



Designation: **B221–14 B221 – 20**

Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes¹

This standard is issued under the fixed designation B221; 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 reappraisal. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reappraisal.

This standard has been approved for use by agencies of the U.S. Department of Defense.

1. Scope*

1.1 This specification² covers aluminum and aluminum-alloy extruded bars, rods, wire, profiles, and tubes in the aluminum alloys (Note 1) and tempers shown in Table 2.

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

NOTE 2—For rolled or cold-finished bar and rod refer to Specification B211, for drawn seamless tube used in pressure applications, Specification B210, for structural pipe and tube, Specification B429/B429M, and for seamless pipe and tube used in pressure applications, Specification B241/B241M.

NOTE 3—Pipe and tube products listed in this specification are intended for general purpose applications. This specification may not address the manufacturing processes, integrity testing, and verification required for fluid-carrying applications involving pressure. See Specifications B210 or B241/B241M, or both as appropriate, for seamless pipe and tube used in fluid-carrying applications involving pressure. See Specification B234, as appropriate, for use in surface condensers, evaporators, and heat exchangers.

1.2 Alloy and temper designations are in accordance with ANSI H35.1/H35.1M. The equivalent Unified Numbering System alloy designations are those of Table 1 preceded by A9; for example, A91100 for Aluminum 1100 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 A complete metric companion to Specification B221 has been developed—Specification B221M; therefore, no metric equivalents are presented in this specification.

1.5 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.

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:

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 ASME Boiler and Pressure Vessel Code applications see related Specification SB-221 in Section II of this Code.

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

2.2 ASTM Standards:³

- [B210](#) Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes (Metric) B0210_B0210M
- [B211](#) Specification for Aluminum and Aluminum-Alloy Rolled or Cold-Finished Bar, Rod, and Wire (Metric) B0211_B0211M
- [B234](#) Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes for Surface Condensers, Evaporators, and Heat Exchangers
- [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
- [B594](#) Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products
- [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
- [B945](#) Practice for Aluminum Alloy Extrusions Press Cooled from an Elevated Temperature Shaping Process for Production of T1, T2, T5 and T10–Type Tempers
- [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 (Withdrawn 2017)⁴~~
- [E527](#) Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)
- ~~[E607](#) Test Method for Atomic Emission Spectrometric Analysis Aluminum Alloys by the Point to Plane Technique Nitrogen Atmosphere (Withdrawn 2011)⁴~~
- [E716](#) Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spark Atomic Emission Spectrometry
- [E1004](#) Test Method for Determining Electrical Conductivity Using the Electromagnetic (Eddy Current) Method
- [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)
- [G34](#) Test Method for Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)
- [G47](#) Test Method for Determining Susceptibility to Stress-Corrosion Cracking of 2XXX and 7XXX Aluminum Alloy Products

2.3 ANSI Standards:⁴

- [ANSI H35.1/H35.1M](#) Alloy and Temper Designation Systems for Aluminum
- [ANSI H35.2](#) Dimensional Tolerances for Aluminum Mill Products

2.4 Federal Standard:⁵

- [Fed. Std. No. 123](#) Marking for Shipment (Civil Agencies)

2.5 Military Standard:⁵

- [MIL-STD-129](#) Marking for Shipment and Storage

2.6 AMS Specification:⁶

- [AMS 2772](#) Heat Treatment of Aluminum Alloy Raw Materials

2.7 CEN Standard:⁷

- [EN 14242](#) Aluminium and Aluminium Alloys—Chemical Analysis—Inductively Coupled Plasma Optical Emission Spectral Analysis

3. Terminology

3.1 *Definitions*—Refer to Terminology [B881](#) for definitions of product terms used in this specification:

3.1 *Definitions:*

³ 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.

⁴ Available from Aluminum Association, Inc., 1525 Wilson Blvd., Suite 600, 1400 Crystal Dr., Suite 430, Arlington, VA 22209-2202, <http://www.aluminum.org>.

⁵ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, DLA Document Services, Building 4/D, 700 Robbins Ave., Philadelphia, PA 19111-5098, <http://www.dodssp.daps.mil>; 19111-5094, <http://quicksearch.dla.mil>.

⁶ Available from Society of Automotive Engineers—SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>; 15096, <http://www.sae.org>.

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

3.1.1 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 (as 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 pieces or pounds.

4.1.3 Alloy (Section 7 and Table 1).

4.1.4 Temper (Section 8 and Table 2).

4.1.5 Nominal cross-sectional dimensions as follows:

4.1.5.1 For rod and round wire: diameter.

4.1.5.2 For square-cornered bar and wire: depth and width.

4.1.5.3 For sharp-cornered hexagonal or octagonal bar and wire: distance across flats.

4.1.5.4 For round tube: outside or inside diameter and wall thickness.

4.1.5.5 For square or sharp-cornered tube other than round: distance across flats and wall thickness.

4.1.5.6 For round-cornered bars, profiles, tube other than round, square, rectangular, hexagonal, or octagonal with sharp corners: drawing required.

4.1.6 Length.

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

NOTE 4—For heat-treatable alloys, the default standard to follow for producing T3, T4, T6, T7, T8 and T9 tempers is AMS 2772. However, in the case of most 6XXX and some 7XXX alloys (see 9.2 for list of alloys), the producer may choose to solution heat treat the product at the press in accordance with Practice **B807/B807M**, as long as the purchaser does not specifically object to this practice in the purchasing agreement. Alternatively, heat treatment may be accomplished in accordance with Practice **B918/B918M** instead of either of the previous options.

It is up to the purchaser to specify in the purchasing agreement if solution heat treatment at the press is not allowed and/or if heat treatment in accordance with Practice **B918/B918M** is preferred. If the purchaser does not specify a preference for a heat treatment practice, Practice **B807/B807M** will be used for any alloy listed in 9.2, and AMS 2772 will be the practice used for any other heat-treatable alloy.

4.2.1 Whether solution heat treatment at the press in accordance with Practice **B807/B807M** is unacceptable (**9-39.2**).

4.2.2 Whether heat treatment in accordance with Practice **B918/B918M** is ~~required~~ preferred to the default practice, AMS 2772 (**9-49.3**).

4.2.3 Whether ultrasonic inspection is required (Section 17, Table 3).

4.2.4 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 18).

4.2.5 Whether certification is required (Section 22).

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

NOTE 1—In case of a discrepancy between the values listed in Table 2 and 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” should be considered the controlling composition. The “Teal Sheets” are available at <http://www.aluminum.org/tealsheets>.

Alloy	Silicon	Iron	Copper	Manga- nese	Magne- sium	Chromium	Zinc	Titanium	Vanadium	Other Elements ^D		Aluminum
										Each	Total ^E	
1060	0.25	0.35	0.05	0.03	0.03	...	0.05	0.03	0.05	0.03	...	99.60 min ^F
1100	0.95 Si + Fe		0.05-0.20	0.05	...	...	0.10	...	...	0.05 ^G	0.15	99.00 min ^F
2014	0.50-1.2	0.7	3.9-5.0	0.40-1.2	0.20-0.8	0.10	0.25	0.15 ^H	...	0.05 ^H	0.15	remainder
2024	0.50	0.50	3.8-4.9	0.30-0.9	1.2-1.8	0.10	0.25	0.15 ^H	...	0.05 ^H	0.15	remainder
2219	0.20	0.30	5.8-6.8	0.20-0.40	0.02	...	0.10	0.02-0.10	0.05-0.15	0.05 ^I	0.15 ^I	remainder
3003	0.6	0.7	0.05-0.20	1.0-1.5	...	...	0.10	...	...	0.05	0.15	remainder
Alclad 3003	...	3003 Clad with 7072 alloy			...	...	...	...	...	...	...	...
3004	0.30	0.7	0.25	1.0-1.5	0.8-1.3	...	0.25	...	...	0.05	0.15	remainder
3102	0.40	0.7	0.10	0.05-0.40	...	...	0.30	0.10	...	0.05	0.15	remainder
5052	0.25	0.40	0.10	0.10	2.2-2.8	0.15-0.35	0.10	...	...	0.05	0.15	remainder
5083	0.40	0.40	0.10	0.40-1.0	4.0-4.9	0.05-0.25	0.25	0.15	...	0.05	0.15	remainder
5086	0.40	0.50	0.10	0.20-0.7	3.5-4.5	0.05-0.25	0.25	0.15	...	0.05	0.15	remainder
5154	0.25	0.40	0.10	0.10	3.1-3.9	0.15-0.35	0.20	0.20	...	0.05 ^G	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
5456	0.25	0.40	0.10	0.50-1.0	4.7-5.5	0.05-0.20	0.25	0.20	...	0.05	0.15	remainder
6005	0.6-0.9	0.35	0.10	0.10	0.40-0.6	0.10	0.10	0.10	...	0.05	0.15	remainder
6005A	0.50-0.9	0.35	0.30	0.50 ^J	0.40-0.7	0.30 ^J	0.20	0.10	...	0.05	0.15	remainder
6013	0.6-1.0	0.50	0.6-1.1	0.20-0.8	0.8-1.2	0.10	0.25	0.10	...	0.05	0.15	remainder
6020 ^K	0.40-0.9	0.50	0.30-0.9	0.35	0.6-1.2	0.15	0.20	0.15	...	0.05	0.15	remainder
6041 ^L	0.50-0.9	0.15-0.7	0.15-0.6	0.05-0.20	0.8-1.2	0.05-0.15	0.25	0.15	...	0.05	0.15	remainder
6042 ^M	0.50-1.2	0.7	0.20-0.6	0.40	0.7-1.2	0.04-0.35	0.25	0.15	...	0.05	0.15	remainder
6060	0.30-0.6	0.10-0.30	0.10	0.10	0.35-0.6	0.5	0.15	0.10	...	0.05	0.15	remainder
6061 ^N	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
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	remainder
6064 ^O	0.40-0.8	0.7	0.15-0.40	0.15	0.8-1.2	0.05-0.14	0.25	0.15	...	0.05	0.15	remainder
6066	0.9-1.8	0.50	0.7-1.2	0.6-1.1	0.8-1.4	0.40	0.25	0.20	...	0.05	0.15	remainder
6070	1.0-1.7	0.50	0.15-0.40	0.40-1.0	0.50-1.2	0.10	0.25	0.15	...	0.05	0.15	remainder
6082	0.7-1.3	0.50	0.10	0.40-1.0	0.6-1.2	0.25	0.20	0.10	...	0.05	0.15	remainder
6105	0.6-1.0	0.35	0.10	0.15	0.45-0.8	0.10	0.10	0.10	...	0.05	0.15	remainder
6162	0.40-0.8	0.50	0.20	0.10	0.7-1.1	0.10	0.25	0.10	...	0.05	0.15	remainder
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 ^P	0.15 ^P	remainder
6351	0.7-1.3	0.50	0.10	0.40-0.8	0.40-0.8	...	0.20	0.20	...	0.05	0.15	remainder
6360	0.35-0.8	0.10-0.30	0.15	0.02-0.15	0.25-0.45	0.05	0.10	0.10	...	0.05	0.15	remainder
6463	0.20-0.6	0.15	0.20	0.05	0.45-0.9	...	0.05	...	...	0.05	0.15	remainder
6560	0.30-0.7	0.10-0.30	0.05-0.20	0.20	0.20-0.6	0.05	0.15	0.10	...	0.05	0.15	remainder
7005	0.35	0.40	0.10	0.20-0.7	1.0-1.8	0.06-0.20	4.0-5.0	0.01-0.06	...	0.05 ^Q	0.15 ^Q	remainder
7072 ^R	0.7 Si + Fe		0.10	0.10	0.10	...	0.8-1.3	...	...	...	...	remainder
7075	0.40	0.50	1.2-2.0	0.30	2.1-2.9	0.18-0.28	5.1-6.1	0.20 ^S	...	0.05 ^S	0.15	remainder
7116	0.15	0.30	0.50-1.1	0.05	0.8-1.4	...	4.2-5.2	0.05	0.05	0.05 ^T	0.15	remainder
7129	0.15	0.30	0.50-0.9	0.10	1.3-2.0	0.10	4.2-5.2	0.05	0.05	0.05 ^T	0.15	remainder
7178	0.40	0.50	1.6-2.4	0.30	2.4-3.1	0.18-0.28	6.3-7.3	0.20	...	0.05	0.15	remainder

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

Alloy	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	V	Other Elements ^D		Al
										Each	Total ^E	
1060	0.25	0.35	0.05	0.03	0.03	...	0.05	0.03	0.05	0.03	...	99.60 min ^F
1100 ^G	0.95 Si + Fe		0.05-0.20	0.05	...	...	0.10	...	...	0.05	0.15	99.00 min ^F
2014 ^H	0.50-1.2	0.7	3.9-5.0	0.40-1.2	0.20-0.8	0.10	0.25	0.15	...	0.05	0.15	rem
2024 ^H	0.50	0.50	3.8-4.9	0.30-0.9	1.2-1.8	0.10	0.25	0.15	...	0.05	0.15	rem
2219 ^I	0.20	0.30	5.8-6.8	0.20-0.40	0.02	...	0.10	0.02-0.10	0.05-0.15	0.05	0.15	rem
3003	0.6	0.7	0.05-0.20	1.0-1.5	...	...	0.10	...	...	0.05	0.15	rem
Alclad 3003	...	3003 Clad with 7072 alloy			...	...	...	...	...	...	...	rem
3004	0.30	0.7	0.25	1.0-1.5	0.8-1.3	...	0.25	...	...	0.05	0.15	rem
3102	0.40	0.7	0.10	0.05-0.40	...	...	0.30	0.10	...	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
5083	0.40	0.40	0.10	0.40-1.0	4.0-4.9	0.05-0.25	0.25	0.15	...	0.05	0.15	rem
5086	0.40	0.50	0.10	0.20-0.7	3.5-4.5	0.05-0.25	0.25	0.15	...	0.05	0.15	rem
5154 ^G	0.25	0.40	0.10	0.10	3.1-3.9	0.15-0.35	0.20	0.20	...	0.05	0.15	rem
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	rem
5456	0.25	0.40	0.10	0.50-1.0	4.7-5.5	0.05-0.20	0.25	0.20	...	0.05	0.15	rem
6005	0.6-0.9	0.35	0.10	0.10	0.40-0.6	0.10	0.10	0.10	...	0.05	0.15	rem
6005A ^J	0.50-0.9	0.35	0.30	0.50	0.40-0.7	0.30	0.20	0.10	...	0.05	0.15	rem
6013	0.6-1.0	0.50	0.6-1.1	0.20-0.8	0.8-1.2	0.10	0.25	0.10	...	0.05	0.15	rem
6020 ^K	0.40-0.9	0.50	0.30-0.9	0.35	0.6-1.2	0.15	0.20	0.15	...	0.05	0.15	rem
6026 ^L	0.6-1.4	0.7	0.20-0.50	0.20-1.0	0.6-1.2	0.30	0.30	0.20	...	0.05	0.05	rem
6041 ^M	0.50-0.9	0.15-0.7	0.15-0.6	0.05-0.20	0.8-1.2	0.05-0.15	0.25	0.15	...	0.05	0.15	rem
6042 ^N	0.50-1.2	0.7	0.20-0.6	0.40	0.7-1.2	0.04-0.35	0.25	0.15	...	0.05	0.15	rem
6060	0.30-0.6	0.10-0.30	0.10	0.10	0.35-0.6	0.5	0.15	0.10	...	0.05	0.15	rem

Alloy	Si	Fe	Cu	Mn	Mg	Cr	Zn	Ti	V	Other Elements ^D		Al
										Each	Total ^E	
6061 ^O	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
6064 ^P	0.40–0.8	0.7	0.15–0.40	0.15	0.8–1.2	0.05–0.14	0.25	0.15	...	0.05	0.15	rem
6066	0.9–1.8	0.50	0.7–1.2	0.6–1.1	0.8–1.4	0.40	0.25	0.20	...	0.05	0.15	rem
6070	1.0–1.7	0.50	0.15–0.40	0.40–1.0	0.50–1.2	0.10	0.25	0.15	...	0.05	0.15	rem
6082	0.7–1.3	0.50	0.10	0.40–1.0	0.6–1.2	0.25	0.20	0.10	...	0.05	0.15	rem
6105	0.6–1.0	0.35	0.10	0.15	0.45–0.8	0.10	0.10	0.10	...	0.05	0.15	rem
6162	0.40–0.8	0.50	0.20	0.10	0.7–1.1	0.10	0.25	0.10	...	0.05	0.15	rem
6262 ^Q	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	0.15	rem
6351	0.7–1.3	0.50	0.10	0.40–0.8	0.40–0.8	...	0.20	0.20	...	0.05	0.15	rem
6360	0.35–0.8	0.10–0.30	0.15	0.02–0.15	0.25–0.45	0.05	0.10	0.10	...	0.05	0.15	rem
6463	0.20–0.6	0.15	0.20	0.05	0.45–0.9	...	0.05	...	...	0.05	0.15	rem
6560	0.30–0.7	0.10–0.30	0.05–0.20	0.20	0.20–0.6	0.05	0.15	0.10	...	0.05	0.15	rem
7005 ^R	0.35	0.40	0.10	0.20–0.7	1.0–1.8	0.06–0.20	4.0–5.0	0.01–0.06	...	0.05	0.15	rem
7072 ^S	0.7 Si + Fe		0.10	0.10	0.10	...	0.8–1.3	...	...	0.05	0.15	rem
7075 ^T	0.40	0.50	1.2–2.0	0.30	2.1–2.9	0.18–0.28	5.1–6.1	0.20	...	0.05	0.15	rem
7116 ^U	0.15	0.30	0.50–1.1	0.05	0.8–1.4	...	4.2–5.2	0.05	0.05	0.05	0.15	rem
7129 ^U	0.15	0.30	0.50–0.9	0.10	1.3–2.0	0.10	4.2–5.2	0.05	0.05	0.05	0.15	rem

^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 the purpose of determining conformance to these limits, an observed value or a calculated value obtained from analysis shall be rounded 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 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 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 The aluminum content shall be calculated by subtracting from 100.00 % the sum of all metallic elements present in amounts of 0.010 % or more each, rounded to the second decimal before determining the sum.

^G Be 0.0003 max for welding electrode, welding rod, and filler wire.

^H Upon agreement between the purchaser and the producer or supplier, a Zr + Ti limit of 0.20 % max is permitted. Properties in Specification ((Table Table 2)-2) are not based on the Zirconium and Titanium algorithm.

^I Zirconium, 0.10–0.25 %. The total for other elements does not include zirconium.

^J Manganese plus chromium shall total 0.12–0.50.

^K Lead 0.05 % max, Tin 0.9–1.50.9–1.5 %.

^L Bismuth 0.30–0.9 %, Tin 0.35–1.2–0.50–1.5 %, Lead 0.4 % max, Tin 0.05 % max.

^M Bismuth 0.30–0.9 %, Tin 0.35–1.2 %.

^N Bismuth 0.20–0.80.20–0.8 % Lead 0.15–0.400.15–0.40 %.

^O In 1965 the requirements for 6062 were combined with those for 6061 by revising the minimum chromium from “0.15 %” to “0.04 %.” This action cancelled alloy 6062.

^P Bismuth 0.50–0.70.50–0.7 %, Lead 0.20–0.400.20–0.40 %, Bismuth and lead shall be 0.40–0.7 % each.

^Q Zirconium 0.08–0.20 %. The total for other elements does not include zirconium.

^R Composition of cladding alloy applied during the course of manufacture. Samples from finished tube shall not be required to conform to these limits.

^T Upon agreement between the purchaser and the producer or supplier, a Zr + Ti limit of 0.25 % max is permitted. Properties in Specification ((Table Table 2)-2) are not based on the Zirconium and Titanium algorithm.

^U Gallium 0.03 % max.

^V 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>.

- 4.2.6 Whether marking for identification is required in accordance with Practice B666/B666M, Section 20.
- 4.2.7 Whether Practice B660 applies and, if so, the levels of preservation, packaging, and packing required (21.3).
- 4.2.8 Requirements for tensile property and dimensional tolerance for sizes not specifically covered (8.1.3 and 15.1.1).
- 4.2.9 Whether Titanium and Zirconium algorithm is allowed as shown in Table 1 (Footnote G);H), when ordering 2014 or 2024.
- 4.2.10 Whether Titanium and Zirconium algorithm is allowed as shown in Table 1 (Footnote N);T), when ordering 7075.

5. Materials and Manufacture

5.1 The products covered by this specification shall be produced by the hot extrusion method or by similar methods at the option of the producer, provided that the resulting products comply with the requirements in this specification.

TABLE 2 Mechanical Property Limits^{A,B}

NOTE 1—Strength values shown in parentheses are for information only.

Temper	Product Type ^H	Specified Section or Wall Thickness, in.	Area, in. ²	Tensile Strength, ksi		Yield Strength, (0.2 % offset), ksi		Elongation in 2 in.-inches or 4×4× Diameter, min, % ^C	
				min	max	min	max	min	max
Aluminum 1060 ^D									
O	Extruded Tube	all	all	8.5	14.0	2.5	...	25	
H112	Extruded Tube	all	all	8.5	...	2.5	...	25	
Aluminum 1100 ^D									
O	Extruded Tube	all	all	11.0	15.5	3.0	...	25	
H112	Extruded Tube	all	all	11.0	...	3.0	...	25	
Alloy 2014 ^D									
O	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	...	30.0	...	18.0	12	
T4	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	50.0	...	35.0	...	12	
T4510 ^E T4511 ^E T4511 ^E									
T42 ^F	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	50.0	...	29.0	...	12	
T6	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	60.0	...	53.0	...	7	
T6									
T6 T6510 ^E T6511 ^E	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	60.0	...	53.0	...	7	
0.750 and over	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	60.0	...	53.0	...	7	
0.750 and over	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	60.0	...	53.0	...	7	
0.750 and over	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	60.0	...	53.0	...	7	
Alloy 2024 ^D									
O	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	...	35.0	...	19.0	12	

TABLE 2 Continued

Temper	Product Type ^H	Specified Section or Wall Thickness, in.		Area, in. ²	Tensile Strength, ksi		Yield Strength (0.2 % offset), ksi		Elongation in 2 in.-inches or 4×4× Diameter, min, % ^C	
					min	max	min	max	min	max
T3	0.250-0.749	up through 0.249	all	57.0	...	42.0	...	12 ^G	...	...
					Extruded Wire, Rod, Bar, and Profiles	up through 0.249 0.250-0.749 0.750-1.499	...	all	57.0	...	42.0...12
		all	60.0	...			44.0...12			
					all	65.0	...	46.0...10		
		T3 T3510 ^E T3511 ^E			all	60.0	...	44.0	...	12 ^G
1.500 and over	up through 25 over 25 through 32	70.0 68.0	...	52.0 48.0	...	10 8	...	...	...	...
T3 T3510 ^E T3511 ^E	Extruded Tube	up through 0.249 0.250-0.749 0.750-1.499	all all all	57.0 60.0 65.0	...	42.0	...	10	...	...
					...	44.0	...	10	...	46.0	...	10
		T3511 ^E			up through 25	70.0	...	52.0 ^H	...	10
	1.500 and over	over 25 through 32	68.0	...	48.0 ^I	...	8	...	...	...
	1.500 and over	up through 25 over 25 through 32	70.0 68.0	...	48.0 46.0	...	10 8	...	...	...
T42 ^F	0.750-1.499	up through 0.749	all	57.0	...	38.0	...	12	...	...
					Extruded Wire, Rod, Bar, Profiles, and Tube	up through 0.749 0.750-1.499	...	all	57.0	...	38.0...12
		all	57.0	...			38.0...10			
	1.500 and over	up through 25	57.0	...	38.0	...	10	...	...	...
1.500 and over	up through 25 over 25 through 32	57.0 57.0	...	38.0 38.0	...	10	...	...	...	...
					...	8	...	...	...	...
	over 25 through 32	57.0	...	38.0	...	8	...	...	...
T81	0.050-0.249		all	64.0	...	56.0	...	4	...	...

Alloy 2024^D (Continued)

TABLE 2 *Continued*

Temper	Product Type ^H	Specified Section or Wall Thickness, in.	Area, in. ²	Tensile Strength, ksi		Yield Strength (0.2 % offset), ksi		Elongation in 2 in.-inches or 4×4× Diameter, min, % ^C		
				min	max	min	max			
T81 T8510 ^E T8511 ^E	Extruded Wire, Rod, Bar, Profiles, and Tube	0.050–0.249	all	64.0	...	56.0	...	4		
		0.250–1.499	all	66.0	...	58.0	...	5		
		1.500 and over	up through 32	up through 32	66.0	...	58.0	...	5	
T8511 ^E	1.500 and over	up through 32	66.0	...	58.0	...	5			
Alloy 2219 ^D										
O T34	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	...	32.0	...	18.0	12		
T3510 ^E		up through 0.499	up through 25	42.0	...	26.0	...	14		
T31 T3510 ^E T3511 ^E	Extruded Wire, Rod, Bar, Profiles, and Tube	up through 0.499	up through 25	42.0	...	26.0	...	14		
		0.500–2.999	up through 25	up through 25	45.0	...	27.0	...	14	
T3511 ^E		0.500–2.999	up through 25	45.0	...	27.0	...	14		
T62 ^E	Extruded Wire, Rod, Bar, Profiles, and Tube	up through 0.999	up through 25	54.0	...	36.0	...	6		
T62 ^F		up through 1.000 and over	up through 25	up through 25	54.0	...	36.0	...	6	
T81 T81 T8510 ^E T8511 ^E	Extruded Wire, Rod, Bar, Profiles, and Tube	up through 2.999	up through 25	58.0	...	42.0	...	6		
T8511 ^E										
Alloy 3003 ^D										
O	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	14.0	19.0	5.0	...	25		
H112 H112	Extruded Wire, Rod, Bar, and Profiles	all	all	14.0	...	5.0	...	25		
H112		Extruded Tube	all	all	14.0	...	5.0	...	25	
Alloy Alclad 3003 ^D										
O	Extruded Tube	all	all	13.0	18.0	4.5	...	25		
H112 H112	Extruded Tube	all	all	13.0	...	4.5 ^J	...	25		
			all	all	13.0	...	4.5 ^I	...	25	
Alloy 3004 ^D										
O	Extruded Tube	all	all	23.0	29.0	8.5	...	...
Alloy 3102										
H112 ^K H112 ^J	Extruded Tube	0.028–0.050	all	11.0	18.0	4.0	...	25		
			0.028–0.050	all	11.0	18.0	4.0	...	25	
Alloy 5052 ^D										
O	Extruded Tube	all	all	25.0	35.0	10.0	...	...
Alloy 5083 ^D										
O		up through 5.000 ^L	up through 32	39.0	51.0	16.0	...	14		

TABLE 2 *Continued*

Temper	Product Type ^H	Specified Section or Wall Thickness, in.	Area, in. ²	Tensile Strength, ksi		Yield Strength Strength, (0.2 % offset), ksi		Elongation in 2 in.-inches or 4×4× Diameter, min, % ^C	
				min	max	min	max		
<u>O</u>	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^K	up through 32	39.0	51.0	16.0	...	14	
H111	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^L	up through 32	40.0	...	24.0	...	12	
H111		up through 5.000 ^K	up through 32	40.0	...	24.0	...	12	
H112		up through 5.000 ^L	up through 32	39.0	...	16.0	...	12	
H112	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^K	up through 32	39.0	...	16.0	...	12	
<u>O</u>	<u>Extruded Tube</u>	up through 2.999 ^G	up through 32	39.0	51.0	16.0	...	14	
H111	<u>Extruded Tube</u>	up through 2.999 ^G	up through 32	40.0	...	24.0	...	12	
H112	<u>Extruded Tube</u>	up through 2.999 ^G	up through 32	39.0	...	16.0	...	12	
Alloy 5086 ^D									
<u>Ø</u>	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^L	up through 32	35.0	46.0	14.0	...	14	
<u>O</u>		up through 5.000 ^K	up through 32	35.0	46.0	14.0	...	14	
H111		up through 5.000 ^L	up through 32	36.0	...	21.0	...	12	
H111	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^K	up through 32	36.0	...	21.0	...	12	
H112	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^L	up through 32	35.0	...	14.0	...	12	
H112		up through 5.000 ^K	up through 32	35.0	...	14.0	...	12	
<u>O</u>	<u>Extruded Tube</u>	up through 2.999 ^G	up through 32	35.0	46.0	14.0	...	14	
Alloy 5086 ^D (Continued)									
H111	<u>Extruded Tube</u>	up through 2.999 ^G	up through 32	36.0	...	21.0	...	12	
H112	<u>Extruded Tube</u>	up through 2.999 ^G	up through 32	35.0	...	14.0	...	12	
Alloy 5154									
<u>O</u>	<u>Extruded Wire, Rod, Bar, Profiles, and Tube</u>	all	all	30.0	41.0	11.0	...	...
H112	<u>Extruded Wire, Rod, Bar, Profiles, and Tube</u>	all	all	30.0	...	11.0	...	...
Alloy 5454 ^D									
<u>Ø</u>	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^L	up through 32	31.0	41.0	12.0	...	14	
<u>O</u>		up through 5.000 ^K	up through 32	31.0	41.0	12.0	...	14	
H111		up through 5.000 ^L	up through 32	33.0	...	19.0	...	12	
H111	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^K	up through 32	33.0	...	19.0	...	12	
H112	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^L	up through 32	31.0	...	12.0	...	12	
H112		up through 5.000 ^K	up through 32	31.0	...	12.0	...	12	
<u>O</u>	<u>Extruded Tube</u>	up through 2.999 ^G	up through 32	31.0	41.0	12.0	...	14	
H111	<u>Extruded Tube</u>	up through 2.999 ^G	up through 32	33.0	...	19.0	...	12	
H112	<u>Extruded Tube</u>	up through 2.999 ^G	up through 32	31.0	...	12.0	...	12	
Alloy 5456 ^D									
<u>Ø</u>	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^L	up through 32	41.0	53.0	19.0	...	14	
<u>O</u>		up through 5.000 ^K	up through 32	41.0	53.0	19.0	...	14	
H111		up through 5.000 ^L	up through 32	42.0	...	26.0	...	12	
H111	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^K	up through 32	42.0	...	26.0	...	12	
H112	<u>Extruded Wire, Rod, Bar, and Profiles</u>	up through 5.000 ^L	up through 32	41.0	...	19.0	...	12	

TABLE 2 *Continued*

Temper	Product Type ^H	Specified Section or Wall Thickness, in.	Area, in. ²	Tensile Strength, ksi		Yield Strength (0.2 % offset), ksi		Elongation in 2 in-inches or 4×4× Diameter, min, % ^C	
				min	max	min	max	min	max
H112	Extruded Wire, Rod, Bar, and Profiles	up through 5.000 ^K	up through 32	41.0	...	19.0	...	12	
O	Extruded Tube	up through 2.999 ^G	up through 32	41.0	53.0	19.0	...	14	
H111	Extruded Tube	up through 2.999 ^G	up through 32	42.0	...	26.0	...	12	
H112	Extruded Tube	up through 2.999 ^G	up through 32	41.0	...	19.0	...	12	
Alloy 6005									
T1	Extruded Wire, Rod, Bar, Profiles, and Tube	up through 0.500	all	25.0	...	15.0	...	16	
T5	Extruded Wire, Rod, Bar, Profiles, and Tube	up through 0.124	all	38.0	...	35.0	...	8	
T5			all	38.0	...	35.0	...	10	
0.125–1.000	all	0.125–1.000	all	38.0	...	35.0	...	10	
Alloy 6005A									
T1	Extruded Wire, Rod, Bar, Profiles, and Tube	up through 0.249	all	25.0	...	14.5	...	15	
T5	Extruded Wire, Rod, Bar, Profiles, and Tube	up through 0.249	all	38.0	...	31.0	...	7	
			all	38.0	...	31.0	...	9	
0.250–0.999	all	0.250–0.999	all	38.0	...	31.0	...	9	
T61	Extruded Wire, Rod, Bar, Profiles, and Tube	up through 0.249	all	38.0	...	35.0	...	8	
		0.250–1.000	all	38.0	...	35.0	...	10	
Alloy 6013									
T61	Extruded Wire, Rod, Bar, Profiles, and Tube	up through 0.249	all	38.0	...	35.0	...	8	
T6			all	49.0	...	46.0	...	8	
T6511		0.200–0.499	all	49.0	...	46.0	...	8	
		0.500–0.749	all	49.0	...	46.0	...	8	
		0.750–2.000	all	49.0	...	45.0	...	8	
Alloy 6020									
0.250–1.000			all	38.0	...	35.0	...	10	
T6511	Extruded Rod and Bar	3.250–6.000	all	38.0	...	35.0	...	10	
Alloy 6013									
Alloy 6026									
T6		0.200–0.499	all	49.0	...	46.0	...	8	
T6 T6510 ^F T6511 ^E	Extruded Profiles	0.200–1.500	all	49.0	...	38.0	...	6	
		0.500–0.749	all	49.0	...	46.0	...	8	
		0.750–2.000	all	49.0	...	45.0	...	8	

TABLE 2 *Continued*

Temper	Product Type ^H	Specified Section or Wall Thickness, in.	Area, in. ²	Tensile Strength, ksi		Yield Strength (0.2 % offset), ksi		Elongation in 2 in.-inches or 4×4× Diameter, min, % ^C	
				min	max	min	max	min	max
T6 T6510 ^E T6511 ^E	Extruded Tube	0.400–1.300	all	49.0	...	38.0	...	6	
		0.200–0.499	all	49.0	...	46.0	...	8	
		0.500–0.749	all	49.0	...	46.0	...	8	
		0.750–2.000	all	49.0	...	45.0	...	8	
Alloy 6020									
T6544		3.250–6.000	all	38.0	...	35.0	...	10	
T6 T6510 ^E T6511 ^E	Extruded Wire, Rod, and Bar	1.300–5.500	all	54.0	...	44.0	...	6	
		5.501–8.000	all	49.0	...	36.0	...	6	
		8.001–10.000	all	44.0	...	29.0	...	6	
Alloy 6041									
T6 ^M		0.400–2.000	all	45.0	...	40.0	...	10	
T6511 ^M		0.400–2.000	all	45.0	...	40.0	...	10	
T6, T6511 ^E	Extruded Rod, Bar, and Profiles	0.400–2.000	all	45.0	...	40.0	...	10	
Alloy 6042									
T5		0.400–0.499	all	38.0	...	35.0	...	10	
		0.500–1.800	all	42.0	...	35.0	...	10	
T5544		0.400–0.499	all	38.0	...	35.0	...	10	
		0.500–1.800	T5, T5511 ^E	Extruded Rod, Bar, and Profiles	0.400–0.499	all	42.0	...	35.0
0.500–1.800		all	42.0	...	35.0	...	10		
Alloy 6060									
T51	Extruded Wire, Rod, Bar, and Profiles	up through 0.125	all	22.0	...	16.0	...	8	
T61		up through 0.124	30.0	...	25.0	...	8		
		0.125–1.000	30.0	...	25.0	...	10		
T61	Extruded Wire, Rod, Bar, and Profiles	up through 0.124	30.0	...	25.0	...	8		
		0.125–1.000	30.0	...	25.0	...	10		
Alloy 6061 ^D									
O	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	...	22.0	...	16.0	16	
T1	Extruded Wire, Rod, Bar, Profiles, and Tube	up through 0.625	all	26.0	...	14.0	...	16	
T4									
T4 T4510 ^E T4511 ^E	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	26.0	...	16.0	...	16	
T4511 ^E									
T42 ^F	Extruded Wire, Rod, Bar, Profiles, and Tube	all	all	26.0	...	12.0	...	16	