METRIC
Designation: B 210M – 0̶0̶2

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

This standard is issued under the fixed designation B 210M; 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] 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 ~~May~~ Oct. 10, 200~~0~~2. Published ~~August 2000.~~ December 2002. Originally ~~published as B 210M–80.~~ approved in 1980. Last previous edition approved in 2000 as B 210M–~~95~~00.

1. Scope *

1.1 This specification 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 2. Coiled tubes are generally available only as round tubes with a wall thickness not exceeding 2.00 mm and only in nonheat-treatable alloys.

1.2 Alloy and temper designations are in accordance with ANSI 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 E 527.

1.3 Preferred metric sizes are in accordance with ANSI B 32.5.

NOTE 1—See Specification B 483M for aluminum and aluminum-alloy drawn tubes for general purpose applications, Specification B 234M 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.

1.4 This specification is the metric counterpart of Specification B 210.

1.5 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 ~~557M Test Methods of Tension Testing Wrought~~ 234 Specification for Aluminum and ~~Cast Aluminum-~~ Aluminum-Alloy Drawn Seamless Tubes for Condensers and ~~Magnesium-Alloy Products [Metric]~~ Heat Exchangers[2]

B ~~597 Practice~~ 241/B 241M Specification for ~~Heat Treatment of~~ Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube[2]

B 483 Specification for Aluminum and Aluminum-Alloy Drawn Tubes for General Purpose Applications[2]

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 Products[2]

B 666/B 666M Practice for Identification Marking of Aluminum and Magnesium Products[2]

B 918 Practice for Heat Treatment of Wrought Aluminum Alloys[2]

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications[3]

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys[4]

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition[4]

E 215 Practice for Standardizing Equipment for Electromagnetic Examination of Seamless Aluminum-Alloy Tube[5]

E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique[4]

[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.

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

TABLE 1 Chemical Composition Limits[A,B,C]

Alloy	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Zinc	Titanium	Other Elements[D]		Aluminum, min
									Each	Total[E]	
1060	0.25	0.35	0.05	0.03	0.03	...	0.05	0.03	0.03[F]	...	99.60 min[G]
1100	0.95 Si + Fe		0.05–0.20	0.05	...	...	0.10	...	0.05	0.15	99.00 min[G]
2011	0.40	0.7	5.0–6.0	...	...	...	0.30	...	0.05[H]	0.15	remainder
2014	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	remainder
2024	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	remainder
3003	0.6	0.7	0.05–0.20	1.0–1.5	...	...	0.10	...	0.05	0.15	remainder
Alclad 3003[I]											
3102	0.40	0.7	0.10	0.05–0.40	...	...	0.30	0.10	0.05	0.15	remainder
Alclad 3102[I]											
3303	0.6	0.7	0.05–0.20	1.0–1.5	...	...	0.30	...	0.05	0.15	remainder
Alclad 3303[I]											
5005	0.30	0.7	0.20	0.20	0.50–1.1	0.10	0.25	...	0.05	0.15	remainder
5050	0.40	0.7	0.20	0.10	1.1–1.8	0.10	0.25	...	0.05	0.15	remainder
5052	0.25	0.40	0.10	0.10	2.2–2.8	0.15–0.35	0.10	...	0.05	0.15	remainder
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	remainder
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	remainder
5154	0.25	0.40	0.10	0.10	3.1–3.9	0.15–0.35	0.20	0.20	0.05	0.15	remainder
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	remainder
6061	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	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
6262	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[J]	0.15	remainder
7072 cladding[K]	0.7 Si + Fe		0.10	0.10	0.10	...	0.8–1.3	...	0.05	0.15	remainder
7075	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	remainder

[A] Limits are in weight 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 obtained from analysis shall be rounded to the nearest unit in the last right-hand place of figures used in expressing the specified limit, in accordance with the rounding-off 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 non-conforming.

[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] Vanadium 0.05 % max.

[G] 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.

[H] Bismuth and lead each 0.20 − 0.6 %.

[I] Alloy clad with Alloy 7072.

[J] Bismuth and lead each 0.40–0.7 %.

[K] Composition of cladding alloy as applied during the course of manufacture. The samples from finished tube shall not be required to conform to these limits.

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 Atmosphere[4]

E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis[4]

E ~~1004 Test Method~~ 1004 Practice for ~~Electromagnetic (Eddy-Current) Measurements of~~ Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method[5]

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[4]

2.3 *ANSI Standards:*

B 32.5 Preferred Metric Sizes For Tubular Metal Products Other Than Pipe[7]

H35.1M Alloy and Temper Designation Systems for Aluminum[2]

H35.2M Dimensional Tolerances for Aluminum Mill Products[2]

2.4 *Military Standard:*

MIL-STD-129 Marking for Shipment and Storage[8]

2.5 ~~*Military*~~*AMS Specification:*

~~MIL-H-6088 Heat~~

AMS 2772 Heat Treatment of Aluminum Alloy Raw Materials[9]

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

~~*Annual Book of ASTM*~~

[7] Available from American National Standards~~, Vol 03.06.~~ Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.

[8] Available from ~~American National Standards Institute, 11 West 42nd Street, 13th Floor, New York, NY 10036.~~ Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.

[9] Available from ~~Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia,~~ Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA ~~19111-5094, Attn: NPODS.~~ 15096-0001.

2.6 *Federal Standard:*

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)[8]

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 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.

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 kilograms,

4.1.3 Alloy (Section 7),

4.1.4 Temper (Section 8),

TABLE 2 Tensile Property Limits[A,B]

Temper	Specified Wall Thickness[C]		Tensile Strength, MPa		Yield Strength[D] (0.2 % offset), MPa		Elongation,[E] min, %		
								Cut-Out Specimen	
	Over	Through	Min	Max	Min	Max	Full-Section Specimen in 50 mm	in 50 mm	in 5 × Diameter ($5.65\sqrt{A}$)
Aluminum 1060[F]									
O	0.45	12.50	60	95	15	...	...	...	...
H12	0.45	12.50	70	...	30	...	...	...	...
H14	0.45	12.50	85	...	70	...	...	...	...
H18	0.45	12.50	110	...	90	...	...	...	...
H113[G]	0.45	12.50	60	...	15	...	...	...	...
F	All		...	...	...	...	...	...	...
Aluminum 1100[F]									
O	0.45	12.50	75	105	25	...	...	...	...
H12	0.45	12.50	95	...	75	...	...	...	...
H14	0.45	12.50	110	...	95	...	...	...	...
H16	0.45	12.50	130	...	115	...	...	...	...
H18	0.45	12.50	150	...	140	...	...	...	...
H113[G]	0.45	12.50	75	...	25	...	...	...	...
F	All		...	...	...	...	...	...	...
Alloy 2011									
T3	0.45	1.20	325	...	275	...	...	...	...
	1.20	12.50	325	...	275	...	10	8	7
T4511	0.45	1.20	305	...	170	...	...	...	...
	1.20	6.50	305	...	170	...	20	18	16
	6.50	12.50	305	...	170	...	20	20	18
Alloy 2014									
O	0.45	12.50	...	220	...	110	...	...	...
T4, T42[H]	0.45	0.63	370	...	205	...	10	...	...
	0.63	1.20	370	...	205	...	12	10	...
	1.20	6.30	370	...	205	...	14	10	...
	6.30	12.50	370	...	205	...	16	12	10
T6, T62[H]	0.45	0.63	450	...	380	...	7	...	...

TABLE 2 *Continued*

Temper	Specified Wall Thickness[C]		Tensile Strength, MPa		Yield Strength[D] (0.2 % offset), MPa		Elongation,[E] min, %		
								Cut-Out Specimen	
	Over	Through	Min	Max	Min	Max	Full-Section Specimen in 50 mm	in 50 mm	in 5 × Diameter ($5.65\sqrt{A}$)
	0.63	1.20	450	...	380	...	7	6	...
	1.20	6.30	450	...	380	...	8	7	...
	6.30	12.50	450	...	380	...	9	8	7
Alloy 2024									
O	0.45	12.50	...	220	...	100	...	...	...
T3	0.45	0.63	440	...	290	...	10	...	...
	0.63	1.20	440	...	290	...	12	10	...
	1.20	6.30	440	...	290	...	14	10	...
	6.30	12.50	440	...	290	...	16	12	10
T42[H]	0.45	0.63	440	...	275	...	10	...	...
	0.63	1.20	440	...	275	...	12	10	...
	1.20	6.30	440	...	275	...	14	10	...
	6.30	12.50	440	...	275	...	16	12	10
Alloy 3003[F]									
O	0.25	0.63	95	130	35	...	...	...	...
	0.63	1.20	95	130	35	...	30	20	...
	1.20	6.30	95	130	35	...	35	25	...
	6.30	12.50	95	130	35	...	...	30	27
H12	0.25	0.63	120	...	85	...	...	...	...
	0.63	1.20	120	...	85	...	...	...	...
H14	...	0.63	140	...	115	...	3	...	...
	0.63	1.20	140	...	115	...	5	3	...
	1.20	6.30	140	...	115	...	8	4	...
	6.30	12.50	140	...	115	...	...	...	...
H16	0.25	0.63	165	...	145	...	...	...	...
	0.63	1.20	165	...	145	...	3	2	...
	1.20	6.30	165	...	145	...	5	4	...
	6.30	12.50	165	...	145	...	...	...	...
H18	...	0.63	185	...	165	...	2	...	...
	0.63	1.20	185	...	165	...	3	2	...
	1.20	6.30	185	...	165	...	5	3	...
	6.30	12.50	185	...	165	...	...	...	...
H113[G]	0.25	12.50	95	...	35	...	...	...	...
F	All		...	...	...	...	...	...	...
Alloy Alclad 3003[F]									
O	0.25	0.63	90	125	30	...	...	...	...
	0.63	1.20	90	125	30	...	30	20	...
	1.20	6.30	90	125	30	...	35	25	...
	6.30	12.50	90	125	30	...	...	30	27
H14	0.25	0.63	135	...	110	...	...	...	...
	0.63	1.20	135	...	110	...	5	...	...
	1.20	6.30	135	...	110	...	8	4	...
	6.30	12.50	135	...	110	...	...	...	...
H18	0.25	12.50	180	...	160	...	...	...	...
H113[G]	1.20	12.50	90	...	30	...	...	...	...
F	All		...	...	...	...	...	...	...
Alloy 3102[F]									
O	0.45	0.63	75	115	25[D]	...	...	...	...
	0.63	1.20	75	115	25[D]	...	30	20	...
	1.20	1.70	75	115	25[D]	...	35	25	...
Alloy Alclad 3102[F]									
O	0.45	0.63	70	115	25	...	...	...	...
	0.63	1.20	70	115	25	...	30	20	...
	1.20	1.70	70	115	25	...	35	25	...
Alloy 3303[F]									
O	0.25	0.63	95	130	35	...	...	...	...
	0.63	1.20	95	130	35	...	30	20	...
	1.20	1.70	95	130	35	...	35	25	...
Alloy Alclad 3303[D]									

TABLE 2 *Continued*

Temper	Specified Wall Thickness[C]		Tensile Strength, MPa		Yield Strength[D] (0.2 % offset), MPa		Elongation,[E] min, %		
								Cut-Out Specimen	
	Over	Through	Min	Max	Min	Max	Full-Section Specimen in 50 mm	in 50 mm	in 5 × Diameter ($5.65\sqrt{A}$)
O	0.25	0.63	90	130	30	...	...	...	...
	0.63	1.20	90	130	30	...	30	20	...
	1.20	1.70	90	130	30	...	35	25	...
				Alloy 5005[F]					
O	0.45	12.50	105	145	35	...	...	...	...
F	All		...	...	...	...	...	...	...
				Alloy 5050[F]					
O	0.45	12.50	125	165	40	...	...	...	...
H32	0.45	12.50	150	...	110	...	...	...	...
H34	0.45	12.50	170	...	140	...	...	...	...
H36	0.45	12.50	185	...	150	...	...	...	...
H38	0.45	12.50	200	...	165	...	...	...	...
F	All		...	...	...	...	...	...	...
				Alloy 5052[F]					
O	0.45	11.50	170	240	70	...	...	...	...
H32	0.45	11.50	215	...	160	...	...	...	...
H34	0.45	11.50	235	...	180	...	...	...	...
H36	0.45	11.50	255	...	200	...	...	...	...
H38	0.45	11.50	270	...	215	...	...	...	...
F	All		...	...	...	...	...	...	...
				Alloy 5083[F]					
O	0.45	11.50	270	350	110	...	...	14	12
F	All		...	...	...	...	...	...	...
				Alloy 5086[F]					
O	0.45	11.50	240	315	95	...	...	14	12
H32	0.45	11.50	275	...	195	...	...	...	...
H34	0.45	11.50	300	...	235	...	...	...	...
H36	0.45	11.50	325	...	260	...	...	...	...
F	All		...	...	...	...	...	...	...
				Alloy 5154[F]					
O	0.25	11.50	205	285	75	...	10	10	9
H34	0.25	11.50	270	...	200	...	5	5	4
H38	0.25	11.50	310	...	235	...	...	...	...
F	All		...	...	...	...	...	...	...
				Alloy 5456[F]					
O	0.45	11.50	285	365	130	...	...	14	12
F	All		...	...	...	...	...	...	...
				Alloy 6061					
O	0.45	12.50	...	150	...	95	15	15	13
T4	0.63	1.20	205	...	100	...	16	14	...
	1.20	6.30	205	...	110	...	18	16	...
	6.30	12.50	205	...	110	...	20	18	16
T42[H]	0.63	1.20	205	...	95	...	16	14	...
	1.20	6.30	205	...	95	...	18	16	...
	6.30	12.50	205	...	95	...	20	18	16
T6, T62[H]	0.63	1.20	290	...	240	...	10	8	...
	1.20	6.30	290	...	240	...	12	10	...
	6.30	12.50	290	...	240	...	14	12	10
				Alloy 6063					
O	0.45	12.50	...	130	...	...	...	...	...
T4, T42[H]	0.63	1.20	150	...	70	...	16	14	...
	1.20	6.30	150	...	70	...	18	16	...
	6.30	12.50	150	...	70	...	20	18	16
T6, T62[H]	0.63	1.20	230	...	195	...	12	8	...
	1.20	6.30	230	...	195	...	14	10	...
	6.30	12.50	230	...	195	...	16	12	10
T83	0.63	6.30	230	...	205	...	5	...	...
T831	0.63	6.30	195	...	170	...	5	...	...
T832	0.63	1.20	285	...	250	...	8	5	...

TABLE 2 *Continued*

Temper	Specified Wall Thickness[C]		Tensile Strength, MPa		Yield Strength[D] (0.2 % offset), MPa		Elongation,[E] min, %		
								Cut-Out Specimen	
	Over	Through	Min	Max	Min	Max	Full-Section Specimen in 50 mm	in 50 mm	in 5 × Diameter ($5.65\sqrt{A}$)
	1.20	6.30	275	...	240		8	5	...
				Alloy 6262					
T6, T62[H]	0.63	1.20	290	...	240	...	10	8	...
	1.20	0.63	290	...	240	...	12	10	...
	6.30	12.50	290	...	240	...	14	12	10
T9	0.63	10.00	330	...	305	...	5	4	3
				Alloy 7075					
O	0.63	1.20	...	275	...	145	10	8	...
	1.20	12.50	...	275	...	145	12	10	9
T6, T62[H]	0.63	6.30	530	...	455	...	8	7	...
	6.30	12.50	530	...	455	...	9	8	7
T73[I]	0.63	6.30	455	...	385	...	10	8	...
	6.30	12.50	455	...	385	...	12	10	9

[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 MPa and each value for elongation to the nearest 0.5 % both in accordance with the rounding method of Practice E 29.

[C] Coiled tube is generally available with a maximum wall thickness of 2.00 mm and only in nonheat-treatable alloys.

[D] Yield strength to be determined only on straight tube.

[E] Elongation in 50 mm apply for tube tested in full-section, for sheet-type specimens, for tubes having a flat wall, and for similar curved specimens for tubes having a curved wall, up to a maximum wall thickness of 12.50 mm. Elongations in $5D$ ($5.65\sqrt{A}$), 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.

[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] 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 tensile test samples in accordance with the applicable electrical conductivity acceptance criteria of Table 3.

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)(see Tables X1.1 and X1.2),[10]

4.1.6 Length (straight or coiled),

4.1.7 Nominal inside diameter of coils and mass, 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~~ B 918 is required (11.2),

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

[10] These tables are taken from American National Standard B 32.5, Preferred Metric Sizes for Tubular Metal Products Other Than Pipe.

TABLE 3 Lot Acceptance Criteria for Resistance to Stress-Corrosion

Alloy and Temper	Lot Acceptance Criteria		Lot Acceptance Status
	Electrical Conductivity,[A,B] % IACS	Level of Mechanical Properties	
7075-T73	40.0 or greater	per specified requirements	acceptable
	38.0 through 39.9	per specified requirements and yield strength does not exceed minimum by more than 82 MPa	acceptable
	38.0 through 39.9	per specified requirements but yield strength exceeds minimum by more than 82 MPa	unacceptable[C]
	less than 38.0	any level	unacceptable[C]

[A] The electrical conductivity shall be determined in accordance with ~~Tes Pract Micethod~~ E 1004 in the following locations:

Wall Thickness, mm	Location
Up through 2.50	surface of tensile sample
Over 2.50	subsurface after removal of approximately 10 % of thickness[A,B]

[A] For curved surfaces, the conductivity shall be measured on a machined flat spot; however, for small size tubes, a cut-out piece may be flattened and the conductivity determined.

[B] When material is found to be unacceptable, it shall be reprocessed (additional precipitation heat treatment or re-solution heat treatment and precipitation heat treatment).

TABLE 4 Minimum Outside Diameter Flattening Factor

Alloy	Temper	Wall Thickness, mm		Minimum Diameter Flattening Factor, *F*
		Over	Through	
1100	O	0.32	12.50	2
	H12	0.32	12.50	3
	H14	0.32	12.50	6
	H16	0.32	12.50	8
3003	O	0.63	12.50	2
	H12	0.63	12.50	3
	H14	0.63	12.50	6
	H16	0.63	12.50	8
2024	O	0.45	1.20	3
		1.20	12.50	4
	T3	0.45	12.50	8
5052	O	0.25	11.50	3
	H32	0.25	11.50	6
	H34	0.25	11.50	8
5086	O	0.25	11.50	3
	H32	0.25	11.50	8
6061	O	0.45	3.20	3
		3.20	6.30	4
		6.30	12.50	6
	T4	0.63	12.50	6
	T6	0.63	12.50	8
7075	O	0.63	1.20	4
		1.20	6.30	5
	T6	0.63	6.30	10

4.2.3 Whether flare testing is required (Section 10),

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),

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

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

5. 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 1. Conformance shall be determined

by the producer by analyzing sample 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.

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 semi-finished product, a sample shall be taken to represent each 2000 kg or fraction thereof of material in the lot, except that no 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 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.

NOTE 4—It is difficult to obtain a reliable analysis of each of the components of clad materials using material in its finished state. A reasonably accurate determination of the core composition can be made if the cladding is substantially removed prior to analysis. The cladding composition is more difficult to determine because of the relatively thin layer and because of diffusion of core elements to the cladding. The correctness of cladding alloy used can usually be verified by a combination of metallographic examination and spectrochemical analysis of the surface at several widely separated points.

7.4 *Methods of Analysis*—The determination of chemical composition shall be made in accordance with suitable chemical (Test Methods E 34), or spectrochemical (Test Methods E 227, E 607, and E 1251), methods. Other methods may be used only when no published ASTM method is available. In case of dispute, the methods of analysis shall be agreed upon between the producer and the purchaser.

8. Tensile Properties of Material as Supplied

8.1 *Limits*—Tube shall conform to the tensile property requirements specified in Table 2.

8.2 *Number of Specimens*:

8.2.1 For tube sizes having a nominal mass up through 1.7 kg/linear m, one tension test specimen shall be taken for each 500 kg or fraction thereof in a lot.

8.2.2 For tube sizes having a nominal mass over 1.7 kg/linear m, one tension test specimen shall be taken for each 300 m or fraction thereof in a lot.

8.2.3 If the shipment contains tubes of more than one alloy, temper, or size, only those tubes of the same alloy, temper, and size shall be grouped for the purpose of selecting tension test specimens. Other procedures for selecting samples may be employed if agreed upon between the producer and the purchaser.

8.3 *Test Specimens*—Geometry of test specimens and the location in the product from which they are taken shall be as specified in Test Methods B 557M.

8.4 *Test Methods*—The tension tests shall be made in accordance with Test Methods B 557M.

9. Flattening Properties

9.1 *Limits*—When specified by the purchaser at the time of placing the order, round tube in alloys and tempers listed in Table 4 shall be tested in full section and withstand, without cracking, the minimum outside diameter flattening factor specified in Table 4.

9.2 *Number of Specimens*:

9.2.1 For tube sizes having a nominal mass up through 1.7 kg/linear m, one flattening test specimen shall be taken for each 500 kg or fraction thereof in a lot.

9.2.2 For tube sizes having a nominal mass over 1.7 kg/linear m, one flattening test specimen shall be taken for each 300 m or fraction thereof in the lot.

9.3 *Test Methods*—Flattening test specimens shall be flattened sidewise under a gradually applied load so as to give a uniform radius of bend until the minimum outside diameter under load is not more than F times the wall thickness of the tube as specified in Table 4.

9.4 *Alternative Bend Test*—In case the tube does not flatten so as to give a uniform radius of bend, suitable jigs may be used to bring about this result, or a section of tube of not less than 12 mm in length, with the subtended arc not greater than one half nor less than one third of the circumference of the original tube, shall be removed from the material in question and without further treatment shall be bent around a mandrel having a diameter N times the wall thickness of the tube as specified in Table 5. The bend shall be made with the pin placed on the inside surface of the specimen, with the longitudinal axis of the pin and the specimen parallel. The bend shall be continued until the specimen encloses at least 180° of the pin.

TABLE 5 Minimum Bend Factor

Alloy	Temper	Wall Thickness, mm		Minimum Bend Factor, *N*
		Over	Through	
2024	T3	0.45	3.20	6
5052	O	0.25	6.30	1
	H32	0.25	6.30	4
	H34	0.25	6.30	6
5086	O	0.25	6.30	1
	H32	0.25	6.30	6
6061	O	0.45	3.20	1
		3.20	6.30	2
		6.30	12.50	4
	T4	0.63	12.50	4
	T6	0.63	12.50	6
7075	O	0.63	3.20	4
		3.20	6.30	6
	T6	0.63	1.60	8
		1.60	3.20	10
		3.20	6.30	12

9.4.1 After the flattening test, the outer surface of the tube shall be examined visually for cracks. Any evidence of cracking shall be cause for rejection.

10. Flaring Properties

10.1 *Limits*—When specified by the purchaser at the time of placing the order, round tube in straight lengths in alloys and tempers 1100-H14, 3003-H14, 5052-O, and 6061-O with a nominal outside diameter of 9.5 mm or less, shall be capable of being double-flared to the configuration of Fig. 1, and with a nominal outside diameter over 9.5 mm shall be capable of being single-flared to the configuration of Fig. 2, without formation of cracks or other defects clearly visible to the unaided eye.

10.2 *Number of Specimens*—When flare testing is specified in the order, samples shall be selected from each lot as follows:

10.2.1 For tube sizes having a nominal mass up through 1.7 kg/linear m, one test specimen shall be taken for each 500 kg or fraction thereof in the lot.

10.2.2 For tube sizes having a nominal mass over 1.7 kg/linear m, one test specimen shall be taken for each 300 m or fraction thereof in the lot.

10.3 *Preparation of Specimens*—Specimens for flaring may be cut from any portion of the tube, or an entire tube may be used as a specimen. The end of the specimen to be flared shall be cut square, with the cut end smooth and free from burrs, but not rounded, except for sizes 9.5 mm and under.

10.4 *Test Methods*—The specimen shall be forced axially with steady pressure over a hardened and polished tapered steel pin having a 74° included angle, to produce a flare having the permanent expanded outside diameter specified in Table 6.

11. Heat Treatment

11.1 Unless specified in 11.2, producer or supplier heat treatment for the applicable tempers in Table 2 shall be in accordance with ~~MIL-H-6088.~~ AMS 2772.

11.2 When specified, heat treatment of applicable tempers in Table 2 shall be in accordance with Practice ~~B 597.~~ B 918.

12. Producer's Confirmation of Heat-Treat Response

12.1 In addition to the requirements of Section 8, material in alloys 2014, 2024, 6061, and 6063 produced in the O or F temper

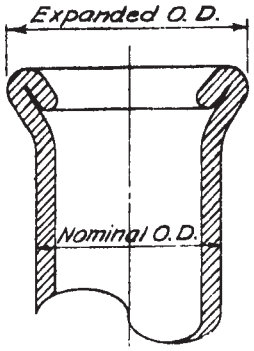

FIG. 1 Double Flare

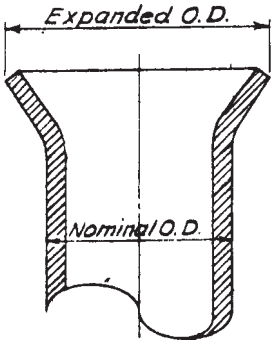

FIG. 2 Single Flare

TABLE 6 Flare Dimensions[A]

Nominal OD, mm		Expanded OD, min	Type Flare
Over	Through		
3.0	6.3	Nominal + 2.5 mm	double
6.3	9.5	Nominal + 2.8 mm	double
9.5	16	Nominal + 4.0 mm	single
16	25	Nominal + 5.0 mm	single
25	40	Nominal + 6.0 mm	single
40	50	Nominal + 9.0 mm	single

[A]Tube with nominal diameter larger than 50 mm, or 3 mm and smaller, shall meet requirements as agreed upon between the purchaser and producer.

(within the size limits specified in Table 2) shall, after proper solution heat treatment and natural aging for not less than 4 days at room temperature, conform to the properties specified in Table 2 for T42 temper material. The heat-treated samples may be tested prior to 4 days natural aging, but if they fail to conform to the T42 temper properties, the tests may be repeated after completion of 4 days natural aging without prejudice.

12.2 Alloy 7075 material produced in the O or F temper (within the size limits specified in Table 2) shall, after proper solution heat treatment and precipitation heat treatment, conform to the properties specified in Table 2 for T62 temper material.

12.3 When specified, 7075-O material (within the size limits specified in Table 2) shall, after proper solution and precipitation heat treatment, conform to the properties specified for T73 temper in Table 2 and Section 14.

12.4 *Number of Specimens*—The number of specimens from each lot of O temper material and F temper material to verify conformance with Section 12 shall be as specified in 8.2.

13. Heat Treatment and Reheat Treatment Capability

13.1 As-received material in the O or F temper and in alloys 2014, 2024, 6061, and 6063 (within the size limitations specified in Table 2 and without the imposition of cold work) shall, after proper solution heat treatment and natural aging for not less than 4 days at room temperature, conform to the properties specified in Table 2 for T42 temper material.

13.2 As-received alloy 7075 material in the O or F temper (within the size limitations specified in Table 2 and without the imposition of cold work) shall, after proper solution and precipitation heat treatment, conform to the properties specified in Table 2 for the T62 temper.

13.3 Material in alloys and tempers 2014-T4, T6; 2024-T8; and 6063-T4, T6 shall, after proper resolution heat treatment and natural aging for not less than 4 days at room temperature, conform to the properties specified in Table 2 for the T42 temper.

NOTE 5—Tubes of 6061-T4 and T6 are excluded from this paragraph because experience has shown that reheat-treated material may develop large recrystallized grains and may fail to develop the tensile properties shown in Table 2.

13.4 Alloy 7075 material in T6 and T73 tempers shall, after proper resolution heat treatment and precipitation heat treatment, conform to the properties specified in Table 2 for the T62 temper.

13.5 Material in T4 and T42 tempers shall, after proper precipitation heat treatment, conform to the properties specified in Table 2 for the T6 and T62 tempers, respectively.

14. Stress-Corrosion Resistance

14.1 For lot acceptance purposes, resistance to stress-corrosion cracking for each lot of 7075-T73 material shall be established by testing the previously selected tension-test samples to the criteria shown in Table 3.

14.2 The producer shall maintain records of all lots so tested and make them available for examination at the producer's facility.

15. Test for Leaks

15.1 When specified by the purchaser at the time of placing the order, tube shall be tested for leaks by one of the following methods at the option of the producer.

15.1.1 *Method 1*—Tubes less than 40 mm in diameter shall be tested pneumatically at not less than 400 kPa air pressure while immersed in water or other suitable liquid. Any evidence of leakage shall be cause for rejection.

15.1.2 *Method 2*—Tubes less than 40 mm in diameter shall be tested pneumatically at not less than 600 kPa air pressure with a gage that will indicate loss of pressure. There shall not be any loss of pressure during a test period of at least 15-s duration.

15.1.3 *Method 3*—Tubes shall be subjected to an eddy-current test in accordance with the procedures described in Practice E 215. Reference standards or secondary standards having equivalent eddy-current response shall serve to define acceptance-rejection limits. These reference standards are acceptable for testing any strain-hardened temper of the nonheat-treatable alloys and the F temper of heat-treatable alloys of Table 2 in tubes less than 40 mm in diameter having a maximum wall thickness of 2.00 mm.

15.1.3.1 For *straight lengths* of tube reference standards described in Appendixes X1 and X2 of Practice E 215 shall be used to standardize the equipment. Tubes less than 40 mm in diameter and maximum wall thickness of 2.00 mm that produce eddy-current indications less than those from the 2A holes of the applicable reference standard or an equivalent secondary standard shall be acceptable. Any tube having a discontinuity that produces an eddy-current indication equal to or greater than those from the 2A holes of the applicable reference standard or an equivalent secondary standard shall be rejected.

15.1.3.2 For *coiled tube* secondary standards having an equivalent eddy-current response to No. 70 (0.70-mm diameter) and No. 60 (1.00-mm diameter) drill holes shall be used to standardize the equipment. Tubes 5 to 25 mm, inclusive, in diameter and maximum wall thickness of 2.00 mm that produce eddy-current indications less than those from the No. 60 hole of the secondary standard shall be acceptable. Any tube that produces an indication equal to or greater than those from the No. 60 hole of the secondary standard shall be rejected. Setup procedures shall include a check to ensure that tubes containing defects giving responses equal to or greater than that from a No. 60 hole are rejected at the speed of inspection. Tube in long coils may contain up to a specified number of defects per coil when agreed upon between the producer and purchaser. In cases where a specified number of defects per coil are allowed, the need for marking such defects in a coil shall be handled as agreed upon between the producer and purchaser.

16. Special Requirements for Coiled Tubes

16.1 *Expansion Test*—Coiled tube in the annealed temper only shall be capable of being expanded on a hardened ground tapered steel pin having an included angle of 60°, to the following amounts, without signs of cracks, ruptures, or other defects clearly visible to the unaided eye:

Nominal Outside Diameter, mm	Expansion of Outside Diameter, %
Up through 20.00	40
Over 20.00	30

NOTE 6—Other expansion capabilities may be required in special cases but shall be the subject of negotiation between the producer and the purchaser.

16.2 *Inside Cleanness Requirements and Test*—When specified by the purchaser at the time of placing the order, the inside of coiled tube in the annealed temper only shall be sufficiently clean so that, when a test sample having a minimum internal area of 0.240 m^2 (except that no more than 15 m of length is required) is washed with 1,1,1-trichloroethane or trichloroethylene or equivalent, the residue remaining upon evaporation of the solvent shall not exceed 0.02 g/m^2 of interior surface.

16.2.1 To perform the test a measured quantity of the solvent shall be pulled through the tube into a flask which is, in turn, attached to an aspirator or vacuum pump. The solvent shall then be transferred to a weighed container (crucible, evaporating dish, or beaker). The solvent in the container shall be evaporated to dryness on a low-temperature hot plate or steam bath. Overheating of the container shall be avoided to prevent charring of the residue. The container shall then be dried in an oven at 100 to 110°C for 10 min, cooled in a desiccator, and weighed. A blank determination shall be run on the measured quantity of solvent, and the gain in mass of the blank shall be subtracted from the mass of the residue sample. The corrected mass shall then be calculated in grams of residue per internal area of tube.

16.2.2 The quantity of the solvent used may vary with the size of tube being examined. A minimum quantity of 100 mL should be used for diameters up to 12.5 mm and should be increased proportionately for the larger sizes. The quantity of solvent used for the blank run shall be the same as that used for the actual examination of the tube sample.

16.2.3 In performing the test, care must be exercised to clean the outside surface of the end of the sample to be immersed in the solvent. The sample must be prepared in such a manner as to prevent the inclusion in the residue of aluminum chips or dust resulting from the cutting of the sample.

17. Cladding

17.1 The aluminum-alloy cladding of alloy Alclad 3003, alloy Alclad 3102, and alloy Alclad 3303 tubes shall comprise either the inside surface (only) or the outside surface (only) of the tube. The purchaser shall specify whether “clad inside” or “clad outside” tubes are required.

17.2 The alloy Alclad 3003, alloy Alclad 3102, and alloy Alclad 3303 tubes shall be fabricated in such a manner that the cladding thickness will be approximately 10 % of the specified composite wall thickness for “clad inside” and 7 % for “clad outside.”

17.3 When the thickness of the cladding is to be determined on finished tubes, transverse cross sections of at least three tubes from the lot shall be polished for examination with a metallurgical microscope. Using a magnification of 100×, the cladding thickness at four points, 90° apart, in each sample shall be measured and the average of the twelve measurements shall be taken as the thickness. In the case of tubes having a diameter larger than can properly be mounted for polishing and examination, the portions of the cross section polished for examination may consist of an arc about 12 mm in length.

18. Dimensional Tolerances

18.1 Variations from the specified or nominal dimensions shall not exceed the permissible variations prescribed in tables of ANSI H35.2M in accordance with Table 7.

18.2 *Sampling for Inspection*—Examinations for dimensions shall be made to ensure conformance to the tolerances specified.

19. General Quality

19.1 Unless otherwise specified, the material shall be supplied in the mill finish and shall be uniform as defined by the requirements of this specification and shall be commercially sound. Any requirement not so covered is subject to negotiation between producer and purchaser.

19.2 Each tube shall be examined to determine conformance to this specification with respect to general quality and identification marking. On approval of the purchaser, however, the producer may use a system of statistical quality control for such examinations.

20. Source Inspection

20.1 If the purchaser desires that his representative inspect or witness the inspection and testing of the material prior to shipment, such agreement shall be made by the purchaser and the producer as part of the purchase contract.

20.2 When such inspection or witness of inspection and testing is agreed upon, the producer shall afford the purchaser's representative all reasonable facilities to satisfy him that the material meets the requirements of this specification. Inspection and tests shall be conducted so there is no unnecessary interference with the producer's operations.

21. Retest and Rejection

21.1 If any material fails to conform to all of the applicable requirements of this specification, it shall be cause for rejection of the inspection lot.

21.2 When there is evidence that a failed specimen was not representative of the inspection lot and when no other sampling plan is provided or approved by the purchaser through the contract or purchase order, at least two additional specimens shall be selected to replace each test specimen that failed. All specimens so selected for retest shall meet the requirements of the specification or the lot shall be subject to rejection.

21.3 Material in which defects are discovered subsequent to inspection may be rejected.

21.4 If material is rejected by the purchaser, the producer or supplier is responsible only for replacement of the material to the purchaser. As much as possible of the rejected material shall be returned to the producer or supplier.

22. Certification

22.1 The producer or supplier shall, on request, furnish to the purchaser a certificate stating that the material has been sampled, tested, and inspected in accordance with this specification, and has met the requirements.

23. Identification Marking of Product

23.1 When specified in the contract or purchase order all tubes in straight lengths shall be marked in accordance with Practice

TABLE 7 Index to Tables of Permissible Variations of ANSI H35.2M

Table No.	Title
11.1	Diameter, Round Tube
11.2	Width and Depth, Square, Rectangular, Hexagonal and Octagonal Tube
11.3	Diameter, Oval, Elliptical, and Streamline Tube
11.4	Corner Radii
11.5	Wall Thickness, Round and Other-than-Round Tube
11.6	Straightness
11.7	Twist
11.8	Length
11.9	Flatness, (Flat Surfaces) Other-than-Round Tube
11.10	Squareness of Cut Ends
11.11	Angularity
11.12	Surface Roughness
11.13	Dents

B 666/B 666M and the marking legend shall include the word“ seamless.”

23.2 Alloys in the 2000 and 7000 series furnished in the T6 and T73 tempers shall also be marked with the lot number in at least one location on each piece.

23.3 The foregoing requirements are minimum; marking systems that involve added information, larger characters, and greater frequencies are acceptable under this specification.

24. Packaging and Package Marking

24.1 The material shall be packaged to provide adequate protection during normal handling and transportation and each package shall contain only one size, alloy, and temper of material unless otherwise agreed. The type of packing and gross mass of containers shall, unless otherwise agreed upon, be at the producer’s or supplier’s discretion, provided that they are such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the delivery point.

24.2 Each shipping container shall be marked with the purchase order number, material size, specification number, alloy and temper, gross and net masses, and the producer’s name or trademark.

24.3 When specified in the contract or purchase order, material shall be preserved, packaged, and packed in accordance with the requirements of Practices B 660. The applicable levels shall be as specified in the contract or order. Marking for shipment of such material shall be in accordance with Fed. Std. No. 123 for civil agencies and MIL-STD-129 for military agencies.

25. Keywords

25.1 aluminum alloy; aluminum-alloy drawn seamless tubes

ANNEXES

(Mandatory Information)

A1. BASIS FOR INCLUSION OF PROPERTY LIMITS

A1.1 Limits are established at a level at which a statistical evaluation of the data indicates that 99 % of the population obtained from all standard material meets the limit with 95 % confidence. For the products described, mechanical property limits for the respective size ranges are based on the analyses of at least 100 data from standard production material with no more than ten data from a given lot. All tests are performed in accordance with the appropriate ASTM test methods. For informational purposes, refer to “Statistical Aspects of Mechanical Property Assurance” in the Related Material section of the *Annual Book of ASTM Standards*, Vol 02.02. Mechanical property limits in this metric issue were derived from the inch-pound system limits that were developed under the above principles. As test data on metric-dimensioned specimens are accumulated, some refinement of limits, particularly for elongations measured in 5D, can be anticipated.

A2. ACCEPTANCE CRITERIA FOR INCLUSION OF NEW ALUMINUM AND ALUMINUM ALLOYS IN THIS SPECIFICATION

A2.1 Prior to acceptance for inclusion in this specification, the composition of wrought or cast aluminum or aluminum alloy shall be registered in accordance with ANSI H35.1(M). The Aluminum Association[11] holds the Secretariat of ANSI H35 Committee and administers the criteria and procedures for registration.

A2.2 If it is documented that the Aluminum Association could not or would not register a given composition, an alternative procedure and the criteria for acceptance shall be as follows:

A2.2.1 The designation submitted for inclusion does not utilize the same designation system as described in ANSI H35.1(M). A designation not in conflict with other designation systems or a trade name is acceptable.

A2.2.2 The aluminum or aluminum alloy has been offered for sale in commercial quantities within the prior twelve months to at least three identifiable users.

A2.2.3 The complete chemical composition limits are submitted.

A2.2.4 The composition is, in the judgment of the responsible subcommittee, significantly different from that of any other aluminum or aluminum alloy already in the specification.

A2.2.5 For codification purposes, an alloying element is any element intentionally added for any purpose other than grain

[11] 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 Oct. 10, 2002. Published December 2002. Originally approved in 1980. Last previous edition approved in 2000 as B 210M–00.

refinement and for which minimum and maximum limits are specified. Unalloyed aluminum contains a minimum of 99.00 % aluminum.

A2.2.6 Standard limits for alloying elements and impurities are expressed to the following decimal places:

Less than 0.001 %	0.000X
0.001 to but less than 0.01 %	0.00X
0.01 to but less than 0.10 %	
Unalloyed aluminum made by a refining process	0.0XX
Alloys and unalloyed aluminum not made by a refining process	0.0X
0.10 through 0.55 %	0.XX
(It is customary to express limits of 0.30 through 0.55 % as 0.X0 or 0.X5)	
Over 0.55 %	0.X, X.X, etc.
(except that combined Si + Fe limits for 99.00 % minimum aluminum must be expressed as 0.XX or 1.XX)	

A2.2.7 Standard limits for alloying elements and impurities are expressed in the following sequence: Silicon; Iron; Copper; Manganese; Magnesium; Chromium; Nickel; Zinc (Note A2.1); Titanium; Other Elements, Each; Other Elements, Total; Aluminum (Note A2.2).

NOTE A2.1—Additional specified elements having limits are inserted in alphabetical order of their chemical symbols between zinc and titanium, or are specified in footnotes.

NOTE A2.2—Aluminum is specified as *minimum* for unalloyed aluminum and as a *remainder* for aluminum alloys.

APPENDIX

(Nonmandatory Information)

X1. PREFERRED METRIC SIZES

TABLE X1.1 Preferred Outside Diameters for Tubular Metal Products Other Than Pipe (mm)

0.12	14	75
0.16	15	80
0.20	16	85
0.25	18	90
0.30	19	95
0.40	20	100
0.50	22	110
0.60	25	120
0.80	28	130
1.0	30	140
1.2	32	150
1.6	35	160
2.0	38	170
2.5	40	180
3.0	42	190
4.0	45	200
5.0	50	220
6.0	54	250
8.0	55	280
10	60	300
12	65	320
	70	

TABLE X1.2 Preferred Wall Thicknesses for Tubular Metal Products Other Than Pipe (mm)

NOTE 1—The preferred range of wall thicknesses for square and rectangular tubular products is normally from 0.30 to 20 mm.

0.050	1.4	10
0.060	1.5	11
0.080	1.6	12
0.10	1.8	14
0.12	2.0	16
0.16	2.2	18
0.20	2.5	20

0.25	2.8	22
0.30	3.0	25
0.40	3.5	28
0.50	4.0	30
0.60	4.5	32
0.70	5.0	35
0.80	5.5	38
0.90	6.0	40
1.0	7.0	42
1.1	8.0	45
1.2	9.0	50
		60

SUMMARY OF CHANGES

This section identifies the principal changes to this standard that have been incorporated since the last issue.

(1) ~~Deleted references to Test Method E 101.~~ Replaced Practice B 597 with Practice B 918 in Section 2, 4.2.1 and 11.2.
(2) Replaced MIL-H-6088 with AMS 2772 in Section 2 and 11.1.