



Designation: B 221 – 00

## Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes<sup>1</sup>

This standard is issued under the fixed designation B 221; 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 ( $\epsilon$ ) indicates an editorial change since the last revision or reapproval.

*This standard has been approved for use by agencies of the Department of Defense.*

### 1. Scope \*

1.1 This specification<sup>2</sup> covers aluminum and aluminum-alloy extruded bar, rod, wire, profile, and tube 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 B 211, for drawn tube to Specification B 210, for structural pipe and tube to Specification B 429, and for seamless pipe and tube to Specification B 241/B 241M.

1.2 Alloy and temper designations are in accordance with ANSI H35.1. 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 For acceptance criteria for inclusion of new aluminum and aluminum alloys in this specification, see Annex A2.

1.4 A complete metric companion to B 221 has been developed—B 221M; 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:

B 557 Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products<sup>3</sup>

B 594 Practice for Ultrasonic Inspection of Aluminum-Alloy Wrought Products for Aerospace Applications<sup>3</sup>

B 597 Practice for Heat Treatment of Aluminum Alloys<sup>3</sup>

B 660 Practices for Packaging/Packing of Aluminum and Magnesium Products<sup>3</sup>

B 666/B 666M Practice for Identification Marking of Aluminum Products<sup>3</sup>

B 807 Practice for Extrusion Press Solution Heat Treatment of Aluminum Alloys<sup>3</sup>

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>4</sup>

E 34 Test Methods for Chemical Analysis of Aluminum and Aluminum-Base Alloys<sup>5</sup>

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition<sup>5</sup>

E 227 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique<sup>5</sup>

E 527 Practice for Numbering Metals and Alloys (UNS)<sup>6</sup>

E 607 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere<sup>7</sup>

E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis<sup>7</sup>

E 1004 Test Method for Electromagnetic (Eddy-Current) Measurements of Electrical Conductivity<sup>8</sup>

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<sup>7</sup>

G 47 Test Method for Determining Susceptibility to Stress-Corrosion Cracking of High-Strength Aluminum Alloy Products<sup>9</sup>

Method of Test for Exfoliation Corrosion Susceptibility in 7xxx Series Copper-Containing Aluminum Alloys (EXCO Test) (G 34-72)<sup>10</sup>

#### 2.3 ANSI Standards:

H35.1 Alloy and Temper Designation Systems for Aluminum<sup>3</sup>

<sup>1</sup> 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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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SB-221 in Section 11 of this Code.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 02.02.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 03.05.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 01.01.

<sup>7</sup> *Annual Book of ASTM Standards*, Vol 03.06.

<sup>8</sup> *Annual Book of ASTM Standards*, Vol 03.03.

<sup>9</sup> *Annual Book of ASTM Standards*, Vol 03.02.

<sup>10</sup> The applicable edition in the use of this specification is G 34-72, which is available in the gray pages of the *Annual Book of ASTM Standards*, Vol 02.02.

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



**TABLE 1 Chemical Composition Limits<sup>A,B,C</sup>**

Alloy	Silicon	Iron	Copper	Manga- nese	Magne- sium	Chromium	Zinc	Vanadium	Titanium	Other Elements <sup>D</sup>		Aluminum
										Each	Total <sup>E</sup>	
1060	0.25	0.35	0.05	0.03	0.03	...	0.05	0.05	0.03	0.03	...	99.60 min <sup>F</sup>
1100	0.95 Si + Fe		0.05–0.20	0.05	...	...	0.10	...	...	0.05	0.15	99.00 min <sup>F</sup>
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
2219	0.20	0.30	5.8–6.8	0.20–0.40	0.02	...	0.10	0.05–0.15	0.02–0.10	0.05 <sup>G</sup>	0.15 <sup>G</sup>	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	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 <sup>H</sup>	0.40–0.7	0.30 <sup>H</sup>	0.20	...	0.10	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 <sup>I</sup>	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
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
6105	0.6–1.0	0.35	0.10	0.10	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 <sup>J</sup>	0.15 <sup>J</sup>	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
6463	0.20–0.6	0.15	0.20	0.05	0.45–0.9	...	0.05	...	...	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 <sup>K</sup>	0.15 <sup>K</sup>	remainder
7072 <sup>L</sup>	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	0.05	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 <sup>M</sup>	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 <sup>M</sup>	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

<sup>A</sup> Limits are in weight percent maximum unless shown as a range, or stated otherwise.

<sup>B</sup> Analysis shall be made for the elements for which limits are shown in this table.

<sup>C</sup> 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 E 29.

<sup>D</sup> *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.

<sup>E</sup> *Other Elements*—Total shall be the sum of unspecified metallic elements 0.010 % or more, rounded to the second decimal before determining the sum.

<sup>F</sup> 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.

<sup>G</sup> Zirconium, 0.10–0.25 %. The total for other elements does not include zirconium.

<sup>H</sup> Manganese plus chromium shall total 0.12–0.50.

<sup>I</sup> 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.

<sup>J</sup> Bismuth and lead shall be 0.40–0.7 % each.

<sup>K</sup> Zirconium 0.08–0.20 %. The total for other elements does not include zirconium.

<sup>L</sup> Composition of cladding alloy applied during the course of manufacture. Samples from finished tube shall not be required to conform to these limits.

<sup>M</sup> Gallium 0.03 % max.

### H35.2 Dimensional Tolerances for Aluminum Mill Products<sup>3</sup>

#### 2.4 Federal Standard:

Fed. Std. No. 123 Marking for Shipment (Civil Agencies)<sup>11</sup>

#### 2.5 Military Standard:

MIL-STD-129 Marking for Shipment and Storage<sup>11</sup>

#### 2.6 Military Specification:

MIL-H-6088 Heat Treatment of Aluminum Alloys<sup>11</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 *extruded bar*—an extruded solid product that is long in relation to cross section, which is square or rectangular (excluding plate and flattened wire) with sharp or rounded corners or edges, or is a regular hexagon or octagon, and in which at least one perpendicular distance between parallel faces is 0.375 in. or greater.

3.1.2 *extruded rod*—an extruded solid product 0.375 in. or greater in diameter that is long in relation to cross section.

3.1.3 *extruded profile*—a hollow or solid extruded section, long in relation to its cross-sectional dimensions, whose cross section is other than that of wire, rod, bar, or tube.

<sup>11</sup> Available from Standardization Documents Order Desk, Bldg. 4 Section D, 700 Robbins Ave., Philadelphia, PA 19111-5094, Attn: NPODS.



**TABLE 2 Mechanical Property Limits<sup>A,B</sup>**

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

Temper	Specified Section or Wall Thickness, in.	Area, in. <sup>2</sup>	Tensile Strength, ksi		Yield Strength (0.2 % offset), ksi		Elongation in 2 in. or 4 × Diameter, min, % <sup>E,F</sup>
			min	max	min	max	
<b>Aluminum 1060<sup>G</sup></b>							
O	all	all	8.5	14.0	2.5	...	25
H112	all	all	8.5	...	2.5	...	25
<b>Aluminum 1100<sup>G</sup></b>							
O	all	all	11.0	15.5	3.0	...	25
H112	all	all	11.0	...	3.0	...	25
<b>Alloy 2014<sup>G</sup></b>							
O	all	all	...	30.0	...	18.0	12
T4	all	all	50.0	...	35.0	...	12
T4510 <sup>J</sup> T4511 <sup>J</sup>							
T42 <sup>K</sup>	all	all	50.0	...	29.0	...	12
T6	up through 0.499	all	60.0	...	53.0	...	7
T6510 <sup>J</sup> T6511 <sup>J</sup>							
T6510 <sup>J</sup> T6511 <sup>J</sup>	0.500–0.749	all	64.0	...	58.0	...	7
T62 <sup>K</sup>	up through 0.749	all	60.0	...	53.0	...	7
T62 <sup>K</sup>	0.750 and over	over 25 through 32	60.0	...	53.0	...	6
<b>Alloy 2024<sup>G</sup></b>							
O	all	all	...	35.0	...	19.0	12
T3	up through 0.249	all	57.0	...	42.0	...	12 <sup>L</sup>
T3510 <sup>J</sup> T3511 <sup>J</sup>	0.750–1.499	all	65.0	...	46.0	...	10
T3510 <sup>J</sup> T3511 <sup>J</sup>	1.500 and over	over 25 through 32	68.0	...	48.0 <sup>N</sup>	...	8
T42 <sup>K</sup>	0.750–1.499	all	57.0	...	38.0	...	10
T42 <sup>K</sup>	1.500 and over	over 25 through 32	57.0	...	38.0	...	8
T8510 <sup>J</sup> T8511 <sup>J</sup>	0.250–1.499	all	66.0	...	58.0	...	5
<b>Alloy 2219<sup>G</sup></b>							
O	all	all	...	32.0	...	18.0	12
T31	up through 0.499	up through 25	42.0	...	26.0	...	14
T3510 <sup>J</sup> T3511 <sup>J</sup>							
T3510 <sup>J</sup> T3511 <sup>J</sup>	0.500–2.999	up through 25	45.0	...	27.0	...	14
T62 <sup>K</sup>	up through 0.999	up through 25	54.0	...	36.0	...	6
T81	up through 2.999	up through 25	58.0	...	42.0	...	6
<b>Alloy 3003<sup>G</sup></b>							
O	all	all	14.0	19.0	5.0	...	25
H112	all	all	14.0	...	5.0	...	25
<b>Alloy Alclad 3003<sup>G</sup></b>							
O	all	all	13.0	18.0	4.5	...	25
H112	all	all	13.0	...	4.5 <sup>H</sup>	...	25



**TABLE 2 Continued**

Temper	Specified Section or Wall Thickness, in.	Area, in. <sup>2</sup>	Tensile Strength, ksi		Yield Strength (0.2 % offset), ksi		Elongation in 2 in. or 4 × Diameter, min, % <sup>E,F</sup>
			min	max	min	max	
<b>Alloy 3004<sup>G</sup></b>							
O	all	all	23.0	29.0	8.5	...	...
<b>Alloy 3102</b>							
H112 <sup>C</sup>	0.028–0.050	all	11.0	18.0	4.0	...	25
<b>Alloy 5052</b>							
O	all	all	25.0	35.0	10.0	...	...
<b>Alloy 5083<sup>G</sup></b>							
O	up through 5.000 <sup>D</sup>	up through 32	39.0	51.0	16.0	...	14
H111	up through 5.000 <sup>D</sup>	up through 32	40.0	...	24.0	...	12
H112	up through 5.000 <sup>D</sup>	up through 32	39.0	...	16.0	...	12
<b>Alloy 5086<sup>G</sup></b>							
O	up through 5.000 <sup>D</sup>	up through 32	35.0	46.0	14.0	...	14
H111	up through 5.000 <sup>D</sup>	up through 32	36.0	...	21.0	...	12
H112	up through 5.000 <sup>D</sup>	up through 32	35.0	...	14.0	...	12
<b>Alloy 5154</b>							
O	all	all	30.0	41.0	11.0	...	...
H112	all	all	30.0	...	11.0	...	...
<b>Alloy 5454<sup>G</sup></b>							
O	up through 5.000 <sup>D</sup>	up through 32	31.0	41.0	12.0	...	14
H111	up through 5.000 <sup>D</sup>	up through 32	33.0	...	19.0	...	12
H112	up through 5.000 <sup>D</sup>	up through 32	31.0	...	12.0	...	12
<b>Alloy 5456<sup>G</sup></b>							
O	up through 5.000 <sup>D</sup>	up through 32	41.0	53.0	19.0	...	14
H111	up through 5.000 <sup>D</sup>	up through 32	42.0	...	26.0	...	12
H112	up through 5.000 <sup>D</sup>	up through 32	41.0	...	19.0	...	12
<b>Alloy 6005</b>							
T1	up through 0.500	all	25.0	...	15.0	...	16
T5	up through 0.124 0.125–1.000	all	38.0	...	35.0	...	8
		all	38.0	...	35.0	...	10
<b>Alloy 6005A</b>							
T1	up through 0.249	all	25.0	...	14.5	...	15
T5	up through 0.249 0.250–0.999	all	38.0	...	31.0	...	7
		all	38.0	...	31.0	...	9
<b>Alloy 6060</b>							
T51	up through 0.125	all	22.0	...	16.0	...	8
<b>Alloy 6061<sup>G</sup></b>							
O	all	all	...	22.0	...	16.0	16
T1	up through 0.625	all	26.0	...	14.0	...	16
T4	all	all	26.0	...	16.0	...	16
T4510 <sup>J</sup>							
T4511 <sup>J</sup>							
T42 <sup>K</sup>	all	all	26.0	...	12.0	...	16
T51	up through 0.625	all	35.0	...	30.0	...	8
T6, T62 <sup>K</sup>	up through 0.249 0.250 and over	all	38.0	...	35.0	...	8
T6510 <sup>J</sup>							
T6511 <sup>J</sup>							



**TABLE 2 Continued**

Temper	Specified Section or Wall Thickness, in.	Area, in. <sup>2</sup>	Tensile Strength, ksi		Yield Strength (0.2 % offset), ksi		Elongation in 2 in. or 4 × Diameter, min, % <sup>E,F</sup>	
			min	max	min	max		
<b>Alloy 6063</b>								
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 <sup>K</sup>	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 T6, T62 <sup>K</sup>	up through 1.000	all	22.0	30.0	16.0	25.0	8	
	up through 0.124	all	30.0	...	25.0	...	8	
	0.125–1.000	all	30.0	...	25.0	...	10	
<b>Alloy 6066</b>								
O	all	all	...	29.0	...	18.0	16	
T4, T4510, <sup>J</sup> T4511 <sup>J</sup>	all	all	40.0	...	25.0	...	14	
	T42 <sup>K</sup>	all	40.0	...	24.0	...	14	
T6, T6510, <sup>J</sup> T6511 <sup>J</sup>	all	all	50.0	...	45.0	...	8	
	T62 <sup>K</sup>	all	50.0	...	42.0	...	8	
<b>Alloy 6070</b>								
T6, T62	up through 2.999	up through 32	48.0	...	45.0	...	6	
<b>Alloy 6105</b>								
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	
<b>Alloy 6162</b>								
T5, T5510 <sup>J</sup> T5511 <sup>J</sup>	up thru 1.000	all	37.0	...	34.0	...	7	
T6, T6510 <sup>J</sup> T6511 <sup>J</sup>	up thru 0.249	all	38.0	...	35.0	...	8	
	0.250–0.499	all	38.0	...	35.0	...	10	
<b>Alloy 6262</b>								
T6 T6510 <sup>J</sup> T6511 <sup>J</sup>	all	all	38.0	...	35.0	...	10	
<b>Alloy 6351</b>								
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	
<b>Alloy 6463</b>								
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	
<b>Alloy 7005</b>								
T53	0.125–1.000	up through 25	50.0	...	44.0	...	10	
<b>Alloy 7075<sup>Q</sup></b>								
O	all	all	...	40.0	...	24.0	10	
T6, T62 <sup>K</sup> T6510 <sup>J</sup> T6511 <sup>J</sup>	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	all	81.0	...	71.0	...	7
		over 20 through 32	all	78.0	...	70.0	...	6
	4.500–5.000	up through 32	all	78.0	...	68.0	...	6



**TABLE 2 Continued**

Temper	Specified Section or Wall Thickness, in.	Area, in. <sup>2</sup>	Tensile Strength, ksi		Yield Strength (0.2 % offset), ksi		Elongation in 2 in. or 4 × Diameter, min, % <sup>E,F</sup>
			min	max	min	max	
<b>Alloy 7075<sup>G</sup>—Continued</b>							
T73	0.062–0.249	up through 20	68.0	...	58.0	...	7
T73510 <sup>J</sup>	0.250–1.499	up through 25	70.0	...	61.0	...	8
T73511 <sup>J</sup>	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
T76	up through 0.049	all	73.0	...	63.0	...	7
T76510 <sup>J</sup>	0.050–0.124	all	74.0	...	64.0	...	7
T76511 <sup>J</sup>	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
<b>Alloy 7116</b>							
T5	0.125–0.500	all	48.0	...	42.0	...	8
<b>Alloy 7129</b>							
T5, T6	up through 0.500	all	55.0	...	49.0	...	9
<b>Alloy 7178<sup>G</sup></b>							
O	all	up through 32	...	40.0	...	24.0	10
T6	up through 0.061	up through 20	82.0	...	76.0	...	...
T6510 <sup>J</sup>	0.062–0.249	up through 20	84.0	...	76.0	...	5
T6511 <sup>J</sup>	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 <sup>K</sup>	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	0.125–0.249	up through 20	76.0	...	66.0	...	7
T76510 <sup>J</sup>	0.250–0.499	up through 20	77.0	...	67.0	...	7
T76511 <sup>J</sup>	0.500–1.000	up through 20	77.0	...	67.0	...	7

<sup>A</sup> The basis for establishment of tensile property limits is shown in Annex A1.

<sup>B</sup> 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 E 29.

<sup>C</sup> Only in tube form.

<sup>D</sup> Properties not applicable to extruded tube over 2.999 in wall thickness.

<sup>E</sup> 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.

<sup>F</sup> See 8.1.1 and 8.1.2 for conditions under which measurements are not required.

<sup>G</sup> These alloys are also produced in the F temper for which no tensile properties are specified or guaranteed.

<sup>H</sup> Yield strength is not applicable to tube.

<sup>J</sup> 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.

<sup>K</sup> Material in the T42 and T62 tempers is not available from the material producers.

<sup>L</sup> Minimum elongation for tube, 10 %.

<sup>M</sup> Minimum yield strength for tube, 48.0 ksi.

<sup>N</sup> Minimum yield strength for tube, 46.0 ksi.

3.1.4 *extruded tube*—an extruded hollow section, long in relation to its cross-sectional dimensions, which is symmetrical and is round, square, rectangular, hexagonal, octagonal, or elliptical with sharp or rounded corners, and has a uniform wall thickness except as affected by corner radii.

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

ing the core against corrosion.

3.1.6 *wire*—a solid section long in relation to its cross-sectional dimensions, having a cross section that is round, hexagonal, or octagonal and whose diameter, width, or greatest distance between parallel faces is less than 3/8 in., or having a symmetrical cross section that is square or rectangular (excluding flattened wire) with sharp or rounded corners or edges.

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

3.1.8 *supplier*—includes only the category of jobbers and