



Designation: B 491/B 491M – 00

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

This standard is issued under the fixed designation B 491/B 491M; 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 Department of Defense.

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 through 0.750 in. [6.00 through 20.00 mm]. For diameters over 0.500 through 0.750 in. [over 12.50 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[H35.1M]. 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 E 527.

NOTE 1—For extruded tubes see Specification B 221, and for drawn tubes for general-purpose applications see Specification B 483.

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 B 491; for metric orders specify B 491M. 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 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. 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:*

B 557 Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products²

B 557M Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)²

B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products²

B 666/B 666M Practice for Identification Marking of Aluminum Products²

B 807 Practice for Extrusion Press Solution Heat Treatment for Aluminum Alloys²

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications³

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum Base Alloys⁴

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition^{4, 00}

E 215 Practice for Standardizing Equipment for Electromagnetic Testing of Seamless Aluminum-Alloy Tube⁵

E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique⁴

E 527 Practice for Numbering Metals and Alloys (UNS)⁶

E 607 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere⁷

E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis⁷

² *Annual Book of ASTM Standards*, Vol 02.02.

³ *Annual Book of ASTM Standards*, Vol 14.02.

⁴ *Annual Book of ASTM Standards*, Vol 03.05.

⁵ *Annual Book of ASTM Standards*, Vol 03.03.

⁶ *Annual Book of ASTM Standards*, Vol 01.01.

⁷ *Annual Book of ASTM Standards*, Vol 03.06.

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

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	...	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	...	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 E 29.

^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.

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	...	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	...	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 E 29.

^C Tubes in this alloy are also available in the F (as extruded) temper. Tensile properties for F temper are not specified or guaranteed.

TABLE 3 Tensile Property Limits [SI Units]

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

^A Tubes in this alloy are also available in the F (as extruded) temper. Tensile properties for F temper are not specified or guaranteed.

E 1251 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Argon Atmosphere, Point-to-Plane, Unipolar Self-Initiating Capacitor Discharge⁷

2.3 ANSI Standards:

H35.1 Alloy and Temper Designation Systems for Aluminum²

H35.1M Alloy and Temper Designation Systems for Aluminum (Metric)²

H35.2 Dimensional Tolerances for Aluminum Mill Products²

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

2.4 Federal Standard:⁸

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

2.5 Military Standard:⁸

MIL-STD-129 Marking for Shipment and Storage

⁸ Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

3. Terminology

3.1 Definitions:

3.1.1 *tube*—a hollow wrought product that is long in relation to its cross section, that is round, a regular hexagon, a regular octagon, elliptical, or square or rectangular with sharp or rounded corners, and that has uniform wall thickness except as may be affected by corner radii.

3.1.1.1 *extruded tube*—a tube formed by hot extruding.

3.1.1.2 *sized tube*—a tube which, after extrusion, has been cold drawn a slight amount to minimize ovalness.

3.1.2 *producer*—the primary manufacturer of the material.

3.1.3 *supplier*—includes only the category of jobbers and distributors as distinct from producers.

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 B 491, for metric orders specify B 491M. 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:

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 B 660 applies 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 tubes shall conform to the chemical composition limits specified in Table 1. Conformance shall be determined by analyzing samples taken at the time the ingots are poured or samples taken from the finished or semifinished product. If the producer has determined the chemical composition of the material during the course of manufacture he shall not be required to sample and analyze the finished product.

NOTE 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 nature of the process, it is not practical to keep a specific ingot analysis identified with a specific quantity of finished material.

7.2 *Number of Samples*—The number of samples taken for determination of chemical composition shall be as follows:

7.2.1 When samples are taken at the time the ingots are poured, at least one sample shall be taken for each group of ingots poured simultaneously from the same source of molten metal.

7.2.2 When samples are taken from the finished or semifinished product, a sample shall be taken to represent each 4000 lb [2000 kg] or fraction thereof in the lot, except that not more than one sample shall be required per piece.

7.3 *Methods of Sampling*—Samples for determination of chemical composition shall be taken in accordance with one of the following methods:

7.3.1 Samples for chemical analysis shall be taken from the material by drilling, sawing, milling, turning, or clipping a representative piece or pieces to obtain a prepared sample of not less than 75 g. Sampling shall be in accordance with Practice E 55.

7.3.2 Sampling for spectrochemical analysis shall be in accordance with Practices E 716. Samples for other methods of analysis shall be suitable for the form of material being analyzed and the type of analytical method used.