



Designation: B211/B211M – 19

# Standard Specification for Aluminum and Aluminum-Alloy Rolled or Cold Finished Bar, Rod, and Wire<sup>1</sup>

This standard is issued under the fixed designation B211/B211M; 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 U.S. Department of Defense.*

## 1. Scope\*

1.1 This specification<sup>2</sup> covers rolled or cold-finished bar, rod, and wire in alloys (Note 1) and tempers as shown in Table 2 [Table 3].

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

NOTE 2—The term *cold finished* is used to indicate the type of surface finish, sharpness of angles, and dimensional tolerances produced by drawing through a die.

NOTE 3—See Specification B221 [B221M] for aluminum and aluminum-alloy extruded bars, rods, wire, shapes, and tubes; and Specification B316/B316M for aluminum and aluminum-alloy rivet and cold-heading wire and rods.

1.2 Alloy and temper designations are in accordance with ANSI H35.1/H35.1M. The equivalent UNS 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 *This international standard was developed in accordance with internationally recognized principles on standardization established in the Decision on Principles for the Development of International Standards, Guides and Recommendations issued by the World Trade Organization Technical Barriers to Trade (TBT) Committee.*

## 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:<sup>3</sup>

- B221 Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes
- B221M Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes (Metric)
- B316/B316M Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods
- B557 Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products
- B557M Test Methods for Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products (Metric)
- 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
- B881 Terminology Relating to Aluminum- and Magnesium-Alloy Products
- B918/B918M Practice for Heat Treatment of Wrought Aluminum Alloys
- B985 Practice for Sampling Aluminum Ingots, Billets, Castings and Finished or Semi-Finished Wrought Aluminum Products for Compositional Analysis
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E290 Test Methods for Bend Testing of Material for Ductility
- E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)
- E607 Test Method for Atomic Emission Spectrometric Analysis Aluminum Alloys by the Point to Plane Technique Nitrogen Atmosphere (Withdrawn 2011)<sup>4</sup>
- E716 Practices for Sampling and Sample Preparation of Aluminum and Aluminum Alloys for Determination of

<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-211 in Section II of that Code.

<sup>3</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For Annual Book of ASTM Standards volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>4</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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

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

Alloy	Si	Fe	Cu	Mn	Mg	Cr	Ni	Zn	Ti	Bi	Pb	Sn	Other Elements <sup>E</sup>		Al, min
													Each	Total <sup>F</sup>	
1100 <sup>G</sup>	0.95 Si + Fe	0.05–0.20	0.05	...	...	...	...	0.10	...	...	...	...	0.05	0.15	99.00 <sup>G</sup>
2011	0.40	0.7	5.0–6.0	...	...	...	...	0.30	...	0.20–0.6	0.20–0.6	...	0.05	0.15	rem
2111	0.40	0.7	5.0–6.0	...	...	...	...	0.30	...	0.20–0.8	...	0.10–0.50	0.05	0.15	rem
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	rem
2017	0.20–0.8	0.7	3.5–4.5	0.40–1.0	0.40–0.8	0.10	...	0.25	0.15	...	...	...	0.05	0.15	rem
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	rem
2219	0.20	0.30	5.8–6.8	0.20–0.40	0.02	...	...	0.10	0.02–0.10	...	...	...	0.05 <sup>H</sup>	0.15 <sup>H</sup>	rem
3003	0.6	0.7	0.05–0.20	1.0–1.5	...	...	...	0.10	...	...	...	...	0.05	0.15	rem
4032	11.0–13.5	1.0	0.50–1.3	...	0.8–1.3	0.10	0.5–1.3	0.25	...	...	...	...	0.05	0.15	rem
5052	0.25	0.40	0.10	0.10	2.2–2.8	0.15–0.35	...	0.10	...	...	...	...	0.05	0.15	rem
5056	0.30	0.40	0.10	0.05–0.20	4.5–5.6	0.05–0.20	...	0.10	...	...	...	...	0.05	0.15	rem
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	rem
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	rem
6020	0.40–0.9	0.50	0.30–0.9	0.35	0.6–1.2	0.15	...	0.20	0.15	...	0.05	0.9–1.5	0.05	0.15	rem
6026	0.6–1.4	0.7	0.20–0.50	0.20–1.0	0.6–1.2	0.30	...	0.30	0.20	0.50–1.5	0.40	0.05	0.05	0.15	rem
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	rem
6110	0.7–1.5	0.8	0.20–0.7	0.20–0.7	0.50–1.1	0.04–0.25	...	0.30	0.15	...	...	...	0.05	0.15	rem
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	0.40–0.7	0.40–0.7	...	0.05	0.15	rem
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	rem

<sup>A</sup> In case of any discrepancy in the values listed in this table when compared with those listed in the “Teal Sheets” (International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys), the composition limits registered with The Aluminum Association and published in the “Teal Sheets” shall be considered the controlling composition. The “Teal Sheets” are available at <http://www.aluminum.org/tealsheets>.

<sup>B</sup> Limits are in mass percent maximum unless otherwise shown.

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

<sup>D</sup> 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 E29.

<sup>E</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 non-conforming.

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

<sup>G</sup> The aluminum content is the difference between 100.00 % and the sum of all other metallic elements and silicon present in amounts of 0.010 % or more each, rounded to the second decimal before determining the sum.

<sup>H</sup> Vanadium 0.05–0.15 % zirconium 0.10–0.25 %. The total for other elements does not include vanadium and zirconium.

## Document Preview

### Chemical Composition by Spark Atomic Emission Spectrometry

**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

**E3061** Test Method for Analysis of Aluminum and Aluminum Alloys by Inductively Coupled Plasma Atomic Emission Spectrometry (Performance Based Method)

**G47** Test Method for Determining Susceptibility to Stress-Corrosion Cracking of 2XXX and 7XXX Aluminum Alloy Products

#### 2.3 ANSI Standards:

**H35.1/H35.1M** Alloy and Temper Designation Systems for Aluminum<sup>5</sup>

**H35.2 [H35.2M]** Dimensional Tolerances for Aluminum Mill Products<sup>5</sup>

#### 2.4 Federal Standard:

**Fed. Std. No. 123** Marking for Shipment (Civil Agencies)<sup>6</sup>

#### 2.5 Military Standard:

**MIL-STD-129** Marking for Shipment and Storage<sup>6</sup>

#### 2.6 Aerospace Material Specification:

**AMS 2772** Heat Treatment of Aluminum Alloy Raw Materials<sup>7</sup>

#### 2.7 The Aluminum Association:

International Alloy Designations and Chemical Composition Limits for Wrought Aluminum and Wrought Aluminum Alloys (“Teal Sheets”)<sup>8</sup>

#### 2.8 Other Standards:

**CEN EN 14242** Aluminium and Aluminium Alloys—Chemical Analysis—Inductively Coupled Plasma Optical Emission Spectral Analysis<sup>9</sup>

### 3. Terminology

#### 3.1 Definitions:

3.1.1 Refer to Terminology **B881** for definitions of product terms in this specification.

3.1.2 *flattened and slit wire*—Flattened wire which has been slit to obtain square edges.

#### 3.2 Definitions of Terms Specific to This Standard:

<sup>7</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001.

<sup>8</sup> Available from The Aluminum Association, Inc. 1400 Crystal Drive, Suite 430, Arlington, VA 22202, [www.aluminum.org](http://www.aluminum.org).

<sup>9</sup> Available from European Committee for Standardization, Central Secretariat (CEN), rue de Stassart 36, B1050 Brussels, Belgium. <http://www.cen.eu/eseach>

<sup>5</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

<sup>6</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</sup> (US Customary)

Temper	Specified Diameter or Thickness, in.	Tensile Strength, ksi		Yield Strength <sup>B</sup> (0.2 % offset), min, ksi	Elongation <sup>B</sup> in 2 in. or 4x Diameter, min %
		min	max		
<b>Aluminum 1100</b>					
O	0.124 and under	11.0	15.5	...	...
	0.125 and over	11.0	15.5	3.0	25
H12	0.374 and under	14.0	...	...	...
H14	0.374 and under	16.0	...	...	...
H16	0.374 and under	19.0	...	...	...
H18	0.374 and under	22.0	...	...	...
H112	all	11.0	...	3.0	...
F	all	<sup>D</sup>	...	<sup>D</sup>	...
<b>Alloy 2011</b>					
T3	0.125–1.500	45.0	...	38.0	10
	1.501–2.000	43.0	...	34.0	12
	2.001–3.500	42.0	...	30.0	12
T4 and T451 <sup>E</sup>	0.125–8.000	40.0	...	18.0	16
T6 and T651 <sup>E</sup>	0.375–6.500	54.0	...	40.0	10
T8	0.125–3.250	54.0	...	40.0	10
<b>Alloy 2111</b>					
T8	0.500–3.500	52.0	...	38.0	10
<b>Alloy 2014<sup>F</sup></b>					
O	0.124 and under	...	35.0	...	...
	0.125–8.000	...	35.0	...	12
T4, T42 <sup>G</sup> , & T451 <sup>E</sup>	0.124 and under	55.0	...	...	...
	0.125–8.000 <sup>H</sup>	55.0	...	32.0	16
T6, T62 <sup>G</sup> , & T651 <sup>E</sup>	0.124 and under	65.0	...	...	...
	0.125–8.000 <sup>H</sup>	65.0	...	55.0	8
<b>Alloy 2017<sup>F</sup></b>					
O	0.124 and under	...	35.0	...	...
	0.125–8.000	...	35.0	...	16
T4, T42 <sup>G</sup> , & T451 <sup>E</sup>	0.124 and under	55.0	...	...	...
	0.125–8.000 <sup>I</sup>	55.0	...	32.0	12
<b>Alloy 2024<sup>F</sup></b>					
O	0.124 and under	...	35.0	...	...
	0.125–8.000	...	35.0	...	16
T36	0.124 and under	69.0	...	...	...
	0.125–0.375	69.0	...	52.0	10
T4 <sup>J</sup>	0.124 and under	62.0	...	...	...
	0.125–0.499	62.0	...	45.0 <sup>J</sup>	10
	0.500–4.500 <sup>H</sup>	62.0	...	42.0 <sup>J</sup>	10
	4.501–6.500 <sup>K</sup>	62.0	...	40.0	10
	6.501–8.000 <sup>K</sup>	58.0	...	38.0	10
T42 <sup>G</sup>	0.124 and under	62.0	...	...	...
T42 <sup>G</sup>	0.125–1.000	62.0	...	40.0	10
	1.001–6.500 <sup>H</sup>	62.0	...	40.0	10
T351 <sup>E</sup>	0.500–6.500 <sup>H</sup>	62.0	...	45.0	10
	6.501–8.000	62.0	...	45.0	9
T6	0.124 and under	62.0	...	...	...
	0.125–6.500 <sup>H</sup>	62.0	...	50.0	5
T62 <sup>G</sup>	0.124 and under	60.0	...	...	...
	0.125–6.500 <sup>H</sup>	60.0	...	46.0	5
T851 <sup>E</sup>	0.500–6.500 <sup>H</sup>	66.0	...	58.0	5
<b>Alloy 2219</b>					
T851 <sup>E</sup>	0.500–2.000	58.0	...	40.0	4
	2.001–4.000	57.0	...	39.0	4
<b>Alloy 3003</b>					
O	all	14.0	19.0	5.0	25
H12	0.374 and under	17.0	...	...	...
H14	0.374 and under	20.0	...	...	...
H16	0.374 and under	24.0	...	...	...
H18	0.374 and under	27.0	...	...	...
H112	all	14.0	...	5.0	...
F	all	<sup>D</sup>	...	<sup>D</sup>	...
<b>Alloy 4032</b>					
T86	0.375–0.750	51.0	...	46.0	4
<b>Alloy 5052</b>					
O	0.124 and under	...	32.0	...	...
	0.125 and over	25.0	32.0	9.5	25
H32	0.124 and under	31.0	...	...	...
	0.125–0.374	31.0	...	23.0	...
H34	0.374 and under	34.0	...	26.0	...
H36	0.124 and under	37.0	...	...	...
	0.125–0.374	37.0	...	29.0	...
H38	0.374 and under	39.0	...	...	...
F	all	<sup>D</sup>	...	<sup>D</sup>	...

**B211/B211M – 19****TABLE 2** *Continued*

Temper	Specified Diameter or Thickness, in.	Tensile Strength, ksi		Yield Strength <sup>B</sup> (0.2 % offset), min, ksi	Elongation <sup>B</sup> in 2 in. or 4x Diameter, min %
		min	max		
<b>Alloy 5056</b>					
O	0.124 and under	...	46.0	...	...
	0.125 and over	...	46.0	...	20
H111	0.374 and under	44.0	...	...	...
H12	0.374 and under	46.0	...	...	...
H32	0.374 and under	44.0	...	...	...
H14	0.374 and under	52.0	...	...	...
H34	0.374 and under	50.0	...	...	...
H18	0.374 and under	58.0	...	...	...
H38	0.374 and under	55.0	...	...	...
H192	0.374 and under	60.0	...	...	...
H392	0.374 and under	58.0	...	...	...
<b>Alloy 5154</b>					
O	all	30.0	41.0	11.0	25
H32	0.374 and under	36.0	...	...	...
H34	0.374 and under	39.0	...	...	...
H36	0.374 and under	42.0	...	...	...
H38	0.374 and under	45.0	...	...	...
H112	all	30.0	...	11.0	...
<b>Alloy 6013</b>					
T651 <sup>E</sup>	0.500–4.000	56.0	...	52.0	7
T8	0.750–1.500	58.0	...	56.0	8
	1.501–5.500	57.0	...	55.0	7
<b>Alloy 6020</b>					
T8	0.187–0.375	43.0	...	40.0	12
	0.376–1.999	42.0	...	39.0	12
	2.000–3.250	39.0	...	36.0	12
<b>Alloy 6026</b>					
T6	0.200–3.000	54.0	...	44.0	6
T8	0.200–3.000	50.0	...	46.0	3
T9	0.200–3.000	52.0	...	48.0	3
<b>Alloy 6061<sup>F</sup></b>					
O	0.124 and under	...	22.0	...	...
	0.125–8.000	...	22.0	...	18
T4 & T451 <sup>E</sup>	0.124 and under	30.0	...	...	...
	0.125–8.000 <sup>I</sup>	30.0	...	16.0	18
T42 <sup>G</sup>	0.125–8.000 <sup>I</sup>	30.0	...	14.0	18
T6, T62 <sup>G</sup> , & T651 <sup>E</sup>	0.124 and under	42.0	...	...	...
	0.125–8.000 <sup>I</sup>	42.0	...	35.0	10
T89 & T94	0.374 and under	54.0	...	47.0	...
<b>Alloy 6110</b>					
T9	0.374 and under	65.0	...	63.0	2
<b>Alloy 6262</b>					
T6 & T651 <sup>E</sup>	0.125–8.000 <sup>H</sup>	42.0	...	35.0	10
T8	0.750–2.000	45.0	...	43.0	12
T9	0.125–2.000	52.0	...	48.0	5
	2.001–3.000	50.0	...	46.0	5
<b>Alloy 7075<sup>F</sup></b>					
O	0.124 and under	...	40.0	...	...
	0.125–8.000	...	40.0	...	10
T6, T62 <sup>G</sup>	0.124 and under	77.0	...	66.0	...
	0.125–4.000 <sup>L</sup>	77.0	...	66.0	7
T651 <sup>E</sup>	0.124 and under	77.0	...	66.0	...
	0.125–4.000 <sup>L</sup>	77.0	...	66.0	7
	4.001–6.000	75.0	...	64.0	7
	6.001–7.000	73.0	...	62.0	7
T73 & T7351 <sup>E</sup>	0.124 and under	68.0	...	...	...
	0.125–4.000	68.0	...	56.0	10
	4.001–5.000	66.0	...	55.0	8
	5.001–6.000	64.0	...	52.0	8
<b>Bend Diameter Factor, N</b>					
<b>Alloy 2017</b>					
T4, T42, & T451	0.124 and under				3 <sup>M</sup>
	0.125–8.000 <sup>I</sup>				6 <sup>M</sup>
<b>Alloy 2024</b>					
O	0.124 and under				1
T351, T4, T42	0.124 and under				3
	0.125–6.500				6
<b>Alloy 3003</b>					
O	all				0
H12	0.374 and under				2
H14	0.374 and under				2
H16	0.374 and under				8

<sup>A</sup> To determine conformance to this specification, each value for tensile strength and for yield strength shall be rounded to the nearest 0.1 ksi [1 MPa] and each value for elongation to the nearest 0.5 %, both in accordance with the rounding-off method of Practice E29. The basis for establishment of tensile property limits is shown in Annex A1.

<sup>B</sup> The measurement of yield strength and elongation is not required for wire less than 0.125 in. [3.20 mm] in thickness or diameter.

<sup>C</sup> Elongations in 50 mm applies to rectangular bar up through 12.5 mm thickness from which a standard rectangular tension test specimen is machined. The 5× diameter (5.65√*A*) requirements, where *D* and *A* are diameter and cross-sectional area of the specimen, respectively, apply to round specimens tested in full section or to standard or proportional, round-machined, tension test specimens.

<sup>D</sup> There are no tensile requirements for material in the F temper but it usually can be expected that material 1½ in. [40 mm] or less in thickness or diameter (except sections over 4 in. [100 mm] in width) will have a strength about equivalent to the H14 or H34 temper. As size increases the strength decreases to nearly that of the O temper.

<sup>E</sup> For stress-relieved tempers, characteristics and properties other than those specified may differ somewhat from the corresponding characteristics and properties of material in the basic tempers.

<sup>F</sup> Also available in the F temper for which no properties are specified or test results provided. Producers shall perform tension tests to confirm response to heat treatment as required by Section 10.

<sup>G</sup> Material in the T42 or T62 tempers is not available from the materials producers. These properties can usually be obtained by the user when material is properly solution heat treated or solution and precipitation heat treated from the O or F temper. These properties also apply to samples of material in the O or F temper that are solution heat treated or solution and precipitation heat treated by the producer to determine that the material will respond to proper heat treatment. Properties attained by the user, however, may be lower than those listed if the material has been formed or otherwise cold or hot worked, particularly in the O temper, prior to solution heat treatment.

<sup>H</sup> Properties listed for this full size increment are applicable to rod. Properties listed are also applicable to square, rectangular, hexagonal, or octagonal bar having a maximum thickness of 4 in. [100 mm] and a maximum cross-sectional area of 36 in.<sup>2</sup> [23 000 mm<sup>2</sup>].

<sup>I</sup> For bar, maximum cross-sectional area is 50 in.<sup>2</sup> [32 000 mm<sup>2</sup>].

<sup>J</sup> Minimum yield strength for 2024-T4 wire and rod 0.125 in. [3.20 mm] and larger in thickness or diameter, produced in coil form for both straight length and coiled products, is 40.0 ksi [275 MPa].

<sup>K</sup> Properties listed for this size increment are applicable to rod only.

<sup>L</sup> For rounds, maximum diameter is 4 in. [100 mm]; for square, hexagonal, or octagonal bar, maximum thickness is 3½ in. [90 mm]; for rectangular bar, maximum thickness is 3 in. [80 mm] with corresponding maximum width of 6 in. [150 mm]; for rectangular bar less than 3 in. [80 mm] in thickness, maximum width is 10 in. [250 mm].

<sup>M</sup> Bend diameter factor values stated for this full size increment apply to T4 product only. Values listed also apply to T451 product in the 0.500–8.000 in. [12.20–200 mm] size range.

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 [kilograms],

4.1.3 Alloy (Section 7),

4.1.4 Temper (Section 9),

4.1.5 *Product Form*, rolled or cold finished bar, rolled or cold finished rod, or wire,

4.1.6 *Geometry and Dimensions*, Diameter for rounds; distance across flats for square-cornered squares, hexagons, or octagons; width and depth for square-cornered rectangles (orders for squares, hexagons, octagons, or rectangles with rounded corners usually require a drawing),

4.1.7 Length, and

4.1.8 Tensile property limits and dimensional tolerances for sized not covered in Table 2 [Table 3] and in ANSI H35.2 [H35.2M], respectively.

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 B918/B918M is required (8.2),

4.2.2 Whether 7075-O material is required to develop requirements for T73 temper (see 10.1.2),

4.2.3 Whether bend testing is required for 2017, 2024, or 3003 (Section 12),

4.2.4 When specified finish of bar and rod is not required (Section 15),

4.2.5 Whether marking for identification is required (Section 16),

4.2.6 Whether ultrasonic inspection is required (Section 17, Table 5 Table 5),

4.2.7 Whether inspection or witness of inspection and tests by the purchaser's representative is required prior to material shipment (Section 19),

4.2.8 Whether certification is required (Section 21), and

4.2.9 Whether Practices B660 apply, and if so, the levels of preservation, packaging, and packing required (Section 22).

## 5. Manufacture

5.1 The products covered by this specification shall be produced either by hot extruding and cold finishing or by hot rolling with or without cold finishing, at the option of the producer.

## 6. Quality Assurance

6.1 *Responsibility for Inspection and Tests*—Unless otherwise specified in the contract or purchase order, the producer is responsible for the performance of all inspection and test requirements specified herein. The producer may use their 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.

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.

**B211/B211M - 19****TABLE 3 Mechanical Property Limits (Metric SI)<sup>A</sup>**  
(See Table 2 for footnotes.)

Temper	Specified Diameter or Thickness, mm		Tensile Strength, MPa		Yield Strength <sup>B</sup> (0.2 % offset), MPa		Elongation, <sup>B,C</sup> min, %	
	over	through	min	max	min	max	in 50 mm	in 5x Diameter (5.65√A)
<b>Aluminum 1100</b>								
O	...	3.20	75	105	...	...	...	...
	3.20	...	75	105	20	...	25	22
H12	...	10.00	95	...	...	...	...	...
H14	...	10.00	110	...	...	...	...	...
H16	...	10.00	130	...	...	...	...	...
H18	...	10.00	150	...	...	...	...	...
H112	all		75	...	20	...	...	...
F	all		<sup>D</sup>	...	<sup>D</sup>	...	...	...
<b>Alloy 2011</b>								
T3	3.20	40.00	310	...	260	...	10	9
	40.00	50.00	295	...	235	...	...	10
	50.00	90.00	290	...	205	...	...	12
T4 and T451 <sup>E</sup>	3.20	200.00	275	...	125	...	16	14
T6 and T651	10.00	160.00	370	...	275	...	10	9
T8	3.20	80.00	370	...	275	...	10	9
<b>Alloy 2111</b>								
T8	12.70	88.90	360	...	260	...	...	9
<b>Alloy 2014<sup>F</sup></b>								
O	...	3.20	...	240	...	...	...	...
	3.20	200.00	...	240	...	...	12	10
T4, T42 <sup>G</sup> , & T451 <sup>E</sup>	...	3.20	380	...	...	...	...	...
	3.20	200.00 <sup>H</sup>	380	...	220	...	16	14
T6, T62 <sup>G</sup> , & T651 <sup>E</sup>	...	3.20	450	...	...	...	...	...
	3.20	200.00 <sup>H</sup>	450	...	380	...	8	7
<b>Alloy 2017<sup>F</sup></b>								
O	...	3.20	...	240	...	...	...	...
	3.20	200.00	...	240	...	...	16	14
T4, T42 <sup>G</sup> , & T451 <sup>E</sup>	...	3.20	380	...	...	...	...	...
	3.20	200.00 <sup>H,I</sup>	380	...	220	...	12	10
<b>Alloy 2024<sup>F</sup></b>								
O	...	3.20	...	240	...	...	...	...
	3.20	200.00	...	240	...	...	16	14
T36	...	3.20	475	...	...	...	...	...
	3.20	10.00	475	...	360	...	10	...
T4 <sup>J</sup>	...	3.20	425	...	...	...	...	...
	3.20	12.50	425	...	310 <sup>J</sup>	...	10	...
	12.50	120.00 <sup>H</sup>	425	...	290 <sup>J</sup>	...	...	9
	120.00	160.00 <sup>K</sup>	425	...	275	...	...	9
	160.00	200.00 <sup>K</sup>	425	...	260	...	...	9
T42 <sup>G</sup>	...	3.20	400	...	...	...	...	...
	3.20	25.00	425	...	275	...	10	9
	25.00	160.00 <sup>H</sup>	425	...	275	...	...	9
T351 <sup>E</sup>	...	12.50	160.00 <sup>H</sup>	425	...	310	...	9
	...	160.00	200.00	425	...	310	...	8
T6	...	3.20	425	...	...	...	...	...
	3.20	160.00 <sup>H</sup>	425	...	345	...	5	4
T62 <sup>G</sup>	...	3.20	415	...	...	...	...	...
	3.20	160.00 <sup>H</sup>	415	...	315	...	5	4
T851 <sup>E</sup>	...	12.50	160.00 <sup>H</sup>	455	...	400	...	4
<b>Alloy 2219</b>								
T851 <sup>E</sup>	...	12.50	400	...	275	...	...	3
	...	50.00	395	...	270	...	...	3
<b>Alloy 3003</b>								
O	...	3.20	95	130	...	...	...	...
	3.20	...	95	130	35	...	25	22
H12	...	10.00	115	...	...	...	...	...
H14	...	10.00	140	...	...	...	...	...
H16	...	10.00	165	...	...	...	...	...
H18	...	10.00	185	...	...	...	...	...
H112	all		95	...	35	...	...	...
F	all		<sup>D</sup>	...	<sup>D</sup>	...	...	...
<b>Alloy 4032</b>								
T86	10.00	20.00	350	...	315	...	4	3
<b>Alloy 5052</b>								
O	...	3.20	170	220	...	...	...	...
	3.20	...	170	220	65	...	25	22
H32	...	3.20	215	...	...	...	...	...
	3.20	10.00	215	...	160	...	...	...
H34	...	3.20	235	...	...	...	...	...
	3.20	10.00	235	...	180	...	...	...