



Designation: **B511/B511M—16 B511/B511M – 21**

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~~ 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 are not necessarily exact equivalents; therefore, to ensure conformance with the standard, each system shall be used independently of the other, and values from the two systems shall not be combined.

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~~ safety, health, and ~~health~~ 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:*³
- [B536 Specification for Nickel-Iron-Chromium-Silicon Alloys 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 Test Methods for Tension Testing of Metallic Materials \[Metric\] E0008_E0008M](#)
 - [E29 Practice for Using Significant Digits in Test Data to Determine Conformance with Specifications](#)
 - [E112 Test Methods for Determining Average Grain Size](#)
 - [E1473 Test Methods for Chemical Analysis of Nickel, Cobalt and High-Temperature Alloys](#)

3. Terminology

3.1 The definitions in Terminology [B899](#) are applicable to this specification.

3.2 *Definitions of Terms Specific to This Standard:*

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-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.

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

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

3.2.2 *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**.

7. Mechanical and Other Properties

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

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.

~~Alloy UNS N08332: 0.05–0.10.~~
^B Element shall be determined arithmetically by difference.

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.

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.

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 ⅝ in. [6.5 to 8.0 mm], incl, and for rounds in the size range from ¼ in. [6.5 mm] to approximate ⅝ 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 ⅝	[6.5 to 8.0]	0.005	[0.13]	0.005	[0.13]	0.008	[0.20]
Over ⅝ to ⅞	[8.0 to 11.0]	0.006	[0.15]	0.006	[0.15]	0.009	[0.23]
Over ⅞ to ⅞	[11.0 to 15.5]	0.007	[0.18]	0.007	[0.18]	0.010	[0.26]
Over ⅞ to ⅞	[15.5 to 22.0]	0.008	[0.20]	0.008	[0.20]	0.012	[0.30]
Over ⅞ to 1	[22.0 to 25.0]	0.009	[0.23]	0.009	[0.23]	0.013	[0.34]
Over 1 to 1 ⅛	[25.0 to 28.0]	0.010	[0.25]	0.010	[0.25]	0.015	[0.38]
Over 1 ⅛ to 1 ¼	[28.0 to 31.5]	0.011	[0.28]	0.011	[0.28]	0.016	[0.42]
Over 1 ¼ to 1 ⅜	[31.5 to 34.5]	0.012	[0.30]	0.012	[0.30]	0.018	[0.46]
Over 1 ⅜ to 1 ½	[34.5 to 38.0]	0.014	[0.35]	0.014	[0.35]	0.021	[0.53]
Over 1 ½ to 2	[38.0 to 50.0]	⅙ ₄	[0.40]	⅙ ₄	[0.40]	0.023	[0.60]
Over 2 to 2 ½	[50.0 to 63.0]	⅙ ₃₂	[0.80]	0	[0]	0.023	[0.60]
Over 2 ½ to 3 ½	[63.0 to 90.0]	⅙ ₆₄	[1.20]	0	[0]	0.035	[0.90]
Over 3 ½ to 4 ½	[90.0 to 115.0]	⅙ ₁₆	[1.60]	0	[0]	0.046	[1.20]
Over 4 ½ to 5 ½	[115.0 to 140.0]	⅙ ₆₄	[2.0]	0	[0]	0.058	[1.50]
Over 5 ½ to 6 ½	[140.0 to 165.0]	⅙ ₈	[3.00]	0	[0]	0.070	[1.80]
Over 6 ½ to 8	[165.0 to 200.0]	⅙ 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 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 1 ½, incl	[25.0 to 38.0]	0.021	[0.53]	0.021	[0.53]	0.025	[0.64]
Over 1 ½ to 2, incl	[38.0 to 50.0]	⅙ ₃₂	[0.80]	⅙ ₃₂	[0.80]	⅙ ₃₂	[0.80]
Over 2 to 2 ½, incl	[50.0 to 63.0]	⅙ ₆₄	[1.20]	⅙ ₆₄	[1.20]	⅙ ₆₄	[1.20]
Over 2 ½ to 3 ½, incl	[63.0 to 90.0]	⅙ ₁₆	[1.60]	⅙ ₁₆	[1.60]	⅙ ₁₆	[1.6]

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 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.

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

Specified Widths, in.	Thickness Tolerances, in., for Given Thickness										
	1/8 to 1/2, incl	Over 1/2 to 1, incl	Over 1 to 2, incl	Over 2 to 4, incl		Over 4 to 6, incl		Over 6 to 8, incl		Width Tolerance	
				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

Specified Widths, in.	Thickness Tolerances, [mm], for Given Thickness										
	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		Width Tolerance	
				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 1/2 to 1, incl		[13.0 to 25.0]	0.002	[0.05]	0.002	[0.05]
1 to 1 1/2, incl		[25.0 to 38.0]	0.0025	[0.06]	0.0025	[0.06]
1 1/2 to 4, incl		[38.0 to 100.0]	0.003	[0.08]	0.003	[0.08]

(Note 2)

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]	[mm]
Over 1/2 to 1, incl		[13.0 to 25.0]	0	0.004	[0.10]
Over 1 to 2, incl		[25.0 to 50.0]	0	0.006	[0.15]
Over 2 to 4, incl		[50.0 to 100.0]	0	0.008	[0.20]
Over 4		[100.0]	0	0.010	[0.25]

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: