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## Standard Specification for Wrought 40Cobalt-20Chromium-16Iron-15Nickel- 7Molybdenum Alloy Wire and Strip for Surgical Implant Applications (UNS R30003 and UNS R30008)<sup>1</sup>

This standard is issued under the fixed designation F 1058; 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 the chemical, mechanical, and metallurgical requirements for two grades of wrought 40cobalt-20chromium-16iron-15nickel-7molybdenum alloy in the form of wire and strip used for the manufacture of surgical implants.

1.2 The values stated in ~~inch-pound~~SI units are to be regarded as ~~the~~ standard. The ~~SI~~inch-pound equivalents of the ~~inch-pound~~ units may be approximate. ~~SI~~ units in parentheses are for information only.

### 2. Referenced Documents

#### 2.1 ASTM Standards:<sup>2</sup>

A 751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

E 8 Test Methods for Tension Testing of Metallic Materials

~~E 18 Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials<sup>3</sup>~~ Test Methods for Rockwell Hardness of Metallic Materials

E 29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E 45 Test Methods for Determining the Inclusion Content of Steel

E 92 Test Method for Vickers Hardness of Metallic Materials

E 112 Test Methods for Determining the Average Grain Size

~~E 140 Standard Hardness Conversion Tables for Metals<sup>3</sup>~~ Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness

E 354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys

#### 2.2 Aerospace Material Specifications:<sup>3</sup>

AMS 2269 Chemical Check Analysis Limits Wrought Nickel and Alloys and Cobalt Alloys

AMS 5833 Alloy Wire, Corrosion and Heat Resistant 20Cr-15Ni-40Co-7.0Mo-16Fe Solution Treated and Cold Drawn

AMS 5834 Alloy Wire, Corrosion and Heat Resistant 20Cr-15Ni-40Co-7.0Mo-16Fe Solution Heat Treated, Cold Drawn, and Aged

AMS 5875 Alloy Strip, Corrosion and Heat Resistant 20Cr-15Ni-40Co-7.0Mo-16Fe Solution Heat Treated, Cold Rolled, and Aged

AMS 5876 Alloy Strip, Corrosion and Heat Resistant 20Cr-15Ni-40Co-7.0Mo-16Fe Solution Heat Treated and Cold Rolled

#### 2.3 ~~American Society for Quality~~ American Society for Quality Standards:

~~ASQ C1~~ Specification of General Requirements for a Quality Program<sup>4</sup>

#### 2.4 ~~ISO Standard~~ ISO Standards:<sup>5</sup>

ISO 5832-7 Implants for Surgery—Metallic Materials—Part 7 Forgeable and Cold Formed Co-Cr-Ni-Mo-Fe Alloy

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F04 on Medical and Surgical Materials and Devices and is the direct responsibility of Subcommittee F04.12 on Metallurgical Materials.

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<sup>2</sup> For referenced ASTM standards, visit the ASTM website, [www.astm.org](http://www.astm.org), or contact ASTM Customer Service at [service@astm.org](mailto:service@astm.org). For *Annual Book of ASTM Standards* Vol 01-03 volume information, refer to the standard's Document Summary page on the ASTM website.

<sup>3</sup> Annual Book of ASTM Standards, Vol 03.01.

<sup>4</sup> Available from Society of Automotive Engineers (SAE), 400 Commonwealth Dr., Warrendale, PA 15096-0001, <http://www.sae.org>.

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

<sup>6</sup> Available from American Society for Quality (ASQ), 600 N. Plankinton Ave., Milwaukee, WI 53203, <http://www.asq.org>.

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

<sup>8</sup> Available from American National Standards Institute (ANSI), 25 W. 43rd St., 4th Floor, New York, NY 10036, <http://www.ansi.org>.

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

ISO 6892 Metallic Materials—Tensile Testing<sup>7</sup>  
ISO 6892 Metallic Materials—Tensile Testing  
ISO 9001 Quality Management Systems—Requirements

### 3. ~~Ordering Information~~

~~3.1 Inquiries and orders for material under this specification shall include the following information:~~

- ~~3.1.1 Quantity (weight or number of pieces);~~
  - ~~3.1.2 ASTM designation, grade, and date of issue;~~
  - ~~3.1.3 Form (wire or strip);~~
  - ~~3.1.4 Applicable dimensions, including size, thickness, width, and length (exact, random, multiples) and tolerances where critical, and drawing number;~~
  - ~~3.1.5 Condition;~~
  - ~~3.1.6 Finish;~~
  - ~~3.1.7 Mechanical properties, if applicable, for special conditions;~~
  - ~~3.1.8 Special tests (if any), and~~
  - ~~3.1.9 Other requirements (if applicable). Terminology~~
- 3.1 Definitions of Terms Specific to This Standard:
- 3.1.1 lot, n—the total number of mill products produced from the same melt heat under the same conditions at essentially the same time.

### 4. ~~Materials and Manufacture~~

#### 4.1 Ordering Information

- 4.1 Inquiries and orders for material under this specification shall include the following information:
- 4.1.1 Quantity (weight or number of pieces),
  - 4.1.2 ASTM designation, grade, and date of issue,
  - 4.1.3 Form (wire or strip),
  - 4.1.4 Applicable dimensions, including size, thickness, width, and length (exact, random, multiples) and tolerances where critical, and drawing number,
  - 4.1.5 Condition,
  - 4.1.6 Finish,
  - 4.1.7 Mechanical properties, if applicable, for special conditions,
  - 4.1.8 Special tests (if any), and
  - 4.1.9 Other requirements (if applicable).

### 5. ~~Materials and Manufacture~~

5.1 Condition—Wire and strip shall be furnished to the purchaser in the annealed, cold worked, or cold worked and aged condition.

4.2

#### 5.2 Finish:

- 45.2.1 Types of finish available for wire are bright-annealed, pickled, cold-drawn, ground, ground and polished, or as specified in the purchase order.
- 45.2.2 Types of finish available for strip are bright-annealed, pickled, cold-rolled, polished, or as specified in the purchase order.

### 5.6. ~~Chemical Requirements~~

5.1.1~~5.6.1~~ The heat analysis shall conform to the chemical requirements of Grade 1 or 2 as specified in Table 1. The supplier shall not ship material that is outside the limits specified in Table 1 for the applicable grade.

56.1.1 Requirements for the major and minor elemental constituents for Grade 1 and 2 of this alloy are listed in Table 1. Also listed are important residual elements. Analysis for elements not listed in Table 1 is not required to verify compliance with this specification.

5.2

6.2 Product Analysis The product analysis is either for the purpose of verifying the composition of a heat or lot or to determine variations in the composition within a heat.

56.2.1 Acceptance or rejection of a heat or lot of material may be made by the purchaser on the basis of this product analysis.

56.2.2 Product analysis tolerances do not broaden the specified heat analysis requirements, but cover variations between laboratories in the measurement of chemical content. The manufacturer shall not ship material that is outside the limits specified in Table 1. Product analysis limits shall be specified in Table 2.

56.3 Methods and practices relating to chemical analysis required by this specification shall be in accordance with Test Methods, Practices, and Terminology A 751.

**TABLE 1 Chemical Requirements, Heat Analysis**

Element	Composition, (% mass/mass)			
	Grade 1 (UNS R30003)		Grade 2 (UNS R30008)	
	min	max	min	max
Carbon	...	0.15	...	0.15
Manganese	1.5	2.5	1.0	2.0
Silicon	...	1.20	...	1.20
Phosphorus	...	0.015	...	0.015
Sulfur	...	0.015	...	0.015
Cobalt	39.0	41.0	39.0	42.0
Chromium	19.0	21.0	18.5	21.5
Nickel	14.0	16.0	15.0	18.0
Molybdenum	6.0	8.0	6.5	7.5
Beryllium	...	0.10	...	0.001
Iron <sup>A</sup>	balance	balance	balance	balance
Iron <sup>A</sup>	Balance	Balance	Balance	Balance

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

**TABLE 2 Product Analysis Tolerances<sup>A</sup>**

Element	Tolerances over the max (upper limit) or under the min (lower limit), % mass/mass	
	Grade 1 (UNS R30003)	Grade 2 (UNS R30008)
	Carbon	
Carbon	0.01	0.01
Manganese		0.04
Manganese	0.04	0.04
Silicon		0.10
Silicon	0.10	0.10
Phosphorus		0.005
Phosphorus	0.005	0.005
Sulfur		0.003
Sulfur	0.003	0.003
Cobalt		0.50
Cobalt	0.50	0.50
Chromium		0.25
Chromium	0.25	0.25
Nickel		0.20
Nickel	0.20	0.20
Molybdenum		0.15
Molybdenum	0.15	0.15
Beryllium, <sup>B</sup>	max 0.10001	max 0.00001
Beryllium, <sup>B</sup>	0.010	0.0001

<sup>A</sup> Refer to AMS 2269.

<sup>B</sup> Based on beryllium analysis by flame atomic absorption with a detection limit of 0.0000001 % (1 ppb).

## 6.

### 7. Mechanical Requirements

#### 6.1

##### 7.1 Tensile Properties:

6.1.1 Tensile properties shall be determined in accordance with Test Methods E 8.

6.1.2 The mechanical properties of test specimens shall conform to the appropriate mechanical requirements specified in

7.1.1 Perform tension tests per Test Methods E 8. Should any of the test specimens not meet the specified requirements, test two additional test pieces representative of the same lot, 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.

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. Refer to subsections 7.11.4 and 7.11.5 of Test Methods E 8. If the elongation is less than the minimum requirement, discard the test and retest. Retest one specimen for each specimen that did not meet the minimum requirement.

7.1.3 The mechanical properties of test specimens shall conform to the appropriate mechanical requirements specified in Table 3, Table 4, Table 5, Table 6, or Table 7.

#### 6.2

**TABLE 3 Mechanical Requirements, Cold Worked Wire**

Diameter—inch ( mm (in.))	Ultimate Tensile Strength, min,—psi ( MPa (psi))
0.001 to 0.005, incl 0.02 to 0.12, incl (0.02 to 0.12) (0.001 to 0.005)	260 000 (1795) 1795 (260 000)
Over 0.005 to 0.040, incl Over 0.12 to 1.00, incl (0.12 to 1.00) (0.005 to 0.040)	240 000 (1655) 1655 (240 000)
Over 0.040 to 0.060, incl Over 1.0 to 1.50, incl (1.00 to 1.50) (0.040 to 0.060)	235 000 (1620) 1620 (235 000)
Over 0.060 to 0.100, incl Over 1.50 to 2.50, incl (1.50 to 2.50) (0.060 to 0.100)	225 000 (1550) 1550 (225 000)
Over 0.100 to 0.140, incl Over 2.5 to 3.50, incl (2.50 to 3.50) (0.100 to 0.140)	220 000 (1515) 1515 (220 000)

**TABLE 4 Mechanical Requirements, Cold Worked and Aged<sup>A</sup> Wire**

Diameter—inch ( mm (in.))	Ultimate Tensile Strength, min,—psi ( MPa (psi))	Yield Strength (0.2 % offset), min,—psi ( MPa (psi))
0.001 to 0.005, incl 0.02 to 0.12, incl (0.02 to 0.12) (0.001 to 0.005)	330 000 (2275) 2275 (330 000)	... ... ...
Over 0.005 to 0.040, incl Over 0.12 to 1.00, incl (0.12 to 1.00) (0.005 to 0.040)	290 000 (2000) 2000 (290 000)	210 000 (1450) 1450 (210 000)
Over 0.040 to 0.060, incl Over 1.00 to 1.50, incl (1.00 to 1.50) (0.040 to 0.060)	285 000 (1965) 1965 (285 000)	200 000 (1380) 1380 (200 000)
Over 0.060 to 0.080, incl Over 1.50 to 2.00, incl (1.50 to 2.00) (0.060 to 0.080)	275 000 (1895) 1895 (275 000)	200 000 (1380) 1380 (200 000)
Over 0.080 to 0.100, incl Over 2.00 to 2.50, incl (2.00 to 2.50) (0.080 to 0.100)	275 000 (1895) 1895 (275 000)	195 000 (1345) 1345 (195 000)
Over 0.100 to 0.120, incl Over 2.50 to 3.00, incl (2.50 to 3.00) (0.100 to 0.120)	270 000 (1860) 1860 (270 000)	185 000 (1275) 1275 (185 000)
Over 0.120 to 0.140, incl Over 3.00 to 3.50, incl (3.00 to 3.50) (0.120 to 0.140)	270 000 (1860) 1860 (270 000)	180 000 (1240) 1240 (180 000)

<sup>A</sup> Thermally aged, for example, by heating to a temperature within the range 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.

## 7.2 Hardness:

67.2.1 When desired, hardness properties may be specified. Test Methods E 18 or E 92 or E 92 and Tables E 140 shall be used. Hardness determination of cold worked or cold worked and aged material shall be made on a product cross section, midway between the center and surface, if the cross section size is adequate.

67.2.2 Hardness values are for information only and shall not be used as a basis for rejection.

## 7.8. Special Tests and Requirements

### 7.8.1 Microstructure:

7.8.1.1 The materials shall have a homogeneous microstructure as observed at 100× magnification.