Designation: B 241/B 241M – 00

Used in USNRC-RDT standards

Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube[1]

This standard is issued under the fixed designation B 241/B 241M; 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[2] covers aluminum and aluminum–alloy seamless pipe in the alloys (Note 1) and tempers shown in Table 1 [Table 2] and extruded round seamless tube in the alloys and tempers shown in Table 3 [Table 4] intended for pressure applications. The standard sizes for seamless pipe are listed in Table 16.7 of ANSI H35.2 and H35.2M. Nonstandard alloys, tempers, and sizes of pipe are produced as seamless extruded tube.

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

NOTE 2—For other seamless drawn tubes, see Specification B 210 or Specification B 483. For extruded tube see Specification B 221, and for structural pipe and tube see Specification B 429.

1.2 Alloy and temper designations are in accordance with ANSI H35.1 and H35.1M. The equivalent Unified Numbering System alloy designations are those of Table 5 preceded by A9, for example, A91100 for aluminum 1100 in accordance with Practice E 527.

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 standard. 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 the two systems will result in nonconformance with this specification.

2. Referenced Documents

2.1 The following documents of the issue in effect on 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 Products[3]

B 557M Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products [Metric][3]

B 594 Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications[3]

B 597 Practice for Heat Treatment of Aluminum Alloys[3]

B 647 Test Method for Indentation Hardness of Aluminum Alloys by Means of a Webster Hardness Gage[3]

B 648 Test Method for Indentation Hardness of Aluminum Alloys by Means of a Barcol Impressor[3]

B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products[3]

B 666/B 666M Practice for Identification Marking of Aluminum Products[3]

B 807 Practice for Extrusion Press Solution Heat Treatment of Aluminum Alloys[3]

E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials[4]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[5]

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum Base Alloys[6]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[6]

E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique[6]

E 527 Practice for Numbering Metals and Alloys (UNS)[7]

E 607 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere[8]

E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis[8]

E 1004 Test Method for Electromagnetic (Eddy-Current)

[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-241/SB-241M in Section II of that Code.

[3] *Annual Book of ASTM Standards*, Vol 02.02.

[4] *Annual Book of ASTM Standards*, Vol 03.01.

[5] *Annual Book of ASTM Standards*, Vol 14.02.

[6] *Annual Book of ASTM Standards*, Vol 03.05.

[7] *Annual Book of ASTM Standards*, Vol 01.01.

[8] *Annual Book of ASTM Standards*, Vol 03.06.

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

TABLE 1 Tensile Property Limits for Pipe, Inch-Pound Units[A,B]

Alloy	Temper	Pipe Size, in.	Tensile Strength, min, ksi	Yield Strength (0.2 % Offset), min, ksi	Elongation in 2 in. or 4 × Diameter, min, %[C]
3003	H18	Under 1	27.0	24.0	4
	H112	1 and over	14.0	5.0	25
6061	T6 (Extruded)	Under 1	38.0	35.0	8
		1 and over	38.0	35.0	10[D]
	T6 (Drawn)	Under 1	42.0	35.0	8[E]
		1 and over	38.0	35.0	10[F]
6063	T6	All	30.0	25.0	8
6351	T5	All	38.0	35.0	10[D]
	T6	All	42.0	37.0	10[G]

[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 E 29.
[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 wall thicknesses less than 0.250 in., the minimum elongation is 8 %.
[E] For wall thickness 0.050 to 0.259 in., the minimum elongation is 10 %.
[F] For wall thickness 0.260 to 0.500 in., the minimum elongation is 12 %.
[G] For wall thickness less than 0.125 in., the minimum elongation is 8 %.

TABLE 2 Tensile Property Limits for Pipe [SI Units][A,B]

Alloy[C]	Temper[C] (Product)	Pipe Size, Designation	Tensile Strength, min, MPa	Yield Strength (0.2 % Offset), min, MPa	Elongation,[C] min, %	
					in 50 mm	in 5 × Diameter ($5.65\sqrt{A}$)
3003	H18	Under 1	185	165	4	...
	H112	1 and over	95	35	25	22
6061	T6 (Extruded)	Under 1	260	240	8	...
		1 and over	260	240	10[D]	9
	T6 (Drawn)	Under 1	290	240	8[E]	...
		1 and over	260	240	10[F]	9
6063	T6	All	205	170	8	7
6351	T5	All	260	240	10[D]	9
	T6	All	290	255	10[G]	9

[A] The basis for establishment of mechanical property limits is shown in Annex A1.
[B] 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 E 29.
[C] Elongations 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. Elongations in 5*D* ($5.65\sqrt{A}$), 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.
[D] For wall thicknesses up through 6.30 mm the minimum elongation is 8 %.
[E] For wall thicknesses over 1.25 through 6.60 mm, the minimum elongation is 10 %.
[F] For wall thicknesses over 6.60 through 12.50 mm, the minimum elongation is 12 %.
[G] For wall thicknesses up through 3.20 mm the minimum elongation is 8 %.

Measurements of Electrical Conductivity[9]
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 Discharge[8]
G 47 Test Method for Determining Susceptibility to Stress-Corrosion Cracking of High-Strength Aluminum Alloy Products[10]

2.3 *ANSI Standards:*
H35.1 Alloy and Temper Designation Systems for Aluminum[3]
H35.1(M) Alloy and Temper Designation Systems for Aluminum[3]
H35.2 Dimensional Tolerances for Aluminum Mill Products[3]
H35.2(M) Dimensional Tolerances for Aluminum Mill Products[3]

2.4 *Federal Standard:*
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[11]

2.5 *Military Standard:*
MIL-STD-129 Marking for Shipment and Storage[11]

2.6 *Military Specification:*
MIL-H-6088 Heat Treatment of Aluminum Alloys[11]

3. Terminology

3.1 *Definitions:*

3.1.1 *alclad seamless pipe or alclad seamless tube*—a composite pipe or tube product composed of a seamless aluminum alloy core having on either the inside or the outside surface a metallurgically bonded aluminum or aluminum-alloy coating that is anodic to the core, thus electrolytically protecting the core against corrosion.

3.1.2 *extruded seamless round tube*—an extruded hollow product having a round cross section and a uniform wall thickness, which does not contain any line junctures resulting from method of manufacture.

[9] *Annual Book of ASTM Standards*, Vol 03.03.
[10] *Annual Book of ASTM Standards*, Vol 03.02.
[11] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

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

3.1.4 *seamless pipe*—extruded or drawn seamless tube having certain standardized sizes of outside diameter and wall thickness commonly designated by "Nominal Pipe Sizes" and American National Standards Institute (ANSI) Schedule Numbers.

3.1.5 *supplier*—jobber or distributor as distinct from producer.

3.2 *Definitions of Terms Specific to This Standard:*

3.2.1 *capable of*—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),

NOTE 3—For inch-pound orders specify B 241; for metric orders specify B 241M. Do not mix units.

4.1.2 Quantity in pieces or pounds [kilograms],

4.1.3 Alloy (Section 7),

4.1.4 Temper (Section 9),

4.1.5 Pipe size and schedule number (Table 16.7 of ANSI H35.2 and H35.2M), or outside diameter and wall thickness (extruded tube), and

4.1.6 Length.

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

4.2.1 Whether solution treatment at the press is unacceptable (8.2),

4.2.2 Whether heat treatment in accordance with Practice B 597 is required (8.3),

4.2.3 Whether pipe size under 1 shall be extruded only (5.1 and Table 1 or [Table 2], Footnote F),

4.2.4 Whether threaded ends are required (see 15.2),

4.2.5 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 16),

4.2.6 Whether marking for identification is required (Section 19), and whether marking of lot number for alloys 2014 and 2024 in the T3- and T4-type tempers and alloy 6061 in the T6-type tempers is required (19.2),

4.2.7 Whether Practices B 660 applies and, if so, the levels of preservation, packaging, and packing required (19.3),

4.2.8 Whether certification of the material is required (Section 20),

4.2.9 Requirements for tensile property and dimensional tolerance for sizes not specifically covered (9.1.2 and 14.2), and

4.2.10 Whether ultrasonic inspection is required (Section 16, Table 6 [Table 7]).

5. Materials and Manufacture

5.1 The pipe and tube shall be produced from hollow extrusion ingot (cast in hollow form, or drilled, or pierced from solid ingot) and shall be extruded by use of the die and mandrel method. Pipe and tube may be subsequently cold drawn at the option of the producer.

6. 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. 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 in the order or at the time of contract signing. The purchaser shall have the right to perform any of the inspections and tests set forth in this specification where such inspections and tests are deemed necessary to ensure 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-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.

TABLE 3 Tensile Property Limits for Extruded Tube, Inch-Pound Units[A,B]

Temper	Specified Section or Wall Thickness, in.	Area, in.[2]	Tensile Strength, ksi		Yield Strength (0.2 % Offset), ksi		Elongation in 2 in. or 4 × Diameter, min, %[C]
			Min	Max	Min	Max	
			Aluminum 1060				
O	all	all	8.5	14.0	2.5	...	25
H112	all	all	8.5	...	2.5	...	25
F[D]	all	all	...	...	...	...	...
			Aluminum 1100				
O	all	all	11.0	15.5	3.0	...	25
H112	all	all	11.0	...	3.0	...	25
F[D]	all	all	...	...	...	...	...
			Alloy 2014				
O	all	all	...	30.0	...	18.0	12
T4 T4510[E] T4511[E]	all	all	50.0	...	35.0	...	12
T42	all	all	50.0	...	29.0	...	12
T6 T6510[E] T6511[E]	up thru 0.499	all	60.0	...	53.0	...	7
	0.500–0.749	all	64.0	...	58.0	...	7
	0.750 and over	up thru 25	68.0	...	60.0	...	7
		over 25 thru 32	68.0	...	58.0	...	6
T62	up thru 0.749	all	60.0	...	53.0	...	7
	0.750 and over	up thru 25	60.0	...	53.0	...	7
		over 25 thru 32	60.0	...	53.0	...	6
F[D]	all	all	...	...	...	...	...
			Alloy 2024				
O	all	all	...	35.0	...	19.0	12
T3 T3510[E] T3511[E]	up thru 0.249	all	57.0	...	42.0	...	10
	0.250–0.749	all	60.0	...	44.0	...	10
	0.750–1.499	all	65.0	...	46.0	...	10
	1.500 and over	up thru 25	70.0	...	48.0	...	10
		over 25 thru 32	68.0	...	46.0	...	8
T42	up thru 0.749	all	57.0	...	38.0	...	12
	0.750–1.499	all	57.0	...	38.0	...	10
	1.500 and over	up thru 25	57.0	...	38.0	...	10
		over 25 thru 32	57.0	...	38.0	...	8
T81 T8510[E] T8511[E]	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 thru 32	66.0	...	58.0	...	5
F[D]	all	all	...	...	...	...	...
			Alloy 2219				
O	all	all	...	32.0	...	18.0	12
T31 T3510[E] T3511[E]	up thru 0.499	up thru 25	42.0	...	26.0	...	14
	0.500-2.999	up thru 25	45.0	...	27.0	...	14
T62	Up thru 0.999	up thru 25	54.0	...	36.0	...	6
	1,000 and over	up thru 25	54.0	...	36.0	...	6
T81 T8510[E] T8511[E]	up thru 2.999	up thru 25	58.0	...	42.0	...	6
F[D]	all	all	...	...	...	...	...
			Alloy 3003				
O	all	all	14.0	19.0	5.0	...	25
H112	all	all	14.0	...	5.0	...	25
F[D]	all	all	...	...	...	...	...

TABLE 3 *Continued*

Temper	Specified Section or Wall Thickness, in.	Area, in.[2]	Tensile Strength, ksi		Yield Strength (0.2 % Offset), ksi		Elongation in 2 in. or 4 × Diameter, min, %[C]
			Min	Max	Min	Max	
			Alclad Alloy 3003				
O	all	all	13.0	18.0	4.5	...	25
H112	all	all	13.0	...	4.5	...	25
F[D]	all	all	...	...	...	...	...
			Alloy 5052				
O	all	all	25.0	35.0	10.0	...	...
F[D]	all	all	...	...	...	...	...
			Alloy 5083				
O	all	up thru 32	39.0	51.0	16.0	...	14
H111	all	up thru 32	40.0	...	24.0	...	12
H112	all	up thru 32	39.0	...	16.0	...	12
F[D]	all	all	...	...	...		...
			Alloy 5086				
O	all	up thru 32	35.0	46.0	14.0	...	14
H111	all	up thru 32	36.0	...	21.0	...	12
H112	all	up thru 32	35.0	...	14.0	...	12
F[D]	all	all	...	...	...	...	...
			Alloy 5454				
O	all	up thru 32	31.0	41.0	12.0	...	14
H111	all	up thru 32	33.0	...	19.0	...	12
H112	all	up thru 32	31.0	...	12.0	...	12
F[D]	all	all	...	...	...	...	...
			Alloy 5456				
O	all	up thru 32	41.0	53.0	19.0	...	14
H111	all	up thru 32	42.0	...	26.0	...	12
H112	all	up thru 32	41.0	...	19.0	...	12
F[D]	all	all	...	...	...	...	...
			Alloy 6061				
O	all	all	...	22.0	...	16.0	16
T1	up thru 0.625	all	26.0	...	14.0	...	16
T4, T4510[E], T4511[E]	all	all	26.0	...	16.0	...	16
T42	all	all	26.0	...	12.0	...	16
T51	up thru 0.625	all	35.0	...	30.0	...	8
T6, T62, T6510[E], T6511[E]	up thru 0.249	all	38.0		35.0	...	8
	0.250 and over	all	38.0	...	35.0	...	10
F[D]	all	all	...	...	...	...	...
			Alloy 6063				
O	all	all	...	19.0	...	...	18
T1[F]	up thru 0.500	all	17.0	...	9.0	...	12
	0.501–1.000	all	16.0	...	8.0	...	12
T4, T42	up thru 0.500	all	19.0	...	10.0	...	14
	0.501–1.000	all	18.0	...	9.0	...	14
T5	up thru 0.500	all	22.0	...	16.0	...	8
	0.501–1.000	all	21.0	...	15.0	...	8
T52	up thru 1.000	all	22.0	30.0	16.0	25.0	8
T6, T62	up thru 0.124	all	30.0	...	25.0	...	8
	0.125–1.000	all	30.0	...	25.0	...	10
F[D]	all	all	...	...	...	...	...

TABLE 3 *Continued*

Temper	Specified Section or Wall Thickness, in.	Area, in.[2]	Tensile Strength, ksi		Yield Strength (0.2 % Offset), ksi		Elongation in 2 in. or 4 × Diameter, min, %[C]
			Min	Max	Min	Max	
			Alloy 6066				
O	all	all	...	29.0	...	18.0	16
T4, T4510,[E] T4511[E]	all	all	40.0	...	25.0	...	14
T42	all	all	40.0	...	24.0	...	14
T6, T6510,[E] T6511[E]	all	all	50.0	...	45.0	...	8
T62	all	all	50.0	...	42.0	...	8
			Alloy 6162				
T5, T5510,[E] T5511[E]	up thru 1.000	all	37.0	...	34.0	...	7
T6, T6510,[E] T6511[E]	up thru 0.249	all	38.0	...	35.0	...	8
	0.250–0.499	all	38.0	...	35.0	...	10
			Alloy 6351				
T4	up thru 0.749	all	32.0	...	19.0	...	16
T6	up thru 0.124	...	42.0	...	37.0	...	8
	0.125-0.749	...	42.0	...	37.0	...	10
			Alloy 7075				
O	all	...	...	40.0	...	24.0	10
T6, T62, T6510[E], T6511[E]	up thru 0.249	all	78.0	...	70.0	...	7
	0.250–0.499	all	81.0	...	73.0	...	7
	0.500–1.499	all	81.0	...	72.0	...	7
	1.500–2.999	all	81.0	...	72.0	...	7
T73, T73510, T73511	0.062–0.249	all	68.0	...	58.0	...	7
	0.250–1.499	up thru 25	70.0	...	61.0	...	8
	1.500–2.999	up thru 25	69.0	...	59.0	...	8
F[D]	all	all	...	...	...	...	...
			Alloy 7178				
O	all	up thru 32	...	40.0	...	24.0	10
T6, T6510[E], T6511[E]	up thru 0.061	all	82.0	...	76.0	...	5
	0.062–0.249	up thru 20	84.0	...	76.0	...	5
	0.250–1.499	up thru 25	87.0	...	78.0	...	5
	1.500–2.499	up thru 25	86.0	...	77.0	...	5
		over 25 thru 32	84.0	...	75.0	...	5
	2.500–2.999	up thru 32	82.0	...	71.0	...	5
T62	up thru 0.061	all	79.0	...	73.0	...	5
	0.062–0.249	up thru 20	82.0	...	74.0	...	5
	0.250–1.499	up thru 25	86.0	...	77.0	...	5
	1.500–2.499	up thru 25	86.0	...	77.0	...	5
		over 25 thru 32	84.0	...	75.0		5
	2.500–2.999	up thru 32	82.0	...	71.0	...	5
F[D]	all	all	...	...	...	...	...

[A] The basis for establishment of mechanical property limits is shown in Annex A1.

[B] To determine conformance to this specification, each value for ultimate 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-off method of Practice E 29.

[C] Elongation of full-section and cut-out sheet-type specimens is measured in 2 in.; of round specimens, in 4 × specimen diameter. See 9.1.1 for conditions under which measurements are not required.

[D] Tests for tensile properties in the F temper are not required.

[E] For stress-relieved tempers (T3510, T3511, T4510, T4511, T5510, T5511, T6510, T6511, T73510, T73511, T8510, T8511), characteristics and properties other than those specified may differ somewhat from the corresponding characteristics and properties of material in the basic tempers.

[F] Formerly designated T42 temper. When properly aged (precipitation heat-treated) 6063-T1 extruded products are designated T5.