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Used in USNRC-NDT standards

Standard Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes[1]

This standard is issued under the fixed designation B 210; 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 drawn seamless tubes in straight lengths and coils for general purpose and pressure applications in alloys (Note 2), tempers, and thicknesses shown in Table 1. Coiled tubes are generally available only as round tubes with a wall thickness not exceeding 0.083 in. and only in nonheat-treatable alloys.

1.2 Alloy and temper designations are in accordance with ANSI H35.1. The equivalent Unified Numbering System alloy designations are those of Table 2 preceded by A9, for example, A91100 for aluminum designation 1100 in accordance with Practice E 527E 527.

NOTE 1—See Specification B 483 for aluminum-alloy drawn tubes for general purpose applications; Specification B 234 for aluminum-alloy drawn seamless tubes for condensers and heat exchangers; and Specification B 241/B 241M for aluminum-alloy seamless pipe and seamless extruded tube.

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

1.3 A complete metric companion to Specification B 210 has been developed—Specification B 210M; therefore, no metric equivalents are presented in this specification.

~~1.4For~~1.4 For acceptance criteria for inclusion of new aluminum and aluminum alloys in this specification, see Annex A2.

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 597 Practice for Heat Treatment of Aluminum Alloys[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]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[4]

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys[5]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[5] ~~E101Test Method for Spectrographic Analysis of Aluminum and Aluminum Alloys by the~~

[1] This specification is under the jurisdiction of ASTM Committee ~~B-7~~ 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-210 in Section II of that Code.

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

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

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

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

~~Point-to-Plane Technique~~[5]

E 215 Practice for Standardizing Equipment for Electromagnetic Examination of Seamless Aluminum-Alloy Tube[6]
E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique[5]
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) Measurements of Electrical Conductivity[6]
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]

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

2.4 *Military Standard:*
MIL-STD-129 Marking for Shipment and Storage[9]

2.5 *Military Specification:*
MIL-H-6088 Heat Treatment of Aluminum Alloys[9]

2.6 *Federal Standard:*
Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[9]

3. Terminology

3.1 *Definitions:*

3.1.1 *tube*—a hollow wrought product that is long in relation to its cross section, which 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.

3.1.2 *drawn seamless tube*—a tube produced from hollow extrusion ingot and brought to final dimensions by drawing through a die.

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

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

3.1.5 *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 subsequent testing by the purchaser establish that the material does not meet these requirements, the material shall be subject to rejection.

TABLE 1 Tensile Property Limits[A,B]

Temper	Specified Wall Thickness,[C] in.	Tensile Strength, ksi		Yield Strength[D] (0.2 % offset), min, ksi	Elongation in 2 in. or 4 × Diameter,[E] min, %	
		min	max		Full-Section Specimen	Cut-Out Specimen
			Aluminum 1060[F]			
O	0.018–0.500	8.5	13.5	2.5	...	...
H12		10.0	...	4.0	...	...
H14		12.0	...	10.0	...	...
H18		16.0	...	13.0	...	...
H113[G]		8.5	...	2.5	...	...
			Aluminum 1100[F]			
O	0.018–0.500	11.0	15.5	3.5	...	...

[6] *Annual Book of ASTM Standards*, Vol 03.03.
[7] *Annual Book of ASTM Standards*, Vol 01.01.
[8] *Annual Book of ASTM Standards*, Vol 03.06.
[9] Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

TABLE 1 *Continued*

Temper	Specified Wall Thickness,[C] in.	Tensile Strength, ksi		Yield Strength[D] (0.2 % offset), min, ksi	Elongation in 2 in. or 4 × Diameter,[E] min, %	
		min	max		Full-Section Specimen	Cut-Out Specimen
H12		14.0	...	11.0	...	...
H14		16.0	...	14.0	...	...
H16		19.0	...	17.0	...	...
H18		22.0	...	20.0	...	...
H113[G]		11.0		3.5		
			Alloy 2011			
T3	0.018–0.049	47.0	...	40.0	...	...
	0.050–0.500	47.0	...	40.0	10	8
T4511	0.018–0.049	44.0	...	25.0	...	...
					20	18
	0.050–0.259	44.0	...	25.0		
	0.260–0.500	44.0	...	25.0	20	20
			Alloy 2014			
O	0.018–0.500	...	32.0	16.0 max	...	...
T4, T42[H]	0.018–0.024	54.0	...	30.0	10	...
	0.025–0.049	54.0	...	30.0	12	10
	0.050–0.259	54.0	...	30.0	14	10
	0.260–0.500	54.0	...	30.0	16	12
T6, T62[H]	0.018–0.024	65.0	...	55.0	7	...
	0.025–0.049	65.0	...	55.0	7	6
	0.050–0.259	65.0	...	55.0	8	7
	0.260–0.500	65.0	...	55.0	9	8
			Alloy 2024			
O	0.018–0.500	...	32.0	15.0 max	...	...
T3[H]	0.018–0.024	64.0	...	42.0	10	...
	0.025–0.049	64.0	...	42.0	12	10
	0.050–0.259	64.0	...	42.0	14	10
	0.260–0.500	64.0	...	42.0	16	12
T42[H]	0.018–0.024	64.0	...	40.0	10	...
	0.025–0.049	64.0	...	40.0	12	10
	0.050–0.259	64.0	...	40.0	14	10
	0.260–0.500	64.0	...	40.0	16	12
			Alloy 3003[F]			
O	0.010–0.024	14.0	19.0	5.0	...	...
	0.025–0.049	14.0	19.0	5.0	30	20
	0.050–0.259	14.0	19.0	5.0	35	25
	0.260–0.500	14.0	19.0	5.0	...	30
H12	0.010–0.500	17.0	...	12.0	...	...
H14	0.010–0.024	20.0	...	17.0	3	...
	0.025–0.049	20.0	...	17.0	5	3
	0.050–0.259	20.0	...	17.0	8	4
	0.260–0.500	20.0	...	17.0	...	...
H16	0.010–0.024	24.0	...	21.0	...	...
	0.025–0.049	24.0	...	21.0	3	2
	0.050–0.259	24.0	...	21.0	5	4
	0.260–0.500	24.0	...	21.0	...	...
H18	0.010–0.024	27.0	...	24.0	2	...
	0.025–0.049	27.0	...	24.0	3	2
	0.050–0.259	27.0	...	24.0	5	3
	0.260–0.500	27.0	...	24.0	...	...
H113[G]	0.010–0.500	14.0	...	5.0	...	...
			Alloy Alclad 3003			
O	0.010–0.024	13.0	19.0	4.5	...	...
	0.025–0.049	13.0	19.0	4.5	30	20
	0.050–0.259	13.0	19.0	4.5	35	25
	0.260–0.500	13.0	19.0	4.5	...	30
H14	0.010–0.024	19.0	...	16.0	...	...
	0.025–0.049	19.0	...	16.0	5	...
	0.050–0.259	19.0	...	16.0	8	4
	0.260–0.500	19.0	...	16.0	...	...
H18	0.010–0.500	26.0	...	23.0	...	...
H113[G]	0.050–0.500	13.0	...	4.5	...	...
			Alloy 3102[F]			
O	0.018–0.049	11.0	17.0	3.5	30[I]	20[I]
	0.050–0.065	11.0	17.0	3.5	35	25

TABLE 1 *Continued*

Temper	Specified Wall Thickness,[C] in.	Tensile Strength, ksi		Yield Strength[D] (0.2 % offset), min, ksi	Elongation in 2 in. or 4 × Diameter,[E] min, %	
		min	max		Full-Section Specimen	Cut-Out Specimen
			Alloy Alclad 3102[F]			
O	0.018–0.049	10.0	17.0	3.5	30[I]	20[I]
						25
	0.050–0.065	10.0	17.0	3.5	35	
			Alloy 3303[F]			
O	0.010–0.024	14.0	19.0	5.0	...	...
						20
	0.025–0.049	14.0	19.0	5.0	30	
	0.050–0.065	14.0	19.0	5.0	35	25
			Alloy Alclad 3303[F]			
O	0.010–0.024	13.0	19.0	4.5	...	...
	0.025–0.049	13.0	19.0	4.5	30	20
	0.050–0.065	13.0	19.0	4.5	35	25
			Alloy 5005[F]			
O[F]	0.018–0.500	15.0	21.0	5.0	...	...
			Alloy 5050[F]			
O[F]	0.018–0.500	18.0	24.0	6.0	...	...
H32		22.0	...	16.0	...	...
H34		25.0	...	20.0	...	...
H36		27.0	...	22.0	...	...
H38		29.0	...	24.0	...	...
			Alloy 5052[F]			
O[F]	0.018–0.450	25.0	35.0	10.0	...	...
H32		31.0	...	23.0	...	...
H34		34.0	...	26.0	...	...
H36		37.0	...	29.0	...	...
H38		39.0	...	24.0	...	...
			Alloy 5083[F]			
O[F]	0.018–0.450	39.0	51.0	16.0	...	14
			Alloy 5086[F]			
O[F]	0.018–0.450	35.0	46.0	14.0	...	...
H32		40.0	...	28.0	...	...
H34		44.0	...	34.0	...	...
H36		47.0	...	38.0	...	...
			Alloy 5154[F]			
O	0.010–0.450	30.0	41.0	11.0	10	10
H34		39.0	...	29.0	5	5
H38		45.0	...	34.0	...	...
			Alloy 5456[F]			
O	0.018	41.0	53.0	19.0	...	14
			Alloy 6061			
O	0.018–0.500	...	22.0	14.0 max	15	15
T4	0.025–0.049	30.0	...	16.0	16	14
	0.050–0.259					
	0.260–0.500	30.0	...	16.0	18	16
		30.0	...	16.0	20	18
T42[H]	0.025–0.049	30.0	...	14.0	16	14
	0.050–0.259	30.0	...	14.0	18	16
	0.260–0.500	30.0	...	14.0	20	18
T6, T62[H]	0.025–0.049	42.0	...	35.0	10	8
	0.050–0.259	42.0	...	35.0	12	10
	0.260–0.500	42.0	...	35.0	14	12
			Alloy 6063			
O	0.018–0.500	...	19.0	...	...	...
T4, T42[H]	0.025–0.049	22.0	...	10.0	16	14
	0.050–0.259	22.0	...	10.0	18	16
	0.260–0.500	22.0	...	10.0	20	18

TABLE 1 *Continued*

Temper	Specified Wall Thickness,^{C} in.	Tensile Strength, ksi		Yield Strength^{D} (0.2 % offset), min, ksi	Elongation in 2 in. or 4 × Diameter,^{E} min, %	
		min	max		Full-Section Specimen	Cut-Out Specimen
T6, T62^{H}	0.025–0.049	33.0	...	28.0	12	8
	0.050–0.259	33.0	...	28.0	14	10
	0.260–0.500	33.0	...	28.0	16	12
T83	0.025–0.259	33.0	...	30.0	5	...
T831	0.025–0.259	28.0	...	25.0	5	...
T832	0.025–0.049	41.0	...	36.0	8	5
	0.050–0.259	40.0	...	35.0	8	5
			Alloy 6262			
T6, T62^{H}	0.025–0.049	42.0	...	35.0	10	8
	0.050–0.259	42.0	...	35.0	12	10
	0.260–0.500	42.0	...	35.0	14	12
T9	0.025–0.375	48.0	...	44.0	5	4
			Alloy 7075			
O	0.025–0.049	...	40.0	21.0 max	10	8
	0.050–0.500	...	40.0	21.0 max	12	10
T6, T62^{H}	0.025–0.259	77.0	...	66.0	8	7
	0.260–0.500	77.0	...	66.0	9	8
T73^{J}	0.025–0.259	66.0	...	56.0	10	8
	0.260–0.500	66.0	...	56.0	12	10

^{A} See 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-off method of Practice E 29E 29.

^{C} Coiled tube is generally available with a maximum wall thickness of 0.083 in. and only in nonheat-treatable alloys.

^{D} Yield strength to be determined only in straight tube.

^{E} Elongation of full-section and cut-out sheet-type specimens is measured in 2 in. of cut-out round specimens, in 4× specimen diameter.

^{F} In this alloy tube other than round is produced only in the F (as drawn) and O tempers. Properties for F temper are not specified or guaranteed.

^{G} Beginning with the 1982 issue the requirements for the H112 tempers were replaced by the H113 temper, applicable to other than round tube, which is fabricated by cold-forming annealed round tube and acquires some temper in this forming operation.

^{H} Material in the T42 or T62 tempers is not available from the material producers.

^{I} For specified wall thickness under 0.025 in., elongation is not required.

^{J} Material in this temper exhibits improved resistance to stress corrosion compared to that of the T6 temper. The stress-corrosion resistance capability of individual lots is determined by testing the previously selected tension-test samples in accordance with the applicable electrical conductivity acceptance criteria of Table 3.

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),

4.1.4 Temper (Section 8),

4.1.5 Cross-sectional dimensions (outside diameter and wall thickness, or inside diameter and wall thickness for round tube; for tube other than round, square, rectangular, hexagonal, or octagonal with sharp corners, a drawing is required),

4.1.6 Length (straight or coiled),

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

4.1.8 For alloy Alclad 3003, Alclad 3102, or Alclad 3303 state clad inside or outside (17.1).

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

4.2.1 Whether heat treatment in accordance with Practice B 597 is required (11.2),

4.2.2 Whether flattening tests are required (Section 9 and Table 4),

4.2.3 Whether flare testing is required (Section 1010),),

4.2.4 Whether 7075-O material is required to develop requirements for T73 temper (12.3),

4.2.5 Whether testing for leaks is required and, when leaks are allowed, the number of leaks allowed and the manner of marking leaks (15.1.3.2),

4.2.6 Whether inside cleanness test is required on coiled tubes (16.2) and frequency of testing required,

4.2.7 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 20),

4.2.8 Whether certification is required (Section 22),

TABLE 4 Minimum Outside Diameter Flattening Factor

Alloy	Temper	Wall Thickness, in.	Minimum Diameter Flattening Factor, *F*
1100	O	0.014–0.500	2
	H12	0.014–0.500	3
	H14	0.014–0.500	6
	H16	0.014–0.500	8
3003	O	0.025–0.500	2
	H12	0.025–0.500	3
	H14	0.025–0.500	6
	H16	0.025–0.500	8
2024	O	0.018–0.049	3
		0.050–0.500	4
	T3	0.018–0.500	8
5052	O	0.010–0.450	3
	H32	0.010–0.450	6
	H34	0.010–0.450	8
5086	O	0.010–0.450	3
	H32	0.010–0.450	8
6061	O	0.018–0.120	3
		0.121–0.238	4
		0.239–0.500	6
	T4	0.025–0.500	6
	T6	0.025–0.500	8
7075	O	0.025–0.049	4
		0.050–0.259	5
	T6	0.025–0.259	10

4.2.9 Whether marking for identification is required (Section 23), and

4.2.10 Whether Practices B 660B 660 applies, and if so, the levels of preservation, packaging, and packing required (Section 24).

5. Materials and Manufacture

5.1 The tube shall be produced by drawing an extruded tube made from hollow extrusion ingot (cast in hollow form or pierced) and extruded by the use of the die and mandrel method.

5.2 The ends of coiled tube shall be crimped or otherwise sealed to avoid contamination during shipment.

6. Responsibility for 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 signing the contract. 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 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.

7. Chemical Composition

7.1 *Limits*—The tubes shall conform to the chemical composition limits prescribed in Table 2. Conformance shall be determined by the producer by analyzing samples taken at the time the ingots are poured, or samples taken from the finished or semi-finished 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 3—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.