



Standard Specification for Aluminum-Alloy Extruded Bar, Rod, Tube, Pipe, and Structural Profiles for Electrical Purposes (Bus Conductor)¹

This standard is issued under the fixed designation B 317; 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 6101 aluminum-alloy extruded bar, rod, tube, pipe (Schedules 40 and 80), and structural profiles (channels and angles) in selected tempers for use as electric conductors as follows:

1.1.1 *Type B*—Hot-finished bar, rod, tube, pipe and structural profiles in T6, T61, T63, T64, T65, and H111 tempers with Type B tolerances, as shown in the “List of ANSI Tables of Dimensional Tolerances.”

1.1.2 *Type C*—Hot-finished rectangular bar in T6, T61, T63, T64, T65, and H111 tempers with Type C tolerances as listed in the tolerances and permissible variations tables.

1.2 Alloy and temper designations are in accordance with ANSI H35.1. The equivalent Unified Numbering System alloy designation in accordance with Practice E 527 is A96101 for Alloy 6101.

NOTE 1—Type A material, last covered in the 1966 issue of this specification, is no longer available; therefore, requirements for cold-finished rectangular bar have been deleted.

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

1.4 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

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

2.2 ASTM Standards:

B 193 Test Method for Resistivity of Electrical Conductor Materials²

B 253 Guide for Preparation of Aluminum Alloys for Electroplating³

B 557 Test Methods of Tension Testing Wrought and Cast

Aluminum- and Magnesium-Alloy Products⁴

B 597 Practice for Heat Treatment of Aluminum Alloys⁴

B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products⁴

B 666/B 666M Practice for Identification Marking of Aluminum Products⁴

B 807 Practice for Extrusion Press Solution Heat Treatment of Aluminum Alloys⁴

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications⁵

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum Base Alloys⁶

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition⁶

E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique⁶

E 290 Test Method for Semi-Guided Bend Test for Ductility of Metallic Materials⁷

E 527 Practice for Numbering Metals and Alloys (UNS)⁸

E 607 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere⁹

E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis⁹

E 1004 Test Method for Electromagnetic (Eddy-Current) Measurements of Electrical Conductivity¹⁰

E 1251 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Argon Atmosphere, Point-to-Plane, Unipolar Self-Initiating Capacitor Discharge⁹

2.3 ANSI Standards:⁴

H35.1 Alloy and Temper Designation Systems for Aluminum

H35.2 Dimensional Tolerances for Aluminum Mill Products

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.

Current edition approved May 10, 2000. Published August 2000. Originally published as B 317–57 T. Last previous edition B 317–96.

² Annual Book of ASTM Standards, Vol 02.03.

³ Annual Book of ASTM Standards, Vol 02.05.

⁴ Annual Book of ASTM Standards, Vol 02.02.

⁵ Annual Book of ASTM Standards, Vol 14.02.

⁶ Annual Book of ASTM Standards, Vol 03.05.

⁷ Annual Book of ASTM Standards, Vol 03.01.

⁸ Annual Book of ASTM Standards, Vol 01.01.

⁹ Annual Book of ASTM Standards, Vol 03.06.

¹⁰ Annual Book of ASTM Standards, Vol 03.03.

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

2.4 *Military Standard:*¹¹

MIL-STD-129 Marking for Shipment and Storage

2.5 *Federal Standard:*¹¹

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

3. Terminology

3.1 Definitions:

3.1.1 *bus conductor*—a rigid electric conductor of any cross section.

3.1.2 *extruded bar*—an extruded solid section long in relation to its cross-sectional dimensions, having a symmetrical cross section that is square or rectangular (excluding flattened wire) with sharp or rounded corners or edges, or is a regular hexagon or octagon, and whose width or greatest distance between parallel faces is $\frac{3}{8}$ in. (9.5 mm) or greater.

3.1.3 *extruded rod*—an extruded solid round section $\frac{3}{8}$ in. (9.5 mm) or greater in diameter, whose length is great in relation to its diameter.

3.1.4 *extruded tube*—an extruded hollow wrought product that is long in relation to its cross section, that is round, a regular hexagon, a regular octagon, elliptical, square, or rectangular with sharp or round corners, and that has uniform wall thickness except as affected by corner radii.

3.1.5 *extruded pipe*—extruded tube in standardized combinations of outside diameter and wall thickness, commonly designated by “Nominal Pipe Sizes” and “ANSI Schedule Numbers.”

3.1.6 *extruded structural profile*—an extruded profile, commonly used for structural purposes but limited to profiles producible by rolling, such as angles and channels.

NOTE 2—Tees, zees, I-beams, and H-sections are rarely used as conductors.

3.1.7 *producer*—the primary manufacturer of the material.

3.1.8 *supplier*—includes only the category of jobbers and distributors as distinct from producers.

3.2 Definitions of Terms Specific to This Standard:

3.2.1 *capable of*—The term *capable of* as used in this specification means that the test need not be performed by the producer of the material. However, should subsequent testing by the purchaser establish that the material does not meet these requirements, the material shall be subject to rejection.

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 pounds or pieces,

4.1.3 Type (1.1.1 and 1.1.2),

4.1.4 Temper (Section 9, Table 2),

4.1.5 Type of section (Section 3),

4.1.6 *Cross-Sectional Dimensions: Bar*—Thickness and width, or distance across flats, and edge contour (Section 13); *Rod*—Diameter; *Pipe*—Nominal pipe size and schedule num-

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

Element	Alloy Designation 6101 Composition, %
Silicon	0.30–0.7
Iron	0.50
Copper	0.10
Manganese	0.03
Magnesium	0.35–0.8
Chromium	0.03
Zinc	0.10
Boron	0.06
<i>Other elements:</i> ^D	
Each	0.03
Total ^E	0.10
Aluminum	remainder

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

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

^C To determine conformance to these limits, an observed value or a calculated value obtained from analysis shall be rounded off to the nearest unit in the last right-hand place of the figures used in expressing the specified limit, in accordance with the rounding-off method of Practice E 29.

^D *Others* includes all unlisted metallic elements. 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.

ber (40 or 80); *Structural Profile*—Nominal dimensions and type of section; *Round Tube*—Outside or inside diameter and wall thickness; *Square or Sharp-Cornered Tube*—Distance across flats and wall thickness; *Round-Cornered Tube Other than Round*—A drawing is required,

4.1.7 Length,

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

4.2.1 Whether solution heat treatment at the extrusion press is unacceptable (8.2),

4.2.2 Whether witness of inspection by the purchaser's representative is required prior to material shipment (Section 16),

4.2.3 Whether marking for identification is required (Section 18),

4.2.4 Whether certification is required (Section 20), and

4.2.5 Whether Practices B 660 applies and, if so, the levels of preservation, packaging, packing and marking required (Section 19).

5. Manufacture

5.1 The bars, rods, tubes, pipe, or structural profiles shall be produced by hot extrusion or by similar methods at the option of the producer, provided that the production method results in material that meets all requirements of this specification.

6. Quality Assurance

6.1 *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. The producer may use his 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

¹¹ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094 Attn: NPODS.

TABLE 2 Tensile Property Limits^{A,B,C}

Temper	Specified Thickness, in.	Tensile Strength, ksi (MPa)		Yield Strength, (0.2 % offset), ksi (MPa)	
		min	max	min	max
T6	0.125–0.500	29.0 (200)	...	25.0 (172)	...
T61	0.125–0.749	20.0 (138)	...	15.0 (103)	...
	0.750–1.499	18.0 (124)	...	11.0 (76)	...
	1.500–2.000	15.0 (103)	...	8.0 (55)	...
T63 ^D	0.125–0.500	27.0 (186)	...	22.0 (152)	...
T64	0.125–1.000	15.0 (103)	...	8.0 (55)	...
T65	0.125–0.749	25.0 (172)	32.0 (221)	20.0 (138)	27.0 (186)
H111	0.250–2.000	12.0 (83)	...	8.0 (55)	...

^A To determine conformance to this specification, each value shall be rounded off to the nearest 0.1 ksi (1 MPa) for strength in accordance with the rounding-off method of Practice E 29.

^B For explanation of SI unit MPa, see Appendix X2.

^C See Annex A1.

^D Formerly designated T62 temper.

signing. 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 assure that material conforms to prescribed requirements.

6.2 Lot Definition—An inspection lot shall be defined as follows:

6.2.1 For heat-treated tempers, an inspection lot shall consist of an identifiable quantity of material of the same mill form, alloy, temper, and thickness traceable to a heat-treat lot or lots, and subjected to inspection at one time.

6.2.2 For nonheat-treated tempers, an inspection lot shall consist of an identifiable quantity of material of the same mill form, alloy, temper, and thickness subjected to inspection at one time.

7. Chemical Composition

7.1 Limits—The material shall conform to the chemical composition limits in Table 1. Conformance shall be determined by the producer by analyzing samples taken at the time ingots are poured, or samples taken from the finished or semifinished product. If chemical composition has been determined during the course of manufacture, analysis of the finished product shall not be required.

NOTE 3—It is standard practice in the United States aluminum industry to determine conformance to the chemical composition limits prior to further processing of ingots into wrought products. Due to the continuous nature of the process, it is not practical to keep a specific ingot analysis identified with a specific quantity of finished material.

7.2 Number of Samples—The number of samples taken for determination of chemical composition shall be as follows:

7.2.1 When samples are taken at the time the ingots are poured, at least one sample shall be taken for each group of ingots poured simultaneously from the same source of molten metal.

7.2.2 When samples are taken from the finished or semifinished product, a sample shall be taken to represent each 4000 lb (1800 kg), or fraction thereof, in the lot, except that not more than one sample shall be required per piece.

7.3 Methods of Sampling—Samples for determination of chemical composition shall be taken in accordance with one of the following methods:

7.3.1 Samples for chemical analysis shall be taken from the material by sawing, milling, turning, or clipping a representative piece or pieces to obtain a prepared sample of not less than

75 g. Sampling shall be in accordance with Practice E 55.

7.3.2 Sampling for spectrochemical analysis shall be in accordance with Practices E 716. Samples for other methods of analysis shall be taken by methods suitable for the form of material being analyzed and the type of analytical method used.

7.4 Methods of Analysis—The determination of chemical composition shall be made in accordance with suitable chemical (Test Methods E 34) or spectrochemical (Test Methods E 227, E 607, and E 1251), methods. Other methods may be used only when no published ASTM method is available. In case of dispute, the methods of analysis shall be agreed upon between the producer and purchaser.

8. Heat Treatment

8.1 Except as noted in 8.2, heat treatment shall be in accordance with Practice B 597.

8.2 Unless otherwise specified, Alloy 6101 may be solution heat-treated and quenched at the extrusion press in accordance with Practice B 807 in the production of T6-type tempers.

9. Tensile Properties of Material as Supplied

9.1 Limits—The material shall conform to the tensile properties in Table 2.

9.2 Number of Specimens—One tension test specimen shall be taken from a random piece representing each 3000 lb (1350 kg) of material, or fraction thereof, of the same temper, thickness, and width or cross section in the shipment. If a shipment contains material of more than one size, only that material of the same cross section shall be grouped for the purpose of selecting tension test specimens. Other procedures for selecting samples may be employed if agreed between the producer and purchaser.

9.3 Test Methods—The tension tests shall be made in accordance with Test Methods B 557.

10. Bend Properties

10.1 Limits:

10.1.1 Flatwise Bends—Bars shall be capable of being bent at room temperature through an angle of 90° around a pin or mandrel having a radius equal to *N* times its thickness without developing cracks or ruptures visible to the unaided eye corrected for normal vision. Surface roughening (“orange peel” appearance) is not considered to be an injurious defect. The