



Designation: B483/B483M – 20

Standard Specification for Aluminum and Aluminum-Alloy Drawn Tube and Drawn Pipe for General Purpose Applications¹

This standard is issued under the fixed designation B483/B483M; 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 aluminum and aluminum-alloy drawn tube and drawn pipe in straight lengths and tube in coils for general purpose applications and climate control (HVAC) in the alloys (Note 2) and tempers shown in Tables 1-3. Coiled tubes are generally available only as round tubes with a wall thickness not exceeding 0.083 in. [2.00 mm] and only in non-heat-treatable alloys.

NOTE 1—For drawn seamless tubes, see Specification B210/B210M, for drawn seamless tubes to be used in condensers and heat exchangers, Specifications B234 and B234M, and for seamless pipe and tube, Specification B241/B241M. For extruded structural tube and pipe, see Specification B429/B429M.

NOTE 2—This specification's use of the term *alloy* in the general sense includes aluminum as well as aluminum alloy.

1.2 Alloy and temper designations are in accordance with ANSI H35.1/H35.1M. The equivalent Unified Number System alloy designations are those of Table 4 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 The values stated in either inch-pound units or SI units are to be regarded separately as standard. Within the text, the SI units are shown in brackets. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in nonconformance with the standard.

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 standard-*

ization 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.

2. Referenced Documents

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

2.2 ASTM Standards:²

B210/B210M Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes

B234 Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes for Surface Condensers, Evaporators, and Heat Exchangers

B234M Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes for Surface Condensers, Evaporators, and Heat Exchangers (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 (Withdrawn 2019)³

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

B807/B807M Practice for Extrusion Press Solution Heat Treatment for Aluminum Alloys

B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products

B918/B918M Practice for Heat Treatment of Wrought Aluminum Alloys

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

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

TABLE 1 Tensile Property Limits, Tube (US Customary)^{A,B}

| Alloy and Temper | Specified Wall Thickness, in. | Tensile Strength, ksi | | | | Elongation ^{C,E,I} min, % | |
|------------------------------|-------------------------------|-----------------------|------|-----------------------------------|------|--|--|
| | | Ultimate | | Yield ^D (0.2 % Offset) | | Full Section Specimen (2 in.) ^E | Cut-out Specimen ^F 4x Diameter ^C |
| | | min | max | min | max | | |
| 1060^{F,H} | | | | | | | |
| 1060-O | 0.010–0.500 | 8.5 | 13.5 | 2.5 | ... | ... | ... |
| 1060-H12 | 0.010–0.500 | 10.0 | ... | 4.0 | ... | ... | ... |
| 1060-H14 | 0.010–0.500 | 12.0 | ... | 10.0 | ... | ... | ... |
| 1060-H18 | 0.010–0.500 | 16.0 | ... | 13.0 | ... | ... | ... |
| 1060-H113 ^J | 0.010–0.500 | 8.5 | ... | 2.5 | ... | ... | ... |
| 1100^{F,H} | | | | | | | |
| 1100-O | 0.014–0.500 | 11.0 | 15.5 | 3.5 | ... | ... | ... |
| 1100-H12 | 0.014–0.500 | 14.0 | ... | 11.0 | ... | ... | ... |
| 1100-H14 | 0.014–0.500 | 16.0 | ... | 14.0 | ... | ... | ... |
| 1100-H16 | 0.014–0.500 | 19.0 | ... | 17.0 | ... | ... | ... |
| 1100-H18 | 0.014–0.500 | 22.0 | ... | 20.0 | ... | ... | ... |
| 1100-H113 ^J | 0.014–0.500 | 11.0 | ... | 3.5 | ... | ... | ... |
| 3003^{F,H} | | | | | | | |
| 3003-O | 0.010–0.024 | 14.0 | 19.0 | 5.0 | ... | ... | ... |
| | 0.025–0.049 | 14.0 | 19.0 | 5.0 | ... | 30 | 20 |
| | 0.050–0.259 | 14.0 | 19.0 | 5.0 | ... | 35 | 25 |
| | 0.260–0.500 | 14.0 | 19.0 | 5.0 | ... | ... | 30 |
| 3003-H12 | 0.010–0.500 | 17.0 | ... | 12.0 | ... | ... | ... |
| 3003-H14 | 0.010–0.024 | 20.0 | ... | 17.0 | ... | 3 | ... |
| | 0.025–0.049 | 20.0 | ... | 17.0 | ... | 5 | 3 |
| | 0.050–0.259 | 20.0 | ... | 17.0 | ... | 8 | 4 |
| | 0.260–0.500 | 20.0 | ... | 17.0 | ... | ... | ... |
| 3003-H16 | 0.010–0.024 | 24.0 | ... | 21.0 | ... | ... | ... |
| | 0.025–0.049 | 24.0 | ... | 21.0 | ... | 3 | 2 |
| | 0.050–0.259 | 24.0 | ... | 21.0 | ... | 5 | 4 |
| | 0.260–0.500 | 24.0 | ... | 21.0 | ... | ... | ... |
| 3003-H18 | 0.010–0.024 | 27.0 | ... | 24.0 | ... | 2 | ... |
| | 0.025–0.049 | 27.0 | ... | 24.0 | ... | 3 | 2 |
| | 0.050–0.259 | 27.0 | ... | 24.0 | ... | 5 | 3 |
| | 0.260–0.500 | 27.0 | ... | 24.0 | ... | ... | ... |
| 3003-H113 ^J | 0.010–0.500 | 14.0 | ... | 5.0 | ... | ... | ... |
| 5050^{F,H} | | | | | | | |
| 5050-O | 0.010–0.500 | 18.0 | 24 | 6.0 | ... | ... | ... |
| 5050-H32 | 0.010–0.500 | 22.0 | ... | 16.0 | ... | ... | ... |
| 5050-H34 | 0.010–0.500 | 25.0 | ... | 20.0 | ... | ... | ... |
| 5050-H36 | 0.010–0.500 | 27.0 | ... | 22.0 | ... | ... | ... |
| 5050-H38 | 0.010–0.500 | 29.0 | ... | 24.0 | ... | ... | ... |
| 5052^{F,H} | | | | | | | |
| 5052-O | 0.010–0.450 | 25.0 | 35.0 | 10.0 | ... | ... | ... |
| 5052-H32 | 0.010–0.450 | 31.0 | ... | 23.0 | ... | ... | ... |
| 5052-H34 | 0.010–0.450 | 34.0 | ... | 26.0 | ... | ... | ... |
| 5052-H36 | 0.010–0.450 | 37.0 | ... | 29.0 | ... | ... | ... |
| 5052-H38 | 0.010–0.450 | 39.0 | ... | 31.0 | ... | ... | ... |
| 6061 | | | | | | | |
| 6061-O | 0.018–0.500 | ... | 22.0 | ... | 14.0 | 15 | 15 |
| 6061-T4 | 0.025–0.049 | 30.0 | ... | 16.0 | ... | 16 | 14 |
| | 0.050–0.259 | 30.0 | ... | 16.0 | ... | 18 | 16 |
| | 0.260–0.500 | 30.0 | ... | 16.0 | ... | 20 | 18 |
| 6061-T42 ^G | 0.025–0.049 | 30.0 | ... | 14.0 | ... | 16 | 14 |
| | 0.050–0.259 | 30.0 | ... | 14.0 | ... | 18 | 16 |
| | 0.260–0.500 | 30.0 | ... | 14.0 | ... | 20 | 18 |
| 6061-T6 and T62 ^G | 0.025–0.049 | 42.0 | ... | 35.0 | ... | 10 | 8 |
| | 0.050–0.259 | 42.0 | ... | 35.0 | ... | 12 | 10 |
| | 0.260–0.500 | 42.0 | ... | 35.0 | ... | 14 | 12 |
| 6061-T8 | 0.035–0.350 | 45.0 | ... | 40.0 | ... | 8 | ... |
| 6063 | | | | | | | |
| 6063-O | 0.018–0.500 | ... | 19.0 | ... | ... | ... | ... |
| 6063-T4 and T42 ^G | 0.025–0.049 | 22.0 | ... | 10.0 | ... | 16 | 14 |
| | 0.050–0.259 | 22.0 | ... | 10.0 | ... | 18 | 16 |
| | 0.260–0.500 | 22.0 | ... | 10.0 | ... | 20 | 18 |
| 6063-T6 and T62 ^G | 0.025–0.049 | 33.0 | ... | 28.0 | ... | 12 | 8 |
| | 0.050–0.259 | 33.0 | ... | 28.0 | ... | 14 | 10 |
| | 0.260–0.500 | 33.0 | ... | 28.0 | ... | 16 | 12 |
| 6063-T83 | 0.025–0.049 | 33.0 | ... | 30.0 | ... | 5 | ... |
| 6063-T831 | 0.025–0.049 | 28.0 | ... | 25.0 | ... | 5 | ... |
| 6063-T832 | 0.025–0.049 | 41.0 | ... | 36.0 | ... | 8 | 5 |
| | 0.025–0.049 | 40.0 | ... | 35.0 | ... | 8 | 5 |

TABLE 1 *Continued*

| Alloy and Temper | Specified Wall Thickness, in. | Tensile Strength, ksi | | | | Elongation ^{C,E,I} min, % | |
|------------------------------|-------------------------------|-----------------------|-----|-----------------------------------|-----|--|--|
| | | Ultimate | | Yield ^D (0.2 % Offset) | | Full Section Specimen (2 in.) ^E | Cut-out Specimen ^F 4× Diameter ^C |
| | | min | max | min | max | | |
| 6262 | | | | | | | |
| 6262-T6 and T62 ^G | 0.025–0.049 | 42.0 | ... | 35.0 | ... | 10 | 8 |
| | 0.050–0.259 | 42.0 | ... | 35.0 | ... | 12 | 10 |
| | 0.260–0.500 | 42.0 | ... | 35.0 | ... | 14 | 12 |
| 6262-T9 | 0.025–0.375 | 48.0 | ... | 4.0 | ... | 5 | 4 |

^A See **Annex A1**.

^B To determine conformance to this specification each value for tensile 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 method of Practice **E29**.

^C Elongation of full-section and cut-out sheet-type specimens is measured in 2 in.; of cut-out round specimens, in 4× specimen diameter.

^D Yield strength to be determined only on straight tube.

^E Round tube 2 inches or less in outside diameter and square tube 1½ in. or less on a side are tested in full section unless the limitations of the testing machine precludes the use of such a specimen.

^F For round tube over 2 in. in diameter, for square tube over 1½ in. on a side, for all sizes of tube other than round and square, or in those cases when a full section specimen cannot be used, a cut-out specimen is used.

^G Material in the T42 or T62 tempers is not available from the material producers.

^H In this alloy tube other than round is produced only in the F (as drawn) and O tempers. Properties for F temper are not specified or guaranteed.

^I For specified wall thickness under 0.025 in. elongation is not required.

^J The H113 temper applies to other than round tube which is fabricated from annealed round tube.

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)

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:⁴

H35.1/H35.1M Alloy and Temper Designation Systems

H35.2 Dimensional Tolerances for Aluminum Mill Products

H35.2M Dimensional Tolerances for Aluminum Mill Products [Metric]

2.4 Military Standard:⁵

MIL-STD-129 Marking for Shipment and Storage

2.5 Federal Standard:⁵

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

2.6 SAE Standard:⁶

AMS 2772 Heat Treatment of Aluminum Alloy Raw Materials

2.7 Other Standard:⁷

CEN EN 14242 Aluminum and Aluminum Alloys – Chemical Analysis – Inductively Coupled Optical Emissions Spectral Analysis

3. Terminology

3.1 Definitions:

3.1.1 Refer to Terminology **B881** for definitions of product terms used in this specification.

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 (**7.1**),

4.1.4 Temper (**8.1**),

4.1.5 Size and schedule number for pipe, cross-sectional dimensions for tube (outside diameter and wall thickness, or inside diameter and wall thickness for round tube; for tube other than round, square, rectangular, hexagonal, or octagonal with sharp corners, a drawing is required),

4.1.6 Length (straight or coiled),

4.1.7 Nominal inside diameter of coils and weight or maximum outside diameter, if applicable,

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

4.2.1 Whether heat treatment in accordance with Practice **B807/B807M** Extrusion Press Solution Heat Treatment is not acceptable (**9.1**),

⁴ Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

⁵ Available from DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5094, <http://quicksearch.dla.mil>.

⁶ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, <http://www.sae.org>.

⁷ Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, <http://www.cen.eu>.

TABLE 2 Tensile Property Limits, Tube (SI Units)^{A,B}

| Alloy and Temper | Specified Wall Thickness, mm (Over-Thru) | Tensile Strength, MPa | | | | Elongation ^{D,I} min, % | | |
|--------------------------------|--|-----------------------|-----|-----------------------------------|-----|--|-------------------------------|---------------------------------------|
| | | Ultimate | | Yield ^C (0.2 % Offset) | | Full Section Specimen (50 mm) ^D | Cut-out Specimen ^F | |
| | | min | max | min | max | | 50 mm | In 5x Diameter (5.65 √A) ^F |
| 1060^{E,H} | | | | | | | | |
| 1060-O | 0.25–12.5 | 60 | 95 | 15 | ... | ... | ... | ... |
| 1060-H12 | 0.25–12.5 | 70 | ... | 30 | ... | ... | ... | ... |
| 1060-H14 | 0.25–12.5 | 85 | ... | 70 | ... | ... | ... | ... |
| 1060-H18 | 0.25–12.5 | 110 | ... | 90 | ... | ... | ... | ... |
| 1060-H113 ^J | 0.25–12.5 | 60 | ... | 15 | ... | ... | ... | ... |
| 1100^{E,H} | | | | | | | | |
| 1100-O | 0.32-12.50 | 75 | 105 | 25 | ... | ... | ... | ... |
| 1100-H12 | 0.32-12.50 | 95 | ... | 75 | ... | ... | ... | ... |
| 1100-H14 | 0.32-12.50 | 110 | ... | 95 | ... | ... | ... | ... |
| 1100-H16 | 0.32-12.50 | 130 | ... | 115 | ... | ... | ... | ... |
| 1100-H18 | 0.32-12.50 | 150 | ... | 140 | ... | ... | ... | ... |
| 1100-H113 ^J | 0.32-12.50 | 75 | ... | 25 | ... | ... | ... | ... |
| 3003^{E,H} | | | | | | | | |
| 3003-O | 0.25–0.63 | 95 | 130 | 35 | ... | ... | ... | ... |
| | 0.63–1.20 | 95 | 130 | 35 | ... | 30 | 20 | ... |
| | 1.20–6.30 | 95 | 130 | 35 | ... | 35 | 25 | ... |
| | 6.30–12.50 | 95 | 130 | 35 | ... | ... | 30 | 27 |
| 3003-H12 | 0.25–12.50 | 120 | ... | 85 | ... | ... | ... | ... |
| 3003-H14 | 0.25–0.63 | 140 | ... | 115 | ... | 3 | ... | ... |
| | 0.63-1.20 | 140 | ... | 115 | ... | 5 | 3 | ... |
| | 1.20–6.30 | 140 | ... | 115 | ... | 8 | 4 | ... |
| | 6.30–12.50 | 140 | ... | 115 | ... | ... | ... | ... |
| 3003-H16 | 0.25-0.63 | 165 | ... | 145 | ... | ... | ... | ... |
| | 0.63–1.20 | 165 | ... | 145 | ... | 3 | 2 | ... |
| | 1.20–6.30 | 165 | ... | 145 | ... | 5 | 4 | ... |
| | 6.30–12.50 | 165 | ... | 145 | ... | ... | ... | ... |
| 3003-H18 | 0.25–0.63 | 185 | ... | 165 | ... | 2 | ... | ... |
| | 0.63–1.20 | 185 | ... | 165 | ... | 3 | 2 | ... |
| | 1.20–6.30 | 185 | ... | 165 | ... | 5 | 3 | ... |
| | 6.30–12.50 | 185 | ... | 165 | ... | ... | ... | ... |
| 3003-H113 ^J | 0.25–12.50 | 95 | ... | 35 | ... | ... | ... | ... |
| 5050^{E,H} | | | | | | | | |
| 5050-O | 0.25–12.50 | 125 | 165 | 40 | ... | ... | ... | ... |
| 5050-H32 | 0.25–12.50 | 150 | ... | 110 | ... | ... | ... | ... |
| 5050-H34 | 0.25–12.50 | 170 | ... | 140 | ... | ... | ... | ... |
| 5050-H36 | 0.25–12.50 | 185 | ... | 150 | ... | ... | ... | ... |
| 5050-H38 | 0.25–12.50 | 200 | ... | 165 | ... | ... | ... | ... |
| 5052^{E,H} | | | | | | | | |
| 5052-O | 0.25–11.50 | 170 | 240 | 70 | ... | ... | ... | ... |
| 5052-H32 | 0.25–11.50 | 215 | ... | 160 | ... | ... | ... | ... |
| 5052-H34 | 0.25–11.50 | 235 | ... | 180 | ... | ... | ... | ... |
| 5052-H36 | 0.25–11.50 | 255 | ... | 200 | ... | ... | ... | ... |
| 5052-H38 | 0.25–11.50 | 270 | ... | 215 | ... | ... | ... | ... |
| 6061 | | | | | | | | |
| 6061-O | 0.45–12.50 | ... | 150 | ... | 95 | 15 | 15 | 13 |
| 6061-T4 | 0.63–1.20 | 205 | ... | 110 | ... | 16 | 14 | ... |
| | 1.20–6.30 | 205 | ... | 110 | ... | 18 | 16 | ... |
| | 6.30–12.50 | 205 | ... | 110 | ... | 20 | 18 | 16 |
| | 6061-T42 ^{F,G} | 0.63–1.20 | 205 | ... | 95 | ... | 16 | 14 |
| 6061-T42 ^{F,G} | 1.20–6.30 | 205 | ... | 95 | ... | 18 | 16 | ... |
| | 6.30–12.50 | 205 | ... | 95 | ... | 20 | 18 | 16 |
| | 6061-T6 & T62 ^{F,G} | 0.63–1.20 | 290 | ... | 240 | 10 | 8 | ... |
| 6061-T6 & T62 ^{F,G} | 1.20–6.30 | 290 | ... | 240 | ... | 12 | 10 | ... |
| | 6.30–12.50 | 290 | ... | 240 | ... | 14 | 12 | 10 |
| 6061-T8 | 1.00–0.800 | 310 | ... | 275 | ... | 8 | 6 | ... |
| 6063 | | | | | | | | |
| 6063-O | 0.45–12.50 | ... | 130 | ... | ... | ... | ... | ... |
| 6063-T4 & T42 ^{F,G} | 0.63–1.20 | 150 | ... | 70 | ... | 16 | 14 | ... |
| | 1.20–6.30 | 150 | ... | 70 | ... | 18 | 16 | ... |
| | 6.30–12.50 | 150 | ... | 70 | ... | 20 | 18 | 16 |
| | 6063-T6 and T62 ^{F,G} | 0.63–1.20 | 230 | ... | 195 | ... | 12 | 8 |
| 6063-T6 and T62 ^{F,G} | 1.20–6.30 | 230 | ... | 195 | ... | 14 | 10 | ... |
| | 6.30–12.50 | 230 | ... | 195 | ... | 16 | 12 | 10 |
| 6063-T83 | 0.63–6.30 | 230 | ... | 205 | ... | 5 | ... | ... |
| 6063-T831 | 0.63–6.30 | 195 | ... | 170 | ... | 5 | ... | ... |
| 6063-T832 | 0.63–1.20 | 285 | ... | 250 | ... | 8 | 5 | ... |
| | 1.20–6.30 | 275 | ... | 240 | ... | 8 | 5 | ... |

TABLE 2 *Continued*

| Alloy and Temper | Specified Wall Thickness, mm (Over–Thru) | Tensile Strength, MPa | | | | Elongation ^{D,I} min, % | | |
|------------------------------|--|-----------------------|-----|-----------------------------------|-----|--|-------------------------------|---------------------------------------|
| | | Ultimate | | Yield ^C (0.2 % Offset) | | Full Section Specimen (50 mm) ^D | Cut-out Specimen ^F | |
| | | min | max | min | max | | 50 mm | In 5× Diameter (5.65 √A) ^F |
| 6262 | | | | | | | | |
| 6262-T6 & T62 ^{F,G} | 0.63–1.20 | 290 | ... | 240 | ... | 10 | 8 | ... |
| | 1.20–6.30 | 290 | ... | 240 | ... | 12 | 10 | ... |
| | 6.30–12.50 | 290 | ... | 240 | ... | 14 | 12 | 10 |
| 6262-T9 | 0.63–10.0 | 330 | ... | 305 | ... | 5 | 4 | 3 |

^A See **Annex A1**.
^B To determine conformance to this specification each value for tensile strength and for yield 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 method of Practice **E29**.
^C Yield strength to be determined only on straight tube.
^D Round tube 50 mm or less in outside diameter and square tube 35 mm or less on a side are tested in full section unless the limitations of the testing machine precludes the use of such a specimen.
^E For round tube over 50 mm in diameter, for square tube over 35 mm on a side, for all sizes of tube other than round and square, or in those cases when a full section specimen cannot be used, a cut-out specimen is used.
^F Elongations in 50 mm apply for tube tested in full-section, for sheet type specimens for tubes having a flat wall, and for similar curved specimens for tubes having a curved wall up to a maximum wall thickness of 12.50 mm. Elongations in 5D (5.65 √A), where D and A are diameter and cross-sectional area specimens, respectively, apply to round test specimens machined from wall thickness over 6.30 mm.
^G Material in the T42 or T62 tempers is not available from the material producers.
^H In this alloy tube other than round is produced only in the F (as drawn) and O tempers. Properties for F temper are not specified or guaranteed.
^I For specified wall thickness under 0.63 mm elongation is not required.
^J The H113 temper applies to other than round tube which is fabricated from annealed round tube.

TABLE 3 Tensile Property Limits, Drawn Pipe^{A,B,C}

| Temper | Pipe Size, Designation | Tensile Strength, ksi [MPa] | | Yield Strength ^C (0.2% Offset), ksi [MPa], min | Elongation, min, % | | |
|-------------------|------------------------|-----------------------------|-----|---|---|----------|---------------------------------------|
| | | min | max | | Elongation in 2 in. or 4× Diameter, ^D min, % | In 50 mm | In 5× Diameter (5.65 √A) ^E |
| Alloy 3003 | | | | | | | |
| H18 | Under 1 | 27.0 [185] | ... | 24.0 [165] | 4 | [4] | ... |
| H112 | 1 and over | 14.0 [95] | ... | 5.0 [35] | 25 | [25] | [22] |

^A The basis for establishment of tensile property limits is shown in **Annex A1**.
^B 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-off method of Practice **E29**.
^C Elongation of full-section and cut-out sheet-type specimens is measured in 2 in.; of round specimens, in 4× specimen diameter.
^D For purposes of determining conformance with this specification, each value for ultimate strength and yield strength shall be rounded to the nearest 1 MPa, and each value for elongation shall be rounded to the nearest 0.5%, both in accordance with the rounding-off method of Practice **E29**.
^E Elongation in 50 mm apply for pipe tested in full-section and to sheet type specimens taken from pipes having a wall up to 12.50 mm thick. Elongation in 5D (5.65 √A) where D and A are diameter and cross-sectional area of the specimens respectively, apply to round test specimens machined from wall thicknesses over 6.30 mm.

- 4.2.2 Whether heat treatment shall be in accordance with Practice **B918/B918M (9.2)** or **AMS2772 (9.3)** is required,
- 4.2.3 Whether testing for leaks is required (**11.1**),
- 4.2.4 Whether specified number of leaks are allowed, and the manner of marking leaks (**11.1.3.2**),
- 4.2.5 Whether inside cleanliness test is required on coiled tubes (**12.2**), and frequency of testing required,
- 4.2.6 Whether inspection or witness of inspection and tests by the purchaser’ representative is required prior to material shipment (**15.1**),
- 4.2.7 Whether marking for identification is required (**17.1**),
- 4.2.8 Whether Practices **B660** applies, and if so, the levels of preservation, packaging, and packing required (**18.3**),
- 4.2.9 Whether certification of the material by the producer is required (Section **19**),
- 4.2.10 Whether threaded ends are required for pipe (**14.3**), and
- 4.2.11 PIN (for Department of Defense only) (**Annex A3**).

5. Manufacture

5.1 The tube may be produced by drawing tube stock produced by extrusion through a bridge-type die or by die and mandrel methods, at the option of the producer, provided that the production method results in material that meets all requirements of this specification.

5.2 The ends of coils shall be crimped or otherwise sealed to avoid contamination during shipment.

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. Except as otherwise specified in the contract or order, 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. The purchaser shall have the right to perform

TABLE 4 Chemical Composition Limits^{A,B,C,I}

| Alloy | Composition, % | | | | | | | | | | |
|-------|----------------|------|-----------|-----------|-----------|-----------|------|----------|-----------------------------|--------------------|------------------------|
| | Silicon | Iron | Copper | Manganese | Magnesium | Chromium | Zinc | Titanium | Other Elements ^D | | Aluminum |
| | | | | | | | | | Each | Total ^E | |
| 1060 | 0.25 | 0.35 | 0.05 | 0.03 | 0.03 | ... | 0.05 | 0.03 | 0.03 ^F | ... | 99.60 min ^G |
| 1100 | 0.95 Si + Fe | | 0.05–0.20 | 0.05 | ... | ... | 0.10 | ... | 0.05 | 0.15 | 99.00 min ^G |
| 3003 | 0.6 | 0.7 | 0.05–0.20 | 1.0–1.5 | ... | ... | 0.10 | ... | 0.05 | 0.15 | rem |
| 5005 | 0.30 | 0.7 | 0.20 | 0.20 | 0.50–1.1 | 0.10 | 0.25 | ... | 0.05 | 0.15 | rem |
| 5050 | 0.40 | 0.7 | 0.20 | 0.10 | 1.1–1.8 | 0.10 | 0.25 | ... | 0.05 | 0.15 | rem |
| 5052 | 0.25 | 0.40 | 0.10 | 0.10 | 2.2–2.8 | 0.15–0.35 | 0.10 | ... | 0.05 | 0.15 | rem |
| 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 | rem |
| 6063 | 0.20–0.6 | 0.35 | 0.10 | 0.10 | 0.45–0.9 | 0.10 | 0.10 | 0.10 | 0.05 | 0.15 | rem |
| 6262 | 0.40–0.8 | 0.7 | 0.15–0.40 | 0.15 | 0.8–1.2 | 0.04–0.14 | 0.25 | 0.15 | 0.05 ^H | 0.15 | rem |

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

^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 method of Practice E29.

^D *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.

^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 Vanadium 0.05 %, maximum.

^G 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.

^H Bismuth and lead each 0.40–0.7 %.

^I In case there is a discrepancy in the values listed in Table 4 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>.

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 alloy, temper, and nominal dimensions, 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 nominal dimensions subjected to inspection at one time.

7. Chemical Composition

7.1 Limits—The material shall conform to the composition limits specified in Table 4. Conformance shall be determined by the producer by taking samples in accordance with E716 when ingots are poured and analyzing those samples in accordance with Test Methods E1251, E3061, or EN14242. 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 composition during pouring of the ingots, he shall not be required to sample and analyze the finished product.

NOTE 3—It is standard practice in the United States aluminum industry to determine conformance to the 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 If it becomes necessary to analyze finished or semi-finished product for conformance to chemical composition limits.

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 E1251, E3061, or EN14242.

7.3 Other methods of analysis or in the case of dispute may be by agreement between the producer and the purchaser.

8. Tensile Properties

8.1 Limits—The material shall conform to the tensile properties in Table 1 [Table 2] and Table 3.

8.2 Number of Specimens:

8.2.1 For material having a nominal weight of less than 1 lb/linear ft [1.7 kg/linear m], one tension test specimen shall be taken for each 1000 lb [500 kg] or fraction thereof in a lot.

8.2.2 For material having a nominal weight of 1 lb [1.7 kg] or more/linear ft [m], one tension test specimen shall be taken for each 1000 ft [300 m] or fraction thereof in a lot.

8.3 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 and B557M.

8.4 Test Methods—The tension tests shall be made in accordance with Test Methods B557 and B557M.

9. Heat Treatment

9.1 Unless otherwise specified (4.2.1), all alloys specified in Practice B807/B807M may be solution heat treated and quenched at the extrusion press in accordance with Practice B807/B807M.

9.2 When specified in 4.2.2, producer or supplier heat treatment for the applicable tempers in Table 1 [Table 2] shall be in accordance with Practice B918/B918M.

9.3 When specified in 4.2.2, heat treatment of applicable tempers in Table 1 [Table 2] shall be in accordance with AMS 2772.

10. Heat Treatment and Reheat Treatment Capability

10.1 As-received material in the O or F temper and in alloys 6061 and 6063 (within the size limitations specified in Table 1 [Table 2] and without the imposition of cold work) shall, after proper solution heat treatment and natural aging for not less than four days at room temperature, conform to the properties specified in Table 1 [Table 2] for T42 temper material.

10.2 Material in alloy and tempers 6063-T4 and T6 shall, after proper resolution heat treatment and natural aging for not less than four days at room temperature, conform to the properties specified in Table 1 [Table 2] for the T42 temper.

NOTE 4—6061-T4 and T6 are excluded from 10.2 because experience has shown the reheat treated material may develop large recrystallized grains and may fail to develop the tensile properties shown in Table 1 [Table 2].

10.3 Material in T4 and T42 tempers shall, after proper precipitation heat treatment, conform to the properties specified in Table 1 [Table 2] for the T6 and T62 tempers, respectively.

11. Testing for Leaks (Tube)

11.1 When specified by the purchaser at the time of placing the order, tube shall be tested for leaks by one of the following methods at the option of the producer.

11.1.1 *Method 1*—Tubes 1.500 in. [40 mm] or less in diameter shall be tested pneumatically at not less than 60 psig [400 kPa] air pressure while immersed in water or other suitable liquid. Any evidence of leakage shall be cause for rejection.

11.1.2 *Method 2*—Tubes 1.500 in. [40 mm] or less in diameter shall be tested pneumatically at not less than 90 psig [600 KPa] air pressure with a gage which will indicate loss of pressure. There shall not be any loss of pressure during a test period of at least 15-s duration.

11.1.3 *Method 3*—Tubes shall be subjected to an eddy current test in accordance with the procedures described in Practice E215. Reference standards or secondary standards having equivalent eddy current response shall serve to define acceptance-rejection limits.

11.1.3.1 *For Straight Lengths*—Tube reference standards described in Appendixes X1 and X2 of Practice E215 shall be used to standardize the equipment. Tubes 1.500 in. [40 mm] or less in diameter and maximum wall thickness of 0.083 in. [2.00 mm] that produce eddy current indications less than those from the 2A holes of the applicable reference standard or an equivalent secondary standard shall be acceptable. Any tube having a discontinuity that produces an eddy current indication equal to or greater than those from the 2A holes of the applicable reference standard or an equivalent secondary standard shall be rejected.

11.1.3.2 *For Coiled Tube*—Secondary standards having an equivalent eddy current response to No. 70 (0.028-in. [0.70-mm] diameter) and No. 60 (0.040-in. [1.00-mm] diameter) drill holes shall be used to standardize the equipment. Tubes 0.188 to 1 in. [5 to 25 mm] incl, in diameter and maximum wall

thickness of 0.083 in. [2.00 mm] that produce eddy current indications less than those from the No. 60 hole of the secondary standard shall be acceptable. Any tube that produces an indication equal to or greater than those from the No. 60 hole of the secondary standard shall be rejected. Set-up procedures shall include a check to ensure that tubes containing defects giving responses equal to or greater than that from No. 60 hole are rejected at the speed of inspection. Tube in long coils may contain up to a specified number of defects per coil when agreed between the producer and purchaser. In a case where a specified number of defects per coil is allowed, the need for marking such defects in a coil shall be handled as agreed by the producer and purchaser.

12. Special Requirements for Coiled Tubes

12.1 *Expansion Test*—Coiled tube in the annealed temper only shall be capable of being expanded on a hardened ground tapered steel pin having an included angle of 60°, to the following amounts, without signs of cracks, ruptures, or other defects clearly visible to the unaided eye:

| Nominal Outside Diameter, in. [mm] | Expansion of Outside Diameter, % |
|---------------------------------------|-------------------------------------|
| Up through 0.750 [20.00] | 40 |
| 0.751 [20.00] and over | 30 |

NOTE 5—Other expansion capabilities may be required in special cases but shall be the subject of negotiation between the producer and the purchaser.

12.2 *Inside Cleanliness Requirements and Test*—When specified by the purchaser at the time of placing the order, the inside of coiled tube, in the annealed temper only, shall be sufficiently clean so that when a test sample of a minimum of 375 in.² [0.240 m²] (except that not more than 50 ft [15 m] of tube shall be required) internal surface is washed with 1,1,1-trichloroethane or trichloroethylene or equivalent (Note 6), the residue remaining upon evaporation of the solvent shall not exceed 0.002 g/ft² (0.14 × 10⁻⁴ g/in.²) [0.02 g/m²] of interior surface.

NOTE 6—Products that are considered equivalent to inhibited 1,1,1-trichloroethane or trichloroethylene, for the purposes of the inside cleanliness test, include, but are not limited to, n-propyl bromide, dichloromethane, acetone, and others, as agreed between the producer and the purchaser.

12.2.1 To perform the test a measured quantity of the solvent should be pulled through the tube into a flask which is, in turn, attached to an aspirator or vacuum pump. The solvent shall then be transferred to a weighed container (crucible, evaporating dish, or beaker). The solvent in the container shall be evaporated to dryness on a low-temperature hot plate or steam bath. Overheating of the container should be avoided to prevent charring of the residue. The container shall then be dried in an oven at 100 to 110 °C for 10 min, cooled in a desiccator, and weighed. A blank determination shall be run on the measured quantity of solvent, and the gain in weight for the blank shall be subtracted from the weighings of the residue sample. The corrected weight shall then be calculated in grams of residue per unit internal area of tube.

12.2.2 The quantity of the solvent used may vary with the size of tube being examined. A minimum quantity of 100 mL should be used for diameters up to 0.500 in. [12.5 mm] and