



# Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes for Surface Condensers, Evaporators, and Heat Exchangers<sup>1</sup>

This standard is issued under the fixed designation B234; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

## 1. Scope\*

1.1 This specification<sup>2</sup> covers aluminum-alloy (Note 1) drawn seamless round tube in straight lengths designated as shown in Table 2, for use in surface condensers, evaporators, and heat exchangers.

NOTE 1—Throughout this specification use of the term *alloy* in the general sense includes aluminum as well as aluminum alloy.

NOTE 2—For drawn seamless tubes used in general applications, see Specifications B210 and B210M; for extruded tubes see Specifications B221 and B221M; for seamless pipe and seamless extruded tube used in pressure applications see Specification B241/B241M; and for structural pipe and tube see Specification B429/B429M.

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, A91060 for aluminum 1060, in accordance with Practice E527.

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

1.4 This specification is the inch-pound companion to Specification B234M; therefore, no SI equivalents are presented in the specification.

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, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.6 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

<sup>1</sup> 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 Oct. 1, 2017. Published October 2017. Originally approved in 1948. Last previous edition approved in 2010 as B234 – 10. DOI: 10.1520/B0234-17.

<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SB-234 in Section II of that Code.

## 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:<sup>3</sup>

- B210 Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes
- B210M Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes (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)
- B241/B241M Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube
- B429/B429M Specification for Aluminum-Alloy Extruded Structural Pipe and Tube
- B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
- 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
- B918 Practice for Heat Treatment of Wrought Aluminum Alloys
- 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
- E215 Practice for Standardizing Equipment and Electromagnetic Examination of Seamless Aluminum-Alloy Tube
- E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)
- E607 Test Method for Atomic Emission Spectrometric

<sup>3</sup> 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

**TABLE 1 Chemical Composition Limits<sup>A,B,C,I</sup>**

| Alloy       | Silicon                         | Iron | Copper    | Manganese | Magnesium | Chromium  | Zinc    | Titanium |                | Other Elements <sup>D</sup> |                    | Aluminum  |
|-------------|---------------------------------|------|-----------|-----------|-----------|-----------|---------|----------|----------------|-----------------------------|--------------------|-----------|
|             |                                 |      |           |           |           |           |         |          |                | Each                        | Total <sup>E</sup> |           |
| 1060        | 0.25                            | 0.35 | 0.05      | 0.03      | 0.03      | ...       | 0.05    | 0.03     | <sup>F,G</sup> | 0.03                        | ...                | 99.60 min |
| 3003        | 0.6                             | 0.7  | 0.05–0.20 | 1.0–1.5   | ...       | ...       | 0.10    | ...      |                | 0.05                        | 0.15               | remainder |
| Alclad 3003 | 3003 alloy clad with 7072 alloy |      |           |           |           |           |         |          |                |                             |                    |           |
| 5052        | 0.25                            | 0.40 | 0.10      | 0.10      | 2.2–2.8   | 0.15–0.35 | 0.10    | ...      |                | 0.05                        | 0.15               | remainder |
| 5454        | 0.25                            | 0.40 | 0.10      | 0.50–1.0  | 2.4–3.0   | 0.05–0.20 | 0.25    | 0.20     |                | 0.05                        | 0.15               | remainder |
| 6061        | 0.40–0.8                        | 0.7  | 0.15–0.40 | 0.15      | 0.8–1.2   | 0.04–0.35 | 0.25    | 0.15     |                | 0.05                        | 0.15               | remainder |
| 7072        | 0.7 Si + Fe                     |      | 0.10      | 0.10      | 0.10      | ...       | 0.8–1.3 | ...      | <sup>H</sup>   | 0.05                        | 0.15               | remainder |

<sup>A</sup> Limits are in percent maximum unless shown as a range or otherwise stated.

<sup>B</sup> Analysis shall be made for the elements for which limits are shown in this table.

<sup>C</sup> 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.

<sup>D</sup> Others includes listed elements for which no specific limit is shown as well as unlisted metallic elements. The producer may analyze samples for trace elements not specified in this 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.

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

<sup>F</sup> Vanadium 0.05 max.

<sup>G</sup> The aluminum content shall be calculated by subtracting from 100.00 % the sum of all the metallic elements present in amounts of 0.010 % or more, rounded to the second decimal before determining the sum.

<sup>H</sup> Composition of cladding alloy as applied during the course of manufacture. The sample from finished tube shall not be required to conform to these limits.

<sup>I</sup> In case there is 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>.

**TABLE 2 Tensile Property Limits<sup>A,B</sup>**

| Alloy       | Temper | Wall Thickness, in. | Tensile Strength, min, ksi | Yield Strength, (0.2 % offset), min, ksi | Elongation in 2 in., or 4 × Dia, <sup>C</sup> min, % |                  |
|-------------|--------|---------------------|----------------------------|--|--|------------------|
|             |        |                     |                            |  | Full-Section Specimen                                | Cut-out Specimen |
| 1060        | H14    | 0.010–0.200         | 12.0                       | 10.0                                     | ...  | ...              |
| 3003        | H14    | 0.010–0.024         | 20.0                       | 17.0                                     | 3  | ...              |
|             |        | 0.025–0.049         | 20.0                       | 17.0                                     | 5  | 3                |
|             |        | 0.050–0.200         | 20.0                       | 17.0                                     | 8  | 4                |
|             |        | 0.010–0.200         | 22.0                       | 19.0                                     | ...  | ...              |
| Alclad 3003 | H14    | 0.010–0.024         | 19.0                       | 16.0                                     | ...  | ...              |
|             |        | 0.025–0.049         | 19.0                       | 16.0                                     | 5  | 3                |
|             |        | 0.050–0.200         | 19.0                       | 16.0                                     | 8  | 4                |
|             |        | 0.010–0.200         | 21.0                       | 18.0                                     | ...  | ...              |
| 5052        | H32    | 0.010–0.200         | 31.0                       | 23.0                                     | ...  | ...              |
|             | H34    | 0.010–0.200         | 34.0                       | 26.0                                     | ...  | ...              |
| 5454        | H32    | 0.010–0.050         | 36.0                       | 26.0                                     | ...  | 5                |
|             |        | 0.051–0.200         | 36.0                       | 26.0                                     | ...  | 8                |
|             |        | 0.010–0.050         | 39.0                       | 29.0                                     | ...  | 4                |
|             |        | 0.051–0.200         | 39.0                       | 29.0                                     | ...  | 6                |
| 6061        | T4     | 0.025–0.049         | 30.0                       | 16.0                                     | 16   | 14               |
|             |        | 0.050–0.200         | 30.0                       | 16.0                                     | 18   | 16               |
|             | T6     | 0.025–0.049         | 42.0                       | 35.0                                     | 10   | 8                |
|             |        | 0.050–0.200         | 42.0                       | 35.0                                     | 12   | 10               |

<sup>A</sup> To determine conformance to this specification, each value for ultimate strength and for yield strength shall be rounded to the nearest 0.1 ksi and each value for elongation to the nearest 0.5 %, both in accordance with the rounding-off method of Practice E29.

<sup>B</sup> The basis for establishment of mechanical property limits is shown in Annex A1.

<sup>C</sup> Elongation of full-section and cut-out sheet-type specimens is measured in 2 in., of cut-out round specimens, in 4 × specimen diameter.

Analysis Aluminum Alloys by the Point to Plane Technique Nitrogen Atmosphere (Withdrawn 2011)<sup>4</sup>

**E716** Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spark Atomic Emission Spectrometry

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

**E3061** Test Method for Analysis of Aluminum and Aluminum Alloys by Inductively Coupled Plasma Atomic Emission Spectrometry (Performance Based Method)

2.3 *ANSI Standards*:<sup>5</sup>

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

**H35.2** Dimensional Tolerances for Aluminum Mill Products

2.4 *Federal Standard*:<sup>6</sup>

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

2.5 *Military Standard*:<sup>6</sup>

**MIL-STD-129** Marking for Shipment and Storage

2.6 *AMS Specification*:<sup>7</sup>

**AMS 2772** Heat Treatment of Aluminum Alloy Raw Materials

2.7 *EN Standard*:<sup>8</sup>

**CEN EN 14242** Aluminum and Aluminum Alloys, Chemical Analysis, Inductively Coupled Plasma Optical Emission Spectral Analysis

### 3. Terminology

3.1 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 *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 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 pieces or pounds,

4.1.3 Alloy (Section 7),

4.1.4 Temper (Section 8),

4.1.5 Outside or inside diameter, wall thickness, and length,

4.1.6 For alloy Alclad 3003, state clad inside or outside (12.1).

<sup>4</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

<sup>5</sup> Available from Aluminum Association, Inc., 1400 Crystal Dr., Suite 430, Arlington, VA 22202, <http://www.aluminum.org>.

<sup>6</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

<sup>7</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

<sup>8</sup> Available from European Committee for Standardization Central Secretariat (CEN), rue de Stassart 36, B1050 Brussels, Belgium, <http://www.cen.eu/esearch>.

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

4.2.1 Whether heat treatment in accordance with Practice **B918** is required (9.2),

4.2.2 Whether cut ends of tube are to be deburred (Section 14),

4.2.3 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 15),

4.2.4 Whether certification of the material is required (Section 17),

4.2.5 Whether marking for identification is required (Section 18), and

4.2.6 Whether Practices **B660** applies and, if so, the level of preservation, packaging, and packing required (19.3).

### 5. Manufacture

5.1 The tube shall be produced by drawing an extruded tube made from hollow extrusion ingot (cast in hollow form or pierced) and extruded by use of the die and mandrel method.

### 6. Responsibility for 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 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 tube shall conform to the chemical composition limits in **Table 1**. Conformance shall be determined by the producer by taking samples in accordance with **E716** when the ingots are poured and analyzing those samples in accordance with in accordance with Test Methods **E607**, **E1251**, **E3061**, 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 of the material during the course of manufacture, he shall not be required to sample and analyze the finished product.

NOTE 3—It is standard practice in the United States aluminum industry