Standard Specification for Nickel-Iron-Chromium Alloy Rod and Bar

This standard is issued under the fixed designation B 408; 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 (e) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers UNS N08120, UNS N08800, UNS N08810, UNS N08811, and UNS N08890 in the form of hot-worked and cold-worked rod and bar. Alloy UNS N08800 is normally employed in service temperatures up to and including 1100°F (593°C). Alloys UNS N08120, UNS N08810, UNS N08811, and UNS N08890 are normally employed in service temperatures above 1100°F (593°C) where resistance to creep and rupture is required, and they are annealed to develop controlled grain size for optimum properties in this temperature range.

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.

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 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:

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 112 Test Methods for Determining Average Grain Size

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.

3.1.1.1 Discussion—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 408, provided the mechanical property requirements of Specification B 408 are met.

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

4. Ordering Information

4.1 Orders for material to this specification should include information with respect to the following:

4.1.1 ASTM designation, and year of issue.

4.1.2 Alloy designation or UNS number.

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

4.1.4 Dimensions—Dimensions including length (Section 8, Tables 1-4 incl).

4.1.5 Condition (Table 5 and Appendix Appendix X1).

4.1.6 Finish (Appendix X1).

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 16).

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. Materials and Manufacture

5.1 Heat Treatment—The final heat treatment of UNS N08120 shall be 2150°F (1177°C) minimum, UNS N08810, 2050°F (1121°C) minimum, UNS N08811, and UNS N08890, 2100°F (1149°C) minimum.

6. Chemical Composition

6.1 The material shall conform to the composition limits specified in Table 6.

6.2 If a product (check) analysis is performed by the purchaser, the material shall conform to the product (check) analysis variations in Specification B 880.

7. Mechanical Properties and Other Requirements

7.1 Mechanical Properties—The material shall conform to the mechanical properties specified in Table 5.

7.2 Grain Size—Annealed UNS Alloys N08120, N08810, N08811, and N08890 shall conform to an average grain size of ASTM No. 5 or coarser.

8. Dimensions and Permissible Variations

8.1 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 1, and of hot-worked rod and bar as prescribed in Table 2.

8.2 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 Table 1 and Table 2, except for hot-worked rods ½ in. (12.7 mm) in diameter and under, which may be out-of-round by the total permissible variations in diameter shown in Table 2.

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

8.4 Machining Allowances for Hot-Worked Materials—When the surfaces of hot-worked products are to be machined, the allowances prescribed in Table 3 are recommended for normal machining operations.

8.5 Length—The permissible variations in length of cold-worked and hot-worked rod and bar shall be as prescribed in Table 4.

8.5.1 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.

8.6 Straightness:

8.6.1 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.

8.6.2 The permissible variations in straightness of hot-worked rod and bar as determined by the departure from straightness shall be as specified in Table 8.

9. Workmanship, Finish, and Appearance

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

10. Sampling

10.1 Lot:

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

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

10.1.2.1 Where material cannot be identified by heat, a lot shall consist of not more than 500 lbs (227 kg) of material in the same size and condition except that a single piece weighing over 500 lbs shall be considered as one lot.

10.2 Test Material Selection:

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

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

10.2.2 Mechanical Properties and Grain Size—Samples of the material to provide test specimens for mechanical properties shall be taken from such locations in each lot as to be representative of that lot.

11. Number of Tests

11.1 Chemical Analysis—One test per lot.

11.2 Tension—One test per lot.
TABLE 3 Normal Machining Allowances for Hot-worked Material

<table>
<thead>
<tr>
<th>Dimensions</th>
<th>On Diameter, for Rods</th>
<th>Distance Between Parallel Surfaces, for Hexagonal and Square Bar</th>
<th>For Rectangular Bar</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hot-worked:</td>
<td>1/8 (3.2)</td>
<td>1/16 (1.6)</td>
<td>1/8 (3.2)</td>
</tr>
<tr>
<td>Rough-turned or Rough Ground:</td>
<td>1/8 (3.2)</td>
<td>1/16 (1.6)</td>
<td>1/8 (3.2)</td>
</tr>
<tr>
<td>Over 4 to 12 (101.6 to 304.8), incl in diameter</td>
<td>1/8 (3.2)</td>
<td>1/16 (1.6)</td>
<td>1/8 (3.2)</td>
</tr>
</tbody>
</table>

TABLE 4 Permissible Variations in Length of Rods and Bars

<table>
<thead>
<tr>
<th>Dimensional Values</th>
<th>For Rods</th>
<th>For Bars</th>
</tr>
</thead>
<tbody>
<tr>
<td>Random mill lengths:</td>
<td>6 to 24 ft (1.83 to 7.31 m)</td>
<td>6 to 20 ft (1.83 to 6.1 m)</td>
</tr>
<tr>
<td>Hot-worked</td>
<td>6 to 24 ft (1.83 to 7.31 m)</td>
<td>6 to 20 ft (1.83 to 6.1 m)</td>
</tr>
<tr>
<td>Cold-worked</td>
<td>6 to 20 ft (1.83 to 6.1 m)</td>
<td>6 to 20 ft (1.83 to 6.1 m)</td>
</tr>
</tbody>
</table>

TABLE 5 Mechanical Properties of Rods and Bars

<table>
<thead>
<tr>
<th>Alloy</th>
<th>Condition</th>
<th>Tensile Strength, min, psi (MPa)</th>
<th>Yield Strength (0.2 % offset) min, psi (MPa)</th>
<th>Elongation in 2 in. or 50 mm (or 4D) min, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>UNS N08120</td>
<td>Cold-worked and hot-worked, annealed</td>
<td>90 000 (621)</td>
<td>40 000 (276)</td>
<td>30</td>
</tr>
<tr>
<td>UNS N08800</td>
<td>Hot worked, as-hot-worked</td>
<td>80 000 (550)</td>
<td>35 000 (240)</td>
<td>25</td>
</tr>
<tr>
<td>UNS N08890</td>
<td>Cold-worked and hot-worked, annealed</td>
<td>75 000 (515)</td>
<td>30 000 (205)</td>
<td>30</td>
</tr>
<tr>
<td>UNS N08810 and UNS N08811</td>
<td>Cold-worked and hot-worked, annealed</td>
<td>65 000 (450)</td>
<td>25 000 (170)</td>
<td>30</td>
</tr>
<tr>
<td>UNS N08980</td>
<td>Hot worked, as-hot-worked, annealed</td>
<td>75 000 (520)</td>
<td>30 000 (205)</td>
<td>35</td>
</tr>
<tr>
<td>UNS N08880, UNS N08810 and UNS N08811</td>
<td>Forging quality</td>
<td>n</td>
<td>n</td>
<td>n</td>
</tr>
</tbody>
</table>

11.3 Grain Size—One test per lot.

12. Specimen Preparation

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

12.1.1 All rod and bar shall be tested in full cross-section size when possible. When a full cross-section size test cannot be performed, the largest possible round specimen shown in Test Methods E 8 shall be used. Longitudinal strip specimens shall be prepared in accordance with Test Methods E 8 for rectangular bar up to 1/2 in. (12.7 mm), inclusive, in thicknesses which are too wide to be pulled full size.

13. Test Method

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

- Chemical Analysis
- Tension
- Rounding Procedure
- Grain Size

13.2 In the event of disagreement, the referee method for the determination of average grain size shall be the planimetric method.

13.3 For purposes of determining compliance with the specified limits for requirements of the properties listed in the following table, an observed value or a calculated value shall be rounded as indicated below, in accordance with the rounding method of Practice E 29:
Test Rounded Unit for Observed Or Calculated Value nearest unit in the last right-and place of figures of the specified limit. If two choices are possible, as when the digits dropped are exactly a 5, or a 5 followed only by zeros, choose the one ending in an even digit, with zero defined as an even digit.

Tensile strength and yield strength nearest 1000 psi (6.9 MPa)

### Chemical Requirements

<table>
<thead>
<tr>
<th>Element</th>
<th>Alloy N08120</th>
<th>Alloy N08800</th>
<th>Alloy N08810</th>
<th>Alloy N08811</th>
<th>Alloy N08890</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nickel</td>
<td>35.0 min</td>
<td>30.0 min</td>
<td>30.0 min</td>
<td>30.0 min</td>
<td>40.0 min</td>
</tr>
<tr>
<td>Chromium</td>
<td>23.0 min</td>
<td>19.0 min</td>
<td>19.0 min</td>
<td>19.0 min</td>
<td>23.5 min</td>
</tr>
<tr>
<td>Iron</td>
<td>remainder</td>
<td>39.5 min</td>
<td>39.5 min</td>
<td>39.5 min</td>
<td>remainder</td>
</tr>
<tr>
<td>Manganese, max</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>Carbon</td>
<td>0.02 min</td>
<td>0.10 max</td>
<td>0.05 to 0.10</td>
<td>0.06 to 0.10</td>
<td>0.06 min</td>
</tr>
<tr>
<td>Copper, max</td>
<td>0.50</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
<td>0.75</td>
</tr>
<tr>
<td>Silicon</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
<td>1.0</td>
</tr>
<tr>
<td>Sulfur, max</td>
<td>0.03</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
<td>0.015</td>
</tr>
<tr>
<td>Aluminum</td>
<td>0.40 max</td>
<td>0.15 min</td>
<td>0.15 min</td>
<td>0.15 min</td>
<td>0.05 min</td>
</tr>
<tr>
<td>Titanium</td>
<td>0.20 max</td>
<td>0.15 min</td>
<td>0.15 min</td>
<td>0.15 min</td>
<td>0.15 min</td>
</tr>
<tr>
<td>Columbium</td>
<td>0.4 min</td>
<td>0.9 max</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Molybdenum</td>
<td>2.50 max</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Niobium</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Tantalum</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Phosphorus</td>
<td>0.040 max</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Tungsten</td>
<td>2.50 max</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Cobalt, max</td>
<td>3.0</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Nitrogen</td>
<td>0.15 min</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
<tr>
<td>Boron</td>
<td>0.010 max</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>

*Iron shall be determined arithmetically by difference.

† Editorially corrected.

### Permissible Variations in Straightness of Cold-Worked Rods and Bars

<table>
<thead>
<tr>
<th>Specified Diameter or Distance Between Parallel Surfaces, in. (mm)</th>
<th>Depth of Chord, Permissible Variations in Lengths Indicated, in. (mm)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rounds: 1/8 (12.7) to 2 1/2 (63.5), incl</td>
<td>0.030 (0.76) per ft (305 mm) of length</td>
</tr>
<tr>
<td>Hexagons, squares, rectangles: 1/8 (12.7) to 2 (50.8), incl</td>
<td>0.030 (0.76) per ft (305 mm) of length</td>
</tr>
</tbody>
</table>

*Material under 1/8 in. (12.7 mm) shall be reasonably straight and free of sharp bends and kinks.

### Permissible Variations in Straightness of Hot-Worked Rods and Bars

<table>
<thead>
<tr>
<th>Finish</th>
<th>Permissible Variations, in./ft. (mm/m)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rods and bars, hot-worked</td>
<td>0.050 (4.2)</td>
</tr>
<tr>
<td>Rods: hot-worked, rough ground, or rough turned</td>
<td>0.050 (4.2)</td>
</tr>
</tbody>
</table>

*Not applicable to forging quality.

† Material under 1/8 in. (12.7 mm) shall be reasonably straight and free of sharp bends and kinks.

‡ The maximum curvature (depth of chord) shall not exceed the values indicated multiplied by the length in feet.

### Inspection

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

### Rejection and Rehearing

15.1 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.

### 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.

### Product Marking

17.1 The following information shall be marked on the material or included on the package, or on a label or tag attached thereto: The name of the material or UNS Number, heat number, condition (temper), this specification number,
date of issue, the size, gross, tare and net weight, consignor and consignee address; contract or order number, or such other information as may be defined in the contract or order.

18. Keywords

18.1 bar; rod; UNS N08120; UNS N08800; UNS N08801; UNS N08810; UNS N08811; UNS N08890

APPENDIX

(Nonmandatory Information)

X1. PROCURABLE CONDITIONS AND FINISHES

X1.1 The various conditions and finishes in which rod and bar are procurable are as follows:

X1.1.1 Hot-Worked—With a tightly adherent, dark oxide surface.

X1.1.2 Hot-Worked, Rough Ground—Similar to X1.1.1 except rough ground.

X1.1.3 Hot-Worked, Rough-Turned—Similar to X1.1.1 except rough turned with a broad nosed tool similar to a bar peeling operation and thus may not be straight. Intended generally for machining where an overhauled surface is desired, essentially for machined step down shafts or parts machined in short lengths of 3 ft (0.91 m) or less.

X1.1.4 Hot-Worked, Forging Quality—Rough turned and spot ground, as necessary, for sizes 1 in. (25.4 mm) in diameter and over; rough ground and spot ground for sizes under 1 in. in diameter. Material is selected from heats of known, good hot malleability.

NOTE X1.1—For sizes 2½ in. (63.5 mm) in diameter and less, cold-worked rod may be used also for forging by virtue of the fact such rod have been overhauled for removal of mechanical surface defects prior to cold-working. In such cases, the user should run pilot forging tests to ensure himself that such material has the desired hot malleability range.

X1.1.5 Hot-Worked, Annealed—Soft, with a tightly adherent dark oxide.

X1.1.6 Hot-Worked, Annealed and Pickled—Same as X1.1.5 except descaled for removal of mill oxide. Provides for better surface inspection than does hot-worked material and often employed where welding is involved where removal of mill oxide is desired.

NOTE X1.2—Annealing prior to pickling may be required in order to reduce the mill oxide since uniform pickling of an unreduced oxide is difficult.

X1.1.7 Cold-Worked, As Worked—Hot-worked, overhauled, cold worked, and straightened with a smooth, bright finish.

X1.1.8 Cold-Worked, Annealed and Pickled—Hotworked, overhauled, cold-worked, annealed, descaled, and straightened. Annealed for softness and with a dull matte finish.