



Designation: B1011/B1011M – 22

Standard Specification for Cobalt Alloy Spring Wire¹

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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:*²

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

E8/E8M Test Methods for Tension Testing of Metallic Materials

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 *NACE Standard:*³

NACE MR0175/ISO 15156 Petroleum and natural gas industries—Materials for use in H₂S-containing environments in oil and gas production

2.3 *SAE Standard:*⁴

J 1086 Numbering Metals and Alloys

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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² 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.

³ Available from NACE International (NACE), 15835 Park Ten Pl., Houston, TX 77084, http://www.nace.org.

⁴ Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, http://www.sae.org.

TABLE 1 Chemical Requirements

UNS Designation ^A	Composition, % ^B										
	Carbon	Manganese	Phosphorus	Sulfur	Silicon	Cobalt	Chromium	Nickel	Molybdenum	Iron	Other Elements
R30003	0.150	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 ^C	Be 0.001 ^D
R30035	0.025	0.15	0.015	0.010	0.15	Balance ^C	19.00–21.00	33.00–37.00	9.00–10.50	1.00	Ti 1.00

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

^B 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.

^C 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.

^D 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/E8M. 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/E8M.

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

TABLE 2 Mechanical Requirements for R30003^A

Round or Square Dimension, in. [mm]	Cold Drawn Condition Tensile Strength, min, ksi [MPa]	Age Hardened, ^B 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

^A 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.

^B Aged at 900 to 1000 °F [480 to 540 °C], holding at the selected temperature within ± 25 °F [± 15 °C] for 5 to 5½ h, and cooling in air to room temperature.

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

TABLE 3 Mechanical Requirements for R30035^A

Round or Square Dimension, in. [mm]	Cold Drawn Condition Tensile Strength, min, ksi [MPa]	Age Hardened, ^B 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]	280 [1930]	270 [1860]	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

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

^B Aged at 1200 to 1250 °F [650 to 675 °C], holding at the selected temperature within ± 25 °F [± 15 °C] for 4 to 4½ h, and cooling in air to room temperature.

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

7.1.3 The mechanical properties of test specimens from both the cold drawn and age hardened conditions shall conform to the appropriate mechanical requirements specified in **Table 2**, **Table 3**, or as specified on the purchase order. Note the spring manufacturer may adjust heat treating times or temperatures, or both, as needed to achieve the desired properties of the finished springs after age hardening.

7.2 Wrap Test:

7.2.1 Wire 0.625 in. [15.9 mm] and smaller in diameter shall be wound on a mandrel having a diameter four times the diameter of the wire without breaking. Wire larger than 0.625 in. [15.9 mm] may be wrap tested as agreed upon between supplier and purchaser.

8. Certification

8.1 The supplier shall provide a certification that the material was tested in accordance with this specification and met all requirements. A report of the test results shall be furnished to the purchaser.

9. Keywords

9.1 cobalt alloy spring wire; NACE MR0175; spring; spring wire; UNS R30003; UNS R30035

SUPPLEMENTARY REQUIREMENTS

When specified in the purchase order, the following supplementary requirements shall apply.

S1. NACE MR0175/ISO 15156

S1.1 *Hardness*—When material is intended for the manufacture of springs that are ordered to be in compliance with NACE MR0175/ISO 15156, hardness properties of S1.1.1 or S1.1.2 are required; otherwise they may be specified by the purchase order. Test Methods **E18** or **E92** shall be used. Hardness determination shall be made on a product cross section, midway between the center and surface.

S1.1.1 UNS R30003 ordered to NACE MR0175/ISO 15156 shall have a maximum hardness after age hardening of 60 HRC.

S1.1.2 UNS R30035 ordered to NACE MR0175/ISO 15156 shall have a maximum hardness after age hardening of 55 HRC.

NOTE 2—NACE MR0175/ISO 15156 may impose age hardening time and temperature requirements for R30035.