



Designation: B491/B491M – 23

Standard Specification for Aluminum and Aluminum-Alloy Extruded Round Tubes for General-Purpose Applications¹

This standard is issued under the fixed designation B491/B491M; 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 extruded round tubes either in coils or straight lengths, for general purpose applications such as refrigeration service, gas lines, oil lines, and instrument lines, in the alloys (Note 2) and tempers shown in Table 2 [Table 3], in outside diameters of 0.250 in. through 0.750 in. [6.00 mm through 20.00 mm]. For diameters over 0.500 in. through 0.750 in. [over 12.50 mm through 20.00 mm], the diameter and wall-thickness tolerances and eddy-current test parameters, if required, shall be agreed upon by the producer and the purchaser. Only tubes in aluminum 1200-H111 and 1235-H111 are sized after extrusion to minimize ovalness.

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, A91050 for aluminum 1050), in accordance with Practice E527.

NOTE 1—For extruded tubes see Specifications B221 or B221M, and for drawn tubes for general-purpose applications see Specification B483/B483M.

NOTE 2—Throughout this specification the term *alloy* in the general sense includes aluminum as well as aluminum alloy.

NOTE 3—For inch-pound orders specify B491; for metric orders specify B491M. Do not mix units.

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 or SI units are to be regarded separately as standards. The SI units are shown either in brackets or in separate tables. The values stated in each system are not exact equivalents; therefore, each system must be used independently of the other. Combining values from two systems will result in nonconformance with the specification.

1.5 *This international standard was developed in accordance with internationally recognized principles on standard-*

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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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 the date of material purchase form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*²

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)

B483/B483M Specification for Aluminum and Aluminum-Alloy Drawn Tube and Drawn Pipe for General Purpose Applications

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

B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products

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

E215 Practice for Standardizing Equipment and Electromagnetic Examination of Seamless Aluminum-Alloy Tube

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.

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

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

2.3 *ANSI Standards*.³

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

H35.2 Dimensional Tolerances for Aluminum Mill Products

H35.2M Dimensional Tolerances for Aluminum Mill Products (Metric)

2.4 *Federal Standard*.⁴

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

2.5 *Military Standard*.⁴

MIL-STD-129 Marking for Shipment and Storage

2.6 *CEN Standard*.⁵

EN 14242 Aluminium and Aluminium Alloys—Chemical Analysis—Inductively Coupled Plasma Optical Emission Spectral Analysis

3. Terminology

3.1 *Definitions*—Refer to Terminology **B881**.

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),

NOTE 4—For inch-pound orders specify B491, for metric orders specify B491M. Do not mix units.

4.1.2 Quantity in pieces or pounds [kilograms],

4.1.3 Alloy (Section 7),

4.1.4 Temper (Section 8),

4.1.5 Cross-sectional dimensions (outside diameter and wall thickness, or inside diameter and wall thickness),

4.1.6 Length, random or specific,

4.1.7 Nominal inside diameter of coils, and weight or maximum outside diameter, if applicable (18.3),

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

³ Available from Aluminum Association, Inc., 1400 Crystal Drive, Suite 430, Arlington, VA 22202, <http://www.aluminum.org>.

⁴ Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098.

⁵ Available from European Committee for Standardization (CEN), Avenue Marnix 17, B-1000, Brussels, Belgium, <http://www.cen.eu>.

4.2.1 Whether testing for leaks is required (Section 10), and frequency of testing required,

4.2.2 For aluminum 1200-H111 and 1235-H111, whether inside cleanliness test is required (11.2), and frequency of testing required,

4.2.3 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 14),

4.2.4 Whether certification is required (Section 16),

4.2.5 Whether marking for identification is required (Section 17), and

4.2.6 Whether Practices **B660** apply and, if so, the levels of preservation packaging, and packing required (18.4).

5. Manufacture

5.1 The tubes covered by this specification shall be produced by the hot-extrusion method. The tube ends shall be crimped or otherwise sealed to avoid contamination during shipping. When sized tube in aluminum 1200-H111 or 1235-H111 is required the extruded tube may be lightly cold drawn.

6. Responsibility for Quality Assurance

6.1 *Responsibility for Inspection*—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 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 nominal dimensions traceable to a heat-treated 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 extrusions shall conform to the chemical composition limits in **Table 1**. Conformance shall be determined by the producer, by taking samples in accordance with Practices **E716** when the ingots are poured and analyzing those samples in accordance with Test Methods **E1251** 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 during pouring of the ingots, they shall not be required to sample and analyze the finished product.

NOTE 5—It is standard practice in the United States aluminum industry to determine conformance to the chemical composition limits prior to further processing of ingots into wrought products. Due to the continuous

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

Alloy	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Zinc	Vanadium	Titanium	Other Elements ^D		Aluminum
										Each	Total ^E	
1050	0.25	0.40	0.05	0.05	0.05	...	0.05	0.05	0.03	0.03 ^G	...	99.50 ^F
1100	0.95 Si + Fe		0.05–0.20	0.05	...	...	0.10	...	...	0.05	0.15	99.00 ^F
1200	1.00 Si + Fe		0.05	0.05	...	...	0.10	...	0.05	0.05	0.15	99.00 ^F
1235	0.65 Si + Fe		0.05	0.05	0.05	...	0.10	0.05	0.06	0.03 ^G	...	99.35 ^F
3003	0.6	0.7	0.05–0.20	1.0–1.5	...	...	0.10	...	...	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
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

^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 off 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 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 Vanadium 0.05 %, maximum.

^H In case there 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>.

TABLE 2 Tensile Property Limits^{A,B}

Alloy	Temper	Specified Wall Thickness, in.	Tensile Strength, ksi		Yield Strength (0.2 % Offset) min, ksi	Elongation in 2 in. min, %
			min	max		
1050 ^C	H112	0.032–0.050	8.5	14.5	2.5	25
1100 ^C	H112	0.032–0.050	11.0	17.0 ^D	3.0	25
1200 ^C	H111	0.032–0.050	11.0	17.0	9.5	25
	H112	0.032–0.050	10.0	16.0	3.0	25
1235 ^C	H111	0.032–0.050	11.0	...	7.5	30
	H112	0.032–0.050	9.0	15.0	3.0	25
3003 ^C	H112	0.032–0.050	14.0	20.0 ^D	5.0	25
3102	H112	0.032–0.050	11.0	18.0	4.0	25
6063	T1	0.032–0.050	17.0	...	9.0	12

^A The basis for establishment of mechanical property limits is shown in 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 Tubes in this alloy are also available in the F (as extruded) temper. Tensile properties for F temper are not specified or guaranteed.

^D Maximum tensile strength for coils. No maximum limit for extruded lengths.

TABLE 3 Tensile Property Limits [SI Units]^{A,B}

Alloy	Temper	Specified Wall Thickness, mm	Tensile Strength, MPa		Yield Strength (0.2 % Offset) min, MPa	Elongation in 50 mm min, %
			min	max		
1050 ^C	H112	0.80–1.30	60	100	15	25
1100 ^C	H112	0.80–1.30	75	115 ^D	20	25
1200 ^C	H111	0.80–1.30	75	115	65	25
	H112	0.80–1.30	70	110	20	25
1235 ^C	H111	0.80–1.30	75	...	50	30
	H112	0.80–1.30	60	105	20	25
3003 ^C	H112	0.80–1.30	95	140 ^D	35	25
3102	H112	0.80–1.30	95	125	30	25
6063	T1	0.80–1.30	115	...	60	12

^A The basis for establishment of mechanical property limits is shown in 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 Tubes in this alloy are also available in the F (as extruded) temper. Tensile properties for F temper are not specified or guaranteed.

^D Maximum tensile strength for coils. No maximum limit for extruded lengths.