Designation: B90/B90M – 15

Standard Specification for Magnesium-Alloy Sheet and Plate[1]

This standard is issued under the fixed designation B90/B90M; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification covers magnesium alloys in sheet and plate form designated as shown in Table 1.

1.2 The values stated in either inch-pound or SI units are to be regarded separately as standards. The SI units are shown in brackets or in separate tables or columns. The values stated in each system are not exact equivalents; therefore, each system must be used independent of the other. Combining values from the two systems may result in nonconformance with the specification.

1.3 Unless the order specifies the "M" specification designation, the material shall be furnished to the inch-pound units.

1.4 *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 material purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[2]

B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products

B557M Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)

B660 Practices for Packaging/Packing of Aluminum and Magnesium Products

B954 Test Method for Analysis of Magnesium and Magnesium Alloys by Atomic Emission Spectrometry

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition

2.3 *Federal Standards:*[3]

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)

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

2.4 *Military Standards:*[3]

MIL-STD-129 Marking for Shipment and Storage

2.5 *Aerospace Materials Specification:*[4]

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

2.6 *ANSI Standards*[5]

ANSI H35.2 American National Standard Dimensional Tolerances for Aluminum Mill Products

ANSI H32.2 (M) American National Standard Dimensional Tolerances for Aluminum Mill Products

3. Terminology

3.1 *Definitions:*

3.1.1 *plate, n*—a rolled product rectangular in cross section and form, of thickness 0.250 in., or more, [over 6.30 mm], either sheared or sawed edges.

3.1.2 *sheet, n*—a rolled product rectangular in cross section and form, of thickness of 0.006 through 0.249 in. [over 0.15 through 6.30 mm] with sheared, slit, or sawed edges.

4. Ordering Information

4.1 Orders for sheet and plate to this specification shall include the following information:

4.1.1 Quantity in pieces, lbs, or [kg]

4.1.2 Alloy (Section 5 and Table 1),

4.1.3 Temper (Section 6 and Table 2),

[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.

[3] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

[4] Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

[5] Available from Americal National Standards Institute, 11 West 42nd Street, New York, NY 10036.

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

TABLE 1 Chemical Composition Limits[A]

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.

	Composition %[A]												
	Al	Mn	R.E.	Zn	Zr	Ca	Cu	Fe	Ni	Si	Each	Total	Mg
AZ31B	2.5-3.5	0.20-1.0	. . .	0.6-1.4	. . .	0.04	0.05	0.005	0.005	0.10	. . .	0.30	Remainder
ZE10A	. . .	. . .	0.12-0.22	1.0-1.5	. . .	. . .	. . .	. . .	. . .	. . .	. . .	0.30	Remainder

[A] Limits are in weight percent maximum unless shown as a range.

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 E29.

Alloy and Temper	Specified Thickness, in.	Tensile Strength, min, ksi	Yield Strength (0.2 % Offset), min, ksi	Elongation in 2 in., or 4 × dia min, %
AZ31B-O	0.016–0.500	32.0[A]	. . .	12
	0.501–2.000	32.0[A]	. . .	10
	2.001–3.000	32.0[A]	. . .	9
AZ31B-H24	0.016–0.249	39.0	29.0	6
	0.250–0.374	38.0	26.0	8
	0.375–0.500	37.0	24.0	8
	0.501–1.000	36.0	22.0	8
	1.001–2.000	34.0	20.0	8
	2.001–3.000	34.0	18.0	8
AZ31B-H26	0.250–0.374	39.0	27.0	6
	0.375–0.500	38.0	26.0	6
	0.501–0.750	37.0	25.0	6
	0.751–1.000	37.0	23.0	6
	1.001–1.500	35.0	22.0	6
	1.501–2.000	35.0	21.0	6
ZE10A-O	0.016-0.066	30.0	18.0	15
	0.067-0.250	30.0	15.0	15
	0.251-0.500	29.0	12.0	12

[A] Tensile strength shall be 40.0 ksi max.

4.1.4 Thickness, width, and length,

4.1.5 Surface treatment (see 8.2),

4.1.6 Whether inspection is required at the manufacturer's works (see 13.1), and

4.1.7 Whether certification of the material by the vendor is required (Section 15).

5. Chemical Composition

5.1 The sheet and plate shall conform to the chemical requirements in Table 1.

6. Tensile Properties

6.1 The sheet and plate shall conform to the tensile requirements in Table 2 [Table 3] unless another agreement is made between seller and purchaser. Properties for sizes and tempers not shown in Table 2 [Table 3] shall be as agreed upon by seller and purchaser.

7. Dimensional Tolerances

7.1 Variations from the specified thickness shall not exceed the amounts prescribed in ANSI H35.2/ANSI 35.2(M) Table 7.7a.

7.2 Variations from the specified width shall not exceed the amounts prescribed in ANSI 35.2/ANSI 35.2(M) Tables 7.8, 7.10 and 7.11.

7.3 Variations from the specified length shall not exceed the amounts prescribed in ANSI H35.2/ ANSI H35.2(M) Tables 7.9 and 7.10.

7.4 Squareness of sheet and plate shall conform to the requirements of ANSI H35.2/ ANSI H35.2(M) Table 7.14.

7.5 Flatness of sheet and plate shall conform to the requirements of Table 4 [Table 5].

7.6 Lateral bow of sheet and plate shall conform to the requirements of ANSI H35.2/ ANSI H35.2(M) Tables 7.12 and 7.13.

8. Workmanship, Finish, and Appearance

8.1 All sheet and plate shall be commercially flat and free of buckles, shall be free of injurious surface defects, and have a workmanlike finish.

8.2 The sheet or plate shall be supplied in the finish specified by the purchaser. One of the following finishes should be specified:

TABLE 3 Tensile Requirements [Metric][A]

Alloy and Temper	Specified Thickness, mm		Tensile Strength, MPa[B]		Yield Strength (0.2 % offset), MPa	Elongation, min %	
	Over	Through	Min	Max	Min	in 50 mm[C]	in 5 × dia (5.65 V *A*)
AZ31B-O	0.40	12.50	221	275	. . .	12	. . .
	12.50	50.00	221	275	. . .	. . .	9
	50.00	80.00	221	275	. . .	. . .	8
AZ31B-H24	0.40	6.30	269	. . .	200	6	. . .
	6.30	10.00	262	. . .	179	8	. . .
	10.00	12.50	255	. . .	165	8	. . .
	12.50	25.00	248	. . .	152	. . .	7
	25.00	50.00	234	. . .	138	. . .	7
	50.00	80.00	234	. . .	124	. . .	7
AZ31B-H26	6.30	10.00	269	. . .	186	6	. . .
	10.00	12.50	262	. . .	179	6	. . .
	12.50	20.00	255	. . .	172	. . .	5
	20.00	25.00	255	. . .	159	. . .	5
	25.00	40.00	241	. . .	152	. . .	5
	40.00	50.00	241	. . .	148	. . .	5
ZE10A-O	0.41	1.52	207		124	15	
	1.53	6.35	207		103	15	
	6.36	12.7	200		83	12	

[A] The basis for establishment of mechanical property limits as shown in Appendix X1.
[B] To determine conformance to this specification each value for tensile strength shall be rounded to the nearest 1 MPa and each value for elongation to the nearest 0.5 %, both in accordance with the rounding-off method of Practice E29.
[C] Elongation in 50 mm apply for thicknesses up through 12.50 mm and in 5× diameter (5.65 V *A*) for thicknesses over 12.50 mm where *A* is the cross-sectional area of the specimen.

TABLE 4 Flatness Tolerances—Magnesium Flat Sheet and Plate

Specified Thickness, in.	Maximum Variation from Flat,[A] in.			
	AZ31B (-0 and -H24 tempers) and ZE10A-O		AZ31B (-H26 temper)	
	In any 1 ft[B]	In any 3 ft[B]	In any 1 ft[B]	In any 3 ft[B]
Under 0.126	commercially flat			
0.126–0.250	0.020	0.030	0.020	0.030
0.251–0.500	0.024	0.036	0.025	0.038
0.501–1.000	0.030	0.045	0.050	0.075
1.001–2.000	0.040	0.060	0.050	0.075

[A] As measured with the plate resting on a flat surface, concave side upward, using a straightedge and a feeler gauge, dial gauge, or scale.
[B] Standard measurement is on the 3-ft basis. Widths and lengths less than 3 ft, but more than 1 ft, have tolerances proportionately less than those for 3 ft, but not smaller than for any 1 ft. Widths and lengths less than 1 ft have tolerances proportionately less than those for any 1 ft.

TABLE 5 Flatness Tolerances, Magnesium Flat Sheet and Plate [Metric]

Specified Thickness, mm Over Through	Maximum Variation from Flat[A] mm			
	AZ31B (–O and H24 Tempers)		AZ31B (–H26 Temper)	
	In Any 300 mm[B]	In Any 900 mm[B]	In Any 300 mm[B]	In Any 900 mm[B]
0–3.20				
3.20–6.30	0.50	0.75	0.50	0.75
6.30–12.50	0.60	0.90	0.63	0.95
12.50–25.00	0.75	1.10	1.25	1.90
25.00–50.00	1.00	1.50	1.25	1.90

[A] As measured with the plate resting on a flat surface, concave side upward, using a straightedge and a feeler gauge, dial gauge, or scale.
[B] Standard measurement is on the 900 mm basis. Widths and lengths less than 900 mm but more than 300 mm have tolerances proportionately less than those for 900 mm, but not smaller than for any 300 mm. Widths and lengths less than 300 mm have tolerances proportionately less than those for any 300 mm.

8.2.1 Mill finish,
8.2.2 Mill finish and oiled,
8.2.3 Chrome pickled, or
8.2.4 Chrome pickled and oiled.

9. Sampling for Chemical Analysis

9.1 *Ingot*—At least one sample shall be taken for each group of ingots of the same alloy poured from the same source of molten metal and analyzed to determine conformance to Table 1. Ingots not conforming shall be rejected.

9.2 *Finished Product*—Unless compliance is established by 9.1, sampling of the finished product shall be according to Practice E55. One sample shall be taken for 4000 lb [1815 kg] or less of material comprising the lot, except that not more than one analysis shall be required per piece.

10. Sampling for Tensile Properties

10.1 *Number of Tests*—One tension test specimen shall be taken from a sheet representing 1000 lb [455 kg] sheet or from a plate representing each 2000 lb [905 kg] of plate of the same alloy, temper, and thickness in the shipment or such other quantity as may be agreed upon by the seller and purchaser.

10.2 *Location of Specimens*—Tension test specimens shall be taken parallel to the direction of rolling. The specimen shall be taken midway between the two plate surfaces for plate in thicknesses of 0.500 through 1.500 in. [12.50 though 40 mm] and midway between the center and the surface of plate over 1.500 in. [40 mm] in thickness.

10.3 *Types of Specimens*—For sheet and plate less than 0.500 in. [12.50 mm] thick the standard sheet-type specimen

shown in Figure 6 of Test Methods B557 [B557M] shall be used, or for plate 0.500 in. [12.5 mm] and over those in Figure 9 of Test Methods B557 [B557M] shall be used. If it is necessary to use specimens smaller than the standard specimens, they shall have dimensions proportional to those of Figure 9 of Test Methods B557 [B557M] but not less than the following dimensions: reduced section, ¼-in. [41.25-mm] diameter by 1-in. [20.00-mm] gauge length; grip ends, ⅜-in. [9.5-mm] diameter; total length, 2⅜ in. [60.3 mm] with shouldered ends, 3 in. [76.2 mm] with threaded ends, and 4 in. [101.6 mm] if tested with plain cylindrical ends. If material less than ¾ in. [19.0 mm] in width is tested in full section because the specimens in Figure 9 of Test Methods B557 [B557M] cannot be used, the elongation shall not be determined.

11. Methods of Chemical Analysis

11.1 Any suitable method of chemical analysis may be used. In case of dispute, the analysis shall be made by methods given in Test Methods B954 or any other standard methods of analysis approved by ASTM unless some other method is agreed upon.

12. Methods of Tension Testing

12.1 *Tension Tests*—The tension tests shall be made in accordance with Test Methods B557 [B557M].

NOTE 1—The values obtained for the tensile properties covered by this specification are not seriously affected by variations in speed of testing. A considerable range of testing speed is permissible; however, the rate of stressing to the yield strength should not exceed 100 ksi/min [690 MPa], and above the yield strength, the movement per minute of the head under load should not exceed 0.5 in./in. [mm/mm] of gauge length (or distance between grips for specimens not having reduced sections). Care must be exercised, especially when making yield strength determinations, that the speed of testing does not exceed the ability of the strain and load-indicating equipment to function satisfactorily.

12.2 *Retests*—If any tension specimen fails to conform to the requirements prescribed in Table 2 [Table 3], two additional specimens shall be selected and tested from other sheet or plate in the lot. If either of these specimens fails to conform to the applicable requirements, the material may be rejected. If, however, the failure of the specimens to conform to the requirements is the result of an inadequate thermal treatment, the material may be reheat treated and resampled in accordance with Section 9. Only one such reworking of the material shall be permitted.

13. Inspection

13.1 If the purchaser desires that his representative inspect or witness the inspection of material prior to shipment, such agreement shall be made by the purchaser and producer as part of the purchase contract.

13.2 When such inspection or witness of inspection and testing is agreed upon, the producer shall afford the purchaser's representative all reasonable facilities to satisfy him that the material meets the requirements of this specification. Inspection and tests shall be conducted so there is no unnecessary interference with the producer's operations.

14. Rejection

14.1 Material that fails to conform to this specification may be rejected, and if rejected, the producer's responsibility shall be limited to replacing the rejected material. The full weight of the rejected material shall be returned to the manufacturer.

15. Certification

15.1 When agreed in writing by the purchaser and seller, the seller shall certify that the material has been sampled, tested, and inspected in accordance with the provisions of the specification. Each certificate so furnished shall be signed by an authorized agent of the producer or seller.

16. Packaging and Package Marking

16.1 The material shall be packaged in such a manner as to prevent damage in ordinary handling and transportation. The type of packaging and gross weight of individual containers shall be left to the discretion of the producer unless otherwise agreed upon. Packaging methods and containers shall be so selected as to permit maximum utility of mechanical equipment in unloading and subsequent handling. Each package or container shall contain only one size, alloy, or condition of material when packed for shipment unless otherwise agreed upon.

16.2 Each package or container shall be marked with the purchase order number, size of material, specification number, alloy and condition, gross and net weights, and name of the producer.

16.3 Packages or containers shall be such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the point of delivery.

16.4 When specified in the contract or purchase order, material shall be preserved, packaged, and packed in accordance with the requirements of Practice B660. The applicable levels shall be as specified in the contract or order. Marking for shipment of such material shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

16.5 When specified in the contract or purchase order, material shall be marked in accordance with Fed. Std. No. 184.

APPENDIX

(Nonmandatory Information)

X1. EXPLANATORY NOTES

X1.1 General Information

X1.1.1 Alloy AZ31B is a general-purpose alloy with good weldability, high strength, and good cold formability.

X1.1.2 Alloy ZE10A is a general purpose alloy with good weldability and does not require stress relief after welding. It has moderate strength and shows superior formability.

X1.2 Specific Gravity

X1.2.1 All of the alloys have a specific gravity of about 1.8.

X1.3 Protection

X1.3.1 Either the chrome pickle or the oil finish affords a measurable protection against tarnish and corrosion during shipment and storage of the sheet. The oil finish is frequently preferred by purchasers intending to perform forming or drawing operations on the sheet or plate. If desired, AMS-M-3171 can be used for the chrome pickle.

TABLE X1.1 Unit Deformation Values [includes Metric]

NOTE 1—The yield strength of magnesium-base alloys is defined as the stress at which the stress-strain curve deviates 0.2 % from the modulus line. It may be determined by the "Offset Method" or the "Extension-Under-Load Method" (the latter is often referred to as the "Approximate Method Without the Stress-Strain Diagram") as described in Test Methods B557 [Test Methods B557M]. In case of dispute, the "Offset Method" shall be used.

NOTE 2—The unit deformation values given in Table X1.1 for use with the "Extension-Under-Load Method" are based on a modulus of elasticity, E = 6,500,000 psi [4.48 GPa].

Alloy and Temper	Yield Strength (0.2 % offset), min, ksi (MPa)	Unit Deformation, in./in. (mm/mm) of gauge length
AZ31B-H24	29.0 (200)	0.0065
	26.0 (179)	0.0060
	24.0 (165)	0.0057
	22.0 (152)	0.0054
	20.0 (138)	0.0051
	18.0 (124)	0.0048
AZ31B-H26	27.0 (186)	0.0062
	26.0 (179)	0.0060
	25.0 (172)	0.0058
	23.0 (159)	0.0055
	22.0 (152)	0.0054
	21.0 (145)	0.0052
ZE10A	18.0 (124)	0.0048
	15.0 (103)	0.0043
	12.0 (83)	0.0038

SUMMARY OF CHANGES

Committee B07 has identified the location of selected changes to this standard since the last issue (B90/B90M – 13) that may impact the use of this standard. (Approved Dec. 1, 2015.)

(1) Revised the tolerance tables to better reflect the state of the industry and match the methods of tolerancing to ASTM aluminum alloy documents.