



Designation: B221 – 21

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 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 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/B211M](#), for drawn seamless tube used in pressure applications, Specification [B210/B210M](#), 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/B210M](#) 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*

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 Sept. 1, 2021. Published November 2021. Originally approved in 1947. Last previous edition approved in 2020 as B221–20. DOI: 10.1520/B0221-21.

² For ASME Boiler and Pressure Vessel Code applications see related Specification SB-221 in Section II of this Code.

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:

2.2 ASTM Standards:³

[B210/B210M](#) Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes

[B211/B211M](#) Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire

[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

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.

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

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

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

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-123 Marking for Shipment (Civil Agencies)

2.5 *Military Standard*:⁵

MIL-STD-129 Military Marking for Shipment and Storage

2.6 *AMS Specification*:⁶

AMS 2772 Heat Treatment of Aluminum Alloy Raw Materials

2.7 *CEN Standard*:⁷

CEN EN 14242 Aluminium and aluminium alloys - Chemical analysis - Inductively coupled plasma optical emission spectral analysis

3. Terminology

3.1 *Definitions*:

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*—(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 Available from Aluminum Association, 1400 Crystal Dr., Suite 430, Arlington, VA 22202, <http://www.aluminum.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>.

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**).

NOTE 4—In the case of a discrepancy in the values listed in **Table 1** with those listed in the “International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys” (known as the “Teal Sheets”), the composition limits registered with the Aluminum Association and published in the “Teal Sheets” should be considered the controlling composition. The “Teal Sheets” are available at <http://www.aluminum.org/tealsheets>.

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 5—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** may be used for any alloy listed in 9.2, and AMS 2772 shall 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 (9.2).

4.2.2 Whether heat treatment in accordance with Practice **B918/B918M** is preferred to the default practice, AMS 2772 (9.3).

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).

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).

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

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
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	...	...	...	...	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 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 0.9–1.5 %.

^L Bismuth 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 0.20–0.8 % Lead 0.15–0.40 %.

^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 0.50–0.7 %, Lead 0.20–0.40 %.

^Q Bismuth and lead shall be 0.40–0.7 % each.

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

^S 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 2) are not based on the Zirconium and Titanium algorithm.

^U Gallium 0.03 % max.