



Designation: ~~B335-98~~ Designation: **B 335 - 03 (Reapproved 2008)**

Standard Specification for Nickel-Molybdenum Alloy Rod¹

This standard is issued under the fixed designation B 335; 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.

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

1. Scope

1.1 This specification² 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 $\frac{5}{16}$ to $\frac{3}{4}$ 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 $\frac{3}{4}$ to $3\frac{1}{2}$ 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 the standard.~~

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:*³

B 880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys

E 8 Test Methods for Tension Testing of Metallic Materials

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

E 55 Practice for Sampling Wrought Nonferrous Metals and Alloys for Determination of Chemical Composition

~~E 354 Test Methods for Chemical Analysis of High-Temperature, Electrical, Magnetic, and Other Similar Iron, Nickel, and Cobalt Alloys⁶~~ 1473 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~~ *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 ~~the safe and satisfactory performance of~~ 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).

¹ This specification is under the jurisdiction of ASTM Committee B-2B02 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-335 in Section II of that Code.

* New designation established in accordance with ASTM E 527 and SAE J1086, Recommended Practice for Numbering Metals and Alloys (UNS).

³ Annual Book of ASTM Standards, Vol 02.04.

³ 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 1 Chemical Requirements

Element	Composition Limits, %				
	Alloy N10001	Alloy N10665	Alloy N10675	Alloy N10629	Alloy N10624
Nickel	remainder ^A	remainder ^A	65.0 min	remainder ^A	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	...	...	...	...	...

^A See 12.1

TABLE 3 2 Mechanical Properties Variations in Diameter and Out-of-Roundness of Finished Rods

Alloy	Tensile Strength, min, psi. (MPa)	Yield Strength (0.2% Offset), min, psi. (MPa)	Elongation		Out of Roundness, in. (mm) or 4D ^A , min %ax
			Diameter		
			Plus	Reckwell Hardness, max	
			N10001		Hot-Finished, A
5/16 to 1 1/2 (7.94 to 38.1) incl	115 000 (795)	46 000 (315)	0.012 (0.30)		35
5/16 to 7/16 (7.94–11.11), incl		0.012 (0.30)			35
Over 7/16 to 5/8 (11.11–15.87), incl	Over 1 to 3 1/2 (38.1 to 88.9) incl	100 000 (690)	0.014 (0.36)		46 000 (315) 30
N10665	to 3 1/2 (7.94 to 88.9) incl	110 000 (760)	0.014 (0.36)		0.020 (0.51) 30
Over 5/8 to 3/4 (15.87–19.05), excl 40	0.016 (0.41)	0.016 (0.41)			51 000 (350)
N10675	5/16 to 3/2 (7.94 to 88.9) incl	110 000 (760)			40
N10675	Hot-Finished, Anneal	110 000 (760)			40
N10629	5/16 to 3 1/2 (7.94 to 88.9) incl	110 000 (760)			51 000 (350)
N10629	5/16 to 3 1/2 (19.05–88.9), incl	0.010 (0.25)			0
N10624	5/16 to 3 1/2 in. (7.94 to 88.9 mm), incl	104 000 (720)			46 000 (320) 40
N10624	5/16 to 3 1/2 in. (7.94 to 88.9 mm), incl	1008 (0)			46 000 (320) 40

^AD refers to the diameter of the tension specimen.

4.1.5 *Samples for Product (Check) Analysis*—State whether samples shall/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 B 880.

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.

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 ^A , 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

^A D refers to the diameter of the tension specimen.

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	lb/in ³	Density	g/cm ³
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

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*:

TABLE 2 4 Permissible Variations in Diameter and Out-of-Roundness of Finished Rods

Specified Diameter, in. (mm)	Minus	Out-of-Roundness, max
to (7.94–11.11), incl	0.012 (0.30)	0.018 (0.46)
Random mill lengths	2 to 12 ft (610 to 3660 mm) long with not more than 25 weight % under 4 ft (0.30)	0.012 (0.30)
Over 7/16 to 5/8 (11.11–15.87), incl	0.014 (0.36)	0.014 (0.36)
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.	0.020 (0.51)
Over 5/8 to (15.87–19.05), excl	0.016 (0.41)	0.016 (0.41)
Nominal lengths	0.016 (0.41)	0.016 (0.41)
to 3 1/2 (19.05–88.9), incl	0.010 (0.25)	0.010 (0.25)
Cut lengths	A specified length to which all rods shall be cut with a permissible variation of + 1/8 in. (3.17 mm) – 0.	