



Designation: B1011/B1011M – 19

## Standard Specification for Cobalt Alloy Spring Wire<sup>1</sup>

This standard is issued under the fixed designation B1011/B1011M; 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.

### 1. Scope

1.1 This specification covers cold-drawn cobalt alloy spring wire intended especially for the manufacture of springs.

1.1.1 This specification requires capability properties after age hardening test samples of the cold worked spring wire to ensure final mechanical properties are satisfied. The spring is typically age hardened after fabrication to increase its strength. However, mechanical properties cannot be obtained from finished springs.

1.2 The values stated in either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the standard.

1.3 Unless the order specifies an “M” designation, the material shall be furnished to inch-pound units.

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>2</sup>

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

**E8** Test Methods for Tension Testing of Metallic Materials [Metric] E0008\_E0008M

**E18** Test Methods for Rockwell Hardness of Metallic Materials

**E92** Test Methods for Vickers Hardness and Knoop Hardness of Metallic Materials

**E354** Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

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

2.2 *SAE Standard:*<sup>3</sup>

**J 1086** Numbering Metals and Alloys

2.3 *NACE International Standard:*<sup>4</sup>

**NACE MR0175/ISO 15156** Petroleum and natural gas industries—Materials for use in H<sub>2</sub>S-containing environments in oil and gas production

### 3. Ordering Information

3.1 It is the responsibility of the purchaser to specify all requirements that are necessary for material ordered under this specification. Such requirements may include, but are not limited to the following:

3.1.1 Quantity (weight or number of pieces),

3.1.2 Name of material,

3.1.3 Melt method (see 5.1),

3.1.4 Finish (see 5.4),

3.1.5 Dimension(s) with tolerance(s),

3.1.6 UNS designation (Table 1),

3.1.7 ASTM designation and date of issue,

3.1.8 Special requirements and any supplementary requirements (such as S1 for NACE MR0175/ISO 15156 service), and

3.1.9 Packaging (see 5.5).

NOTE 1—A typical ordering description is as follows:

2000 lb [900 kg] Cobalt Alloy Spring Wire, cold-drawn and stearate coated, 0.032-in. [0.82 mm] diameter, in 100-lb [45 kg] 16-in. [0.4 m] coils, UNS R30035, to ASTM B1011/B1011M, dated \_\_\_\_.

### 4. General Requirements for Delivery

4.1 Spring wire shall be shipped in suitable packing and shall include a shipping tag or label to include size, alloy, purchase order number, heat or batch number and other

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<sup>2</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.

<sup>3</sup> Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.

<sup>4</sup> Available from NACE International (NACE), 15835 Park Ten Pl., Houston, TX 77084, http://www.nace.org.

**TABLE 1 Chemical Requirements**

| UNS Designation <sup>A</sup> | Composition, % <sup>B</sup> |           |            |        |         |                      |             |             |            |                      |                       |
|------------------------------|-----------------------------|-----------|------------|--------|---------|----------------------|-------------|-------------|------------|----------------------|-----------------------|
|                              | Carbon                      | Manganese | Phosphorus | Sulfur | Silicon | Cobalt               | Chromium    | Nickel      | Molybdenum | Iron                 | Other Elements        |
| R30003                       | 0.015                       | 1.5–2.5   | 0.015      | 0.015  | 1.20    | 39.0–41.0            | 19.0–21.0   | 14.0–16.0   | 6.0–8.0    | Balance <sup>C</sup> | Be 0.001 <sup>D</sup> |
| R30035                       | 0.025                       | 0.15      | 0.015      | 0.010  | 0.15    | Balance <sup>C</sup> | 19.00–21.00 | 33.00–37.00 | 9.00–10.50 | 1.00                 | Ti 1.00               |

<sup>A</sup> Designations established in accordance with Practice E527 and SAE J 1086, Practice for Numbering Metals and Alloys (UNS).

<sup>B</sup> Maximum unless range or minimum is indicated. Where ellipses ( . . . ) appear in this table, there is no requirement and the element need not be determined or reported.

<sup>C</sup> Approximately equal to the difference between 100 % and the sum percentage of the other specified elements. The percentage content by difference for this element is not required to be reported.

<sup>D</sup> Denotes more restrictive limit than the composition defined by the UNS designation.

applicable ordering information; and a test report to confirm the properties and other requirements of this specification are met.

## 5. Material and Manufacture

5.1 *Melt Method*—The acceptable melt methods for production of the ingot used to make drawing rod and rod coil are vacuum induction melting followed by vacuum arc remelting, or vacuum induction melting followed by electro-slag remelting.

5.2 *Surface Quality*—Drawing rod and rod coil used for drawing shall be shaved, peeled, or suitably prepared prior to final drawing to remove laps, seams, and other surface defects.

5.3 *Condition*—Spring wire shall be furnished in the cold-drawn condition. Following fabrication, springs are typically age hardened to increase mechanical properties. The capability tensile strengths following the prescribed heat treatment are shown in Table 2 and Table 3.

5.4 *Finish*—Types of finish typically available for spring wire include (but are not limited to) as-drawn (including bright and diamond-drawn), and as-drawn with a suitable coating for coiling springs.

5.5 *Packaging*—Typical packaging includes coils, spools, or reels. These are generally wrapped and secured to pallets or placed in crates to protect from contamination and damage during shipment.

## 6. Chemical Composition

6.1 The material shall conform to the chemical composition requirements in Table 1.

6.2 Methods and practices relating to chemical analysis required by this specification shall be in accordance with Test Methods E354.

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

## 7. Mechanical Requirements

### 7.1 Tensile Properties:

7.1.1 Tensile properties shall be determined in accordance with Test Methods E8. Tensile tests of two samples from each lot shall be performed: one sample which has only been cold drawn and one sample which has been cold drawn and age hardened in a capability test. Should any test specimen not meet the specified mechanical requirements, two additional test pieces in the same condition from the same lot shall be tested, in the same manner for each failed test piece. The lot shall be considered in compliance only if all additional test pieces meet the specified requirements. The conditions for replacement of specimens and acceptance of these tests are in accordance with Test Methods E8.

7.1.2 Tensile test results for which any specimen fractures outside the gage length shall be considered acceptable if the elongation meets the minimum requirements specified.

**TABLE 2 Mechanical Requirements for R30003<sup>A</sup>**

| Round or Square Dimension, in. [mm]       | Cold Drawn Condition Tensile Strength, min, ksi [MPa] | Age Hardened, <sup>B</sup> ksi [MPa] |                                |                                    |                           |
|---|---|--------------------------------------|--------------------------------|------------------------------------|---------------------------|
|   |   | Tensile Strength, min, ksi [MPa]     | Yield Strength, min, ksi [MPa] | Elongation in $\geq 4D^C$ , min, % | Reduction in Area, min, % |
| 0.010 [0.25] to 0.125 [3.18], incl        | 250 [1724]  | 290 [2000]                           | 280 [1930]                     | 2                                  | Report                    |
| Over 0.125 [3.18] to 0.170 [4.32], incl   | 240 [1655]  | 280 [1930]                           | 270 [1860]                     | 4                                  | 20                        |
| Over 0.170 [4.32] to 0.250 [6.35], incl   | 240 [1655]  | 260 [1795]                           | 240 [1655]                     | 4                                  | 20                        |
| Over 0.250 [6.35] to 0.437 [11.10], incl  | 220 [1517]  | 240 [1655]                           | 230 [1585]                     | 6                                  | 20                        |
| Over 0.437 [11.10] to 0.625 [15.88], incl | 210 [1448]  | 230 [1585]                           | 220 [1515]                     | 8                                  | 20                        |
| Over 0.625 [15.88] to 0.750 [19.05], incl | 190 [1310]  | 210 [1448]                           | 200 [1379]                     | 8                                  | 20                        |

<sup>A</sup> When wire is specified in straightened and cut lengths, the minimum tensile strength specified herein do not apply and are typically 85 to 90 % of the values listed in the table.

<sup>B</sup> Aged at 900 to 1000°F [480 to 540°C], holding at the selected temperature within  $\pm 25^\circ\text{F}$  [ $\pm 15^\circ\text{C}$ ] for 5 to 5½ h, and cooling in air to room temperature.

<sup>C</sup> The gauge length for wire up to 0.125 in. [3.18 mm] diameter, inclusive, shall be 0.5 in. [12.7 mm].