Designation: B581 – 17

Standard Specification for Nickel-Chromium-Iron-Molybdenum-Copper Alloy Rod[1]

This standard is issued under the fixed designation B581; 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 (ε) indicates an editorial change since the last revision or reapproval.

1. Scope*

1.1 This specification[2] covers rod of Ni-Cr-Fe-Mo-Cu alloys (UNS N06007, N06975, N06985, N06030, N08031, and N08034)[3] as shown in Tables 1-3, for use in general corrosive service.

1.2 The following products are covered under this specification:

1.2.1 Rods 5⁄16 to 3⁄4 in. (7.94 to 19.05 mm) excl in diameter, hot- or cold-finished, solution annealed and pickled or mechanically descaled.

1.2.2 Rods 3⁄4 to 3½ in. (19.05 to 88.9 mm) incl in diameter, hot- or cold-finished, solution annealed, ground or turned.

1.3 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.

1.4 *This standard does not purport to address all of the safety concerns, if any, associated with its use. It is the responsibility of the user of this standard to become familiar with all hazards including those identified in the appropriate Safety Data Sheet (SDS) for this product/material as provided by the manufacturer, to establish appropriate safety, health and environmental practices, and determine the applicability of regulatory limitations prior to use.*

1.5 *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:*[4]

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

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition

E1473 Test Methods for Chemical Analysis of Nickel, Cobalt and High-Temperature Alloys

3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *rod, n*—material of round solid section furnished in straight lengths.

4. Ordering Information

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

4.1.1 *Alloy*—Table 1.

4.1.2 *Dimensions*—Nominal diameter and length. The shortest useable multiple length shall be specified (Table 4).

4.1.3 *Certification*—State if certification or a report of test results is required (Section 16).

4.1.4 *Purchaser Inspection*—State which tests or inspections are to be witnessed (Section 14).

4.1.5 *Samples for Product (Check) Analysis*—State whether samples shall be furnished (10.2.2).

5. Chemical Composition

5.1 *Heat Analysis*—The material shall conform to the composition limits specified in Table 1.

5.2 *Product (Check) Analysis*—If a product (check) analysis is made by the purchaser, the material shall conform to the

[1] This specification is under the jurisdiction of ASTM Committee B02 on Nonferrous Metals and Alloys and is the direct responsibility of Subcommittee B02.07 on Refined Nickel and Cobalt and Their Alloys.

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[2] For ASME Boiler and Pressure Vessel Code applications see related Specification SB-581 in Section II of that Code.

[3] New designation established in accordance with ASTM E527 and SAE J1086, Practice for Numbering Metals and Alloys (UNS).

[4] 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.

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

TABLE 1 Chemical Requirements

Element	Composition Limits, %					
	Alloy N06007	Alloy N06975	Alloy N06985	Alloy N06030	Alloy N08031	Alloy N08034
Nickel	remainder[A]	47.0–52.0	remainder[A]	remainder[A]	30.0-32.0	33.5-35.0
Chromium	21.0–23.5	23.0–26.0	21.0–23.5	28.0–31.5	26.0-28.0	26.0-27.0
Iron	18.0–21.0	remainder[A]	18.0–21.0	13.0–17.0	remainder[A]	remainder[A]
Molybdenum	5.5–7.5	5.0–7.0	6.0–8.0	4.0–6.0	6.0-7.0	6.0-7.0
Copper	1.5–2.5	0.70–1.20	1.5–2.5	1.0–2.4	1.0-1.4	0.5-1.5
Manganese	1.0–2.0	1.0 max	1.0 max	1.5 max	2.0 max	1.0-4.0
Cobalt, max	2.5	...	5.0 max	5.0 max	...	...
Carbon, max	0.05	0.03	0.015 max	0.03 max	0.015	0.01
Tungsten	1.0 max	...	1.5 max	1.5–4.0	...	...
Silicon, max	1.0	1.0	1.0 max	0.8 max	0.3	0.1
Phosphorus, max	0.04	0.03	0.04 max	0.04 max	0.020	0.020
Sulfur, max	0.03	0.03	0.03 max	0.02 max	0.010	0.010
Columbium + tantalum	1.75–2.50	...	0.50 max	0.30–1.50	...	...
Titanium	...	0.7–1.5	...	...	...	...
Nitrogen	0.15-0.25	...	...	...	...	0.10-0.25
Aluminum						0.3

[A] See 13.1.1.

TABLE 2 Mechanical Property Requirements

Alloy	Specified Diameter, in. (mm)	Tensile Strength min, psi (MPa)	Yield Strength (0.2 % Offset), min, psi (MPa)	Elongation in 2 in. or 50.8 mm or 4*D* [A] min
N06007	5/16 to 3/4 (7.94 to 19.05), incl	90 000 (621)	35 000 (241)	35
	Over 3/4 to 3 1/2 (19.05 to 88.9), incl	85 000 (586)	30 000 (207)	30
N06975	5/16 to 3 1/2 (7.94 to 88.9), incl	85 000 (586)	32 000 (221)	40
N06985	5/16 to 3/4 (7.9 to 19.05), incl	90 000 (621)	35 000 (241)	45
	Over 3/4 to 3 1/2 (19.05 to 88.9), incl	85 000 (586)	30 000 (207)	35
N06030	...	85 000 (586)	35 000 (241)	30
N08031	All sizes	94 000 (648)	40 000 (276)	40
N08034	All sizes	94 000 (650)	40 000 (280)	40

[A] *D* refers to the diameter of the tension specimen.

TABLE 3 Permissible Variations in Diameter and Out-of-Roundness of Rods

Specified Diameter, in. (mm)	Permissible Variations, in. (mm)		
	Diameter		Out-of-Roundness, max
	+	–	
Hot-Finished, Annealed, and Descaled Rods			
5/16 to 7/16 (7.94 to 11.11), incl	0.012 (0.305)	0.012 (0.305)	0.018 (0.457)
Over 7/16 to 5/8 (11.11 to 15.87), incl	0.014 (0.355)	0.014 (0.355)	0.020 (0.508)
Over 5/8 to 3/4 (15.87 to 19.05), excl	0.016 (0.406)	0.016 (0.406)	0.024 (0.610)
Hot-Finished, Annealed, and Ground or Turned Rods			
3/4 to 3 1/2 (19.05 to 88.9), incl	0.010 (0.254)	0	0.008 (0.203)

requirements specified in Table 1 subject to the permissible tolerances in Specification B880.

6. Mechanical and Other Requirements

6.1 The material shall conform to the requirements of Table 2.

7. Straightness

7.1 The maximum curvature (depth of cord) shall not exceed 0.050 in. multiplied by the length in feet (0.04 mm multiplied by the length in centimetres).

8. Permissible Variations in Dimensions

8.1 *Diameter*—The permissible variations from the specified diameter and out-of-roundness shall be as prescribed in Table 3.

TABLE 4 Permissible Variations in Length of Rods

Random mill lengths	2 to 12 ft (61 to 366 cm) long with not more than 25 weight % under 4 ft (122 cm).
Multiple lengths	Furnished in multiples of a specified unit length, within the length limits indicated above. For each multiple, an allowance of 1/4 in. (6.35 mm) will be made for cutting, unless otherwise specified. At the manufacturer's option, individual specified unit lengths may be furnished.
Nominal lengths	Specified nominal lengths having a range of not less than 2 ft (61 cm) with no short lengths allowed.
Cut lengths	A specified length to which all rods will be cut with a permissible variation of + 1/8 in. (3.17 mm), – 0.

8.2 *Machining Allowances*—When the surfaces of finished material are to be machined, the following allowances are suggested for normal machining operations:

8.2.1 *As-Finished Rounds (Annealed and Descaled)*—For diameters of 5⁄16 to 1 1⁄16 in. (7.94 to 17.46 mm) incl, an allowance of 1⁄16 in. (1.59 mm) on the diameter should be made for finish machining.

8.3 *Length*—The permissible variations in length of finished rods shall be as prescribed in Table 4. Unless otherwise specified, random mill lengths shall be furnished. Rods ordered to random or nominal lengths shall be furnished with either cropped or saw-cut ends; material ordered to cut lengths shall be furnished with square saw-cut or machined ends. Where rods are ordered in multiple lengths, a ¼-in. (6.35-mm) length addition shall be allowed for each uncut multiple length.

8.4 *Weight*—For calculation of mass or weight, the following densities shall be used:

	Density	
Alloy	lb/in.^{3}	g/cm^3
N06007	0.300	8.31
N06975	0.295	8.17
N06985	0.300	8.31
N06030	0.297	8.22
N08031	0.293	8.10
N08034	0.293	8.10

9. Workmanship, Finish, and Appearance

9.1 The material shall be uniform in quality and condition, smooth, commercially straight, and free of injurious imperfections.

10. Sampling

10.1 *Lots for Chemical Analysis and Mechanical Testing:*

10.1.1 A lot for chemical analysis shall consist of one heat.

10.1.2 A lot of rod for mechanical testing shall be defined as the material from one heat in the same condition and specified thickness.

10.2 *Sampling for Chemical Analysis:*

10.2.1 A representative sample shall be obtained from each lot during pouring or subsequent processing.

10.2.2 Product (check) analysis shall be wholly the responsibility of the purchaser and shall conform to the product (check) analysis variations per Specification B880.

10.3 *Sampling for Mechanical Testing:*

10.3.1 A representative sample shall be taken from each lot of finished material.

11. Number of Tests and Retests

11.1 *Chemical Analysis*—One test per lot.

11.2 *Tension Tests*—One test per lot.

11.3 *Retests*—If the specimen used in the mechanical test of any lot fails to meet the specified requirements, two additional specimens shall be taken from different sample pieces and tested. The results of the tests on both of these specimens shall meet the specified requirements.

12. Specimen Preparation

12.1 Tension test specimens shall be taken from material after final heat treatment and tested in the direction of fabrication.

12.2 Tension test specimens shall be any of the standard or subsized specimens shown in Test Methods E8.

12.3 In the event of disagreement, the referee specimen shall be the largest possible round specimen shown in Test Methods E8.

13. Test Methods and Chemical Analysis

13.1 The chemical composition and mechanical properties of the material as enumerated in this specification shall be determined, in case of disagreement, in accordance with the following ASTM methods:

13.1.1 *Chemical Analysis*—Test Methods E1473. For elements not covered by Test Methods E1473, the referee method shall be as agreed upon between the manufacturer and purchaser. The composition of the remainder element shall be determined arithmetically by difference.

13.1.2 *Tension Test*—Test Methods E8.

13.1.3 *Method of Sampling*—Practice E55.

13.1.4 *Determining Significant Places*—Practice E29.

13.2 For purposes of determining compliance with the limits in this specification, an observed value or a calculated value shall be rounded in accordance with the rounding method of Practice E29:

Requirements	Rounded Unit for Observed or Calculated Value
Chemical composition and tolerances	nearest unit in the last right-hand place of figures of the specified limit
Tensile strength and yield strength	nearest 1000 psi (7 MPa)
Elongation	nearest 1 %

14. Inspection

14.1 Inspection of the material shall be made as agreed upon by the manufacturer and the purchaser as part of the purchase contract.

15. Rejection and Rehearing

15.1 Material that fails to conform to the requirements of this specification may be rejected. Rejection should be reported to the producer or supplier promptly and in writing. In case of dissatisfaction with the results of the test, the producer or supplier may make claim for a rehearing.

16. Certification

16.1 When specified in the purchase order or contract, a manufacturer's certification shall be furnished to the purchaser stating that material has been manufactured, tested, and inspected in accordance with this specification, and that the test results on representative samples meet specification requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

17. Product Marking

17.1 Each piece of material ½ in. (12.7 mm) and over in diameter shall be marked with this specification number, name of the material, and size of the product.

17.2 Each bundle or shipping container shall be marked with the name of the material; this specification number; alloy; the size; gross, tare and net weight; consignor and consignee address; contract or other number; or such other information as may be defined in the contract or order.

18. Keywords

18.1 rod; N06007; N06975; N06985; N06030; N08031; N08034

APPENDIX

(Nonmandatory Information)

X1. HEAT TREATMENT

X1.1 Proper heat treatment during or subsequent to fabrication is necessary for optimum performance and the manufacturer shall be consulted for details.

SUMMARY OF CHANGES

Committee B04 has identified the location of selected changes to this standard since the last issue (B851-02(2013)$^{\varepsilon 1}$) that may impact the use of this standard. (Approved July 1, 2017.)

(1) Added new alloy UNS N08034 to scope (Section 1.)
(2) Added chemistry data for UNS N08034 to Table 1.
(3) Added Mechanical property data to Table 2 for UNS N08034.
(4) Added density data for UNS N08034 in section 8.4.
(5) Added UNS N08034 in Keywords in Section 18.