10						0.01						3.6-5.5	0.50-1.0			0.30
ZK51A	M16511	B93/ B93M	[C]			0.03						0.010		0.01				3.8-5.3	0.3-1.0			0.30
ZK60A	M16600	B91 B107/ B107M	[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	B80 B403	[C]			0.10						0.01						5.5-6.5	0.6-1.0			0.30
ZK61A	M16611	B93/ B93M	[C]			0.03						0.010		0.01				5.7-6.3	0.3-1.0			0.30

[A]For nuclear applications the cadmium and boron (high-capture cross-section elements) shall be specified as follows:
Cadmium, max, % 0.0001 or 0.00005
Boron, max, % 0.00007 or 0.00003

[B] 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.

[C] Remainder.

[D] For 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.

[E]Beryllium 0.0005 – 0.0015.

[F] Manganese minimum limit need not be met if Iron is 0.005 % or less.

[G] If the iron content exceeds 0.005 %, the Iron to Manganese ratio shall not exceed 0.032 for AZ91E alloy.

[H]Rod for welding AZ91 and AZ92 alloys.

[I] Rare earth elements are in the form of Didymium, with not less than 70 % Neodymium and remainder substantially Praesodymium.

[J]Alloys EV31A and WE43C are patented compositions, both 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.

[K] Other Rare Earths may also be present to a total maximum of 0.4 %. These Rare Earths shall principally be Cerium, Lanthanum, and Praseodymium.

[L] Total 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.

[M] Other 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.

[N] Zinc + Silver content shall not exceed 0.20 %.

[O]Zinc + Silver content shall not exceed 0.15 %.

[P]Other Rare Earths are heavy rare earths, such as Gadolinium, Dysprosium, Erbium, Samarium and Ytterbium. The total of Gadolinium + Dysprosium + Erbium shall be 0.3-1.0%. Samarium shall not exceed 0.04% and Ytterbium shall not exceed 0.02%

APPENDIX

(Nonmandatory Information)

X1. EXAMPLES OF CODIFICATION

X1.1 *Example 1*—For Alloys AZ91A, B, and C, in Specification B93/B93M, "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.

SUMMARY OF CHANGES

Committee B07 has identified the location of selected changes to this standard since the last issue (B951 – 10) that may impact the use of this standard. (Approved November 1, 2011)

(1) Added WE43C to Table 2.