



Designation: **B166—19 B166 – 24**

## Standard Specification for Nickel-Chromium-Aluminum Alloy, Nickel-Chromium-Iron Alloys, Nickel-Chromium-Cobalt-Molybdenum Alloy, Nickel- Iron-Chromium-Tungsten Alloy, and Nickel-Chromium- Molybdenum-Copper Alloy Rod, Bar, and Wire<sup>1</sup>

This standard is issued under the fixed designation B166; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

*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 nickel-chromium-aluminum alloy, nickel-chromium-iron alloys,<sup>3</sup> nickel-chromium-cobalt-molybdenum alloy, nickel-iron-chromium-tungsten alloy, and nickel-chromium-molybdenum-copper alloy in the form of hot-finished and cold-worked rounds, squares, hexagons, rectangles, and cold-worked wire.

1.2 The values stated in inch-pound units are to be regarded as standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 The following precautionary caveat pertains only to the test methods portion, Section 12, of this specification: *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Safety Data Sheet (SDS) for this product/material as provided by the manufacturer, to establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

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 ASTM Standards:<sup>4</sup>

**B168** Specification for Nickel-Chromium-Aluminum Alloys (UNS N06699), Nickel-Chromium-Iron Alloys (UNS N06600, N06601, N06603, N06690, N06693, N06025, N06045, and N06696), Nickel-Chromium-Cobalt-Molybdenum Alloy (UNS N06617), Nickel-Iron-Chromium-Tungsten Alloy (UNS N06674), and

**B880** Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys

**B899** Terminology Relating to Non-ferrous Metals and Alloys

**E8/E8M** Test Methods for Tension Testing of Metallic Materials

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.07 on Refined Nickel and Cobalt and Their Alloys.

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<sup>2</sup> For ASME Boiler and Pressure Vessel Code application see related Specification SB-166 in Section II of that Code.

<sup>3</sup> Designation established in accordance with Practice E527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

<sup>4</sup> 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

- E18 Test Methods for Rockwell Hardness of Metallic Materials
- E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications
- E38 Methods for Chemical Analysis of Nickel-Chromium and Nickel-Chromium-Iron Alloys (Withdrawn 1989)<sup>5</sup>
- E112 Test Methods for Determining Average Grain Size
- E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness
- E527 Practice for Numbering Metals and Alloys in the Unified Numbering System (UNS)
- E1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys
- 2.2 *Federal Standards*:<sup>6</sup>
  - Fed. Std. No. 102 Preservation, Packaging and Packing Levels
  - Fed. Std. No. 123 Marking for Shipment (Civil Agencies)
  - Fed. Std. No. 182 Continuous Identification Marking of Nickel and Nickel-Base Alloys
- 2.3 *Military Standard*:<sup>6</sup>
  - MIL-STD-129 Marking for Shipment and Storage

### 3. Terminology

- 3.1 For definitions of terms used in this specification, refer to Terminology **B899**.
- 3.2 In case of conflict between the definitions of this specification and Terminology **B899**, this specification shall prevail.
- 3.3 *Definitions of Terms Specific to This Standard*:
  - 3.3.1 *bar, n*—material of rectangular (flats), hexagonal, or square solid section up to and including 10 in. (254 mm) in width and 1/8 in. (3.2 mm) and over in thickness in straight lengths.
  - 3.3.2 *rod, n*—material of round solid section furnished in straight lengths.
    - 3.3.2.1 *Discussion*—  
Hot-worked rectangular bar in widths 10 in. and under may be furnished as hot-rolled plate with sheared or cut edges in accordance with Specification **B168**, provided the mechanical property requirements of this specification are met.
  - 3.3.3 *wire, n*—a cold-worked solid product of uniform round cross section along its whole length, supplied in coil form.

### 4. Ordering Information

- <https://standards.iteh.ai/catalog/standards/astm/9cd76b0e-6a4a-438f-a43b-0fbf54732213/astm-b166-24>
- 4.1 It is the responsibility of the purchaser to specify all requirements that are necessary for the safe and satisfactory performance of material ordered under this specification. Examples of such requirements include, but are not limited to, the following:
    - 4.1.1 *Alloy Name or UNS Number*—see **Table 1**,
    - 4.1.2 *ASTM Designation*, including year of issue,
    - 4.1.3 *Section*—Rod (round), bar (square, hexagonal, or rectangular), or wire (round),
    - 4.1.4 *Condition* (see **Table 2** and **Table 3**),
    - 4.1.5 *Finish*,
    - 4.1.6 *Dimensions*, including length (see **Tables 4-8**),
    - 4.1.7 *Quantity*—feet or number of pieces,
    - 4.1.8 ~~*Certification*—State if certification is required,~~
    - 4.1.8 *Samples for Product (Check) Analysis*—State whether samples for product (check) analysis shall be furnished, and

<sup>5</sup> The last approved version of this historical standard is referenced on [www.astm.org](http://www.astm.org).

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

TABLE 1 Chemical Requirements<sup>A</sup>

| Element    | Composition Limits, % |                        |              |                        |              |                        |                        |              |                        |                        |                        |                        |
|------------|-----------------------|------------------------|--------------|------------------------|--------------|------------------------|------------------------|--------------|------------------------|------------------------|------------------------|------------------------|
|            | Alloy N06600          | Alloy N06601           | Alloy N06617 | Alloy N06674           | Alloy N06690 | Alloy N06693           | Alloy N06025           | Alloy N06045 | Alloy N06603           | Alloy N06696           | Alloy N06699           | Alloy N06235           |
| Nickel     | 72.0 min              | 58.0–63.0              | 44.5 min     | remainder <sup>B</sup> | 58.0 min     | remainder <sup>B</sup> | remainder <sup>B</sup> | 45.0 min     | remainder <sup>B</sup> | remainder <sup>B</sup> | remainder <sup>B</sup> | remainder <sup>B</sup> |
| Chromium   | 14.0–17.0             | 21.0–25.0              | 20.0–24.0    | 21.5–24.5              | 27.0–31.0    | 27.0–31.0              | 24.0–26.0              | 26.0–29.0    | 24.0–26.0              | 28.0–32.0              | 26.0–30.0              | 30.0–32.5              |
| Cobalt     | ...                   | ...                    | 10.0–15.0    | ...                    | ...          | ...                    | ...                    | ...          | ...                    | ...                    | ...                    | 1.0 max                |
| Cobalt     | ...                   | ...                    | 10.0–15.0    | ...                    | ...          | ...                    | ...                    | ...          | ...                    | ...                    | ...                    | 1.0                    |
| Molybdenum | ...                   | ...                    | 8.0–10.0     | ...                    | ...          | ...                    | ...                    | ...          | ...                    | ...                    | ...                    | 5.0–6.2                |
| Iron       | 6.0–10.0              | remainder <sup>B</sup> | 3.0 max      | 20.0–27.0              | 7.0–11.0     | 2.5–6.0                | 8.0–11.0               | 21.0–25.0    | 8.0–11.0               | 2.0–6.0                | 2.5 max                | 1.5 max                |
| Iron       | 6.0–10.0              | remainder <sup>B</sup> | 3.0          | 20.0–27.0              | 7.0–11.0     | 2.5–6.0                | 8.0–11.0               | 21.0–25.0    | 8.0–11.0               | 2.0–6.0                | 2.5                    | 1.5                    |
| Manganese  | 1.0 max               | 1.0 max                | 1.0 max      | 1.50 max               | 0.5 max      | 1.0 max                | 0.15 max               | 1.0 max      | 0.15 max               | 1.0 max                | 0.50 max               | 0.3–0.65               |
| Manganese  | 1.0                   | 1.0                    | 1.0          | 1.50                   | 0.5          | 1.0                    | 0.15                   | 1.0          | 0.15                   | 1.0                    | 0.50                   | 0.3–0.65               |
| Aluminum   | ...                   | 1.0–1.7                | 0.8–1.5      | ...                    | ...          | 2.5–4.0                | 1.8–2.4                | ...          | 2.4–3.0                | ...                    | 1.9–3.0                | 0.2–0.4                |
| Carbon     | 0.15 max              | 0.10 max               | 0.05–0.15    | 0.01 max               | 0.05 max     | 0.15 max               | 0.15–0.25              | 0.05–0.12    | 0.20–0.40              | 0.15 max               | 0.005–0.10             | 0.02–0.06              |
| Carbon     | 0.15                  | 0.10                   | 0.05–0.15    | 0.01                   | 0.05 max     | 0.15                   | 0.15–0.25              | 0.05–0.12    | 0.20–0.40              | 0.15                   | 0.005–0.10             | 0.02–0.06              |
| Copper     | 0.5 max               | 1.0 max                | 0.5 max      | ...                    | 0.5 max      | 0.5 max                | 0.1 max                | 0.3 max      | 0.50 max               | 1.5–3.0                | 0.50 max               | 3.5–4.0                |
| Copper     | 0.5                   | 1.0                    | 0.5          | ...                    | 0.5 max      | 0.5                    | 0.1                    | 0.3          | 0.50                   | 1.5–3.0                | 0.50                   | 3.5–4.0                |
| Silicon    | 0.5 max               | 0.5 max                | 1.0 max      | 1.0 max                | 0.5 max      | 0.5 max                | 0.5 max                | 2.5–3.0      | 0.50 max               | 1.0–2.5                | 0.50 max               | 0.2–0.6                |
| Silicon    | 0.5                   | 0.5                    | 1.0          | 1.0                    | 0.5 max      | 0.5                    | 0.5                    | 2.5–3.0      | 0.50                   | 1.0–2.5                | 0.50                   | 0.2–0.6                |
| Sulfur     | 0.015 max             | 0.015 max              | 0.015 max    | 0.015 max              | 0.015 max    | 0.01 max               | 0.010 max              | 0.010 max    | 0.010 max              | 0.010 max              | 0.01 max               | 0.015 max              |
| Sulfur     | 0.015                 | 0.015                  | 0.015        | 0.015                  | 0.015 max    | 0.01                   | 0.010                  | 0.010        | 0.010                  | 0.010                  | 0.01                   | 0.015                  |
| Titanium   | ...                   | ...                    | 0.6 max      | 0.05–0.20              | ...          | 1.0 max                | 0.1–0.2                | ...          | 0.01–0.25              | 1.0 max                | 0.60 max               | 0.5 max                |
| Titanium   | ...                   | ...                    | 0.6          | 0.05–0.20              | ...          | 1.0                    | 0.1–0.2                | ...          | 0.01–0.25              | 1.0                    | 0.60                   | 0.5                    |
| Phosphorus | ...                   | ...                    | ...          | 0.030 max              | ...          | ...                    | 0.020 max              | 0.020 max    | 0.20 max               | ...                    | 0.02 max               | 0.03 max               |
| Phosphorus | ...                   | ...                    | ...          | 0.030                  | ...          | ...                    | 0.020                  | 0.020        | 0.20                   | ...                    | 0.02                   | 0.03                   |
| Zirconium  | ...                   | ...                    | ...          | ...                    | ...          | ...                    | 0.01–0.10              | ...          | 0.01–0.10              | ...                    | 0.10 max               | ...                    |
| Zirconium  | ...                   | ...                    | ...          | ...                    | ...          | ...                    | 0.01–0.10              | ...          | 0.01–0.10              | ...                    | 0.10                   | ...                    |
| Yttrium    | ...                   | ...                    | ...          | ...                    | ...          | ...                    | 0.05–0.12              | ...          | 0.01–0.15              | ...                    | ...                    | ...                    |
| Boron      | ...                   | ...                    | 0.006 max    | 0.0005–0.006           | ...          | ...                    | ...                    | ...          | ...                    | ...                    | 0.008 max              | ...                    |
| Boron      | ...                   | ...                    | 0.006        | 0.0005–0.006           | ...          | ...                    | ...                    | ...          | ...                    | ...                    | 0.008                  | ...                    |
| Nitrogen   | ...                   | ...                    | ...          | 0.02 max               | ...          | ...                    | ...                    | ...          | ...                    | ...                    | 0.05 max               | ...                    |
| Nitrogen   | ...                   | ...                    | ...          | 0.02                   | ...          | ...                    | ...                    | ...          | ...                    | ...                    | 0.05                   | ...                    |
| Niobium    | ...                   | ...                    | ...          | 0.10–0.35              | ...          | 0.5–2.5                | ...                    | ...          | ...                    | ...                    | 0.50 max               | 1.0 max                |
| Niobium    | ...                   | ...                    | ...          | 0.10–0.35              | ...          | 0.5–2.5                | ...                    | ...          | ...                    | ...                    | 0.50                   | 1.0                    |
| Cerium     | ...                   | ...                    | ...          | ...                    | ...          | ...                    | 0.03–0.09              | ...          | ...                    | ...                    | ...                    | ...                    |
| Tungsten   | ...                   | ...                    | ...          | 6.0–8.0                | ...          | ...                    | ...                    | ...          | ...                    | ...                    | ...                    | 0.60 max               |
| Tungsten   | ...                   | ...                    | ...          | 6.0–8.0                | ...          | ...                    | ...                    | ...          | ...                    | ...                    | ...                    | 0.60                   |

<sup>A</sup> Where ellipses (...) appear in this table, there is no requirement, and the element need neither be analyzed for nor reported. All values are maximums unless a range is provided or is a minimum or a remainder.

<sup>B</sup> Element shall be determined arithmetically by difference.

**TABLE 2 Mechanical Properties of Rods and Bars**

| Condition and Diameter or Distance Between Parallel Surfaces, in. (mm)       | Tensile Strength, min, psi (MPa) | Yield Strength (0.2 % offset), min, psi (MPa) | Elongation in 2 in. or 50 mm or 4D, min,% |
|--|----------------------------------|---|---|
| <b>UNS N06600:</b>   |                                  |   |   |
| Cold-worked (as worked):   |                                  |   |   |
| Rounds:  |                                  |   |   |
| Under ½ (12.7)   | 120 000 (825)                    | 90 000 (620)                                  | 7 <sup>A</sup>                            |
| ½ to 1 (12.7 to 25.4), incl  | 110 000 (760)                    | 85 000 (585)                                  | 10  |
| Over 1 to 2½ (25.4 to 63.5), incl  | 105 000 (725)                    | 80 000 (550)                                  | 12  |
| Squares, hexagons, and rectangles:   |                                  |   |   |
| ¼ (6.4) and under  | 100 000 (690)                    | 80 000 (550)                                  | 5 <sup>A</sup>                            |
| Over ¼ to ½ (6.4 to 12.7), excl  | 95 000 (655)                     | 70 000 (480)                                  | 7   |
| Hot worked (as worked):  |                                  |   |   |
| Rounds:  |                                  |   |   |
| ¼ to ½ (6.4 to 12.7), incl   | 95 000 (655)                     | 45 000 (310)                                  | 20  |
| Over ½ to 3 (12.7 to 76.2), incl   | 90 000 (620)                     | 40 000 (275)                                  | 25  |
| Over 3 (76.2)  | 85 000 (585)                     | 35 000 (240)                                  | 30  |
| Squares, hexagons, and rectangles:   |                                  |   |   |
| All sizes  | 85 000 (585)                     | 35 000 (240)                                  | 20  |
| Rings and disks <sup>B</sup>   | —                                | —   | —   |
| Cold-worked (annealed) or hot-worked (annealed):                             |                                  |   |   |
| Rods and bars, all sizes   | 80 000 (550)                     | 35 000 (240)                                  | 30 <sup>A</sup>                           |
| Rings and disks <sup>C</sup>   | —                                | —   | —   |
| Forging Quality:   |                                  |   |   |
| All sizes  | <i>D</i>                         | <i>D</i>                                      | <i>D</i>                                  |
| <b>UNS N06601:</b>   |                                  |   |   |
| Cold-worked (annealed) or hot-worked (annealed):                             |                                  |   |   |
| All products, all sizes  | 80 000 (550)                     | 30 000 (205)                                  | 30  |
| Forging Quality:   |                                  |   |   |
| All sizes  | <i>D</i>                         | <i>D</i>                                      | <i>D</i>                                  |
| <b>UNS N06617:</b>   |                                  |   |   |
| Cold-worked (annealed) or hot-worked (annealed):                             |                                  |   |   |
| All products, all sizes  | 95 000 (655)                     | 35 000 (240)                                  | 35  |
| Forging Quality:   |                                  |   |   |
| All sizes  | <i>D</i>                         | <i>D</i>                                      | <i>D</i>                                  |
| <b>UNS N06674</b>  |                                  |   |   |
| Cold-worked (annealed <sup>E</sup> ) or hot-worked (annealed <sup>E</sup> ): |                                  |   |   |
| All products, all sizes  | 86 000 (590)                     | 34 000 (235)                                  | 30  |
| Forging Quality:   |                                  |   |   |
| All sizes  | <i>D</i>                         | <i>D</i>                                      | <i>D</i>                                  |
| <b>UNS N06690:</b>   |                                  |   |   |
| Cold-worked (as worked):   |                                  |   |   |
| Rounds:  |                                  |   |   |
| Under ½ (12.7)   | 120 000 (825)                    | 90 000 (620)                                  | 7 <sup>A</sup>                            |
| ½ to 1 (12.7 to 25.4), incl  | 110 000 (760)                    | 85 000 (585)                                  | 10  |
| Over 1 to 2½ (25.4 to 63.5), incl  | 105 000 (725)                    | 80 000 (550)                                  | 12  |
| Squares, hexagons, and rectangles:   |                                  |   |   |
| ¼ (6.4) and under  | 100 000 (690)                    | 80 000 (550)                                  | 5 <sup>A</sup>                            |
| Over ¼ to ½ (6.4 to 12.7), excl  | 95 000 (655)                     | 70 000 (480)                                  | 7   |
| Hot worked (as worked):  |                                  |   |   |
| Rounds:  |                                  |   |   |
| ¼ to ½ (6.4 to 12.7), incl   | 95 000 (655)                     | 45 000 (310)                                  | 20  |
| Over ½ to 3 (12.7 to 76.2), incl   | 90 000 (620)                     | 40 000 (275)                                  | 25  |
| Over 3 (76.2)  | 85 000 (585)                     | 35 000 (240)                                  | 30  |
| Squares, hexagons, and rectangles:   |                                  |   |   |
| All sizes  | 85 000 (585)                     | 35 000 (240)                                  | 20  |
| Rings and disks <sup>B</sup>   | —                                | —   | —   |
| Cold-worked (annealed) or hot-worked (annealed):                             |                                  |   |   |
| Rods and bars, all sizes   | 85 000 (586)                     | 35 000 (240)                                  | 30 <sup>A</sup>                           |
| Rings and disks <sup>C</sup>   | —                                | —   | —   |
| Forging Quality:   |                                  |   |   |
| All sizes  | <i>D</i>                         | <i>D</i>                                      | <i>D</i>                                  |
| <b>UNS N06693:</b>   |                                  |   |   |
| Cold-worked (annealed) or hot-worked (annealed):                             |                                  |   |   |
| Rods and bars, all sizes   | 100 000 (690)                    | 50 000 (345)                                  | 30  |
| Forging Quality:   |                                  |   |   |
| All sizes  | <i>D</i>                         | <i>D</i>                                      | <i>D</i>                                  |
| <b>UNS N06603:</b>   |                                  |   |   |
| Cold-worked (annealed) or hot-worked (annealed):                             |                                  |   |   |
| All products, all sizes  | 94 000 (650)                     | 43 000 (300)                                  | 25  |
| Forging Quality:   |                                  |   |   |
| All sizes  | <i>D</i>                         | <i>D</i>                                      | <i>D</i>                                  |
| <b>UNS N06025:</b>   |                                  |   |   |
| Cold-worked (annealed) or hot-worked (annealed):                             |                                  |   |   |
| All products, all sizes  | 98 000 (680)                     | 39 000 (270)                                  | 30  |
| Forging Quality:   |                                  |   |   |
| All sizes  | <i>D</i>                         | <i>D</i>                                      | <i>D</i>                                  |
| <b>UNS N06045:</b>   |                                  |   |   |
| Cold-worked (annealed) or hot-worked (annealed):                             |                                  |   |   |

**TABLE 2** *Continued*

| Condition and Diameter or Distance Between Parallel Surfaces, in. (mm)                | Tensile Strength, min, psi (MPa) | Yield Strength (0.2 % offset), min, psi (MPa) | Elongation in 2 in. or 50 mm or 4D, min,% |
|---|----------------------------------|---|---|
| All products, all sizes   | 90 000 (620)                     | 35 000 (240)                                  | 35  |
| Hot-worked (Annealed): <sup>F</sup>   |                                  |   |   |
| Rods and bars, all sizes  | 75 000 (517)                     | 30 000 (207)                                  | 30  |
| Forging Quality:  | <i>D</i>                         | <i>D</i>                                      | <i>D</i>                                  |
| All sizes   |                                  |   |   |
| <i>UNS N06696</i>   |                                  |   |   |
| Cold-worked (annealed and water quenched) or hot-worked (annealed and water quenched) | 85 000 (586)                     | 35 000 (240)                                  | 30  |
| All products, all sizes   |                                  |   |   |
| <i>UNS N06699</i> :   |                                  |   |   |
| Cold-worked (annealed) or hot-worked (annealed):                                      | 89 000 (610)                     | 35 000 (240)                                  | 40  |
| All products, all sizes   |                                  |   |   |
| Forging Quality:  | <i>D</i>                         | <i>D</i>                                      | <i>D</i>                                  |
| All sizes   |                                  |   |   |
| <i>UNS N06235</i>   |                                  |   |   |
| Cold-worked (annealed) or hot-worked (annealed):                                      | 90 000 (620)                     | 35 000 (240)                                  | 35  |
| All products, all sizes   |                                  |   |   |
| Forging Quality:  | <i>D</i>                         | <i>D</i>                                      | <i>D</i>                                  |
| All sizes   |                                  |   |   |

<sup>A</sup> Not applicable to diameters or cross sections under 3/32 in. (2.4 mm).

<sup>B</sup> Hardness B75 to B100, or equivalent.

<sup>C</sup> Hardness B75 to B95, or equivalent.

<sup>D</sup> Forging quality is furnished to chemical requirements and surface inspection only. No mechanical properties are required.

<sup>E</sup> Solution annealed at a minimum temperature of 2150°F (1175°C) followed by a water quench or rapidly cooled by other means.

<sup>F</sup> High-temperature annealed condition.

**TABLE 3 Mechanical Properties of Cold-Worked Wire in Coil (Alloys N06600 and N06690 Only)<sup>A</sup>**

| Condition and Size, in. (mm)            | Tensile Strength, psi (MPa) |                | Wrapping Test   |
|---|-----------------------------|----------------|---|
|   | Min                         | Max            |   |
| Annealed                                |                             |                |   |
| Under 0.032 (0.81)                      | 80 000 (552)                | 115 000 (793)  | The wire shall be wrapped eight consecutive turns in a closed helix (pitch approximately equal to the diameter of the wire) around a mandrel as follows:<br>(1) For all annealed and regular temper wire and for spring temper wire 0.229 in. (5.82 mm) and less: Same as diameter of wire.<br>(2) For spring temper wire over 0.229 in. (5.82 mm): Twice the diameter of wire. |
| 0.032 (0.81) and over                   | 80 000 (552)                | 105 000 (724)  |   |
| Cold-worked, regular temper, all sizes  | 120 000 (827)               | 165 000 (1138) | The wire shall withstand the wrapping test without fracture or development of a pebbled or orange-peel surface.   |
| Cold-worked, spring temper              |                             | 165 000 (1138) |   |
| Cold-worked, spring temper              |                             | ...            | The wire shall withstand the wrapping test without fracture or development of a pebbled or orange-peel surface.   |
| Up to 0.057 (1.45), incl                | 185 000 (1276)              | ...            |   |
| Over 0.057 (1.45) to 0.114 (2.90), incl | 175 000 (1207)              | ...            |   |
| Over 0.114 (2.90) to 0.229 (5.82), incl | 170 000 (1172)              | ...            |   |
| Over 0.229 (5.82) to 0.329 (8.36), incl | 165 000 (1138)              | ...            |   |
| Over 0.329 (8.36) to 0.375 (9.53), incl | 160 000 (1103)              | ...            |   |
| Over 0.375 (9.53) to 0.500 (12.7), incl | 155 000 (1069)              | ...            |   |
| Over 0.500 (12.7) to 0.563 (14.3), incl | 140 000 (965)               | ...            |   |

<sup>A</sup> Properties are not applicable to wire after straightening and cutting.

4.1.9 *Purchaser Inspection*—If purchaser wishes to witness tests or inspection of material at place of manufacture, the purchase order must so state indicating which test or inspections are to be witnessed.

## 5. Chemical Composition

5.1 The material shall conform to the composition limits specified in **Table 1**.

5.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in Specification **B880**.

**TABLE 4 Permissible Variations in Diameter or Distance Between Parallel Surfaces of Cold-Worked Rod and Bar**

| Specified Dimension, in. (mm) <sup>A</sup>   | Permissible Variations From Specified Dimension, in. (mm) |              |
|--|---|--------------|
|  | +   | -            |
| <b>Rounds:</b>                               |   |              |
| 1/16 (1.6) to 3/16 (4.8), excl               | 0   | 0.002 (0.05) |
| 3/16 (4.8) to 1/2 (12.7), excl               | 0   | 0.003 (0.08) |
| 1/2 (12.7) to 15/16 (23.8), incl             | 0.001 (0.03)  | 0.002 (0.05) |
| over 15/16 (23.8) to 1 15/16 (49.2),<br>incl | 0.0015 (0.04)   | 0.003 (0.08) |
| over 15/16 (23.8) to 1 15/16 (49.2),<br>incl | 0.0015 (0.04)   | 0.003 (0.08) |
| over 1 15/16 (49.2) to 2 1/2 (63.5),<br>incl | 0.002 (0.05)  | 0.004 (0.10) |
| over 1 15/16 (49.2) to 2 1/2 (63.5),<br>incl | 0.002 (0.05)  | 0.004 (0.10) |
| <b>Hexagons, squares, rectangles:</b>        |   |              |
| 1/2 (12.7) and less                          | 0   | 0.004 (0.10) |
| over 1/2 (12.7) to 7/8 (22.2), incl          | 0   | 0.005 (0.13) |
| over 7/8 (22.2) to 1 1/4 (31.8), incl        | 0   | 0.007 (0.18) |
| over 1 1/4 (31.8) to 2 (50.8), incl          | 0   | 0.009 (0.23) |

<sup>A</sup> Dimensions apply to diameter of rounds, to distance between parallel surfaces of hexagons and squares, and separately to width and thickness of rectangles.

**TABLE 5 Permissible Variations in Diameter or Distance Between Parallel Surfaces of Hot-Worked Rod and Bar**

| Specified Dimension, in. (mm) <sup>A</sup> | Permissible Variations from Specified Dimensions, in. (mm) |              |
|--|--|--------------|
|  | +  | -            |
| <b>Rod and bar, hot-worked:</b>            |  |              |
| 1 (25.4) and under                         | 0.016 (0.41)   | 0.016 (0.41) |
| over 1 (25.4) to 2 (50.8), incl            | 0.031 (0.79)   | 0.016 (0.41) |
| over 2 (50.8) to 4 (101.6), incl           | 0.047 (1.19)   | 0.031 (0.79) |
| over 4 (101.6)                             | 0.125 (3.18)   | 0.063 (1.60) |
| <b>Rod, rough-turned or ground:</b>        |  |              |
| under 1 (25.4)                             | 0.005 (0.13)   | 0.005 (0.13) |
| 1 (25.4) and over                          | 0.031 (0.79)   | 0            |
| <b>Forging quality rod:<sup>B</sup></b>    |  |              |
| Under 1 (25.4)                             | 0.005 (0.13)   | 0.005 (0.13) |
| 1 (25.4) and over                          | 0.031 (0.79)   | 0            |

<sup>A</sup> Dimensions apply to diameter of rods, to distance between parallel surfaces of hexagons and squares, and separately to width and thickness of rectangles.

<sup>B</sup> Spot grinding is permitted to remove minor surface imperfections. The depth of these spot ground areas shall not exceed 3 % of the diameter of the rod.

**TABLE 6 Permissible Variations in Diameter of Cold-Worked Wire**

| Diameter, in. (mm)                             | Permissible Variations, in. (mm) |  |
|--|----------------------------------|--|
|  | + or -                           |  |
| Up to 0.0044 (0.112), incl                     | 0.0002 (0.005)                   |  |
| Over 0.0044 (0.112) to 0.0079 (0.201),<br>incl | 0.00025 (0.006)                  |  |
| Over 0.0079 (0.201) to 0.0149 (0.378),<br>incl | 0.0003 (0.008)                   |  |
| Over 0.0149 (0.378) to 0.0199 (0.505),<br>incl | 0.0004 (0.010)                   |  |
| Over 0.0199 (0.505) to 0.031 (0.79),<br>incl   | 0.0005 (0.013)                   |  |
| Over 0.031 (0.79) to 0.045 (1.14), incl        | 0.0006 (0.015)                   |  |
| Over 0.045 (1.14) to 0.079 (2.01), incl        | 0.0007 (0.018)                   |  |
| Over 0.079 (2.01) to 0.1875 (4.76), incl       | 0.001 (0.025)                    |  |
| Over 0.1875 (4.76) to 0.3125 (7.93),<br>incl   | 0.002 (0.051)                    |  |
| Over 0.3125 (7.93) to 0.563 (14.3), incl       | 0.003 (0.076)                    |  |