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# Standard Specification for Nickel-Molybdenum Alloy Rod<sup>1</sup>

This standard is issued under the fixed designation B335; 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.

*This standard has been approved for use by agencies of the Department of Defense.*

## 1. Scope

1.1 This specification<sup>2</sup> covers rod of nickel-molybdenum alloys (UNS N10001, N10665, N10675, N10629, and N10624)\* as shown in Table 1, 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 3 1/2 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 Material Safety Data Sheet (MSDS) for this product/material as provided by the manufacturer; to establish appropriate safety and health practices, and determine the applicability of regulatory limitations prior to use.*

## 2. Referenced Documents

2.1 *ASTM Standards:*<sup>3</sup>

**B880** Specification for General Requirements for Chemical

TABLE 1 Chemical Requirements

Element	Composition Limits, %				
	Alloy N10001	Alloy N10665	Alloy N10675	Alloy N10629	Alloy N10624
Nickel	remainder <sup>A</sup>	remainder <sup>A</sup>	65.0 min	remainder <sup>A</sup>	Bal
Molybdenum	26.0–30.0	26.0–30.0	27.0–32.0	26.0–30.0	21.0–25.0
Iron	4.0–6.0	2.0 max	1.0–3.0	1.0–6.0	5.0–8.0
Chromium	1.0 max	1.0 max	1.0–3.0	0.5–1.5	6.0–10.0
Carbon, max	0.05	0.02	0.01	0.01	0.01
Silicon, max	1.0	0.10	0.10	0.05	0.10
Cobalt, max	2.5	1.00	3.0	2.5	1.0
Manganese, max	1.0	1.0	3.0	1.5	1.0
Phosphorus, max	0.04	0.04	0.030	0.04	0.025
Sulfur, max	0.03	0.03	0.010	0.01	0.01
Vanadium	0.2–0.4	...	0.20 max	...	...
Nickel plus Molybdenum	...	...	94.0–98.0	...	...
Aluminum	...	...	0.50 max	0.1–0.5	0.5
Columbium (Nb), max	...	...	0.20	...	...
Copper, max	...	...	0.20	0.5	0.5
Tantalum, max	...	...	0.20	...	...
Titanium, max	...	...	0.20	...	...
Tungsten, max	...	...	3.0	...	...
Zirconium, max	...	...	0.10	...	...
Magnesium, max	...	...	...	...	...

<sup>A</sup> See 12.1

[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:*

<sup>1</sup> 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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<sup>2</sup> For ASME Boiler and Pressure Vessel Code applications see related Specification SB-335 in Section II of that Code.

\* New designation established in accordance with ASTM E527 and SAE J1086, Recommended Practice for Numbering Metals and Alloys (UNS).

<sup>3</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.

**TABLE 2 Permissible Variations in Diameter and Out-of-Roundness of Finished Rods**

Specified Diameter, in. (mm)	Permissible Variations, in. (mm)		
	Diameter		Out of Roundness, max
	Plus	Minus	
Hot-Finished, Annealed, and Descaled Rods			
5/16 to 7/16 (7.94–11.11), incl	0.012 (0.30)	0.012 (0.30)	0.018 (0.46)
Over 7/16 to 5/8 (11.11–15.87), incl	0.014 (0.36)	0.014 (0.36)	0.020 (0.51)
Over 5/8 to 3/4 (15.87–19.05), excl	0.016 (0.41)	0.016 (0.41)	0.024 (0.61)
Hot-Finished, Annealed, and Ground or Turned Rods			
3/4 to 3 1/2 (19.05–88.9), incl	0.010 (0.25)	0	0.008 (0.20)

**TABLE 3 Mechanical Properties**

Alloy	Thickness, in. (mm)	Tensile Strength, min, psi (MPa)	Yield Strength (0.2 % Offset), min, psi (MPa)	Elongation in 2 in. (50 mm) or 4D <sup>A</sup> , min %	Rockwell Hardness, max
N10001	5/16 to 1 1/2 (7.94 to 38.1) incl	115 000 (795)	46 000 (315)	35	
	Over 1 1/2 to 3 1/2 (38.1 to 88.9) incl	100 000 (690)	46 000 (315)	30	
N10665	5/16 to 3 1/2 (7.94 to 88.9) incl	110 000 (760)	51 000 (350)	40	
N10675	5/16 to 3 1/2 (7.94 to 88.9) incl	110 000 (760)	51 000 (350)	40	
N10629	5/16 to 3 1/2 (7.94 to 88.9) incl	110 000 (760)	51 000 (350)	40	100 HRB
N10624	5/16 to 3 1/2 in. (7.94 to 88.9 mm), incl	104 000 (720)	46 000 (320)	40	100 HRB

<sup>A</sup> D refers to the diameter of the tension specimen.

3.1.1 *rod, n*—a product 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 usable multiple length shall be specified (Table 2).

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 13).

4.1.5 *Samples for Product (Check) Analysis*—State whether samples should be furnished (9.2.2).

#### 5. Chemical Composition

5.1 The material shall conform to the composition limits specified in Table 1.

5.2 If a product (check) analysis is made by the purchaser, the material shall conform to the requirements specified in Table 1 subject to the permissible tolerances in B880.

#### 6. Mechanical Properties and Other Requirements

6.1 The mechanical properties of the material at room temperature shall conform to those shown in Table 3.

#### 7. Dimensions and Permissible Variations

7.1 *Diameter*—The permissible variations from the specified diameter shall be as prescribed in Table 2.

7.2 *Out of Roundness*—The permissible variation in roundness shall be as prescribed in Table 2.

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

7.3.1 *As-finished (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.

7.4 *Length*:

7.4.1 Unless multiple, nominal, or cut lengths are specified, random mill lengths shall be furnished.

7.4.2 The permissible variations in length of multiple, nominal, or cut length rod shall be as prescribed in Table 4. Where rods are ordered in multiple lengths, a 1/4-in. (6.35-mm) length addition shall be allowed for each uncut multiple length.

7.5 *Ends*:

7.5.1 Rods ordered to random or nominal lengths shall be furnished with either cropped or sawed ends.

7.5.2 Rods ordered to cut lengths shall be furnished with square saw-cut or machined ends.

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

Alloy	Density	
	lb/in <sup>3</sup>	g/cm <sup>3</sup>
N10001	0.334	9.24
N10665	0.333	9.22
N10675	0.333	9.22
N10629	0.333	9.22
N10624	0.322	8.9

**TABLE 4 Permissible Variations in Length of Rods**

Random mill lengths	2 to 12 ft (610 to 3660 mm) long with not more than 25 weight % under 4 ft (1.22 m).
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) shall 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 (610 mm) with no short lengths allowed.
Cut lengths	A specified length to which all rods shall be cut with a permissible variation of + 1/8 in. (3.17 mm) – 0.

7.7 *Straightness*—The maximum curvature (depth of chord) shall not exceed 0.050 in. multiplied by the length of the chord in feet (0.04 mm multiplied by the length in centimetres).

## 8. Workmanship, Finish, and Appearance

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

## 9. Sampling

9.1 *Lots for Chemical Analysis and Mechanical Testing:*

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

9.1.2 A lot of bar for mechanical testing shall be defined as the material from one heat in the same condition and specified diameter.

9.2 *Sampling for Chemical Analysis:*

9.2.1 A representative sample shall be obtained from each heat during pouring or subsequent processing.

9.2.2 Product (check) analysis shall be wholly the responsibility of the purchaser.

9.3 *Sampling for Mechanical Testing:*

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

## 10. Number of Tests and Retests

10.1 *Chemical Analysis*—One test per heat.

10.2 *Tension Tests*—One test per lot.

10.3 *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.

## 11. Specimen Preparation

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

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

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

## 12. Test Methods

12.1 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:

12.1.1 *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 the

purchaser. The nickel composition shall be determined arithmetically by difference.

12.1.2 *Tension Test*—Test Methods E8.

12.1.3 *Method of Sampling*—Practice E55.

12.1.4 *Determining Significant Places*—Practice E29.

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

Requirements	Rounded Unit for Observed or Calculated Value
Chemical composition and tolerance	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 %

## 13. Inspection

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

## 14. Rejection and Rehearing

14.1 Material tested by the purchaser 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.

## 15. Certification

15.1 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.

## 16. Product Marking

16.1 Each piece of material ½ in. (12.7 mm) and over in diameter shall be marked with the specification number, alloy, heat number, manufacturer's identification, and size. The markings shall have no deleterious effect on the material or its performance and shall be sufficiently stable to withstand normal handling.

16.2 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 order number; and such other information as may be defined in the contract or order.

## 17. Keywords

17.1 rod; N10001; N10624; N10629; N10665; N10675

**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.

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