



Standard Specification for High Magnesium Aluminum-Alloy Products for Marine Service and Similar Environments¹

This standard is issued under the fixed designation B928/B928M; 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 specification covers high magnesium aluminum-alloy products in the mill finish condition that are intended for marine hull construction and other marine applications where frequent or constant direct contact with seawater is expected and for similar environments (**Note 1**). Aluminum alloy products covered by this specification include the alloy-temper of flat sheet, coiled sheet, and plate shown in Table 2 [Table 3] and Table 4 [Table 5], and alloy-temper of extruded profiles shown in Table 6 [Table 7].

NOTE 1—There are other aluminum alloy-temper products that may be suitable for use in marine and similar environments, but which may not require the corrosion resistance testing specified by B928/B928M. See Specification **B209** or **B209M** for other aluminum sheet and plate alloy-temper products. For other aluminum extruded alloy-temper products see Specification **B221** or **B221M** and/or other relevant specifications for aluminum extruded products.

1.2 Alloy and temper designations are in accordance with ANSI H35.1/H35.1 (M). The equivalent Unified Numbering System alloy designations are those of Table 1 preceded by A9, for example, A95083 for 5083 in accordance with Practice **E527**.

1.3 The values stated in either SI units (Table 3 and Table 5) or inch-pound units (Table 2 and Table 4) are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of each other. Combining values from the two systems may result in non-conformance with the standard.

1.4 For acceptance criteria for inclusion of new aluminum and aluminum alloys in this specification, see **Annex A2**.

1.5 *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.*

¹ This specification is under the jurisdiction of ASTM Committee **B07** on Light Metals and Alloys and is the direct responsibility of Subcommittee **B07.03** on Aluminum Alloy Wrought Products.

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2. Referenced Documents

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

2.2 ASTM Standards:²

- B209** Specification for Aluminum and Aluminum-Alloy Sheet and Plate
- B209M** Specification for Aluminum and Aluminum-Alloy Sheet and Plate (Metric)
- B221** Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
- B221M** Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
- 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
- B666/B666M** Practice for Identification Marking of Aluminum and Magnesium Products
- B881** Terminology Relating to Aluminum- and Magnesium-Alloy Products
- B985** Practice for Sampling Aluminum Ingots, Billets, Castings and Finished or Semi-Finished Wrought Aluminum Products for Compositional Analysis
- E29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E34** Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys
- E50** Practices for Apparatus, Reagents, and Safety Considerations for Chemical Analysis of Metals, Ores, and Related Materials
- E527** Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

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

E607 Test Method for Atomic Emission Spectrometric Analysis Aluminum Alloys by the Point to Plane Technique Nitrogen Atmosphere (Withdrawn 2011)³

E716 Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spectrochemical Analysis

E1251 Test Method for Analysis of Aluminum and Aluminum Alloys by Spark Atomic Emission Spectrometry

G66 Test Method for Visual Assessment of Exfoliation Corrosion Susceptibility of 5XXX Series Aluminum Alloys (ASSET Test)

G67 Test Method for Determining the Susceptibility to Intergranular Corrosion of 5XXX Series Aluminum Alloys by Mass Loss After Exposure to Nitric Acid (NAMLT Test)

2.3 ANSI Standards:⁴

H35.1/H35.1 (M) Alloy and Temper Designation Systems for Aluminum

H35.2 Dimensional Tolerances for Aluminum Mill Products

H35.2(M) Dimensional Tolerances for Aluminum Mill Products

2.4 Other Standards:

CEN EN 14242 Aluminum and Aluminum Alloys—Chemical Analysis—Inductively Coupled Plasma Optical Emission Spectral Analysis⁵

3. Terminology

3.1 *Definitions*—Refer to Terminology **B881** for definitions of product terms used in this specification.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *exfoliation, n*—corrosion that proceeds laterally from the sites of initiation along planes parallel to the original rolling surface, generally at grain boundaries, forming corrosion products that force metal away from the body of the material, giving rise to a layered appearance.

3.2.2 *high magnesium aluminum alloys, n*—in the general sense, includes those 5xxx alloys containing 3 % or more nominal magnesium.

3.2.3 *intergranular corrosion, n*—corrosion that preferentially occurs at, or adjacent to, the grain boundaries of a metal or alloy.

3.2.4 *lot, n*—an inspection lot shall consist of an identifiable quantity of material of the same mill form, alloy, temper, cast or melt lot, and thickness, subjected to inspection at one time.

3.2.5 *sensitization, n*—the development of a continuous or nearly continuous grain boundary precipitate in 5xxx alloy-temper material, that causes the material to be susceptible to intergranular forms of corrosion.

3.2.6 *stress-corrosion cracking, n*—a cracking process that requires the simultaneous action of a corrodent, and sustained

tensile stress. (This excludes corrosion-reduced sections, which fail by fast fracture. It also excludes intercrystalline or transcrystalline corrosion which can disintegrate an alloy without either applied or residual stress.)

4. Ordering Information

4.1 Orders for material to this specification shall include the following information:

4.1.1 This specification designation (which includes the number, the year, and the revision letter, if applicable),

4.1.2 Quantity in pieces or pounds [kilograms],

4.1.3 Alloy (see 7.1 and Table 1),

4.1.4 Temper (see 8.1 and Table 2 [Table 3] and Table 4 [Table 5] for sheet and plate or Table 6 [Table 7] for extrusions),

4.1.5 For sheet, whether flat or coiled, and

4.1.6 For sheet and plate, dimensions (thickness, width, and length or coil size).

4.1.7 For extruded products, dimensions and tolerances including but not limited to the following:

4.1.7.1 For rod and round wire—diameter.

4.1.7.2 For square cornered bar and wire—width and depth.

4.1.7.3 For sharp cornered hexagonal or octagonal bar and wire—distance across the flats.

4.1.7.4 For round tube—outside or inside diameter and wall thickness.

4.1.7.5 For square or sharp cornered tube other than round—distance across flats and wall thickness.

4.1.7.6 For round cornered bars, profiles, tube other than round, square, rectangular, hexagonal, or octagonal with sharp corners a drawing is required showing all dimensions and tolerances relevant for the manufacture of the product to requirements.

4.1.7.7 Length.

4.2 Additionally, orders for material to this specification shall include the following information when required by the purchaser:

4.2.1 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (see 12.1),

4.2.2 Whether Practices **B660** applies and, if so, the levels of preservation, packaging, and packing required (see 16.3),

4.2.3 Whether certification is required (see Section 14),

4.2.4 Whether G66 and G67 testing is the required lot release method for the H116 and H321 tempers (see 9.5),

4.2.5 Whether the G66 and G67 test results are to be included in the certification (see Section 14), and

4.2.6 Whether tensile testing should be in the longitudinal or long transverse direction (see 8.1.5).

5. Responsibility for Quality Assurance

5.1 *Responsibility for Inspection and Tests*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. Producers may use their own or any other suitable facilities for the performance of the inspection and test requirements specified herein, unless disapproved by the purchaser in the order or at the time of contract signing.

³ The last approved version of this historical standard is referenced on www.astm.org.

⁴ Available from Aluminum Association, Inc., 1400 Crystal Dr., Suite 430, Arlington, VA, 22202, <http://www.aluminum.org>.

⁵ Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000 Brussels, <http://www.cenorm.be>.

The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections are deemed necessary to ensure that material conforms to prescribed requirements.

6. General Quality

6.1 Unless otherwise specified, the material shall be supplied in the mill finish, shall be uniform as defined by the requirements of this specification and shall be commercially sound. Any requirement not so covered is subject to negotiation between producer and purchaser.

6.2 Each coil, sheet and plate, or extrusion lot shall be examined to determine conformance to this specification with respect to general quality and identification marking. On approval of the purchaser, however, the producer may use a system of statistical quality control for such examinations.

7. Chemical Composition

7.1 *Limits*—The sheet and plate shall conform to the chemical composition limits specified in **Table 1**. Conformance shall be determined by the producer, by taking samples in accordance with Practices **E716** when the ingots are poured and analyzing those samples in accordance with Test Methods **E607**, **E1251**, **E34** or EN 14242. At least one sample shall be taken for each group of ingots poured simultaneously from the same source of molten metal. If the producer has determined the chemical composition during pouring of the ingots, they shall not be required to sample and analyze the finished product.

7.2 If it becomes necessary to analyze the finished or semifinished product for conformance to chemical composition limits, the methods of sampling and methods of analysis shall be as provided in the following:

7.2.1 *Methods of Sampling*—Samples for chemical analysis shall be taken in accordance with Practice **B985**.

7.2.2 *Methods of Analysis*—Analysis shall be performed in accordance with Test Methods **E607**, **E1251**, or **E34**, or CEN EN 14242 (ICP method).

8. Tensile Properties of Material as Supplied

8.1 Tensile Properties for Sheet and Plate Products:

8.1.1 *Limits*—The sheet and plate shall conform to the requirements for tensile properties as specified in **Table 2** [**Table 3**] or **Table 4** [**Table 5**]. **Table 2** [**Table 3**] includes specification limits for tensile properties in the longitudinal direction. **Table 4** [**Table 5**] includes specification limits for tensile properties in the long transverse direction.

8.1.1.1 Tensile property limits for sizes not covered in **Table 2** [**Table 3**] or **Table 4** [**Table 5**] shall be as agreed upon between the producer and purchaser and shall be so specified in the contract or purchase order.

8.1.2 *Number of Samples*—One sample shall be taken from each end of each parent coil, or parent plate, but no more than one sample per 2000 lb [1000 kg] of sheet or 4000 lb [2000 kg] of plate, or part thereof, in a lot shall be required. Other procedures for selecting samples may be employed if agreed upon between the producer and purchaser.

8.1.3 *Test Specimens*—Geometry of test specimens and the location in the product from which they are taken shall be as specified in Test Methods **B557** or **B557M**, with the exception that the test direction will be as specified in **8.1.5**.

8.1.4 *Test Methods*—The tension test shall be made in accordance with Test Methods **B557** or **B557M**.

8.1.5 *Testing Direction*—Tensile testing shall be in the longitudinal direction unless the long transverse direction is specified in the contract or purchase order. Tensile testing direction shall be noted on all documentation.

8.2 Tensile Properties for Extruded Products:

8.2.1 *Limits*—The material shall conform to the tensile property requirements specified in **Table 6** [**Table 7**].

8.2.1.1 The elongation requirements shall not be applicable to the following:

(1) Material of such dimensions that a standard test specimen cannot be taken in accordance with Test Methods **B557** or **B557M** and of such a profile that it cannot be satisfactorily tested in full section.

(2) Material thinner than 0.062 in [1.5 mm].

TABLE 1 Chemical Composition Limits^{A,B,C,H}

Alloy	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Zinc	Titanium	Other Elements ^D		Aluminum
									Each ^F	Total ^E	
5059	0.45	0.50	0.25	0.6 to 1.2	5.0 to 6.0	0.25	0.40 to 0.9	0.20	0.05 ^F	0.15	remainder
5083	0.40	0.40	0.10	0.40 to 1.0	4.0 to 4.9	0.05 to 0.25	0.25	0.15	0.05	0.15	remainder
5086	0.40	0.50	0.10	0.20 to 0.7	3.5 to 4.5	0.05 to 0.25	0.25	0.15	0.05	0.15	remainder
5383	0.25	0.25	0.20	0.7 to 1.0	4.0 to 5.2	0.25	0.40	0.15	0.05 ^G	0.15	remainder
5456	0.25	0.40	0.10	0.50 to 1.0	4.7 to 5.5	0.05 to 0.20	0.25	0.20	0.05	0.15	remainder

^A Limits are in weight percent maximum unless shown as a range or stated otherwise.

^B Analysis shall be made for the elements for which limits are shown in this table.

^C For purposes of determining conformance to these limits, an observed value or a calculated value attained from analysis shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the specified limit, in accordance with the rounding-off method of Practice **E29**.

^D Others include listed elements for which no specific limit is shown, as well as unlisted metallic elements, but doesn't include elements shown with composition limits in the footnotes. The producer may analyze samples for trace elements not specified in the specification. However, such analysis is not required and may not cover all metallic Others elements. Should any analysis by the producer or the purchaser establish that an Others element exceeds the limit of Each or that the aggregate of several Others elements exceeds the limit of Total, the material shall be considered nonconforming.

^E Other Elements—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.

^F 0.05 to 0.25 Zr.

^G 0.20 Zr max.

^H In case of a discrepancy in the values listed in **Table 1** with those listed in the *International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys* (known as the "Teal Sheets"), the composition limits registered with the Aluminum Association and published in the "Teal Sheets" shall be considered the controlling composition. The "Teal Sheets" are available at <http://www.aluminum.org/tealsheets>.