Designation: B221 – 14

Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes[1]

This standard is issued under the fixed designation B221; 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 U.S. Department of Defense.

1. Scope*

1.1 This specification[2] covers aluminum and aluminum-alloy extruded bars, rods, wire, profiles, and tubes in the aluminum alloys (Note 1) and tempers shown in Table 2.

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

NOTE 2—For rolled or cold-finished bar and rod refer to Specification B211, for drawn seamless tube used in pressure applications, Specification B210, for structural pipe and tube, Specification B429/B429M, and for seamless pipe and tube used in pressure applications, Specification B241/B241M.

NOTE 3—Pipe and tube products listed in this specification are intended for general purpose applications. This specification may not address the manufacturing processes, integrity testing, and verification required for fluid-carrying applications involving pressure. See Specifications B210 or B241/B241M, or both as appropriate, for seamless pipe and tube used in fluid-carrying applications involving pressure. See Specification B234, as appropriate, for use in surface condensers, evaporators, and heat exchangers.

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, A91100 for Aluminum 1100 in accordance with Practice E527.

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

1.4 A complete metric companion to Specification B221 has been developed—Specification B221M; therefore, no metric equivalents are presented in this specification.

2. Referenced Documents

2.1 The following documents of the issue in effect on the date of material purchase, unless otherwise noted, form a part of this specification to the extent referenced herein:

2.2 *ASTM Standards:*[3]

B210 Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes

B211 Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire

B234 Specification for Aluminum and Aluminum-Alloy Drawn Seamless Tubes for Condensers and Heat Exchangers

B241/B241M Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube

B429/B429M Specification for Aluminum-Alloy Extruded Structural Pipe and Tube

B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products

B594 Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products

B660 Practices for Packaging/Packing of Aluminum and Magnesium Products

B666/B666M Practice for Identification Marking of Aluminum and Magnesium Products

B807/B807M Practice for Extrusion Press Solution Heat Treatment for Aluminum Alloys

B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products

B918 Practice for Heat Treatment of Wrought Aluminum Alloys

B945 Practice for Aluminum Alloy Extrusions Press Cooled from an Elevated Temperature Shaping Process for Production of T1, T2, T5 and T10–Type Tempers

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys

E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)

E607 Test Method for Atomic Emission Spectrometric

[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-221 in Section II of this Code.

[3] For referenced ASTM standards, visit the ASTM website, www.astm.org, or contact ASTM Customer Service at service@astm.org. For *Annual Book of ASTM Standards* volume information, refer to the standard's Document Summary page on the ASTM website.

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

Analysis Aluminum Alloys by the Point to Plane Technique Nitrogen Atmosphere (Withdrawn 2011)[4]
E716 Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of Chemical Composition by Spectrochemical Analysis
E1004 Test Method for Determining Electrical Conductivity Using the Electromagnetic (Eddy-Current) Method
E1251 Test Method for Analysis of Aluminum and Aluminum Alloys by Spark Atomic Emission Spectrometry
G34 Test Method for Exfoliation Corrosion Susceptibility in 2XXX and 7XXX Series Aluminum Alloys (EXCO Test)
G47 Test Method for Determining Susceptibility to Stress-Corrosion Cracking of 2XXX and 7XXX Aluminum Alloy Products

2.3 *ANSI Standards:*[5]

ANSI H35.1/H35.1M Alloy and Temper Designation Systems for Aluminum
ANSI H35.2 Dimensional Tolerances for Aluminum Mill Products

2.4 *Federal Standard:*[6]

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

2.5 *Military Standard:*[6]

MIL-STD-129 Marking for Shipment and Storage

2.6 *AMS Specification:*[7]

AMS 2772 Heat Treatment of Aluminum Alloy Raw Materials

2.7 *CEN Standard:*[8]

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

3. Terminology

3.1 *Definitions*—Refer to Terminology B881 for definitions of product terms used in this specification.

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 pounds.

4.1.3 Alloy (Section 7 and Table 1).

4.1.4 Temper (Section 8 and Table 2).

4.1.5 Nominal cross-sectional dimensions as follows:

4.1.5.1 For rod and round wire: diameter.

4.1.5.2 For square-cornered bar and wire: depth and width.

4.1.5.3 For sharp-cornered hexagonal or octagonal bar and wire: distance across flats.

4.1.5.4 For round tube: outside or inside diameter and wall thickness.

4.1.5.5 For square or sharp-cornered tube other than round: distance across flats and wall thickness.

4.1.5.6 For round-cornered bars, profiles, tube other than round, square, rectangular, hexagonal, or octagonal with sharp corners: drawing required.

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 (9.3).

4.2.2 Whether heat treatment in accordance with Practice B918 is required (9.4).

4.2.3 Whether ultrasonic inspection is required (Section 17, Table 3).

4.2.4 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 18).

4.2.5 Whether certification is required (Section 22).

4.2.6 Whether marking for identification is required in accordance with Practice B666/B666M, Section 20.

4.2.7 Whether Practice B660 applies and, if so, the levels of preservation, packaging, and packing required (21.3).

4.2.8 Requirements for tensile property and dimensional tolerance for sizes not specifically covered (8.1.3 and 15.1.1).

4.2.9 Whether Titanium and Zirconium algorithm is allowed as shown in Table 1 (Footnote G), when ordering 2014 or 2024.

4.2.10 Whether Titanium and Zirconium algorithm is allowed as shown in Table 1 (Footnote N), when ordering 7075.

5. Materials and Manufacture

5.1 The products covered by this specification shall be produced by the hot extrusion method or by similar methods at the option of the producer, provided that the resulting products comply with the requirements in this specification.

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 are deemed necessary to ensure that material conforms to prescribed requirements.

[4] The last approved version of this historical standard is referenced on www.astm.org.

[5] Available from Aluminum Association, Inc., 1525 Wilson Blvd., Suite 600, Arlington, VA 22209, http://www.aluminum.org.

[6] Available from Standardization Documents Order Desk, DODSSP, Bldg. 4, Section D, 700 Robbins Ave., Philadelphia, PA 19111-5098, http://www.dodssp.daps.mil.

[7] Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, http://www.sae.org.

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

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

NOTE 1—In case of a discrepancy between the values listed in Table 2 and those listed in the "International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys" (known as the "Teal Sheets"), the composition limits registered with the Aluminum Association and published in the "Teal Sheets" should be considered the controlling composition. The "Teal Sheets" are available at http://www.aluminum.org/tealsheets.

Alloy	Silicon	Iron	Copper	Manganese	Magnesium	Chromium	Zinc	Titanium	Vanadium	Other Elements[D]		Aluminum
										Each	Total[E]	
1060	0.25	0.35	0.05	0.03	0.03	...	0.05	0.03	0.05	0.03	...	99.60 min[F]
1100	0.95 Si + Fe		0.05–0.20	0.05	...	...	0.10	...	...	0.05[G]	0.15	99.00 min[F]
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[H]	...	0.05[H]	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[H]	...	0.05[H]	0.15	remainder
2219	0.20	0.30	5.8–6.8	0.20–0.40	0.02	...	0.10	0.02–0.10	0.05–0.15	0.05[I]	0.15[I]	remainder
3003	0.6	0.7	0.05–0.20	1.0–1.5	...	...	0.10	...	...	0.05	0.15	remainder
Alclad 3003	...	3003 Clad with 7072 alloy		...	...	...	...	...	...	...	...	...
3004	0.30	0.7	0.25	1.0–1.5	0.8–1.3	...	0.25	...	...	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
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[G]	0.15	remainder
5454	0.25	0.40	0.10	0.50–1.0	2.4–3.0	0.05–0.20	0.25	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
6005	0.6–0.9	0.35	0.10	0.10	0.40–0.6	0.10	0.10	0.10	...	0.05	0.15	remainder
6005A	0.50–0.9	0.35	0.30	0.50[J]	0.40–0.7	0.30[J]	0.20	0.10	...	0.05	0.15	remainder
6013	0.6-1.0	0.50	0.6-1.1	0.20-0.8	0.8-1.2	0.10	0.25	0.10	...	0.05	0.15	remainder
6020[K]	0.40-0.9	0.50	0.30-0.9	0.35	0.6-1.2	0.15	0.20	0.15	...	0.05	0.15	remainder
6041[L]	0.50-0.9	0.15-0.7	0.15-0.6	0.05-0.20	0.8-1.2	0.05-0.15	0.25	0.15	...	0.05	0.15	remainder
6042[M]	0.50-1.2	0.7	0.20-0.6	0.40	0.7-1.2	0.04-0.35	0.25	0.15	...	0.05	0.15	remainder
6060	0.30–0.6	0.10–0.30	0.10	0.10	0.35–0.6	0.5	0.15	0.10	...	0.05	0.15	remainder
6061[N]	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
6064[O]	0.40-0.8	0.7	0.15-0.40	0.15	0.8-1.2	0.05-0.14	0.25	0.15	...	0.05	0.15	remainder
6066	0.9–1.8	0.50	0.7–1.2	0.6–1.1	0.8–1.4	0.40	0.25	0.20	...	0.05	0.15	remainder
6070	1.0–1.7	0.50	0.15–0.40	0.40–1.0	0.50–1.2	0.10	0.25	0.15	...	0.05	0.15	remainder
6082	0.7–1.3	0.50	0.10	0.40–1.0	0.6–1.2	0.25	0.20	0.10	...	0.05	0.15	remainder
6105	0.6–1.0	0.35	0.10	0.15	0.45–0.8	0.10	0.10	0.10	...	0.05	0.15	remainder
6162	0.40–0.8	0.50	0.20	0.10	0.7–1.1	0.10	0.25	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[P]	0.15[P]	remainder
6351	0.7–1.3	0.50	0.10	0.40–0.8	0.40–0.8	...	0.20	0.20	...	0.05	0.15	remainder
6360	0.35-0.8	0.10-0.30	0.15	0.02-0.15	0.25-0.45	0.05	0.10	0.10	...	0.05	0.15	remainder
6463	0.20–0.6	0.15	0.20	0.05	0.45–0.9	...	0.05	...	...	0.05	0.15	remainder
6560	0.30–0.7	0.10–0.30	0.05–0.20	0.20	0.20–0.6	0.05	0.15	0.10	...	0.05	0.15	remainder
7005	0.35	0.40	0.10	0.20–0.7	1.0–1.8	0.06–0.20	4.0–5.0	0.01–0.06	...	0.05[Q]	0.15[Q]	remainder
7072[R]	0.7 Si + Fe		0.10	0.10	0.10	...	0.8–1.3	...	...			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[S]	...	0.05[S]	0.15	remainder
7116	0.15	0.30	0.50–1.1	0.05	0.8–1.4	...	4.2–5.2	0.05	0.05	0.05[T]	0.15	remainder
7129	0.15	0.30	0.50–0.9	0.10	1.3–2.0	0.10	4.2–5.2	0.05	0.05	0.05[T]	0.15	remainder
7178	0.40	0.50	1.6–2.4	0.30	2.4–3.1	0.18–0.28	6.3–7.3	0.20	...	0.05	0.15	remainder

[A] Limits are in weight percent maximum unless shown as a range, or stated otherwise.
[B] Analysis shall be made for the elements for which limits are shown in this table.
[C] For the purpose 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 the figures used in expressing the specified limit, in accordance with the rounding-off method of Practice E29.
[D] *Others* includes listed elements for which no specific limit is shown as well as unlisted metallic elements. The producer may analyze samples for trace elements not specified in the specification. However, such analysis is not required and may not cover all metallic *Others* elements. Should any analysis by the producer or the purchaser establish that an *Others* element exceeds the limit of *Each*, or that the aggregate of several *Others* elements exceeds the limit of *Total*, the material shall be considered nonconforming.
[E] *Other Elements*—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.
[F] The aluminum content shall be calculated by subtracting from 100.00 % the sum of all metallic elements present in amounts of 0.010 % or more each, rounded to the second decimal before determining the sum.
[G] Be 0.0003 max for welding electrode, welding rod, and filler wire.
[H] Upon agreement between the purchaser and the producer or supplier, a Zr + Ti limit of 0.20 % max is permitted. Properties in Specification (Table 2) are not based on the Zirconium and Titanium algorithm.
[I] Zirconium, 0.10–0.25 %. The total for other elements does not include zirconium.
[J] Manganese plus chromium shall total 0.12–0.50.
[K] Lead 0.05 % max, Tin 0.9-1.5 %.
[L] Bismuth 0.30-0.9 %, Tin 0.35-1.2 %.
[M] Bismuth 0.20-0.8 % Lead 0.15-0.40 %.
[N] In 1965 the requirements for 6062 were combined with those for 6061 by revising the minimum chromium from "0.15 %" to" 0.04 %." This action cancelled alloy 6062.
[O] Bismuth 0.50-0.7 %, Lead 0.20-0.40 %,
[P] Bismuth and lead shall be 0.40–0.7 % each.
[Q] Zirconium 0.08–0.20 %. The total for other elements does not include zirconium.
[R] Composition of cladding alloy applied during the course of manufacture. Samples from finished tube shall not be required to conform to these limits.
[S] Upon agreement between the purchaser and the producer or supplier, a Zr + Ti limit of 0.25 % max is permitted. Properties in Specification (Table 2) are not based on the Zirconium and Titanium algorithm.
[T] Gallium 0.03 % max.

TABLE 2 Mechanical Property Limits[A,B]

NOTE 1—Strength values shown in parentheses are for information only.

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[D]							
O	all	all	8.5	14.0	2.5	. . .	25
H112	all	all	8.5	. . .	2.5	. . .	25
Aluminum 1100[D]							
O	all	all	11.0	15.5	3.0	. . .	25
H112	all	all	11.0	. . .	3.0	. . .	25
Alloy 2014[D]							
O	all	all	. . .	30.0	. . .	18.0	12
T4 T4510[E] T4511[E]	all	all	50.0	. . .	35.0	. . .	12
T42[F]	all	all	50.0	. . .	29.0	. . .	12
T6	up through 0.499	all	60.0	. . .	53.0	. . .	7
T6510[E]	0.500–0.749	all	64.0	. . .	58.0	. . .	7
T6511[E]	0.750 and over	up through 25	68.0	. . .	60.0	. . .	7
		over 25 through 32	68.0	. . .	58.0	. . .	6
T62[F]	up through 0.749	all	60.0	. . .	53.0	. . .	7
	0.750 and over	up through 25	60.0	. . .	53.0	. . .	7
		over 25 through 32	60.0	. . .	53.0	. . .	6
Alloy 2024[D]							
O	all	all	. . .	35.0	. . .	19.0	12
T3	up through 0.249	all	57.0	. . .	42.0	. . .	12[G]
T3510[E]	0.250–0.749	all	60.0	. . .	44.0	. . .	12[G]
T3511[E]	0.750–1.499	all	65.0	. . .	46.0	. . .	10
		up through 25	70.0	. . .	52.0[H]	. . .	10
	1.500 and over	over 25 through 32	68.0	. . .	48.0[I]	. . .	8
T42[F]	up through 0.749	all	57.0	. . .	38.0	. . .	12
	0.750–1.499	all	57.0	. . .	38.0	. . .	10
	1.500 and over	up through 25	57.0	. . .	38.0	. . .	10
		over 25 through 32	57.0	. . .	38.0	. . .	8
T81	0.050–0.249	all	64.0	. . .	56.0	. . .	4
T8510[E]	0.250–1.499	all	66.0	. . .	58.0	. . .	5
T8511[E]	1.500 and over	up through 32	66.0	. . .	58.0	. . .	5
Alloy 2219[D]							
O	all	all	. . .	32.0	. . .	18.0	12
T31 T3510[E]	up through 0.499	up through 25	42.0	. . .	26.0	. . .	14
T3511[E]	0.500–2.999	up through 25	45.0	. . .	27.0	. . .	14
T62[F]	up through 0.999	up through 25	54.0	. . .	36.0	. . .	6
	1.000 and over	up through 25	54.0	. . .	36.0	. . .	6

TABLE 2 *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	
T81 T8510^E T8511^E	up through 2.999	up through 25	58.0	. . .	42.0	. . .	6
		Alloy 3003^D					
O	all	all	14.0	19.0	5.0	. . .	25
H112	all	all	14.0	. . .	5.0	. . .	25
		Alloy Alclad 3003^D					
O	all	all	13.0	18.0	4.5	. . .	25
H112	all	all	13.0	. . .	4.5^J	. . .	25
		Alloy 3004^D					
O	all	all	23.0	29.0	8.5	. . .	. . .
		Alloy 3102					
H112^K	0.028–0.050	all	11.0	18.0	4.0	. . .	25
		Alloy 5052					
O	all	all	25.0	35.0	10.0	. . .	. . .
		Alloy 5083^D					
O	up through 5.000^L	up through 32	39.0	51.0	16.0	. . .	14
H111	up through 5.000^L	up through 32	40.0	. . .	24.0	. . .	12
H112	up through 5.000^L	up through 32	39.0	. . .	16.0	. . .	12
		Alloy 5086^D					
O	up through 5.000^L	up through 32	35.0	46.0	14.0	. . .	14
H111	up through 5.000^L	up through 32	36.0	. . .	21.0	. . .	12
H112	up through 5.000^L	up through 32	35.0	. . .	14.0	. . .	12
		Alloy 5154					
O	all	all	30.0	41.0	11.0	. . .	. . .
H112	all	all	30.0	. . .	11.0	. . .	. . .
		Alloy 5454^D					
O	up through 5.000^L	up through 32	31.0	41.0	12.0	. . .	14
H111	up through 5.000^L	up through 32	33.0	. . .	19.0	. . .	12
H112	up through 5.000^L	up through 32	31.0	. . .	12.0	. . .	12
		Alloy 5456^D					
O	up through 5.000^L	up through 32	41.0	53.0	19.0	. . .	14
H111	up through 5.000^L	up through 32	42.0	. . .	26.0	. . .	12
H112	up through 5.000^L	up through 32	41.0	. . .	19.0	. . .	12
		Alloy 6005					
T1	up through 0.500	all	25.0	. . .	15.0	. . .	16
T5	up through 0.124	all	38.0	. . .	35.0	. . .	8
	0.125–1.000	all	38.0	. . .	35.0	. . .	10
		Alloy 6005A					
T1	up through 0.249	all	25.0	. . .	14.5	. . .	15
T5	up through 0.249	all	38.0	. . .	31.0	. . .	7
	0.250–0.999	all	38.0	. . .	31.0	. . .	9
T61	up through 0.249	all	38.0	. . .	35.0	. . .	8
	0.250–1.000	all	38.0	. . .	35.0	. . .	10
		Alloy 6013					
T6	0.200-0.499	all	49.0	. . .	46.0	. . .	8
	0.500-0.749	all	49.0	. . .	46.0	. . .	8
	0.750-2.000	all	49.0	. . .	45.0	. . .	8
T6511	0.200-0.499	all	49.0	. . .	46.0	. . .	8
	0.500-0.749	all	49.0	. . .	46.0	. . .	8
	0.750-2.000	all	49.0	. . .	45.0	. . .	8
		Alloy 6020					
T6511	3.250-6.000	all	38.0	. . .	35.0	. . .	10
		Alloy 6041					
T6^M	0.400-2.000	all	45.0	. . .	40.0	. . .	10
T6511^M	0.400-2.000	all	45.0	. . .	40.0	. . .	10
		Alloy 6042					
T5	0.400-0.499	all	38.0	. . .	35.0	. . .	10
	0.500-1.800	all	42.0	. . .	35.0	. . .	10
T5511	0.400-0.499	all	38.0	. . .	35.0	. . .	10
	0.500-1.800	all	42.0	. . .	35.0	. . .	10
		Alloy 6060					
T51	up through 0.125	all	22.0	. . .	16.0	. . .	8
T61	up through 0.124		30.0	...	25.0	...	8
	0.125–1.000		30.0	...	25.0	...	10

TABLE 2 *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 6061^D					
O	all	all	. . .	22.0	. . .	16.0	16
T1	up through 0.625	all	26.0	. . .	14.0	. . .	16
T4 T4510^E T4511^E	all	all	26.0	. . .	16.0	. . .	16
T42^F	all	all	26.0	. . .	12.0	. . .	16
T51	up through 0.625	all	35.0	. . .	30.0	. . .	8
T6, T62^F T6510^E	up through 0.249	all	38.0	. . .	35.0	. . .	8
T6511^E	0.250 and over	all	38.0	. . .	35.0	. . .	10
		Alloy 6063					
O	all	all	. . .	19.0	. . .	. . .	18
T1	up through 0.500	all	17.0	. . .	9.0	. . .	12
	0.501–1.000	all	16.0	. . .	8.0	. . .	12
T4, T42^F	up through 0.500	all	19.0	. . .	10.0	. . .	14
	0.501–1.000	all	18.0	. . .	9.0	. . .	14
T5	up through 0.500	all	22.0	. . .	16.0	. . .	8
	0.501–1.000	all	21.0	. . .	15.0	. . .	8
T52	up through 1.000	all	22.0	30.0	16.0	25.0	8
T54	up through 0.124	all	33.0	...	30.0	...	8
	0.125–0.499	all	33.0	...	30.0	...	10
T6, T62^F	up through 0.124	all	30.0	. . .	25.0	. . .	8
	0.125–1.000	all	30.0	. . .	25.0	. . .	10
T65	up through 0.182	all	36.0	. . .	33.0	. . .	8
		Alloy 6064					
T6	0.180-3.250	all	42.0	. . .	38.0	. . .	10
T6511	0.180-3.250	all	42.0	. . .	38.0	. . .	10
		Alloy 6066					
O	all	all		29.0	. . .	18.0	16
T4, T4510, T4511^E	all	all	40.0	. . .	25.0	. . .	14
T42^F	all	all	40.0	. . .	24.0	. . .	14
T6, T6510, T6511^E	all	all	50.0	. . .	45.0	. . .	8
T62^F	all	all	50.0	. . .	42.0	. . .	8
		Alloy 6070					
T6, T62	up through 2.999	up through 32	48.0	. . .	45.0	. . .	6
		Alloy 6082					
T6,T6511	0.200–0.750	all	45.0	...	38.0	...	6
	0.751–6.000	all	45.0	....	38.0	....	8
	6.001–8.000	all	41.0	...	35.0	...	6
		Alloy 6105					
T1	up through 0.500	all	25.0	. . .	15.0	. . .	16
T5	up through 0.124	all	38.0	. . .	35.0	. . .	8
	0.125–1.000	all	38.0	. . .	35.0	. . .	10
		Alloy 6162					
T5, T5510,^{E} T5511^E	up thru 1.000	all	37.0	. . .	34.0	. . .	7

TABLE 2 *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	
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 6262							
T6 T6510[E] T6511[E]	all	all	38.0	. . .	35.0	. . .	10
Alloy 6351							
T1	up through 0.499	up through 20	26.0	. . .	13.0	. . .	15
T11	up through 0.749	all	26.0	. . .	16.0	. . .	16
T4	up through 0.749	all	32.0	. . .	19.0	. . .	16
T5	up through 0.249	all	38.0	. . .	35.0	. . .	8
	0.250–1.000	all	38.0	. . .	35.0	. . .	10
T51	0.125–1.000	all	36.0	. . .	33.0	. . .	10
T54	up through 0.500	all	30.0	. . .	20.0	. . .	10
T6	up through 0.124	all	42.0	. . .	37.0	. . .	8
	0.125–0.749	all	42.0	. . .	37.0	. . .	10
Alloy 6360							
T5	up through 0.250	all	22.0	. . .	16.0	. . .	8
T6	up through 0.120	all	30.0	. . .	25.0	. . .	8
	0.121–0.250	all	30.0	. . .	25.0	. . .	10
Alloy 6463							
T1	up through 0.500	up through 20	17.0	. . .	9.0	. . .	12
T5	up through 0.500	up through 20	22.0	. . .	16.0	. . .	8
T6	up through 0.124	up through 20	30.0	. . .	25.0	. . .	8
	0.125–0.500	up through 20	30.0	. . .	25.0	. . .	10
Alloy 6560							
T5	0.090–0.125	all	22.0	...	16.0	...	8
T6	0.090–0.125	all	30.0	...	25.0	...	8
Alloy 7005							
T53	up through 0.750	all	50.0	. . .	44.0	. . .	10
Alloy 7075[D]							
O	all	all	. . .	40.0	. . .	24.0	10
T6, T62[F] T6510[E] T6511[E]	up through 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
	3.000–4.499	up through 20	81.0	. . .	71.0	. . .	7
		over 20 through 32	78.0	. . .	70.0	. . .	6
	4.500–5.000	up through 32	78.0	. . .	68.0	. . .	6
T73 T73510[E] T73511[E]	0.062–0.249	up through 20	68.0	. . .	58.0	. . .	7
	0.250–1.499	up through 25	70.0	. . .	61.0	. . .	8
	1.500–2.999	up through 25	69.0	. . .	59.0	. . .	8
	3.000–4.499	up through 20	68.0	. . .	57.0	. . .	7
		over 20 through 32	65.0	. . .	55.0	. . .	7

TABLE 2 *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	
T76, T76510[E], T76511[E]	up through 0.049	all	73.0	. . .	63.0	. . .	7
	0.050–0.124	all	74.0	. . .	64.0	. . .	7
	0.125–0.249	up through 20	74.0	. . .	64.0	. . .	7
	0.250–0.499	up through 20	75.0	. . .	65.0	. . .	7
	0.500–1.000	up through 20	75.0	. . .	65.0	. . .	7
	1.001–2.000	up through 20	75.0	. . .	65.0	. . .	7
	2.001–3.000	up through 20	74.0	. . .	64.0	. . .	7
	3.001–4.000	up through 20	74.0	. . .	63.0	. . .	7
Alloy 7116							
T5	0.125–0.500	all	48.0	. . .	42.0	. . .	8
Alloy 7129							
T5, T6	up through 0.500	all	55.0	. . .	49.0	. . .	9
Alloy 7178[D]							
O	all	up through 32	. . .	40.0	. . .	24.0	10
T6, T6510[E], T6511[E]	up through 0.061	up through 20	82.0	. . .	76.0	. . .	. . .
	0.062–0.249	up through 20	84.0	. . .	76.0	. . .	5
	0.250–1.499	up through 25	87.0	. . .	78.0	. . .	5
	1.500–2.499	up through 25	86.0	. . .	77.0	. . .	5
		over 25 through 32	84.0	. . .	75.0	. . .	5
	2.500–2.999	up through 32	82.0	. . .	71.0	. . .	5
T62[F]	up through 0.061	up through 20	79.0	. . .	73.0	. . .	5
	0.062–0.249	up through 20	82.0	. . .	74.0	. . .	5
	0.250–1.499	up through 25	86.0	. . .	77.0	. . .	5
	1.500–2.499	up through 25	86.0	. . .	77.0	. . .	5
		over 25 through 32	84.0	. . .	75.0	. . .	5
	2.500–2.999	up through 32	82.0	. . .	71.0	. . .	5
T76, T76510[E], T76511[E]	0.125–0.249	up through 20	76.0	. . .	66.0	. . .	7
	0.250–0.499	up through 20	77.0	. . .	67.0	. . .	7
	0.500–1.000	up through 20	77.0	. . .	67.0	. . .	7

[A] The basis for establishment of tensile property limits is shown in Annex A1.
[B] To determine conformance to this specification, each value shall be rounded to the nearest 0.1 ksi for strength and nearest 0.5 % for elongation in accordance with the rounding-off-method of Practice E29.
[C] Elongation of full-section and cut-out sheet-type specimens is measured in 2 in. Elongation of cut-out round specimens is measured in 4× specimen diameter. See 8.1.1 and 8.1.2 for conditions under which measurements are not required.
[D] These alloys are also produced in the F temper for which no tensile properties are specified or guaranteed.
[E] For stress relieved tempers (T3510, T3511, T4510, T4511, T5510, T5511, T6510, T6511, T73510, T73511, T76510, T76511, 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] Material in the T42 and T62 tempers is not available from the material producers.
[G] Minimum elongation for tube, 10 %.
[H] Minimum yield strength for tube, 48.0 ksi.
[I] Minimum yield strength for tube, 46.0 ksi.
[J] Yield strength is not applicable in tube.
[K] Only in tube form.
[L] Properties not applicable to extruded tube over 2.999 in wall thickness.
[M] Tentative; properties subject to revision.

TABLE 3 Ultrasonic Discontinuity Limits for Extruded Bar and Profiles[A]

Alloy	Thickness,[B] in.	Weight, max per Piece, lb	Max Width: Thickness Ratio	Discontinuity Class[C]
2014, 2024, 2219	0.500 and over	600	10:1	B
7075	0.500–1.499	600	10:1	B
7178	1500 and over	600	10:1	A

[A] Discontinuities in excess of those listed in this table shall be allowed, subject to the approval of the procuring activity, if it is established that they will be removed by machining or that they are in noncritical areas.
[B] The thickness of any element of a profile shall be deemed to be the smallest dimension of that element and the discontinuity class applicable to that particular thickness shall apply to that element of the profile.
[C] The discontinuity class limits are defined in Section 11 of Practice B594.

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 material shall conform to the chemical composition limits in Table 1. Conformance shall be determined by the producer by taking samples in accordance with Practices E716 when the ingots are poured and analyzing those samples in accordance with Test Methods E607, E1251, E34, or EN 14242. At least one sample shall be taken for each group of ingots poured simultaneously from the same source of molten metal. If the producer has determined the chemical composition during pouring of the ingots, they shall not be required to sample and analyze the finished product.

NOTE 4—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 If it becomes necessary to analyze extrusions for conformance to chemical composition limits, the method used to sample extrusions for the determination of chemical compositions shall be by agreement between the producer and the purchaser. Analysis shall be performed in accordance with Practices E716, Test Methods E607, E1251, E34, and EN 14242 (ICP method). The number of samples taken for determination of chemical composition shall be as follows:

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

7.3 Other methods of analysis, or in the case of dispute, may be decided by agreement between the producer and the purchaser.

NOTE 5—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 Method E34) or spectrochemical (Test Methods E607 and E1251) methods. Other methods may be used only when no published ASTM test method is available. In case of dispute, the methods of analysis shall be agreed upon between the producer and purchaser.

8. Tensile Properties of Material from Producer

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

8.1.1 The elongation requirements shall not be applicable to the following:

8.1.1.1 Material of such dimensions that a standard test specimen cannot be taken in accordance with Test Method B557, and of such a profile that it cannot be satisfactorily tested in full section.

8.1.1.2 Material thinner than 0.062 in.

8.1.1.3 Wire less than 0.125 in. in diameter.

8.1.2 The measurement for yield strength is not required for wire less than 0.125 in. in diameter.

8.1.3 Tensile property limits for sizes not covered in Table 2 shall be as agreed upon between the producer and purchaser, and shall be so specified in the contract or purchase order.

8.2 *Number of Specimens:*

8.2.1 For material having a nominal weight of less than 1 lb/linear ft, one tension test specimen shall be taken for each 1000 lb or fraction thereof in the lot.

8.2.2 For material having a nominal weight of 1 lb or more per linear foot, one tension test specimen shall be taken for each 1000 ft or fraction thereof in the lot.

8.2.3 Other procedures for selecting samples may be employed if agreed upon between the producer or supplier and the purchaser.

8.3 Geometry of test specimens and the location in the product from which they are taken shall be as specified in Test Method B557.

8.4 *Test Methods*—The tension tests shall be made in accordance with Test Method B557.

8.5 *Retests*—When there is evidence that the test specimen is defective or is not representative of the lot of material, retesting may be performed in accordance with Sections 8 and 9 of Test Method B557.

9. Heat Treatment

9.1 For the production of T1 and T5-type tempers, producer or supplier heat treatment shall be in accordance with ASTM Practice B945.

9.2 For the production of T3, T4, T6, T7 and T8-type tempers, except as noted in 9.3 or 9.4, shall be in accordance with AMS 2772.

9.3 Unless otherwise specified (4.2.1), alloys 6005A, 6041, 6060, 6061, 6063, 6064, 6066, 6162, 6082, 6262, 6351, 6360, 6463, and 6560 may be solution heat treated and quenched at the extrusion press in accordance with Practice B807/B807M for the production of T4 and T6-type tempers.

9.4 When specified (4.2.2), heat treatment of the production of T3, T4, T6, T7, and T8-type tempers shall be in accordance with Practice B918.

10. Producer Confirmation of Heat-Treat Response

10.1 In addition to the requirements of Section 8, material in alloys 2014, 2024, and 6061 produced in the O or F temper (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 sample may be tested prior to 4 days natural aging but if they fail to conform to the T42 temper properties, the test may be repeated after completion of 4 days natural aging without prejudice.

10.2 Alloys 2219, 7075, and 7178 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.

10.3 *Number of Specimens*—The number of specimens from each lot of O temper material and F temper material to be tested to verify conformance with 10.1 and 10.2 shall be as specified in 8.2.

11. Heat Treatment and Reheat-Treatment Capability

11.1 As-received material in the O or F temper in alloys 2014, 2024, and 6061 (within the size limitations specified in Table 2 and without the imposition of cold work) shall be capable of conforming to the properties specified in Table 2 for T42 temper, upon being properly solution heat-treated and naturally aged for not less than 4 days at room temperature.

11.2 As-received material in the O and F tempers in alloys 2219, 7075, and 7178 (within the size limitations specified in Table 2 and without the imposition of cold work) shall be capable of conforming to the properties specified in Table 2 for the T62 temper, upon being properly solution and precipitation heat-treated.

11.3 Material in alloys and tempers 2014-T4, T4510, T4511, T6, T6510, and T6511, and 2024-T3, T3510, T3511, T81, T8510, and T8511, shall be capable of conforming to the properties specified in Table 2 for the T42 temper, upon being properly resolution heat-treated and naturally aged for not less than 4 days at room temperature.

NOTE 6—Beginning with the 1975 revision, 6061-T4, T6, T4510, T4511, T6510, and T6511 were deleted from 11.3 because experience has shown the reheat-treated material tends to develop large recrystallized grains and may fail to develop the tensile properties shown in Table 2.

11.4 Alloy 2219 in the T31, T3510, T3511, T81, T8510, and T8511 tempers, and alloys 7075 and 7178 in the T6, T651, T6510, and T6511 tempers, shall be capable of conforming to the properties specified in Table 2 for the T62 temper, upon being properly resolution heat-treated and precipitation heat-treated.

11.5 Material in T3/T31, T3510, T3511, T4, T4510, and T4511 tempers shall be capable of conforming, upon being properly precipitation heat-treated, to the properties specified in Table 2 for the T81, T8510, T8511, T6, T6510, and T6511 tempers, respectively.

12. Stress-Corrosion Resistance

12.1 Alloy 7075 in the T73 and T76-type tempers, and alloy 7178 in the T76-type tempers, shall be capable of exhibiting no evidence of stress-corrosion cracking when subjected to the test specified in 12.2.

12.1.1 For lot-acceptance purposes, resistance to stress-corrosion cracking for each lot of material shall be established by testing the previously selected tension-test samples to the criteria shown in Table 4.

12.1.2 For surveillance purposes, each month the producer shall perform at least one test for stress corrosion resistance on each applicable alloy-temper, for each thickness range 0.750 in. and over produced that month. Each sample shall be taken from material considered acceptable in accordance with the lot-acceptance criteria of Table 4. A minimum of three adjacent replicate specimens shall be taken from each sample and tested. The producer shall maintain records of all lots so tested and make them available for examination at the producer's facility.

12.2 The stress-corrosion cracking test shall be performed on material 0.750 in. and over in thickness as follows:

12.2.1 Specimens shall be stressed in tension in the short transverse direction with respect to grain flow and held at constant strain. The stress level shall be 75 % of the specified minimum yield strength for T73-type tempers and 25 ksi for T76-type tempers.

12.2.2 The stress-corrosion test shall be made in accordance with Test Method G47.

12.2.3 There shall be no visual evidence of stress-corrosion cracking in any specimen, except that the retest provisions of 19.2 shall apply.

13. Exfoliation-Corrosion Resistance

13.1 Alloys 7075 and 7178 in the T76, T76510, and T76511 tempers shall be capable of exhibiting no evidence of exfoliation corrosion equivalent to or in excess of that illustrated by Category B in Fig. 2 of Test Method G34 when tested in accordance with 13.1.1.

13.1.1 For surveillance purposes, each month at least one exfoliation-corrosion test shall be performed for each size range of extrusions produced during that month. The test shall be in accordance with Test Method G34 on material considered

TABLE 4 Lot Acceptance Criteria for Resistance to Stress Corrosion and Exfoliation Corrosion

Alloy and Temper	Lot Acceptance Criteria		Lot Acceptance Status
	Electrical Conductivity, % IACS[A]	Level of Mechanical Properties	
7075-T73, T73510, and T73511	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 11.9 ksi	acceptable
	38.0 through 39.9	per specified requirements but yield strength exceeds minimum by 12.0 ksi or more	unacceptable[B]
	less than 38.0	any level	unacceptable[B]
7075-T76, T76510, and T76511	38.0 or greater	per specified requirements	acceptable
	36.0 through 37.9	per specified requirements	suspect[C]
	less than 36.0	any level	unacceptable[B]
7178-T76, T76510, and T76511	38.0 or greater	per specified requirements	acceptable
	35.0 through 37.9	per specified requirements	suspect[C]
	less than 35.0	any level	unacceptable[B]

[A] Sampling for electrical conductivity tests shall be the same as for tensile tests as specified in 8.2. Test specimens may be prepared by machining a flat, smooth surface of sufficient width for proper testing. For small sizes of tubes, a cut-out portion may be flattened and the conductivity determined on the surface. Chemical milling may be used on flat surface samples. The electrical conductivity shall be determined in accordance with Practice E1004 in the following locations:

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

[C] When material in these tempers is found to be suspect it is either tested for exfoliation corrosion resistance in accordance with Test Method G34 and stress corrosion in accordance with Test Method G47, or it is reprocessed (additional precipitation heat treatment or resolution heat treatment and precipitation heat treatment). Favorable exfoliation corrosion test results must never be used as acceptance criteria for stress corrosion resistance.

Section thickness, in.		
over	through	Location
...	0.100	surface of tension sample
0.100	0.500	subsurface after removal of approximately 10 % of the thickness
0.500	1.500	subsurface at approximate center of section thickness, on a plane parallel to the longitudinal center line of the material
1.500	...	subsurface on tension-test specimen surface that is closest to the center of the section thickness and on a plane parallel to the extrusion surface

acceptable in accordance with lot-acceptance criteria of Table 4. Specimens shall be selected at random and shall be, if possible, a minimum of 2 by 4 in. with the 4-in. dimension in a plane parallel to the direction of extrusion. The test location shall be in accordance with that specified in Table 4. The producer shall maintain records of all surveillance test results and make them available for examination at the producer's facility.

13.2 For lot-acceptance purposes, resistance to exfoliation corrosion for each lot of material in the alloys and tempers listed in 13.1 shall be established by testing the previously selected tension-test samples to the criteria shown in Table 4.

14. Cladding

14.1 The aluminum-alloy cladding on clad tube shall comprise the inside surface (only) of the tube and its thickness shall be approximately 10 % of the total wall thickness.

14.2 When the cladding thickness is to be determined on finished tube, transverse cross sections of at least three tubes from the lot shall be polished for examination with a metallurgical microscope. Using a 100× magnification, the cladding thickness at four points 90° apart in each sample shall be measured and the average of the 12 measurements shall be taken as the thickness. For a tube having a diameter larger than can be properly mounted for polishing and examination, the portions of the cross section polished for examination may consist of an arc about ½ in. in length.

15. Dimensional Tolerances

15.1 *Dimensions*—Variations from the specified dimensions for the type of material ordered shall not exceed the permissible variations prescribed in the tables of ANSI H35.2 (see Table 5).

15.1.1 Dimensional tolerances for sizes not covered in ANSI H35.2 shall be agreed upon between the producer and purchaser and shall be specified in the contract or purchase order.

15.2 *Sampling for Inspection*—Examination for dimensional conformance shall be made to ensure conformance to the tolerance specified.

16. General Quality

16.1 Unless otherwise specified the extruded bar, rod, wire, profile, and tube 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 the producer and purchaser.

16.2 Each bar, rod, wire, profile, or tube shall be examined to determine conformance to this specification with respect to general quality and identification marking. On approval of the

TABLE 5 Tables of ANSI H35.2

Table No.	Title
11.2	Cross-Sectional Dimension Tolerances: Profiles Except for Profiles in T3510, T4510, T6510, T73510, T76510 and T8510 Tempers
11.3	Diameter or Distance across Flats-Round Wire and Rod—Square, Hexagonal and Octagonal Wire and Bar
11.4	Thickness or Width (Distance Across Flats)—Rectangular Wire and Bar
11.5	Length: Wire, Rod, Bar and Profiles
11.6	Straightness: Rod, Bar and Profiles
11.7	Twist—Bar and Profiles
11.8	Flatness (Flat Surfaces)—Bar, Solid Profiles and Semihollow Profiles Except for O, T3510, T4510, T6510, T73510, T76510 and T8510 Tempers
11.9	Flatness (Flat Surfaces)—Hollow Profiles Except for O, T3510, T4510, T6510, T73510, T76510 and T8510 Tempers
11.10	Surface Roughness—Wire, Rod, Bar and Profiles
11.11	Contour (Curved Surfaces) Profiless
11.12	Squareness of Cut Ends—Wire, Rod, Bar and Profiles
11.13	Corner and Fillet Radii—Bar and Profiles
11.14	Angularity—Bar and Profiles Except for O, T3510, T4510, T6510, T73510, T76510, and T8510 Tempers
12.2	Diameter Round Tube Except for T3510, T4510, T6510, T73510, T76510 and T8510 Tempers
12.3	Width and Depth—Square, Rectangular, Hexagonal, Octagonal Tube Except for T3510, T4510, T6510, T73510, T76510 and T8510 Temper
12.4	Wall Thickness—Round Extruded Tube
12.5	Wall Thickness—Other Than Round Extruded Tube
12.6	Length—Extruded Tube
12.7	Twist—Other Than Round Extruded Tube
12.8	Straightness—Tube in Straight Lengths
12.9	Flatness (Flat Surfaces)
12.10	Squareness of Cut Ends
12.11	Corner and Fillet Radii: Tube Other Than Round
12.12	Angularity: Tube Other Than Round
12.13	Surface Roughness: Extruded Tube
12.14	Dents: Extruded Tube

purchaser, however, the producer or the supplier may use a system of statistical quality control for such examination.

17. Internal Quality

17.1 When specified by the purchaser at the time of placing the contract or order, each bar or profile 0.500 in. or greater in thickness or smallest dimension, in alloys 2014, 2024, 2219, 7075, and 7178, shall be tested ultrasonically in accordance with Practice B594 to the discontinuity acceptance limits of Table 3.

18. Source Inspection

18.1 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 or supplier as part of the purchase contract.

18.2 When such inspection or witness of inspection and testing is agreed upon, the producer or supplier 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 or supplier's operations.

19. Retest and Rejection

19.1 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.

19.2 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.

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

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

20. Identification Marking of Product

20.1 When specified in the contract or purchase order, all material shall be marked in accordance with Practice B666/B666M.

NOTE 7—Ordering per B666/B666M will require the supplier to mark the lot number on each extruded section.

20.2 The requirements specified in 20.1 are minimum; marking systems that involve added information, larger characters, and greater frequencies are acceptable under this specification and shall be agreed upon between the producer and purchaser.

21. Packaging and Package Marking

21.1 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 upon. The type of packing and gross weight of containers shall, unless otherwise agreed upon, be at the producer or supplier's discretion, provided they are such as to ensure acceptance by common or other carriers for safe transportation at the lowest rate to the delivery point.

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

21.3 When specified in the contract or purchase order, material shall be preserved, packaged, and packed in accordance with the requirements of Practices B660. The applicable level 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.

22. Certification

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

23. Keywords

23.1 aluminum alloy; extruded bars; extruded profiles; extruded rods; extruded tubes; extruded wire

ANNEXES

(Mandatory Information)

A1. BASIS FOR INCLUSION OF PROPERTY LIMITS

A1.1 Mechanical property limits are established in accordance with Section 6, Standards Section, of the most current edition of *Aluminum Standards and Data* and the latest edition of the Aluminum Association publication *Tempers for Aluminum and Aluminum Alloy Products (Yellow and Tan Sheets)*.

A1.2 Limits are based on a statistical evaluation of the data indicating that at least 99 % of the population obtained from all standard material meets the limit with 95 % confidence. For the products described, mechanical property limits are based on the statistical analyses of at least 100 tests from at least 5 cast lots of standard production material with no more than 10 observations from a given heat treat or inspection lot. Mechanical properties limits for press solution heat treated products have specific additional requirements that are provided in *Tempers for Aluminum and Aluminum Alloy Products*.

A1.3 Limits denoted as "tentative" by the Aluminum Association may be included. Requirements for tentative property registrations are defined in the latest edition of *Tempers for Aluminum and Aluminum Alloy Products*. Tentative property limits are established at levels at which at least 99 % of the data conform at a confidence level of 95 %. Tentative property limits, which are subject to revision, shall be based on a statistical analysis of at least 30 tests from at least 3 cast lots of standard production material with no more than 10 observations from a given heat treat or inspection lot. Where tentative property limits are listed, they shall be shown in italics and footnoted as "tentative" in the standard.

A1.4 All tests shall be performed in accordance with the appropriate ASTM test methods.

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/H35.1M. The Aluminum Association[5] 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/H35.1M. 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 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, and so forth
(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 titanium and other elements, each, 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. DESIGNATIONS FOR METALS AND ALLOYS FORMERLY ASSIGNED IN CONFORMANCE WITH PRACTICE B275

X1.1 Designations assigned in conformance with this practice were used for wrought aluminum and wrought aluminum alloys in ASTM specifications prior to 1960, and for cast aluminum and aluminum alloys and ingot prior to 1974, but now designations conforming to the American National Standard Alloys and Temper Designation Systems for Aluminum (ANSI H35.1/H35.1M) are standard with the UNS, Practice E527 for information only. The former ASTM designations and the corresponding ANSI and UNS designations for wrought alloys are as shown in Table X3.1. Cast alloys and ingot are as shown in Table X3.2. (See Table X1.1.)

TABLE X1.1 Wrought Aluminum Alloys

Designations			Designations		
ANSI H35.1/H35.1M	Former B275 – 63	UNS	ANSI H35.1/H35.1M	Former B275 – 63	UNS
1060	996A	A91060	5056	GM50A	A95056
1100	990A	A91100	5083	GM41A	A95083
2011	CB60A	A92011	5086	GM40A	A95086
2014	CS41A	A92014	5154	GR40A	A95154
2017	CM41A	A92017	5254	GR40B	A95254
2018	CN42C	A92018	5454	GM31A	A95454
2024	CG42A	A92024	5456	GM51A	A95456
2117	CG30A	A92117	5652	GR20B	A95652
3003	M1A	A93003	6053	GS11B	A96053
3004	MG11A	A93004	6061	GS11A	A96061
4032	SG121A	A94032	6063	GS10A	A96063
5005	G1B	A95005	6101	GS10B	A96101
5050	G1A	A95050	7075	ZG62A	A97075
†5052	GR20A	A95052			

†Editorially corrected.

SUMMARY OF CHANGES

Committee B07 has identified the location of selected changes to this standard since the last issue (B221 – 13) that may impact its use. (Approved Oct. 1, 2014.)

(1) Changed thickness range for 6005A-T61 to 0.250–1.000 in., instead of 0.250–0.999 in., in Table 2, to match properties listed in AS&D.

Committee B07 has identified the location of selected changes to this standard since the last issue (B221 – 12a) that may impact its use. (Approved April 1, 2013)

(1) Revised Note 3.