



Designation: ~~B160-05~~ Designation: **B 160 – 05^{ε1}**

Standard Specification for Nickel Rod and Bar¹

This standard is issued under the fixed designation B 160; 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.

ϵ^1 NOTE—Table 2 was corrected editorially in October 2008.

1. Scope

1.1 This specification² covers nickel (UNS N02200)*, low carbon nickel (UNS N02201)*, and solution strengthened nickel (UNS N02211) in the form of hot-worked and cold-worked rod and bar in the conditions shown in Table 1.

1.2 The values stated in inch-pound units are to be regarded as the standard. The values given in parentheses are for information only.

2. Referenced Documents

2.1 *ASTM Standards*:³

B 162 Specification for Nickel Plate, Sheet, and Strip

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

E 8 Test Methods for Tension Testing of Metallic Materials

E 18 ~~Test Methods for Rockwell Hardness and Rockwell Superficial Hardness of Metallic Materials~~ Test Methods for Rockwell Hardness of Metallic Materials

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

E 140 ~~Hardness Conversion Tables for Metals~~ Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, and Scleroscope Hardness

E 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 *bar, n*—material of rectangular (flats), hexagonal, or square solid section up to and including 10 in. (254 mm) in width and 1/8 in. (3.2 mm) and over in thickness in straight lengths.

NOTE 1—Hot-worked rectangular bar in widths 10 in. (254 mm) and under may be furnished as hot-rolled plate with sheared or cut edges in accordance with Specification B 162, provided the mechanical property requirements of Specification B 160 are met.

3.1.2 *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 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 ASTM designation and year of issue.

4.1.2 UNS number.

4.1.3 *Section*—Rod (round) or bar (square, hexagonal, or rectangular).

4.1.4 *Dimensions*—Dimensions including length.

4.1.5 Condition.

4.1.6 Finish.

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.

Current edition approved May 1, 2005. Published June 2005. Originally approved in 1941. Last previous edition approved in 1999 as B 160 – 99.

² For ASME Boiler and Pressure Vessel Code applications see related Specification SB-160 in Section II of that Code.

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

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 Mechanical Properties

Condition and Diameter or Distance Between Parallel Surfaces, in. (mm)	Tensile Strength, min, psi (MPa)	Yield Strength (0.2 % offset), min. psi (MPa) ^A	Elongation in 2 in. or 50 mm or 4D, min %
Nickel (UNS N02200)			
Cold-worked (as worked):			
Rounds, 1 (25.4) and under	80 000 (550)	60 000 (415)	10 ^B
Rounds over 1 to 4 (25.4 to 101.6) incl.	75 000 (515)	50 000 (345)	15
Squares, hexagons, and rectangles, all sizes	65 000 (450)	40 000 (275)	25 ^B
Hot-worked:			
All sections, all sizes	60 000 (415)	15 000 (105)	35 ^C
Rings and disks ^D	—	—	—
Annealed:			
Rods and bars, all sizes	55 000 (380)	15 000 (105)	40 ^B
Rings and disks ^E	—	—	—
Forging quality			
All sizes	F	F	F
Low-Carbon Nickel (UNS N02201) and Solution Strengthened Nickel (UNS N02211)			
Hot-worked:			
All sections, all sizes	50 000 (345)	10 000 (70)	40 ^C
Annealed:			
All products, all sizes	50 000 (345)	10 000 (70)	40 ^B

^A See 12.2.

^B Not applicable to diameters or cross sections under 3/32 in. (2.4 mm).

^C For hot-worked flats 5/16 in. (7.9 mm) and under in thickness the elongation shall be 25%, min.

^D Hardness B45 to B80, or equivalent.

^E Hardness B45 to B70 or equivalent.

^F Forging quality is furnished to chemical requirements and surface inspection only. No tensile properties are required.

4.1.7 *Quantity*—feet or number of pieces.

4.1.8 *Certification*—State if certification or a report of test results is required (Section 15).

4.1.9 *Samples for Product (Check) Analysis*—State whether samples for product (check) analysis should be furnished.

4.1.10 *Purchaser Inspection*—If purchaser wishes to witness tests or inspection of material at place of manufacture, the purchase order must so state indicating which test or inspections are to be witnessed.

5. Chemical Composition

5.1 The material shall conform to the composition limits specified in Table 2.

5.2 If a product (check) analysis is performed by the purchaser, the material shall be done per Specification B 880 and the material shall conform to the product (check) analysis variations defined in Check Analysis Variation table of Specification B 880.

6. Mechanical and Other Requirements

6.1 *Mechanical Properties*—The material shall conform to the mechanical properties specified in Table 1.

7. Dimensions and Permissible Variations

7.1 *Diameter, Thickness, or Width*—The permissible variations from the specified dimensions as measured on the diameter or between parallel surfaces of cold-worked rod and bar shall be as prescribed in Table 3, and of hot-worked rod and bar as prescribed in Table 4.

7.2 *Out-of-Round*—Hot-worked rods and cold-worked rods (except “forging quality”), all sizes, in straight lengths, shall not be out-of-round by more than one half the total permissible variations in diameter shown in Tables 3 and 4, except for hot-worked rods 1/2 in. (12.7 mm) in diameter and under, which may be out-of-round by the total permissible variations in diameter shown in Table 4.

TABLE 2 Chemical Requirements

Element	Composition Limits, %		
	Nickel (UNS N02200)	Low-Carbon Nickel (UNS N02201)	Solution Strengthened Nickel (UNS N02211)
Nickel, min ^A	99.0	99.0	93.7
Copper, max	0.25	0.25	0.25
Iron, max	0.40	0.40	0.75
Manganese, max	0.35	0.35	4.25 – 5.25
Carbon, max	—	0.02	0.02
Carbon, max	0.15†	0.02	0.02
Silicon, max	0.35	0.35	0.15
Sulfur, max	0.01	0.01	0.015

^A Element shall be determined arithmetically by difference.

† Carbon max value for UNS N02200 was corrected editorially.

TABLE 3 Permissible Variations in Diameter or Distance Between Parallel Surfaces of Cold-Worked Rod and Bar

Specified Dimension, in. (mm) ^A	Permissible Variations from Specified Dimension, in. (mm)	
	+	-
Rounds:		
1/16 (1.6) to 3/16 (4.8), excl	0	0.002 (0.05)
3/16 (4.8) to 1/2 (12.7), excl	0	0.003 (0.08)
1/2 (12.7) to 15/16 (23.8), incl	0.001 (0.03)	0.002 (0.05)
Over 15/16 (23.8) to 1 15/16 (49.2), incl	0.0015 (0.04)	0.003 (0.08)
Over 1 15/16 (49.2) to 2 1/2 (63.5), incl	0.002 (0.05)	0.004 (0.10)
Over 2 1/2 (63.5) to 3 (76.2), incl	0.0025 (0.06)	0.005 (0.13)
Over 3 (76.2) to 3 (88.9), incl	0.003 (0.08)	0.006 (0.15)
Over 3 1/2 (88.9) to 4 (101.6), incl	0.0035 (0.09)	0.007 (0.18)
Hexagons, squares, rectangles:		
1/2 (12.7) and less	0	0.004 (0.10)
Over 1/2 (12.7) to 5/8 (22.2), incl	0	0.005 (0.13)
Over 5/8 (22.2) to 1 1/4 (31.8), incl	0	0.007 (0.18)
Over 1 1/4 (31.8) to 2 1/4 (57.2), incl	0	0.009 (0.23)
Over 2 1/4 (57.2) to 3 (76.2), incl	0	0.011 (0.28)
Over 3 (76.2) to 3 1/2 (88.9), incl	0	0.015 (0.38)
Over 3 1/2 (88.9) to 4 (101.6), incl	0	0.017 (0.43)

^A Dimensions apply to diameter of rounds, to distance between parallel surfaces of hexagons and squares, and separately to width and thickness of rectangles.

TABLE 4 Permissible Variations in Diameter or Distance Between Parallel Surfaces of Hot-Worked Rod and Bar

Specified Dimension, in. (mm) ^A	Permissible Variations from Specified Dimensions, in. (mm)	
	+	-
Rod and bar, hot-worked:		
1 (25.4) and under	0.016 (0.41)	0.016 (0.41)
Over 1 (25.4) to 2 (50.8), incl	0.031 (0.79)	0.016 (0.41)
Over 2 (50.8) to 4 (101.6), incl	0.047 (1.19)	0.031 (0.79)
Over 4 (101.6)	0.125 (3.18)	0.063 (1.60)
Rod, rough-turned or rough-ground:		
Under 1 (25.4)	0.005 (0.13)	0.005 (0.13)
1 (25.4) and over	0.031 (0.79)	0
Forging quality rod:^B		
Under 1 (25.4)	0.005 (0.13)	0.005 (0.13)
1 (25.4) and over	0.031 (0.79)	0

^A Dimensions apply to diameter of rods, to distance between parallel surfaces of hexagons and squares, and separately to width and thickness of rectangles.

^B Spot grinding is permitted to remove minor surface imperfections. The depth of these spot ground areas shall not exceed 3 % of the diameter of the rod.

7.3 *Corners*—Cold-worked bars will have practically exact angles and sharp corners.

7.4 *Machining Allowances for Hot-Worked Materials*—When the surfaces of hot-worked products are to be machined, the allowances prescribed in Table 5 are recommended for normal machining operations.

7.5 *Length*—The permissible variations in length of cold-worked and hot-worked rod and bar shall be as prescribed in Table 6.

7.5.1 Rods and bars ordered to random or nominal lengths will be furnished with either cropped or saw-cut ends; material ordered to cut lengths will be furnished with square saw-cut or machined ends.

7.6 *Straightness:*

7.6.1 The permissible variations in straightness of cold-worked rod and bar as determined by the departure from straightness shall be as prescribed in Table 7.

7.6.2 The permissible variations in straightness of precision straightened cold-worked rod as determined by the departure from straightness shall be as prescribed in Table 8.

7.6.2.1 In determining straightness in the standard 42-in. (1.07-m) distance between supports or, when specified, in determining straightness in lengths not in excess of those shown in Table 8, the rod shall be placed on a precision table equipped with ballbearing rollers and a micrometer or dial indicator. The rod shall then be rotated slowly against the indicator, and the deviation from straightness in any portion of the rod between the supports shall not exceed the permissible variations prescribed in Table 8. The deviation from straightness (throw in one revolution) is defined as the difference between the maximum and minimum readings of the dial indicator in one complete revolution of the rod.

7.6.3 The permissible variations in straightness of hot-worked rod and bar as determined by the departure from straightness shall be as specified in Table 9.