

Designation: B 211 – 99

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

This standard is issued under the fixed designation B 211; 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 rolled or cold-finished bar, rod, and wire in alloys (Note 1) and tempers as shown in Table 1.

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 B 221 for aluminum and aluminum-alloy extruded bars, rods, wire, shapes, and tubes; and Specification B 316 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. The equivalent UNS alloy designations are those of Table 2 preceded by A9, for example, A91100 for aluminum 1100 in accordance with Practice E 527.

1.3 A complete metric companion to Specification B 211 has been developed—B 211M; therefore, no metric equivalents are presented in this specification.

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

2. Referenced Documents/catalog/standards/sist/67497fl

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

- 2.2 ASTM Standards:
- B 557 Test Methods of Tension Testing Wrought and Cast Aluminum- and Magnesium-Alloy Products<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

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B-7 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> Annual Book of ASTM Standards, Vol 02.02.

Magnesium Products<sup>3</sup>

- B 666/B 666M Practice for Identification Marking of Aluminum Products<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 290 Test Methods for Bend Testing of Material for Ductility<sup>6</sup>
- E 527 Practice for Numbering Metals and Alloys (UNS)<sup>7</sup>
- E 607 Test Method for Optical Emission Spectrometric Analysis of Aluminum and Aluminum Alloys by the Point-to-Plane Technique, Nitrogen Atmosphere<sup>8</sup>
- E 716 Practices for Sampling Aluminum and Aluminum Alloys for Spectrochemical Analysis<sup>8</sup>
- E 1004 Test Method for Electromagnetic (Eddy-Current) Measurements of Electrical Conductivity<sup>9</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>8</sup>
- G 47 Test Method for Determining Susceptibility to Stress-Corrosion Cracking of 2XXX and 7XXX Aluminum-Alloy Products<sup>10</sup>
- 2.3 ANSI Standards:
- H35.1 Alloy and Temper Designation Systems for Aluminum<sup>3</sup>

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

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

<sup>&</sup>lt;sup>4</sup> Annual Book of ASTM Standards, Vol 14.02.

<sup>&</sup>lt;sup>5</sup> Annual Book of ASTM Standards, Vol 03.05.

<sup>&</sup>lt;sup>6</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>&</sup>lt;sup>7</sup> Annual Book of ASTM Standards, Vol 01.01.

<sup>&</sup>lt;sup>8</sup> Annual Book of ASTM Standards, Vol 03.06.

<sup>&</sup>lt;sup>9</sup> Annual Book of ASTM Standards, Vol 03.03.

<sup>&</sup>lt;sup>10</sup> Annual Book of ASTM Standards, Vol 03.02.

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 Aerospace Material Specification:

AMS-H-6088 Heat Treatment of Aluminum Alloys<sup>12</sup>

#### 3. Terminology

3.1 Definitions: Definitions:

3.1.1 *alclad wire*—wire having on its surface a metallurgically bonded aluminum or aluminum-alloy coating that is anodic to the core alloy to which it is bonded, thus electrolytically protecting the core alloy against corrosion.

3.1.2 *bar*—a 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.

3.1.3 *cold-finished bar*—bar brought to final dimensions by cold working to obtain improved surface finish and dimensional tolerances.

3.1.4 *cold-finished rod*—rod brought to final dimensions by cold working to obtain improved surface finish and dimensional tolerances.

3.1.5 *drawn wire*—wire brought to final dimensions by drawing through a die.

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

3.1.7 *flattened wire*—a solid section having two parallel flat surfaces and rounded edges produced by roll-flattening round wire.

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

3.1.9 *rod*—a solid product 0.375 in. or greater in diameter that is long in relation to cross section.

3.1.10 *supplier*—includes only the category of jobbers and distributors as distinct from producers.

3.1.11 *wire*—a solid section long in relation to its crosssectional dimensions, having a cross section that is round, hexagonal, or octagonal and whose diameter, width, or greatest distance between parallel faces is less than 0.375 in., or having a symmetrical cross section that is square or rectangular (excluding flattened wire) with sharp or rounded corners or edges.

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),
- 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,

4.1.8 Tensile property limits and dimensional tolerances for sized not covered in Table 1 and in ANSI H35.2, 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 B 597 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 16),

4.2.5 Whether marking for identification is required (Section 17),

4.2.6 Whether ultrasonic inspection is required (Section 18, Table 3),

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

4.2.8 Whether certification is required (Section 22), and 4.2.9 Whether Practices B 660 apply, and if so, the levels of preservation, packaging, and packing required (Section 23).

#### 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 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.

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

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

<sup>&</sup>lt;sup>12</sup> Available from SAE, 400 Commonwealth Drive, Warrendale, PA 15096.

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form, alloy, temper, and nominal dimensions traceable to a heat-treat lot or lots, and subjected to inspection at one time.

form, alloy, temper, and nominal dimensions 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

Ampen      Ampendence methods      Tensie Stereigh, kd      Yead Strength (0.2 % ofted), 02 % ofted),			TABI	LE 1 Mechanical Property Limits <sup>A</sup>				
Image: Constraint of the second sec	Temper	Specified Diameter or Thickness, in.		Tensile Strength, ksi	Yield Strength <sup>B</sup> (0.2 % offset), min ksi	Elonga- tion <sup>B</sup> in 2 in. or $4 \times$ Diam-		
Aluminum 1090        O      0.124 and under      8.0        2.5      25        H14      0.374 and under      10.0       10.0       10.0         O      0.125 and ounder      11.0      15.5            O      0.125 and ounder      11.0      15.5            H12      0.374 and under      11.0      15.5            H13      0.374 and under      11.0             H14      0.374 and under      15.0             H14      0.374 and under      15.0        30.0      12        H14      0.374 and under      15.0        30.0      12        T      H16      0.125-300      45.0       38.0      12          T				min max	11111, K31	eter, min, %		
O      0.124 and under      8.0            H14      0.374 and under      12.0       10.0         H14      0.374 and under      12.0       10.0         0      0.374 and under      11.0      1.5.5      3.0         0      0.124 and under      11.0      1.5.5      3.0         0.374 and under      11.0      1.5.5      3.0          0.374 and under      16.0             110      0.374 and under      16.0             111      0.374 and under      10.0               110                111				Aluminum 1060				
H14    0.153 and over 0.154 and under H18    8.0     2.5    2.5      H18    0.254 and under 16.0     13.0       O    0.124 and under 0.125 and over H12    11.0    15.5        H12    0.254 and under 0.254 and under H13    15.5         H12    0.254 and under 0.254 and under H14    0.57         H14    0.57 and under H14    0.57          H14    0.57 and under H16    0.57 and under H16           H14    0.57 and under H16    0.125-1500    45.0          Join-2000    45.0            Join-2000    45.0            Join-2000    45.0            Join-2000 <td>0</td> <td>0.124 and under</td> <td>8.0</td> <td></td> <td></td> <td></td>	0	0.124 and under	8.0					
Hild    0.374 and under    16.0     13.0       Aluminum 1100      Aluminum 1100      0    0.124 and under    11.0    15.5         H12    0.125 and over    11.0    15.5         H13    0.257 and under    11.0    15.5         H14    0.257 and under    120          H16    0.257 and under    120           H17    0.274 and under    120      30.0        H17    130    1.57 - 2000    450     30.0    12       130    1.25 - 500    450     30.0    12        141    151 - 2000    450     350         141    1412            141	H14	0.125 and over 0.374 and under	8.0 12.0		2.5 10.0	25		
Auminum 1100      Auminum 1100        0      0.124 and under      11.0      15.5          1112      0.125 and over      11.0      15.5      3.0      25        1114      0.374 and under      16.0            1114      0.374 and under      19.0            1118      0.374 and under      19.0            1118      0.374 and under      22.0            1110       30.0            1110        30.0          1111        30.0          1110         30.0         1111	H18	0.374 and under	16.0		13.0			
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n      1.25 and over H14      1.0      15.5      3.0      25        H14      0.374 and under      16.0	0	0.124 and under	11.0	15.5				
H12    0.374 and under    14.0 <td></td> <td>0.125 and over</td> <td>11.0</td> <td>15.5</td> <td>3.0</td> <td>25</td>		0.125 and over	11.0	15.5	3.0	25		
H14    0.374 and under    16.0 <td>H12</td> <td>0.374 and under</td> <td>14.0</td> <td></td> <td></td> <td></td>	H12	0.374 and under	14.0					
n10    0.374 and under    150 <td>H14</td> <td>0.374 and under</td> <td>16.0</td> <td></td> <td></td> <td></td>	H14	0.374 and under	16.0					
H112      all      11.0       30 $F$ all      1.0       30         Ta      0.125-1500      450       34.0      12        Ta      0.125-1500      450       34.0      12        Ta and T451 <sup>20</sup> 0.125-3200      42.0      State      30.0      12        Ta and T451 <sup>20</sup> 0.125-3200      54.0       40.0      10        Alloy 2014"        O      0.124 and under       35.0           O      0.124 and under       35.0       32.0      16        C124 and under              O      0.124 and under             O      0.124 and under             O      0.124 and under <t< td=""><td>H18</td><td>0.374 and under</td><td>19.0 22.0</td><td></td><td></td><td></td></t<>	H18	0.374 and under	19.0 22.0					
p      all      c      n      c      n        Alloy 2011        T3      0.125-1500      45.0       38.0      10        1.507-2.000      43.0       38.0      12        2.007-3.500      42.0       38.0      12        3.00      0.125-8.000      40.0      10        TH and TAS1P      0.122-8.000       40.0      10        O      0.124 and under       35.0           0      0.124 and under       35.0           0      0.124 and under       35.0           12        35.0           0      0.124 and under        35.0          14      T42 <sup>P</sup> 35.0           14       35.0 <td>H112</td> <td>all</td> <td>11 0</td> <td></td> <td> 3.0</td> <td></td>	H112	all	11 0		 3.0			
$\begin{tabular}{ c c c c c c } \hline Alloy 2011 \\ \hline T_4 and T451^0 & 0.125-1.500 & 45.0 & & & 38.0 & 10 \\ 12.01-3.500 & 42.0 & Stan + 1 and S & 34.0 & 12 \\ 2.001-3.500 & 42.0 & Stan + 1 and S & 30.0 & 12 \\ 0.125-3.250 & 54.0 & & 40.0 & 10 \\ \hline T_4 and T451^0 & 0.125-3.250 & 54.0 & & & 40.0 & 10 \\ \hline T_4 , T42^r, and T451^0 & 0.124 and under &$	F	all	c		C			
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T8    0.128-3280    54.0     40.0    10      Alloy 2014 <sup>4</sup> Alloy 2014 <sup>4</sup> 40.0    10      O    0.124 and under 0.125-8.000     35.0      12      Alloy 2017 <sup>6</sup> 32.0    16      T6, T62 <sup>7</sup> , and T651 <sup>0</sup> 0.124 and under 0.125-8.000 <sup>9</sup> 65.0          O    0.124 and under 0.128-8.000 <sup>9</sup> 65.0            O    124 and under 0.128-8.000 <sup>9</sup> 65.0              O    124 and under 0.128-8.000 <sup>9</sup> 55.0	T4 and T451 <sup>D</sup>	0.125-8.000	40.0		18.0	16		
O      0.124 and under 0.125-8.000       35.0          74, T42 <sup>F</sup> , and T451 <sup>O</sup> 0.124 and under 0.125-8.000 <sup>O</sup> 55.0	Т8	0.125–3.250	54.0	tondo itolo	40.0	10		
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Image: No. 10. 128-0.000      53.0       52.0      12        Alloy 2024 <sup>E</sup> O      0.124 and under       35.0          T36      0.124 and under      69.0           0      0.125-0.000            136      0.124 and under      69.0            0.125-0.375      69.0             0.125-0.499      62.0             0.125-0.499      62.0       42.0'      10        0.500-4.500 <sup>G</sup> 62.0       42.0'      10        4.501-6.500 <sup>G</sup> 62.0            T42 <sup>E</sup> 0.124 and under      62.0       40.0      10        1.001-6.500 <sup>G</sup> 62.0            T51 <sup>D</sup> 0.500-6.500 <sup>G</sup> 62.0      <	T4, T42 <sup><i>r</i></sup> , and T451 <sup><i>D</i></sup>	0.124 and under	55.0					
Alloy 2024 <sup>a</sup> Alloy 2024 <sup>a</sup> O      0.124 and under       35.0          T36      0.125-0.00       35.0          0.125-0.375      69.0            0.125-0.375      69.0            0.125-0.499      62.0       45.0'      10        0.125-0.499      62.0       45.0'      10        0.500-4.500 <sup>a</sup> 62.0       42.0'      10        0.501-8.000 <sup>J</sup> 62.0       40.0      10        6.501-8.000 <sup>J</sup> 62.0       38.0      10        742 <sup>F</sup> 0.124 and under      62.0       37.0      10        1.001-6.500 <sup>a</sup> 62.0       37.0      10        751 <sup>D</sup> 0.500-6.500 <sup>a</sup> 62.0       40.0      10        751 <sup>D</sup> 0.500-6.500 <sup>a</sup> 62.0           762 <sup>F</sup> 0.124 a	0.125-8.000'' 55.0 32.0 12							
O    0.124 and under     35.0        T36    0.125-8.000     35.0     16      T36    0.124 and under    69.0     52.0    10      T4'    0.125-0.375    69.0     52.0    10      T4'    0.125-0.499    62.0     45.0'    10      0.125-0.499    62.0     42.0'    10      0.500-4.500 <sup>G</sup> 62.0     42.0'    10      0.501-8.000'    58.0     38.0    10      T42 <sup>F</sup> 0.124 and under    62.0         0.125-1.000    62.0     37.0    10      1.001-6.500 <sup>G</sup> 62.0     37.0    10      1.001-6.500 <sup>G</sup> 62.0          0.125-6.500 <sup>G</sup> 62.0     45.0    10       T62 <sup>F</sup> 0.124 and under    60.0          0.125-6.500 <sup>G</sup> 60.0 <td< td=""><td></td><td></td><td></td><td>Alloy 2024<sup>2</sup></td><td></td><td></td></td<>				Alloy 2024 <sup>2</sup>				
T36      0.123-0.000        10        136      0.124 and under      69.0           14'      0.125-0.375      69.0            0.125-0.499      62.0             0.125-0.499      62.0       45.07      10        0.500-4.500 <sup>G</sup> 62.0       42.07      10        4.501-6.500 <sup>G</sup> 62.0       42.07      10        6.501-8.000 <sup>J</sup> 58.0       38.0      10        742 <sup>F</sup> 0.125-1.000      62.0           0.125-1.000      62.0       37.0      10        1001-6.500 <sup>G</sup> 62.0       45.0      10        751 <sup>D</sup> 0.500-6.500 <sup>G</sup> 62.0           0.125-6.500 <sup>G</sup> 62.0       45.0      10        762 <sup>F</sup> 0.124 and under      60.0 <t< td=""><td>0</td><td>0.124 and under</td><td></td><td>35.0</td><td></td><td></td></t<>	0	0.124 and under		35.0				
100    0.125-0.375    69.0     52.0    10      T4'    0.125-0.375    69.0     45.0'    10      0.125-0.499    62.0     45.0'    10      0.500-4500°    62.0     45.0'    10      0.500-4500°    62.0     40.0    10      4.501-6.500'    62.0     40.0    10      6.501-8.000'    58.0     38.0    10      T42 <sup>F</sup> 0.124 and under    62.0     38.0    10      0.125-1.000    62.0     40.0    10    10      1.001-6.500°    62.0     40.0    10    10      T51 <sup>D</sup> 0.500-6.500°    62.0     45.0    10      T6    0.124 and under    62.0          0.125-6.500°    62.0           T62 <sup>F</sup> 0.124 and under    60.0          T62 <sup>F</sup> 0.124 and under </td <td>T36</td> <td>0.125-8.000 0.124 and under</td> <td> 69 0</td> <td>35.0</td> <td></td> <td>10</td>	T36	0.125-8.000 0.124 and under	 69 0	35.0		10		
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	100	0.125-0.375	69.0		52.0	10		
0.125-0.499      62.0       45.0'      10        0.500-4.500 <sup>6</sup> 62.0       42.0'      10        4.501-6.500 <sup>7</sup> 62.0       40.0      10        6.501-8.000 <sup>7</sup> 58.0       38.0      10        742 <sup>F</sup> 0.124 and under      62.0       38.0      10        1.001-6.500 <sup>6</sup> 62.0       37.0      10        1.001-6.500 <sup>6</sup> 62.0       45.0      10        7351 <sup>D</sup> 0.500-6.500 <sup>6</sup> 62.0       45.0      10        76      0.124 and under      62.0            62.6              7851 <sup>D</sup> 0.500-6.500 <sup>G</sup> 62.0            7851 <sup>P</sup> 0.124 and under      60.0       58.0      5        7851 <sup>P</sup> 0.500-6.500 <sup>G</sup> 66.0       58.0      4        2.001-4.000      57.0	T4′	0.124 and under	62.0					
0.500-4.500 <sup>G</sup> 62.0       42.0'      10        4.501-6.500 <sup>J</sup> 62.0       40.0      10        6.501-8.000 <sup>J</sup> 58.0       38.0      10        T42 <sup>F</sup> 0.124 and under      62.0           0.125-1.000      62.0       37.0      10        1.001-6.500 <sup>G</sup> 62.0       45.0      10        7351 <sup>D</sup> 0.500-6.500 <sup>G</sup> 62.0       45.0      10        T6      0.124 and under      62.0            0.125-6.500 <sup>G</sup> 62.0       45.0      10         T6      0.124 and under      62.0            10.125-6.500 <sup>G</sup> 62.0             T851 <sup>D</sup> 0.124 and under      60.0       46.0      5         T851 <sup>D</sup> 0.500-6.500 <sup>G</sup> 66.0       39.0      4		0.125-0.499	62.0		45.0′	10		
$4.501-6.500^3$ $62.0$ $40.0$ $10$ $6.501-8.000^J$ $58.0$ $38.0$ $10$ $T42^F$ $0.124$ and under $62.0$ $37.0$ $10$ $0.125-1.000$ $62.0$ $40.0$ $10$ $1.001-6.500^G$ $62.0$ $40.0$ $10$ $T351^D$ $0.500-6.500^G$ $62.0$ $45.0$ $10$ $T6^F$ $0.124$ and under $62.0$ $45.0$ $10$ $T62^F$ $0.124$ and under $60.0$ $0.125-6.500^G$ $60.0$ $46.0$ $5$ $T62^F$ $0.124$ and under $60.0$ $38.0$ $5$ $T62^F$ $0.125-6.500^G$ $60.0$ $46.0$ $5$ $751^D$ $0.500-6.500^G$ $66.0$ $58.0$ $5$ Alloy 2219T851 <sup>D</sup> $0.500-2.000$ $58.0$ $40.0$ $4$ Alloy 3003O $11.0$ $19.0$ $5.0$ $25$		0.500–4.500 <sup>G</sup>	62.0		42.0'	10		
$142^F$ $6.501-8.00^\circ$ $58.0$ $38.0$ $10$ $T42^F$ $0.124$ and under $62.0$ $$ $$ $$ $$ $0.125-1.000$ $62.0$ $40.0$ $10$ $1001-6.500^\circ$ $62.0$ $40.0$ $10$ $T351^D$ $0.500-6.500^\circ$ $62.0$ $45.0$ $10$ $T6$ $0.124$ and under $62.0$ $$ $$ $$ $102^F$ $0.125-6.500^\circ$ $62.0$ $$ $$ $$ $162^F$ $0.124$ and under $60.0$ $$ $$ $$ $102^F$ $0.125-6.500^\circ$ $66.0$ $$ $58.0$ $5$ $7851^D$ $0.500-6.500^\circ$ $66.0$ $$ $46.0$ $5$ $7851^D$ $0.500-2.000$ $58.0$ $$ $40.0$ $4$ Alloy 2219Alloy 3003O $41.0$ Alloy 3003OAlloy 3003OAlloy 3003		4.501–6.500 <sup>J</sup>	62.0		40.0	10		
142*    0.124 and under    62.0          0.125-1.000    62.0     37.0    10      1.001-6.500 <sup>G</sup> 62.0     40.0    10      T351 <sup>D</sup> 0.500-6.500 <sup>G</sup> 62.0     45.0    10      T6    0.124 and under    62.0          0.125-6.500 <sup>G</sup> 62.0           0.125-6.500 <sup>G</sup> 62.0           0.125-6.500 <sup>G</sup> 62.0           T62 <sup>F</sup> 0.124 and under    60.0          0.125-6.500 <sup>G</sup> 60.0           T851 <sup>D</sup> 0.500-6.500 <sup>G</sup> 66.0     38.0    5       T851 <sup>D</sup> 0.500-2.000    58.0     40.0    4      2.001-4.000    57.0     39.0    4	TIOF	6.501–8.000 <sup>3</sup>	58.0		38.0	10		
1001-6.500 <sup>G</sup> 62.0       37.0      10        T351 <sup>D</sup> 0.500-6.500 <sup>G</sup> 62.0       40.0      10        T6      0.124 and under      62.0       45.0      10        T6      0.125-6.500 <sup>G</sup> 62.0           0.125-6.500 <sup>G</sup> 62.0       50.0      5        T62 <sup>F</sup> 0.124 and under      60.0           0.125-6.500 <sup>G</sup> 60.0            T851 <sup>D</sup> 0.500-6.500 <sup>G</sup> 66.0       46.0      5        T851 <sup>D</sup> 0.500-6.500 <sup>G</sup> 66.0       38.0      5        T851 <sup>D</sup> 0.500-2.000      58.0       39.0      4        T851 <sup>D</sup> 0.500-2.000      58.0       39.0      4        Coll-4.000      57.0       39.0      4        Coll-4.000      57.0       39.0      25	142	0.124 and under	62.0					
T351 <sup>D</sup> 1.500-6.500 <sup>G</sup> 62.0   45.0  10    T6  0.124 and under  62.0        0.125-6.500 <sup>G</sup> 62.0        T6  0.124 and under  60.0        T62 <sup>F</sup> 0.124 and under  60.0        0.125-6.500 <sup>G</sup> 60.0         T851 <sup>D</sup> 0.500-6.500 <sup>G</sup> 66.0   46.0  5    T851 <sup>D</sup> 0.500-6.500 <sup>G</sup> 66.0   38.0  5    Alloy 2219    T851 <sup>D</sup> 0.500-2.000  58.0   40.0  4    2.001-4.000  57.0   39.0  4    Alloy 3003    O  all  14.0  19.0  5.0  25		$1.001-6.500^{G}$	62.0		40.0	10		
T6  0.124 and under  62.0       0.125-6.500 <sup>G</sup> 62.0   50.0  5    T62 <sup>F</sup> 0.124 and under  60.0       0.125-6.500 <sup>G</sup> 60.0        0.125-6.500 <sup>G</sup> 60.0        0.125-6.500 <sup>G</sup> 60.0   46.0  5    7851 <sup>D</sup> 0.500-6.500 <sup>G</sup> 66.0   58.0  5    Alloy 2219    T851 <sup>D</sup> 0.500-2.000  58.0   40.0  4    2.001-4.000  57.0   39.0  4    Alloy 3003    O  all  14.0  19.0  5.0  25	T351 <sup>D</sup>	$0.500-6.500^{G}$	62.0		45.0	10		
0.125-6.500 <sup>G</sup> 62.0       50.0      5        T62 <sup>F</sup> 0.124 and under 0.125-6.500 <sup>G</sup> 60.0            T851 <sup>D</sup> 0.500-6.500 <sup>G</sup> 66.0       46.0      5        T851 <sup>D</sup> 0.500-6.500 <sup>G</sup> 66.0       40.0      4        T851 <sup>D</sup> 0.500-2.000      58.0       39.0      4        T851 <sup>D</sup> 0.500-2.000      57.0       39.0      4        Coll-4.000      57.0       39.0      4	T6	0.124 and under	62.0					
T62 <sup>F</sup> 0.124 and under 0.125-6.500 <sup>G</sup> 60.0   46.0  5    T851 <sup>D</sup> 0.500-6.500 <sup>G</sup> 66.0   58.0  5    Alloy 2219    T851 <sup>D</sup> 0.500-2.000 2.001-4.000  58.0   40.0  4    Colspan="4">Alloy 3003    Alloy 3003    O  all  14.0  19.0  5.0  25		0.125–6.500 <sup>G</sup>	62.0		50.0	5		
0.125-6.500G60.046.05T851D0.500-6.500G66.058.05Alloy 2219T851D0.500-2.00058.040.02.001-4.00057.039.04Alloy 3003Oall14.019.05.025	T62 <sup>F</sup>	0.124 and under	60.0					
Non-O-Solution      Non-O-S	TOEID	$0.125-6.500^{G}$	60.0		46.0	5		
Alloy 2219    T851 <sup>D</sup> 0.500–2.000 2.001–4.000  58.0 57.0 40.0 39.0  4    Alloy 3003    O  all  14.0  19.0  5.0  25	10012	0.500-6.500	00.0		0.00	Э		
T851 <sup>D</sup> 0.500-2.000  58.0   40.0  4    2.001-4.000  57.0   39.0  4    Alloy 3003    O  all  14.0  19.0  5.0  25	Alloy 2219							
2.001-4.000  57.0   39.0  4    Alloy 3003    O  all  14.0  19.0  5.0  25	T851 <sup>D</sup>	0.500-2.000	58.0		40.0	4		
Alloy 3003        O      all      14.0      19.0      5.0      25		2.001-4.000	57.0		39.0	4		
O all 14.0 19.0 5.0 25	Alloy 3003							
	0	all	14.0	19.0	5.0	25		

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TABLE	1	Continued

Temper	Specified Diameter or Thickness, in.		Tensile Strength, ksi	Yield Strength <sup>B</sup> (0.2 % offset), min, ksi	Elonga- tion <sup>B</sup> in 2 in.
remper		min	max		or 4 × Diam- eter. min. %
L10	0.271 and under	17.0			
H12 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	С		С	
			Alloy 5052		
0	0.124 and under		32.0		
	0.125 and over	25.0	32.0	9.5	25
H32	0.124 and under	31.0			
110.4	0.125–0.374	31.0		23.0	
П34 Ц26	0.124 and under	34.0		26.0	
1130	0.124 and under	37.0		 29 0	
H38	0.374 and under	39.0			
F	all	С		С	
			Alloy 5056		
0	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			
H38 H38	0.374 and under	55.0			
H192	0.374 and under	60.0	Standards		
H392	0.374 and under	58.0			
	(http:	c•//cta	Alclad Alloy 5056	ai	
H192	0.374 and under	52.0		•••••	
H392	0.374 and under	50.0			
H393	0.120-0.192	54.0	ent Preview	47.0	
			Alloy 5154		
0	all	30.0	41.0	11.0	25
H32	0.374 and under	36.0 AS	TM B211-99		
H34	0.374 and under	39.0	40702 101 4000 00		
H36ps://standards.	0.374 and under Stand	12 42.0 SIST/6 /	49/f13-19bc-4233-82ae-	// <u>/</u> b52a244e4b/ast	m-b211-99
H38	0.374 and under	45.0			
H112	all	30.0	 Aller: 0001E	11.0	
	0.124 and under		Alloy 60612		
0	0.124 and under 0.125-8.000		22.0 22 N		 18
T4 and T451 <sup>D</sup>	0.124 and under	30.0			10
	0.125–8.000 <sup>H</sup>	30.0		16.0	18
T42 <sup><i>F</i></sup>	0.125–8.000 <sup>H</sup>	30.0		14.0	18
T6, T62 <sup><i>F</i></sup> , and T651 <sup><i>D</i></sup>	0.124 and under	42.0			
	0.125-8.000	42.0		35.0	10
189 and 194	0.374 and under	54.0	 Allow 6110	47.0	
			Alloy 0110		
T9	0.374 and under	65.0		63.0	2
Alloy 6262					
T6 and T651 <sup>D</sup>	0.125–8.000 <sup>G</sup>	42.0		35.0	10
Т9	0.125-2.000	52.0		48.0	5
	2.001-3.000	50.0		46.0	5
Alloy 7075 <sup>E</sup>					
0	0.124 and under		40.0		
	0.125-8.000	<u></u> .	40.0		10
T6, T62	0.124 and under	77.0		66.0	
Teel	0.125-4.000 <sup>^</sup>	//.0		66.0	1
1001	0.124 and under 0.125-/ 000 <sup>K</sup>	77.0		66 0	 7
	4.001-6.000	75.0		64.0	7
	6.001-7.000	73.0		62.0	7



TABLE 1 Continued

Temper	Specified Diameter or Thickness, in.		Tensile Strength, ksi	Yield Strength <sup>B</sup>	Elonga- tion <sup><i>B</i></sup> in 2 in. or 4 × Diam- eter, min, %
		min	max	min, ksi	
T73 and T7351 <sup>D</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

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<u>ASTM B211-99</u>

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Tempe	r Specified D	iameter or Thickness, in.	Bend Diameter Factor, N
		Alloy 2017	
T4, T42, and T451	0.124 and under	3 <sup>L</sup>	
	0.125–8.000 <sup>H</sup>	6 <sup><i>L</i></sup>	
		Alloy 2024	
0	0.124 and under	1	
T351, T4, T42	0.124 and under	3	
	0.125-6.500	6	
		Alloy 3003	
0	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 and each value for elongation to the nearest 0.5 %, both in accordance with the rounding-off method of Practice E 29. 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. in thickness or diameter.

<sup>C</sup> There are no tensile requirements for material in the F temper but it usually can be expected that material 1½ in. or less in thickness or diameter (except sections over 4 in. 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>D</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>E</sup> Also available in the F temper for which no properties are specified and no tension tests are performed but for which tests are performed for confirmation of heat-treat response as required by Section 10.

<sup>F</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>G</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. and a maximum cross-sectional area of 36 in.<sup>2</sup>.

<sup>H</sup> For bar, maximum cross-sectional area is 50 in.<sup>2</sup>.

<sup>1</sup> Minimum yield strength of coiled 2024-T4 wire and rod 0.125 in. and larger in thickness or diameter is 40.0 ksi.

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

<sup>K</sup> For rounds, maximum diameter is 4 in.; for square, hexagonal, or octagonal bar, maximum thickness is 3½ in.; for rectangular bar, maximum thickness is 3 in. with corresponding maximum width of 6 in.; for rectangular bar less than 3 in. in thickness, maximum width is 10 in.

<sup>L</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. size range.

#### 7. Chemical Composition

7.1 *Limits*—The bars, rods, and wire shall conform to the chemical composition limits specified in Table 2. Conformance shall be determined by the producer by analyzing samples taken at the time the ingots are cast, or samples taken from the finished or semifinished product. If the producer has determined the chemical composition of the material during the course of manufacture, sampling and analysis of the finished product shall not be required.

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 *Number of Samples*—The number of samples taken for determination of chemical composition shall be as follows:

7.2.1 When samples are taken at the time the ingots are cast, at least one sample shall be taken for each group of ingots cast simultaneously from the same source of molten metal.

7.2.2 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 no more than one sample shall be required per piece.

7.3 *Methods of Sampling*—Samples for determination of chemical composition shall be taken in accordance with one of the following methods:

7.3.1 Samples for chemical analysis shall be taken from the material by drilling, sawing, milling, turning, clipping, etc., a representative piece or pieces to obtain a weight of prepared sample not less than 75 g. Sampling shall be in accordance with Practice E 55.

7.3.2 Sampling for spectrochemical analysis shall be in accordance with Practices E 716. Samples for other methods of analysis shall be suitable for the form of material being analyzed and the type of analytical method used.

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