



Standard Specification for Nickel-Iron-Chromium-Silicon Alloy Bars and Shapes¹

This standard is issued under the fixed designation B511/B511M; 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.

1. Scope

1.1 This specification² 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 either SI units or inch-pound units are to be regarded separately as standard. The values stated in each system may not be exact equivalents; therefore, each system shall be used independently of the other. Combining values from the two systems may result in non-conformance with the 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 become familiar with all hazards including those identified in the appropriate Safety Data Sheet (SDS) 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

B536 Specification for Nickel-Iron-Chromium-Silicon Alloys (UNS N08330 and N08332) Plate, Sheet, and Strip

B880 Specification for General Requirements for Chemical Check Analysis Limits for Nickel, Nickel Alloys and Cobalt Alloys

E8 Test Methods for Tension Testing of Metallic Materials

E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications

E112 Test Methods for Determining Average Grain Size

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, 2016. Published May 2016. Originally approved in 1970. Last previous edition approved in 2009 as B511 – 01 (2009). DOI: 10.1520/B0511_B0511M-16.

² For ASME Boiler and Pressure Vessel Code applications, see related Specification SB-511 in Section II of that Code.

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.

E1473 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 round, rectangular, hexagonal, octagonal, or square solid section, furnished in straight lengths.

3.1.2 *shapes, n*—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. [2504 mm] and under may be furnished as hot-finished plate with sheared or cut edges in accordance with Specification **B536**.

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 in accordance with Specification **B880**.



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 [485]	30 000 [210]	30 ^A
UNS N08332	annealed	67 000 [465]	27 000 [190]	30

^A 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	... ^A
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 ^B

^A Alloy UNS N08330: 0.08 max.

Alloy UNS N08332: 0.05–0.10.

^B Element shall be determined arithmetically by difference.

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.

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.

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. [6.5 to 8.0 mm], incl, and for rounds in the size range from ¼ in. [6.5 mm] to approximate 5/8 in. [15.5 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]		
¼ to 5/16	[6.5 to 8.0]	0.005	[0.13]	0.005	[0.13]	0.008	[0.20]
Over 5/16 to 7/16	[8.0 to 11.0]	0.006	[0.15]	0.006	[0.15]	0.009	[0.23]
Over 7/16 to 5/8	[11.0 to 15.5]	0.007	[0.18]	0.007	[0.18]	0.010	[0.26]
Over 5/8 to 7/8	[15.5 to 22.0]	0.008	[0.20]	0.008	[0.20]	0.012	[0.30]
Over 7/8 to 1	[22.0 to 25.0]	0.009	[0.23]	0.009	[0.23]	0.013	[0.34]
Over 1 to 1 1/8	[25.0 to 28.0]	0.010	[0.25]	0.010	[0.25]	0.015	[0.38]
Over 1 1/8 to 1 1/4	[28.0 to 31.5]	0.011	[0.28]	0.011	[0.28]	0.016	[0.42]
Over 1 1/4 to 1 3/8	[31.5 to 34.5]	0.012	[0.30]	0.012	[0.30]	0.018	[0.46]
Over 1 3/8 to 1 1/2	[34.5 to 38.0]	0.014	[0.35]	0.014	[0.35]	0.021	[0.53]
Over 1 1/2 to 2	[38.0 to 50.0]	1/64	[0.40]	1/64	[0.40]	0.023	[0.60]
Over 2 to 2 1/2	[50.0 to 63.0]	1/32	[0.80]	0	[0]	0.023	[0.60]
Over 2 1/2 to 3 1/2	[63.0 to 90.0]	3/64	[1.20]	0	[0]	0.035	[0.90]
Over 3 1/2 to 4 1/2	[90.0 to 115.0]	1/16	[1.60]	0	[0]	0.046	[1.20]
Over 4 1/2 to 5 1/2	[115.0 to 140.0]	5/64	[2.0]	0	[0]	0.058	[1.50]
Over 5 1/2 to 6 1/2	[140.0 to 165.0]	1/8	[3.00]	0	[0]	0.070	[1.80]
Over 6 1/2 to 8	[165.0 to 200.0]	5/32	[4.00]	0	[0]	0.085	[2.20]

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

Specified Sizes Measured Between Opposite Sides		Size Tolerance				Maximum Difference for Measurements for Hexagons Only	
		Over		Under			
in.	[mm]	in.	[mm]	in.	[mm]	in.	[mm]
½ to 1, incl	[13.0 to 25.0]	0.010	[0.25]	0.010	[0.25]	0.015	[0.38]
Over 1 to 1½, incl	[25.0 to 38.0]	0.021	[0.53]	0.021	[0.53]	0.025	[0.64]
Over 1½ to 2, incl	[38.0 to 50.0]	⅓ ₃₂	[0.80]	⅓ ₃₂	[0.80]	⅓ ₃₂	[0.80]
Over 2 to 2½, incl	[50.0 to 63.0]	⅜ ₆₄	[1.20]	⅜ ₆₄	[1.20]	⅜ ₆₄	[1.20]
Over 2½ to 3½, incl	[63.0 to 90.0]	⅛ ₁₆	[1.60]	⅛ ₁₆	[1.60]	⅛ ₁₆	[1.6]

TABLE 5 Permissible Variations in Thickness and Width for Hot Rolled Flat Bars

Specified Widths, in.	Thickness Tolerances, in., for Given Thickness								Width Tolerance		
	⅛ to ½, incl	Over ½ to 1, incl	Over 1 to 2, incl	Over 2 to 4, incl		Over 4 to 6, incl		Over 6 to 8, incl			
	Over and Under		Over	Under	Over	Under	Over	Under	Over	Under	
To 1, incl	0.008	0.010	...	...	...	...	...	...	...	0.015	0.015
Over 1 to 2, incl	0.012	0.015	0.031	...	...	...	...	...	...	0.031	0.031
Over 2 to 4, incl	0.015	0.020	0.031	0.062	0.031	...	...	...	...	0.062	0.031
Over 4 to 6, incl	0.015	0.020	0.031	0.062	0.031	0.093	0.062	...	...	0.093	0.062
Over 6 to 8, incl	0.016	0.025	0.031	0.062	0.031	0.093	0.062	0.125	0.156	0.125	0.156
Over 8 to 10, incl	0.021	0.031	0.031	0.062	0.031	0.093	0.062	0.125	0.156	0.156	0.187

	Thickness Tolerances, [mm], for Given Thickness								Width Tolerance		
	3.2 to 13, incl	Over 13 to 25, incl	Over 25 to 50, incl	Over 50 to 100, incl		Over 100 to 150, incl		Over 150 to 200, incl			
	Over and Under		Over	Under	Over	Under	Over	Under	Over	Under	
To 25.0, incl	0.20	0.25	...	...	...	...	...	...	...	0.40	0.40
25.0 to 50.0, incl	0.30	0.40	0.80	...	...	...	...	...	...	0.80	0.80
50.0 to 100.0, incl	0.40	0.50	0.80	1.60	0.80	...	...	...	...	1.60	0.80
100.0 to 150.0, incl	0.40	0.50	0.80	1.60	0.80	2.40	1.60	...	...	2.40	1.60
150.0 to 200.0, incl	0.40	0.65	0.80	1.60	0.80	2.40	1.60	3.20	4.00	3.20	4.00
200.0 to 250.0, incl	0.50	0.80	0.80	1.60	0.80	2.40	1.60	3.20	4.00	4.00	4.80

TABLE 6 Permissible Variations in Size of Cold-Finished Round Bars

NOTE 1—Size tolerances are over and under as shown in the table. Also, rounds can be produced to tolerances all over and nothing under, or all under and nothing over, or any combination of over and under, if the total spread in size tolerance for a specified size is not less than the total spread shown in the table.

NOTE 2—When it is necessary to heat treat or heat treat and pickle after cold finishing, size tolerances are double those shown in the table.

NOTE 3—Cold-finished bars over 4 in. [100 mm] in diameter are produced; size tolerances for such bars are not included herein.

Specified Size	Size Tolerance (Note 1)				
	Over		Under		
in.	[mm]	in.	[mm]	in.	[mm]
Over ½ to 1, incl	[13.0 to 25.0]	0.002	[0.05]	0.002	[0.05]
1 to 1½, incl	[25.0 to 38.0]	0.0025	[0.06]	0.0025	[0.06]
1½ to 4, incl	[38.0 to 100.0]	0.003	[0.08]	0.003	[0.08]

(Note 2)

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.

TABLE 7 Permissible Variations in Size of Cold-Finished Hexagonal, Octagonal, and Square Bars

NOTE 1—When it is necessary to heat treat or heat treat and pickle after cold finishing, size tolerances are double those shown in the table.

Specified Size		Permissible Variations from Specified Size			
		Over		Under	
in.	[mm]			in.	[mm]
Over ½ to 1, incl	[13.0 to 25.0]	0	0.004	0.004	[0.10]
Over 1 to 2, incl	[25.0 to 50.0]	0	0.006	0.006	[0.15]
Over 2 to 4, incl	[50.0 to 100.0]	0	0.008	0.008	[0.20]
Over 4	[100.0]	0	0.010	0.010	[0.25]

TABLE 8 Permissible Variations in Width and Thickness of Cold-Finished Flat Bars

NOTE 1—When it is necessary to heat treat or heat treat and pickle after cold finishing, tolerances are double those shown in the table.

NOTE 2—Cold-finished flat bars over 4½ in. [115 mm] wide or thick are produced: width and thickness tolerances for such bars are not included herein.

Width		Width Tolerance (Note 1), Over and Under			
		For Thicknesses ¼ in. [6.5 mm] and Under		For Thicknesses over ¼ in. [6.5 mm]	
in.	[mm]	in.	[mm]	in.	[mm]
¾ to 1, incl	[9.5 to 25.0]	0.004	[0.10]	0.004	[0.10]
Over 1 to 2, incl	[25.0 to 50.0]	0.006	[0.15]	0.004	[0.10]
Over 2 to 3, incl	[50.0 to 75.0]	0.008	[0.20]	0.004	[0.10]
Over 3 to 4½, incl	[75.0 to 115.0]	0.010	[0.25]	0.005	[0.13]

Thickness		Thickness Tolerance, (Note 1) Over and Under	
in.	[mm]	in.	[mm]
¾ to 1, incl	[3.0 to 25.0]	0.002	[0.05]
Over 1 to 2, incl	[25.0 to 50.0]	0.003	[0.08]
Over 2 to 3, incl	[50.0 to 75.0]	0.004	[0.10]
Over 3 to 4½, incl	[75.0 to 115.0]	0.005	[0.13]

TABLE 9 Permissible Variations in Length of Hot Finished or Cold Finished Bars

NOTE 1—Tolerances in this table apply when specific lengths are ordered. When random lengths are ordered, the length range is not less than 24 in. [610 mm].

Specified Sizes of Rounds, Squares, Hexagons, Octagons and Widths of Flats, ^A in. [mm]	Permissible Variations in Length, in. [mm]			
	To 12 ft [4 m], incl		Over 12 to 25 ft [4 to 8 m], incl	
	Over	Under	Over	Under
To 2, incl	½ [13.0]	0	¾ [20.0]	0
Over 2 to 4, incl	¾ [20.0]	0	1 [25.0]	0
Over 4 to 6, incl	1 [25.0]	0	1¼ [31.5]	0
Over 6 to 9, incl	1¼ [31.5]	0	1½ [38.0]	0
Over 9 to 10, incl	1½ [38.0]	0	2 [50.0]	0

^A The maximum width of bar flats is 10 in. [250 mm].

TABLE 10 Permissible Variations in Length of Hot Finished or Cold Finished Bars Machine-Cut After Machine Straightening

NOTE 1—Tolerances in this table apply when specific lengths are ordered. When random lengths are ordered, the length range is not less than 24 in. [610 mm].

Specified Sizes of Rounds, Squares, Hexagons, Octagons and Widths of Flats, ^A in. [mm]	Permissible Variations in Length, in. [mm]			
	To 12 ft [4], incl		Over 12 ft to 25 ft [4 to 8 m], incl	
	Over	Under	Over	Under
To 3, incl	⅙ [3.0]	0	⅜ [5.0]	0
Over 3 to 6, incl	⅜ [5.0]	0	¼ [6.5]	0
Over 6 to 9, incl	¼ [6.5]	0	⅜ [8.0]	0
Over 9 to 12, incl	½ [13.0]	0	½ [13.0]	0

^A The maximum width of bar flats is 10 in. [250 mm].



TABLE 11 Dimensional Tolerances—Hot Extrusions

Largest Section Dimension, in. [mm]	Tolerance, ±, in. [mm]
Under 1 [25.0]	0.020 [0.50]
1 [25.0] to 3 [75.0], excl	0.031 [0.80]

TABLE 12 Angularity Tolerance—Hot Extrusions

Specified angle or angles	Tolerance, ±, °
	2

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 E8 shall be used. Longitudinal strip specimens shall be prepared in accordance with Test Methods E8 for rectangular bar up to ½ in. [13.0 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 E1473.

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 Test Methods E112. In case of dispute the “referee” method for determining average grain size shall be the planimetric method.

13.3 *Tension Test*—Test Methods E8.

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 E29:

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 [5 MPa]
Elongation	nearest 1 %
Grain size	
0.0024 in. [0.060 mm] or larger	nearest multiple of 0.0002 in. [0.005 mm]
Less than 0.0024 in. [0.060 mm]	nearest multiple of 0.0001 in. [0.002 mm]

14. Inspection

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.

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



TABLE 13 Length Tolerances For Shapes and Hot Extrusions Specified to Exact Lengths, Machine Cut After Straightening

Largest Sectional Dimension, in. [mm]	Length Tolerance, in. [mm]	
	Over	Under
Up to 3 [75], excl	¼ [6.5]	0

TABLE 14 Permissible Variations in Straightness (Camber) of Hot-Finished Bars, Hot Extrusions and Cold-Finished Bars

NOTE 1—Measurement is taken on the concave side of the bar with a straightedge, and represents the greatest deviation of the side from a straight line.

Hot-finished bars and hot extrusions:

¼ in. [3.0 mm] in any 5 ft [1.5 m], but may not exceed (1/8 × No. of feet in length)/5

[3 mm × No. of metres in length/1.5]

Cold-finished bars:

1/16 in. [2 mm] in any 5 ft [1.5 m] but may not exceed (1/16 × No. of feet in length)/5

[2 mm × No. of metres in length/1.5]

ASTM International takes no position respecting the validity of any patent rights asserted in connection with any item mentioned in this standard. Users of this standard are expressly advised that determination of the validity of any such patent rights, and the risk of infringement of such rights, are entirely their own responsibility.

This standard is subject to revision at any time by the responsible technical committee and must be reviewed every five years and if not revised, either reapproved or withdrawn. Your comments are invited either for revision of this standard or for additional standards and should be addressed to ASTM International Headquarters. Your comments will receive careful consideration at a meeting of the responsible technical committee, which you may attend. If you feel that your comments have not received a fair hearing you should make your views known to the ASTM Committee on Standards, at the address shown below.

This standard is copyrighted by ASTM International, 100 Barr Harbor Drive, PO Box C700, West Conshohocken, PA 19428-2959, United States. Individual reprints (single or multiple copies) of this standard may be obtained by contacting ASTM at the above address or at 610-832-9585 (phone), 610-832-9555 (fax), or service@astm.org (e-mail); or through the ASTM website (www.astm.org). Permission rights to photocopy the standard may also be secured from the Copyright Clearance Center, 222 Rosewood Drive, Danvers, MA 01923, Tel: (978) 646-2600; http://www.copyright.com/