



Designation: B 511 – 01

# Standard Specification for Nickel-Iron-Chromium-Silicon Alloy Bars and Shapes<sup>1</sup>

This standard is issued under the fixed designation B 511; 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 reappraisal. A superscript epsilon ( $\epsilon$ ) indicates an editorial change since the last revision or reappraisal.

## 1. Scope

1.1 This specification<sup>2</sup> covers wrought alloys UNS N08330 and UNS N08332 in the form of hot-finished and cold-finished bar and shapes intended for heat-resisting applications and general corrosive service.

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:*

**B 536** Specification for Nickel-Iron-Chromium-Silicon Alloys (UNS N08330 and N08332) Plate, Sheet, and Strip<sup>3</sup>

**B 880** Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys<sup>3</sup>

**E 8** Test Methods for Tension Testing of Metallic Materials<sup>4</sup>

**E 29** Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications<sup>5</sup>

**E 112** Test Methods for Determining the Average Grain Size<sup>4</sup>

**E 1473** Test Methods for Chemical Analysis of Nickel, Cobalt, and High-Temperature Alloys<sup>6</sup>

## 3. Terminology

3.1 *Definitions of Terms Specific to This Standard:*

3.1.1 *bar*—material round, rectangular, hexagonal, octagonal, or square solid section, furnished in straight lengths.

3.1.2 *shapes*—material of solid section in such forms as angles, channels, tees, I-beams, and four-fluted bars.

## 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 Quantity (weight or number of pieces),

4.1.3 ASTM designation and year of issue,

4.1.4 Section (round, square, I-beam, etc.),

4.1.5 Dimension, including length,

4.1.6 *Certification*—State if certification is required.

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

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

## 5. Materials and Manufacture

5.1 All material shall be furnished in the heat-treated condition, except that cold-drawn hexagons may be given a cold-draw sizing pass subsequent to the final heat treatment.

NOTE 1—Hot-finished rectangular bar in widths 10 in. (254 mm) and under may be furnished as hot-finished plate with sheared or cut edges in accordance with Specification **B 536**.

## 6. Chemical Composition

6.1 The material shall conform to the requirements as to chemical composition specified in **Table 2**.

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

## 7. Mechanical and Other Properties

7.1 The mechanical properties of the material at room temperature shall conform to those shown in **Table 1**.

7.2 *Grain Size*—Annealed alloy UNS N08332 shall conform to an average grain size of ASTM No. 5 or coarser.

7.3 *Annealing Temperature*—Alloy UNS N08330 shall be annealed at 1900°F (1040°C) minimum. Alloy UNS N08332 shall be annealed at 2100°F (1150°C) minimum.

## 8. Dimensions and Permissible Variations

8.1 All bars and shapes shall conform to the permissible variations in dimensions specified in **Tables 3-14**, inclusive.

<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-511 in Section II of that Code.

<sup>3</sup> *Annual Book of ASTM Standards*, Vol 02.04.

<sup>4</sup> *Annual Book of ASTM Standards*, Vol 03.01.

<sup>5</sup> *Annual Book of ASTM Standards*, Vol 14.02.

<sup>6</sup> *Annual Book of ASTM Standards*, Vol 03.05.

**TABLE 1 Mechanical Properties**

Alloy	Condition	Tensile Strength, min, psi (MPa)	Yield Strength 0.2% off-set, min, psi (MPa)	Elongation in 2 in. or 50 mm, or 4D, min, %
UNS N08330	annealed	70 000 (483)	30 000 (207)	30 <sup>A</sup>
UNS N08332	annealed	67 000 (462)	27 000 (186)	30

<sup>A</sup>Applies to round bar only. For other bar cross-sections and shapes the minimum elongation shall be 25 %.

**TABLE 2 Chemical Requirements**

Element	Composition Limits, %
C	... <sup>A</sup>
Mn	2.00 max
P	0.03 max
S	0.03 max
Si	0.75–1.50
Cr	17.0–20.0
Ni	34.0–37.0
Cu	1.00 max
Pb	0.005 max
Sn	0.025 max
Fe	remainder <sup>B</sup>

<sup>A</sup>Alloy UNS N08330: 0.08 max.

Alloy UNS N08332: 0.05–0.10.

<sup>B</sup>Element shall be determined arithmetically by difference.

## 9. Workmanship, Finish, and Appearance

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

## 10. Sampling

### 10.1 Lot Definition:

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 material from one heat of the same condition and cross section, and in no case more than 30 000 lb (13 600 kg) in weight.

### 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 and grain size 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 *Grain Size*—One test per lot.

11.3 *Mechanical Properties*—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 material 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 ½ in. (12.7 mm) inclusive, in thicknesses that are too wide to be pulled full size.

## 13. Test Methods

13.1 *Chemical Composition*—In case of dispute, the chemical analysis shall be made in accordance with Test Methods E 1473.

13.2 *Grain Size*—The measurement of average grain size may be carried out by the planimetric method, the comparison method, or the intercept method described in Methods E 112. In case of dispute the “referee” method for determining average grain size shall be the planimetric method.

13.3 *Tension Test*—Test Methods E 8.

13.4 *Rounding Method*—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 E 29:

Requirements	Rounded Unit for Observed or Calculated Value
Chemical composition and tolerances (when expressed in decimals)	nearest unit in the last right-hand 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)
Elongation	nearest 1 %
Grain size	nearest multiple of 0.0002 in. (0.005 mm)
0.0024 in. (0.060 mm) or larger	nearest multiple of 0.0001 in. (0.002 mm)
Less than 0.0024 in. (0.060 mm)	

## 14. Inspection <https://www.astm.org/standards/B511-01>

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

## 15. Rejection and Rehearing

15.1 Material 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.

## 16. Certification

16.1 When specified in the purchase order or contract, a producer’s or supplier’s certification shall be furnished to the purchaser that the material was manufactured, sampled, tested, and inspected in accordance with this specification and has been found to meet the requirements. When specified in the purchase order or contract, a report of the test results shall be furnished.

## 17. Packaging and Package Marking

17.1 Material shall be bundled or boxed in such a manner as to assure undamaged delivery to its destination when properly transported by a common carrier.

**TABLE 3 Permissible Variations in Size of Hot-Rolled Round and Square Bars**

NOTE 1—Out-of-round is the difference between the maximum and minimum diameters of the bar, measured at the same cross section.

NOTE 2—Out-of-square section is the difference in the two dimensions at the same cross section of a square bar, each dimension being the distance between opposite faces.

NOTE 3—Size tolerances for rounds in the size range from ¼ to 5/16 in. (6.4 to 7.9 mm), incl, and for rounds in the size range from ¼ in. (6.4 mm) to approximate 5/8 in. (15.9 mm), which are produced on rod mills in coils, are not shown herein.

NOTE 4—Variations in size of coiled product made on rod mills are greater than size tolerances for product made on bar mills.

Specified Size		Size Tolerance				Out-of-Round (Note 1) or Out-of-Square Section (Note 2)	
		Over		Under		in	mm
in.	mm	in.	mm	in.	mm	in	mm
¼ to 5/16	6.4 to 7.9	0.005	0.13	0.005	0.13	0.008	0.20
Over 5/16 to 7/16	7.9 to 11.1	0.006	0.15	0.006	0.15	0.009	0.23
Over 7/16 to 5/8	11.1 to 15.9	0.007	0.18	0.007	0.18	0.010	0.25
Over 5/8 to 7/8	15.9 to 22.2	0.008	0.20	0.008	0.20	0.012	0.30
Over 7/8 to 1	22.2 to 25.4	0.009	0.23	0.009	0.23	0.013	0.33
Over 1 to 1 1/8	25.4 to 28.6	0.010	0.25	0.010	0.25	0.015	0.38
Over 1 1/8 to 1 1/4	28.6 to 31.8	0.011	0.28	0.011	0.28	0.016	0.41
Over 1 1/4 to 1 3/8	31.8 to 34.9	0.012	0.30	0.012	0.30	0.018	0.46
Over 1 3/8 to 1	#4.9 to 38.1	0.014	0.36	0.014	0.36	0.021	0.53
Over 1 1/2 to 2	38.1 to 50.8	1/64	0.4	1/64	0.4	0.023	0.58
Over 2 to 2 1/2	50.8 to 63.5	1/32	0.8	0		0.023	0.58
Over 2 1/2 to 3 1/2	63.5 to 88.9	3/64	1.2	0		0.035	0.89
Over 3 1/2 to 4 1/2	88.9 to 114.3	1/16	1.6	0		0.046	1.17
Over 4 1/2 to 5 1/2	114.3 to 139.7	5/64	2.0	0		0.058	1.47
Over 5 1/2 to 6 1/2	139.7 to 165.1	1/8	3.2	0		0.070	1.78
Over 6 1/2 to 8	165.1 to 203.2	5/32	4.0	0		0.085	2.16

**TABLE 4 Permissible Variations in Size of Hot-Rolled Hexagonal and Octagonal Bars**

Specified Sizes Measured Between Opposite Sides		Size Tolerance				Maximum Difference Measurements for Hexagons Only	
		Over		Under		in	mm
in.	mm	in.	mm	in.	mm	in	mm
½ to 1, incl	12.7 to 25.4	0.010	0.25	0.010	0.25	0.015	0.38
Over 1 to 1 1/2, incl	25.4 to 38.1	0.021	0.53	0.021	0.53	0.025	0.64
Over 1 1/2 to 2, incl	38.1 to 50.8	1/32	0.8	1/32	0.8	1/32	0.8
Over 2 to 2 1/2, incl	50.8 to 63.5	3/64	1.2	3/64	1.2	3/64	1.2
Over 2 1/2 to 3 1/2, incl	63.5 to 88.9	1/16	1.6	1/16	1.6	1/16	1.6

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17.2 Each bundle or shipping container shall be marked with the name of the material or UNS number, heat number, condition (temper), this specification number, the size, gross, and net weight, consignor and consignee address, and contract or order number.

## 18. Keywords

18.1 UNS N08330; UNS N08332; bar