



Designation: B160 – 24

Standard Specification for Nickel Rod and Bar¹

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1. Scope*

1.1 This specification² covers nickel (UNS N02200),³ low-carbon nickel (UNS N02201),³ 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 standard. The values given in parentheses are mathematical conversions to SI units that are provided for information only and are not considered standard.

1.3 *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 establish appropriate safety, health, and environmental practices and determine the applicability of regulatory limitations prior to use.*

1.4 *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
 - [B162 Specification for Nickel Plate, Sheet, and Strip](#)
 - [B880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys](#)
 - [B899 Terminology Relating to Non-ferrous Metals and Alloys](#)
 - [E8/E8M Test Methods for Tension Testing of Metallic Materials](#)

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-160 in Section II of that Code.

³ New designations 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.

- [E18 Test Methods for Rockwell Hardness of Metallic Materials](#)
- [E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)
- [E140 Hardness Conversion Tables for Metals Relationship Among Brinell Hardness, Vickers Hardness, Rockwell Hardness, Superficial Hardness, Knoop Hardness, Scleroscope Hardness, and Leeb Hardness](#)
- [E1473 Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys](#)

3. Terminology

3.1 For definitions of terms used in this specification, refer to Terminology [B899](#).

3.2 In case of conflict between the definitions of this specification and Terminology [B899](#), this specification shall prevail.

3.3 Definitions of Terms Specific to This Standard:

3.3.1 *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 [B162](#), provided the mechanical property requirements of Specification B160 are met.

3.3.2 *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.
- 4.1.7 *Quantity*—Feet or number of pieces.

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

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.

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

4.1.9 *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 B880 and the material shall conform to the product (check) analysis variations defined in Check Analysis Variation table of Specification B880.

6. Mechanical and Other Requirements

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

TABLE 2 Chemical Requirements^A

| Element | Composition Limits, % | | |
|--------------------------|-----------------------|--------------------------------|---|
| | Nickel (UNS N02200) | Low-Carbon Nickel (UNS N02201) | Solution-Strengthened Nickel (UNS N02211) |
| Nickel, min ^B | 99.0 | 99.0 | 93.7 |
| Copper | 0.25 | 0.25 | 0.25 |
| Iron | 0.40 | 0.40 | 0.75 |
| Manganese | 0.35 | 0.35 | 4.25 to 5.25 |
| Carbon | 0.15 | 0.02 | 0.20 |
| Silicon | 0.35 | 0.35 | 0.15 |
| Sulfur | 0.01 | 0.01 | 0.015 |

^A All values are maximums unless a range is provided or is marked as a minimum.

^B Element shall be determined arithmetically by difference.

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

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 115/16 (49.2), incl | 0.0015 (0.04) | 0.003 (0.08) |
| Over 115/16 (49.2) to 21/2 (63.5), incl | 0.002 (0.05) | 0.004 (0.10) |
| Over 21/2 (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 31/2 (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 7/8 (22.2), incl | 0 | 0.005 (0.13) |
| Over 7/8 (22.2) to 11/4 (31.8), incl | 0 | 0.007 (0.18) |
| Over 11/4 (31.8) to 21/4 (57.2), incl | 0 | 0.009 (0.23) |
| Over 21/4 (57.2) to 3 (76.2), incl | 0 | 0.011 (0.28) |
| Over 3 (76.2) to 31/2 (88.9), incl | 0 | 0.015 (0.38) |
| Over 31/2 (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.

may be out-of-round by the total permissible variations in diameter shown in [Table 4](#).

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](#).

8. Workmanship, Finish, and Appearance

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

9. Sampling

9.1 Lot—Definition:

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

9.2.1 A lot for mechanical properties testing shall consist of all material from the same heat, nominal diameter or thickness, and condition.

9.2.1.1 Where material cannot be identified by heat, a lot shall consist of not more than 500 lb (227 kg) of material in the same size and condition.

9.3 Test Material Selection:

9.3.1 Chemical Analysis—Representative samples from each lot shall be taken during pouring or subsequent processing.

TABLE 5 Normal Machining Allowances for Hot-worked Material

| Finished-Machined Dimensions for Finishes as Indicated Below, in. (mm) ^A | Normal Machining Allowance, in. (mm) | | | |
|---|--------------------------------------|---|---------------------|------------|
| | On Diameter, for Rods | Distance Between Parallel Surface, for Hexagonal and Square Bar | For Rectangular Bar | |
| | | | On Thickness | On Width |
| Hot-worked: ^B | | | | |
| Up to 7/8 (22.2), incl | 1/8 (3.2) | 1/8 (3.2) | 1/8 (3.2) | 3/16 (4.8) |
| Over 7/8 to 1 1/8 (22.2 to 47.6), incl | 1/8 (3.2) | 3/16 (4.8) | 1/8 (3.2) | 3/16 (4.8) |
| Over 1 1/8 to 2 7/8 (47.6 to 73.0), incl | 3/16 (4.8) | 1/4 (6.4) | — | 3/16 (4.8) |
| Over 2 7/8 to 3 1/16 (73.0 to 96.8), incl | 1/4 (6.4) | — | — | 3/16 (4.8) |
| Over 3 1/16 (96.8) | 1/4 (6.4) | — | — | 3/8 (9.5) |
| Hot-worked rods: | | | | |
| Rough-turned or Rough-ground: ^C | | | | |
| 1 5/16 to 4 (23.8 to 101.6), incl in diameter | 1/16 (1.6) | — | — | — |
| Over 4 to 12 (101.6 to 304.8), incl in diameter | 1/8 (3.2) | — | — | — |

^A Dimensions apply to diameter of rods, to distance between parallel surfaces of hexagonal and square bar, and separately to width and thickness of rectangular bar.

^B The allowances for hot-worked material in [Table 5](#) are recommended for rods machined in lengths of 3 ft (0.91 m) or less and for bars machined in lengths of 2 ft (0.61 m) or less. Hot-worked material to be machined longer lengths should be specified showing the finished cross-sectional dimension and the length in which the material will be machined in order that the manufacturer may supply material with sufficient oversize, including allowance for out-of-straightness.

^C Applicable to 3 ft (0.91 m) max length.