



Designation: F1586 – 08

# Standard Specification for Wrought Nitrogen Strengthened 21Chromium—10Nickel— 3Manganese—2.5Molybdenum Stainless Steel Alloy Bar for Surgical Implants (UNS S31675)<sup>1</sup>

This standard is issued under the fixed designation F1586; 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 wrought nitrogen strengthened 21chromium—10nickel—3manganese—2.5molybdenum stainless steel alloy bar for surgical implants.

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.

## 2. Referenced Documents

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

A262 Practices for Detecting Susceptibility to Intergranular Attack in Austenitic Stainless Steels

A484/A484M Specification for General Requirements for Stainless Steel Bars, Billets, and Forgings

A751 Test Methods, Practices, and Terminology for Chemical Analysis of Steel Products

E8 Test Methods for Tension Testing of Metallic Materials

E10 Test Method for Brinell Hardness 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

E112 Test Methods for Determining Average Grain Size

F138 Specification for Wrought 18Chromium-14Nickel-2.5Molybdenum Stainless Steel Bar and Wire for Surgical Implants (UNS S31673)

F746 Test Method for Pitting or Crevice Corrosion of

Metallic Surgical Implant Materials

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

AMS 2248 Chemical Check Analysis Limits, Corrosion and Heat Resistant Steels and Alloys, Maraging and Other Highly-Alloyed Steels, and Iron Alloys

2.3 *ASQC Standard*:<sup>4</sup>

ASQ C1 Specification of General Requirements for a Quality Program

2.4 *ISO Standard*:<sup>5</sup>

ISO 6892 Metallic Materials Tensile Testing at Ambient Temperature

ISO 9001 Quality Management System—Requirements

## 3. 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. General Requirements for Delivery

4.1 In addition to the requirements of this specification, all requirements of the current edition of Specification A484/A484M shall apply.

4.2 In cases in which a conflict exists between this specification and the standards listed in Section 2, this specification shall take precedence.

## 5. Ordering Information

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

5.1.1 Quantity,

5.1.2 ASTM designation and date of issue,

5.1.3 Mechanical properties (if applicable, for special conditions),

<sup>1</sup> This specification is under the jurisdiction of ASTM Committee F04 on Medical and Surgical Materials and Devices and is under 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, 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.

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

<sup>5</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

- 5.1.4 Form,
- 5.1.5 Applicable dimensions including size, thickness, width, and length (exact, random, or multiples) or drawing number,
- 5.1.6 Condition (see 6.1),
- 5.1.7 Finish (see 6.2),
- 5.1.8 Special tests (if any), and
- 5.1.9 Other requirements.

**6. Materials and Manufacture**

6.1 *Condition*—Bars shall be furnished in the annealed, medium hard, or hard condition, as specified.

6.2 *Finish*—Types of bar finishes available are cold-drawn, pickled, ground, ground and polished, or as specified by the purchaser.

**7. Chemical Requirements**

7.1 The supplier’s heat analysis shall conform to the chemical requirements prescribed in Table 1. The supplier shall not ship material that is outside the limits specified in Table 1.

7.1.1 Requirements for the major and minor elemental constituents 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.

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

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

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

7.2.2 Product analysis tolerances do not broaden the specified heat analysis requirements but cover variations between laboratories in the measurement of chemical content. Product analysis limits shall be as specified in Table 2.

**8. Metallurgical Requirements**

8.1 The material shall exhibit no delta ferrite, chi, or sigma phases when it is examined metallographically at 100x magnification.

**TABLE 1 Chemical Requirements**

Element	Composition, % (Mass/Mass)
Carbon	0.08 max
Manganese	2.00 to 4.25
Phosphorus	0.025 max
Sulfur	0.01 max
Silicon	0.75 max
Chromium	19.5 to 22.0
Nickel	9.0 to 11.0
Molybdenum	2.0 to 3.0
Nitrogen	0.25 to 0.50
Niobium	0.25 to 0.80
Copper	0.25 max
Iron	balance <sup>A</sup>

<sup>A</sup> The percentage of iron is determined by difference and need not be determined or certified.

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

Element	Tolerance Under the Minimum or Over the Maximum Limit <sup>B</sup>
Carbon	0.01
Manganese	0.05
Phosphorus	0.005
Sulfur	0.005
Silicon	0.05
Chromium	0.25
Nickel	0.15
Molybdenum	0.10
Nitrogen <sup>C</sup>	0.02 under minimum; 0.04 over maximum
Niobium	0.05
Copper	0.03

<sup>A</sup> Refer to AMS 2248 for chemical check analysis limits (except nitrogen).  
<sup>B</sup> For elements in which only a maximum percentage is indicated, the “under minimum limit” is not applicable.  
<sup>C</sup> The specified range for this element is not covered by AMS 2248 and permissible variation has been established through industrial practice.

8.2 The microcleanliness of the steel, as determined by Test Methods E45, Method A, except using Plate Ir, on representative billet or bar samples from the heat shall not exceed the following:

Inclusion Type	A (Sulfide)	B (Alumina)	C (Silicate)	D (Globular Oxide)
Thin	1.5	2.0	2.0	2.5
Heavy	1.5	1.5	1.5	1.5

**9. Mechanical Requirements**

9.1 *Tensile Properties:*

9.1.1 Tensile properties shall be determined in accordance with Test Methods E8.

9.1.2 The mechanical properties of test specimens shall conform to the requirements specified in Table 3.

9.2 *Hardness:*

9.2.1 Hardness values shall be determined in accordance with Test Method E10 or Test Methods E18.

**TABLE 3 Mechanical Properties**

Condition	Diameter or Thickness, in. (mm)	Ultimate Tensile Strength, min, psi (MPa)	Yield Strength (0.2 % Offset), min, psi (MPa)	Elongation <sup>A</sup> in 4D, min, %
Annealed	all	107 000 (740)	62 400 (430)	35
Medium hard <sup>B</sup>	1/16 to 3/4 (1.59 to 19.1) <sup>C</sup>	145 000 (1000)	102 000 (700)	20
Hard <sup>B</sup>	1/16 to 3/4 (1.59 to 19.1) <sup>C</sup>	160 000 (1100)	145 000 (1000)	10

<sup>A</sup> Elongation of material 0.063 in. (1.6 mm) or greater in diameter (D) or thickness shall be measured using a gage length of 2 in. or 4D or 4W (W = width). The gage length must be reported with the test results. The method for determining elongation of material under 0.063 in. (1.6 mm) in diameter or width may be negotiated. Alternatively, a gage length corresponding to ISO 6892 may be used when agreed upon between supplier and purchaser. (5.65 times the square root of So, where So is the original cross sectional area.)  
<sup>B</sup> The word “hard” is used to express strength relative to annealed material and is not intended to specify a hardness value.  
<sup>C</sup> Other sizes may be furnished by agreement between the supplier and the purchaser.