



Designation: **F1058—08 F1058 – 16**

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

This standard is issued under the fixed designation F1058; 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.

## 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~~ wire, strip and stripbar used for the manufacture of surgical implants.

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

## 2. Referenced Documents

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

[A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products](#)

[E8E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

[E18 Test Methods for Rockwell Hardness of Metallic Materials](#)

[E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)

[E45 Test Methods for Determining the Inclusion Content of Steel](#)

[E92 Test Methods for Vickers Hardness and Knoop Hardness of Metallic Materials](#)

[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](#)

[E354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys](#)

[IEEE/ASTM SI 10 American National Standard for Metric Practice](#)

### 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 Standards:

[ASQ C1 Specification of General Requirements for a Quality Program<sup>4</sup>](#)

<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.

Current edition approved May 1, 2008 Nov. 1, 2016. Published June 2008 January 2017. Originally approved in 1991. Last previous edition approved in 2002 2008 as F1058—02-F1058 – 08. DOI: 10.1520/F1058-08-10.1520/F1058-16.

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

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

### 2.3 ISO Standards:<sup>4</sup>

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

[ISO 6892:6892-1 Metallic Materials—Tensile Testing materials—Tensile testing—Part 1: Method of test at room temperature](#)

[ISO 9001 Quality Management Systems—Requirements](#)

### 2.4 Society of Automotive Engineers:<sup>5</sup>

[SAE J1086 Practice for Numbering Metals and Alloys \(UNS\)](#)

## 3. Terminology

### 3.1 Definitions of Terms Specific to This Standard:

3.1.1 *bar, n*—round bars and flats from 4.75 to 101.60 mm [0.1875 to 4.00 in.] in diameter or thickness (other shapes by special order).

3.1.2 *fine wire, n*—wire as described in 3.1.5, less than 1.60 mm [0.063 in.] in diameter or thickness.

3.1.3 *lot, n*—the total number of mill products produced from the same melt heat under the same conditions at essentially the same time.

3.1.4 *strip, n*—any product under 4.76 mm [0.188 in.] in thickness and under 610 mm [24 in.] wide.

3.1.5 *wire, n*—rounds, flats or other shapes less than 4.76 mm [0.1875 in.] in diameter or thickness.

## 4. 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~~);

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~~);

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. Bars shall be furnished to the purchaser in the cold worked or cold worked and aged condition.

### 5.2 Finish:

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

5.2.2 Types of finish available for strip are bright-annealed, pickled, cold-rolled, polished, or as specified in the purchase order.

5.2.3 Types of finish available for bar are cold-drawn, cold-drawn and aged, ground, ground and polished, or as specified in the purchase order.

## 6. Chemical Requirements

6.1 Chemical analysis shall be in accordance with Test Methods [E354](#) and [A751](#).

6.2 The 40cobalt-20chromium-16iron-15nickel-7molybdenum alloy 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.

6.2.1 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 but is allowed to verify compliance with this specification.

6.2.2 All commercial metals contain small amounts of elements other than those which are specified. It is neither practical nor necessary to specify limits for unspecified elements, whether residual elements or trace elements, that can be present. The producer is permitted to analyze for unspecified elements and is permitted to report such analyses. The presence of an unspecified element and the reporting of an analysis for that element shall not be a basis for rejection.

<sup>4</sup> Available from American Society for Quality (ASQ), 600 N. Plankinton Ave., Milwaukee, WI 53203, <http://www.asq.org>.

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

<sup>5</sup> Available from SAE International (SAE), 400 Commonwealth Dr., Warrendale, PA 15096, <http://www.sae.org>.

**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	...	0.010	...	0.004
Beryllium	...	0.001 <sup>B</sup>	...	0.001
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.

<sup>B</sup> Denotes more restrictive limit than UNS.

6.3 *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.

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

6.3.2 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 as specified in Table 2.

**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	0.01
Manganese	0.04	0.04
Silicon	0.10	0.10
Phosphorous	0.005	0.005
Sulfur	0.003	0.003
Cobalt	0.50	0.50
Chromium	0.25	0.25
Nickel	0.20	0.20
Molybdenum	0.15	0.15
Beryllium, <sup>B</sup>	0.010	0.004
Beryllium, <sup>B</sup>	0.0001	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).

~~6.3 Methods and practices relating to chemical analysis required by this specification shall be in accordance with Test Methods, Practices, and Terminology A751.~~

## 7. Mechanical Requirements

### 7.1 Tensile Properties:

7.1.1 ~~Perform tension tests per~~ Tension properties shall be determined in accordance with Test Methods **E8E8/E8M**. ~~Perform at least one tension test from each lot.~~ 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 **E8E8/E8M**. 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, Table 7 or, Table 78**, or as specified on the purchase order

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

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

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

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

<sup>A</sup> Thermally aged, for example, by heating to a temperature within the range 480 to 540°C (900[900 to 1000°F]; 1000°F), holding at the selected temperature within ±15°C (±25°F) [±25°F] for 5 to 5½ h, and cooling in air to room temperature.

## 7.2 Hardness:

7.2.1 When desired, hardness properties may be specified. Test Methods E18 or E92 and Tables E140 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.

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

## 8. Dimensions and Permissible Variations

### 8.1 Units of Measure:

8.1.1 Selection—This specification requires that the purchaser select the units (SI or inch-pound) to be used for product clarification. In the absence of a stated selection of units on the purchase order, this selection may be expressed by the purchaser in several alternate forms listed in order of precedence.

8.1.1.1 If the purchaser and supplier have a history of using specific units, these units shall continue to be certified until expressly changed by the purchaser.

8.1.1.2 In the absence of historic precedence, if the units used to define the product on the purchaser's purchase order (PO), specification, and engineering drawing are consistent, these units shall be used by the supplier for product certification.

8.1.1.3 If the purchaser's selection of units is unclear, the units of measure shall be agreed upon between the purchaser and supplier.